Date 26/01/2018

Project details

Project name:	River Nent
Contact name:	Andrew Edwards
Contact team:	Wear and Tees and water
Area Environment Manager:	Fiona Morris

Water body summary information

Water body name:	Nent from Source to South Tyne
Water body id:	GB103023075420
Water body type:	Surface Water
Catchment:	South Tyne
RBP Measure	Mine water treatment and Sediment management
RFF database	Abandoned Metal mines
Related catchments	• GB103023075531 – S Tyne, Black Burn to Tipalt • GB103023075532 – S Tyne Tipalt to Allen • GB103023075710 – S Tyne Allen to N Tyne

Water body classification

Surface water body classification	**Status (2009) Cycle 1**	**Status (2016) Cycle 2**	**Elements failing**
Ecological Status	Moderate potential	Moderate potential	
Biological Status	Poor	Bad	Fish, Invertebrates
Specific Pollutants	Moderate	Moderate	Zinc
Chemical Status	Not assessed	Fail	Cadmium, Lead
Groundwater Body	**Name/ID**	**Status**	**Elements failing**
	Tyne Carboniferous Limestone and Coal Measures GB40302G701500	Poor	Chemical (GE) Status General Chemical Test

Comments

It should be noted that the EQS changed between cycle 1 and cycle 2, cycle 2 now uses a bioavailable measure as opposed to a hardness based assessment.

Summary of impacts from abandoned mines

NoCAM result River Nent from source to South Tyne	Impacted etc	**Score = 15** **RBD rank = 1** **National rank 2**

SWMI = Fail	At risk/Probably at risk	

Mining Waste Directive

MWD inventory					
URN	**Site name**	**Mine type**	**Reason**	**Easting**	**Northing**
1005	Nenthead mines	Metalliferous	Water Pollution	378420	543300
1137	Hudgill burn	Metalliferous	Water Pollution	375180	545660
Potential MWD inventory					

Summary of data review or source apportionment study

Item	Details	Comment
Summary of impacts		
# water bodies impacted	4	The River Nent is not the only source of metal loading in downstream water bodies however it contributes a significant source of metals to the downstream catchments. The River Nent contributes around 50% of the metal loading in the River Tyne.
Length of river impacted (km)	60 km (Including the River South Tyne) 100km (including the main River Tyne)	
Metals failing current EQS	Zn = 7.7 - 135 Cu = not failing Cd = 14.5 – 42.7 Pb = 1.2 – 10.3 Ni = 0.14 – 1.41	These data are based on the full range of samples collected from 2014 to present
Metals failing bioavailable EQS	As above	
Is there an outbreak risk?	Potential outbreak risk from the Nent force level	
# of sources		
Metal loading – point sources (kg/day	Zn = 3.88 – 45.2 Cu = not failing Cd = 0.005 – 0.049 Pb = 0 – 1.667 Ni = not failing	Minimum and maximum units given for the sum of 3 point sources from the full dataset of 2014 - present
Metal loading – river (d/s) kg/day	Zn = 4.9 – 602.6 Cu = Cd = 0.016 – 1.7 Pb = 0.052 - 213 Ni =	Minimum and Maximum units given for the Nent at Alston from the full dataset of 2014 to present.

How many sources need to be treated to achieve EQS (good status) ?	The data suggests that EQS compliance would be limited even with point and diffuse pollution measures	The River South Tyne is impacted heavily by this catchment, therefore any improvements in this catchment would improve the downstream catchment
Length of river improved by treatment (km)	This would be dependent on the nature of the interventions used but there would be 60km of River South Tyne improved by any remediation installed in this catchment.	
NWEBS benefit (£m over 25 years)	Dealing with mine water pollution in the Nent catchment was considered to be cost-beneficial during the 2nd cycle economic appraisal work by the EA. The economic benefits of cleaning up metals in the South Tyne, particularly those impacting sediment qualities in the estuary, have been estimated at £300m - £1,000m over 25 years (BAG assessment).	
Potential contribution from others?	Yes, eligible for the NE LEP Local Growth Fund budget.	

Recommendations

Options	**Comment**
SWMI review	
Confirmed pollution from metal mines:	Recommend for source apportionment study, and identify monitoring locations.
Pollution uncertain:	Spot samples at appropriate locations (2-3 rounds) and then: • If confirm polluted by mines, potential source apportionment study • If confirm NOT polluted by mines, recommend remove from SWMI list.
Source apportionment study	
Monitor: **sources not defined, more monitoring needed**	
Feasibility: **sources defined, move to feasibility**	1. The main sources of Zn and Cd are: • Haggs adit • Capelcleugh adit 2. Pb arises from two main diffuse sources:

	• Wastes around Nenthead Smelt Mill 3. Share final report with the Coal Authority:	
Suspend: **sources too complicated, not feasible with current technology/costs**		
National delivery team decision		**Priority**

Introduction and site map(s) (OS 1:25,000)

The River Nent headwaters are sourced south of Nenthead town with the River Nent itself flowing for around 10km before joining the South Tyne at Alston. The Nent catchment has been heavily modified. There are significant areas of exposed mine spoil and tailings dams throughout the catchment resulting in varied metals loadings within the River Nent and associated downstream water bodies. Water quality data indicates pollution from abandoned metal mines in the Nent catchment is having a significant impact on the downstream water bodies.

During 'normal' flow conditions the main measured point sources of pollution, (Capelcleugh, Rampgill and Haggs) are the most important sources of pollution. However, during high flows the diffuse sources of metal pollution become more important. The Nent Force Level was not monitored during this study.

The River Nent forms a single water body for Water Framework Directive purposes. The Regional River Basin Management Plan states that the River Nent has an overall status of Moderate with an objective of Good ecological and overall status by 2027. It should be noted that it is not be technically feasible to achieve overall Good status in the River Nent by 2015.

Review of historical data and information

The Nent Valley is one of the most intensively mined catchments in the country. The Nenthead Mines are a Scheduled Ancient Monument. Mining in this area probably dates back to before the 1700s in the form of surface workings and shallow pits. During the 18th century most of the mines located around Nenthead were owned by the London Lead Company, with the exception of Browney Hill. By 1905 most of the leases were acquired by a Belgium company, Vieille Montagne who switched from lead to zinc mining. Mining of the Nenthead mines stopped just before the Second World War.

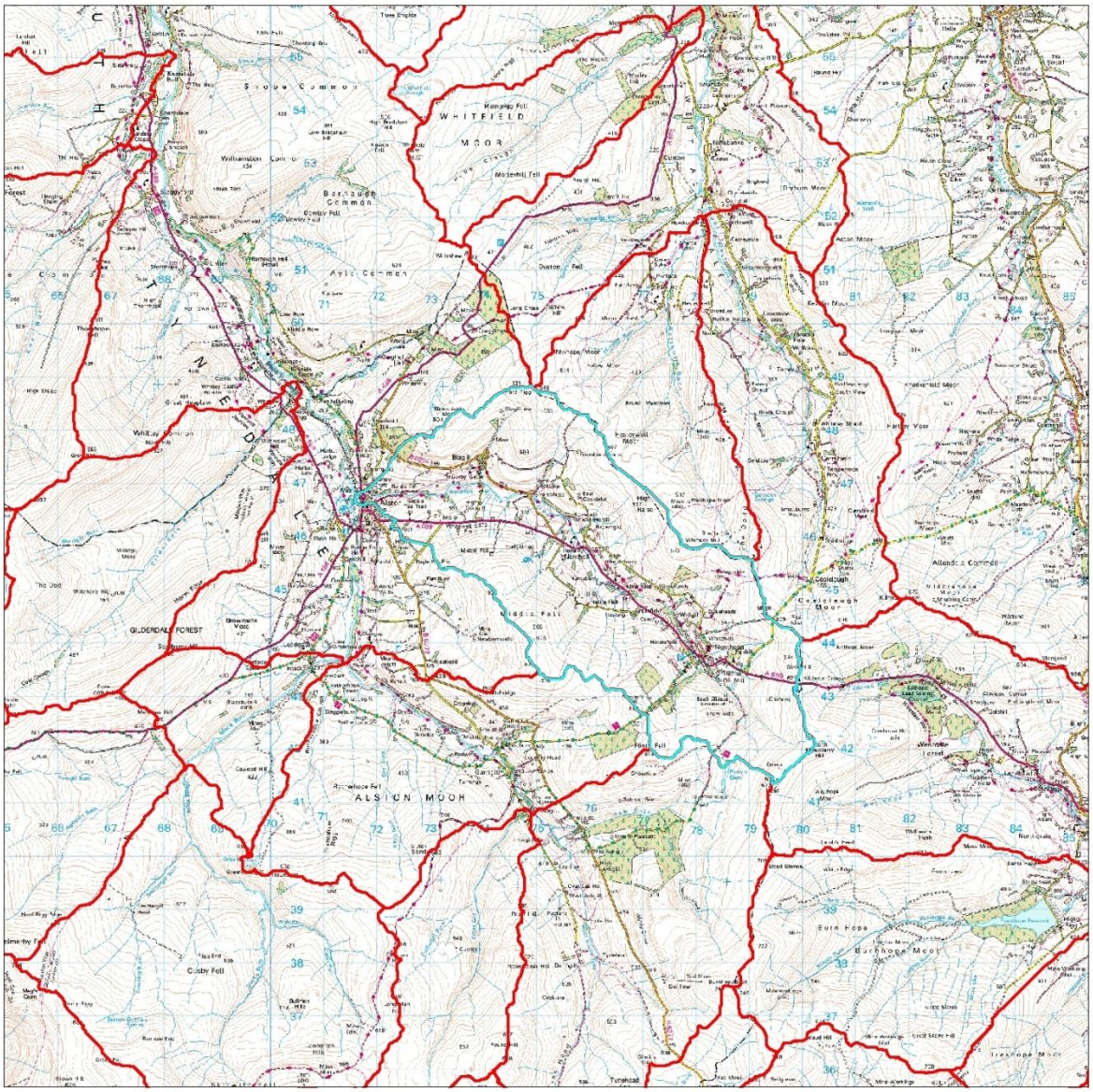
A monitoring program which involved gathering flow and water quality data was set up by the Environment Agency in late 2013. Information from the Atkins Report, 2010 indicated that 3 point sources, Capelcleugh, Rampgill and Haggs adits were significant and could lead to significant benefits to the River Nent if they were treated. These 3 adits, along with 4 river points were in initially targeted for sampling, however, previous data analysis suggested that there were large unknown inputs between the Sewage

treatment works (N4) and Nenthall (N6). It is suspected that there is a groundwater input in this section of river, and additional sample points were investigated.
A walkover was undertaken starting at Haggs discharge and moving upstream towards Crook bank cottage, this identified no significant inputs and very slight drop in concentration.
Two additional sample points were included at Crookbank cottage and upstream of the Haggs input to attempt to identify any additional flow from groundwater inputs.

The Nent Force is not included in this write up but will hopefully be included in future as monitoring equipment is in the process of being installed.

The maps detailed below show the River Nent catchment, the sample points used for this characterisation, the designations in and around the River Nent catchment, the spoil heaps and MWD inventory sites and mineral veins in this area.

River Nent - WFD Catchment



Legend

WFD River catchments. Cycle

0 0.4 0.8 1 2 1.6
Kilometers

N

Figure 1 - WFD catchments

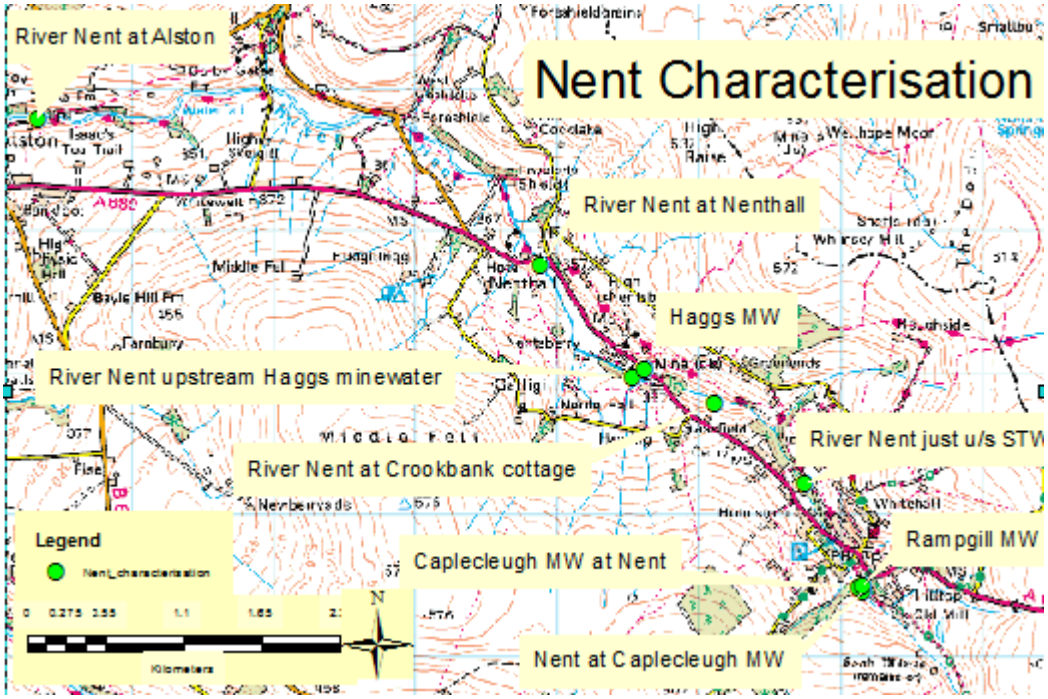


Figure 2 - Sample points

River Nent - Designations

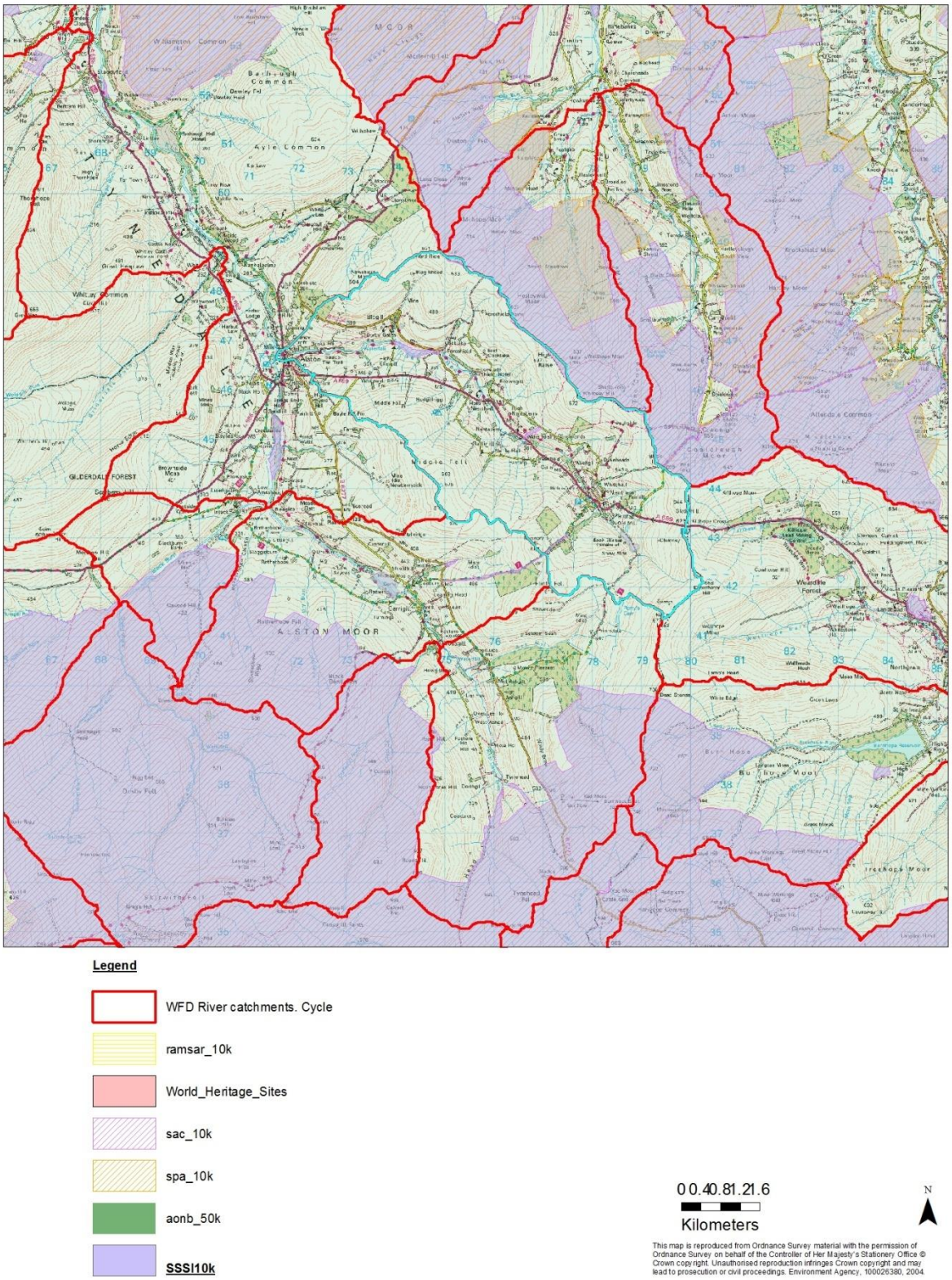


Figure 3 - Designations

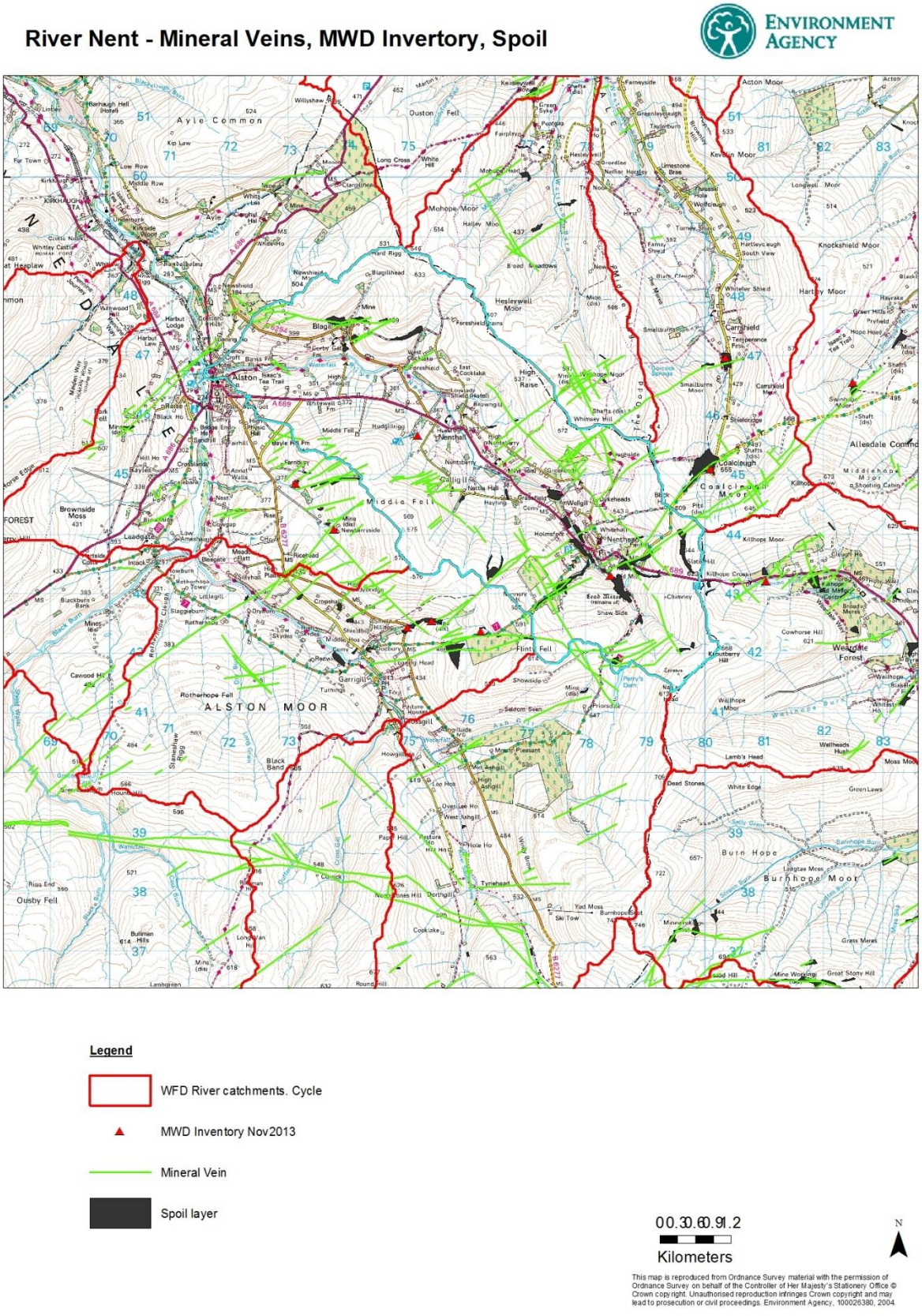


Figure 4 - Mineral veins and spoil heaps

Geological setting and map

The Nent valley drains the Western side of the Alston Block mining area. This consists of a dome of 'Weardale' Granite overlain with thick limestone capped with sedimentary sandstone and mudstones. The limestone has fractures in multiple directions, allowing hot mineral rich water to flow and leave ore deposits in many of the veins as it cooled. The ore body has a number of zones radiating out from the central source of mineralisation. Zinc and lead are more prominent toward the centre with barium and fluorite towards the outer body. The town of Nenthead is located almost at the centre of this ore body resulting in particularly high zinc content in the ground surrounding Nenthead. This is reflected in the high zinc concentrations in the mine drainage in this area. The limestone geology buffers acid produced when sulphide minerals oxidise, resulting in the mine waters discharge being close to neutral pH. The main River Nent and its tributaries are deeply incised into the rock. This had exposed some of the veins and enabling historical mines to access the minerals

Biological / ecological info

The River Nent joins the South Tyne at Alston. The South Tyne is considered environmentally significant in terms of fisheries and water resources. The concentrations of zinc in the River Nent waters and sediments restrict aquatic biodiversity. The elevated zinc concentrations cause both direct toxicity and reduction in the invertebrate community, reducing the food supply within the river.

	C1 2009	C1 2014	C2 2014
Fish	Poor	Good	Bad
Invertebrates	Moderate	Poor	Poor
Macrophytes	Moderate	Moderate	Bad

Stakeholders and discussions to date

Extensive discussions have taken place with a wide variety of stakeholders for the purpose of dredging checkwiers, creating a new check weir and the proposed building of two treatment schemes.

Monitoring programme

The monthly sample regime set up to take flow gaugings and water quality samples from sample references N1-N7 are identified in Table 1 below. Flow data was collated from sample refs N1-N7. The River South Tyne gauging station was used to calculate the Q value for flows on the River Nent as no flow level site existed on the River Nent at the time this data was collected.

Data collected between 2014 and June 2017 suggested that there were large unknown inputs between the Sewage treatment works (N4) and Nenthall (N6). It is suspected that there is a groundwater input in this section of river owing to the existence of bedrock on the river bed around Nentsberry bridge, additional sample points were added at Crookbank cottage (the upstream end of the suspected groundwater input) and upstream of Haggs minewater. This created 2 new sections of river to analyse,

Sewage Works (N4) to Crookbank cottge (N8) and Crook bank cottage to upstream of Haggs (N9).

There are several known sources of metal between N4 and N8 in the form of old talings dams on both banks of the river aswell as mine workings and associated spoil at Browley Hill mine on Gudham gill.

The main section of concern, N8 to N9 was walked over starting at Haggs discharge and moving upstream towards Crook bank cottage, this identified no significant inputs and very slight drop in concentration. 1 discharge from an adit was identified on the left bank but the flow was very low from this, despite the concentration being over 5mg/l Zinc. There are two tributaries between these two points in which concentrations of zinc were elevated are cleaner then the River Nent when they meet. The results of this walkover are shown below in figure 3.

The two new sample points are shown on the maps above (figure 2) and detailed in table 1 below. The analysis used is also included in table 1.

Location	**Sample Ref**	**NGR**	**Gauging method**	**Sample suite**
Nent at Caplecleugh MW	N1	NY 78140 43450	EA Flow tracker	METSTR
Caplecleugh MW at Nent	N2	NY 78140 43450	CA logger	METPR
Rampgill	N3	NY 78200 43500	CA logger	METPR
River Nent just u/s of STW	N4	NY 77700 44400	EA ADCP	METSTR
Haggs Adit	N5	NY 76620 45140	CA logger	METPR
River Nent at Nenthall	N6	NY 75800 45800	EA Flow tracker	METSTR
River Nent at Alston	N7	NY 72332 46799	EA ADCP	METSTR
River Nent at Crookbank cottage	**N8**	**NY 7710544793**	**EA Flow tracker**	**METSTR**
River Nent upstream Haggs	**N9**	**NY 76529 44970**	**EA Flow tracker**	**METSTR**

Table 1 - Monitoring points

Analysis Suit	**Field Determinants**	**Laboratory Determinants**	**Metals(Dissolved and Total**
METSTR for surface waters	pH, EC, DO, Temp	Dissolved Organic Carbon Suspended Solids, Hardness as $CaCO_3$, pH, Alkalinity @ pH4.5, Cl, NO_2, NH_3, SiO_2, SO_4	Al, B, Ba, Ca, Cd, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Pb, Sr, Zn
METPR for adits/levels	pH, EC, DO, Temp	EC, DO%, Hardness as $CaCO_3$, pH, Alkalinity @ pH4.5, Cl, NO_2, NH_3, SiO_2, SO_4	

Table 2 - Analysis suites

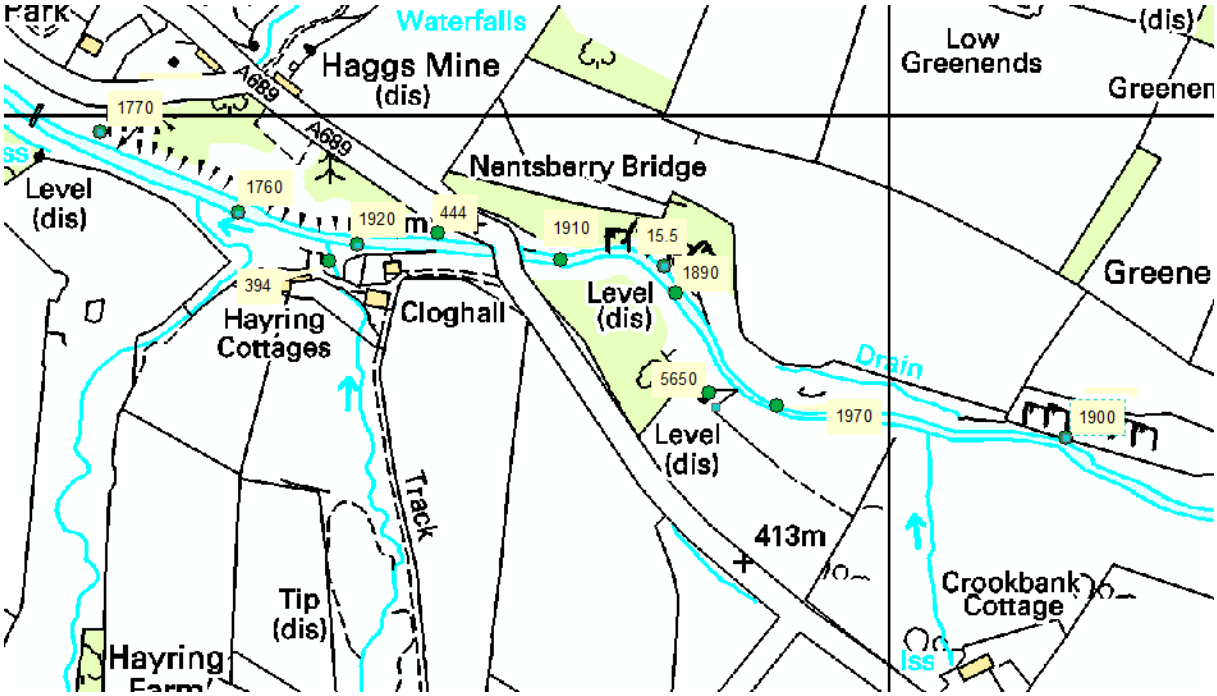
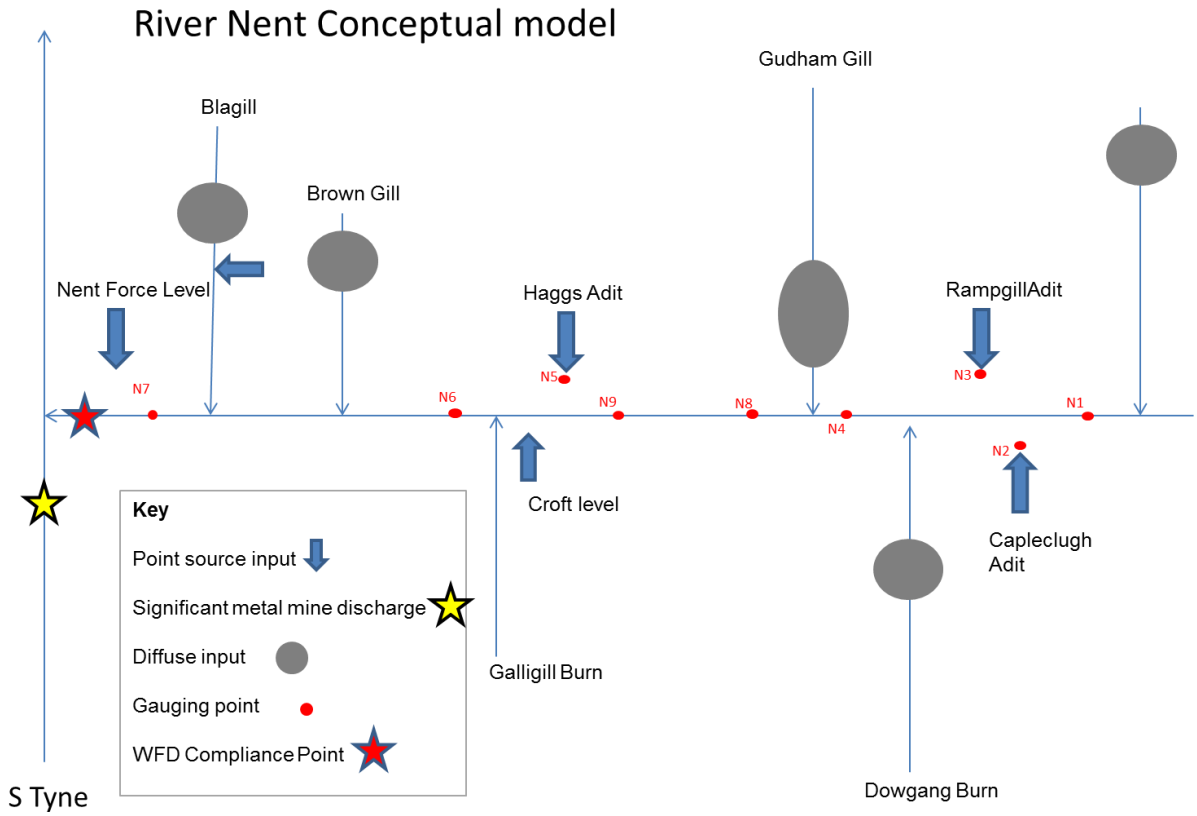


Figure 5 - Walkover results (Zinc)

Conceptual model



Flow balances

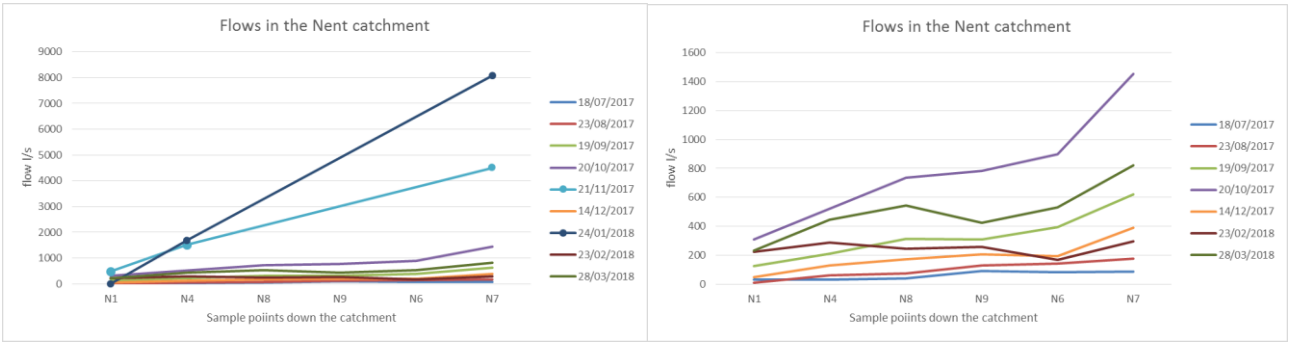


Figure 6 - Flows in the River Nent with and without the 2 very highest flow events.

Balances

		Nent upstream STW			Nent at Crookbank cottage			Nent upstream Haggs		
Date	Flow at Alston	N1 + N2 + N3	N4	% accounted for	N4	N8	% accounted for	N8	N9	% accounted for
18/07/2017	86	41.890	31.4	133.41%	31.4	41.1	76.40%	41.1	91.7	44.82%
23/08/2017	175	29.030	60.4	48.06%	60.4	74.2	81.40%	74.2	127.0	58.43%
23/02/2018	296	246.440	288.0	85.57%	288.0	244.0	118.03%	244.0	259.0	94.21%
14/12/2017	388.1	71.020	127.0	55.92%	127.0	170.0	74.71%	170.0	206.0	82.52%
19/09/2017	620.2	148.780	210.7	70.61%	210.7	312.0	67.53%	312.0	308.2	101.23%
28/03/2018	823	232.000	447.0	51.90%	447.0	544.0	82.17%	544.0	425.0	128.00%
20/10/2017	1452	342.380	0.0		0.0	736.9		736.9	782.8	94.14%
21/11/2017	4500	516.090	1523.0	33.89%	1523.0	0.0		0.0	0.0	
24/01/2018	8083	64.000	1695.0	3.78%	1695.0	0.0		0.0	0.0	

		Nent at Nenthall bridge			Nent at Alston		
Date	Flow at Alston	N4 + N5 / from July17- N9+N5	N6	% accounted for	N6	N7	% accounted for
18/07/2017	86	98.9	83.3	118.68%	83.3	86.0	96.86%
23/08/2017	175	135.0	142.0	95.08%	142.0	175.0	81.14%
23/02/2018	296	269.1	167.0	161.13%	167.0	296.0	56.42%
14/12/2017	388.1	214.9	194.4	110.53%	194.4	388.1	50.09%
19/09/2017	620.2	316.7	395.0	80.18%	395.0	620.2	63.69%
28/03/2018	823	435.6	531.0	82.03%	531.0	823.0	64.52%
20/10/2017	1452	787.2	899.6	87.50%	899.6	1452.0	61.96%
21/11/2017	4500	4.3	0.0		0.0	4500.0	
24/01/2018	8083	12.5	0.0		0.0	8083.0	

Figure 7 - Flow balances in the River Nent since new points introduced

Figure 1 and 2 show the flows measured in the River Nent since July 2017 when two new sample points were introduced. At N4 there is an unmeasured input of flow that becomes more significant in higher flows, Dowgang burn and Gill gill burn enter the river between the two points and are likely to account for the majority of the flow, there is also another tributary on the right bank.

There is also an unmeasured input of flow between N4 and N8, this is most likely to be accounted for by Gudham Gill, which is the only tributary between these two points.

At N9 there is an unmeasured input of flow that becomes less significant in higher flows, this suggests that there is a regular, relatively unfluctuating, flow that enter the river in this section. There are 2 surface water inputs visible, greengill hush and an un-named tributary. It is unlikely that these would account for this regular input as the contribution from these tributaries would increase as the river flows and therefore represent a similar percentage contribution. It is possible that there is a groundwater input in this section that becomes far less significant in higher flows, similar to a point source adit input. The difference in patter can be seen in figure 8 below.

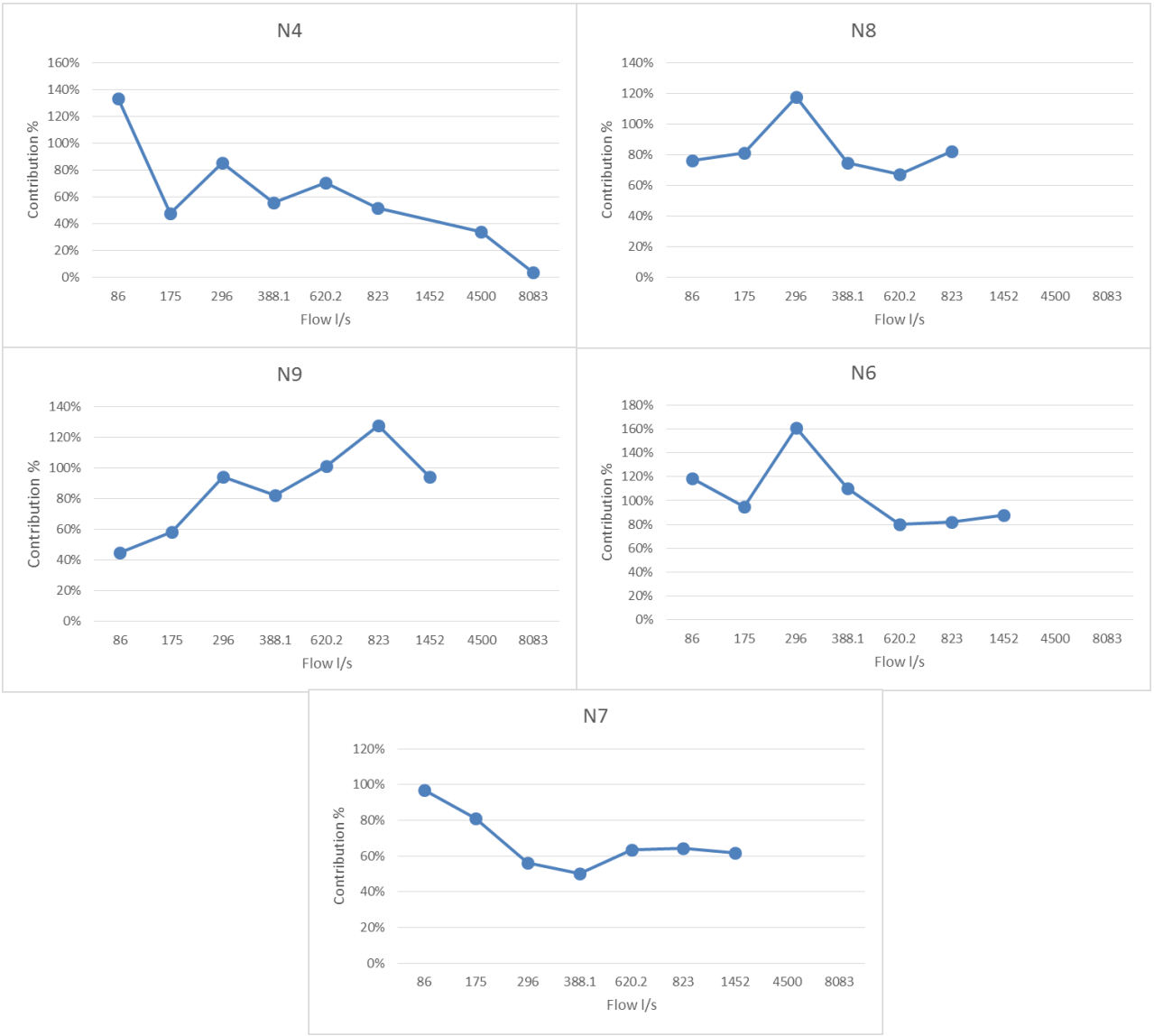


Figure 8 - Flow accounted for at each sample point

Results and interpretation

Loadings

Zinc

		Nent upstream STW			Nent at Crookbank cottage			Nent upstream Haggs		
Date	Flow at Alston	N1 + N2 + N3	N4	% accounted for	N4	N8	% accounted for	N8	N9	% accounted for
18/07/2017	86	10.700	3.8	281.72%	3.8	5.1	73.76%	5.1	11.7	43.91%
23/08/2017	175	10.109	7.6	133.60%	7.6	8.1	93.68%	8.1	19.4	41.59%
23/02/2018	296	12.729	20.4	62.46%	20.4	38.4	53.11%	38.4	38.0	100.86%
14/12/2017	388.1	11.650	18.3	63.58%	18.3	28.5	64.31%	28.5	34.5	82.52%
19/09/2017	620.2	14.158	16.2	87.29%	16.2	23.7	68.45%	23.7	24.1	98.32%
28/03/2018	823	4.249	27.4	15.50%	27.4	33.0	83.11%	33.0	31.7	104.12%
20/10/2017	1452	24.354	0.0	#DIV/0!	0.0	53.0	0.00%	53.0	48.0	110.31%
21/11/2017	4500	33.964	79.9	42.52%	79.9	0.0	#DIV/0!	0.0	0.0	#DIV/0!
24/01/2018	8083	18.711	87.9	21.29%	87.9	0.0	#DIV/0!	0.0	0.0	#DIV/0!

		Nent at Nenthall bridge			Nent at Alston		
Date	Flow at Alston	N4 + N5 / from July17- N9+N5	N6	% accounted for	N6	N7	% accounted for
18/07/2017	86	18.3	9.9	186.06%	9.9	13.2	74.97%
23/08/2017	175	26.8	25.3	106.15%	25.3	28.9	87.52%
23/02/2018	296	44.4	23.7	187.44%	23.7	32.5	72.86%
14/12/2017	388.1	43.0	31.7	135.36%	31.7	40.2	78.89%
19/09/2017	620.2	30.5	38.6	79.17%	38.6	61.6	62.58%
28/03/2018	823	37.5	38.8	96.53%	38.8	54.6	71.07%
20/10/2017	1452	51.2	68.1	75.12%	68.1	79.4	85.74%
21/11/2017	4500	2.6	0.0	#DIV/0!	0.0	206.1	0.00%
24/01/2018	8083	6.1	0.0	#DIV/0!	0.0	258.4	0.00%

Figure 9 - Zinc mass balance

The mass balance calculations above in figure 9 above show that at N4 as flows rise there is an increasing influence from a diffuse source, This could be Dowgang burn, Gill gill burn or the old tailings dams located in this short stretch of river. In the very lowest flows at this point there appears to be a deposition of metal, this could be metal settling out in the check weirs that are present immediately upstream of the sample point.

At N8 there is a fairly constant input of metal, the most that remains the same through to mid to high flows. This suggests that Gudham Gill is putting proportionate amounts of metal into the River Nent in most flow conditions. It is likely to be influence by diffuse sources in the same way that the main river is.

At N9 there is only an input of metal in the lowest flow events, this points to a fairly constant input that is not as influenced by diffuse sources in wet weather. In dry weather this input is contributing significant amounts of metal the the river, however, as flows increase the significance of this input is drowned out by the amount of metal originating upstream in the river system. This input could be from a point source located on one the tributaries in this stretch, however, none have been found wen investigated. There are diffuse sources on the tributaries that join the river, but they do not increase in the same way that would be expected in wet weather. The other potential source is a groundwater input, there is an outcrop of bedrock in the section of river and this presents the most likely source of increased metal load between N8 and N9.

Through the bottom half of the catchment below N6, there are additional inputs, however these do not represent the most significant sources in the catchment at around 30%. No further investigations have taken place in this stretch of river.

The cadmium mass balances ar shown below, they follow much the same pattern as the zinc loads.

		Nent upstream STW			Nent at Crookbank cottage			Nent upstream Haggs		
Date	Flow at Alston	N1 + N2 + N3	N4	% accounted for	N4	N8	% accounted for	N8	N9	% accounted for
18/07/2017	86	22.035	9.1	243.18%	9.1	13.7	66.28%	13.7	31.2	43.80%
23/08/2017	175	17.317	16.8	103.38%	16.8	17.1	97.86%	17.1	38.0	45.09%
23/02/2018	296	24.044	38.3	62.74%	38.3	63.2	60.59%	63.2	72.1	87.77%
14/12/2017	388.1	23.747	35.4	67.00%	35.4	55.8	63.50%	55.8	69.6	80.20%
19/09/2017	620.2	26.184	33.5	78.17%	33.5	51.8	64.72%	51.8	50.3	102.84%
28/03/2018	823	10.864	58.7	18.51%	58.7	69.6	84.39%	69.6	66.5	104.66%
20/10/2017	1452	47.585	0.0	#DIV/0!	0.0	110.1	0.00%	110.1	112.3	98.11%
21/11/2017	4500	73.041	188.2	38.82%	188.2	0.0	#DIV/0!	0.0	0.0	#DIV/0!
24/01/2018	8083	34.118	218.2	15.64%	218.2	0.0	#DIV/0!	0.0	0.0	#DIV/0!

		Nent at Nenthall bridge			Nent at Alston		
Date	Flow at Alston	N4 + N5 / from July17- N9+N5	N6	% accounted for	N6	N7	% accounted for
18/07/2017	86	36.4	30.4	119.83%	30.4	34.5	88.09%
23/08/2017	175	43.5	44.9	96.97%	44.9	55.9	80.27%
23/02/2018	296	77.5	42.0	184.65%	42.0	59.3	70.77%
14/12/2017	388.1	78.2	55.8	140.21%	55.8	73.8	75.59%
19/09/2017	620.2	55.4	77.1	71.78%	77.1	121.1	63.69%
28/03/2018	823	72.1	78.9	91.35%	78.9	112.3	70.24%
20/10/2017	1452	114.6	136.8	83.78%	136.8	185.7	73.68%
21/11/2017	4500	2.0	0.0	#DIV/0!	0.0	451.0	0.00%
24/01/2018	8083	6.0	0.0	#DIV/0!	0.0	636.9	0.00%

Figure 10 - Cadmium mass balance calculations

Lead

		Nent upstream STW			Nent at Crookbank cottage			Nent upstream Haggs		
Date	Flow at Alston	N1 + N2 + N3	N4	% accounted for	N4	N8	% accounted for	N8	N9	% accounted for
18/07/2017	86	63.733	23.8	267.26%	23.8	48.3	49.38%	48.3	101.4	47.62%
23/08/2017	175	63.663	275.0	23.15%	275.0	153.2	179.49%	153.2	201.9	75.89%
23/02/2018	296	196.139	261.3	75.07%	261.3	250.9	104.15%	250.9	279.7	89.69%
14/12/2017	388.1	92.519	154.7	59.80%	154.7	174.8	88.52%	174.8	227.8	76.72%
19/09/2017	620.2	318.074	491.5	64.71%	491.5	814.1	60.38%	814.1	844.1	96.44%
28/03/2018	823	425.663	965.5	44.09%	965.5	789.6	122.28%	789.6	694.0	113.78%
20/10/2017	1452	847.330	0.0	#DIV/0!	0.0	2597.7	0.00%	2597.7	2860.9	90.80%
21/11/2017	4500	1910.735	6026.7	31.70%	6026.7	0.0	#DIV/0!	0.0	0.0	#DIV/0!
24/01/2018	8083	141.800	4598.5	3.08%	4598.5	0.0	#DIV/0!	0.0	0.0	#DIV/0!

		Nent at Nenthall bridge			Nent at Alston		
Date	Flow at Alston	N4 + N5 / from July17- N9+N5	N6	% accounted for	N6	N7	% accounted for
18/07/2017	86	101.4	90.0	112.73%	90.0	81.0	111.08%
23/08/2017	175	201.9	217.2	92.97%	217.2	243.4	89.21%
23/02/2018	296	279.7	194.8	143.60%	194.8	291.5	66.81%
14/12/2017	388.1	227.8	171.3	132.98%	171.3	355.4	48.20%
19/09/2017	620.2	844.1	1109.2	76.10%	1109.2	1634.4	67.87%
28/03/2018	823	694.0	779.9	88.98%	779.9	938.6	83.09%
20/10/2017	1452	2861.7	3046.8	93.92%	3046.8	3362.1	90.62%
21/11/2017	4500	0.9	0.0	#DIV/0!	0.0	7231.7	0.00%
24/01/2018	8083	4.0	0.0	#DIV/0!	0.0	13338.9	0.00%

Figure 11 - Lead Mass balance

The mass balance calculations in Figure 11 show that at N4 there is an increasingly significant source of lead that enters the River Nent between these two points. As previously, the two tributaries that input to the river here are, Dowgang burn and Gill gill burn, there is also an old tailings dam which has the potential to contribute metals to the system.

Between N4 and N8 the input of lead to the river appears to be intermittent, some results show deposition and others show increased level without any real pattern. The reason for this is not known. There are no known intermittent discharges between these points.

Between N8 and N9, similar to zinc, there is an input of lead that becomes less significant at as flows increase. This again could point to a ground water input or to diffuse sources on the tributaries that do not react as readily to rainfall as upstream sources. The most likely scenario is an input of groundwater.

Adit contributions
In order to highlight the influence of the point source discharges from Haggs, Rampgill and Capelcleugh discharges the graphs below, figure 12, were created to show the load that originates from the 3 adits compared to the metal load at N6 and N7 (Nenthall and Alston respectively). They show metal load in low flows is almost entirely due to the 3 adits used for the comparison. Conversely, in higher flows they become less significant.

Figure 12 - Point source and river load comparison

MINDAR – metal bioavailability and potential improvements with treatment

The potential improvements with treatment have been calculated previously and are documented in Capelcleugh design flow review and the previous catchment characterisation report written in 2016.

Constraints

Highest flows are not measureable at N6, N9, N8 or N1. The monitoring team are due to start using a salt gauging flow gauging technique so that some of the higher flows should be possible more often as it does not require direct access to the river.

Summary and conclusions

The understanding of this catchment at a high level has not changed. The point sources at Haggs and Capelcleugh dominate the catchment in low flow events and treatment of these will lead to significant improvements in water quality in low flow events and contribute to an ongoing improvement of the water quality in the river.

There are diffuse inputs between Capelcleugh and the Sewage works that become increasingly significant as flows increase. **It may be worth investigating the 2 tributaries in this stretch further when sample points are able to be moved. Dowgang burn and Gill burn are the two inputs**. There is very little distance between these points and difficult access so additional in river points may not be possible. Initially a walkover would be useful in wet weather to sample at various points both in the river and any discharges that are present.

The data collected from the new sample points suggest that there are diffuse inputs between the sewage works and Crookbank cottage. **It may also be useful to include this stretch in the walkover so that priority sites could start to be investigated to inform ongoing diffuse works in the catchment.**

The data also shows a potential groundwater input between Crookbank cottage and Haggs mine. In the lowest flow events this input contributes significant amount of flow and metal load to the catchment. It would be valuable to understand the input from the tributaries in this section however. This is unlikely to lead to further work being put forward as interventions. The ground water input averages 10% (up to 50%) of the load at Alston, to put this into context, in the lowest flows it contributes as much metal as Haggs mine.

There are no further recommendations that can be passed to the CA at this stage.