A38 Derby Junctions

TR010022

Volume 6

6.3 Environmental Statement Appendices

Appendix 13.1: HAWRAT Methods A & D Data and Results

Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

April 2019

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A38 Derby Junctions Development Consent Order 202[ ]

6.3 Environmental Statement Appendices
Appendix 13.1: HAWRAT Methods A & D Data and Results

Regulation Number	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010022
Application Document Reference	6.3
Author	A38 Derby Junctions Project Team, Highways England

Version	Date	Status of Version
1	April 2019	DCO Application

List of Tables

APPENDIX 13.1: HAWRAT METHODS A & D DATA AND RESULTS

1.1.1 The following technical notes provides a summary of the results of the water quality risk assessment of routine highway runoff and spillage risk from the A38 Derby Junctions scheme: Kingsway, Markeaton and Little Eaton junctions.

1.1.2 A full description of the drainage design and the drainage catchments for the three junctions are shown in Figures 2.2, 2.3 and 2.4 within the A38 Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**]).

HAWRAT Method A

1.1.3 Method A assesses the impact of routine road runoff on receiving waterbodies by considering the copper and zinc content of the runoff (as a proxy for a range of metals typically found in highway runoff), together with the potential for chronic sediment impact on the receiving watercourse (and associated sediment-bound pollutants such as hydrocarbons which tend to be predominantly associated with sediments).

1.1.4 Should the assessment indicate that discharges from the outfalls are failing to meet standards, then treatment measures can be considered. The effectivity of various treatment systems in terms of sediment removal, treatment of dissolved metals and hydrocarbons is described in DMRB HD33/16 and HA103/06, and is based on research carried out by the then named Highways Agency.

1.1.5 Data used in the assessment is presented in Tables 1, 3 and 5 for the three junctions, with the results are presented in Tables 2, 4 and 6. Screen prints from the assessment are also included herein.

Kingsway junction

Table 1: Data used within the HAWRAT Method A routine runoff assessment: Kingsway junction

Parameter	Value	Source
Annual Average Daily Traffic (AADT)	Outfall 1: >50,000 - <100,000 (highest trafficked part of catchment area) Outfall 2: >=10,000 and <50,000 (highest trafficked part of catchment area) Outfall 3: >=10,000 and <50,000 (highest trafficked part of catchment area) Outfall 4: >=10,000 and <50,000 (highest trafficked part of catchment area) Outfall 5: >50,000 - <100,000 (highest trafficked part of catchment area)	AECOM engineers, email rcvd 10/10/2018 – design traffic flow in 2039
Climatic Region	Cold-Dry	HAWRAT embedded data
Rainfall Site	Lincoln (Standard Annual Average Rainfall 600 mm)	HAWRAT embedded data
Annual 95%ile river flow	Bramble Brook Calculated Q95: 0.002 m^3/s	Calculated using Wallingford Hydrosolutions Ltd LowFlow software
Estimated River Width	2.5 m	Measured from MAGIC map
Catchments	Catchment 1: eastern dumbbell and south (to outfall 1) Catchment 2: northern dumbbell and slip roads (to outfall 2) Catchment 3: south off slip (to outfall 3) Catchment 4: eastern access road (outfall to 4) Catchment 5: mainline through junction	Figure 2.2 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])
Impermeable road area drained (ha)	C1: 1.943 C2: 1.338 C3: 0.589 C4: 0.476 C5: 0.850 Cumulative: C1+C2+C3+C4+C5= 5.196 ha C2+C1= 3.281 ha C1+C5= 2.793 ha C5+C3+C4= 1.915 ha	Figure 2.2 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])
Permeable area drained (ha)	C1: 0.2626 C2: 0.1318 C3: 0.0876 C4: 0.0506 C5: 0.2392 Cumulative: C1+C2+C3+C4+C5= 0.7718 ha C2+C1= 0.3944 ha C1+C5= 0.5018 ha C5+C3+C4= 0.5018 ha	Figure 2.2 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])
Base Flow Index	0.5	Adopted value of 0.5 is a default as suggested by the HAWRAT manual. No gauging stations are on the impacted watercourses on National River Flow Archive to provide data.

Parameter	Value	Source
Hardness	High=> 200 mg/L $CaCO_3$	Environment Agency Data, for Mackworth Brook at Markeaton used as a proxy for watercourses in this area.
Protected Sites in or within 1km downstream	None	Magic Map

Table 2: HAWRAT Method A assessment results without mitigation: Kingsway junction

Outfall	Soluble Acute Impact Copper	Soluble Acute Impact Zinc	Sediment Chronic Impact			Annual Average Cu	Annual Average Soluble Zn
			Accumulating ?	Extensive ?	Deposition Index (% treatment required)	EQS: 10 µg/l	EQS: 7.8 µg/l
C1	PASS	PASS	Yes	Yes	141 (30% settlement required)	0.32	1.43
C2	PASS	PASS	Yes	No	97 (no required treatment)	0.20	0.85
C3	PASS	PASS	Yes	No	43 (no required treatment)	0.10	0.42
C4	PASS	PASS	Yes	No	35 (no required treatment)	0.08	0.35
C5	PASS	PASS	Yes	No	62 (no required treatment)	0.16	0.73
Cumulative for outfalls within 1km, C1, C2, C3, C4 and C5	PASS	PASS	n/a	n/a	n/a	0.64	2.79

With existing drainage design mitigation

Outfall	Soluble Acute Impact Copper	Soluble Acute Impact Zinc	Sediment Chronic Impact			Annual Average Cu	Annual Average Soluble Zn
			Accumulating ?	Extensive ?	Deposition Index (% treatment required)	EQS: 10 µg/l	EQS: 7.8 µg/l
C1 (with Attenuation Pond)	PASS	PASS	Yes	No	56 (no other treatment required)	0.19	0.86

Summary of Results: Kingsway junction

1.1.6 The initial results without mitigation show that all outfalls, even considering cumulative assessment, pass all the criteria for acute and long term metal pollution. However, for sediment impact, without mitigation, Catchment C1 fails for sediment impact (30% settlement required).

1.1.7 Within the drainage design there is a pond included the system for outfall C1. A wet attenuation pond results in a decrease of 60% of suspended solids (HD 33/16 Table 8.1 Indicative Treatment Efficiencies of Drainage Systems). With the mitigation already included within the drainage design outfall C1 passes the HAWRAT assessment.

Markeaton junction

Table 3: Data used within the HAWRAT Method A routine runoff assessment: Markeaton junction

Parameter	Value	Source
Annual Average Daily Traffic (AADT)	Outfall 6: local traffic to park Outfall 7: >50,000 - <100,000 (highest trafficked part of catchment area) Outfall 8: assess on highest contributing traffic, mainline >50,000 - <100,000 Outfall 9: assess on highest contributing traffic, mainline >50,000 - <100,000 Outfall 10: >50,000 - <100,000 (highest trafficked part of catchment area) Outfall 11: >=10,000 and <50,000 (highest trafficked part of catchment area)	AECOM engineers, email rcvd 10/10/2018 – design traffic flow in 2039
Climatic Region	Cold-Dry	HAWRAT embedded data
Rainfall Site	Lincoln (Standard Annual Average Rainfall 600 mm)	HAWRAT embedded data
Width of watercourse	Outfall 7:13m wide lake at location of discharge north of A38 Outfall 8: downstream of Markeaton Lake outflow 2.5m Outfall 9: downstream of A38, 2.5m Outfall 10: 7m wide lake at location of discharge south of A38	Measured from MAGIC map
Annual 95%ile river flow	Kedleston Road Junction assumed a conservative 0.001 m^3/s to be conservative. Difficult to calculate using LowFlow software due to modified flow regime with weirs/lakes and sluices upstream Markeaton Lake flow assumed to be 0.001m^3/s	No flow
Catchments	Catchment 6: to Markeaton park* Catchment 7: to Markeaton Lake Catchment 8: Kedleston Road, Northbound off slip, and some mainline Catchment 9: Kedleston Road, Southbound on slip and mainline Catchment 10: to Mill Pond, south of A38 Catchment 11: to Ashbourne Road*	Figure 2.3 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])
Impermeable road area drained (ha)	C6: 0.152 ha C7: 1.513 ha C8: 0.388 ha C9: 0.833 ha C10: 3.391 ha C11: 0.184 ha Cumulative: C10+ C7 = 4.904 ha C8 + C9 = 1.221 ha	Figure 2.3 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])

Parameter	Value	Source
Permeable area drained (ha)	C7: 0.1086 ha C8: 0.0526 ha C9: 0.0388 ha C10: 0.0872 ha Cumulative: C10+ C7 = 0.1958 ha C8 + C9 = 0.0914 ha	Figure 2.3 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])
Base Flow Index	0.5	Adopted value of 0.5 is a default as suggested by the HAWRAT manual. No gauging stations are on the impacted watercourses on National River Flow Archive to provide data.
Hardness	High=> 200 mg/L $CaCO_3$	Environment Agency Data for Markeaton Brook
Protected Sites in or within 1km downstream	None	Magic Map

*Catchments 11 and 6 cannot be assessed using HAWRAT due to outfalling to combined sewer, and small area outfalling to Markeaton Park drainage respectively.

Table 4: HAWRAT Method A assessment results without mitigation: Markeaton junction

Outfall	Soluble Acute Impact Copper	Soluble Acute Impact Zinc	Sediment Chronic Impact			Annual Average Cu	Annual Average Soluble Zn
			Accumulating?	Extensive?	Deposition Index (% treatment required)	EQS: 10 µg/l	EQS: 7.8 µg/l
C7	PASS	PASS	Yes	No, but alert downstream structure	22 (no required treatment)	0.45	1.98
C8	PASS	PASS	Yes	No	29 (no treatment required)	0.15	0.68
C9	PASS	PASS	Yes	No	62 (no treatment required)	0.24	1.02
C10	PASS	PASS	Yes	No, but alert downstream structure	90 (no required treatment)	0.76	3.29
C8 +C9 (within 100m)	PASS	PASS	Yes	No	90 (no treatment required)	0.39	1.70
C7 +C10 (within 100 m)	FAIL (2 exceedances allowed – result is 2.7 exceedances per year)	PASS	Yes	Yes – and alert downstream structure	130 (24% settlement needed)	0.92	3.99
Addition of mitigation on C1, recalculation of C1+C4 cumulative assessment							
C7 +C10 (within 100 m	PASS	PASS	Yes	No, but alert d/s structure	96 (sedimentation pond with 24 hr retention period, and ditches)	0.75	3.23

Summary of Results: Markeaton junction

1.1.8 The low flow conditions have been assumed to be 1l/s for a conservative assessment. This is due to the difficulties of calculating the volume of the Q95 low flow measurement using the LowFlow software in this area. The software is based on catchment area and rainfall/runoff. In this area the flow regime is highly modified due to the presence of weirs, diverted watercourses, lakes and man-operated sluice gates.

1.1.9 The initial results without mitigation show that the outfalls for catchments 7 and 10 pass all the criteria for acute and long term metal pollution, and for sediment impact. However, for both outfalls, there is an 'alert downstream structure' due to the presence of a still water body/lake system downstream of the A38.

1.1.10 Initial results without mitigation show that outfalls C8, and C9 pass all the criteria for acute and long term metal pollution, and for sediment impact. Also the cumulative assessment for C8 and C9 pass all the criteria for acute and long term metal pollution and sediment impact.

1.1.11 The outfalls for catchments 7 and 10 are also assessed using the cumulative assessment procedure for outfalls under 100m apart. Without mitigation, the combined outfalls C7 and C10 failed for soluble copper in addition to a failure for sediments, and there being the 'alert downstream structure', indicating a need for mitigation. The drainage design was subsequently developed to include a forebay/sedimentation wet pond to provide some mitigation to reduce levels of soluble copper and suspended sediments in part of the road drainage prior to discharge. The wet pond has been sized to accept the first flush for a 1 in 10 year rainfall event, with at least a 24 hour retention time. In addition, there are lined ditches conveying the water to the lined forebay and will drain through to the attenuation tank via a filter drain. The retention time of the lined forebay would be greater than 24 hours. There is then a short length of ditch to the discharge location.

1.1.12 From Table 8.1 within HD 33/16, a wet retention pond has a potential maximum suspended solids removal of 60%, and a dissolved copper removal of 40%, and ditches have a potential maximum suspended solids removal of 25%, and a dissolved metals removal of 15%. However, as the drainage strategy allows for the retention of first flush only, the maximum percentage removal cannot be applied to the calculations. As most of the pollutants/sediments would be within the first flush, it is reasonable to apply an efficiency of half of the above percentage removal figures i.e.:

- (60 + 25)/2 = 43% removal for suspended solids
- (40 + 15)/2 = 28% removal for dissolved metals

1.1.13 The mitigation provided by the wet pond applies to only part of the cumulative area (i.e. C10 and not C7). The ratio of C10 to the whole area is 0.69, and therefore the above treatment efficiencies have been decreased again to correspond to the fact that not 100% of the impermeable area is being treated, i.e.:

- Suspended solids: 43 X 0.69 = 30%
- Dissolved metals: 28 X 0.69 = 19%

1.1.14 Using the above treatment efficiencies within the HAWRAT assessment results, the cumulative assessment for C7 + C10 results in a Pass.

1.1.15 This assessment does not take into any organic carbon content in the lake which may also reduce the bioavailability of certain dissolved metals.

Little Eaton junction

Table 5: Data used within the HAWRAT Method A routine runoff assessment: Little Eaton junction

Parameter	Value	Source
Annual Average Daily Traffic (AADT)	Outfall 12: >50,000 - <100,000 Outfall 13: >50,000 - <100,000 Outfall 14: >10,000 - <50,000 Outfall 15: >50,000 - <100,000	AECOM engineers, email rcvd 10/10/2018 – design traffic flow in 2039
Climatic Region	Cold-Dry	HAWRAT embedded data
Rainfall Site	Lincoln (Standard Annual Average Rainfall 600 mm)	HAWRAT embedded data
Width of Watercourse	Dam Brook : 4 m River Derwent : 32 m (outfall 4)	Measured from MAGIC map
Annual 95%ile river flow	Dam Brook : 0.009 m^3/s River Derwent : 4.609 m^3/s	Calculated using Wallingford Hydrosolutions Ltd LowFlow software for Dam Brook, National River Flow Archive Data, Station 28085 Derwent at St Marys Bridge
Catchments	Catchment 12: to Dam Brook Catchment 13: to Dam Brook Catchment 14: to Dam Brook Catchment 15: to River Derwent	Figure 2.4 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])
Impermeable road area drained (ha)	C12: 2.625 C13: 1.837 C14: 0.332 C15: 0.953 C12 + C13 = 4.462 ha	Figure 2.4 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])
Permeable area drained (ha)	C12: 0.3112 C13: 0.2608 C14: 0.1782 C15: 0.1194 C12 + C13 =0.572	Figure 2.4 within the Road Drainage Strategy (refer to Appendix 13.4 [**TR010022/APP/6.3**])
Base Flow Index	0.5	Adopted value of 0.5 is a default as suggested by the HAWRAT manual. No gauging stations are on the impacted watercourses on National River Flow Archive to provide data.
Hardness	High=> 200 mg/L $CaCO_3$	Environment Agency Data
Protected Sites in or within 1km downstream	None	Magic Map

Table 6: HAWRAT Method A assessment results without mitigation: Little Eaton junction

Outfall	Soluble Acute Impact Copper	Soluble Acute Impact Zinc	Sediment Chronic Impact			Annual Average Cu	Annual Average Soluble Zn
			Accumulating?	Extensive?	Deposition Index (% treatment required)	EQS: 10 µg/l	EQS: 7.8 µg/l
C12	PASS	PASS	Yes	Yes	109 (9% settlement required)	0.12	0.53
C13	PASS	PASS	Yes	No	76 (no required treatment)	0.09	0.38
C14	PASS	PASS	Yes	No	14 (no required treatment)	0.01	0.06
C15	PASS	PASS	No	No	n/a	0.00	0.00
C12 +C13 (within 100m)	PASS	PASS	Yes	Yes	185 (46% settlement needed)	0.19	0.84

With mitigation already in the drainage design

Outfall	Soluble Acute Impact Copper	Soluble Acute Impact Zinc	Sediment Chronic Impact			Annual Average Cu	Annual Average Soluble Zn
			Accumulating?	Extensive?	Deposition Index (% treatment required)	EQS: 10 µg/l	EQS: 7.8 µg/l
C12 (with attenuation pond)	PASS	PASS	Yes	NO	43 (no further treatment required)	0.07	0.32
C12 +C13 (within 100m)	PASS	PASS	Yes	NO	74 (no further treatment required)	0.11	0.50

Summary of Results: Little Eaton junction

1.1.16 The initial results without mitigation show that outfalls C13, C14 and C15 pass all the criteria for acute and long term metal pollution, and for sediment impact. However, for outfall C12, there is a failure for sediment impact, without mitigation (9% settlement required), and the cumulative assessment for C12+C13 (46% settlement required).

1.1.17 With the proposed attenuation ponds included as mitigation, the HAWRAT assessment passes for all parameters.

Method D Assessment: Spillage Risk

1.1.18 Method D in DMRB HD45/09 provides a method that gives an indication of an accidental spillage resulting in a serious pollution incident on a receiving water body, and guides the need for spillage containment measures. Watercourses should be protected so that the risk of a serious pollution incident has an annual probability of less than 1% (equivalent to a return period of 1 in 100 years), unless they are considered to be sensitive (e.g. covered by a SSSI designation), in which case a more stringent annual probability of 0.5% is applied (i.e. 1 in 200 years). Where the risk is greater than the allowable standard, spillage containment measures can be built into the drainage designs to reduce the risk.

1.1.19 For the Scheme, the probability that a spillage would cause a pollution incident has been calculated for the outfalls. Data used includes road lengths draining to each outfall, and modelled traffic data. Results have been provided in Tables 7, 8 and 9.

1.1.20 Based on the analysis carried out no significant spillage risk is anticipated from any of the remodelled road junctions.

Table 7: Method D assessment results: Kingsway junction

Outfall (s)	Annual Probability of Spillage (%)	Predicted Return Period (years)
C1	0.0003	3441
C2	0.0001	9726
C3	0.0000	22013
C4	0.0000	32949
C5	0.0001	9273
C1+C2+C3+C4+c5	0.0005	1734

Table 8: Method D assessment results: Markeaton junction

Outfall (s)	Annual Probability of Spillage (%)	Predicted Return Period (years)
C7	0.0002	4622
C8	0.0000	32506
C9	0.0001	7922
C10	0.0005	2135
C8+C9	0.0001	6369
C7+C10	0.0006	1460

C11 not assessed as small catchment outfalling to sewer

C6 not assessed as park access road

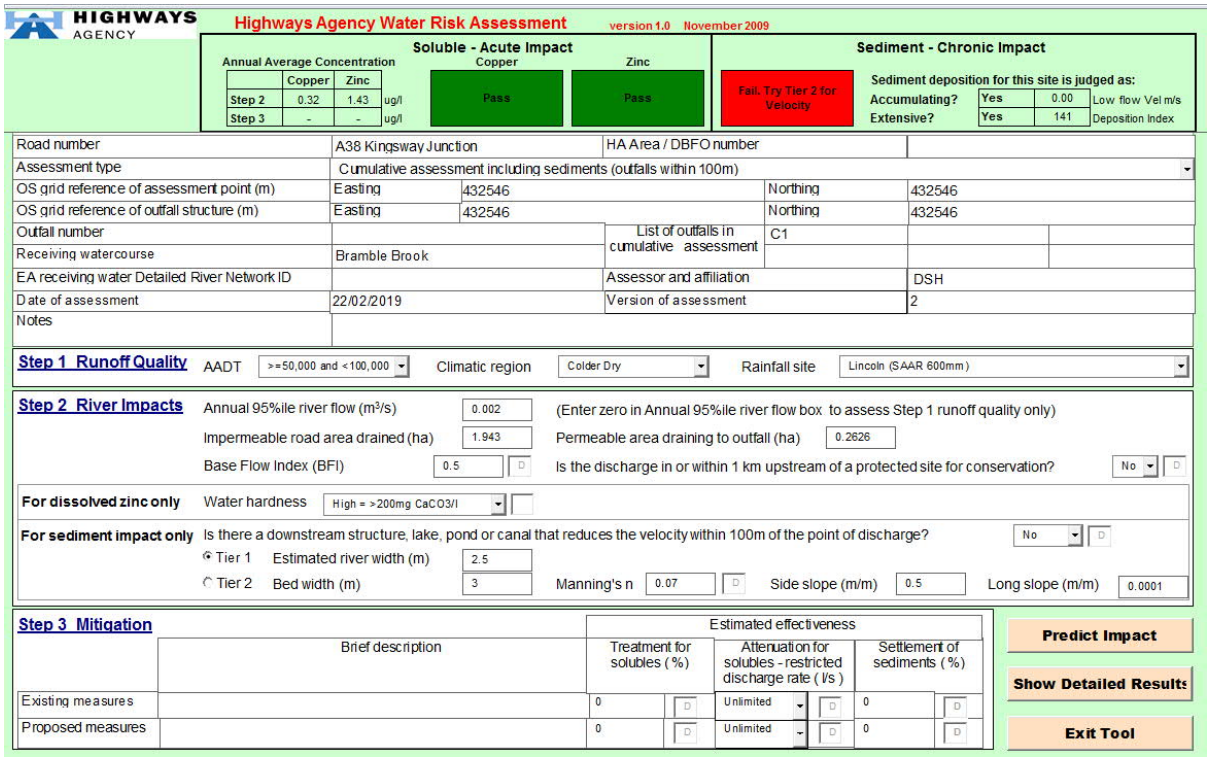
Table 9: Method D assessment results: Little Eaton junction

Outfall (s)	Annual Probability of Spillage (%)	Predicted Return Period (years)
C12	0.0003	3093
C13	0.0003	3443
C14	0.0000	43652
C15	0.0001	8753
C12,C13,C14	0.0006	1570

C3 – assumed higher traffic at north end of mainline carries through junction to be a more conservative estimate of spillage risk

Screen prints from HAWRAT for all assessments

Kingsway junction:



HIGHWAYS AGENCY — Highways Agency Water Risk Assessment version 1.0 November 2009

Soluble - Acute Impact — Annual Average Concentration

	Copper	Zinc	
Step 2	0.32	1.43	ug/l
Step 3	-	-	ug/l

Copper: Pass. Zinc: Pass.

Sediment - Chronic Impact: Fail. Try Tier 2 for Velocity

Sediment deposition for this site is judged as:
Accumulating? Yes 0.00 Low flow Vel m/s
Extensive? Yes 141 Deposition Index

Road number	A38 Kingsway Junction		HA Area / DBFO number		
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	432546		Northing	432546
OS grid reference of outfall structure (m)	Easting	432546		Northing	432546
Outfall number			List of outfalls in cumulative assessment	C1	
Receiving watercourse	Bramble Brook				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

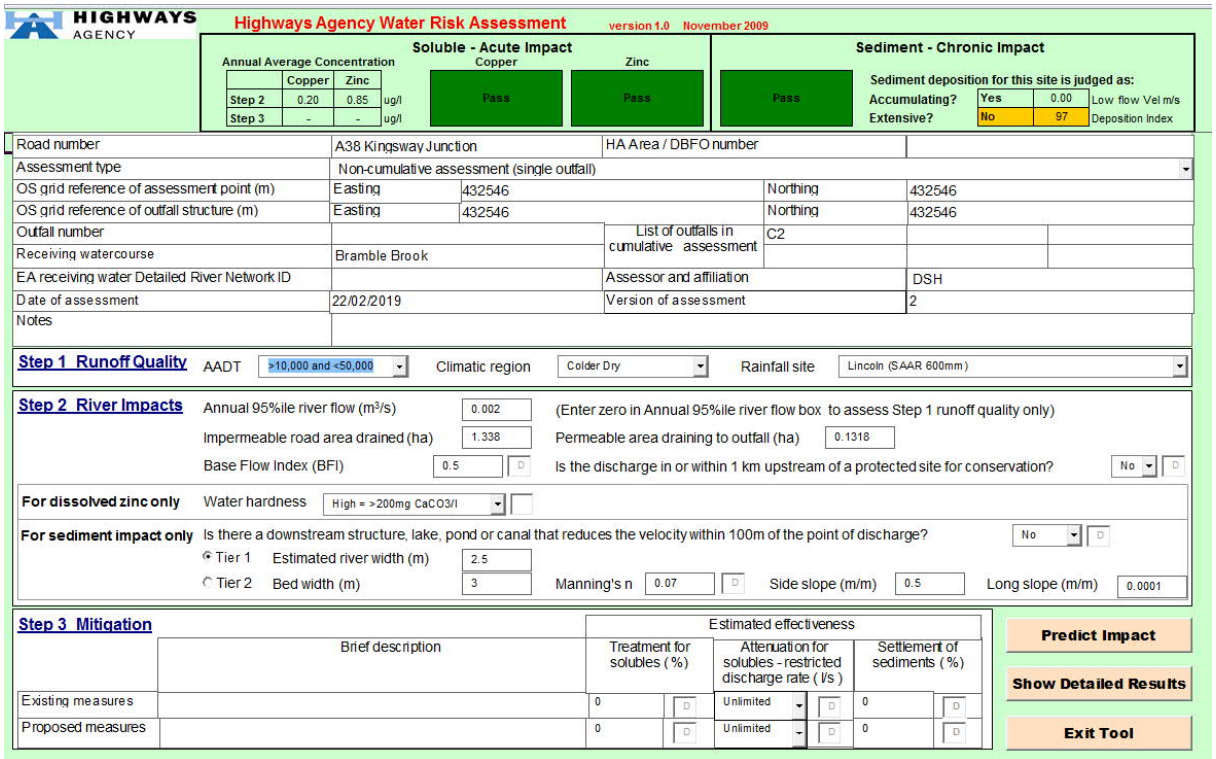
Step 1 Runoff Quality — AADT: >=50,000 and <100,000 — Climatic region: Colder Dry — Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts
- Annual 95%ile river flow (m³/s): 0.002 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
- Impermeable road area drained (ha): 1.943 — Permeable area draining to outfall (ha): 0.2626
- Base Flow Index (BFI): 0.5 — Is the discharge in or within 1 km upstream of a protected site for conservation? No
- For dissolved zinc only: Water hardness: High = >200mg CaCO3/l
- For sediment impact only: Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
- Tier 1: Estimated river width (m): 2.5
- Tier 2: Bed width (m): 3 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact — Show Detailed Results — Exit Tool



HIGHWAYS AGENCY — Highways Agency Water Risk Assessment version 1.0 November 2009

Soluble - Acute Impact — Annual Average Concentration

	Copper	Zinc	
Step 2	0.20	0.85	ug/l
Step 3	-	-	ug/l

Copper: Pass. Zinc: Pass.

Sediment - Chronic Impact: Pass

Sediment deposition for this site is judged as:
Accumulating? Yes 0.00 Low flow Vel m/s
Extensive? No 97 Deposition Index

Road number	A38 Kingsway Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	432546		Northing	432546
OS grid reference of outfall structure (m)	Easting	432546		Northing	432546
Outfall number			List of outfalls in cumulative assessment	C2	
Receiving watercourse	Bramble Brook				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

Step 1 Runoff Quality — AADT: >10,000 and <50,000 — Climatic region: Colder Dry — Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts
- Annual 95%ile river flow (m³/s): 0.002 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
- Impermeable road area drained (ha): 1.338 — Permeable area draining to outfall (ha): 0.1318
- Base Flow Index (BFI): 0.5 — Is the discharge in or within 1 km upstream of a protected site for conservation? No
- For dissolved zinc only: Water hardness: High = >200mg CaCO3/l
- For sediment impact only: Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
- Tier 1: Estimated river width (m): 2.5
- Tier 2: Bed width (m): 3 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact — Show Detailed Results — Exit Tool

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment version 1.0 November 2009

Annual Average Concentration	Copper	Zinc	
Step 2	0.10	0.42	ug/l
Step 3	-	-	ug/l

Soluble - Acute Impact: Copper: Pass; Zinc: Pass

Sediment - Chronic Impact: Pass

Sediment deposition for this site is judged as:
Accumulating? Yes 0.00 Low flow Vel m/s
Extensive? No 43 Deposition Index

Road number	A38 Kingsway Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	432546		Northing	432546
OS grid reference of outfall structure (m)	Easting	432546		Northing	432546
Outfall number			List of outfalls in cumulative assessment	C3	
Receiving watercourse	Bramble Brook				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

Step 1 Runoff Quality AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts
Annual 95%ile river flow (m^3/s): 0.002 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
Impermeable road area drained (ha): 0.589 | Permeable area draining to outfall (ha): 0.0876
Base Flow Index (BFI): 0.5 | Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
Tier 1 Estimated river width (m): 2.5
Tier 2 Bed width (m): 3 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment version 1.0 November 2009

Annual Average Concentration	Copper	Zinc	
Step 2	0.08	0.35	ug/l
Step 3	-	-	ug/l

Soluble - Acute Impact: Copper: Pass; Zinc: Pass

Sediment - Chronic Impact: Pass

Sediment deposition for this site is judged as:
Accumulating? Yes 0.00 Low flow Vel m/s
Extensive? No 35 Deposition Index

Road number	A38 Kingsway Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	432546		Northing	432546
OS grid reference of outfall structure (m)	Easting	432546		Northing	432546
Outfall number			List of outfalls in cumulative assessment	C4	
Receiving watercourse	Bramble Brook				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

Step 1 Runoff Quality AADT: >10,000 and <50,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts
Annual 95%ile river flow (m^3/s): 0.002 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
Impermeable road area drained (ha): 0.476 | Permeable area draining to outfall (ha): 0.0506
Base Flow Index (BFI): 0.5 | Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
Tier 1 Estimated river width (m): 2.5
Tier 2 Bed width (m): 3 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment version 1.0 November 2009

Annual Average Concentration	Copper	Zinc	
Step 2	0.16	0.73	ug/l
Step 3	-	-	ug/l

Soluble - Acute Impact: Copper: Pass; Zinc: Pass

Sediment - Chronic Impact: Pass

Sediment deposition for this site is judged as:
Accumulating? Yes 0.00 Low flow Vel m/s
Extensive? No 62 Deposition Index

Road number	A38 Kingsway Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	432546		Northing	432546
OS grid reference of outfall structure (m)	Easting	432546		Northing	432546
Outfall number			List of outfalls in cumulative assessment	C5	
Receiving watercourse	Bramble Brook				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

Step 1 Runoff Quality: AADT >=50,000 and <100,000; Climatic region: Colder Dry; Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts
- Annual 95%ile river flow (m³/s): 0.002 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
- Impermeable road area drained (ha): 0.850; Permeable area draining to outfall (ha): 0.2392
- Base Flow Index (BFI): 0.5; Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only: Water hardness: High = >200mg CaCO3/l

For sediment impact only: Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
- Tier 1: Estimated river width (m): 2.5
- Tier 2: Bed width (m): 3; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool

HIGHWAYS AGENCY

Highways Agency Water Risk Assessment version 1.0 November 2009

Annual Average Concentration	Copper	Zinc	
Step 2	0.64	2.79	ug/l
Step 3	-	-	ug/l

Soluble - Acute Impact: Copper: Pass; Zinc: Pass

Sediment - Chronic Impact

Sediment deposition for this site is judged as:
Accumulating? Low flow Vel m/s
Extensive? Deposition Index

oad number	A38 Kingsway Junction		HA Area / DBFO number		
ssessment type	Cumulative assessment excluding sediments (outfalls between 100m and 1km apart)				
S grid reference of assessment point (m)	Easting	432824		Northing	336169
S grid reference of outfall structure (m)	Easting			Northing	
utfall number			List of outfalls in cumulative assessment	C1 to C5	
eceiving watercourse	Bramble Brook				
A receiving water Detailed River Network ID			Assessor and affiliation	DSH	
ate of assessment	19/11/2018		Version of assessment	1	
otes					

tep 1 Runoff Quality: AADT >=50,000 and <100,000; Climatic region: Colder Dry; Rainfall site: Lincoln (SAAR 600mm)

tep 2 River Impacts
- Annual 95%ile river flow (m³/s): 0.002 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
- Impermeable road area drained (ha): 5.196; Permeable area draining to outfall (ha): 0.7718
- Base Flow Index (BFI): 0.5; Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only: Water hardness: High = >200mg CaCO3/l

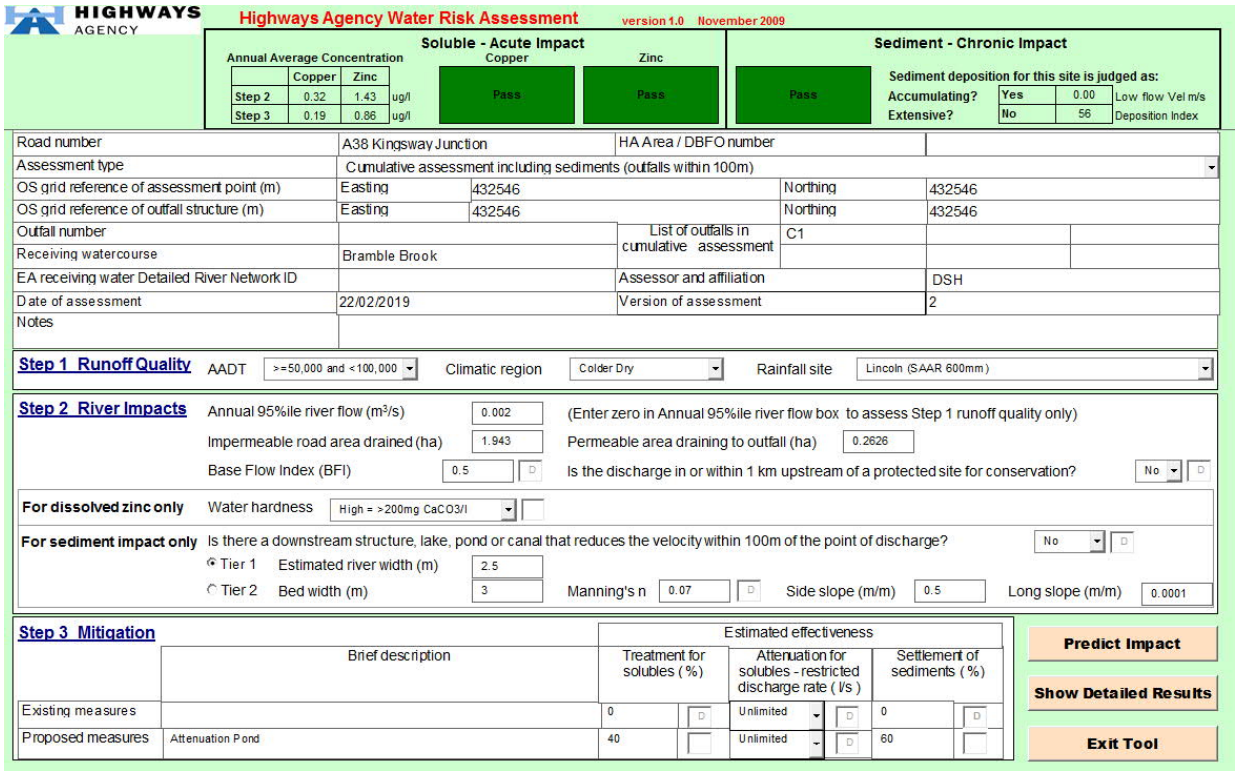
For sediment impact only: Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
- Tier 1: Estimated river width (m): 2.5
- Tier 2: Bed width (m): 3; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

tep 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool

Outfall Catchment C1 with design mitigation included:



HIGHWAYS AGENCY

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Annual Average Concentration	Copper	Zinc	
Step 2	0.32	1.43	ug/l
Step 3	0.19	0.86	ug/l

Soluble - Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.00	Low flow Vel m/s
Extensive?	No	56	Deposition Index

Road number	A38 Kingsway Junction		HA Area / DBFO number		
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	432546	Northing	432546	
OS grid reference of outfall structure (m)	Easting	432546	Northing	432546	
Outfall number			List of outfalls in cumulative assessment	C1	
Receiving watercourse	Bramble Brook				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

Step 1 Runoff Quality AADT: >=50,000 and <100,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s)	0.002	(Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)	
Impermeable road area drained (ha)	1.943	Permeable area draining to outfall (ha)	0.2626
Base Flow Index (BFI)	0.5	Is the discharge in or within 1 km upstream of a protected site for conservation?	No

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 Estimated river width (m): 2.5

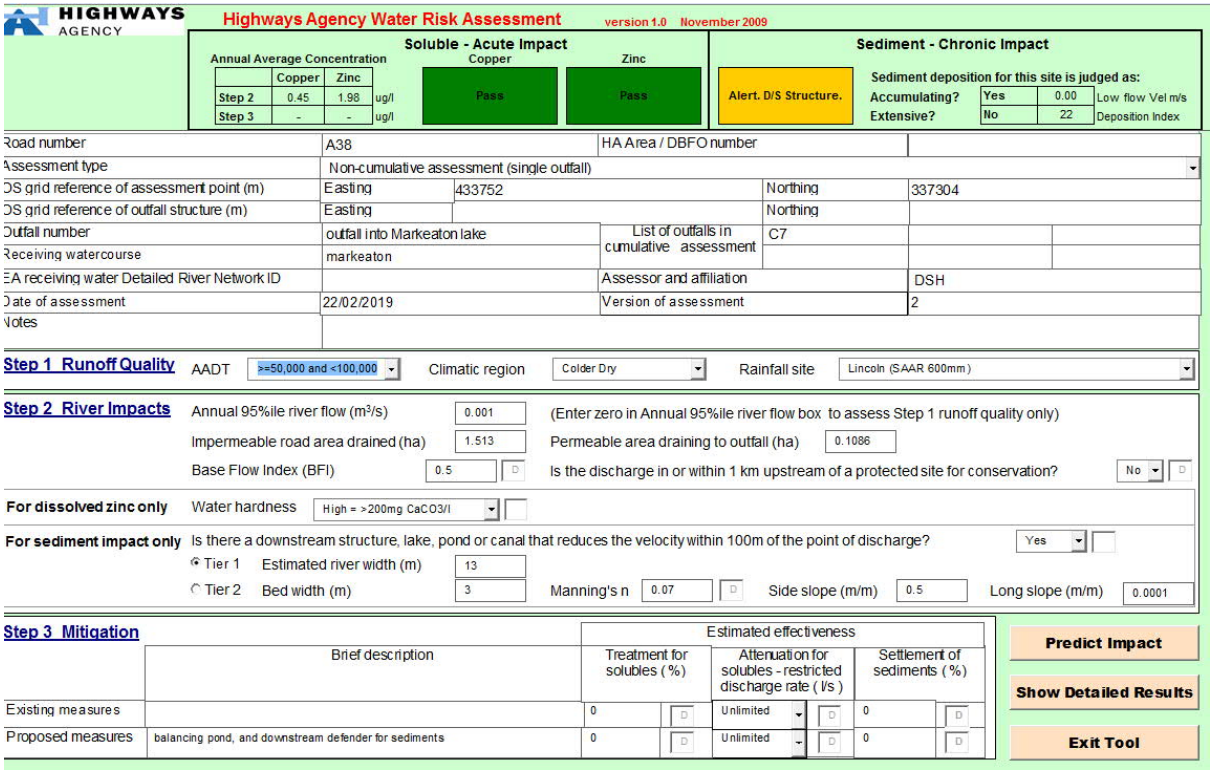
Tier 2 Bed width (m): 3 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures	Attenuation Pond	40	Unlimited	60

Predict Impact | Show Detailed Results | Exit Tool

Markeaton junction:



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Soluble - Acute Impact	Annual Average Concentration			Copper	Zinc	Sediment - Chronic Impact			
	Copper	Zinc					Sediment deposition for this site is judged as:		
Step 2	0.45	1.98	ug/l	Pass	Pass	Alert. D/S Structure.	Accumulating?	Yes 0.00	Low flow Vel m/s
Step 3	-	-	ug/l				Extensive?	No 22	Deposition Index

Road number	A38	HA Area / DBFO number			
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	433752	Northing	337304	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number	outfall into Markeaton lake	List of outfalls in cumulative assessment	C7		
Receiving watercourse	markeaton				
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH		
Date of assessment	22/02/2019	Version of assessment	2		
Notes					

Step 1 Runoff Quality — AADT: >=50,000 and <100,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts — Annual 95%ile river flow (m³/s): 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
Impermeable road area drained (ha): 1.513 | Permeable area draining to outfall (ha): 0.1086
Base Flow Index (BFI): 0.5 | Is the discharge in or within 1 km upstream of a protected site for conservation?: No

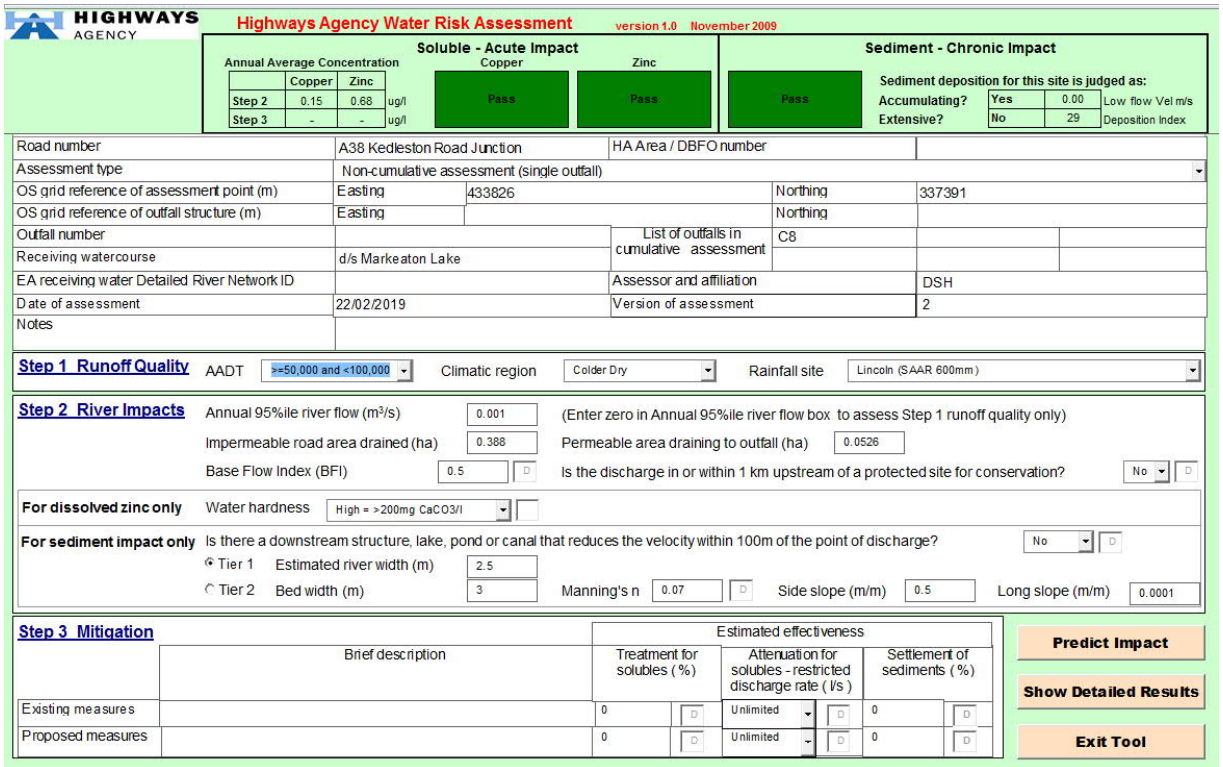
For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?: Yes
Tier 1 — Estimated river width (m): 13
Tier 2 — Bed width (m): 3 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures	balancing pond, and downstream defender for sediments	0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool



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Soluble - Acute Impact	Annual Average Concentration			Copper	Zinc	Sediment - Chronic Impact			
	Copper	Zinc					Sediment deposition for this site is judged as:		
Step 2	0.15	0.68	ug/l	Pass	Pass	Pass	Accumulating?	Yes 0.00	Low flow Vel m/s
Step 3	-	-	ug/l				Extensive?	No 29	Deposition Index

Road number	A38 Kedleston Road Junction	HA Area / DBFO number			
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	433826	Northing	337391	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number		List of outfalls in cumulative assessment	C8		
Receiving watercourse	d/s Markeaton Lake				
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH		
Date of assessment	22/02/2019	Version of assessment	2		
Notes					

Step 1 Runoff Quality — AADT: >=50,000 and <100,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts — Annual 95%ile river flow (m³/s): 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
Impermeable road area drained (ha): 0.388 | Permeable area draining to outfall (ha): 0.0526
Base Flow Index (BFI): 0.5 | Is the discharge in or within 1 km upstream of a protected site for conservation?: No

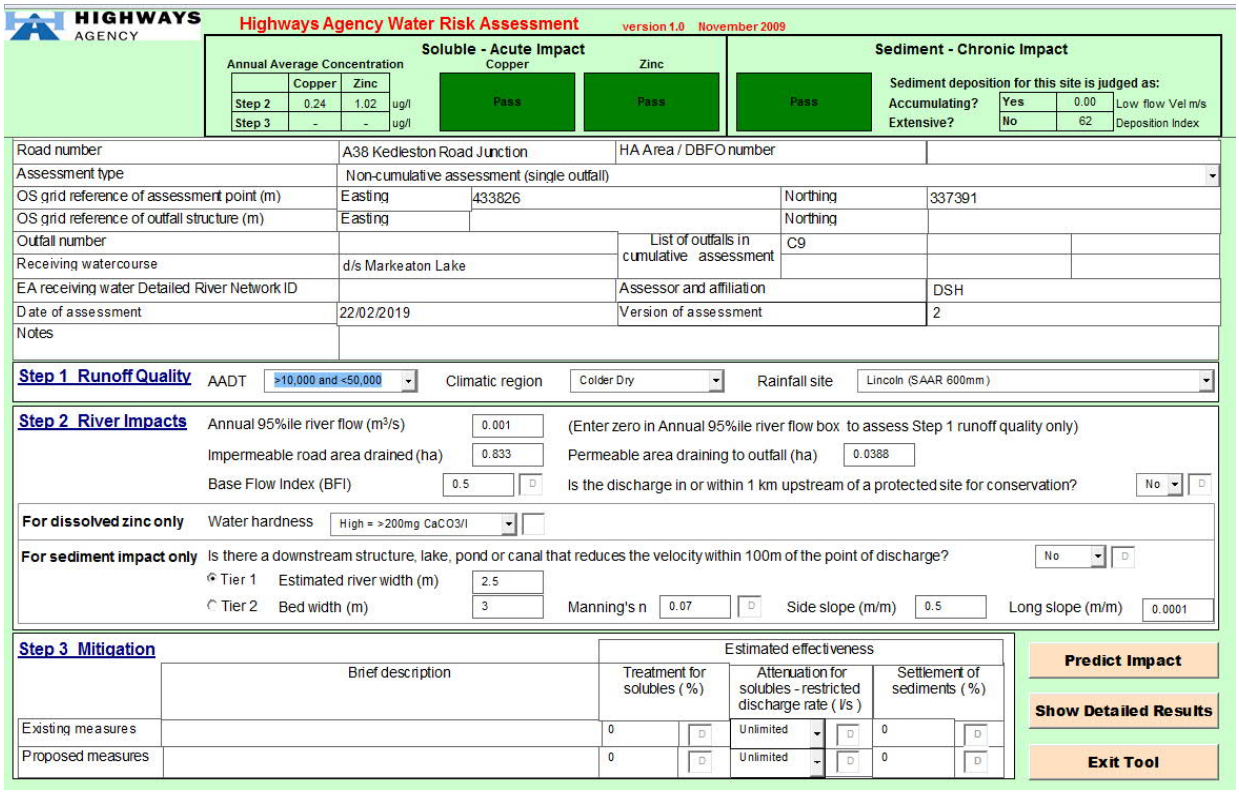
For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge?: No
Tier 1 — Estimated river width (m): 2.5
Tier 2 — Bed width (m): 3 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool



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Soluble - Acute Impact	Annual Average Concentration			Copper	Zinc	Sediment - Chronic Impact			
	Copper	Zinc							
Step 2	0.24	1.02	ug/l	Pass	Pass	Pass	Sediment deposition for this site is judged as:		
Step 3	-	-	ug/l				Accumulating?	Yes 0.00	Low flow Vel m/s
							Extensive?	No 62	Deposition Index

Road number	A38 Kedleston Road Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	433826	Northing	337391	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number		List of outfalls in cumulative assessment	C9		
Receiving watercourse	d/s Markeaton Lake				
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH		
Date of assessment	22/02/2019	Version of assessment	2		
Notes					

Step 1 Runoff Quality AADT >10,000 and <50,000 Climatic region Colder Dry Rainfall site Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s) 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 0.833 Permeable area draining to outfall (ha) 0.0388

Base Flow Index (BFI) 0.5 D Is the discharge in or within 1 km upstream of a protected site for conservation? No D

For dissolved zinc only Water hardness High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

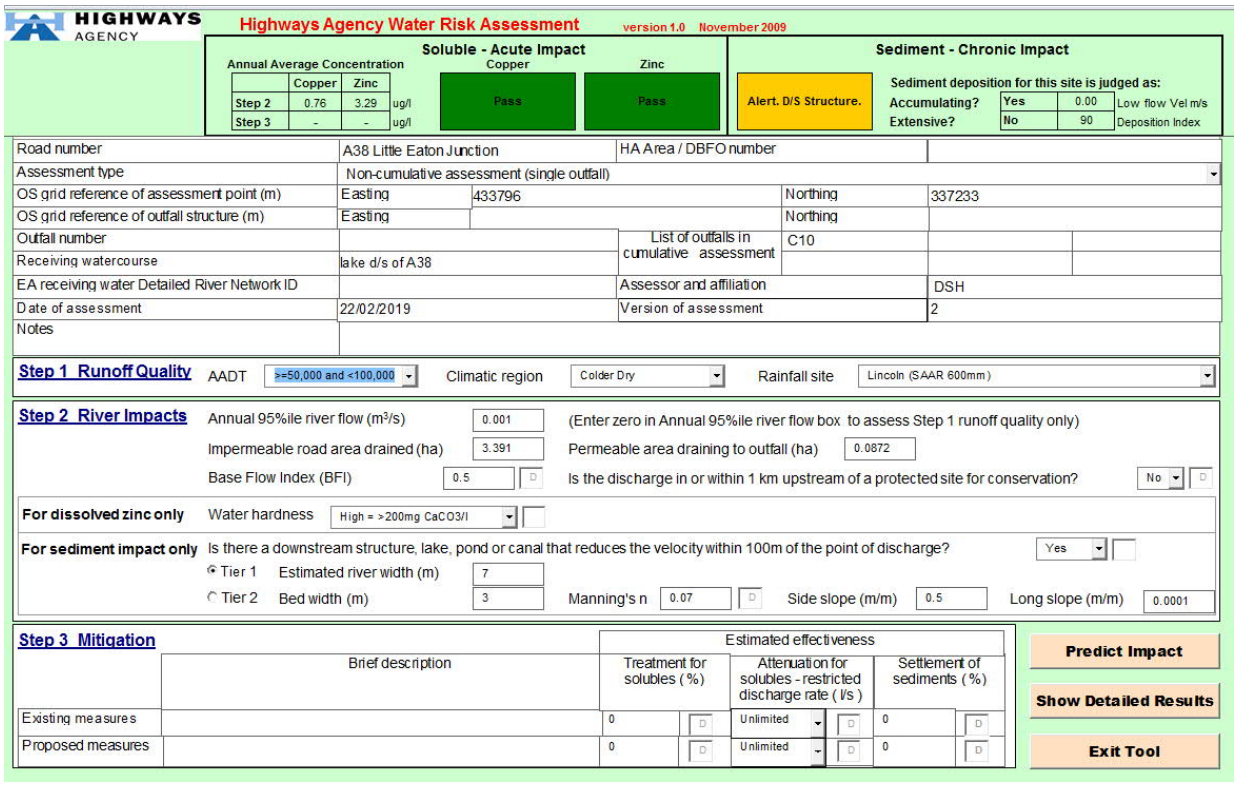
Tier 1 Estimated river width (m) 2.5

Tier 2 Bed width (m) 3 Manning's n 0.07 D Side slope (m/m) 0.5 Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	Unlimited D	0 D
Proposed measures		0 D	Unlimited D	0 D

Predict Impact | Show Detailed Results | Exit Tool



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Soluble - Acute Impact	Annual Average Concentration			Copper	Zinc	Sediment - Chronic Impact			
	Copper	Zinc							
Step 2	0.76	3.29	ug/l	Pass	Pass	Alert. D/S Structure.	Sediment deposition for this site is judged as:		
Step 3	-	-	ug/l				Accumulating?	Yes 0.00	Low flow Vel m/s
							Extensive?	No 90	Deposition Index

Road number	A38 Little Eaton Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	433796	Northing	337233	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number		List of outfalls in cumulative assessment	C10		
Receiving watercourse	lake d/s of A38				
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH		
Date of assessment	22/02/2019	Version of assessment	2		
Notes					

Step 1 Runoff Quality AADT >=50,000 and <100,000 Climatic region Colder Dry Rainfall site Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s) 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 3.391 Permeable area draining to outfall (ha) 0.0872

Base Flow Index (BFI) 0.5 D Is the discharge in or within 1 km upstream of a protected site for conservation? No D

For dissolved zinc only Water hardness High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? Yes

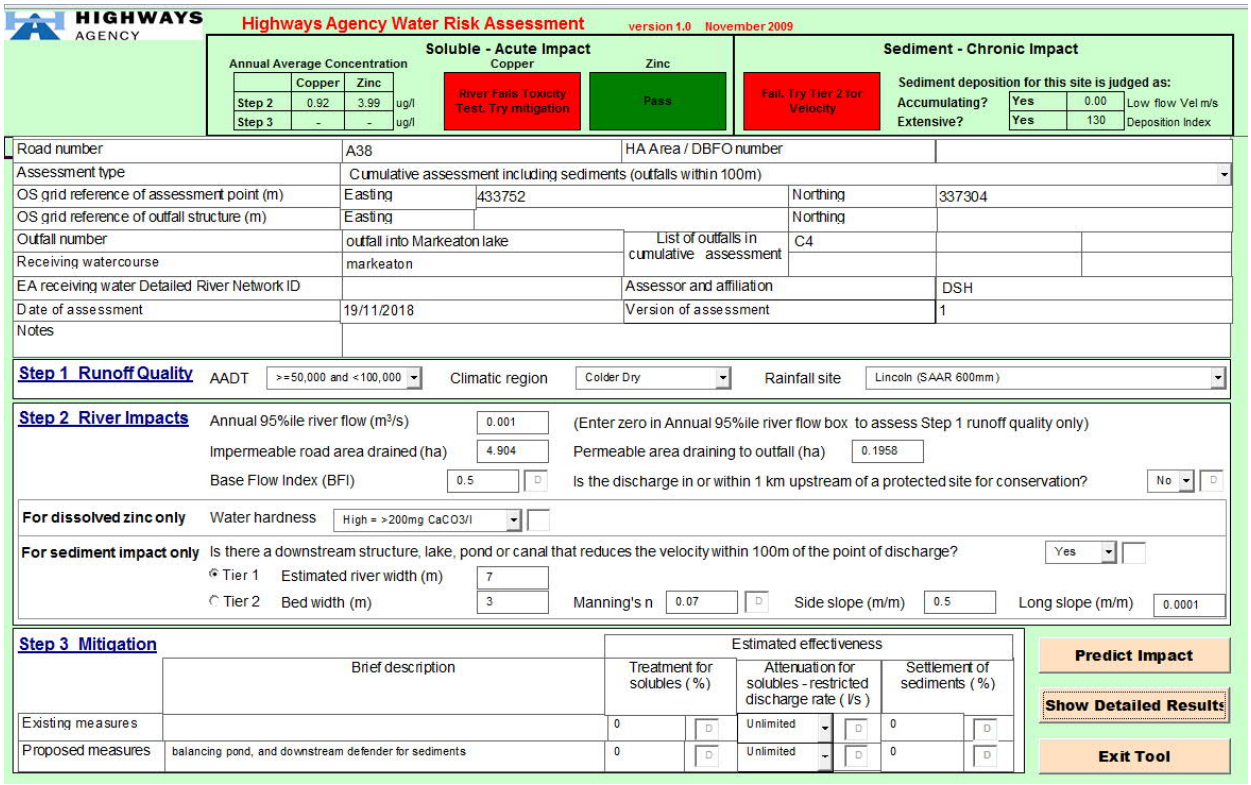
Tier 1 Estimated river width (m) 7

Tier 2 Bed width (m) 3 Manning's n 0.07 D Side slope (m/m) 0.5 Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	Unlimited D	0 D
Proposed measures		0 D	Unlimited D	0 D

Predict Impact | Show Detailed Results | Exit Tool



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Soluble - Acute Impact

Annual Average Concentration

	Copper	Zinc	
Step 2	0.92	3.99	ug/l
Step 3	-	-	ug/l

Copper: River Fails Toxicity Test. Try mitigation

Zinc: Pass

Sediment - Chronic Impact

Fail. Try Tier 2 for Velocity

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.00	Low flow Vel m/s
Extensive?	Yes	130	Deposition Index

Road number	A38		HA Area / DBFO number		
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	433752		Northing	337304
OS grid reference of outfall structure (m)	Easting			Northing	
Outfall number	outfall into Markeaton lake		List of outfalls in cumulative assessment	C4	
Receiving watercourse	markeaton				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	19/11/2018		Version of assessment	1	
Notes					

Step 1 Runoff Quality AADT: >=50,000 and <100,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m³/s): 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 4.904 | Permeable area draining to outfall (ha): 0.1958

Base Flow Index (BFI): 0.5 | Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? Yes

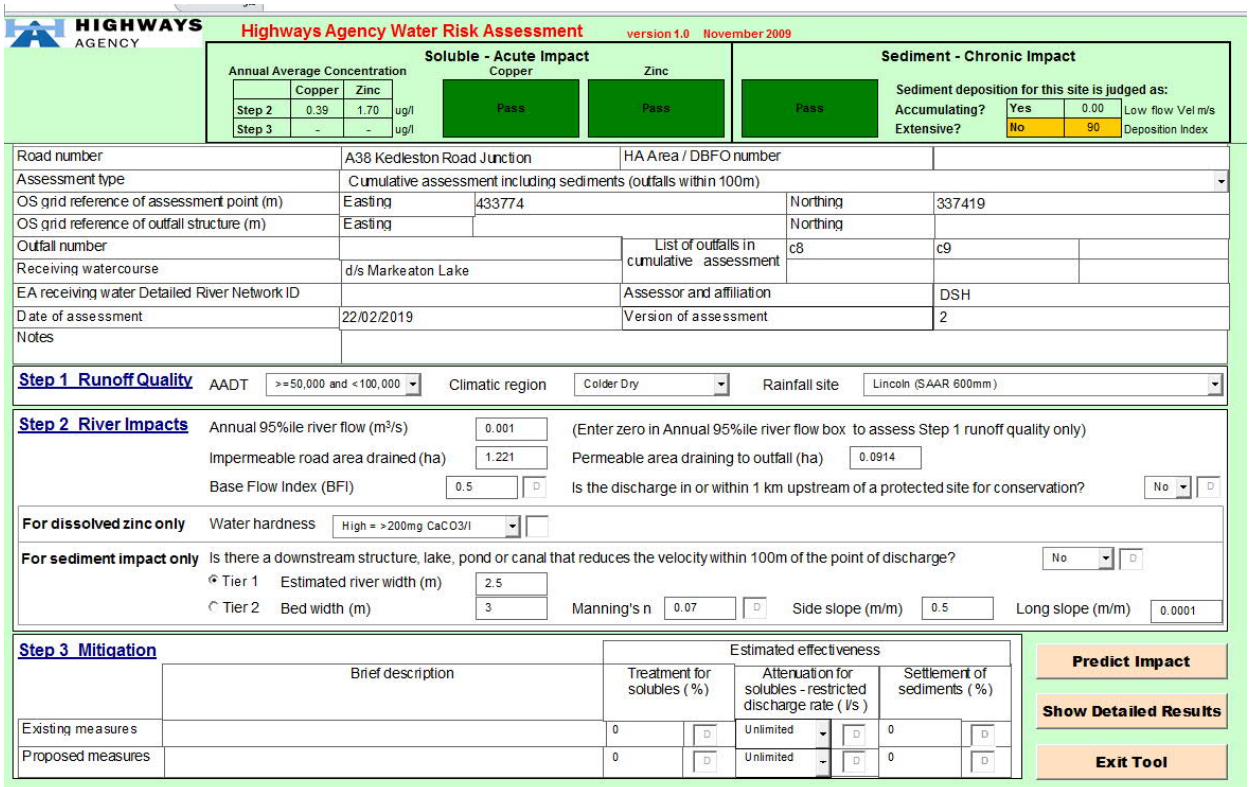
Tier 1 Estimated river width (m): 7

Tier 2 Bed width (m): 3 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures	balancing pond, and downstream defender for sediments	0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool



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Soluble - Acute Impact

Annual Average Concentration

	Copper	Zinc	
Step 2	0.39	1.70	ug/l
Step 3	-	-	ug/l

Copper: Pass

Zinc: Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.00	Low flow Vel m/s
Extensive?	No	90	Deposition Index

Road number	A38 Kedleston Road Junction		HA Area / DBFO number		
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	433774		Northing	337419
OS grid reference of outfall structure (m)	Easting			Northing	
Outfall number			List of outfalls in cumulative assessment	c8	c9
Receiving watercourse	d/s Markeaton Lake				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

Step 1 Runoff Quality AADT: >=50,000 and <100,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m³/s): 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 1.221 | Permeable area draining to outfall (ha): 0.0914

Base Flow Index (BFI): 0.5 | Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 Estimated river width (m): 2.5

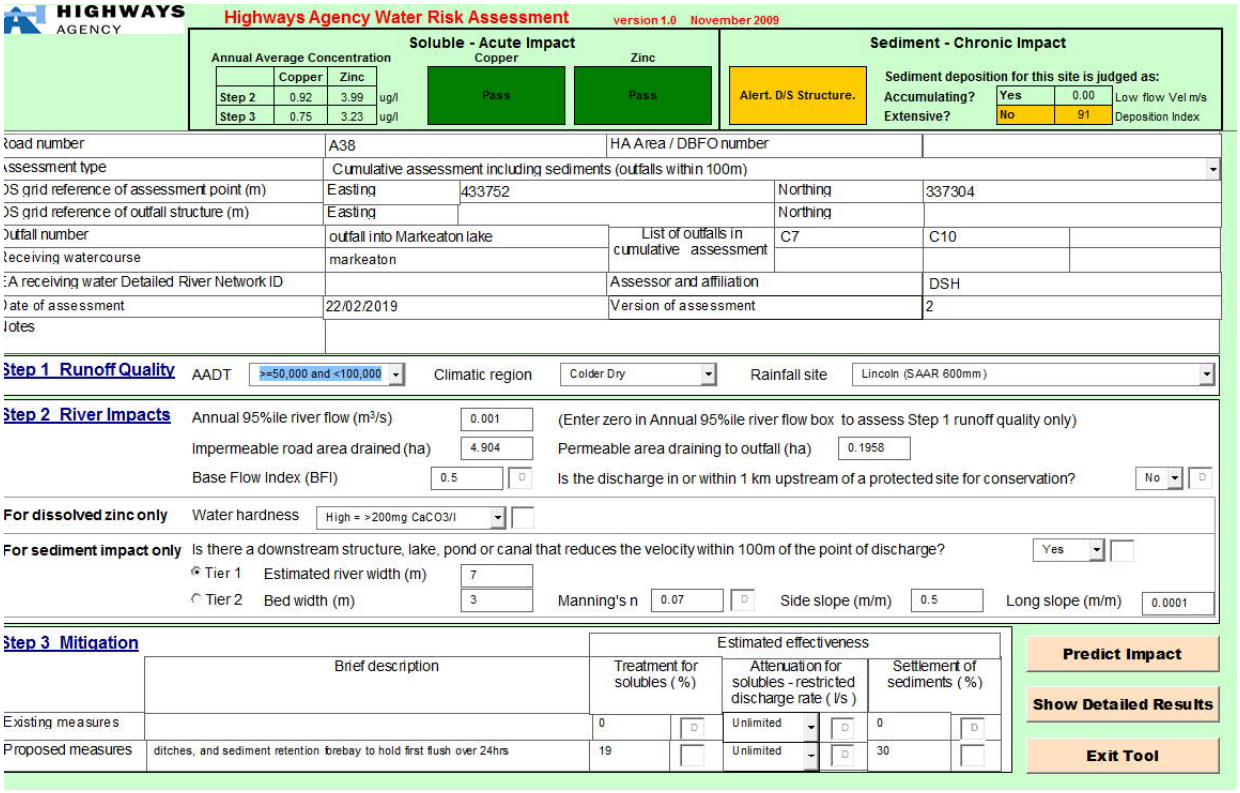
Tier 2 Bed width (m): 3 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool

With mitigation:



HIGHWAYS AGENCY

Highways Agency Water Risk Assessment version 1.0 November 2009

Soluble - Acute Impact

Annual Average Concentration

	Copper	Zinc	
Step 2	0.92	3.99	ug/l
Step 3	0.75	3.23	ug/l

Copper: Pass

Zinc: Pass

Sediment - Chronic Impact

Alert. D/S Structure.

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.00	Low flow Vel m/s
Extensive?	No	91	Deposition Index

Road number	A38		HA Area / DBFO number		
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	433752		Northing	337304
OS grid reference of outfall structure (m)	Easting			Northing	
Outfall number	outfall into Markeaton lake		List of outfalls in cumulative assessment	C7	C10
Receiving watercourse	markeaton				
EA receiving water Detailed River Network ID			Assessor and affiliation		DSH
Date of assessment	22/02/2019		Version of assessment		2
Notes					

Step 1 Runoff Quality AADT >=50,000 and <100,000 | Climatic region: Colder Dry | Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s): 0.001 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 4.904 | Permeable area draining to outfall (ha): 0.1958

Base Flow Index (BFI): 0.5 | Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? Yes

Tier 1 Estimated river width (m): 7

Tier 2 Bed width (m): 3 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures	ditches, and sediment retention forebay to hold first flush over 24hrs	19	Unlimited	30

Predict Impact

Show Detailed Results

Exit Tool

Little Eaton junction:

HIGHWAYS AGENCY

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Soluble - Acute Impact

Annual Average Concentration

	Copper	Zinc	
Step 2	0.12	0.53	ug/l
Step 3	-	-	ug/l

Copper: Pass — Zinc: Pass

Sediment - Chronic Impact

Fail. Try Tier 2 for Velocity

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.01	Low flow Vel m/s
Extensive?	Yes	109	Deposition Index

Road number	A38 Little Eaton Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	436496		Northing	339967
OS grid reference of outfall structure (m)	Easting			Northing	
Outfall number			List of outfalls in cumulative assessment	C12	
Receiving watercourse	Dam Brook				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

Step 1 Runoff Quality AADT: >=50,000 and <100,000 — Climatic region: Colder Dry — Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s): 0.009 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 2.625 — Permeable area draining to outfall (ha): 0.3112

Base Flow Index (BFI): 0.5 — Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 — Estimated river width (m): 4

Tier 2 — Bed width (m): 3 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool

HIGHWAYS AGENCY

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Soluble - Acute Impact

Annual Average Concentration

	Copper	Zinc	
Step 2	0.09	0.38	ug/l
Step 3	-	-	ug/l

Copper: Pass — Zinc: Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.01	Low flow Vel m/s
Extensive?	No	76	Deposition Index

Road number	A38 Little Eaton Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	436453		Northing	339895
OS grid reference of outfall structure (m)	Easting			Northing	
Outfall number			List of outfalls in cumulative assessment	C13	
Receiving watercourse	Dam Brook				
EA receiving water Detailed River Network ID			Assessor and affiliation	DSH	
Date of assessment	22/02/2019		Version of assessment	2	
Notes					

Step 1 Runoff Quality AADT: >=50,000 and <100,000 — Climatic region: Colder Dry — Rainfall site: Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s): 0.009 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 1.837 — Permeable area draining to outfall (ha): 0.2608

Base Flow Index (BFI): 0.5 — Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only — Water hardness: High = >200mg CaCO3/l

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 — Estimated river width (m): 4

Tier 2 — Bed width (m): 3 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool

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Soluble - Acute Impact	Annual Average Concentration			Copper	Zinc	Sediment - Chronic Impact			
	Copper	Zinc					Sediment deposition for this site is judged as:		
Step 2	0.01	0.06	ug/l	Pass	Pass	Pass	Accumulating?	Yes 0.01	Low flow Vel m/s
Step 3	-	-	ug/l				Extensive?	No 14	Deposition Index

Road number	A38 Little Eaton Junction	HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)			
OS grid reference of assessment point (m)	Easting 436416		Northing	340135
OS grid reference of outfall structure (m)	Easting		Northing	
Outfall number		List of outfalls in cumulative assessment	C14	
Receiving watercourse	Dam Brook			
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH	
Date of assessment	22/02/2019	Version of assessment	2	
Notes				

Step 1 Runoff Quality AADT >10,000 and <50,000 Climatic region Colder Dry Rainfall site Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s) 0.009 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 0.332 Permeable area draining to outfall (ha) 0.1782

Base Flow Index (BFI) 0.5 D Is the discharge in or within 1 km upstream of a protected site for conservation? No D

For dissolved zinc only Water hardness High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

Tier 1 Estimated river width (m) 4

Tier 2 Bed width (m) 3 Manning's n 0.07 D Side slope (m/m) 0.5 Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	Unlimited D	0 D
Proposed measures		0 D	Unlimited D	0 D

Predict Impact | Show Detailed Results | Exit Tool

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Soluble - Acute Impact	Annual Average Concentration			Copper	Zinc	Sediment - Chronic Impact			
	Copper	Zinc					Sediment deposition for this site is judged as:		
Step 2	0.00	0.00	ug/l	Pass	Pass	Pass	Accumulating?	No 0.12	Low flow Vel m/s
Step 3	-	-	ug/l				Extensive?	No -	Deposition Index

Road number	A38 Little Eaton Junction	HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)			
OS grid reference of assessment point (m)	Easting 435883		Northing	339938
OS grid reference of outfall structure (m)	Easting		Northing	
Outfall number		List of outfalls in cumulative assessment	C15	
Receiving watercourse	River Derwent			
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH	
Date of assessment	22/02/2019	Version of assessment	2	
Notes				

Step 1 Runoff Quality AADT >=50,000 and <100,000 Climatic region Colder Dry Rainfall site Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s) 4.609 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 0.953 Permeable area draining to outfall (ha) 0.1194

Base Flow Index (BFI) 0.5 D Is the discharge in or within 1 km upstream of a protected site for conservation? No D

For dissolved zinc only Water hardness High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

Tier 1 Estimated river width (m) 32

Tier 2 Bed width (m) 3 Manning's n 0.07 D Side slope (m/m) 0.5 Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	Unlimited D	0 D
Proposed measures		0 D	Unlimited D	0 D

Predict Impact | Show Detailed Results | Exit Tool

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Annual Average Concentration	Copper	Zinc		Soluble - Acute Impact: Copper	Soluble - Acute Impact: Zinc	Sediment - Chronic Impact
Step 2	0.19	0.84	ug/l	Pass	Pass	Fail. Try Tier 2 for Velocity
Step 3	-	-	ug/l			

Sediment deposition for this site is judged as:
Accumulating? Yes 0.01 Low flow Vel m/s
Extensive? Yes 185 Deposition Index

Road number	A38 Little Eaton Junction		HA Area / DBFO number		
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	436453	Northing	339895	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number		List of outfalls in cumulative assessment	C12	C13	
Receiving watercourse	Dam Brook				
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH		
Date of assessment	22/02/2019	Version of assessment	2		
Notes					

Step 1 Runoff Quality AADT >=50,000 and <100,000 Climatic region Colder Dry Rainfall site Lincoln (SAAR 600mm)

Step 2 River Impacts
Annual 95%ile river flow (m^3/s) 0.009 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
Impermeable road area drained (ha) 4.462 Permeable area draining to outfall (ha) 0.572
Base Flow Index (BFI) 0.5 Is the discharge in or within 1 km upstream of a protected site for conservation? No
For dissolved zinc only Water hardness High = >200mg CaCO3/l
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
Tier 1 Estimated river width (m) 4
Tier 2 Bed width (m) 3 Manning's n 0.07 Side slope (m/m) 0.5 Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures		0	Unlimited	0

Predict Impact | Show Detailed Results | Exit Tool

With mitigation included within drainage design:

HIGHWAYS AGENCY

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Annual Average Concentration	Copper	Zinc		Soluble - Acute Impact: Copper	Soluble - Acute Impact: Zinc	Sediment - Chronic Impact
Step 2	0.12	0.53	ug/l	Pass	Pass	Pass
Step 3	0.07	0.32	ug/l			

Sediment deposition for this site is judged as:
Accumulating? Yes 0.01 Low flow Vel m/s
Extensive? No 43 Deposition Index

Road number	A38 Little Eaton Junction		HA Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	436496	Northing	339967	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number		List of outfalls in cumulative assessment	C12		
Receiving watercourse	Dam Brook				
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH		
Date of assessment	19/11/2018	Version of assessment	1		
Notes					

Step 1 Runoff Quality AADT >=50,000 and <100,000 Climatic region Colder Dry Rainfall site Lincoln (SAAR 600mm)

Step 2 River Impacts
Annual 95%ile river flow (m^3/s) 0.009 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)
Impermeable road area drained (ha) 2.625 Permeable area draining to outfall (ha) 0.3112
Base Flow Index (BFI) 0.5 Is the discharge in or within 1 km upstream of a protected site for conservation? No
For dissolved zinc only Water hardness High = >200mg CaCO3/l
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
Tier 1 Estimated river width (m) 4
Tier 2 Bed width (m) 3 Manning's n 0.07 Side slope (m/m) 0.5 Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	Unlimited	0
Proposed measures	Proposed attenuation pond on outfall C12	40	Unlimited	60

Predict Impact | Show Detailed Results | Exit Tool

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Annual Average Concentration	Copper	Zinc	
Step 2	0.19	0.84	ug/l
Step 3	0.11	0.50	ug/l

Soluble - Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.01	Low flow Vel m/s
Extensive?	No	74	Deposition Index

Road number	A38 Little Eaton Junction		HA Area / DBFO number		
Assessment type	Cumulative assessment including sediments (outfalls within 100m)				
OS grid reference of assessment point (m)	Easting	436453	Northing	339895	
OS grid reference of outfall structure (m)	Easting		Northing		
Outfall number		List of outfalls in cumulative assessment	C12	C13	
Receiving watercourse	Dam Brook				
EA receiving water Detailed River Network ID		Assessor and affiliation	DSH		
Date of assessment	22/02/2019	Version of assessment	2		
Notes					

Step 1 Runoff Quality AADT >=50,000 and <100,000 | Climatic region Colder Dry | Rainfall site Lincoln (SAAR 600mm)

Step 2 River Impacts

Annual 95%ile river flow (m^3/s) 0.009 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha) 4.4624 Permeable area draining to outfall (ha) 0.572

Base Flow Index (BFI) 0.5 D Is the discharge in or within 1 km upstream of a protected site for conservation? No D

For dissolved zinc only Water hardness High = >200mg CaCO3/l

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

Tier 1 Estimated river width (m) 4

Tier 2 Bed width (m) 3 Manning's n 0.07 D Side slope (m/m) 0.5 Long slope (m/m) 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0 D	Unlimited D	0 D
Proposed measures	attenuation pond	40	Unlimited D	60

Predict Impact

Show Detailed Results

Exit Tool