Sirius Minerals

Phase 2 Site Preparation Works

NYMNPA 60 and 79 Surface Water Drainage Scheme

REP-P10-DNF-CD-001

Rev 1 | 21 December 2016

Job number 234376-00

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Contents

Appendix F

Typical Drainage Details

1 Introduction

1.1 Overview

This document has been prepared on behalf of Sirius Minerals PLC and details the surface water drainage design for the Site Preparation Works at Dove's Nest Farm for Phase 2 construction activity (Phase 2 Works). This is required to discharge conditions 60 and 79 of the North York Moors National Park Authority (NYMNPA) planning permission NYM/2014/0676/MEIA [1].

This report only details the works required at the Dove's Nest Farm site.

The Phase 2 Works comprise:

- General site clearance including tree clearance and scrub clearance, as shown on Arup drawing YP-P10-DNF-CX-009.
- Construction of an acoustic fence/environmental barrier and installation of fencing, gates and security, as shown on Arup drawing YP-P10-DNF-CX-004.
- Excavation and construction of the two tiered working platform with a western upper level at around 204m Above Ordnance Data (AOD) and an eastern lower level at around 200m AOD, as shown in Arup drawing YP-P10-DNF-CX-004.
- Excavation and construction of site roads, as shown on Arup drawing YP-P10-DNF-CX-004.
- Construction of temporary and permanent soil mounds including the environmental screening bund (Bund A) along the western boundary, as shown on Arup drawing YP-P10-DNF-CX-010.
- Construction of surface water drainage, a silt removal facility and an attenuation pond with outfall to an existing drain, as shown on Arup drawing YP-P10-DNF-CD-001.
- Construction of a site compound to the east of the welfare access road.

1.2 Compliance with Conditions

The wording of planning condition 60, and where the necessary material has been provided within the report, is set out in the table below:

NYMNPA 60	**Compliance with Condition 60**
Surface water management at the Doves Nest Farm site during construction shall incorporate measures to slow water flow such that sediment settles out prior to surface water draining from the site into the Sneaton Thorpe Beck. Prior to the commencement of preparatory works the design of the surface water management system at Doves Nest Farm shall be submitted to and agreed in writing by the MPA to ensure it incorporates measures that may be required to prevent sediment entering the Sneaton Thorpe Beck causing harm to the brown trout population present there.	Refer to the Surface Water Management Plan and Construction Risk Assessment and Method Statements in Appendix C.

The wording of planning condition 79, and where the necessary material has been provided within the report, is set out in the table below:

NYMNPA 79	**Compliance with Condition 79**
No development shall take place at Doves Nest Farm until a Surface Water Drainage Scheme for the site, based on sustainable drainage principles and an assessment of the hydrological and hydro-geological context of the development, has been submitted to and approved in writing by the MPA.	Refer to this report and appendices for the surface water drainage scheme. Refer to Sections 2.2, 2.3, 2.4, 2.5 and 2.6.
The drainage strategy must demonstrate that surface water run-off generated up to and including the 1 in 100 critical storm will not exceed the run-off from the undeveloped site following the corresponding rainfall event.	This element of condition 79 does not need to be discharged for the Phase 2 Works because the 1 in 100 critical storm is applicable only to the operational phase. Refer to section 2.2.
The scheme shall include: *Confirmation that the surface water drainage system is to be built first so that it is available to provide the drainage for the construction phase as well as the completed mine head, and is to be in accordance with information provided in the Supplementary Environmental Information report (specifically Section 15 and Appendix C). Details of the surface water drainage system will include a plan for silt management and reduction during the construction phase;*	Refer to the Surface Water Management Plan and Construction Risk Assessment and Method Statements in Appendix C. Refer to sections 1.4, 2.2, 2.3 and 2.6.
The scheme shall include: *In order to construct the settlement facility/facilities some site preparation works have to be undertaken before the settlement facility/facilities are operational - details of temporary silt reduction and management measures shall be included;*	Refer to the Surface Water Management Plan and Construction Risk Assessment and Method Statements in Appendix C. Refer to the Typical Drainage Details in Appendix F
The scheme shall include: *Surface water discharge rates from the impermeable areas of the site are to be limited to greenfield Qbar flows as calculated in Appendix C of the Supplementary Environmental Information report (an overall maximum surface water discharge of 6.5 litres per second per hectare);*	Refer to section 2.6 and Appendix D.
The scheme shall include: *Sufficient attenuation storage for up to and including the 1 in 100 year storm event plus a 30% allowance for climate change, and surcharging the drainage system can be stored on the site without risk to people or property and without overflowing into a watercourse;*	This element of condition 79 does not need to be discharged for the Phase 2 Works because the 1 in 100 critical storm is applicable only to the operational phase. Refer to section 2.2.
The scheme shall include: *Details of the design of the attenuation storage basins;*	Refer to section 2.6 and Appendix F
The scheme shall include: *Details of the outfalls to watercourse(s), including the provision of a penstock, erosion protection measures*	Refer to section 2.6 and Appendix E and F.

and measures to ensure velocities are limited to no more than 0.3m per second unless otherwise agreed by the MPA in consultation with the Environment Agency;	
The scheme shall include: *Details of how the whole surface water drainage system will be designed so as to maximise its biodiversity benefits;*	This element of condition 79 does not need to be discharged for the Phase 2 Works because the final restoration of the site will occur during later phases of the project.
The scheme shall include: *Drainage from the landscaped areas is to drain into the proposed swales, upstream of a check dam where required to reduce velocities;*	Refer to section 2.3.1 and Appendix B, D and F.
The scheme shall include: *Details of the proposed rainwater harvesting system;*	This element of condition 79 does not need to be discharged for the Phase 2 Works because no permanent buildings are to be constructed in this phase.
The scheme shall include: *The provision of permeable surfacing on areas where it can be demonstrated that the risk of pollution is low;*	This element of condition 79 does not need to be discharged for the Phase 2 Works because no permanent permeable surfacing is proposed during the Phase 2 Works.
The scheme shall include: *Details of how clean roof water shall be discharged to ground;*	This element of condition 79 does not need to be discharged for the Phase 2 Works because no permanent buildings are to be constructed in this phase.
The scheme shall include: *Details of how the entire surface water drainage system will be maintained and managed throughout the lifetime of the development, including the construction phase. This must include details of maintenance to deal with any siltation of the attenuation storage basins and any resultant loss of capacity; and*	Refer to the Surface Water Management Plan in Appendix C.
The scheme shall include: *A timetable for the implementation of the Surface Water Drainage Scheme, including during the construction phase. This is to include details regarding the phasing of the construction works demonstrating that the storage available during construction is maximised (i.e. that the period of time that only the minimum 1 in 20 standard of protection is kept to the shortest possible).*	Refer to the Surface Water Management Plan and Construction Risk Assessment and Method Statements in Appendix C. Refer to section 2.6.
Development shall thereafter proceed only in strict accordance with the approved Surface Water Drainage Scheme and the timetable included within it. Once implemented, the Surface Water Drainage Scheme shall be retained and maintained throughout the lifetime of the development such that it continues to function in the manner intended and so as to ensure identified limits are not breached.	Refer to the Surface Water Management Plan and Construction Risk Assessment and Method Statements in Appendix C.

1.3 Site and Location

The Dove's Nest Farm site is located approximately 5 km south of Whitby bounded by the B1416 to the West/South. The site is located in the River Esk catchment and at the very upper reaches of the Sneaton Thorpe Beck.

1.4 Other Documents Key to this Report

BWB undertook the Baseline Surface Hydrology report, Ref: LDT/2021/BSH [2]. This has been used to inform the surface water drainage (SWD) design. The SWD design follows the principles set out in the Surface Water Drainage Design Parameters report, Ref: LDT/2021/SWDS [3] and the Surface Water Drainage - Design Basis Report for Dove's Nest Site, Ref: REP-P2-CD-001 [4]. The design has been developed in parallel with the masterplan for the site which is shown in Appendix A, *"Dove's Nest Farm Construction Phase 2 Masterplan YP-P10-DNF-CX-004"*.

1.5 Design Guidance

The design standards and guidance used in the SWD design for the site include:

- Sewers for Adoption (7th Edition, 2012).
- BS EN 752 Drains and sewer systems outside buildings.
- DEFRA, Rainfall runoff management for developments – Report SC030219.
- Technical Guidance to National Planning Policy Framework (NPPF).
- Design Analysis of urban storm drainage – The Wallingford Procedure.
- CIRIA Report C697, The SuDS Manual, 2007.
- CIRIA Report C609, Sustainable Drainage Systems – Hydraulic, Structural and water quality advice, 2004.
- CIRIA Book 14, The Design of Flood Storage Reservoirs, 1993.
- CIRIA Report 156, Infiltration Drainage – Manual of Good practice, 1996.
- Environment Agency and Department for Environment, Food & Rural Affairs, Pollution prevention for businesses, 12 July 2016.
- BRE Digest 365, Soakaway Design 2012.
- Environment Agency Guidance on Outfalls: Flood Defence Information Sheet No. 3.
- Fluvial Forms and Processes, A New Perspective, David Knighton, 1998.
- Open-channel hydraulics: New York, McGraw-Hill, Chow, V.T., 1959.

2 Phase 2 Works Surface Water Drainage Design

2.1 General Arrangement

The masterplan for the Phase 2 Works (YP-P10-DNF-CX-004) is included in Appendix A.

2.2 Design Principles

The SWD has been designed to drain the hard standing areas, the landscaped areas and the access road, so that the development does not increase flood risk to the surrounding area and manages flood risk at the site. To help minimise runoff from bare ground and to reduce any possible siltation of watercourses, the SWD will be one of the first construction activities. Refer to the Surface Water Management Plan in Appendix C for more details of the construction programme.

Where the potential for contamination of surface water runoff by hydrocarbons has been assessed to be sufficiently high, the surface water runoff from these areas will pass through an oil separator before being passed first to a silt removal facility then to an attenuation pond, before discharging into the local watercourse.

The runoff from developed and disturbed areas will be directed to the attenuation ponds. These include hard standing areas; disturbed soils; granular access road and, due to the natural slope of the ground, some of the undisturbed vegetated permeable areas. One small section of the access road near the welfare entrance cannot gravitate to the attenuation ponds, and as such will be treated locally before discharging to the tributaries of Sneaton Thorpe Beck. This is described further in the Surface Water Management Plan in Appendix C and the technical note for the highways work at the welfare entrance (reference TN-P10-DNF-CH-001) [5].

The surface water runoff from temporary spoil bunds will be controlled by the aid of swales with check dams and silt fencing. There will be silt fences positioned in the fields downstream of these swales to intercept, slow and treat any water that seeps over the edge of the swales to mimic a ‘natural’ response and avoid surface water ‘sheeting’ off the slopes. This runoff would eventually find its way into existing perimeter ditches at the boundary of the site and then into the tributaries of Sneaton Thorpe Beck. The locations of these drainage features are shown on the Surface Water Drainage General Arrangement drawing YP-P10-DNF-CD-001 in Appendix B.

For the impermeability values used in the design for the different area types, refer to table 2.0. These values are conservative and have been derived using the surface water drainage design basis report, (reference REP-P2-CD-001) [4], which is in accordance with BS EN 752.

Table 2.0: Specific Impermeability for area types

Area	Percentage Impermeable
Hard standing	100%
Disturbed bare soils	80%
Granular Access Road	80%
Landscaped Bunds	30%
Undisturbed Fields/grass	30%

Only surface water runoff is to be directed to the attenuation ponds, other sources of water, such as ground water and waste water, will not discharge to the attenuation ponds.

During the Phase 2 Works, the discharge rate from all the drained areas on site will be limited to the theoretical Q_{Bar} greenfield runoff rate for return periods up to the 1 in 20 year event for the critical duration. This is in accordance with the sustainable drainage principles outlined in the Surface Water Drainage Design Parameters report, (reference: LDT/2021/SWDS) [3] and has been agreed by the Environment Agency in a letter dated 13th March 2014 (reference: RA/2014/127863/01-L01). During the operational phase, the discharge rate will be limited to the theoretical Q_{Bar} greenfield runoff rate for return periods up to the 1 in 100 year event for the critical duration.

The sequencing and timescales of constructing the drainage during the Phase 2 Works is summarised in the Surface Water Management Plan in Appendix C.

2.3 Drainage Features

A drainage plan for the Dove's Nest Farm site has been developed. The drainage plan shows principal drainage infrastructure for the drained areas during Phase 2, including silt fences, swales, ditches, carrier pipes, oil separators, a silt removal facility and an attenuation pond.

Refer to the general arrangement drawing, *"YP-P10-DNF-CD-001 Dove's Nest Farm Surface Water Drainage General Arrangement"* in Appendix B for the location of the principal proposed SWD features.

Appendix F contains typical details of drainage features such as swales, ditches, check dams, the silt removal feature and the attenuation pond.

2.3.1 Swales/Ditches

Swales and ditches will be used to collect surface water runoff at the toe of the landscaping bunds and around the perimeter of the hard standing platform.

They will incorporate check dams to create a terraced ponding effect, thus helping to attenuate the flow. Energy dissipation / erosion protection will be provided where required, downstream of the check dams across both the base and sides of the swale/ditch. Where possible, swales/ditches that are not located next to hard standing will incorporate a 3.5m wide access route to allow maintenance vehicles to access these assets.

Swales/ditches will also be used to intercept any runoff from undisturbed areas so that this water does not flow onto disturbed areas of the construction. Where possible, these swales/ditches will direct the runoff to local ditches/streams without going through attenuation ponds in order to mimic the natural and existing hydraulic characteristics of the site. Refer to the general arrangement drawing in Appendix B.

2.3.2 Silt Removal Facility

The silt removal facility will incorporate a long flat treatment ditch designed to settle out fine sediments that get past the silt fences and check dams. The ditch will be lined with concrete canvas or similar to enable easier dredging operations and will have a control valve on the outlet, so that dredging can be undertaken without sediment laden water escaping downstream to the attenuation pond.

2.3.3 Attenuation Pond

Following a review of the drainage scheme, a new location has been selected for the surface water ponds that attenuate run-off from the shaft sinking platform at the minehead site. The new location offers several advantages over the location proposed in the planning application. These are summarised below:

- The ponds are closer to, and discharge to, larger tributaries of Sneaton Thorpe Beck than the previous scheme, providing a closer match to the current hydrological regime.
- The new location avoids the need to divert an overhead electricity cable.
- The new location avoids the need to fell mature trees.
- Site investigation has shown clay to a depth of approximately 4m, and a groundwater level at approximately 3m depth. The groundwater level in the previous location was close to the ground surface, meaning that the ponds were to be predominantly above the existing ground level, impounded by raised embankments. In the new proposed location, the ponds can be excavated into the landscape to a larger degree. This will ease construction and help to blend them into the surrounding landscape. It also means the same volume of storage can be achieved by a smaller pond footprint.

During Phase 2, one attenuation pond will be constructed and will receive surface water flows from the hard standing and landscaped areas of the site as described in section 2.2. The location of the pond is shown on the layout in Appendix B.

The pond has capacity to store rainfall runoff such that no surface flooding occurs on the site during the 1 in 20 year design critical rainfall event. If a rainfall event exceeds the design capacity, an emergency overflow will be incorporated to allow water to discharge from the pond without compromising its integrity.

As stated in the planning conditions and as agreed with the Environment Agency in a letter dated 13th March 2014 (reference: RA/2014/127863/01-L01), during construction, the discharge rate from the attenuation pond will be limited to the Q_{Bar} greenfield runoff rate for return periods up to the 1 in 20 year event for the critical duration. The method of calculating Q_{Bar} is detailed in the BWB Baseline Surface Hydrology report, Ref LDT/2021/BSH. [2].

2.3.4 Additional Sediment Control

In addition to the silt removal facility, attenuation pond, swales / ditches and check dams, there will be further sediment control techniques and features such as silt fences at the toe of the bare landscaped bunds. These features will be maintained throughout the Phase 2 Works to ensure the silt runoff is managed appropriately. Further details can be found in the Surface Water Management Plan in Appendix C.

2.3.5 Oil Separators

Oil separators will be provided on all SWD systems installed to collect and convey runoff from hard standing areas. The separators will be designed in accordance with the Environment Agency's Pollution prevention for businesses guidance. The locations of the separators are shown on the general arrangement drawing in Appendix B.

2.3.6 Flow control

The discharge from the pond into the watercourse will be controlled by a flow control device such as an orifice plate or vortex flow control device (e.g. Hydrobrake), which will be installed during the Phase 2 Works. These can be easily modified or replaced as and when required throughout subsequent phases of construction to maintain the required design standard, i.e. a maximum allowable rate of discharge equating to 6.5 litres per second per hectare.

2.3.7 Outfall

A temporary outfall from the attenuation pond will comply with the Environment Agency typical design requirements to ensure that it does not create an obstruction or jeopardise the stability of the banks of the watercourse. Land Drainage Consent will be obtained for any new structures in watercourses.

The outfall will discharge to the upstream tributaries of Sneaton Thorpe Beck, as shown on the general arrangement drawing in Appendix B. During later phases this temporary outfall will be removed and an additional pond and permanent outfall arrangement will be constructed downstream.

2.4 Groundwater

There will be no permanent ground water discharges to the proposed SWD attenuation features. On impermeable networks, where some drainage features are required below normal ground water level, liners will be used to exclude ground water from the SWD system.

All the landscaping and temporary spoil bunds will be surrounded by swales. The swales will have check dams to attenuate the runoff during rainfall events and help to settle out sediments. Although no positive infiltration will be provided, over time some of this water will infiltrate into the superficial deposits.

2.5 Calculation Methodology

The Phase 2 Works layout for the Dove's Nest Farm site has been assessed and the required attenuation volumes calculated. The results are shown in section 2.6.

The allowable rate of discharge from the pond has been calculated for the Phase 2 Works based on the Q_{Bar} greenfield runoff rate for the total contributing area.

For the Phase 2 Works, a 1 in 20 year return period design storm with no climate change allowance has been applied to a MicroDrainage model of the proposed network. Simulations have been undertaken using a range of durations from 15 minutes to 7 days to determine the critical duration for each part of the network to ensure no flooding occurs and the attenuation is sufficient.

2.6 Calculation Results

The MicroDrainage model outputs in Appendix D demonstrate that the design described in this report meets the requirements set out in the planning conditions [1]. In particular the discharge rate from the developed areas has been limited to the Q_{Bar} greenfield runoff rate and the volume of attenuation provided is sufficient to attenuate flows up to the 1 in 20 year return period event.

Runoff Rates

The allowable Q_{Bar} greenfield runoff rate is 6.5 l/s/ha, based on the Baseline Surface Hydrology report [2].

The flow rate is controlled by a flow control device at the outlet of the attenuation pond. Table 2.1 summarises the modelling outputs in Appendix D.

	Attenuation Pond	**Refer to:**
Gross Area drained	8.75 hectares	Appendix D, Area Summary table
Allowable Runoff Rate	6.5 x 8.75 = 56.9 l/s	
Maximum modelled runoff rate	56.6l/s	Appendix D, critical results by maximum level for Pipe S1.019.

Table 2.1 Summary of modelled Runoff Rates

Volume of Attenuation

A summary of the MicroDrainage modelling results are shown in Table 2.2 and the modelling outputs are shown in Appendix D.

	Attenuation Pond	**Refer to:**
Required Volume in MicroDrainage model	1400 m^3	Appendix D, Graphs for Pipe S1.019
Volume provided by proposed Phase 2 Earthworks Design	4900 m^3	Appendix F, Attenuation pond plan and sections.

Table 2.2 Summary of modelled attenuation volume requirements

The attenuation pond provided in the earthworks design has a sufficient storage volume to attenuate the flow to the allowable runoff rate. The attenuation pond is over 3 times the size it needs to be for the Phase 2 Works.

Silt Removal

As stated in the Surface Water Drainage Design Parameters report, Ref: LDT/2021/SWDS [3], a minimum of 3 stages of treatment have been provided to minimise the risk of sediments entering the tributaries of Sneaton Thorpe Beck. The design in Phase 2 incorporates; swales and ditches with check dams, infiltration to ground, oil separators with silt traps, a silt removal facility and an attenuation pond.

Calculations have been carried out to estimate the percentage removal of sediments in both the Silt Removal Facility and the Attenuation Pond using the 1 in 20 year critical duration storm event. CIRIA Book 14, Chapter 6.5, "Estimating Pollutant Removal Efficiency" was used for this calculation. A summary of the results are shown in the table below. The calculations are provided in Appendix E.

Particle	Settling velocities (mm/s)	% Removal in Silt Removal Facility	% Removal in Attenuation Pond
Coarse Sand	200	100%	
Fine Sand	22	100%	
Coarse Silt	6.7	100%	
Fine Silt	0.18	100%	
Coarse Clay	0.016	15%	100%
Fine Clay	0.011	10%	78%

Table 2.3 Summary of Silt Removal Calculations

All the sands and all the silts are shown to drop out in the silt removal facility before reaching the attenuation pond. Approximately 90% of all clays would drop out before discharging to the watercourse. These calculations are conservative as they do not take into account the additional settlement that would occur in the swales, the oil separator, behind the silt fences and in the check dams. The calculations are also conservative because they use the maximum flow rates generated during the critical duration storm.

In large events such as the 1 in 20 year critical duration storm sediment erosion and transportation would be expected in the existing tributaries. Therefore, removal of 90% clays and 100% of larger particles in the 1 in 20 year storm is considered acceptable.

Outfall Velocities

There are three temporary outfalls in the Phase 2 Works as shown on drawing YP-P10-DNF-CD-001 Dove's Nest Farm Surface Water Drainage General Arrangement in Appendix B. Two of these outfalls are simply conveying the runoff from one side of the access road to the other to maintain the existing drainage paths. The catchments discharging to these two outfalls will not be affected by the works carried out in Phase 2. Apart from constructing ditches to

intercept the runoff, the soil in these catchments will not be disturbed. The interception ditches would be culverted in a pipe below the access road and outfall into existing ditches on the site which then flow into the tributaries of Sneaton Thorpe Beck. As there is very little change to the current drainage regime, no disturbed soil apart from the ditch creation and as these two outfalls are not going to be used in the subsequent phases, velocity calculations were not undertaken for these two outfalls.

The third temporary outfall in the Phase 2 Works that discharges the runoff from all the works areas is located downstream of the attenuation pond and outfalls to a tributary of Sneaton Thorpe Beck. During later phases this outfall will be removed and an additional pond and outfall will be constructed downstream of this pond. Appendix E contains an assessment and calculations specific to this temporary outfall.

The calculations suggest a maximum allowable velocity of 1.2m/s would be appropriate for this outfall location.

The MicroDrainage model results in Appendix D show a maximum velocity of 0.8m/s at the outfall during the 1 in 20 year critical duration storm event.

To achieve this velocity, the outfall would have a stilling basin/up-stand incorporated in the headwall. Additional erosion protection in the tributary would not be required based on the low velocities generated by the discharge.

3 Conclusions

The design demonstrates how the surface water will be managed on site during the Phase 2 Works. The proposed arrangements will ensure that the site is not at risk of flooding and does not impact on flood risk elsewhere.

The MicroDrainage model outputs demonstrate that the design described in this report meets the requirements set out in the planning conditions. In particular the discharge rates from the developed areas have been limited to the Q_{Bar} greenfield runoff rates and the volume of attenuation provided is sufficient to attenuate flows up to the 1 in 20 year return period event.

The design complies with the sustainable drainage strategy. In particular an appropriate treatment train is proposed and the calculations demonstrate that the provision for sediment removal is sufficient prior to discharging to the watercourse and that the outfall velocity is appropriate to minimise the impact on the receiving water body.

This report demonstrates that the SWD design and management during the Phase 2 Works meets the requirements of conditions 60 and 79 of the North York Moors National Park Authority (NYMNPA) planning permission NYM/2014/0676/MEIA.

The necessary land drainage consents will be applied for from North Yorkshire County Council ahead of the works.

References

[1] North York Moors National Park Authority planning permission NYM/2014/0676/MEIA.

[2] Baseline Surface Hydrology, Ref LDT/2021/BSH, Revision F, BWB, 11/09/2014.

[3] Surface Water Drainage Design Parameters, Ref LDT/2021/SWDS, Revision D, BWB, 12/09/2014.

[4] Surface Water Drainage - Design Basis Report for Dove's Nest Site, REP-P2-CD-001, Rev 3, Arup, July 2014.

[5] Highway Improvement 2: Dove's Nest Farm Welfare Access B1416. Technical Note, TN-P10-DNF-CH-001, Rev A, Arup, November 2016.

Appendix A

Site Preparation Phase 2 Masterplan

A1

Safety bunds to be constructed.

Environmental screening bund, to be constructed with topsoil, subsoil and superficial soils from existing temporary mounds.

Security cabin to be provided at the site access junction.

For section details refer to drawing YP-P10-DNF-CX-005.

Proposed acoustic fence / environmental barrier.

Land ownership boundary

Attenuation pond with volume of 5,000m³.

Slit separation facility is to be provided to treat the surface water runoff before outfalling into the attenuation pond.

Proposed location for site preparation contractors temporary site compound located within and around the existing farm buildings. No demolition works to be undertaken.

Security cabin to be provided at the site access.

Key:

- Land ownership boundary
- Construction Phase Security Fence
- Temporary Heras Fence
- Topographical survey
- Proposed layout
- 3m high Environmental / acoustic barrier
- Safety Bund
- Proposed drainage ditch

Key to utilities:

- HV — Existing Northern Powergrid electrical apparatus

Wind Rose:

Issue	Date	By	Chkd	Appd
1	15/12/16	JB	CW	AH
	Issue			
0	08/12/16	JB	CW	AH
	Issue			
C	02/12/16	JB	CW	AH
	Draft			
B	25/11/16	JB	CW	AG
	Draft			
A	11/11/16	JB	CW	AH
	Draft			

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Client
Sirius Minerals Plc

Job Title
York Potash
Site Preparation
Redesign

Dove's Nest Farm
Construction Phase 2
Masterplan

Scale at A1 1:2000

Discipline Highways

Job No **234376**

Drawing Status **Issue**

Drawing No **YP-P10-DNF-CX-004**

Issue **1**

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Do not scale

Appendix B

Site Preparation Phase 2
Drainage Layout

A1

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Temporary bund with silt fence swales and check dams.

Secondary silt fences to capture overflow from temporary swales.

Tributary of Sneaton Thorpe Beck where additional temporary silt control measures are able to be installed.

Landscape bund.

Silt fence.

Overflow from swale.

Swale with check dams around landscaped bund.

Temporary bund with silt fence swales and check dams.

Perimeter ditch around platforms.

Temporary outfall to tributary of Sneaton Thorpe Beck.

Surface water attenuation pond. Refer to drawing YP-P10-DNF-CD-020.

For continuation see inset plan

Oil separators.

Silt removal facility. Refer to drawing YP-P10-DNF-CD-025.

Phase 2 platforms.

Temporary ditch with check dams.

Oil separators.

Tributary of Sneaton Thorpe Beck where additional temporary silt control measures are able to be installed.

Temporary outfall to existing ditch to maintain existing drainage paths.

Ditch to intercept run-off and direct it to watercourse.

Temporary outfall to existing ditch to maintain existing drainage paths.

Ditch with check dams to drain access road.

Access road.

Ditch to intercept run-off and direct it to watercourse.

Existing stream to be culverted under access road to maintain existing drainage paths.

Tributary of Sneaton Thorpe Beck where additional temporary silt control measures are able to be installed.

Ditch to intercept run-off and direct it to watercourse.

Existing stream to be culverted under access road, to maintain exisiting drainage paths.

Sneaton Thorpe Wood

Sneaton Thorpe Beck

Drain

Issues

Inset Plan

Notes:

1. The surface water drainage has been coordinated with Earthworks contours dated November 2016.
2. This drawing shows the proposed surface water drainage network for Site Preparation Phase 2.
3. For surface water drainage features refer to drawings YP-P10-DNF-CD-020 to 025.
4. The perimeter ditches around the platforms are to be lined with an impermeable liner.

Key:

- Land Ownership Boundary
- Proposed General Arrangement layout
- Surface water drainage attenuation pond
- Existing watercourses / ditch
- Manhole and carrier pipe
- Swale
- Check dam
- Silt fence
- Ditch
- Inlet/ outlet headwall

Issue	Date	By	Chkd	Appd
1	19/12/16	SM	NF	AH
	Issue			
0	15/12/16	JB	NF	AH
	Issue			
C	07/12/16	JB	NF	AH
	Discharge Planning			
B	02/12/16	EC	NF	AH
	Discharge Planning			
A	01/12/16	SM	NF	AH
	Discharge Planning			

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Client
Sirius Minerals Plc

Job Title
York Potash

Surface Water Drainage General Arrangement

Scale at A1
1:2000

Discipline
Drainage

Job No
234376

Drawing Status
Issue

Drawing No
YP-P10-DNF-CD-001

Issue
1

Do not scale

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Appendix C

Surface Water Management Plan

Sirius Minerals

Phase 2 Site Preparation Works

NYMNPA 60 and 79: Surface Water Management Plan

REP-P10-DNF-CD-002

Rev 1 | 21 December 2016

Job number 234376-00

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Document Verification

ARUP

Job title		Phase 2 Site Preparation Works		**Job number** 234376-00
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Document ref		REP-P10-DNF-CD-002		
Revision	**Date**	**Filename**	REP-P10-DNF-CD-002 Phase 2 Surface Water Management Plan Rev 0.docx	
Rev 0	20 Dec 2016	**Description**	First Issue	
			Prepared by	Checked by	Approved by
		Name	N Ferro	D Ainger	A Hornung
		Signature			
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		Description	Section 2 amended following client review	
			Prepared by	Checked by	Approved by
		Name	Nick Ferro	D Ainger	A Hornung
		Signature			
		Filename		
		Description		
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename		
		Description		
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

1 Surface Water Management Plan (Phase 2)

There are a range of methodologies for managing sediment contaminated surface water runoff from construction sites, with the method used being dependent on the volumes of surface water runoff and the levels of sedimentation. The surface water drainage masterplan for Site Preparation Phase 2 is shown on drawing YP-P10-DNF-CD-001. This drawing shows the location of the main drainage network and the features to manage sediment. Typical details of the drainage features are shown on drawings YP-P10-DNF-CD-020 to 025.

As far as practicable, surface water runoff from areas of hard standing will be kept separate from those areas where sediment contaminated surface water runoff is anticipated. While runoff from areas of hard standing is not anticipated to generate large quantities of sediment, this surface water will be collected in hard standing perimeter ditches with check dams and passed through oil separators, a silt removal facility and attenuation storage before being discharged to the tributaries of Sneaton Thorpe Beck. Surface water runoff from permanent landscaped bunds or spoil that is being stored for a long time will be controlled by the aid of swales with check dams and cleansed with hay/heather bales and silt fencing before being passed through the same treatment train of silt removal and attenuation.

The drainage of the main access road connecting the welfare entrance and the platform will combine with the drainage from the platform and drain through the treatment train. There is a short section of the access road near the welfare entrance that cannot gravitate to the main attenuation pond. For this section of the access road, local measures will be applied similar to the treatment methodology described in the Technical Note TN-P10-DNF-CH-001 Rev B for the highways work at the welfare entrance.

Surface water runoff from temporary spoil bunds will be controlled by the aid of swales with check dams and cleansed with hay/heather bales and silt fencing. There will be multiple secondary silt fences positioned in the fields downstream of these swales to intercept, slow and treat any water that seeps over the edge of the swales to mimic a more ‘natural’ response and avoid surface water ‘sheeting’ off the slopes. This runoff would eventually find its way into existing perimeter ditches at the boundary of the site and then into the tributaries of Sneaton Thorpe Beck.

The discharge from the attenuation pond will be monitored for suspended solids, using a combination of visual monitoring and turbidity meter monitoring in accordance with the Groundwater and Surface Water Monitoring Scheme, condition NYMNPA 46. If the trigger levels are exceeded the appropriate plan of action will be implemented in accordance with the remedial action plan condition NYMNPA 46. Depending on the results a number of options are available:

The penstock on the attenuation pond can be temporarily closed or partially closed to temporarily reduce the flow to the watercourse and increase the retention time to allow the sediments to settle out. This will be particularly effective for short

intense storms. The proposed pond to be constructed in Site Preparation Phase 2 has more than enough storage to meet the design attenuation requirements for this stage of construction. As such these temporary measures can be put in place without compromising the overall drainage strategy for Phase 2. This would be actively managed so that the pond is empty before the next storm event occurs.

Additional treatment such as hay/heather bales and silt fences could be put in place in the tributaries of Sneaton Thorpe Beck downstream of the pond outfall location but still within the site boundary. An experienced drainage engineer or geomorphologist will supervise the placement of these features to maximise sediment removal. These additional treatments will be readily available and stored local to the beck, should the need arise.

An environmentally friendly coagulant can be used in specific check dams upstream of the silt removal facility to promote flocculation of the finer particles within the storage areas and speed up the settling rate.

In addition to inspections of the pond discharge, regular monitoring of the tributaries of Sneaton Thorpe Beck will be undertaken, as detailed in the Groundwater and Surface Water Monitoring Scheme, to ensure that the discharge is not causing discoloration, erosion of the bank or disturbance of the bed of the watercourse. Records of all monitoring will be kept along with actions that were taken in the event of issues arising.

During Phase 2 all permanent landscaped bunds and temporary spoil bunds will be grass seeded as soon as practicable to ensure that sediment laden surface water runoff from is minimised. Erecting silt fences at source around these spoil bunds, in combination with swales and check dams is the main method to prevent siltation getting into the drainage system. Silt fences will be installed to manufacturer's recommendations (such as http://www.geofabrics.co.nz/media/2910/silt-fence-installation.pdf).

The silt fences and check dams will be monitored through regular surveys. If silt builds up and 30% of the available storage is used up, then scraping, dredging or emptying and re-profiling will be undertaken to ensure the full storage volume is maintained.

The silt removal facility and attenuation storage will be monitored through regular surveys. If silt builds up to a depth of 200mm then scraping, dredging or emptying and re-profiling will be undertaken to ensure the full storage volume is maintained.

Throughout Site Preparation Phase 2, the surface water drainage system will be inspected on a daily basis to ensure that it is in good working order and when necessary all pipework, swales and other drainage elements, such as the oil separators and flow control devices, shall be cleaned out to guarantee unobstructed flow and prevent build-up of sediment. Any extracted sediment will be redistributed thinly over the works area to dry out and become integrated into the landscaping.

Due to the nature of the works, and their phasing, the drainage arrangements will alter during construction and as a result, the Surface Water Management Plan will

be a live and flexible document. While the attenuation pond will be sized to take account of storm events, the flexibility of the Plan will also allow rapid response to weather conditions and unexpected events.

The timescales and construction methods for this work are summarised below.

2 Surface Water Drainage – Sequence of Works

The order in which the proposed surface water drainage measures are implemented will have a bearing on the protection of Seaton Thorpe Beck; the surface water drainage will be constructed, in general, working from the downstream end towards the upstream end. The following sequencing will be undertaken (start date on site of 03/04/17 is assumed).

- (03/04 to 05/04) Secondary silt fences will be constructed downstream of the working area and within the Seaton Thorpe Beck Tributary.
- (03/04 to 05/04) - A settlement basin will be established downstream of the eastern attenuation pond to prevent discharge into the Sneaton Thorpe Beck Tributary ahead of the discharge consent being in place.
- (03/04 to 07/04) The drainage ditches along the route of the access road will be established, with check dams installed for de-silting purposes. Excavation works for the access road will not commence until the perimeter ditches have been formed, with check dams installed for de-silting purposes
- (03/04 to 07/04) Culvert pipes and headwalls will be installed to maintain existing watercourses that cross the route of the access road.
- (06/04 to 12/04) The eastern attenuation pond will be constructed during a dry period to prevent silt run-off during construction of this element of the scheme.
- (13/04 to 18/04) The proposed silt removal facility will be constructed and a carrier drain installed to connect this with the attenuation pond.
- (17/04 to 21/04) Before starting works to the platforms, the proposed perimeter ditches, plus ditch to the silt removal facility, will be established, with check dams installed for de-silting purposes.
- (24/04 to 05/05) The proposed oil interceptors will be installed.
- (24/04 to 28/04) Swales with silt fences will be constructed to the perimeter of all earth bunds.
- Check dams and silt fences will be inspected weekly and de-silting will be undertaken as required.
- De-watering of excavations and working areas will be undertaken using submersible pumps with discharge directed into the silt removal facility or a suitable area within the site upstream of this.

Appendix D

Micro Drainage Model Outputs

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.283	0.283	0.283
1.001	User	-	30	0.016	0.005	0.005
	User	-	100	0.031	0.031	0.036
1.002	User	-	30	0.028	0.008	0.008
	User	-	100	0.129	0.129	0.138
1.003	User	-	100	0.052	0.052	0.052
1.004	User	-	100	0.062	0.062	0.062
1.005	User	-	100	0.055	0.055	0.055
2.000	User	-	100	0.079	0.079	0.079
	User	-	30	0.044	0.013	0.092
2.001	User	-	100	0.090	0.090	0.090
	User	-	30	0.079	0.024	0.114
3.000	User	-	30	0.083	0.025	0.025
3.001	User	-	30	0.163	0.049	0.049
3.002	User	-	30	0.104	0.031	0.031
4.000	User	-	30	0.138	0.041	0.041
4.001	User	-	30	0.106	0.032	0.032
4.002	User	-	30	0.049	0.015	0.015
4.003	User	-	30	0.042	0.013	0.013
4.004	-	-	100	0.000	0.000	0.000
4.005	-	-	100	0.000	0.000	0.000
4.006	User	-	30	0.087	0.026	0.026
3.003	-	-	100	0.000	0.000	0.000
2.002	User	-	100	0.061	0.061	0.061
	User	-	30	0.074	0.022	0.083
2.003	User	-	100	0.046	0.046	0.046
2.004	User	-	100	0.047	0.047	0.047
2.005	User	-	100	0.036	0.036	0.036
2.006	User	-	100	0.174	0.174	0.174
2.007	User	-	100	0.224	0.224	0.224
2.008	User	-	100	0.136	0.136	0.136
2.009	User	-	100	0.174	0.174	0.174
2.010	User	-	100	0.175	0.175	0.175
2.011	User	-	100	0.066	0.066	0.066
2.012	User	-	100	0.149	0.149	0.149
2.013	User	-	100	0.272	0.272	0.272
2.014	User	-	100	0.232	0.232	0.232
1.006	User	-	100	0.035	0.035	0.035
	User	-	100	0.184	0.184	0.218
5.000	User	-	100	0.034	0.034	0.034
5.001	User	-	100	0.032	0.032	0.032
5.002	User	-	100	0.089	0.089	0.089
5.003	-	-	100	0.000	0.000	0.000
5.004	-	-	100	0.000	0.000	0.000
6.000	User	-	30	0.011	0.003	0.003
6.001	User	-	30	0.028	0.008	0.008
6.002	User	-	30	0.033	0.010	0.010
6.003	User	-	30	0.017	0.005	0.005
6.004	User	-	30	0.036	0.011	0.011
6.005	User	-	30	0.047	0.014	0.014
6.006	User	-	30	0.030	0.009	0.009
6.007	User	-	30	0.009	0.003	0.003

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
7.000	User	-	30	0.043	0.013	0.013
7.001	User	-	30	0.052	0.016	0.016
7.002	User	-	30	0.038	0.011	0.011
7.003	User	-	30	0.018	0.005	0.005
	User	-	30	0.010	0.003	0.008
6.008	User	-	30	0.016	0.005	0.005
6.009	User	-	30	0.026	0.008	0.008
6.010	User	-	30	0.085	0.026	0.026
6.011	User	-	30	0.050	0.015	0.015
8.000	User	-	30	0.019	0.006	0.006
8.001	User	-	30	0.017	0.005	0.005
8.002	User	-	30	0.079	0.024	0.024
8.003	User	-	30	0.042	0.013	0.013
8.004	User	-	30	0.041	0.012	0.012
6.012	-	-	100	0.000	0.000	0.000
5.005	User	-	100	0.127	0.127	0.127
5.006	User	-	100	0.052	0.052	0.052
5.007	User	-	100	0.048	0.048	0.048
5.008	User	-	100	0.049	0.049	0.049
5.009	User	-	100	0.044	0.044	0.044
5.010	User	-	100	0.050	0.050	0.050
5.011	User	-	100	0.042	0.042	0.042
5.012	User	-	100	0.052	0.052	0.052
5.013	User	-	100	0.060	0.060	0.060
5.014	User	-	100	0.053	0.053	0.053
5.015	User	-	100	0.050	0.050	0.050
5.016	User	-	100	0.064	0.064	0.064
5.017	User	-	100	0.070	0.070	0.070
5.018	User	-	100	0.080	0.080	0.080
5.019	User	-	100	0.121	0.121	0.121
5.020	User	-	100	0.052	0.052	0.052
1.007	User	-	100	0.021	0.021	0.021
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
1.010	-	-	100	0.000	0.000	0.000
9.000	User	-	100	0.029	0.029	0.029
9.001	User	-	100	0.050	0.050	0.050
9.002	User	-	100	0.078	0.078	0.078
9.003	User	-	100	0.124	0.124	0.124
9.004	User	-	100	0.210	0.210	0.210
9.005	User	-	100	0.297	0.297	0.297
9.006	User	-	100	0.450	0.450	0.450
10.000	User	-	100	0.030	0.030	0.030
10.001	User	-	100	0.021	0.021	0.021
10.002	User	-	100	0.342	0.342	0.342
9.007	User	-	100	0.471	0.471	0.471
	User	-	100	0.339	0.339	0.810
9.008	-	-	100	0.000	0.000	0.000
9.009	-	-	100	0.000	0.000	0.000
1.011	-	-	100	0.000	0.000	0.000
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.000	0.000	0.000

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.014	-	-	100	0.000	0.000	0.000
1.015	-	-	100	0.000	0.000	0.000
1.016	-	-	100	0.000	0.000	0.000
1.017	-	-	100	0.000	0.000	0.000
1.018	User	-	100	0.106	0.106	0.106
1.019	User	-	100	0.458	0.458	0.458
1.020	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				8.746	7.513	7.513

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	20	F (1km)	2.381	Maximum Backdrop Height (m)	1.500
Site Location		Maximum Rainfall (mm/hr)	100	Min Design Depth for Optimisation (m)	1.200
C (1km)	-0.022	Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
D1 (1km)	0.374	Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
D2 (1km)	0.409	Volumetric Runoff Coeff.	0.750		
D3 (1km)	0.270	Add Flow / Climate Change (%)	0		
E (1km)	0.288	Minimum Backdrop Height (m)	0.200		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S1.000	23.185	0.250	92.7	0.283	5.00	0.0	0.020	1.5	_/	1000	
S1.001	60.605	0.350	173.2	0.036	0.00	0.0	0.020	1.5	_/	1000	
S1.002	36.000	0.225	160.0	0.138	0.00	0.0	0.020	1.5	_/	1000	
S1.003	30.000	0.188	159.6	0.052	0.00	0.0	0.020	1.5	_/	1000	
S1.004	30.000	0.188	159.6	0.062	0.00	0.0	0.020	1.5	_/	1000	
S1.005	25.500	1.800	14.2	0.055	0.00	0.0	0.020	1.5	_/	1000	
S2.000	59.344	0.083	715.0	0.092	5.00	0.0	0.020	1.5	_/	1000	
S2.001	41.532	0.017	2443.1	0.114	0.00	0.0	0.020	1.5	_/	1000	
S3.000	39.366	0.500	78.7	0.025	15.00	0.0	0.250	3	\=/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	100.00	5.21	203.000	0.283	0.0	0.0	0.0	1.83	795.3	76.6
S1.001	100.00	5.97	202.750	0.319	0.0	0.0	0.0	1.34	582.0	86.3
S1.002	100.00	6.40	202.400	0.457	0.0	0.0	0.0	1.39	605.5	123.7
S1.003	100.00	6.76	202.175	0.508	0.0	0.0	0.0	1.39	606.3	137.6
S1.004	100.00	7.11	201.987	0.570	0.0	0.0	0.0	1.39	606.3	154.5
S1.005	100.00	7.21	201.800	0.625	0.0	0.0	0.0	4.68	2034.9	169.3
S2.000	100.00	6.50	203.500	0.092	0.0	0.0	0.0	0.66	286.4	25.0
S2.001	98.69	8.45	203.417	0.206	0.0	0.0	0.0	0.36	155.0	55.0
S3.000	52.10	21.28	208.500	0.025	0.0	0.0	0.0	0.10	22.7	3.5

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S3.001	77.126	1.000	77.1	0.049	0.00	0.0	0.250	3	\=/	1000	
S3.002	42.943	0.700	61.3	0.031	0.00	0.0	0.250	3	\=/	1000	
S4.000	70.000	1.000	70.0	0.041	15.00	0.0	0.250	3	\=/	1000	
S4.001	53.700	0.409	131.4	0.032	0.00	0.0	0.250	3	\=/	1000	
S4.002	20.500	0.156	131.4	0.015	0.00	0.0	0.250	3	\=/	1000	
S4.003	20.200	0.154	131.2	0.013	0.00	0.0	0.250	3	\=/	1000	
S4.004	10.700	0.081	132.1	0.000	0.00	0.0	0.250	3	\=/	1000	
S4.005	21.800	0.390	55.9	0.000	0.00	0.0	0.250	3	\=/	1000	
S4.006	31.600	0.010	3160.0	0.026	0.00	0.0	0.250	3	\=/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S3.001	41.08	30.00	208.000	0.074	0.0	0.0	0.0	0.11	23.0	8.2
S3.002	41.08	30.00	207.000	0.105	0.0	0.0	0.0	0.12	25.7	11.7
S4.000	45.94	25.53	208.500	0.041	0.0	0.0	0.0	0.11	24.1	5.2
S4.001	41.08	30.00	207.500	0.073	0.0	0.0	0.0	0.08	17.6	8.2
S4.002	41.08	30.00	207.091	0.088	0.0	0.0	0.0	0.08	17.6	9.8
S4.003	41.08	30.00	206.935	0.101	0.0	0.0	0.0	0.08	17.6	11.2
S4.004	41.08	30.00	206.781	0.101	0.0	0.0	0.0	0.08	17.5	11.2
S4.005	41.08	30.00	206.700	0.101	0.0	0.0	0.0	0.12	27.0	11.2
S4.006	41.08	30.00	206.310	0.127	0.0	0.0	0.0	0.02	3.6«	14.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S3.003	38.400	3.200	12.0	0.000	0.00	0.0	0.600		o	300	
S2.002	28.500	0.430	66.3	0.083	0.00	0.0		0.020	1.5 _/	1000	
S2.003	31.400	0.470	66.8	0.046	0.00	0.0		0.020	1.5 _/	1000	
S2.004	23.261	2.000	11.6	0.047	0.00	0.0		0.020	1.5 _/	1000	
S2.005	22.262	0.045	500.0	0.036	0.00	0.0		0.020	1.5 _/	1000	
S2.006	30.187	0.060	500.0	0.174	0.00	0.0		0.020	1.5 _/	1000	
S2.007	15.880	0.032	496.3	0.224	0.00	0.0		0.020	1.5 _/	1000	
S2.008	15.603	0.031	503.3	0.136	0.00	0.0		0.020	1.5 _/	1000	
S2.009	30.421	0.061	498.7	0.174	0.00	0.0		0.020	1.5 _/	1000	
S2.010	9.111	0.011	828.3	0.175	0.00	0.0		0.020	1.5 _/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S3.003	41.08	30.00	206.600	0.232	0.0	0.0	0.0	4.56	322.5	25.8
S2.002	41.08	30.00	203.400	0.521	0.0	0.0	0.0	2.16	940.8	58.0
S2.003	41.08	30.00	202.970	0.567	0.0	0.0	0.0	2.15	937.0	63.1
S2.004	41.08	30.00	202.500	0.614	0.0	0.0	0.0	5.16	2245.8	68.3
S2.005	41.08	30.00	200.500	0.650	0.0	0.0	0.0	0.79	342.5	72.3
S2.006	41.08	30.00	200.445	0.823	0.0	0.0	0.0	0.79	342.5	91.6
S2.007	41.08	30.00	200.385	1.047	0.0	0.0	0.0	0.79	343.8	116.5
S2.008	41.08	30.00	200.353	1.183	0.0	0.0	0.0	0.78	341.4	131.7
S2.009	41.08	30.00	200.322	1.358	0.0	0.0	0.0	0.79	343.0	151.1
S2.010	41.08	30.00	200.261	1.532	0.0	0.0	0.0	0.61	266.1	170.5

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S2.011	20.000	0.050	400.0	0.066	0.00	0.0	0.011		600 []	1000	
S2.012	32.900	0.075	438.7	0.149	0.00	0.0		0.020	1.5 _/	1000	
S2.013	30.700	0.070	438.6	0.272	0.00	0.0		0.020	1.5 _/	1000	
S2.014	24.100	0.055	438.2	0.232	0.00	0.0		0.020	1.5 _/	1000	
S1.006	12.500	0.300	41.7	0.218	0.00	0.0	0.011		600 []	1000	
S5.000	32.000	1.100	29.1	0.034	5.00	0.0		0.020	1.5 _/	1000	
S5.001	31.000	1.100	28.2	0.032	0.00	0.0		0.020	1.5 _/	1000	
S5.002	29.000	0.320	90.6	0.089	0.00	0.0		0.020	1.5 _/	1000	
S5.003	30.000	0.320	93.8	0.000	0.00	0.0		0.020	1.5 _/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.011	41.08	30.00	200.250	1.598	0.0	0.0	0.0	1.81	940.4	177.8
S2.012	41.08	30.00	200.200	1.747	0.0	0.0	0.0	0.84	365.7	194.4
S2.013	41.08	30.00	200.125	2.019	0.0	0.0	0.0	0.84	365.7	224.7
S2.014	41.08	30.00	200.055	2.251	0.0	0.0	0.0	0.84	365.9	250.5
S1.006	41.08	30.00	200.000	3.095	0.0	0.0	0.0	6.02	3130.4	344.4
S5.000	100.00	5.16	206.500	0.034	0.0	0.0	0.0	3.26	1420.0	9.2
S5.001	100.00	5.32	205.400	0.065	0.0	0.0	0.0	3.32	1442.8	17.7
S5.002	100.00	5.58	204.300	0.154	0.0	0.0	0.0	1.85	804.5	41.7
S5.003	100.00	5.86	203.980	0.154	0.0	0.0	0.0	1.82	791.0	41.7

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S5.004	29.987	0.320	93.7	0.000	0.00	0.0	0.020	1.5	_/	1000	
S6.000	22.836	0.640	35.7	0.003	15.00	0.0	0.250	3	\=/	1000	
S6.001	23.250	0.760	30.6	0.008	0.00	0.0	0.250	3	\=/	1000	
S6.002	24.359	0.400	60.9	0.010	0.00	0.0	0.250	3	\=/	1000	
S6.003	16.357	0.100	163.6	0.005	0.00	0.0	0.250	3	\=/	1000	
S6.004	20.000	0.100	200.0	0.011	0.00	0.0	0.250	3	\=/	1000	
S6.005	23.000	0.300	76.7	0.014	0.00	0.0	0.250	3	\=/	1000	
S6.006	14.800	0.362	40.9	0.009	0.00	0.0	0.250	3	\=/	1000	
S6.007	4.200	0.138	30.4	0.003	0.00	0.0	0.045	3	\=/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S5.004	100.00	6.13	203.660	0.154	0.0	0.0	0.0	1.82	791.2	41.7
S6.000	59.75	17.45	208.300	0.003	0.0	0.0	0.0	0.16	33.8	0.6
S6.001	54.83	19.76	207.660	0.012	0.0	0.0	0.0	0.17	36.5	1.8
S6.002	49.10	23.18	206.900	0.022	0.0	0.0	0.0	0.12	25.8	2.9
S6.003	44.26	26.94	206.500	0.027	0.0	0.0	0.0	0.07	15.8	3.2
S6.004	41.08	30.00	206.400	0.038	0.0	0.0	0.0	0.07	14.3	4.2
S6.005	41.08	30.00	206.300	0.052	0.0	0.0	0.0	0.11	23.0	5.7
S6.006	41.08	30.00	206.000	0.061	0.0	0.0	0.0	0.15	31.5	6.8
S6.007	41.08	30.00	205.638	0.064	0.0	0.0	0.0	0.93	203.1	7.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S7.000	41.200	0.200	206.0	0.013	15.00	0.0	0.250	3	\=/	1000	
S7.001	30.400	0.800	38.0	0.016	0.00	0.0	0.250	3	\=/	1000	
S7.002	19.700	0.853	23.1	0.011	0.00	0.0	0.250	3	\=/	1000	
S7.003	11.000	0.900	12.2	0.008	0.00	0.0	0.250	3	\=/	1000	
S6.008	21.500	0.200	107.5	0.005	0.00	0.0	0.250	3	\=/	1000	
S6.009	30.500	0.800	38.1	0.008	0.00	0.0	0.250	3	\=/	1000	
S6.010	30.000	0.200	150.0	0.026	0.00	0.0	0.250	3	\=/	1000	
S6.011	13.300	0.100	133.0	0.015	0.00	0.0	0.255	3	\=/	1000	
S8.000	17.700	0.050	354.0	0.006	15.00	0.0	0.250	3	\=/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S7.000	45.81	25.63	208.300	0.013	0.0	0.0	0.0	0.06	14.1	1.6
S7.001	42.06	29.00	208.100	0.029	0.0	0.0	0.0	0.15	32.7	3.3
S7.002	41.08	30.00	207.300	0.040	0.0	0.0	0.0	0.19	42.0	4.4
S7.003	41.08	30.00	206.400	0.048	0.0	0.0	0.0	0.27	57.7	5.4
S6.008	41.08	30.00	205.500	0.117	0.0	0.0	0.0	0.09	19.5	13.0
S6.009	41.08	30.00	205.300	0.125	0.0	0.0	0.0	0.15	32.7	13.9
S6.010	41.08	30.00	204.500	0.150	0.0	0.0	0.0	0.08	16.5«	16.7
S6.011	41.08	30.00	204.300	0.165	0.0	0.0	0.0	0.08	17.1«	18.4
S8.000	52.60	20.99	206.500	0.006	0.0	0.0	0.0	0.05	10.7	0.8

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S8.001	30.600	0.450	68.0	0.005	0.00	0.0		0.250	3 \=/	1000	
S8.002	29.700	0.200	148.5	0.024	0.00	0.0		0.250	3 \=/	1000	
S8.003	30.800	0.900	34.2	0.013	0.00	0.0		0.250	3 \=/	1000	
S8.004	17.700	0.800	22.1	0.012	0.00	0.0		0.250	3 \=/	1000	
S6.012	20.300	1.060	19.2	0.000	0.00	0.0	0.600		o	150	
S5.005	31.000	0.340	91.2	0.127	0.00	0.0		0.020	1.5 _/	1000	
S5.006	30.500	0.108	283.0	0.052	0.00	0.0		0.020	1.5 _/	1000	
S5.007	29.500	0.104	283.7	0.048	0.00	0.0		0.020	1.5 _/	1000	
S5.008	24.500	0.087	281.6	0.049	0.00	0.0		0.020	1.5 _/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S8.001	45.94	25.52	206.450	0.011	0.0	0.0	0.0	0.11	24.5	1.3
S8.002	41.08	30.00	206.000	0.034	0.0	0.0	0.0	0.08	16.6	3.8
S8.003	41.08	30.00	205.800	0.047	0.0	0.0	0.0	0.16	34.5	5.2
S8.004	41.08	30.00	204.900	0.059	0.0	0.0	0.0	0.20	42.9	6.6
S6.012	41.08	30.00	204.400	0.224	0.0	0.0	0.0	2.31	40.9	25.0
S5.005	41.08	30.00	203.340	0.505	0.0	0.0	0.0	1.84	802.1	56.2
S5.006	41.08	30.00	203.000	0.557	0.0	0.0	0.0	1.05	455.3	62.0
S5.007	41.08	30.00	202.892	0.605	0.0	0.0	0.0	1.05	454.8	67.3
S5.008	41.08	30.00	202.788	0.654	0.0	0.0	0.0	1.05	456.4	72.7

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S5.009	30.000	0.106	283.0	0.044	0.00	0.0	0.020	1.5	_/	1000	
S5.010	27.000	0.095	284.2	0.050	0.00	0.0	0.020	1.5	_/	1000	
S5.011	30.800	0.342	90.1	0.042	0.00	0.0	0.020	1.5	_/	1000	
S5.012	29.800	0.331	90.0	0.052	0.00	0.0	0.020	1.5	_/	1000	
S5.013	29.500	0.327	90.2	0.060	0.00	0.0	0.020	1.5	_/	1000	
S5.014	30.000	0.299	100.5	0.053	0.00	0.0	0.020	1.5	_/	1000	
S5.015	30.000	0.299	100.3	0.050	0.00	0.0	0.020	1.5	_/	1000	
S5.016	30.000	0.299	100.3	0.064	0.00	0.0	0.020	1.5	_/	1000	
S5.017	37.000	0.368	100.5	0.070	0.00	0.0	0.020	1.5	_/	1000	
S5.018	28.600	0.286	100.0	0.080	0.00	0.0	0.020	1.5	_/	1000	
S5.019	15.300	0.150	102.0	0.121	0.00	0.0	0.020	1.5	_/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S5.009	41.08	30.00	202.701	0.698	0.0	0.0	0.0	1.05	455.3	77.7
S5.010	41.08	30.00	202.595	0.748	0.0	0.0	0.0	1.04	454.3	83.2
S5.011	41.08	30.00	202.500	0.790	0.0	0.0	0.0	1.85	806.9	87.9
S5.012	41.08	30.00	202.158	0.842	0.0	0.0	0.0	1.86	807.2	93.7
S5.013	41.08	30.00	201.827	0.902	0.0	0.0	0.0	1.85	806.4	100.4
S5.014	41.08	30.00	201.500	0.955	0.0	0.0	0.0	1.76	764.0	106.3
S5.015	41.08	30.00	201.201	1.006	0.0	0.0	0.0	1.76	764.6	111.9
S5.016	41.08	30.00	200.902	1.070	0.0	0.0	0.0	1.76	764.6	119.0
S5.017	41.08	30.00	200.604	1.140	0.0	0.0	0.0	1.76	764.0	126.8
S5.018	41.08	30.00	200.236	1.220	0.0	0.0	0.0	1.76	765.9	135.7
S5.019	41.08	30.00	199.950	1.341	0.0	0.0	0.0	1.74	758.4	149.2

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S5.020	28.000	0.100	280.0	0.052	0.00	0.0		0.020	1.5 _/	1000	
S1.007	6.500	0.150	43.3	0.021	0.00	0.0	0.600		o	225	
S1.008	21.000	0.042	500.0	0.000	0.00	0.0	0.600		oo	600	
S1.009	42.000	1.772	23.7	0.000	0.00	0.0	0.600		o	300	
S1.010	50.700	2.028	25.0	0.000	0.00	0.0	0.600		o	300	
S9.000	40.500	0.540	75.0	0.029	5.00	0.0		0.020	1.5 _/	1000	
S9.001	28.250	0.380	74.3	0.050	0.00	0.0		0.020	1.5 _/	1000	
S9.002	28.250	0.380	74.3	0.078	0.00	0.0		0.020	1.5 _/	1000	
S9.003	15.600	0.130	120.0	0.124	0.00	0.0		0.020	1.5 _/	1000	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S5.020	41.08	30.00	199.800	1.393	0.0	0.0	0.0	1.05	457.7	155.0
S1.007	41.08	30.00	200.000	4.509	0.0	0.0	0.0	1.99	79.2«	501.7
S1.008	41.08	30.00	199.475	4.509	0.0	0.0	0.0	1.08	612.0	501.7
S1.009	41.08	30.00	199.050	4.509	0.0	0.0	0.0	3.24	229.2«	501.7
S1.010	41.08	30.00	197.278	4.509	0.0	0.0	0.0	3.16	223.2«	501.7
S9.000	100.00	5.33	200.500	0.029	0.0	0.0	0.0	2.03	884.4	7.7
S9.001	100.00	5.56	199.960	0.078	0.0	0.0	0.0	2.04	888.3	21.2
S9.002	100.00	5.79	199.580	0.157	0.0	0.0	0.0	2.04	888.3	42.4
S9.003	100.00	5.95	199.200	0.280	0.0	0.0	0.0	1.61	699.2	76.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S9.004	22.800	0.190	120.0	0.210	0.00	0.0		0.020	1.5 _/	1000	
S9.005	55.600	0.460	120.9	0.297	0.00	0.0		0.020	1.5 _/	1000	
S9.006	51.000	0.420	121.4	0.450	0.00	0.0		0.020	1.5 _/	1000	
S10.000	26.300	0.300	87.7	0.030	5.00	0.0		0.020	1.5 _/	1000	
S10.001	43.700	0.900	48.6	0.021	0.00	0.0		0.020	1.5 _/	1000	
S10.002	29.300	0.600	48.8	0.342	0.00	0.0		0.020	1.5 _/	1000	
S9.007	6.500	0.064	101.6	0.810	0.00	0.0	0.600		o	300	
S9.008	23.000	0.146	157.5	0.000	0.00	0.0	0.600		o	750	
S9.009	37.029	2.540	14.6	0.000	0.00	0.0	0.600		o	300	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S9.004	100.00	6.19	199.070	0.490	0.0	0.0	0.0	1.61	699.2	132.7
S9.005	100.00	6.77	198.880	0.787	0.0	0.0	0.0	1.60	696.7	213.1
S9.006	100.00	7.30	198.420	1.236	0.0	0.0	0.0	1.60	695.0	334.8
S10.000	100.00	5.23	199.800	0.030	0.0	0.0	0.0	1.88	818.0	8.2
S10.001	100.00	5.52	199.500	0.051	0.0	0.0	0.0	2.53	1099.1	13.9
S10.002	100.00	5.72	198.600	0.394	0.0	0.0	0.0	2.52	1096.0	106.6
S9.007	100.00	7.37	198.000	2.440	0.0	0.0	0.0	1.56	110.3«	660.9
S9.008	100.00	7.54	197.936	2.440	0.0	0.0	0.0	2.23	983.9	660.9
S9.009	100.00	7.69	197.790	2.440	0.0	0.0	0.0	4.14	292.5«	660.9

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Auto Design
S1.011	79.320	3.600	22.0	0.000	0.00	0.0	0.600		o	300	
S1.012	35.970	2.650	13.6	0.000	0.00	0.0	0.600		o	300	
S1.013	68.857	0.070	983.7	0.000	0.00	0.0		0.020	_|	-3	
S1.014	31.857	0.029	1098.5	0.000	0.00	0.0		0.020	_|	-3	
S1.015	8.019	0.001	8018.9	0.000	0.00	0.0		0.020	_|	-3	
S1.016	33.632	0.030	1121.1	0.000	0.00	0.0		0.020	_|	-3	
S1.017	69.673	0.070	995.3	0.000	0.00	0.0		0.020	_|	-3	
S1.018	77.813	4.800	16.2	0.106	0.00	0.0	0.600		o	225	
S1.019	26.252	3.000	8.8	0.458	0.00	0.0	0.600		o	375	
S1.020	5.000	0.010	500.0	0.000	0.00	0.0	0.600		o	375	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.011	41.08	30.00	195.250	6.949	0.0	0.0	0.0	3.36	237.8«	773.2
S1.012	41.08	30.00	191.650	6.949	0.0	0.0	0.0	4.29	303.2«	773.2
S1.013	41.08	30.00	189.000	6.949	0.0	0.0	0.0	0.83	1461.0	773.2
S1.014	41.08	30.00	188.930	6.949	0.0	0.0	0.0	0.79	1382.5	773.2
S1.015	41.08	30.00	188.900	6.949	0.0	0.0	0.0	0.29	511.7«	773.2
S1.016	41.08	30.00	188.899	6.949	0.0	0.0	0.0	0.78	1368.6	773.2
S1.017	41.08	30.00	188.870	6.949	0.0	0.0	0.0	0.83	1452.4	773.2
S1.018	41.08	30.00	188.800	7.055	0.0	0.0	0.0	3.27	129.9«	785.0
S1.019	41.08	30.00	184.000	7.513	0.0	0.0	0.0	6.16	679.9«	835.9
S1.020	41.08	30.00	181.000	7.513	0.0	0.0	0.0	0.80	88.7«	835.9

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 54 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH C (1km) -0.022 D2 (1km) 0.409 E (1km) 0.288 Cv (Summer) 0.750
Site Location D1 (1km) 0.374 D3 (1km) 0.270 F (1km) 2.381 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status ON Inertia Status ON
Analysis Timestep Fine DVD Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 360, 600, 960, 2160, 10080
Return Period(s) (years) 20
Climate Change (%) 0

PN	Duration (mins)	Water Level (m)	Flooded Volume (m³)	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.000	360	203.374	0.000	0.1	11.7	OK
S1.001	360	203.374	0.000	0.5	10.0	FLOOD RISK*
S1.002	360	203.064	0.000	0.1	12.7	FLOOD RISK*
S1.003	360	202.751	0.000	0.1	14.0	FLOOD RISK*

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	Duration (mins)	Water Level (m)	Flooded Volume (m^3)	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.004	360	202.436	0.000	0.1	15.7	OK
S1.005	360	202.119	0.000	0.9	17.2	OK
S2.000	60	203.766	0.000	0.1	11.4	FLOOD RISK*
S2.001	60	203.757	0.000	0.1	18.6	FLOOD RISK*
S3.000	15	208.555	0.000	0.1	3.8	OK
S3.001	30	208.307	0.000	0.2	8.0	FLOOD RISK*
S3.002	60	207.307	0.000	0.2	9.5	FLOOD RISK*
S4.000	15	208.571	0.000	0.1	6.3	OK
S4.001	30	207.806	0.000	0.1	8.4	FLOOD RISK*
S4.002	120	207.393	0.000	0.1	3.1	FLOOD RISK*
S4.003	960	207.056	0.000	0.0	1.2	OK
S4.004	960	207.056	0.000	0.1	1.0	FLOOD RISK*
S4.005	2160	206.867	0.000	0.0	0.9	OK
S4.006	2160	206.867	0.000	0.0	1.0	FLOOD RISK*
S3.003	360	206.616	0.000	2.0	3.6	OK*
S2.002	15	203.439	0.000	0.7	27.2	OK
S2.003	15	203.316	0.000	1.1	40.1	OK
S2.004	15	202.858	0.000	2.5	49.8	OK
S2.005	120	201.211	0.000	0.1	27.8	FLOOD RISK*
S2.006	120	201.200	0.000	0.1	27.3	FLOOD RISK*
S2.007	180	201.181	0.000	0.2	25.7	FLOOD RISK*
S2.008	180	201.169	0.000	0.2	28.0	FLOOD RISK*
S2.009	180	201.156	0.000	0.2	31.8	FLOOD RISK*
S2.010	180	201.125	0.000	0.2	34.5	FLOOD RISK*
S2.011	180	201.119	0.000	0.3	36.0	FLOOD RISK*
S2.012	180	201.117	0.000	0.1	40.0	FLOOD RISK*

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	Duration (mins)	Water Level (m)	Flooded Volume (m^3)	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S2.013	180	201.059	0.000	0.0	46.2	FLOOD RISK*
S2.014	180	200.709	0.000	0.7	52.7	OK
S1.006	180	200.353	0.000	0.6	71.5	OK*
S5.000	15	206.517	0.000	0.6	10.1	OK
S5.001	15	205.722	0.000	2.1	20.0	FLOOD RISK*
S5.002	15	204.659	0.000	0.3	46.7	OK
S5.003	15	204.319	0.000	1.4	34.0	OK
S5.004	30	203.985	0.000	1.1	22.7	OK
S6.000	15	208.314	0.000	0.0	0.5	OK
S6.001	15	207.813	0.000	0.2	1.0	OK
S6.002	60	207.145	0.000	0.1	1.0	FLOOD RISK*
S6.003	180	206.740	0.000	0.1	0.7	FLOOD RISK*
S6.004	180	206.587	0.000	0.1	0.8	OK
S6.005	120	206.429	0.000	0.1	1.0	OK
S6.006	360	206.210	0.000	0.1	1.0	FLOOD RISK*
S6.007	15	205.645	0.000	0.2	1.8	OK
S7.000	15	208.350	0.000	0.0	2.0	OK
S7.001	60	208.252	0.000	0.2	1.0	OK
S7.002	180	207.578	0.000	0.2	1.0	FLOOD RISK*
S7.003	120	206.700	0.000	0.2	1.3	FLOOD RISK*
S6.008	360	205.605	0.000	0.0	2.5	OK
S6.009	360	205.601	0.000	0.1	2.7	OK
S6.010	600	205.030	0.000	0.1	2.2	FLOOD RISK*
S6.011	600	204.729	0.000	0.1	2.3	FLOOD RISK*
S8.000	30	206.550	0.000	0.0	0.8	FLOOD RISK*
S8.001	30	206.536	0.000	0.1	0.9	OK

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	Duration (mins)	Water Level (m)	Flooded Volume (m^3)	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S8.002	60	206.252	0.000	0.1	1.0	FLOOD RISK*
S8.003	180	205.986	0.000	0.2	1.0	OK
S8.004	360	205.200	0.000	0.2	1.2	FLOOD RISK*
S6.012	600	204.428	0.000	1.4	3.3	OK*
S5.005	960	203.622	0.000	0.3	7.5	OK
S5.006	960	203.622	0.000	0.1	6.7	OK
S5.007	960	203.621	0.000	0.1	6.6	FLOOD RISK*
S5.008	960	203.620	0.000	0.0	7.3	FLOOD RISK*
S5.009	960	203.618	0.000	0.0	8.2	FLOOD RISK*
S5.010	960	203.311	0.000	0.0	9.1	FLOOD RISK*
S5.011	960	203.004	0.000	0.1	9.9	OK
S5.012	960	202.697	0.000	0.3	10.7	OK
S5.013	960	202.390	0.000	0.1	11.6	OK
S5.014	960	202.082	0.000	0.1	12.5	OK
S5.015	600	201.776	0.000	0.1	12.8	OK
S5.016	600	201.482	0.000	0.1	13.8	OK
S5.017	600	201.181	0.000	0.1	14.9	OK
S5.018	600	200.880	0.000	0.1	16.5	OK
S5.019	360	200.621	0.000	0.1	16.8	OK
S5.020	360	200.621	0.000	0.8	17.8	FLOOD RISK*
S1.007	180	200.325	0.000	1.8	72.0	SURCHARGED*
S1.008	180	199.611	0.000	0.7	72.0	OK*
S1.009	180	199.170	0.000	2.7	72.0	OK
S1.010	180	197.399	0.000	2.7	72.0	OK
S9.000	15	200.519	0.000	0.4	8.5	OK
S9.001	15	200.283	0.000	1.0	19.8	OK

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	Duration (mins)	Water Level (m)	Flooded Volume (m^3)	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S9.002	30	199.839	0.000	0.4	22.5	OK
S9.003	30	199.839	0.000	0.1	24.6	OK
S9.004	30	199.519	0.000	0.4	48.1	OK
S9.005	30	199.510	0.000	1.2	84.4	OK
S9.006	30	199.154	0.000	1.2	94.6	FLOOD RISK*
S10.000	15	199.825	0.000	0.4	9.0	OK
S10.001	30	199.807	0.000	0.3	6.7	OK
S10.002	30	199.104	0.000	2.0	75.1	OK
S9.007	30	198.770	0.000	2.6	184.4	SURCHARGED*
S9.008	30	198.218	0.000	1.2	184.4	OK
S9.009	30	197.972	0.000	4.1	184.4	OK
S1.011	30	195.960	0.000	3.8	241.8	SURCHARGED
S1.012	30	191.853	0.000	4.7	241.8	OK*
S1.013	120	189.500	0.000	0.3	224.2	FLOOD RISK*
S1.014	120	189.430	0.000	0.3	196.2	FLOOD RISK*
S1.015	120	189.376	0.000	0.3	183.6	FLOOD RISK*
S1.016	120	189.355	0.000	0.3	182.1	FLOOD RISK*
S1.017	120	189.292	0.000	0.3	166.3	OK
S1.018	120	189.225	0.000	3.7	132.7	SURCHARGED*
S1.019	960	184.513	0.000	3.8	56.6	SURCHARGED
S1.020	10080	181.375	0.000	0.8	28.2	SURCHARGED*

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 54 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

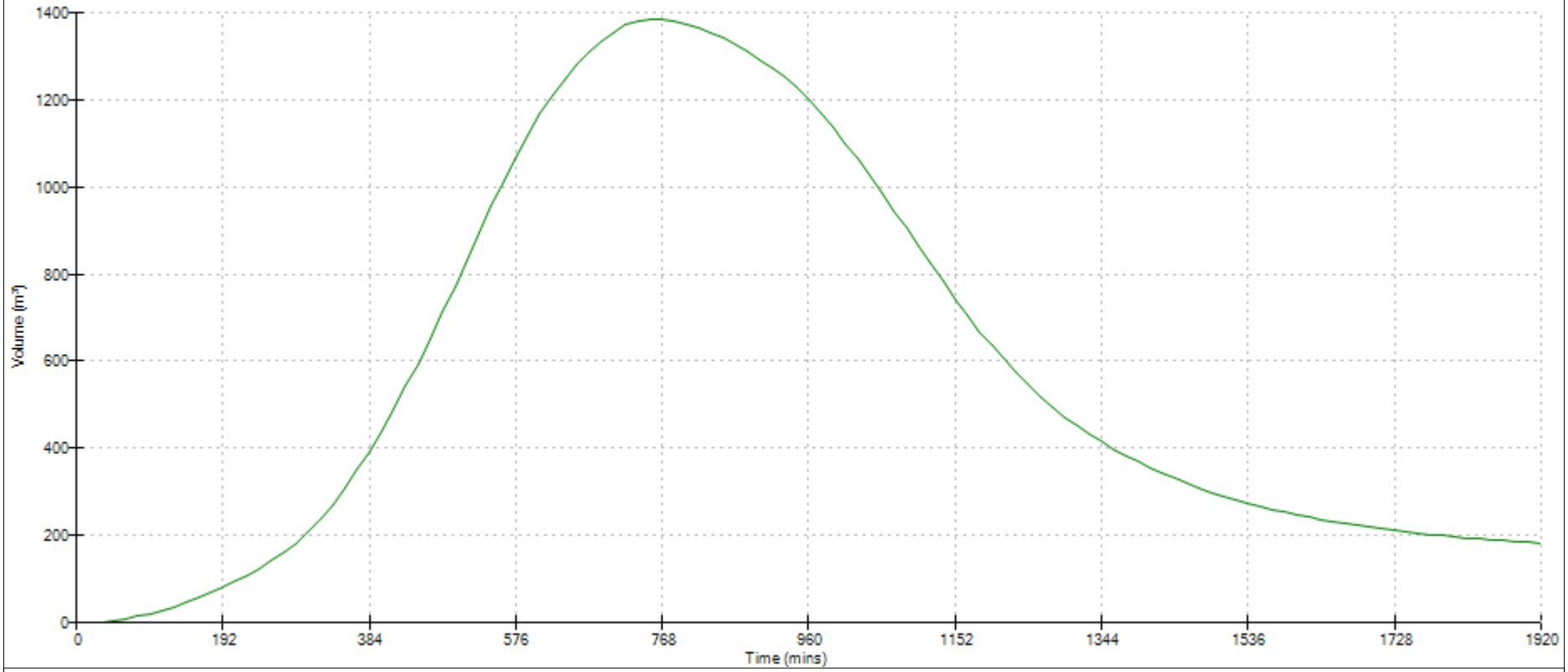
Rainfall Model FEH C (1km) -0.022 D2 (1km) 0.409 E (1km) 0.288 Cv (Summer) 0.750
Site Location D1 (1km) 0.374 D3 (1km) 0.270 F (1km) 2.381 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status ON Inertia Status ON
Analysis Timestep Fine DVD Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 360, 600, 960, 2160, 10080
Return Period(s) (years) 20
Climate Change (%) 0

PN	Duration (mins)	Water Level (m)	Flooded Volume (m³)	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S1.019	960	184.513	0.000	3.8	56.6	SURCHARGED

Graphs for Pipe S1.019 US/MH S102 (Storm)
960 minute 20 year Winter I+0%
Status: SURCHARGED



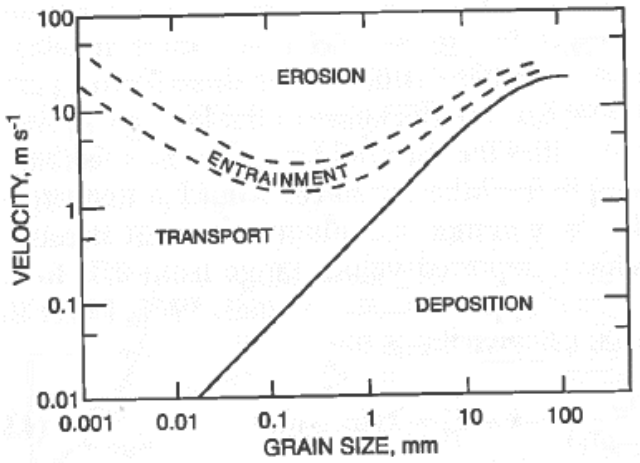
Appendix E

Outfall Velocity and Silt Removal Calculations

Subject	Maximum velocity to discharge surface water into Sneaton Thorpe Beck		
Date	7 December 2016	Job No/Ref	234376-00

Determination of a maximum velocity to discharge surface water into Sneaton Thorpe Beck for the temporary outfall downstream of the attenuation pond for Site Preparation Phase 2.

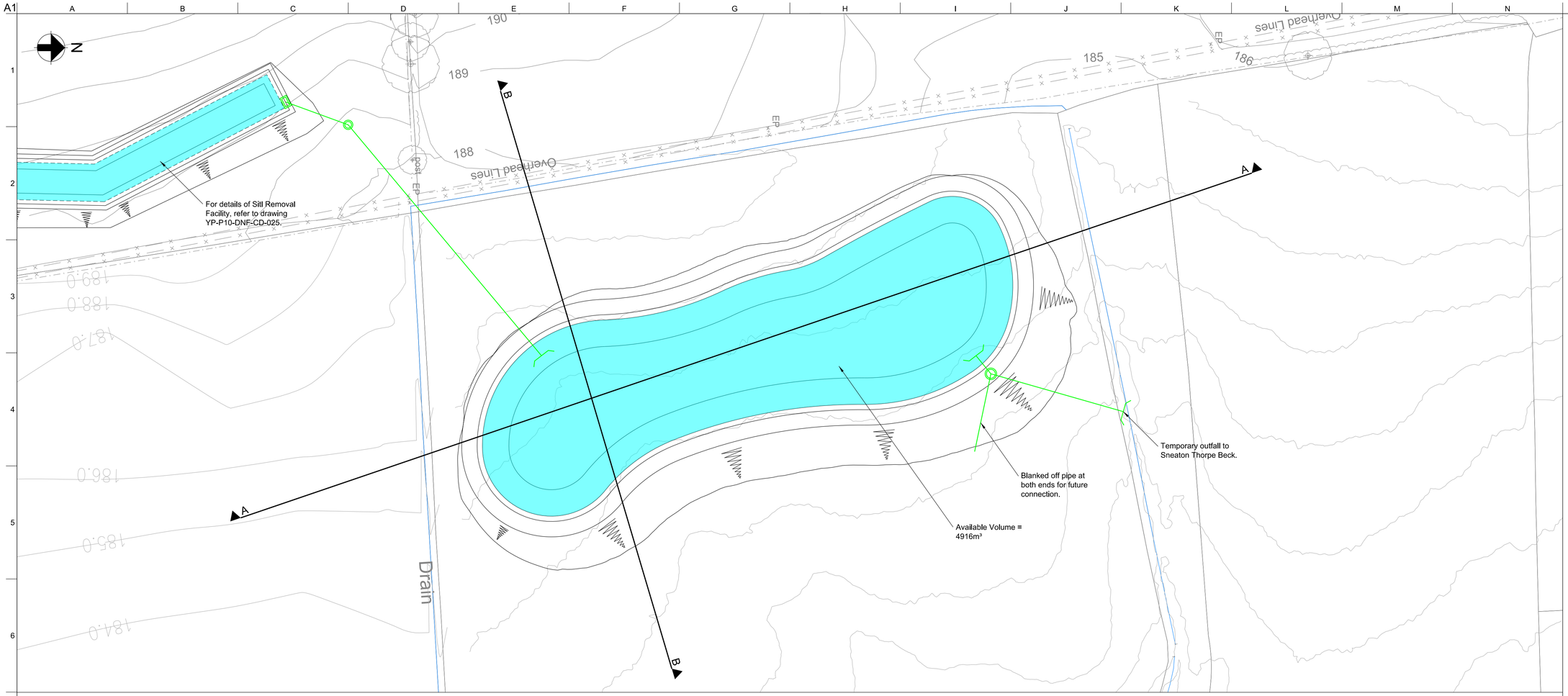
The textbook "Fluvial Forms and Processes, A New Perspective" contains a graph that gives some basic limiting velocities for sediment erosion and entrainment based on various grain sizes.

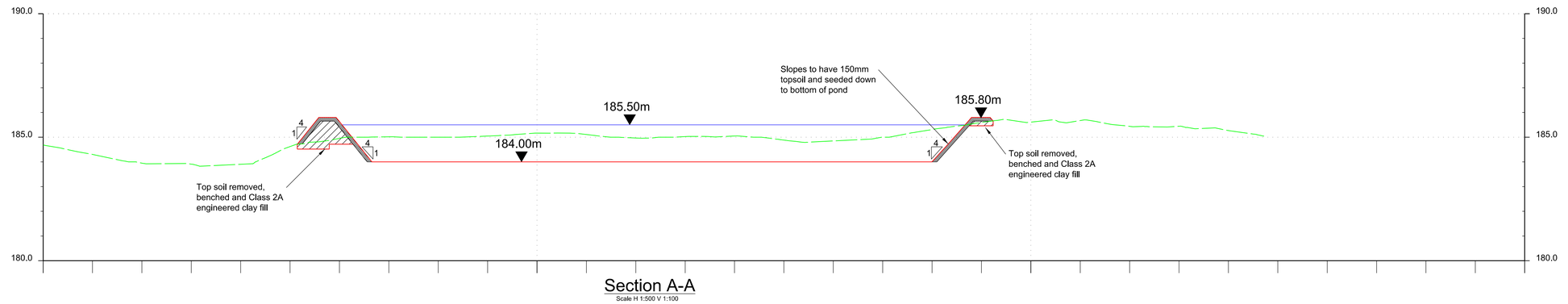


The graph shows that no grain sizes are entrained into the flow until velocities are greater than 1m/s.

Using Ordnance Survey maps and contours produced from LIDAR Data, Sneaton Thorpe Beck has an average gradient of approximately 1 in 20 at the outfall location.

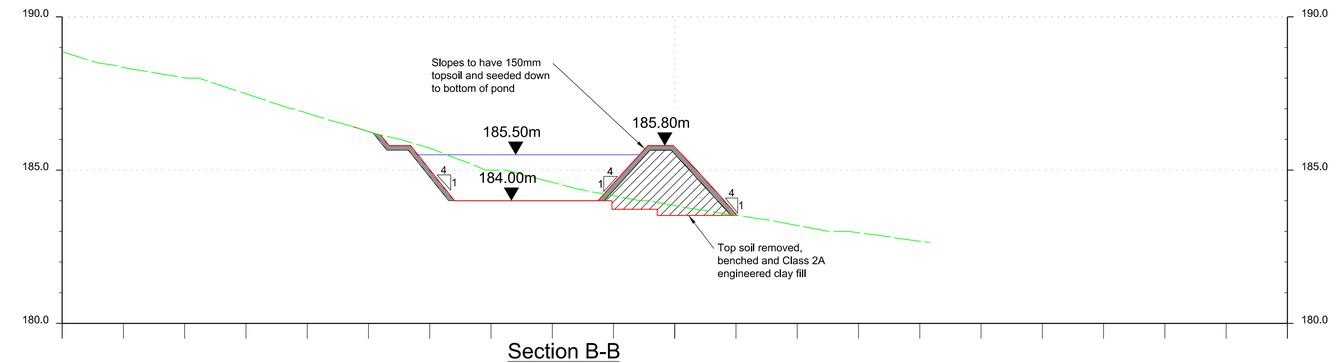
The tributaries of Sneaton Thorpe Beck are small. The photograph below shows the typical size of the tributaries just downstream of the outfall location. The width of the tributary has been estimated at approximately 1m wide.





Section A-A

Scale H 1:500 V 1:100



Section B-B

Scale H 1:500 V 1:100

Key for Plan:

- Extents of pond top of water level
- Carrier drain and manhole
- Headwall

Key for Sections:

- Existing ground profile
- Proposed landscape profile
- Design top water level
- 150mm topsoil seeded
- Class 2A engineered clay fill

Issue	Date	By	Chkd	Appd
0	19/12/16	SM	NF	AH
	Discharge Planning			
A	07/12/16	JB	NF	AH
	Discharge Planning			

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Client
York Potash Ltd

Job Title
York Potash
Site Preparation
(Phase 2)

Surface Water Drainage
Attenuation Pond
General Arrangement and Sections

Scale at A1 1:500

Discipline Drainage

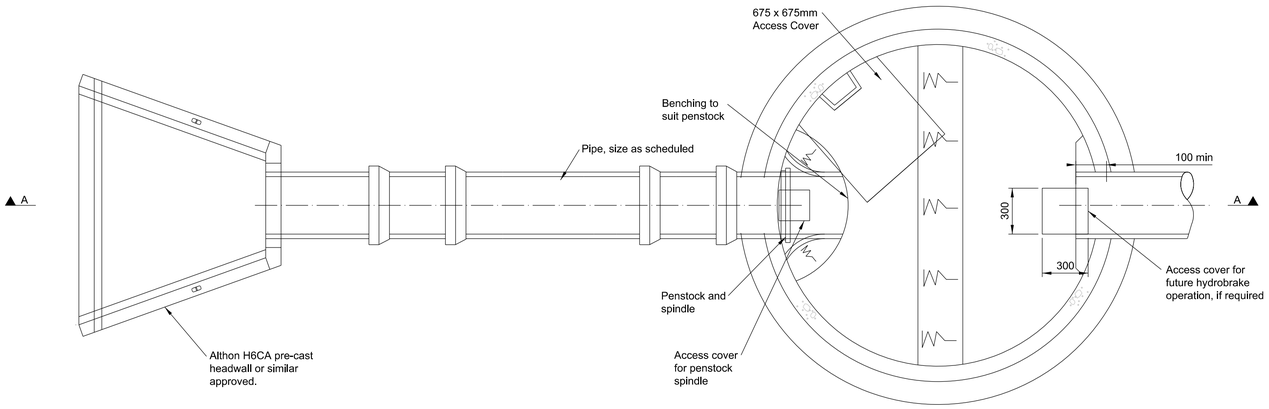
Job No **234376**

Drawing Status **Issue**

Drawing No **YP-P10-DNF-CD-020**

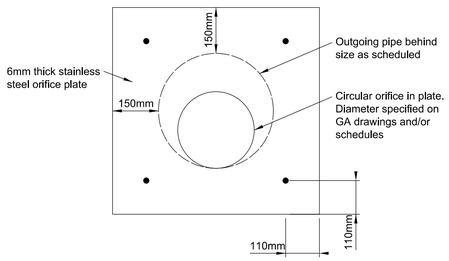
Issue **0**

Do not scale



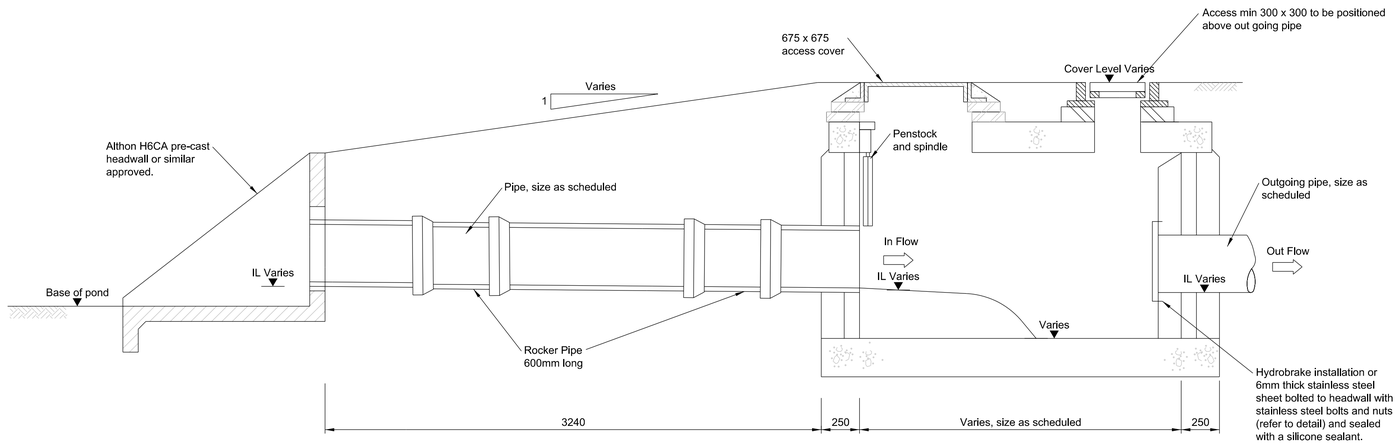
Plan

Scale 1:20



Orifice Plate Detail

Scale 1:10



Cross Section A - A

Scale 1:20

Typical Attenuation Pond Outlet Details with Typical Orifice Flow Control Chamber

Notes:

1. All levels in metres above Ordnance Datum.
2. All dimensions in mm unless otherwise stated.

Issue	Date	By	Chkd	Appd
0	16/12/16	SM	NF	AH
	Discharge Planning			
A	07/12/16	JB	NF	AG
	Discharge Planning			

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Client
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Job Title
York Potash
Site Preparation
Phase 2

Surface Water Drainage
Attenuation Pond Details
Sheet 1

Scale at A1: As shown

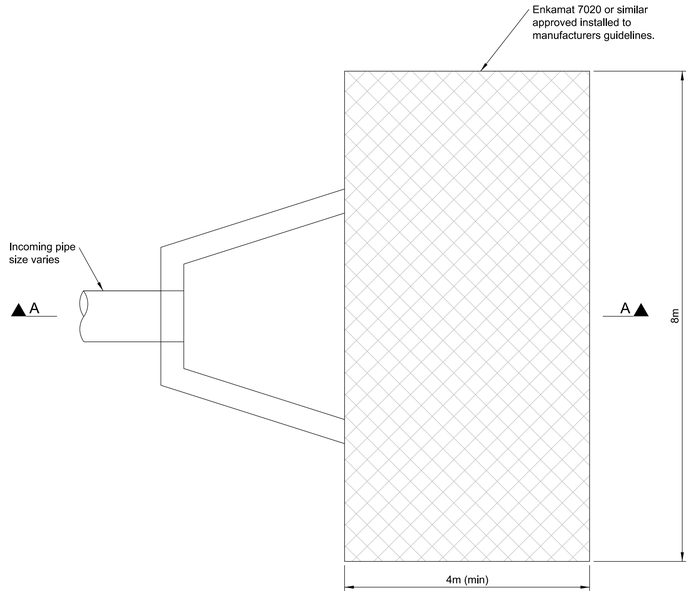
Discipline: Drainage

Job No: **234376**

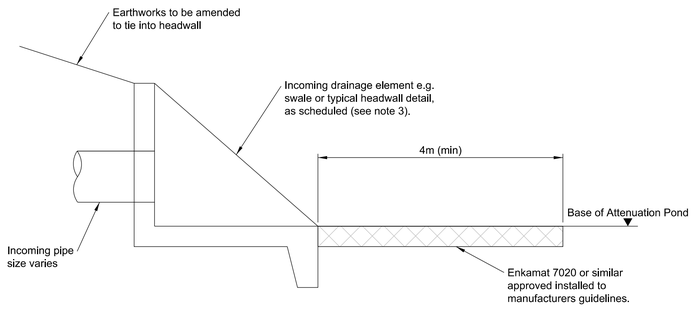
Drawing Status: **Issue**

Drawing No: **YP-P10-DNF-CD-021**

Issue: **0**



Plan



Section A-A

Typical Inlet to Attenuation Ponds

Scale 1:50

Notes:

1. All levels in metres above Ordnance Datum.
2. All dimensions in mm unless otherwise stated.
3. Typical headwall detail Althon or similar approved

Maximum Pipe Size (mm)		Althon Headwall reference
Clay or Plastic	PCC	
300	225	H3C
500	450	H6C
900	900	H10C
1050	1050	H20C

Issue	Date	By	Chkd	Appd
0	16/12/16	SM	NF	AH
	Discharge Planning			
A	07/12/16	JB	NF	AG
	Discharge Planning			

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Client
York Potash Ltd

Job Title
York Potash
Site Preparation
(Phase 2)

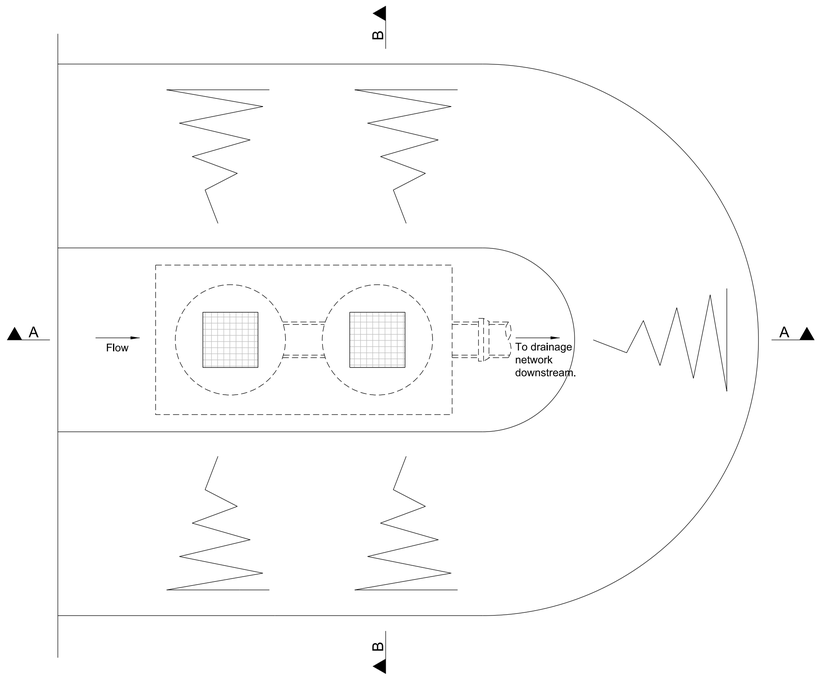
Surface Water Drainage
Attenuation Pond Details
Sheet 2

Scale at A1: As shown

Discipline: Drainage

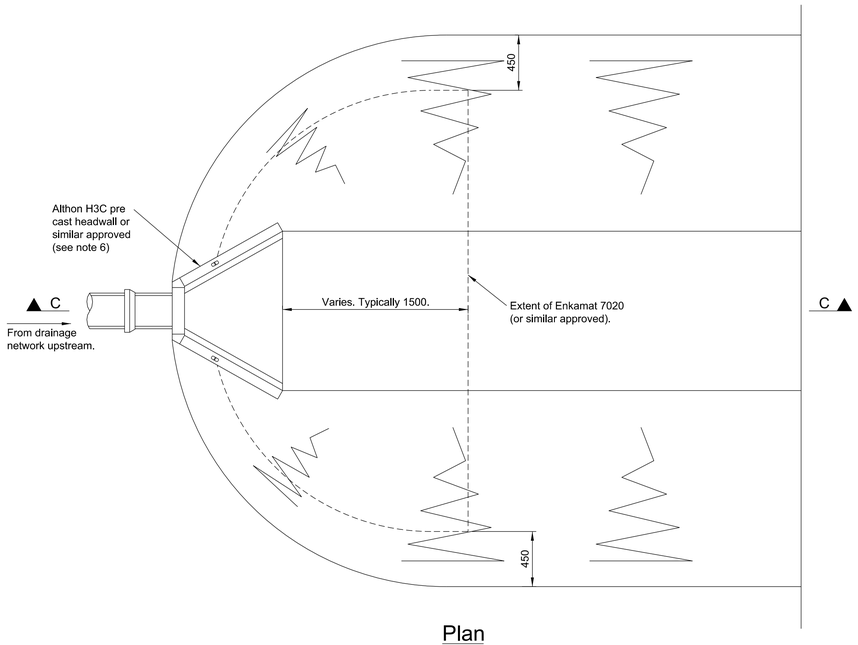
Job No	Drawing Status
234376	Issue

Drawing No	Issue
YP-P10-DNF-CD-022	0



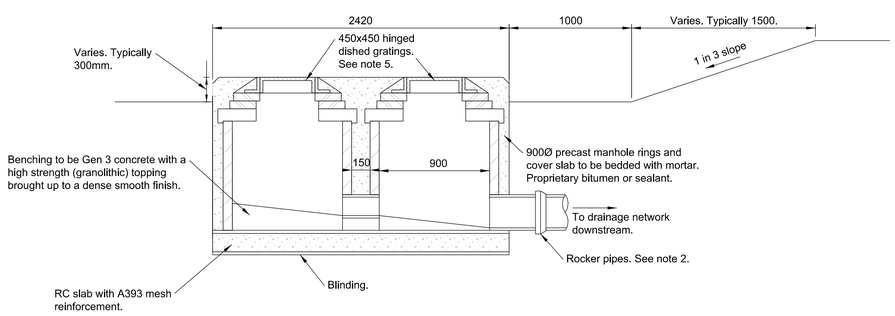
Plan

Scale 1:25



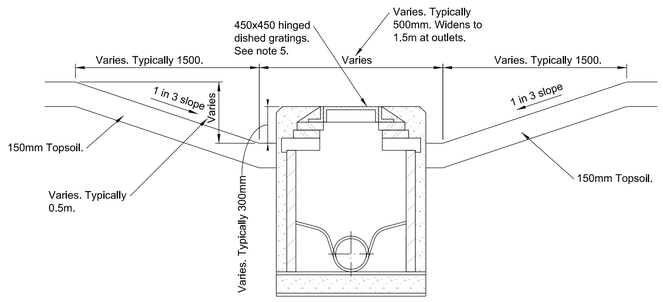
Plan

Scale 1:25



Section A-A

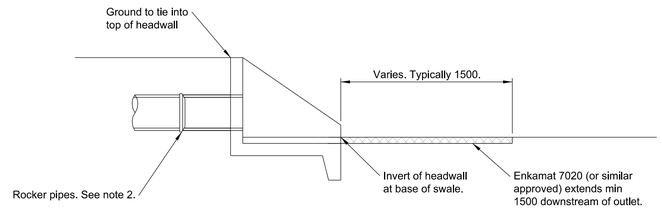
Scale 1:25



Section B-B

Scale 1:25

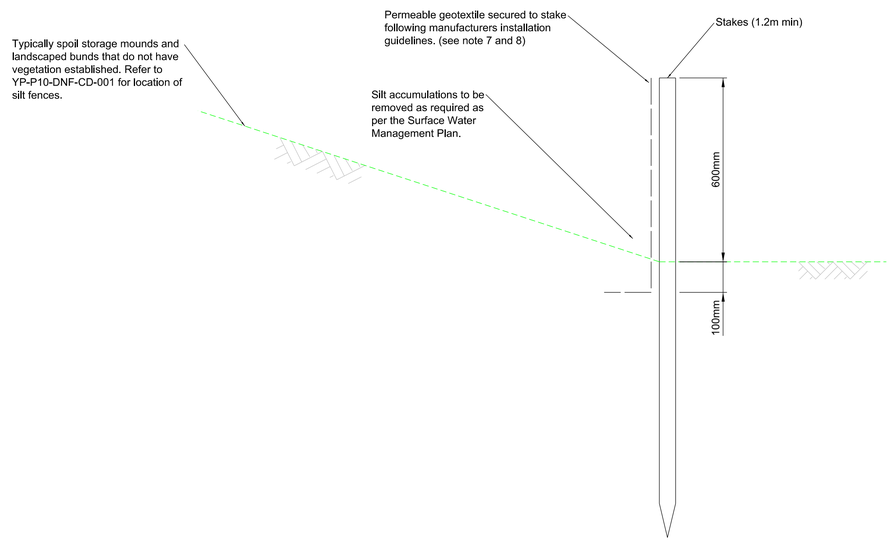
Typical Swale Outlet Detail (Chamber)



Section C-C

Scale 1:25

Typical Swale Inlet and Outlet Detail (Headwall)



Silt Fence Typical Detail

Scale 1:10

Notes:

1. All works to be in accordance with Sewers for Adoption 7th Edition.
2. Rocker pipe lengths as follows:

Schedule of rocker pipe lengths	
Rocker pipe lenght (mm)	Nominal diameter of pipe (mm)
600	150 to 600
1000	675 to 750
1250	over 750

3. For locations of swales refer to drawing YP-P10-DNF-CH-001.
4. Outlet chambers shall be 900mm Ø precast concrete rings with 150 thick concrete surround.
5. Gratings shall be hinged dishes. Gratings to load class B125 minimum with 450x450 clear opening.
6. Headwall to be installed to manufacturers installation details. For pipe sizes greater than 300mm Ø use Headwall H6CA or similar approved.
7. A proprietary silt fence product should be used and installed to the manufacturers guidelines.
8. Silt fences to be installed to intercept all runoff from all unvegetated slopes. When vegetation has been established and risk silt run off is minimal the silt fence can be removed.

Issue	Date	By	Chkd	Appd
0	16/12/16	SM	NF	AH
	Discharge Planning			
A	07/12/16	JB	NF	AH
	Discharge Planning			

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78 East Street, Leeds, LS9 8EE

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Client
York Potash Ltd

Job Title
York Potash
Site Preparation
Phase 2

Surface Water Drainage
Typical Swale and Silt Fence Details

Scale at A1: As shown

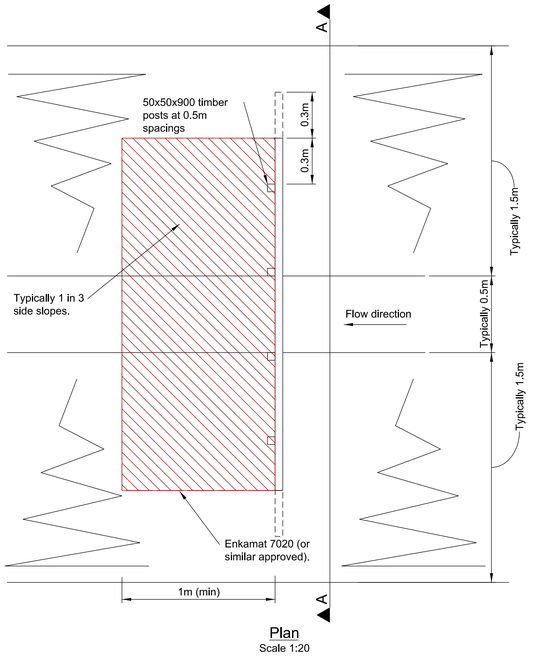
Discipline: Drainage

Job No: **234376**

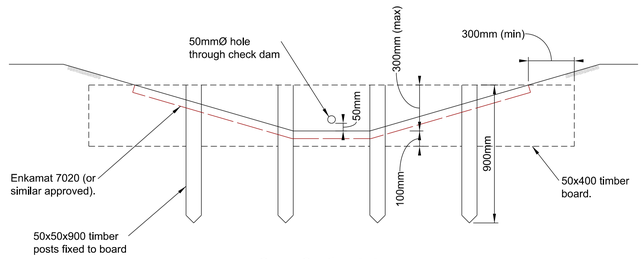
Drawing Status: **Issue**

Drawing No: **YP-P10-DNF-CD-023**

Issue: **0**

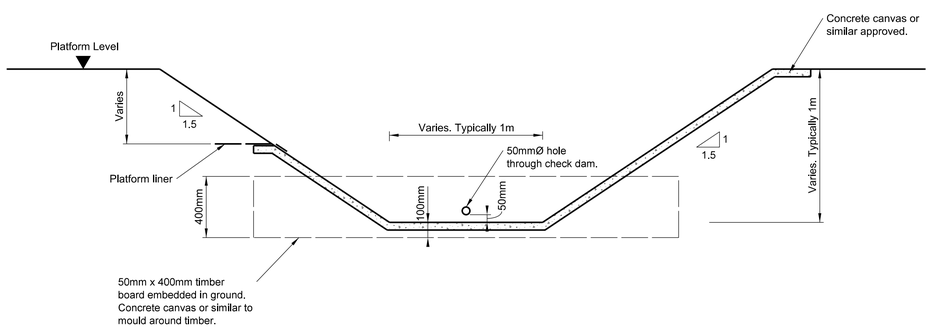


Plan
Scale 1:20

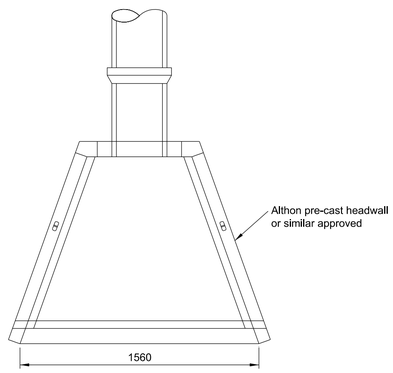


Cross Section A-A
Scale 1:20

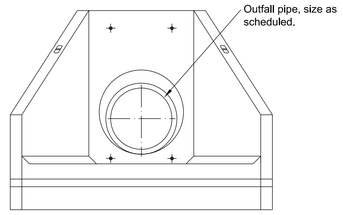
Typical Check Dam in Swale



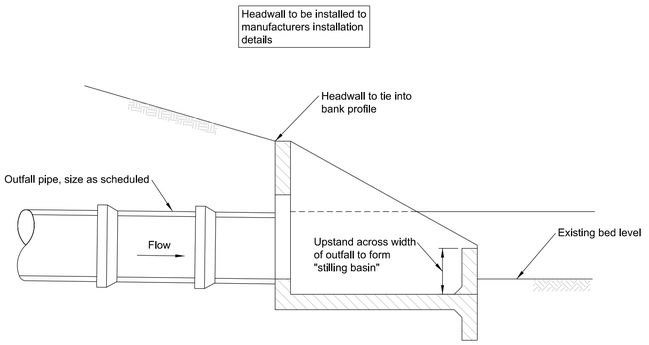
Typical Ditch with Check Dam
Scale 1:20



Plan
Scale 1:20



Elevation
Scale 1:20



Section
Scale 1:20

Outfall to Existing Watercourse Typical Detail

Notes:

1. To be read in conjunction with all relevant project drawings and specifications.
2. All levels in metres above Ordnance Datum.
3. All dimensions in mm unless otherwise stated.
4. For outfall locations, refer to the surface water drainage general arrangement plan, YP-P10-DNF-CD-001. Exact position to be confirmed on-site by a qualified engineer.

Issue	Date	By	Chkd	Appd
0	16/12/16	SM	NF	AH
	Discharge Planning			
A	07/12/16	JB	NF	AH
	Discharge Planning			

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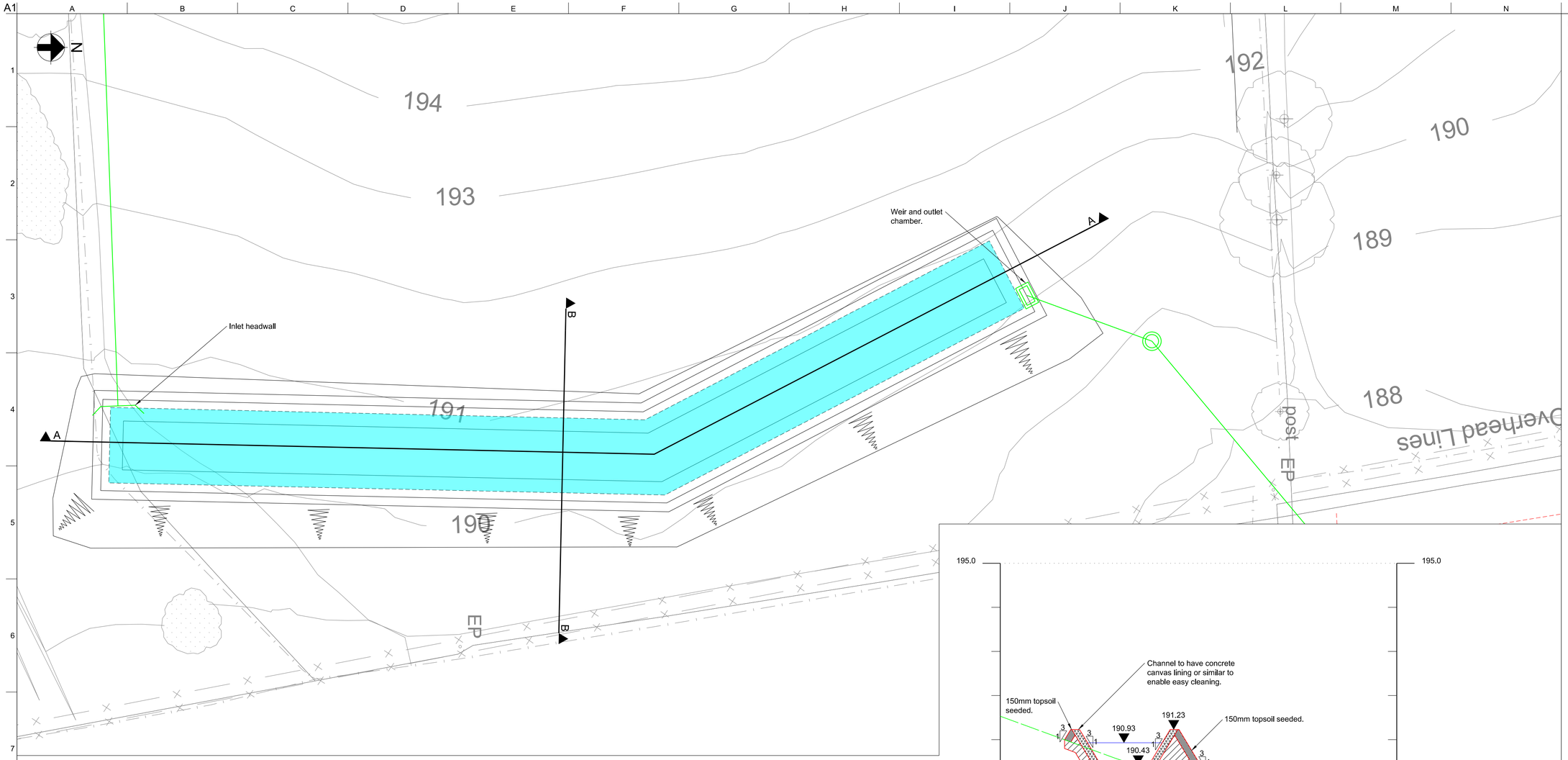
Client
York Potash Ltd

Job Title
York Potash
Site Preparation
(Phase 2)

Surface Water Drainage
Typical Ditch Check Dam and Outfall Details

Scale at A1: As shown
Discipline: Drainage
Job No: 234376
Drawing Status: Issue
Drawing No: YP-P10-DNF-CD-024
Issue: 0

A1



Section B-B

Scale H 1:250 V 1:50

Section A-A

Scale H 1:250 V 1:50

Key for Plan:

- Extents of design water level
- Carrier drain and manhole
- Headwall

Key for Sections:

- Existing ground profile
- Proposed landscape profile
- Design water level
- 150mm topsoil seeded
- Concrete Canvas Lining or similar approved
- Class 2A engineered clay fill

\\Global\europe\Leeds\Jobs\230000\234376-00\7 Anup\5-32 CAD\0_Drawings\YP-P10-DNF-CD-025.dgn

Issue	Date	By	Chkd	Appd
0	19/12/16	SM	NF	AH
	Discharge Planning			
A	07/12/16	JB	NF	AH
	Discharge Planning			

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Client
York Potash Ltd

Job Title
York Potash
Site Preparation
(Phase 2)

Surface Water Drainage
Silt Removal Facility
General Arrangement and Sections

Scale at A1 1:250

Discipline Drainage

Job No **234376**

Drawing Status **Issue**

Drawing No **YP-P10-DNF-CD-025**

Issue **0**

Do not scale

Photograph 1. Sneaton Thorpe Beck Tributary in the vicinity of the proposed temporary outfall location

Flow monitoring has been undertaken at a number of locations on Sneaton Thorpe Beck. The monitoring data gives typical depth of flow at three monitoring points on the beck over a 4 month period. During rainfall events the depths at these monitoring points increase to about 200mm. The depths of the water in the beck will be dependent on the geometry at any specific location, but the data offers a guide to allow us to undertake some calculations. If we consider that the depth data only covers a 4 month period, we would expect increased depths during higher return period rainfall events.

Using the above information a manning's calculation was undertaken to give an indication of typical velocities in the existing beck during rainfall events:

Manning's "n" has been estimated using (Chow, 1959):
3a. Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged. Bottom: gravels cobbles and few boulders: normal n = 0.040

Slope: 1 in 20
Width of base = 1m
Depth of flow = varies

Manning's Equation

$$V = \frac{R^{2/3} S^{1/2}}{n}$$

V is average velocity (m/s)
R = hydraulic radius (m)
S = energy slope (m/m)
n = Manning's roughness coefficient

Subject Maximum velocity to discharge surface water into Sneaton Thorpe Beck

Date 7 December 2016 Job No/Ref 234376-00

Depth of flow (mm)	Velocity (m/s)
100	1.07
200	1.53
300	1.83
400	2.05

This table gives indicative average velocities in the tributary of Sneaton Thorpe Beck downstream of the outfall during rainfall events.

The results suggest velocities ranging from about 1 m/s to 2m/s would be expected during rainfall events. Velocities nearer the upper end of this range would be expected for large storm events such as a 1 in 20year return period event.

An email from the Environment Agency on the 18th February 2016 contained guidance notes with typical outfall structures that contained limits to the exit velocities. These were 1.2m/s for a typical outfall without a stilling basin and 1.8m/s for outfalls with a stilling basin.

Using the information above, a conservative maximum discharge velocity to set for this outfall is 1.2m/s for return periods up to the 1 in 20 year return period event.

ARUP	Job No.	Sheet No.	Rev.
	234376-00		
	Member/Location	Leeds	
Job Title: York Potash	Drg. Ref.		
Calculation: Site Prep Phase 2 Calcs Critical Storm	Made by: VS	Date: 05/12/2016	Chd.: NF

The volume of the ditch and the pond, as well as the discharge flow rates are based on the results from the P10 WinDES Model: Dove_Nest_Farm_Phase_2 _rev7_For_Planning.
Maximum utilised flow depth and volume diring the critical storm used as most conservative estimate.

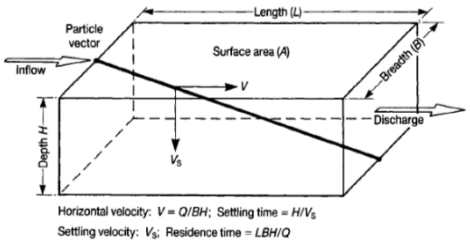

Figure 6.8 *Idealised settlement of discrete particles*

$$\eta = V_s t_R / d_1$$

"*Design of flood storage reservoirs*" *(CIRIA B14, 1993),*
Chapter 6.5, "estimating Pollutant Removal Efficiency "

Table 6.6 Settling velocities and particle size

Sediment grade	*Particle diameter d (mm)*	*Settling velocity*	V_s *(mm/s) at 10°C*
		Sand, density 2650 kg/m³	*Sewage solids, density 1200 kg/m³*
Gravel	10.0	800.0	—
Coarse sand	1.0	200.0	30.0
Medium sand	0.5	70.0	17.0
Fine sand	0.2	22.0	5.0
Very fine sand	0.1	10.0	1.3
Coarse silt	0.06	6.7	0.3
Fine silt	0.01	0.18	0.08
Coarse clay	0.004	0.016	0.002
Fine clay	0.001	0.011	0.001

For soil particles: $V_s = 1/10\ [d/0.0314]^{1/2}$

Silt removal facility

Volume of treatment ditch	640	m3	Based on Geometry of treatment facility
Total Treatment Volume =	640	m3	
Discharge Rate =	167.8	l/s	*120min critical duration design storm.*
Average Retention Time =	3814	s	1.1 h
Depth Varies, approx:	0.4	m	

Treatment Efficiency Rates

Fine Silt Particles
Settling Velocity Vs= 0.18 mm/s *From Table 6.6*
Removal efficiency is 172%
Therefore it is assumed that all silt and coarser particles will settle out.

Coarse Clay
Settling Velocity Vs= 0.016 mm/s
Removal efficiency is 15.3%
Therefore it is assumed that 15.3% of the coarse clay particles will settle out.

Fine Clay
Settling Velocity Vs= 0.011 mm/s
Removal efficiency is 10.5%
Therefore it is assumed that 10.5% of the fine clay particles will settle out.

POND

Volume of pond	1400	m3	Based on critical Design Storm
Total Treatment Volume =	1400	m3	
Discharge Rate =	56.4	l/s	*Q Bar From the WinDes Model*
Average Retention Time =	24823	s	6.9 h
Depth Varies, approx:	0.35	m	*From the WinDes Model*

Treatment Efficiency Rates

Fine Silt Particles
Settling Velocity Vs= 0.18 mm/s *From Table 6.6*
Removal efficiency is 1277%
Therefore it is assumed that all silt and coarser particles will settle out.

Coarse Clay
Settling Velocity Vs= 0.016 mm/s
Removal efficiency is 113.5%
Therefore it is assumed that all the coarse clay particles will settle out.

Fine Clay
Settling Velocity Vs= 0.011 mm/s
Removal efficiency is 78.0%
Therefore it is assumed that 78% of the fine clay particles will settle out.

Particle Size	Typical Settling velocities (mm/s)	% Removal in Silt Removal Facility	% Removal in Attenuation Pond
Course Sand	200	100%	
Fine Sand	22	100%	
Coarse Silt	6.7	100%	
Fine Silt	0.18	100%	
Coarse Clay	0.016	15%	100%
Fine Clay	0.011	10%	78%

Particle Size	Overall Removal
Sand	100%
Silt	100%
Clay	90%

Excluding any removal benefits from Silt Fences and Check Dams

Appendix F

Typical Drainage Details