Low-Flow Estimates from LowFlows
www.hydrosolutions.co.uk

Catchment Characteristics

Region	England: Northwest
Area	(72) Wyre and Lune
Boundary source	Imported polygon
Catchment Area (km²)	2.3272

No significant lakes in catchment

Grid-resolution used	20

for derivation of catchment characteristics (m)

Runoff (mm)	1669
BFI	0.256

	Annual
Qmean	0.123
Q(0.1)	1.906
Q(1)	0.933
Q(2)	0.734
Q(3)	0.622
Q(4)	0.542
Q(5)	0.484
Q(6)	0.436
Q(7)	0.401
Q(8)	0.367
Q(9)	0.341
Q(10)	0.318
Q(11)	0.294
Q(12)	0.274
Q(13)	0.259
Q(14)	0.245
Q(15)	0.23
Q(16)	0.218
Q(17)	0.205
Q(18)	0.194
Q(19)	0.183
Q(20)	0.174
Q(21)	0.166
Q(22)	0.158
Q(23)	0.151
Q(24)	0.143
Q(25)	0.137
Q(26)	0.13
Q(27)	0.124
Q(28)	0.118
Q(29)	0.114
Q(30)	0.108
Q(31)	0.104
Q(32)	0.099
Q(33)	0.095

Q(34)	0.091
Q(35)	0.087
Q(36)	0.083
Q(37)	0.08
Q(38)	0.078
Q(39)	0.074
Q(40)	0.072
Q(41)	0.07
Q(42)	0.066
Q(43)	0.065
Q(44)	0.062
Q(45)	0.06
Q(46)	0.058
Q(47)	0.056
Q(48)	0.054
Q(49)	0.052
Q(50)	0.05
Q(51)	0.049
Q(52)	0.047
Q(53)	0.046
Q(54)	0.045
Q(55)	0.043
Q(56)	0.042
Q(57)	0.041
Q(58)	0.039
Q(59)	0.038
Q(60)	0.037
Q(61)	0.036
Q(62)	0.035
Q(63)	0.034
Q(64)	0.033
Q(65)	0.032
Q(66)	0.031
Q(67)	0.03
Q(68)	0.03
Q(69)	0.028
Q(70)	0.027
Q(71)	0.026
Q(72)	0.026
Q(73)	0.025
Q(74)	0.024
Q(75)	0.023
Q(76)	0.022
Q(77)	0.022
Q(78)	0.021
Q(79)	0.02
Q(80)	0.02
Q(81)	0.019
Q(82)	0.018
Q(83)	0.018

Q(84)	0.017
Q(85)	0.017
Q(86)	0.016
Q(87)	0.015
Q(88)	0.014
Q(89)	0.014
Q(90)	0.014
Q(91)	0.013
Q(92)	0.013
Q(93)	0.012
Q(94)	0.011
Q(95)	0.011
Q(96)	0.01
Q(97)	0.01
Q(98)	0.009
Q(99)	0.007
Q(99.9)	0.005

Needlehouse Pico Hydro Scheme

Rev A 15.03.22

INTAKE V-NOTCH

Target Hands off Flow		**11**	lps	**Q95**
Discharge	Q	0.011	m^3/s	
Coefficient of discharge	Cd	0.58642		
Acceleration due gravity	g	9.81	m/s	
Notch Angle	θ	30	degrees	
Head Correction Factor	k	2.12909	mm	
Depth of notch to nearest mm	H	**243**	**mm**	

Based on following formulae

$Cd = (0.607165052) - (0.000874466963\ \theta) + (6.10393334 \times 10^{-6}\ \theta^2)$

$k = ((0.0144902648) - (0.00033955535\ \theta) + (3.29819003 \times 10^{-6}\ \theta^2) - (1.06215442 \times 10^{-8}\ \theta^3)) \times 304.8$

$Q = (8/15)\ Cd\ \sqrt{(2g)}\ (H+k)^{5/2}\ \tan(\theta/2)$

FLOW SPLIT — Unrestricted notch

A take of 83% is to be ensured by a weir incorporating a flow split as detailed below.
The weir crest and the flow split crest are open notches and the Open notch discharge formula can be used to evaluate the flows.

Formula

$Q = 2/3\ C_d\ w\ 2g^{0.5}\ d^{3/2}$

Target Flow split 83.74% to hydro

where C_d is 0.64

All year	Depth*, d (m)	Width, w (m)	Discharge, Q m^3/s	**Proportion of Water**
Coanda Notch	0.060	0.900	0.025	**83.1%**
Flow Split Notch	0.060	0.183	0.005	**16.9%**

*Note - Depth varies depending on flow but is always the same for each notch as crest levels are all the same , the proportions always remain exactly the same and are not effected by changes in depth. Proportion of water is calculated by dividing the flow by the sum of both flows and converting to a precentage. Values are based to the nearest litre per second and millimetre.

NEEDLEHOUSE HYDRO
HYDRO SCHEME

Water Framework Assessment Report

Version A

Prepared for:
Sam Frankland, site owner

By:
Adam Cropper

Tel: +44 (0)1539 726013
Email: adam@ellergreen.com

February 2022

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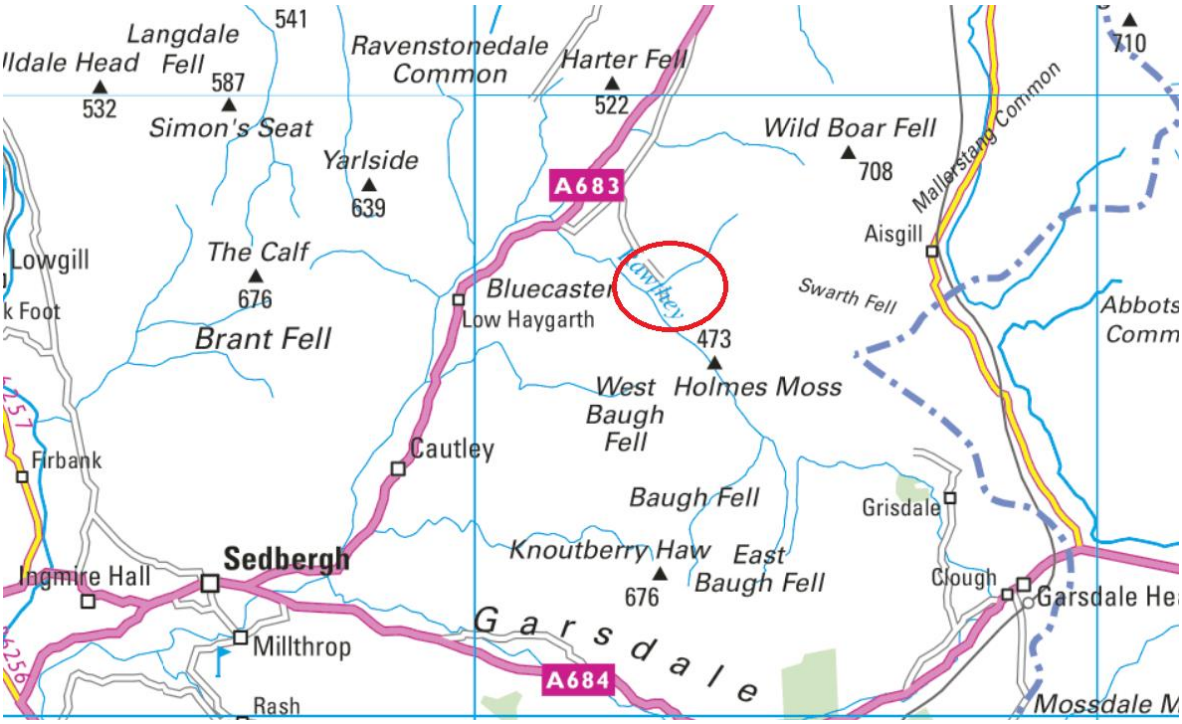
2.1 Location

The scheme is to be located on Needlehouse Gill which flows into the River Rawthey, which later joins River Lune.



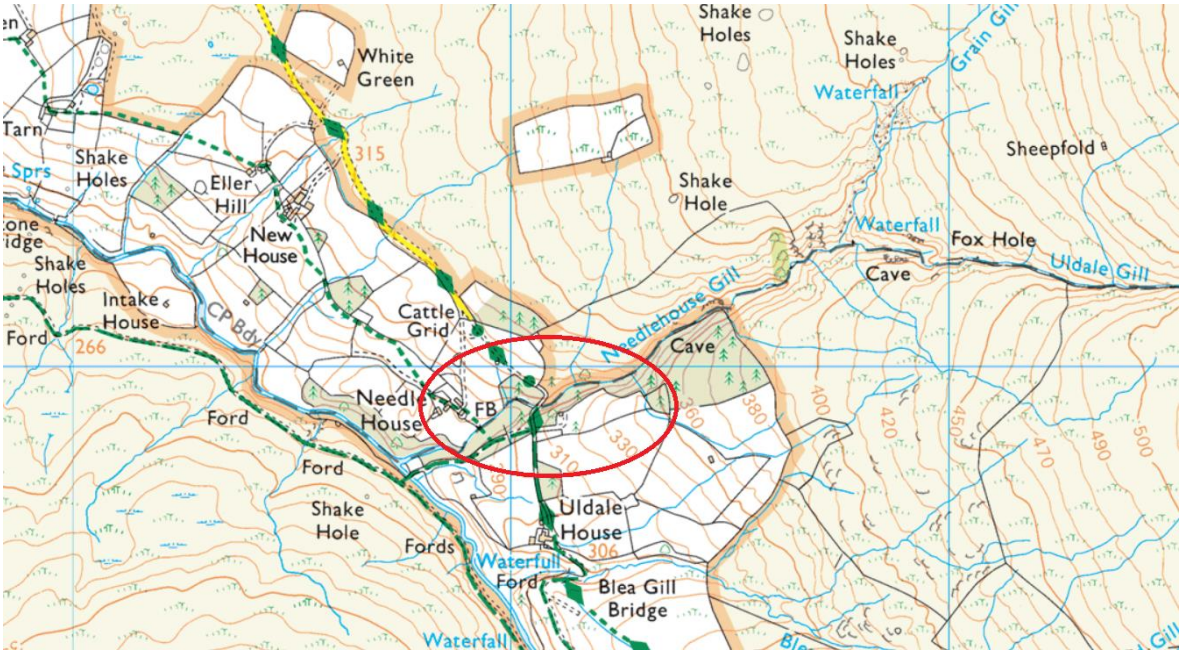


Fig 1: Scheme location (red ring)

2.2 Scope of works

In summary, the works will cover:

- A intake structure across Needlehouse Gill, incorporating a Coanda type screen with 1mm bar-spacing, and intake chamber underneath
- 462m of partially buried plastic pipe (PE100 250mm outside dia.), running from the intake down the wooded bank of the gill. Reaching the turbine house structure in the field adjacent to the property.
- Turbine house, enclosing the hydroelectric turbine complete with generator, and control system.
- An outfall to return water to the beck at the rear of the power house incorporating a 30mm vertical bar screen.
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Low Flows analysis of catchment hydrology indicated an annual mean flow of Needlehouse gill at the intake location of 0.123 m^3/s.

2.4 Abstraction regime

The scheme is to abstract a flow 40l/s – 33% of Qmean and a HOF of Q95 (11l/s).

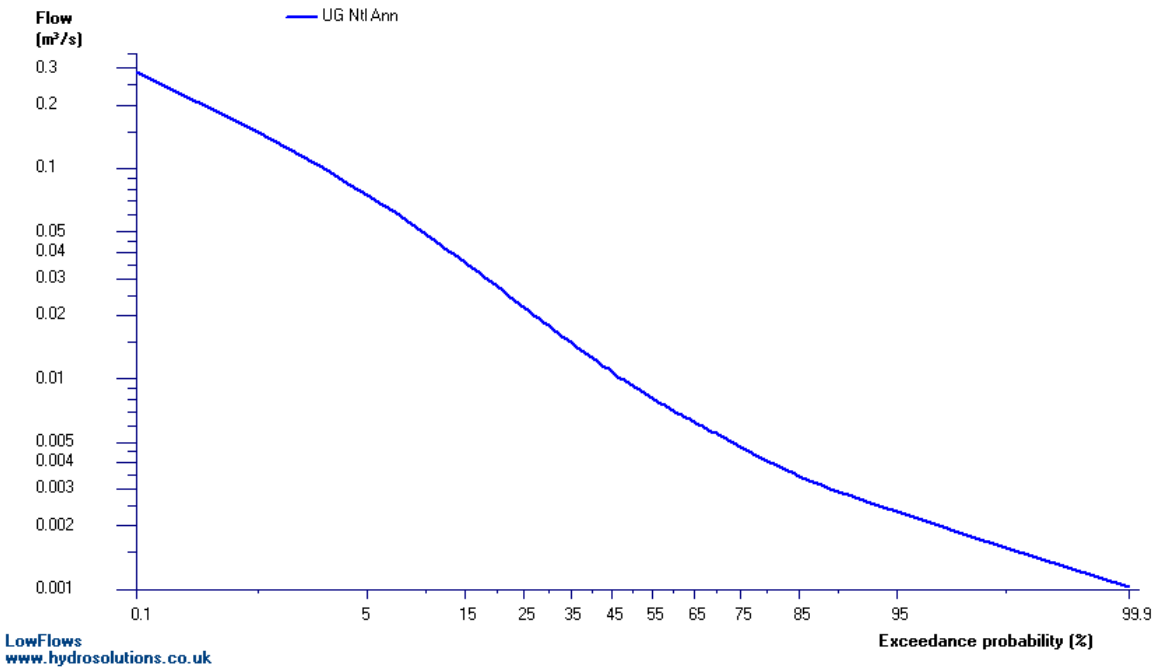

Figure 2: Flow duration curve for Backstone Gill

6. WATER FRAMEWORK DIRECTIVE ASSESSMENT

Needlehouse Gill is a tributary that flows into the River Rawthey, and as such it is part of the waterbody Rawthey - Upper (GB112072071830). The water body currently has a 'Good' ecological status. This forms part of the Lune Management catchment.

Rawthey - Upper Water Body

Good ecological status

Viewing latest data (Updated on 14 September 2021).

Rawthey - Upper data

Attributes

- **Water Body ID** GB112072071830
- **Water Body Type** River
- **Hydromorphological designation** not designated artificial or heavily modified
- **NGR** SD6872393818

- **Surveillance Water Body** No
- **Length** 43.167 km
- **Catchment area** 61.97 km2
- **Catchment area** 6196.98 ha

Classifications

Time period: Cycle 2

Classification Item	2013	2014	2015	2016	2019
Ecological	Good	Good	Good	Good	Good
Biological quality elements		High	High	High	High
Invertebrates		High	High	High	High
Macrophytes and Phytobenthos Combined		High	High	High	High
Physico-chemical quality elements	High	High	High	High	High
Ammonia (Phys-Chem)	High	High	High	High	High
Dissolved oxygen	High	High	High	High	High
Phosphate	High	High	High	High	High
Temperature	High	High	High	High	High
pH	High	High	High	High	High
Hydromorphological Supporting Elements	Supports good	Supports good	Supports good	Supports good	Supports good
Hydrological Regime	High	High	High	High	High
Morphology	Supports good	Supports good	Supports good	Supports good	Supports good
Specific pollutants	High	High			
Copper	High	High			
Triclosan	High	High			
Zinc	High	High			
Chemical	Good	Good	Good	Good	Fail
Priority hazardous substances	Good	Good	Does not require assessment	Does not require assessment	Fail
Benzo(a)pyrene					Good
Cadmium and Its Compounds	Good	Good			
Di(2-ethylhexyl)phthalate (Priority hazardous)	Good	Good			
Dioxins and dioxin-like compounds					Good
Heptachlor and cis-Heptachlor epoxide					Good
Hexabromocyclododecane (HBCDD)					Good
Hexachlorobenzene					Good
Hexachlorobutadiene					Good
Mercury and Its Compounds					Fail
Nonylphenol	Good	Good			
Perfluorooctane sulphonate (PFOS)					Fail
Polybrominated diphenyl ethers (PBDE)					Fail
Tributyltin Compounds	Good	Good			
Priority substances	Good	Good	Does not require assessment	Does not require assessment	Good
Cypermethrin (Priority hazardous)					Good
Fluoranthene					Good
Lead and Its Compounds	Good	Good			
Nickel and Its Compounds	Good	Good			
Other Pollutants	Does not require assessment	Does not require assessment	Does not require assessment	Does not require assessment	Does not require assessment

Investigations into classification status

No data to show

Reasons for not achieving good (RNAG) and reasons for deterioration (RFD)

Reason Type	SWMI	Activity	Category	Classification Element	More information

Reasons for not achieving good status by business sector

Issues preventing waters reaching good status and the sectors identified as contributing to them. The numbers in the table are individual counts of the reasons for not achieving good status in water bodies, there may be more than one reason in a single water body.

Significant water management issue	Physical modifications	Pollution from waste water	Pollution from towns, cities and transport	Changes to the natural flow and level of water	Invasive non-native species	Pollution from rural areas	Pollution from abandoned mines
Agriculture and rural land management	0	0	0	0	0	0	0
Industry	0	0	0	0	0	0	0
Mining and quarrying	0	0	0	0	0	0	0
Navigation	0	0	0	0	0	0	0
Urban and transport	0	0	0	0	0	0	0
Water Industry	0	0	0	0	0	0	0
Local & central government	0	0	0	0	0	0	0
Domestic general public	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0
Waste treatment and disposal	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0
No sector responsible	0	0	0	0	0	0	0
Sector under investigation	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Objectives

Classification Item	Status	Year	Reasons
Ecological	**Good**	2015	
Biological quality elements	**Good**	2015	
Invertebrates	**Good**	2015	
Macrophytes and Phytobenthos Combined	**Good**	2015	
Physico-chemical quality elements	**Good**	2015	
Ammonia (Phys-Chem)	**Good**	2015	
Dissolved oxygen	**Good**	2015	
Phosphate	**Good**	2015	
Temperature	**Good**	2015	
pH	**Good**	2015	
Hydromorphological Supporting Elements	**Supports good**	2015	
Hydrological Regime	**Supports good**	2015	
Supporting elements (Surface Water)	**Not assessed**	2015	
Specific pollutants	**Not assessed**	2015	
Chemical	**Good**	2015	
Priority hazardous substances	**Does not require assessment**	2015	
Priority substances	**Does not require assessment**	2015	

Classification Item	Status	Year	Reasons
Other Pollutants	**Does not require assessment**	2015	

Protected areas

PA Name	Id	Directive	Type	More information
Asby Complex	UK0014778	Habitats and Species Directive	SAC	Natural England

Monitoring sites

- RIVER LUNE/RIVER RAWTHEY/RAWTHEY GILL QUARRY/ 547966
- RIVER LUNE/RIVER RAWTHEY/LOW HAYGARTH FARM/ 529646
- RIVER LUNE/RIVER RAWTHEY/CROOKHOLME/ 481791
- RIVER RAWTHEY AT RAWTHEY BR BLUECASTER 303330
- RIVER LUNE/RIVER RAWTHEY/RAWTHEY BRIDGE (BLUECASTER)/ 531512
- RIVER LUNE/RIVER RAWTHEY/SALLY BECK/AT FOOTBRIDGE/ 481403
- RIVER RAWTHEY D/S RAWTHEY BRIDGE NEAR BLUECASTER 528050
- RIVER LUNE/RIVER RAWTHEY/SALLY BECK/D/S HAG HOUSE/ 530275
- RIVER LUNE/RIVER RAWTHEY/WANDALE BECK/PTC RIVER RAWTHEY/ 531419
- RIVER LUNE/RIVER RAWTHEY/BACKSIDE BECK/PTC RIVER RAWTHEY/ 529505
- RIVER LUNE/RIVER RAWTHEY/CAUTLEY BECK/ 531194
- RIVER LUNE/RIVER RAWTHEY/CROSSHAW BECK/PTC RIVER RAWTHEY/ 529015
- RIVER RAWTHEY PTC RIVER LUNE 303341

Upstream water bodies

Downstream water bodies

- Rawthey - Lower

Summary

This installation is by proven design using a 1mm Coanda screen at the intake that allows sediment transportation to be uninterrupted over the impoundment that is additionally backfilled with existing sediment present at the intake location. This avoids a scenario where a sediment sink is created. Due to the limited flows being abstracted (Q95 hands off flow & maximum abstraction of well below Qmean) there is little risk of impact on sediment transfer through the reach. Additionally, the outfall, which includes a large diameter outfall pipe prior to screening and scree, ensuring low velocities. The boulder scree ensures that no erosion and associated sedimentation will occur at the outfall.

It can be concluded that the WFD status of the waterbody will not be affected by the operation of the pico hydro scheme.

NEEDLEHOUSE HYDRO
HYDRO SCHEME

Hydromorphology Report

Version A

Prepared for:
Sam Frankland, site owner

By:
Adam Cropper

Tel: +44 (0)1539 726013
Email: adam@ellergreen.com

February 2022

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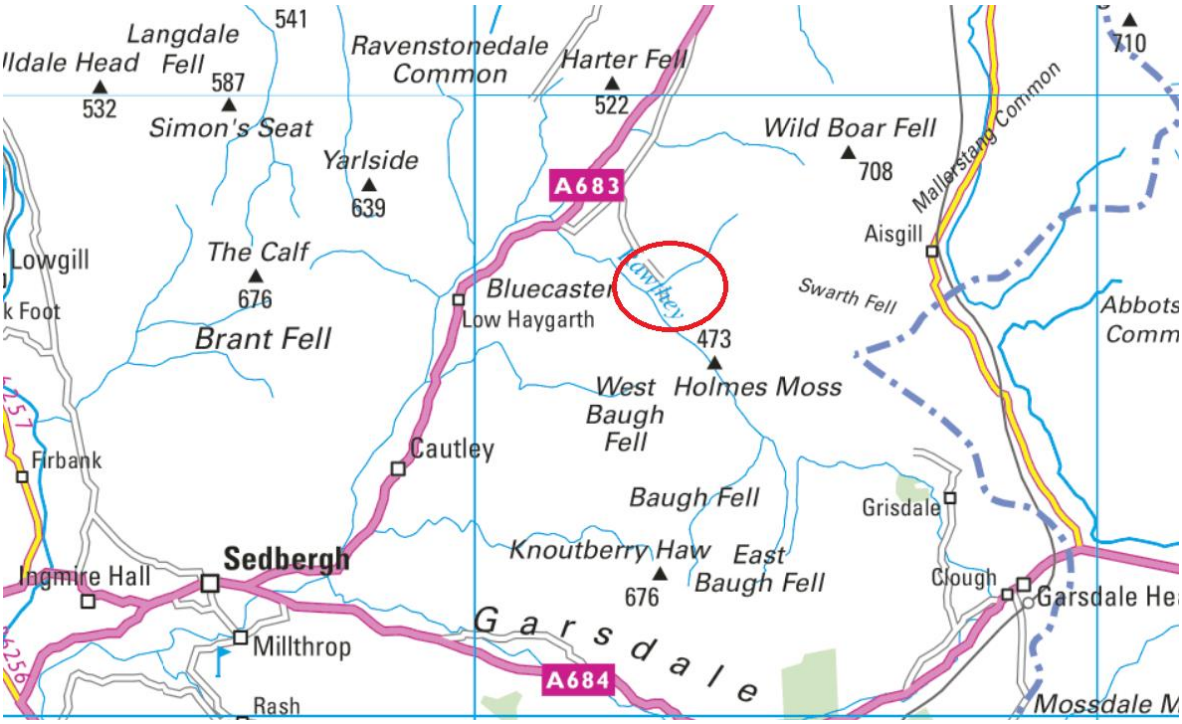

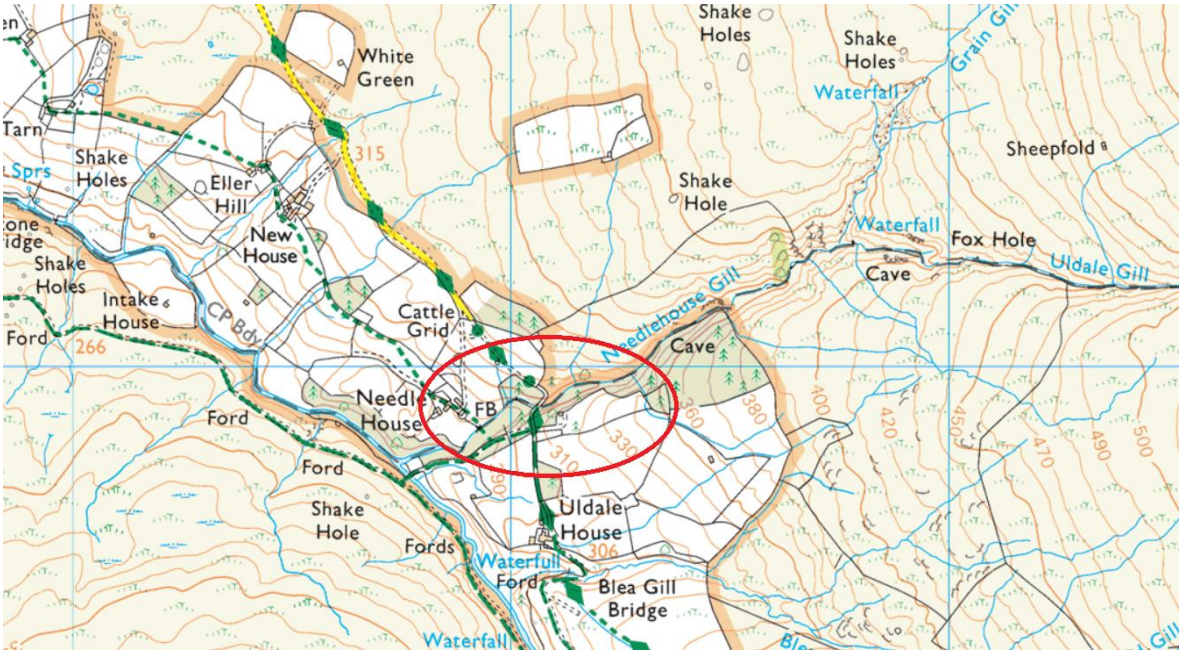

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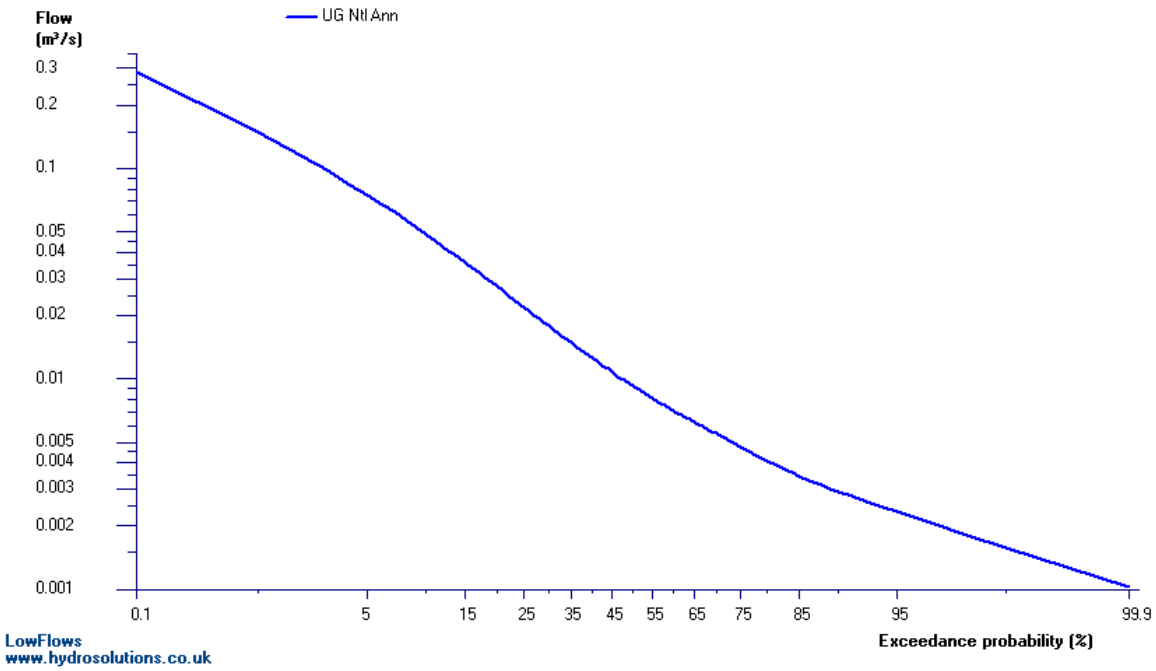


Figure 2: Flow duration curve for Backstone Gill

3 Geomorphology Character

3.1 Reach type

The depleted reach is typically of a steep mountain stream found in Cumbria and Yorkshire. The reach flows through woodland throughout. The further up the reach towards the intake the more the derogated reach is incised in a gorge after being more of a V shaped valley.

Much of the reach is a combination of stepped pool and riffle pool, with chutes and waterfalls in abundance.

The bed is loose and mobile in many some areas, with predominantly armoured bedrock through quite a lot of the reach. It is relatively well sorted and armoured with some limited loose and mobile material here and there.

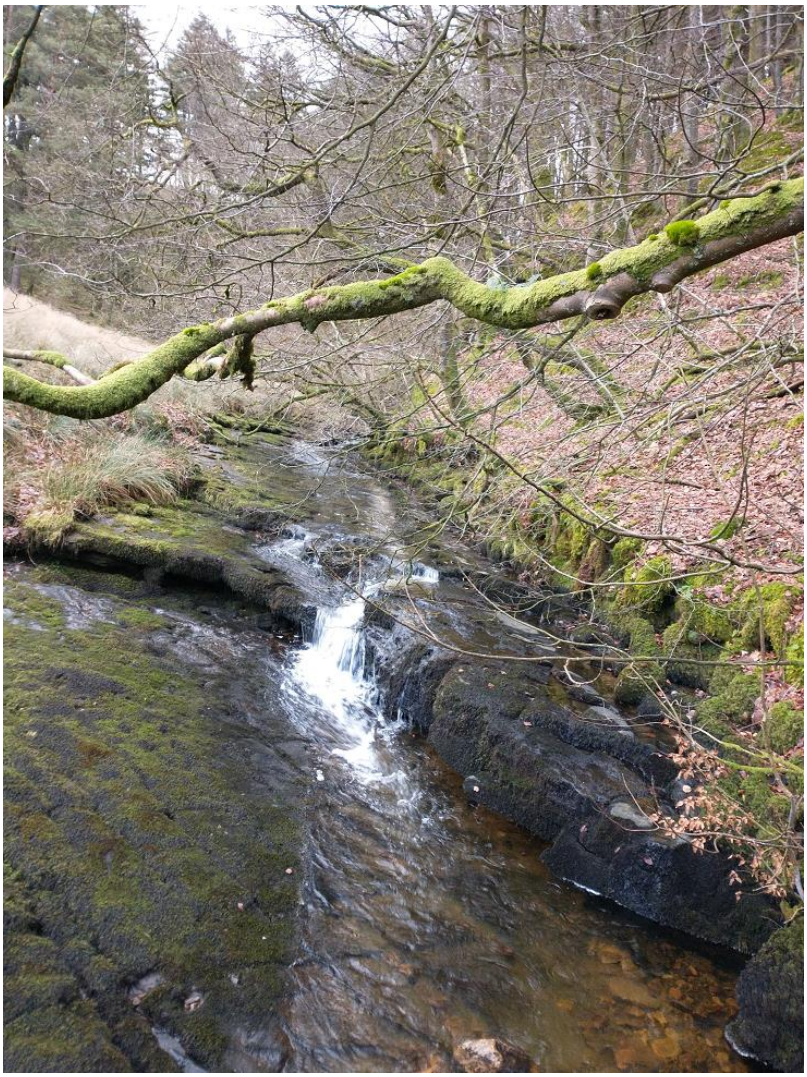
There are no islands within the reach.

Bed size is variable, average b-axis size being around 55-120mm so slightly larger than might be typical. *('b axis' - this is the intermediate axis with the a-axis being the longest length and the c-axis the shortest)*

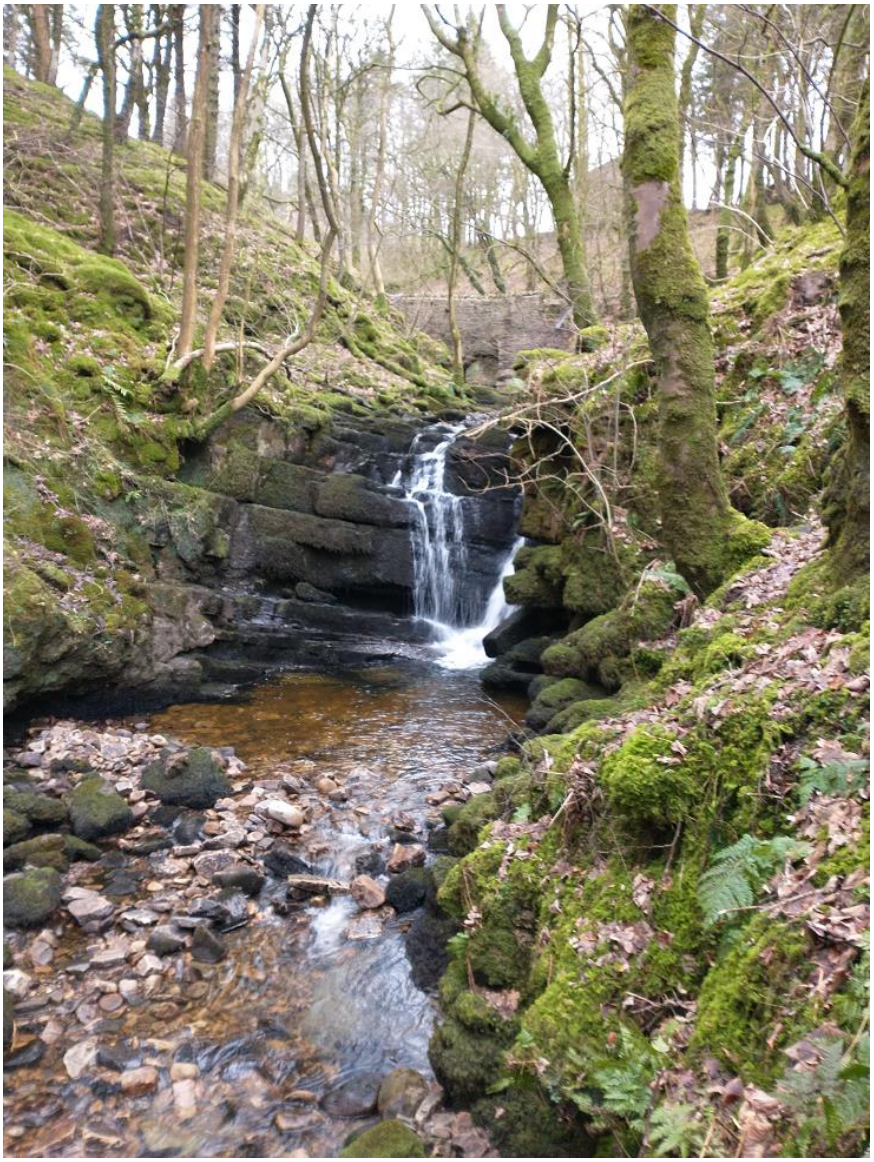
3.2 Photography Study

Two visits have taken place to produce this photographic study of the derogated reach at Needlehouse Gill.

The flows during the visit on 26th January 2022 was 48lps (spot gauging carried our during same visit) around Q75 based on gauging station (SPRINT). Starting at the bottom of the reach going upstream towards the intake location.



Upstream of powerhouse, halfway up to road bridge 26th Jan 2022

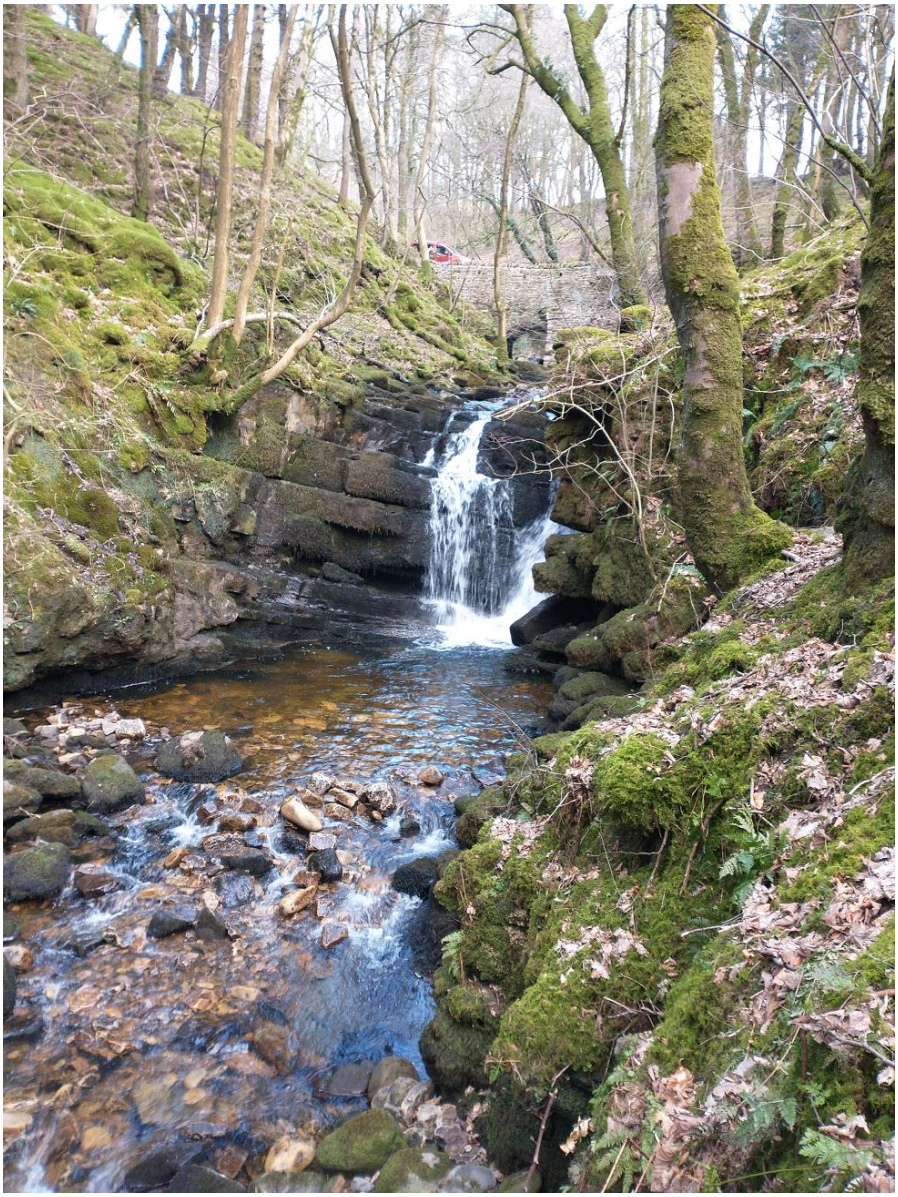


One of many fish blockers with pool at foot of waterfall 26th Jan 2022

Downstream of side road bridge 26th Jan 2022

Round corner upstream of road bridge, intake further upstream 26th Jan 2022

The second visit took place on the 8th March 2022. Flow was 102lps (spot gauging carried our during same visit) around Q50 based on gauging station (SPRINT). Starting at the bottom of the reach going upstream towards the intake location.



Very small tributary entering the reach up towards but below the intake location so this tributary is not abstracted from and helps naturalise the depleted reach flows.

3.3 Summary and Conclusions

Sediment transfer into the derogated reach, downstream of the proposed intake weir will not be impacted. The intake is being installed on the face of a small waterfall and so no new weir is required, the bed of the watercourse on top of the watercourse will remain unchanged apart from the installation of the flow split notches. The height of these notches is less than 200mm and will be backfilled with sediment, naturally flashy flows will ensure sediment trapping upstream of the weir will be negligible.

Transfer of coarse sediment (gravels and cobbles) through the reach will largely be unaffected by the altered flow regime through the derogated reach. Flood flows, capable of transferring sediment of this calibre, will be reduced only very marginally with negligible impact of geomorphological function of the channel. This is especially the case given the max abstraction figure is so low with this small domestic sized project.

Fine material may be stored more frequently in the derogated reach as 'flushing' flows are of very slightly less frequent, but material fine enough to cause any impact to spawning gravels will enter the 1mm coanda screen and bypass the derogated reach, when the hydro scheme is in operation and the reach is experiencing an altered flow regime. The fact that the scheme max abstraction is so far below the mean flow means that he alteration to flushing flows are negligible.

HOF impact assessment – The reach route is still wetted albeit with some zones of boulders being above the waterline in these flows due to the size of some of the typical boulders being large and flows in the watercourse being low. There are no sections of the watercourse cut off during these flows as no islands or features like this are present. The barriers are significant enough to be fish blockers at both low and high flows in the gorge which is not far above the outfall location. Further up some on the small cascade and falls will be passable at high flows but not at medium or low flows.

Needlehouse Gill Hydro Scheme

Method Statement

25th March 2022

Document Control

Scheme Name:

Needlehouse Gill Hydro Scheme

Client Name:

Mr & Mrs R Frankland

Client Address:

Needle House,
Fellend
Ravenstonedale,
Kirkby Stephen
CA17 4LN

Tel: **015396 20346**

Revision:	A
Prepared by:	SF
Approved by:	
Date:	25.03.2022
Status:	Issue
Comments:	

Outline Method Statement

This outline method statement (MS) describes the proposed activities required for the installation of a micro hydro scheme on Needlehouse Gill, Fellend, Kirkby Stephen, Cumbria.
The purpose is to enable the Yorkshire Dales National Park (YDNP) & the Enrivonment Agency to give comment and offer advise. Based on the YDNP advice at this early stage environmental studies have been commissioned to further progress the design and abstraction arrangements drawn up. Once permissions are in place it will then form the basis of the Construction Phase Plan, with any revisions or modifications made as required.

Fig 01 Context OS map

General Description of Works

The layout is shown in Fig. 02, and the works consist of the following:

• A small intake structure across Needlehouse Gill, incorporating a Coanda screen with 1mm aperture and an integrated sump.

• A partially exposed and partially buried penstock of approx. 450m HDPE plastic pipe (250mm outside dia.) running from the intake down to the turbine house on the West side of the watercourse. The top two thirds will be overburdened, the lower thrid will be buried.

• A timber faced turbine house complimenting the existing agricultural buildings enclosing the hydroelectric turbine, generator, and control panel.

• An 5m(approx) 400mm diameter discharge pipe with a screen with 30mm spacing, and an outfall structure, in the form of bank supporting concrete walls and bank reinforcing boulders, to return water to the gill.

• A buried electrical cable from the turbine enclosure to the main distribution board of Needlehouse Farm.

• Temporary construction access routes to the intake

All materials / equipment will be delivered to a main site compound.

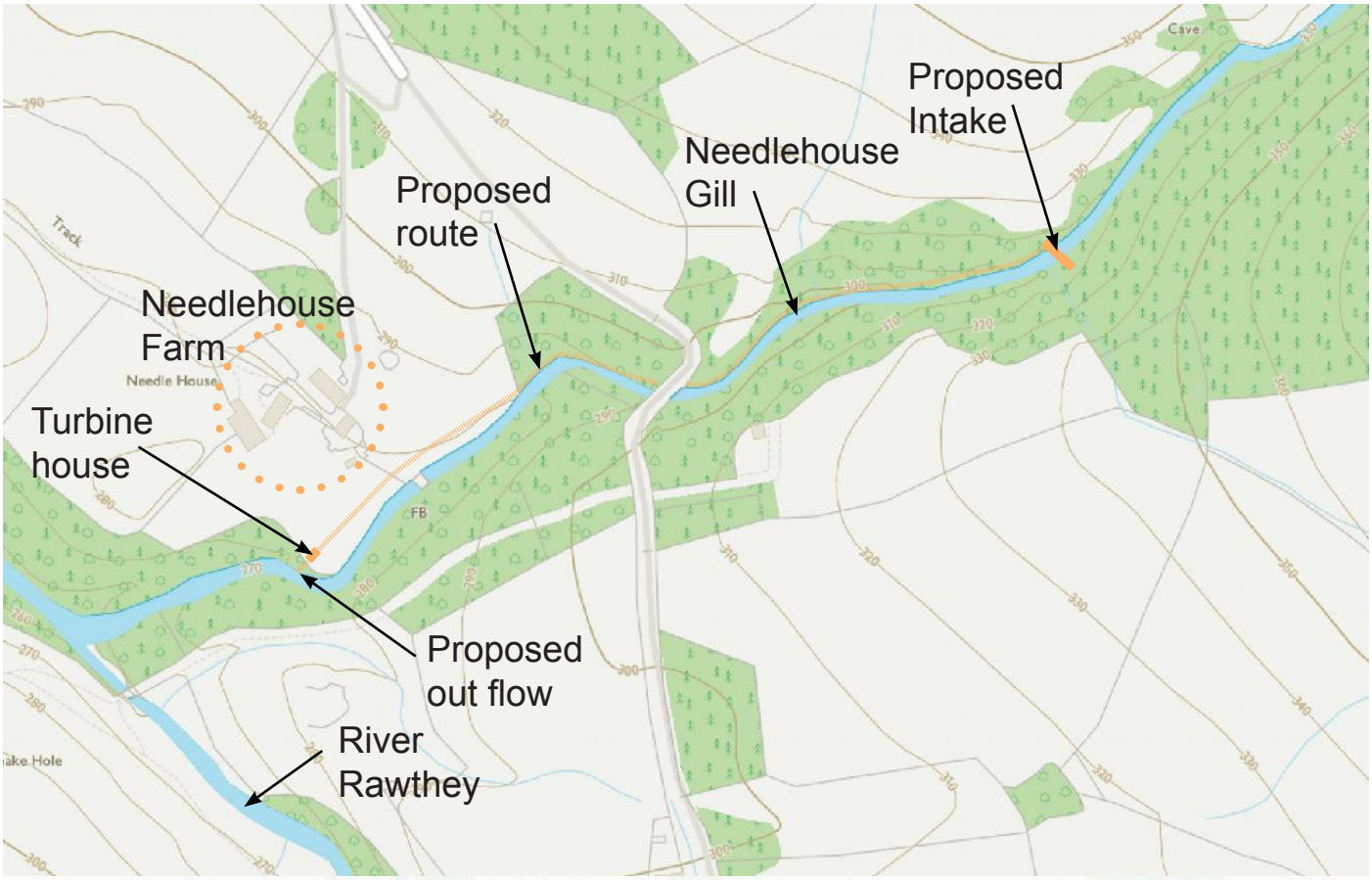


Fig 02 Topographical representation produced by OS to illustrate the key locations and route of the penstock

Duration of Works

It is estimated that the works will take 4 months to complete. However, the weather could impact on the length of time required on site. The preferred approach for schemes of this scale is to hold back on construction during very wet periods in order to avoid degrading the working area.

Outline Method Statement

1. Site Preperataion

1.1 Set up compound areas including storage and welfare
1.2 Install signage and fencing as required
1.3 Runoff protection measures to be implemented. All methods of runoff management, and spoil storage to follow the recommendations from the Ecological Clerk of Works
1.4 Consolidate access route.
1.5 Topsoil on upper side of route to be stripped and stored
1.6 If the workings expose any underground water drainage routes, these may require temporary fluming and/ or containment using clay barriers to prevent access/ penstock route from becoming drainage route

2 Intake Construction

The intake is to be a Coanda screen. Work to install the intake will only commence when water levels are low and no heavy rain is forecast.
2.1 Use Ø600mm twin-wall pipe (or similar) with sandbags, visqueen and plastic sheeting to create a temporary diversion from natural stream crest upstream of works. The flow will be returned to the beck in a rocky section where the risk of the flow disturbing the river bed is minimal.
2.2 Place straw bales downstream of works to catch any displaced sediment
2.3 Any remaining water below the diversion point will be pumped out and returned to the stream via a silt trap and/ or discharged over grass: whichever is necessary to ensure that no silt from the working area enters the watercourse.
2.4 If required, remove bedrock using heavy duty battery SDS chisel handheld rotary cutters etc to form stable bedrock base for the cast in situ weir to sit on.
2.5 Drill and chem-set steel rebar anchors into bedrock
2.6 Wire-brush bedrock to remove slime and allow good bond with concrete
2.7 Craft timber stuttering for the split flow notches on the top side of the waterfall,
2.8 Hand mix concrete on location
Cast weir NOTE - Check weather forecast and only proceed with placement of concrete if three clear dry days ahead – this is to prevent washout of works in spate flows.
2.9 Drill and chem-set steel rebar anchors into bedrock waterfall face for the Stainless steel intake.

2.10 Transport prefabricated stainless steel intake to weir
2.11 Bolt prefabricated stainless steel intake to waterfall face.
2.12 Upstream of weir to be back filled to raise bed level to just below the coanda crest and residual flow notch.
2.13 All tools are to be washed in a specially dug pit away from the river.
2.14 Allow minimum three days for concrete to cure before removing any diversion works.

3 Pipeline

3.1 Deliver pipe to site
3.2 Place sections of pipe along route using tracked dumper where possible.
3.3 Excavate pipe trench in short sections. Ensure weather windows are appropriate and that the runoff protection measures are adhered to.
3.4 Starting at the intake, sections of pipe to be welded together using butt fusion welding then laid and reinstated over. (Note: unless construction uncovers any areas of bedrock, no pipe bedding material is required).
3.5 At bends, which will be formed by the natural flexibility of the pipe material, the pipe should be buried with at least 600mm cover to help restrain thrust forces. Particular attention should be paid to the outside of bends.
3.6 Lay pipeline up fellside, using excavator and/ or tracked dumper to move pipes and fittings as required
3.7 HLS signal cable to be laid along pipe route. Cable to be covered in slit trench or similar.

4 Powerhouse

The powerhouse is designed around a concrete floor slab which underlies both the pipe and the turbine. The turbine will discharge into a concrete sump, with a tailrace made from 400mm twin-wall pipe or similar. Measures for the protection of runoff must be implemented.
4.1 Mark out powerhouse and tailrace
4.2 Excavate foundation trenches, sump and upper trench for tailrace
4.3 Cast wall footings and floor of sump
4.4 Install tailrace pipe
4.5 Construct formwork for sump around first section tailrace pipe, and formwork for turbine bed frame. Include anchor block, floor drain and cable ducts (as will be shown in engineering drawings)

4.6 Cast sump walls and main floor slab, with starter bars for anchor block. Slab to have slight fall to allow drainage into floor drain, and apron to slope away from building
4.7 Construct timber walls and roof as per Architects drawings
4.8 Fit doors and rainwater goods as appropriate

5 Tailrace & outfall

5.1 Use steel piles or sandbags/ visqueen to form barrier around outfall to isolate works from watercourse
5.2 Dig remaining trench for tailrace pipe to beck
5.3 Install tailrace pipe
5.4 Create scour protection and stepped cascade at outfall and landscape pipe exit to include boulder reinforcement to the bank upstream and downstream of the outfall.
5.5 Fit Outfall screen (stainless steel with 30mm spacing)
5.6 Backfill pipe trench (selected backfill to avoid damage)

6 Electro-mechanical installation

6.1 Deliver turbine/ generator, control panel and ancillaries to site, unload onto concrete apron and use rollers to move into powerhouse lifting area
6.2 Fit turbine and generator in place, align, bolt down and grout in
6.3 Fix main inlet valve support to concrete, and check alignment/ positioning of unit

7 Connect & restrain pipe.

7.1 Pipe to be flushed with intake screen in place to remove debris from pipe (small stones etc.).
7.2 Cut pipe to length, and fit reducer with stub pipe to suit turbine inlet; reducer to be located within anchor block, at upstream end
7.3 Connect pipe to turbine inlet using dismantling joint
7.4 Construct formwork for anchor block, fixing pipe securely to prevent suspension in concrete
7.5 Pour anchor block
7.6 Backfill around block from the working area enters the watercourse.

8 Electrical Installation & Power Cabling

8.1 Install control cabinet
8.2 Connect generator, actuator and sensor cables; install

local power and lights
8.3 Connect signal cable from intake
8.4 Cable route to be excavated from powerhouse to connection point
8.5 Warning tape to be placed in trench
8.6 Install intake level sensor(s) under intake screen.

9 Final civils

9.1 Making good
9.2 Final pumping out and clearing of working area prior to removal of diversions; all silt water to be pumped out of working area
9.3 Remove straw bales, waste and excess materials
9.4 Remove downstream intake bund, followed by diversion works bund; original flow to be restored.
9.5 Remove sediment from any traps; fill and reinstate turf

10 Commissioning

10.1 System commissioning as per turbine supplier instructions

Restoration Plan

1 Intake Area

1.1 On completion of the weir (incl screen & intake chamber to a watertight/secure degree) and reinstatement of the riverbed material (incl formation of any necessary pools), removal of the diversion works should take place at the earliest convenience to restore normal flows to the watercourse.
1.2 Diversion channel entrances must be blocked securely, and channels refilled with excavated material
1.3 Reform watercourse banks using excavated/stored rock & subsoil paying close attention to reinforcement using larger rocks/boulders in areas sensitive to erosion and around weir wing walls.
1.4 Landscape around intake area to reform natural topography and blend weir structure into landscape. Ensure ground levels are sufficiently high at ends of weir walls to prevent floods bypassing or washing out around the weir structure.
1.5 Re-seed or re-lay topsoil and turf to banks and intake area.

2 Pipe/Access Route

2.1 Working backwards down the pipe/access route replace topsoil's and turfs along tracks, trenches, and storage areas; grading landscape as required to reflect natural contours of the topography.
2.2 Reinstate water drainage to original flows, paying particular attention to the water to wet flushes.
2.3 All stone walls to be reinstated to as before condition or if improvements to unstable walls can be made for this to take place following the style and using the same stone as before.
2.4 Collection of any waste material used during construction such as pipe cut offs, packaging, safety tape etc.
2.5 Removal of all temporary access track material including stone and membrane.

3 Powerhouse/Outfall & Main Compound Areas

3.1 Landscaping of powerhouse area to ensure coverage of anchor block and aesthetic integration of powerhouse into the landscape.
3.2 Reinstatement of watercourse banks surrounding outfall area.
3.4 Redistribution of compound area topsoil across compound area, reseeding as necessary.
3.5 Removal of tree protection fencing from protected areas
3.6 Reinstatement of any gateway/stonewall or hedge altered for access purposes.

Needlehouse Gill Hydro Scheme

Design & Access Statement

25th March 2022

Document Control

Scheme Name:

Needlehouse Gill Hydro Scheme

Client Name:

Mr & Mrs R Frankland

Client Address:

Needle House,
Fellend
Ravenstonedale,
Kirkby Stephen
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Revision:	A
Prepared by:	SF
Approved by:	
Date:	25.03.2022
Status:	Issue
Comments:	

Contents

1. Introduction

Park in fulfilment of requirements of The Planning & Compulsory Purchase Act 2004 (paragraph 42) (Ref 1-1) and advice provided in the Commission for Architecture and the Built Environment's (CABE) guidance Design and access statements: how to write, read and use them (2006) (Ref 1-3), as well as the Yorkshire Dales National Park Local Development Framework Core Strategy.

Design and Access Statements are important as they provide a clear way in which to demonstrate that a proposed development has gone through a proper design process and are good, sustainable and inclusive design. Apart from any legislative requirement, statements will have benefits for all involved with applications.

This statement refers to the objectives of good design as set out in The Town and Country Planning (Development Management Procedure) Order 2012 and explains how they have informed the design process. The particular relevance and weight attached to each of the objectives may depend on local policy, circumstances and the nature of the proposed development.

The objectives are outlined under five headings:

Context

Environmental Sustainability

Community

Access

Movement

2. Context

A proposed 10kW micro hydro scheme for the generation of electricity from a renewable source, water. The applicant intends to increase their portfolio of renewable energy schemes under their ownership with a view to their properties and organisation as a whole becoming 100% powered by renewable energy sources. This will reduce the reliance on imported electricity and fossil fuel sources, and in future will enable funds to be directed to other goals such as increased efforts in environmental protection and conservation. The applicant also supports efforts to address and seek solutions to climate change and is therefore making an effort to contribute towards National and regional requirements for clean energy.

Micro hydropower is naturally constrained in scale by the availability of the natural resource it utilizes. The ability of the technology components to be buried, hidden by natural features, and blended into the local landscape by the use of stonework and timber cladding results in schemes that have a very minor visual footprint. The Needlehouse Gill scheme will barely be visible unless in its immediate vicinity.

2.1 Policy

The Yorkshire Dales National Parks Local Development Framework - Core Strategy (Adopted Version 20 December 2016) sets out the policies and frameworks which guide sustainable development in the National Park. The LDF as a whole supports the development of decentralised renewable energy sources and the proposed scheme meets the requirements set out:

SP1 Sustainable development

“g) reduces waste and greenhouse gas emissions through compliance with the spatial strategy, improved energy efficiency and making full use of small-scale renewable energy”

CC1 Renewable and low carbon energy

“To enable the National Park’s communities and businesses to meet their energy needs in a more cost efficient and environmentally friendly manner, without compromising the special qualities of the area.”

The development plan for this area is the Eden Local Plan (2014 – 2032). The policies of this plan which are most relevant to this proposal are:

ENV6 – Renewable Energy

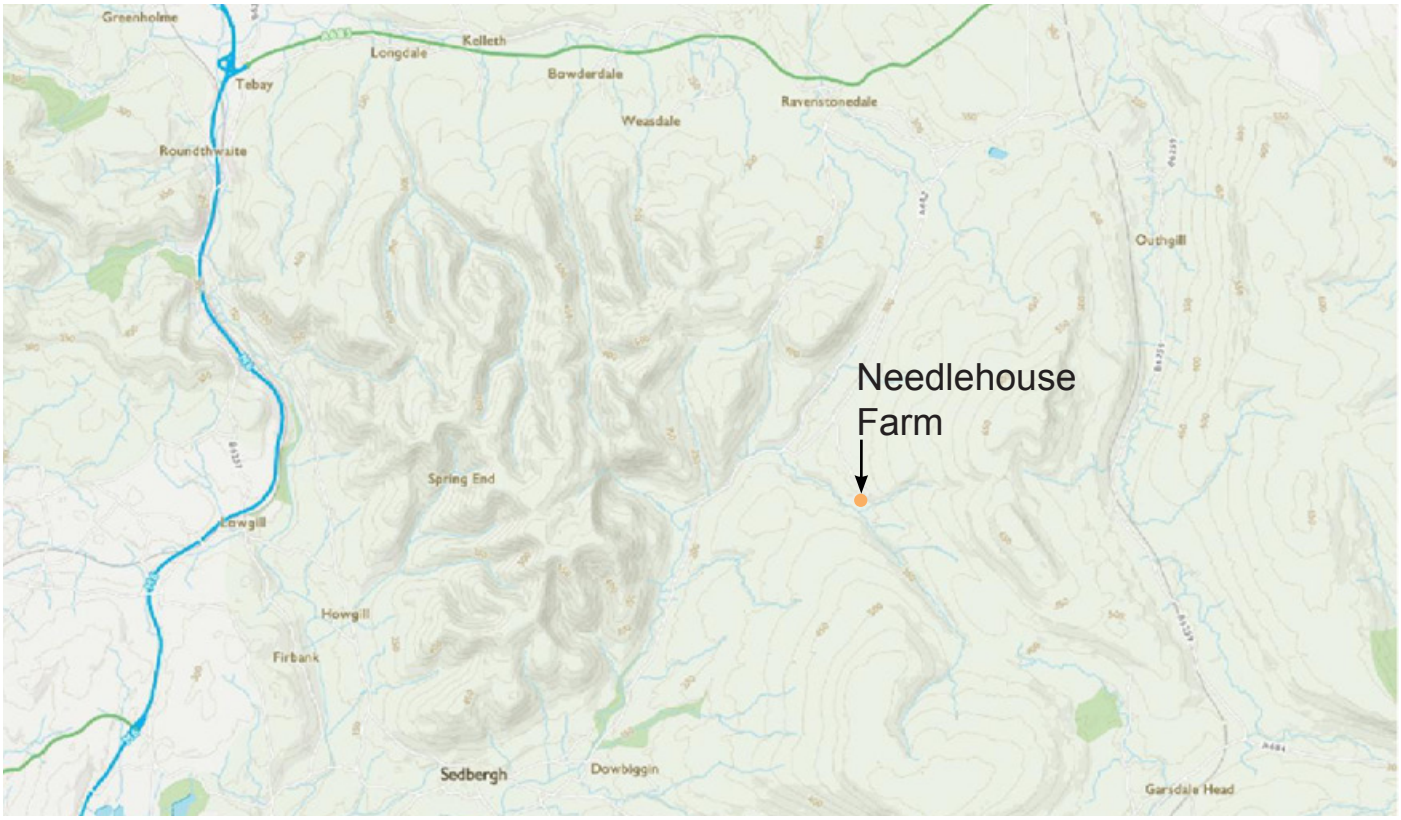

Fig 01 Context OS map

2.2 Location

Needlehouse Gill originates on the South Eastern slopes of Wild Boar Fell at the confluence of Grain Gill and Uldale gill, approximately 500m northeast of the proposed intake location, and feeds directly into the River Rawthey some 120m downstream of the proposed discharge location.

A Site Plan has been included with the application, and the layout of scheme is shown in the General Layout drawing.

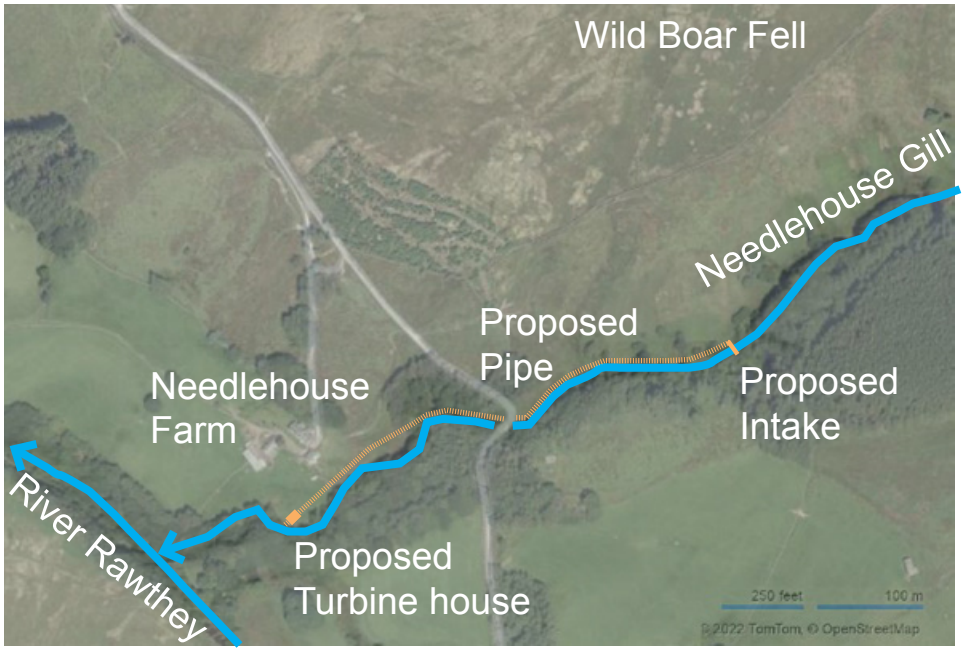

Fig 02 Site schematic areial view, From Bing maps

2.3 Works Overview

The works will include:
• A small stainless steel intake structure across Needlehouse Gill, incorporating a Coanda screen with 1mm aperture and an integrated sump.
• A part buried penstock of 480m HDPE plastic pipe (250mm outside dia.) running from the intake down to the turbine house on the North side of the watercourse. The top half will be overburdened, the lower half will be buried.
• A timber clad turbine house matching the existing farm buildings enclosing the hydroelectric turbine, generator, and control panel.
• A 5m 400mm diameter discharge pipe with a screen with 30mm spacing, and an outfall structure, in the form of bank supporting concrete walls and bank reinforcing boulders, to return water to the beck.
• A buried electrical cable from the turbine enclosure to the main distribution board of Needlehouse and Needlehouse cottage
• Temporary construction access routes to the intake.

2.4 Scale of the Proposed Scheme

Needlehouse Gill as a watercourse offers fantastic hydropower generation potential. With a high head, high average annual flow, and limited ecological impacts. Initial scoping of the gill identified it as a 50kW potential scheme.

However, the area is remote and the grid capacity is particularly constrained with only sub G83 regulation capacity being available. This limits the scale of the project to 10kW. Consequently the scheme will now only abstract an almost negligible amount of water from the gill and all impacts are similarly reduced due to the lower level of civil construction required.

The generation will be grid connected but it shall also have a distribution panel supplying electricity directly to the properties on the farm enabling any electricity usage by the farm buildings to be supplied by the scheme when it is running and excess electricity to be exported to the national grid.

2.5 Landscaping and Appearance

All visible elements of the scheme will not constitute a dominating factor to the local environment by appropriate sizing and conforming to the local characteristics of the landscape.

The powerhouse will be based on the existing timber buildings already present on the site.

Fig. 03 Looking north up the Gill with existing chicken coop at Needlehouse Farm on the left of the image.

The intake weir is a very low structure and anchored to the face of the waterfall. The crest level is denoted by the red lines. Please note for exact detail please refer to the intake drawing enclosed with our application.

Fig. 04 Intake position.

The pipeline will be overburdened and anchored to the sides of the beck, lightly touching the ground for the upper portion of its journey. This top portion is largely hidden from view due to the steep topography and vegetation and hence does not pose any long term change to the appearance of the landscape.
Once the pipeline leaves the wooded areas it will be buried as it passes across the pastures.

Fig. 05 View looking north from the outflow position.

Similarly the outfall pipe will remain unobtrusive, being buried through the banks where the outfall structure and will be located. See appendix outfall drawing for more detail.

2.6 General Design Principles

Hydro power is a non-consumptive technology that utilises the potential energy available in flowing water dropping from one point to another. Water is abstracted from a watercourse through a dedicated weir structure with an intake screen, and passed into a pipeline which minimise frictional losses. Water then passes through a control valve, which regulates the amount of flow, to a turbine that is coupled, either directly or by belt, to a generator. A control system regulates the control valve depending on the water available to abstract, and also connects the generator to the distribution network to export electricity.

2.6.1 Physical Layout & Siting

The location of the scheme (intake, pipeline, powerhouse, outfall, and grid connection) is proposed on the basis of achieving a balance between increasing the respective height difference between the intake and powerhouse to maximise the scheme output.

The locations and pipeline have also been checked to ensure minimal interference and disturbance is caused to known environmental resources such as ecology, hydrology, and archaeology. No SSSIs, SACs, Ancient Woodlands or Scheduled Ancient Monuments are located within the boundaries of the site.

The effect of the scheme on the wider landscape beyond the application site can be regarded as minimal during construction and almost negligible over the long term. During construction the largest effects will be the visual aspect of general construction works and machinery operating in the lower sections of the scheme. This visual intrusion will be limited to the immediate surroundings, with works quickly being obscured by landscape features with further distance from the scheme. Works at the intake location will be largely invisible, due to being at such a high elevation and screened by the natural topography.

During construction the wider landscape is potentially at risk of a pollution incident due to any pollutant entering the watercourse and being transported downstream of the application site to the River Rawthey and beyond. The outline method statement enclosed details the measures taken to avoid such a scenario.

Over the long term the visual aspect of the construction works will fade to the point where the route of the buried pipeline will no longer be discernable; the powerhouse will be in keeping with the existing farm buildings, vegetation growth will increase over the on the surface pipeline areas, and the intake construction will weather and be colonised by mosses and so on as has occurred at other similar hydro sites build in this manner and of this scale.

2.6.2 Noise Emission

During the design phase, careful attention has been given to the mitigation of noise. Concerns are often raised during the planning stage of a hydro scheme about potential noise impacts, though in practice, it has been proven that they can be minimised via design. The next nearest dwelling is approximately 400 hundred metres away and the scheme will be inaudible from there. Nevertheless, the ambient noise of the scheme will be limited by the following:

- Turbine house wall construction being thick stone walls
- Insulated roof and walls
- Ventilation vents will be baffled to control noise emissions
- This scheme is of a smaller size and design to other schemes Ellergreen Hydro have built, where these measures have been utilised and proven to absorb noise effectively.

Fig. 06 View looking south down the Gill after heavy rain

2.6.3 Hydrology

The stream is not gauged by the Environment Agency. The LowFlows Enterprise (LFE) model from the Institute of Hydrology was commissioned to develop the flow characteristic of the site, estimating the mean annual flow to be 0.123m³/s, with a catchment area of 2.3272 km2
The hydrological report is enclosed with the consenting applications.

Qmean	Average Flow	123	Litres/sec
Q90	Flow exceeded 90% of the time	14	Litres/sec
Q50	Median Flow – flow exceeded 50% of the time	50	Litres/sec
Q10	Flow exceeded 10% of the time	318	Litres/sec

2.6.4 Licensing

Consultations have been initiated with the Yorkshire Dales National Park and the Environment Agency. It was advised that an ecological assessment would be required, which was commissioned from PBA Ecology Ltd and is included with the application.

A pre-application was submitted to the Environment Agency in January 2021. Emma Thompson conducted an initial onsite meeting. During correspondence with Damien Mason leading up the submittal of this application he outlined what we would be required to submit initially.

An application for the following licenses has been submitted to the Environment Agency in March 2022:

• An Abstraction Licence, to allow water to be temporarily removed from a water source
• An Impoundment Licence, to implement a structure which impounds water.

2.6.5 Abstracted Flow

Hydropower is a non-consumptive abstraction. The turbine will draw a flow not exceeding 40 litres per sec. (Q57).

Under EA guidelines, the HEP scheme will be based on an abstraction percentage of 80% take above the hands off flow, with 20% remaining within the reach in addition to the hands off flow. This ratio is secured by two open rectangular notches of calculated dimensions. Please see the intake drawing for more details.

2.6.6 Residual Flow & the Deprived Reach

Following EA good practice guidelines, a figure of Q95 has been allocated for the Hands Off Flow i.e. 11 litres/sec. This will be guaranteed by a rectangle notch built into the weir, which will be sized to discharge 11 litres/sec before any flow passes over the coanda screen crest to the turbine.

It should be also noted that additional flow enters the watercourse from runoff down the derogated reach and provides a variance of flows as well as extra flow on top of the hands off flow provision.

2.6.7 Flow measurement

Because the turbines have a very flat efficiency curve against flow rate, the total flow passing through the turbine is directly proportional to the units of energy generated, as recorded on the kilowatthour meter in the powerhouse. Hence the annual kWh reading, multiplied by the appropriate factor of proportionality, will provide an accurate figure for the annual flow abstracted. This method is used satisfactorily on other small hydro schemes around the UK and will be used to provide the annual abstraction submission to the Environment Agency.

2.6.8 Output

The installation has an intake crest level of 307.00mAOD and a turbine level of 272mAOD, giving a net head, at the 0.04 m^3/s design flow, of 35m. It would produce a maximum electrical output of 10.16 kW and is projected to provide up to 52.8 MWh of renewable electricity per year, equivalent to the consumption of 12 average homes, and preventing the emission of 24.18 tonnes of CO2 annually.

The scheme will supply the two residences at Needlehouse and the farm buildings with the majority of their annual energy supply and export any surplus energy to the distribution network.

3. ENVIRONMENTAL SUSTAINABILITY

The purpose of the proposed hydro power scheme is to contribute towards the energy requirements of the applicant, as well as the broader National requirements for sustainable electricity generation. In both contexts the scheme increases the economic sustainability of the applicant organisation with income generation through the export of power to the grid and reduces the UK's dependency on fossil fuels.

Via a small construction time period and no long term effect on the local ecology, the scheme will generate the equivalent energy of the demand of 12 average homes, and with regular maintenance and care could operate in excess of 60 years.

As noted above, the annual prevention of the emission 24.18t of CO2 is a small but important step in mitigating the effects of climate change.

Fig. 07 View looking North up the varied banks of the Gill

4. COMMUNITY

4.1 Safety

It has been established that there is no threat to community safety from the operation of the hydro power scheme. All access points to the water flow, and generation equipment, are either screened or locked to protect the members of the community and to protect the scheme from vandalism. Furthermore, the limited moving parts of the scheme, I.e. the turbine and generator, are contained within their own casings and are also locked against entry.

4.2 Social

Renewable energy schemes such as that proposed are often the focal point of social debate. There is often concern over the general welfare of the community and the schemes effect on it. With appropriate responses from land owner and developer, concerns can be alleviated and the community made more aware of the potential of renewable energy and its benefits for rural areas. The applicant, The Frankland Family, actively engages with the tenant farmer and landowners in the vicinity of the scheme and their opinions regarding access and so on have fed into the overall design of the scheme.

The long term social effect of the scheme, as experienced with previously constructed schemes of the scale, will be that of a positive awareness of renewable energy, particularly hydro, whereby locals will discuss the technology in the wider community, further alleviating concerns in other areas and generally increasing support.

4.3 Economic

The scheme is owned by the Frankland Family. The economic effect on the wider community will be marginal, with only the tenant farmers and landowner associated with the access to the scheme receiving direct income through income forgone compensation or lease of land agreement.

The scheme will support and fund the Frankland Family's work in maintaining and improving the surrounding rural landscape which attracts the tourist trade. Local businesses in the tourist trade will therefore indirectly benefit from the proposed hydro scheme.

During construction, where practical and possible, local expertise and trade will be sought. This would include electrical works, Stonemasonry, labour and so on. The scheme will not create long term permanent jobs in the community but will support existing businesses and employees for the purposes of maintenance of the scheme for 20years and more.

4.4 Flood Risk

The proposed works are outside of flood risk zones as identified by the EA Flood Risk Maps. However, the power house is designed with all electronics suitably above ground level and with automatic safety shut down incorporated into the electrical connections. Furthermore, the intake structure will have a very low profile and be structurally reinforced to ensure that high waters will not cause damage to the integrity of the weir.

5. ACCESS

5.1 Proposed Access Arrangements

The access arrangements proposed below take into account the practical need to have suitable vehicular access to undertake the construction of the scheme.

Access has been sought after that utilises existing entrances and routes wherever possible. During the design of the scheme the access to the upper pipe route and intake was thoroughly explored, with consultation with the applicant and the Environment Agency.

A 4m working corridor for the buried pipe route will allow sufficient area of machinery access, excavation and set aside of material. Temporary compounds will allow storage of additional equipment or material.

5.1.1 Powerhouse

Access from the farm yard for the powerhouse will utilise existing access entrances.

Temporary access all the way to the powerhouse location is required during construction. Any future maintenance of permanent access to the proposed scheme will be undertaken by the applicant. This includes the upkeep of the gateways, and wall boundaries or fences.

5.1.2 Intake & Pipe Route

The route of the pipe will act as the access route for the intake. The majority of the penstock is surface mounted with a buried portion within semi improved acid grassland. Here access will be consolidated by the removal and setting aside of topsoil ready for reinstatement following the pipe burial. The intake and the over ground section of pipeline do not require machinery access with the exception of a hand held petrol winch to assist pipe laying and movement of the intake items.

6. MOVEMENT

6.1 Equipment Distribution

All materials / equipment will be delivered to the temporary compounds at and nearby the powerhouse location and will be distributed from there as appropriate.

6.2 Pipe Route

Removed vegetation/topsoil will be set aside for reinstatement, boulders will be removed only if they are a direct obstacle, 3m wide 70mm deep bog mats will be used wherever
appropriate for traversing over and wet flush areas, and any tributaries will be flumed for crossing. Vehicles utilising the access will include:

- Minidigger
- Telehandler
- Track Dumper

The construction of the upper penstock will occur from the intake downwards by electrofusion coupling or butt fusion welding short sections together and placing in their final position, before reinstating excavated material. The lower penstock will occur by excavating the section, butt fusion welding a string of penstock together, siting and backfilling the pipe, and then reinstating the ground cover before moving on to the next section. Trenches will not be open for the duration of construction, as the pipe will be laid in sections and reinstatement will occur incrementally as construction proceeds.

6.3 Powerhouse

This access will be utilised by larger vehicles delivering components and will act as permanent access to the scheme powerhouse.

6.5 Rights of Way

The public right of way running from Needlehouse Cottage across the footbridge and up through Uldale wood will be kept open over the short construction timeframe.

The public right of way running from Fellend towards Uldale House will be part utilised for some access in during the construction. This route will be kept open over the short construction timeframe.

We have consulted with the National Park Ranger about how best to manage the works with suitable temporary fencing to keep the public safe whilst maintaining access to users of the PROW.

Providing Ecological Solutions

Needlehouse Hydro

Preliminary Ecological Appraisal

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Document Information

Project Title:	Needlehouse Hydro
Report Type:	Preliminary Ecological Appraisal
Report Date:	08/03/2022
Author:	A. Macaulay
Client:	Ellergreen Group LLP
PBA Ref:	PC21074/PEA/1.2

Quality Control

Version	*Status*	*Originated/Revised*	*Checked*	*Approved*	*Date*
1.0	Draft	AM	LE		07/03/2022
1.1	Draft	AM	LE	NW	08/03/2022
1.2	Final	NW	IC	NW	21/03/2022

Declaration of Compliance

This Preliminary Ecological Appraisal has been undertaken in accordance with British Standard 42020:2013 “Biodiversity: Code of practice for planning and development” (BSI 2013), the CIEEM Guidelines for Preliminary Ecological Appraisal (CIEEM 2017a) and Ecological Impact Assessment (CIEEM 2016). The information has been prepared and provided in compliance with the CIEEM’s Code of Professional Conduct (CIEEM 2019) and Guidelines for Ecological Report Writing (CIEEM 2017b).

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CONTENTS

TABLES

FIGURES

KEY FINDINGS

This report assesses the ecological baseline conditions at Needlehouse Hydro and identifies any potential ecological constraints to the proposed works to install a new hydroelectric scheme including intake and outfall. A desktop study of site attributes and an 'Extended' habitat survey (using UK Habitat Classifications) identified features of apparent or potential ecological significance. Potential ecological impact of the proposed works is assessed and recommendations are detailed to limit impact on biodiversity and ecological features.

Further designs and method statements are required to assess the impact of other habitats that are present on site.

Designated Sites

The site is within the Yorkshire Dales National Park. There are also three statutory designated sites within 2 km of the site.

Habitats & Species

Habitats present include river priority habitat (r2a), bryophyte spring priority habitat (TN1), *Holcus-Juncus* grassland (g3c8), other woodland broadleaved (w1g), other woodland mixed (w1h), upland mixed ashwoods (w1b), gorse scrub (h3e), upland acid grassland (g1b), bracken (g1c), and other coniferous woodland (w2c).

Recommendations

In order to inform the assessment of impacts, additional surveys and actions are recommended below:

- An updated PEA may be required if the method, timing or location of works change, to include relevant phase two recommendations.
- Finalised method of works and works designs should be reviewed once issued by a suitably experienced ecologist to screen for additional constraints and impacts.
- Trees that need to be removed must be felled outside of the nesting bird season (March to August inclusive).
- Mature trees that are to be removed will require bat roost surveys.
- An INNS survey should be completed during the summer prior to any works starting on site.
- A fish rescue of the proposed intake location will likely be required immediately prior to in-channel works, to occur between June 15th – September 31st (in-river working season).

1. INTRODUCTION

1.1. TERMS OF REFERENCE

PBA Applied Ecology Ltd was commissioned by Ellergreen Group LLP to undertake a Preliminary Ecological Appraisal including a bryophyte species list at Needle House Hydro, Ravenstonedale, Cumbria. This report assesses the ecological baseline conditions at the site and identifies any potential ecological constraints to the proposed works. The objectives of the ecological appraisal were to:

- determine the habitats present on site,
- determine the protected/notable species evident or potentially present on site,
- identify likely constraints and assess potential impacts of the proposed works,
- highlight further survey work which may be required,
- provide recommendations for mitigation/avoidance measures.

The level of detail in this appraisal and report is intended to be proportionate to the scale of works and complexity of its potential impacts.

Unless stated otherwise, the information provided within this report is valid for a maximum period of 24 months from the date of survey. If works at the site have not progressed by this time an updated site visit may be required in order to determine any changes in site composition and ecological constraints.

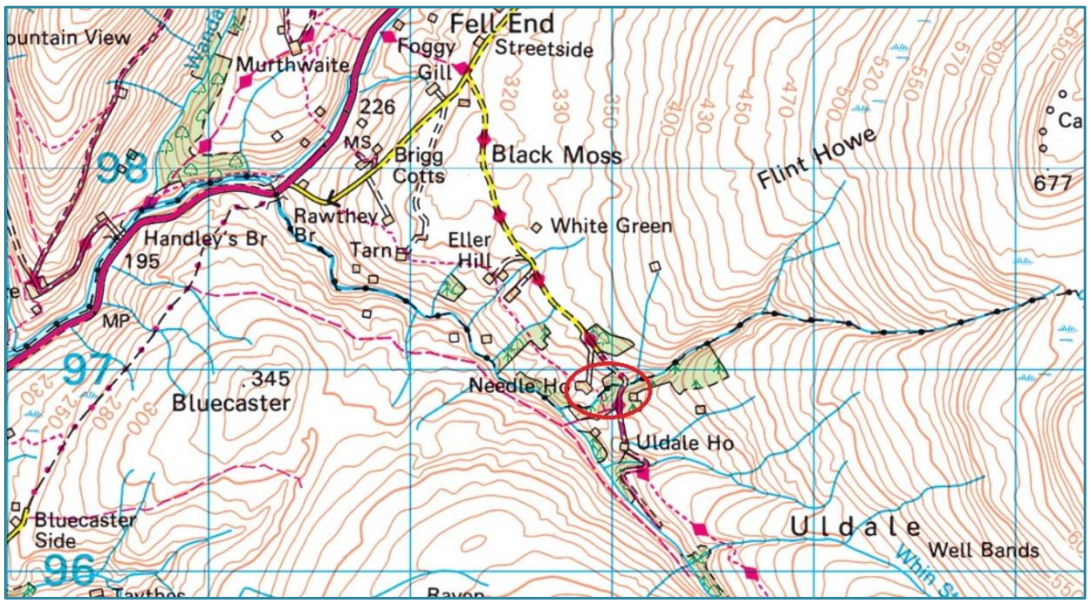

Figure 1: *Site location (Bing Maps, 2022)*

1.2. SITE DESCRIPTION AND CONTEXT

The survey site is located approximately 8.3 km northeast of the town of Sedbergh (SD 72759 96815, Figures 1 & 2). The site comprises of agricultural fields, mixed woodland and the River Rawthey.

The wider landscape is dominated by grazing pasture, moorland, and fells (Figures 1 & 2).

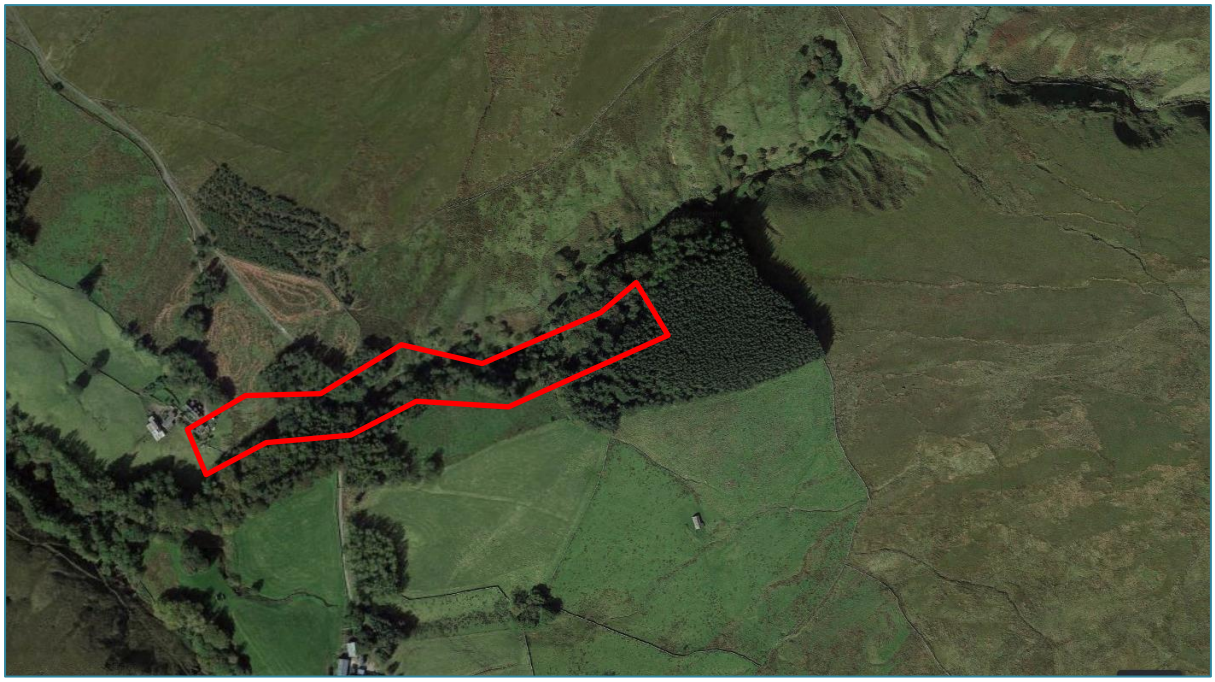

Figure 2: *Site context (Google Maps, 2022)*

1.3. DESCRIPTION OF WORKS

The proposed works are expected to include the installation of an intake, powerhouse, and outfall for a hydroelectric generator. This will impact both terrestrial and aquatic habitats on site.

The intake will be built across Needlehouse Gill upstream of the bridge across the Gill (figure 4). The powerhouse, outfall, and access track will then be built on the field south of Needle House. The pipe connecting the intake and powerhouse will then be built following the northern bank of the Gill. This will be over land in the woodland and buried through the field.

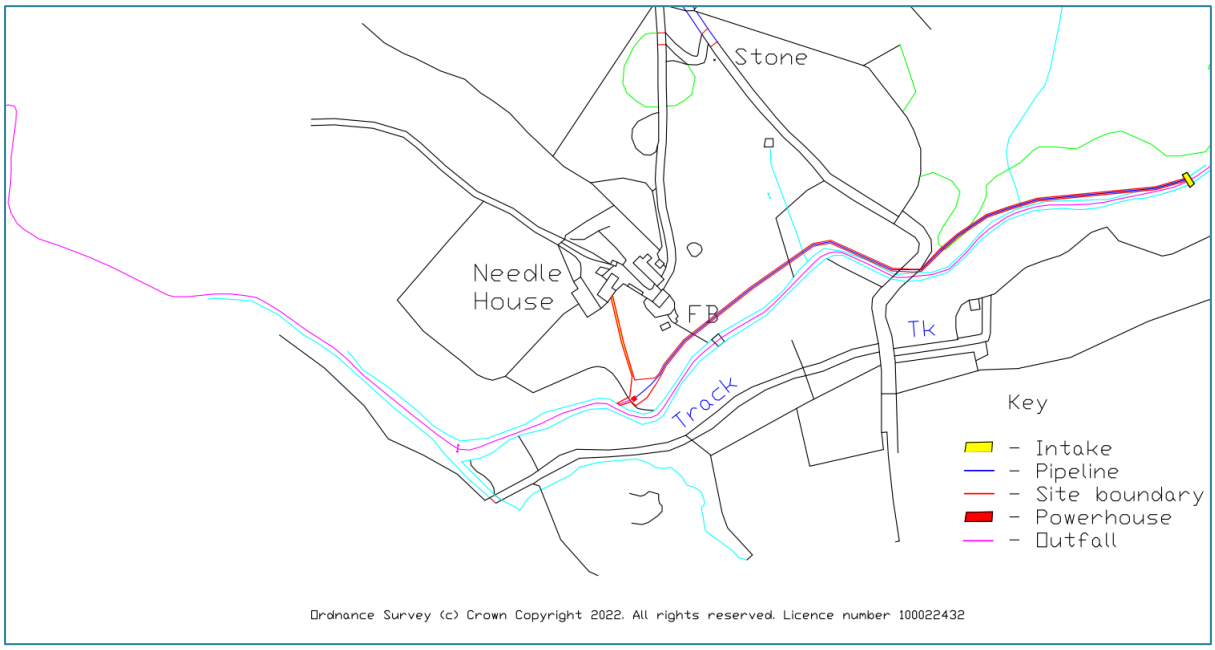

Figure 3: *Site plan*

1.4. WILDLIFE LEGISLATION AND PLANNING POLICY

This Preliminary Ecological Appraisal has been undertaken with reference to relevant environmental and wildlife legislation and planning policy. Key international and national legislation considered within the scope of this document includes:

- EC Habitats Directive 1992 (Council Directive 92/43/EEC)
- Wildlife and Countryside Act 1981 (as amended)
- Countryside and Rights of Way Act 2000
- Natural Environment and Rural Communities Act 2006
- The Conservation of Habitats and Species Regulations 2017 (as amended)
- Protection of Badgers Act 1992
- Hedgerow Regulations 1997
- Environmental Protection Act 1990
- Salmon and Freshwater Fisheries Act 1975
- National Parks and Access to the Countryside Act 1949

The most recent amendments to the Conservation of Habitats and Species Regulations 2017 take account of the UKs exit from the European Union. These amendments are found in the Conservation of Habitats and Species (amendment) (EU Exit) Regulations 2019.

In addition to obligations under wildlife legislation, Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services sets the Government's main objective for protecting UK biodiversity as *"to halt overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people."* (DEFRA 2011).

Further information on legislation and policy is provided later in this report (5. Evaluation) and in Appendix A, including levels of protection granted to the species and habitats identified at this site.

2. APPROACH

This Preliminary Ecological Appraisal is based on a desktop study of site attributes and an 'Extended' habitat survey. The standard habitat mapping survey (using UK Habitat Classifications (UK HCWG 2018)) is 'Extended' to highlight features of apparent or potential ecological significance, in relation to habitats present that have the potential to support notable or protected species (CIEEM 2017a). The field work to support this PEA was undertaken on 28th January 2022 by Dr Dan Chadwick and Andrew Macaulay BSc.

2.1. DESKTOP STUDY

Information on local, national and international designations, including statutory wildlife sites (*e.g.* SSSI, SAC), within a 2 km radius of the site were identified using the Natural England online facility 'Magic Map'.

Records of rare and protected species, and non-statutory wildlife sites within a 2 km radius of the site were obtained from online sources of readily-available data. This data was interpreted to determine the presence of protected and notable species and habitats. Although biological records are rarely comprehensive, they may provide valuable information on the presence of species not recorded during field surveys. Such records are generally collected by *ad hoc* surveys, therefore the absence of records does not demonstrate the absence of species.

To identify suitability for amphibians, and particularly great crested newts *Triturus cristatus*; aerial photographs and OS maps were used to identify any water bodies within 500 m of the survey site.

2.2. HABITAT SURVEY

The habitat survey comprised of the mapping of vegetation communities present on-site. The survey area covered Needlehouse Gill. The habitats immediately surrounding these features were also surveyed and covered an area of approximately 4 ha. The habitat survey followed standard UKHABS classification, habitats definitions, condition assessments and mapping methodology (UK HCWG 2018). Each habitat type is recorded by way of colour or code, allowing simple display and interpretation on the resulting habitat map. Dominant and indicator plant species were observed and recorded within each habitat type. Additional description is added to provide supplementary information relating to species composition, habitat structure, management and features of local ecological interest or potential significance.

2.3. SPECIES SCOPING SURVEY

In line with standard practice (JNCC 2010, CIEEM 2017a), an assessment of the potential for the habitats on site to support protected or notable species was made. Notable species are those which are legally protected, are nationally or locally rare or endangered, or are identified as a 'priority' species in the UK or locally. The likelihood of presence at the site of each notable species was determined; the assessment was based on the results of the desktop study, visual evidence of animal activity on site, and the quality and extent of suitable habitats. Impact of the proposed development on notable species and supporting habitats was determined. An impact assessment was conducted to the extent that can be supported by the completed surveys; in cases where further surveys are recommended, more specific impact assessment can be developed subsequently.

In addition, any invasive non-native and/or controlled species present on site were recorded.

2.4. SURVEY CONDITIONS AND CONSTRAINTS

Weather conditions at the time of survey were: overcast, with heavy rain and snow, strong wind, and a temperature of ~0 ^{o}C.

In accordance with Clause 6.7 of BS 42020:2013, any limitations to the survey and ecological assessment are detailed below and within the results.

The species scoping survey does not constitute a full survey for each taxa, and cannot categorically ascertain the presence or absence of any species. Where there is potential for protected species of florally rich communities, additional survey work may be required to confirm and detail their presence.

Although potential of the habitats to support notable species could be determined to some extent, conditions for surveying were sub-optimal, many animals would be inactive and vegetation communities could not be identified in detail.

Where impact could not be confidently ascertained, checks by an ecologist are recommended immediately prior to works starting.

A second survey was needed due to the intake structure for the hydro scheme exceeding the previous redline boundary (Appendix D).

2.1. BRYOPHYTE SURVEY AND FISH HABITAT ASSESSMENT

A survey of riparian bryophyte species was conducted with specialist taxonomic assistance from Dr Allan Pentecost. The extent of the survey site was walked and, where safe, the stream and rocky banks were accessed. Bryophytes were predominantly surveyed from the stream and splash zone at the intake location and at the proposed outfall location. Incidental records from the penstock route, adjacent habitats and within the reach were included. The species recorded were assessed against the oceanic bryophyte scoring system (Averis et al. 2012) and lists of nationally rare and scarce bryophytes (Pescott 2016).

The potential of riverine and still-water habitats to support fish populations were assessed throughout the site, with areas of spawning habitat and shelters identified. Barriers to fish movement were assessed and mapped along the target reach.

3. Desktop Study Results

The following chapter has been produced based upon information gathered from the desk study.

3.1. Designated sites

Records show three statutory sites within 2 km radius of the survey area (Table 1; Appendix B). The site is within the Yorkshire Dales National Park. The designation requires that any work must not disrupt the natural beauty, wildlife or cultural heritage of this area. The site is within the Impact Zone of River Rawthey Wandale Beck and Sally Beck SSSI. This SSSI is approximately 1.4 km northwest from the site.

One non-statutory site is within 2 km radius of the proposed development, Murthwaite Park (Table 1; Appendix B). This is designated because it is an ancient woodland of significant importance. This site is approximately 1.9 km northwest from the location of the works.

Table 1: *Designated sites within 2 km of Needlehouse Hydro.*

Statutorily designated sites			
Yorkshire Dales	National Park	The site is located within this designation.	National Park designation was given to this area due to its extraordinary natural beauty, habitat diversity and cultural heritage.
River Rawthey, Wandale Beck and Sally Beck SSSI	Site of Special Scientific Interest	1.4 km northwest	It is a dual interest geological site covering most of the Ordovician and Silurian exposures in the Murthwaite Inlier, Cautely in Westmorland.
SSSI Impact Risk Zone		The site is within the SSSI Impact Risk Zone.	In order to protect and maintain the SSSI status of River Rawthey, Wandale Beck and Sally Beck SSSI.
Non-statutorily designated sites			
Murthwaite Park	Ancient Woodland	1.9 km northwest	This site is designated due to a number of ancient trees and the significance of this.

3.2. Species records

The data records provided by CBDC and readily available online resources (Appendix C) show that a range of nationally and internationally protected species are present within 2 km of the site. A summary of the most significant results of relevance to the survey area and proposed works are detailed below. Distances are taken from a central grid reference.

In total 567 species have been recorded within 2 km of the works location. This includes 78 species of bird. There are records of bullhead, Atlantic salmon and brown trout. Mammal records include roe deer, field vole, fox and European mole. The only invasive species recorded is the Eastern grey squirrel.

4. Field Survey Results

The following provides an assessment of the habitat categories identified within the survey area, and any notable species observed or potentially present. Habitats present include: river priority habitat (r2a),

Holcus-Juncus grassland (g3c8), other woodland broadleaved (w1g), other woodland mixed (w1h), upland mixed ashwoods (w1b), gorse scrub (h3e), upland acid grassland (g1b), bracken (g1c), and other coniferous woodland (w2c) (Appendix D). Needlehouse Gill is a priority habitat of flowing water, the woodland on site contains upland ash woodland, which is a priority habitat, finally the woodland downstream of the bridge contains a bryophyte spring which is an upland flush priority habitat. A buzzard was observed whilst conducting the survey, and surrogate signs of fox and rabbits were recorded (Table 3). No other surrogate signs of other animals were recorded, however, habitats on site have potential to support notable species.

Habitat distribution and location of target notes are recorded on the UK Habitat Classifications Map (Appendix D) and photographs are provided in Appendix E.

4.1. NEEDLEHOUSE GILL – RIVER PRIORITY HABITAT (R2A)

Along the entire site runs Needlehouse Gill, a semi-natural stream thats bed material is dominated by bedrock and cobble, with boulders scattered throughout the watercourse. A total of eleven waterfalls were on site, with very little gravel spawning habitat for trout *Salmo trutta*. The larvae of *Dinocras cephalotes* were found in the watercourse indicating potential presence of invertebrate communities requiring consistent good water quality.

4.2. *HOLCUS-JUNCUS* GRASSLAND (G3C8)

This area of semi-improved grassland is the majority of what will be disturbed by the hydro installation. It is dominated by Yorkshire fog *Holcus lanatus* and soft rush *Juncus effusus*. Other species included perennial ryegrass *Lolium perenne*, common bent *Agrostis capillaris*, foxglove *Digitalis purpurea*, sharp-flowered rush *Juncus acutiflorus*, creeping buttercup *Ranunculus repens*, spear thistle *Cirsium vulgare*, bedstraw *Galium* sp., speedwell *Veronica* sp., and wood sorrel *Oxalis acetosella*. The grassland was heavily grazed which led to a short sward height of below 5 cm, however, the rush was left ungrazed and was much higher at ~50 cm. Bryophyte species are covered Section 4.10.

4.3. RIPARIAN WOODLAND 1 – OTHER WOODLAND BROADLEAVED (W1G)

This area of woodland closely followed Needlehouse Gill along the majority of the site. This habitat was dominated by beech *Fagus sylvatica* and sycamore *Acer pseudoplatanus*. Other tree species included hazel *Corylus avellana,* ash *Fraxinus excelsior,* holly *Ilex aquifolium*, and wych elm *Ulmus glabra*. Ground flora was dominated by various bryophyte species, other species included honeysuckle *Lonicera periclymenum*, wood avens *Geum urbanum*, Sitka spruce *Picea sitchensis*, wood sorrel *Oxalis acetosella*, scaly-malefern *Dryopteris affinis*, broad-leaved buckler fern *Dryopteris dilatata*, and hart's tongue fern *Asplenium scolopendrium*. This woodland also contained a bryophyte spring (TN1) which was ~25 m^2 in size and dominated by *Palustriella commutate* and *Pellia endiviifolia.*

4.4. RIPARIAN WOODLAND 2 – UPLAND MIXED ASHWOODS (W1B)

This area of woodland again closely followed Needlehouse Gill but was upstream of riparian woodland 1. This habitat was dominated by ash, rowan *Sorbus aucuparia*, and hazel. Other tree species included birch *Betula* sp. Ground flora was dominated by lesser celandine *Ficaria verna* and speedwell *Veronica* sp.. Other ground flora included columbine *Aquilegia vulgaris*, and hard fern *Blechnum spicant*.

4.5. OTHER WOODLAND MIXED (W1H)

This covered the majority of the woodland on the site covering the northern and southern slopes where the riparian woodland ended. The habitat was dominated by Sitka spruce and beech. Other tree species included larch *Larix* sp., Scots pine *Pinus sylvestris*, Norway spruce *Picea abies*, sweet chestnut *Castanea sativa,* and noble fir *Abies procera*. Ground flora again was dominated by various bryophyte species. Other ground flora included wood sorrel. Areas heavily shaded by the conifers had very sparse ground flora coverage.

4.6. GORSE SCRUB (H3E)

The gorse scrub along the northern slope of Needlehouse Gill in the middle of the site which was dominated by gorse *Urex europaeus*. Other species included hawthorn *Crataegus monogyna*, silver birch *Betula pendula*, sycamore, rush *Juncus* sp., Yorkshire fog, common bent, creeping bent *Agrostis stolonifera*, and foxglove.

4.7. UPLAND ACID GRASSLAND (G1B)

At the top of the northern slope of the site where the gradient of the slope became more gradual started a large area of upland acid grassland that extended far beyond the survey boundary. This habitat was dominated by matt grass *Nardus stricta*. Other species included wood-rush *Luzula* sp., and bedstraw *Galium* sp.. Rush flushes were also scattered over the acid grassland with rushes and purple moor grass *Molinia caruelea*.

4.8. BRACKEN (G1C)

East of the gorse scrub is the start of an expanse of bracken *Pteridium aquilinum* with scattered trees. Tree species present were sycamore, silver birch, and rowan. Other species included common bent, bedstraw, fescue *Festuca* sp., and Yorkshire fog. This area was likely once part of the surrounding riparian woodland, but due to grazing from livestock and no fencing preventing the animals entering the woodland, the tree seedlings from the woodland were supressed. Canopy cover has gradually been lost with a few scattered trees remaining and dense bracken dominating elsewhere.

4.9. OTHER CONIFEROUS WOODLAND (W2C)

In the southeast corner of the site is a plantation of coniferous woodland dominated by Sitka spruce. Other tree species included Norway spruce and Scot's pine. The plantation has likely been planted in the last 25 years.

4.10. BRYOPHYTE SURVEY RESULTS

A diverse community of bryophytes is present along Needlehouse Gill, within the splash zone and on adjacent banks. Aquatic and riparian species were surveyed for within the redline boundary (Appendix D). Species recorded are presented in Table 2; none are considered notable, scarce, or sensitive to change in water flow.

Table 2: *Bryophyte species recorded along Needlehouse Gill.*

Bryophyte spring (TN1)	Woodland	Grassland	Needlehouse Gill and splash zone
Palustriella commutata (including the form falcate) *Pellia endiviifolia*	*Polytrichum commune* *Thuidium tamariscinum* *Brachythecium sp.* *Dicranum majus* *Mnium hornum* *Plagiochila asplenioides* *Plagiothecium undulatum* *Rhynchostegium riparioides* *Thamnobryum alopecurum*	*Brachythecium sp.* *Fissidens osmundoides* *Rhytidiadelphus squarrosus*	*Thuidium tamariscinum* *Dicranum majus* *Didymodon spadiceus* *Jungermannia atrovirens* *Mnium hornum* *Plagiochila asplenioides* *Plagiothecium undulatum* *Rhizomnium punctatum* *Rhynchostegium riparioides* *Thamnobryum alopecurum* *Fontinalis antipyretica*

4.11. FISH HABITAT ASSESSMENT

Salmonids are heavily dependent on three main factors: chemical conditions within the stream, abundance of habitat suitable for different stages of their life cycle, and the availability of accessible food (Poff and Huryn 1998, De Crespin De Billy and Usseglio-Polatera 2002). Both Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) prefer to spawn in the pool-riffle transition zone (De Gaudemar *et al*. 2000, Louhi *et al*. 2008). Water depth, velocity and substrate size are considered the primary variables in determining the suitability of spawning gravels (Crisp 2000, Armstrong *et al*. 2003). Other important factors include suitable water temperature, high levels of dissolved oxygen, and low levels of fine sediment within the bed substrate (Chapman 1988, Kirstensen and Closs 2008).

Needlehouse Gill originates from the confluence of Uldale Gill and Grain Gill 400 m upstream of the proposed hydro intake. It then flows for 700 m downstream until it flows into the River Rawthey. The depleted reach extends for approximately 500 m and contains a range of waterfalls, pools, and sections of riffle. The wetted channel width varied through the site, ranging from 1-3.5 m. Water depth ranged from 5-20 cm through the riffles and runs to >1 m in plunge pools. On average the water depth was recorded at 20 cm across the site. Bed material across the entire site was dominated by bedrock and cobble with occasional boulders; there was a lack of suitable spawning gravel.

Upstream of both the hydro and the upper section of the depleted reach are both dominated by fast flowing riffles over cobbles boulders and bedrock with relatively little gravel. The central section of the depleted reach is dominated by a total of eleven waterfalls. This contained two individual notable waterfalls, the first has a 3 m vertical drop and the second has a 4 m vertical drop. Given the size of the drop and depth of the plunge pools associated with each of these waterfalls it is assessed that they are substantial enough to block all migratory fish species. The lower section of the depleted reach and

downstream of the powerhouse and outfall are both dominated by fast flowing riffles over cobbles boulders and bedrock with relatively little gravel.

Overall, the scheme is not expected to impact the ability of migratory or residential fish species to traverse the watercourse and no spawning gravels are expected to be impacted by lower flows.

Table 3: *Summary of desktop study and field survey results.*

Taxa	Previous Records	Observations and likelihood of presence on site
Amphibians	No records.	**High –** Likely presence of amphibians surrounding the river and wet grassland.
Birds	78 species including but limited to: skylark, swift, treecreeper, greenfinch, red grouse, fieldfare and mistle thrush.	**High –** Various woodland bird species were present during the survey including robin, blackbird, blue tit, and great tit. There is also ample nesting opportunities throughout the site.
Bats	No records.	**High –** The bridge over the river provides roosting potential for bats as well as various trees on site with rot holes. The river also provides an excellent foraging opportunity.
Fish	Bullhead, Atlantic salmon and brown trout (records from NBN Atlas).	**Low –** No fishes were observed during the site survey. It is likely that various fish species are present in the beck downstream of the site, but the large waterfalls are a barrier to fish colonising the upper site.
Reptiles	No records.	**Moderate –** There are no nearby records for reptiles, however, the scrub habitat on site provides suitable habitat.
Invasive Non-native Species	Eastern grey squirrel	**Moderate –** No invasive species were observed on site, however the survey was completed in winter. Habitats present on site are ideal for INNS.

5. EVALUATION AND RECOMMENDATIONS

The site is within the Yorkshire Dales National Park; two priority habitats are present and likely to be impacted by the works. The bryophyte spring priority habitat is currently along the route of the pipeline connecting the intake and the outfall, the overland section of the pipeline should be designed to avoid damage to this habitat. The pipe will also go through the deciduous woodland, the overland pipeline design will ensure no tree removal is needed, prevent damage to root systems and reduce impacts to ground flora.

Several bird species were confirmed to use habitats on and near the site and likely will be nesting during the nesting bird season (March-August inclusive). There is potential for other protected and notable species to use habitats on site. In addition, it is likely that transient mammals and birds will use the habitats on site. Significant ecological features of interest are marked on the UK Habitat Classifications Map in Appendix D and photographs provided in Appendix E.

Below is an evaluation of the ecological features found on site, and the potential impact and effect of the proposed development in the absence of any mitigation. Recommendations are made in order to avoid the potential risk of short- or long-term adverse impacts on local biodiversity due to the proposed development, and to prevent contravention of environmental and wildlife law (Table 4). Implementation of appropriate environmental control procedures will be essential to protect the river habitats and species.

The site is within the Yorkshire Dales National Park, all works must therefore comply with the relevant planning regulations.

Table 4: *Ecological features – evaluation and recommendations*

Ecological Feature	Potential impact of proposed development	Recommendations for mitigation and/or further surveys
Deciduous woodland on northern slope of the site, bryophyte spring.	The overland pipe method should limit impacts on these habitats. Small patched for the pipe supports will be impacted.	Impacts to these habitats should be avoided and minimised as much as possible given the method of installation. Any trees that need to be removed should be left as dead wood habitat on site.
Needlehouse Gill	The priority river habitat at Needlehouse Gill will be destroyed or partially impacted by the hydro development with no current plans to replace them within the development.	Pollution prevention measures will be required to ensure that pollution caused by construction works does not impact Needlehouse Gill. Further details can be provided once a method of works is finalised. Likely that the site will require sediment fencing with the potential for the need for a sediment control plan. A fish rescue will likely be required of the proposed installation location of the intake structure.
Birds	**High** – Suitable nesting bird habitat present on site.	All wild birds are protected under the Wildlife and Countryside Act 1981 (as amended), as such it is a criminal offence to intentionally or recklessly kill or injure any wild bird, damage or destroy the nest of any wild bird while it is in use or under construction, or take or destroy the egg of any wild bird. **Vegetation clearance works**

Ecological Feature	Potential impact of proposed development	Recommendations for mitigation and/or further surveys
		should be timed to avoid the nesting bird season which runs from March to August inclusive.
Bats	**High** – Impact if mature trees are to be removed.	If mature trees are to be removed, further bat surveys must be conducted by a suitably qualified ecologist. The depleted reach will still provide foraging opportunities for bats.
INNS	**High** – No invasive species observed on site but if the INNS Himalayan balsam was introduced then this would have a devastating impact on the catchment of the River Rawthey as Needlehouse Gill is at the top of the catchment.	An INNS survey should be completed by a suitably qualified ecologist during the summer prior to any of the works starting on site. Strict biosecurity measures should be adhered to including the washing of all equipment (boots, machinery etc) on arrival to, and removal from, site.
- Ecologist to give a toolbox talk at the start of works to ensure all site personnel are aware of the potential presence of protected species, designated sites and their legal obligations to protect the environment. - Any excavations created during the development/works should be left covered overnight or fitted with a ramp to allow any entrapped mammals to escape.		

6. CONCLUSION

The current plans may cause small scale temporary damage to a small area of BAP habitat, the pipeline route could be moved slightly north to further avoid the spring TN1.

General recommendations below:

- If any trees or scrub need to be removed must be felled outside of the nesting bird season (March to August inclusive).
- If any mature trees need due to design changes to be removed, they will require bat roost surveys.
- An INNS survey should be completed during the summer prior to any works starting on site.
- A fish rescue of the proposed intake location will likely be required immediately prior to in-channel works, to occur between June 15th – September 31st (in-river working season).

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APPENDICES

Appendix A – Policy and Legislation

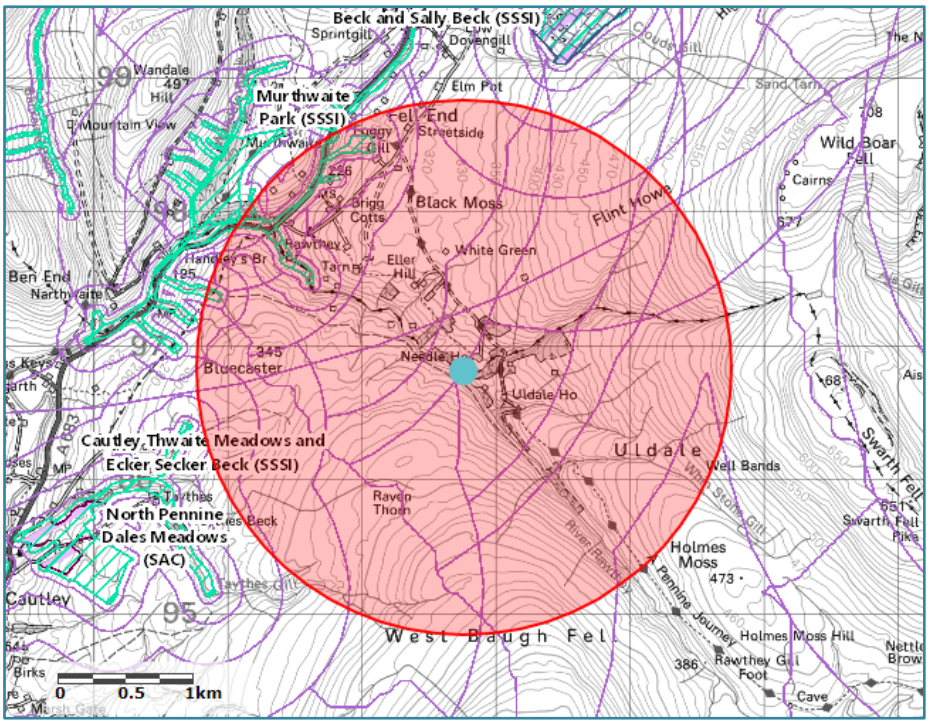
Statutory measures are in place to protect habitats and wildlife; these measures range from the global to the local, and variously give protection to whole ecosystems or single species. Included is a brief summary of legislation and planning policy, this is not an exhaustive list. The original texts of the relevant legislation should be consulted for further details.

	Legislation	Description
INTERNATIONAL	Convention on the Conservation of European Wildlife and Natural Habitats 1979 (Bern Convention)	Parties are required to protect all wild plant and animal species and their natural habitats; and to afford special protection to the most vulnerable or threatened species.
	Convention on Biological Diversity 1992	Parties are required to develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity. In the UK, this is implemented through the UK Post-2010 Biodiversity Framework.
	Habitats Directive 1992/43/EEC	European member states are required to implement legislation to designate a network of protected sites and maintain their ecological integrity. Certain species are also strictly protected through this Directive. In England, this is implemented through the Conservation of Habitats & Species Regulations 2010.
	Water Framework Directive 2000/60/EC	European member states must implement legislation to designate, monitor and maintain or improve the ecological status of river basins and coastal waters. In England, this is implemented through the Water Environment Regulations 2003.
	Birds Directive 2009/147/EC	European member states are required to provide general protection to all wild birds and to designate protected sties for rare or vulnerable species. In the UK, this is implemented through the Wildlife and Countryside Act 1981.
NATIONAL	National Parks and Access to the Countryside Act 1949 (as amended)	Provides the protection of National Parks and is still the primary legislation under which some local sites for nature conservation are designated.
	Wildlife and Countryside Act 1981 (as amended)	Provides for the protection of sites and species of national importance for nature conservation. The level of protection depends on which Schedule of the Act the species is listed on. Species protection includes prohibition of some or all of: killing, injuring, disturbing or taking, and also protection of breeding and sheltering places. Schedule 9 (with 2010 amendments) lists invasive non-native species, for which it is an offence to not adequately control and thus cause to grow in the wild.
	Countryside and Rights of Way Act 2000	Amends and strengthens existing legislation for protection of threatened species and SSSIs. For example, some offences under the Wildlife and Countryside Act can now result in imprisonment.

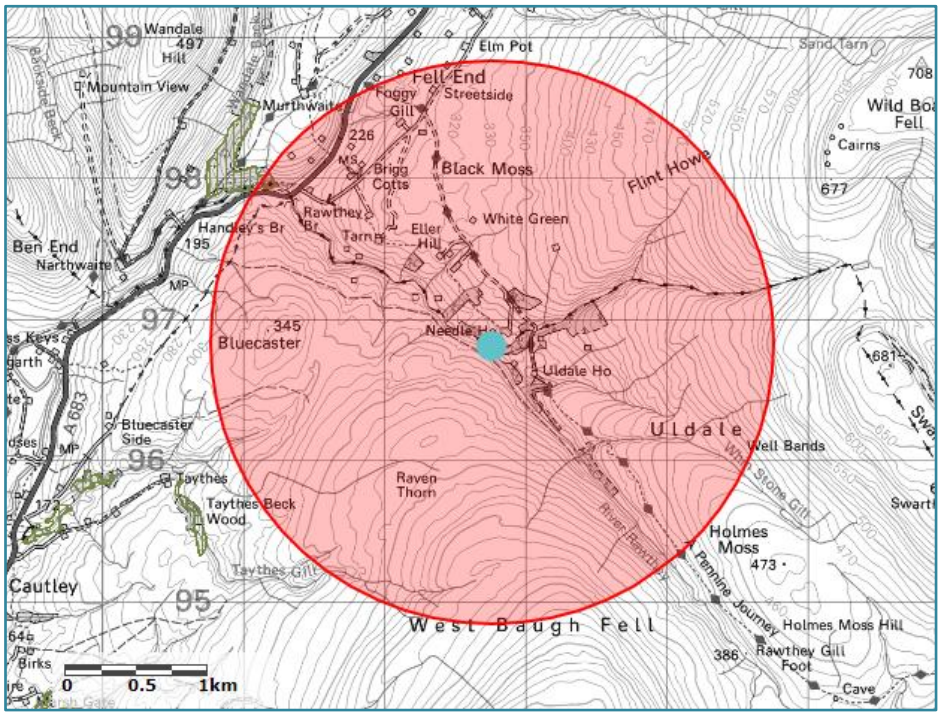
	Legislation	Description
NATIONAL	Natural Environment and Rural Communities Act 2006	Places a duty on all public authorities to consider biodiversity in their work. The duty extends beyond just conserving what is already there to carrying out, supporting and requiring actions that may also restore or enhance biodiversity. Requires the Secretary of State to produce a list of species and habitats of principal importance for the conservation of biodiversity; this list is used to guide authorities when implementing their duty.
	The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019	An amendment to the Conservation of Habitats and Species Regulations 2017 to transpose these EU regulations to UK law post-Brexit. Provides for the protection of sites in the UK that support habitats and species in need of conservation across Europe (SPAs/SACs). Provides full protection of species of European importance. The Regulations also set out how licensing for European protected species should work and makes breaching the conditions of a licence an offence.
	Environmental Sanctions Regulations 2010	Under these Regulations, Natural England and the Environment Agency are able to halt illegal activities, to order the restoration of environmental damage and to impose fines (up to £250,000) where legislation has been breached.
	National Planning Policy Framework 2012	States that the planning system should help minimise the impacts that development can have on biodiversity and provide net gains in biodiversity where possible.
	Hedgerows Regulations 1997	Allow the identification of important hedgerows which are protected under the Regulations. Permission to remove important hedgerows must be obtained from the local planning authority.
	Infrastructure Act 2015	Contains amendments to the Wildlife and Countryside Act in relation to non-native invasive species. Enables an environmental authority to issue a species control order requiring a landowner to undertake control measures or the authority to do so, at the landowner's expense.
	Protection of Badgers Act 1992	Provides strict protection for badgers and their setts. Offences under the act include killing or injuring a badger, disturbance, or to damage or interfere with a sett unless a licence is obtained.

Legislation		Description
	Salmon and Freshwater Fisheries Act 1975	Legislation to protect freshwater fish, with a particularly strong focus on Salmonids. Activities that constitute an offence include direct mortality of fish, creating barriers to migration, and causing degradation of habitats. It is also an offence to discharge poisonous matter into waters containing fish or spawn.

Appendix B – Designated Sites



Statutory designated sites within 2 km of works site (MAGIC, 2022).



Non-statutory designated sites within 2 km of works site (MAGIC, 2022).

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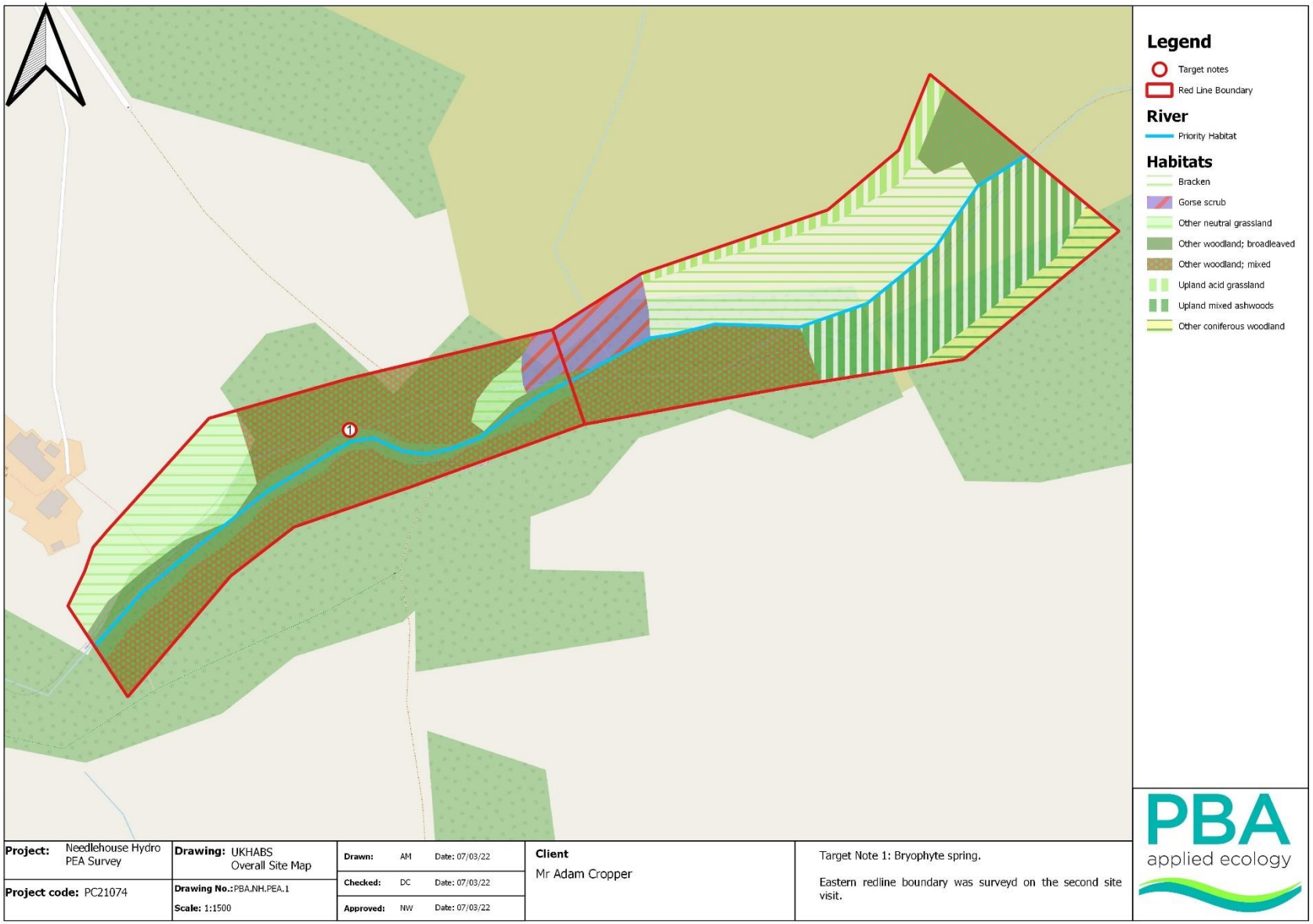
Appendix C – Species Records

Taxon group	Latin name	Common name	Most recent record	Closest record (KM) and direction from site
Acanthis cabaret	Lesser Redpoll	bird	2011	2.5
Accipiter nisus	Sparrowhawk	bird	2012	2.5
Alauda arvensis	Skylark	bird	2013	0.3
Allophyes oxyacanthae	Green-brindled Crescent	insect - moth	2013	1.3
Amphipoea oculea	Ear Moth	insect - moth	2013	1.3
Anas crecca	Teal	bird	2013	1.8
Anas platyrhynchos	Mallard	bird	2013	0.3
Anthus pratensis	Meadow Pipit	bird	2013	0.3
Anthus trivialis	Tree Pipit	bird	2012	0.3
Apamea remissa	Dusky Brocade	insect - moth	2014	1.9
Apus apus	Swift	bird	2013	1.8
Ardea cinerea	Grey Heron	bird	2008	0.3
Arion (Arion) ater	Large Black Slug	mollusc	1994	2.3
Athene noctua	Little Owl	bird	2011	1.8
Buteo buteo	Buzzard	bird	2013	0.3
Calidris alpina	Dunlin	bird	2013	1.8
Carduelis carduelis	Goldfinch	bird	2013	0.3
Celaena haworthii	Haworth's Minor	insect - moth	2013	1.3
Ceramica pisi	Broom Moth	insect - moth	2014	1.9
Certhia familiaris	Treecreeper	bird	2011	0.3
Chiroptera	Bat	terrestrial mammal	1996	0.6
Chloris chloris	Greenfinch	bird	2011	1.8
Chroicocephalus ridibundus	Black-headed Gull	bird	2013	2.2
Cinclus cinclus	Dipper	bird	2013	0.3
Coenonympha pamphilus	Small Heath	insect - butterfly	2017	2.3
Coloeus monedula	Jackdaw	bird	2013	0.3
Columba oenas	Stock Dove	bird	2012	0.3
Columba palumbus	Woodpigeon	bird	2013	0.3
Cordulegaster boltonii	Golden-ringed Dragonfly	insect - dragonfly (Odonata)	1999	0.2
Corvus corone	Carrion Crow	bird	2013	0.3
Corvus frugilegus	Rook	bird	2013	0.3
Cuculus canorus	Cuckoo	bird	2012	1.8
Cyanistes caeruleus	Blue Tit	bird	2013	0.3
Delichon urbicum	House Martin	bird	2013	0.3
Dendrocopos major	Great Spotted Woodpecker	bird	2011	0.3

Taxon group	Latin name	Common name	Most recent record	Closest record (KM) and direction from site
Emberiza schoeniclus	Reed Bunting	bird	2011	1.8
Erithacus rubecula	Robin	bird	2013	0.3
Falco tinnunculus	Kestrel	bird	2011	0.3
Ficedula hypoleuca	Pied Flycatcher	bird	2012	1.8
Gallinago gallinago	Snipe	bird	2011	0.3
Garrulus glandarius	Jay	bird	2009	2.8
Haematopus ostralegus	Oystercatcher	bird	2010	1.8
Hirundo rustica	Swallow	bird	2013	0.3
Hydraecia micacea	Rosy Rustic	insect - moth	2013	1.3
Lagopus lagopus	Red Grouse	bird	2012	2.5
Larus fuscus	Lesser Black-backed Gull	bird	2013	2.5
Lepus europaeus	Brown Hare	terrestrial mammal	1998	0.9
Linaria cannabina	Linnet	bird	2012	1.8
Loxia curvirostra	Crossbill	bird	2009	1.8
Lyrurus tetrix	Black Grouse	bird	2011	0.3
Mergus merganser	Goosander	bird	1998	0.3
Mniotype adusta	Dark Brocade	insect - moth	2014	1.9
Motacilla alba	Pied Wagtail	bird	2013	0.3
Motacilla cinerea	Grey Wagtail	bird	2013	0.3
Muscicapa striata	Spotted Flycatcher	bird	2013	0.3
Myosotis stolonifera	Pale Forget-me-not	flowering plant	2018	1.9
Neomys fodiens	Eurasian Water Shrew	terrestrial mammal	2011	0.4
Numenius arquata	Curlew	bird	2013	0.3
Oenanthe oenanthe	Wheatear	bird	2013	0.3
Oreodytes davisii	Oreodytes davisii	insect - beetle (Coleoptera)	2009	1.9
Oryctolagus cuniculus	European Rabbit	terrestrial mammal	2012	0.2
Parus major	Great Tit	bird	2013	0.3
Passer domesticus	House Sparrow	bird	2008	2.2
Peltigera leucophlebia	Peltigera leucophlebia	lichen	2005	1.0
Perdix perdix	Grey Partridge	bird	1997	2.5
Periparus ater	Coal Tit	bird	2013	0.3
Phasianus colchicus	Pheasant	bird	2012	0.3
Phoenicurus phoenicurus	Redstart	bird	2013	1.8

Taxon group	Latin name	Common name	Most recent record	Closest record (KM) and direction from site
Phylloscopus sibilatrix	Wood Warbler	bird	2000	0.3
Phylloscopus trochilus	Willow Warbler	bird	2013	0.3
Pica pica	Magpie	bird	2013	0.3
Pinus sylvestris	Scots Pine	conifer	2018	2.1
Pluvialis apricaria	Golden Plover	bird	2013	1.8
Prunella modularis	Dunnock	bird	2009	1.8
Regulus regulus	Goldcrest	bird	2013	0.3
Saxicola rubicola	Stonechat	bird	2009	0.3
Sciurus carolinensis	Eastern Grey Squirrel	terrestrial mammal	2015	0.2
Sciurus vulgaris	Eurasian Red Squirrel	terrestrial mammal	2015	0.2
Scolopax rusticola	Woodcock	bird	2011	1.8
sensitive_species_f	sensitive_species_f	bird	2012	2.9
sensitive_species_h	sensitive_species_h	bird	2008	2.8
sensitive_species_l	sensitive_species_l	bird	2000	0.3
sensitive_species_n	sensitive_species_n	bird	2012	2.9
sensitive_species_t	sensitive_species_t	bird	1991	2.1
sensitive_species_u	sensitive_species_u	bird	2011	0.3
sensitive_species_w	sensitive_species_w	bird	2011	0.3
Sitta europaea	Nuthatch	bird	2012	0.3
Spinus spinus	Siskin	bird	2011	1.8
Strix aluco	Tawny Owl	bird	2012	0.3
Sturnus vulgaris	Starling	bird	2011	0.3
Tabanus sudeticus	Dark Giant Horsefly	insect - true fly (Diptera)	2009	0.2
Troglodytes troglodytes	Wren	bird	2013	0.3
Turdus merula	Blackbird	bird	2013	0.3
Turdus philomelos	Song Thrush	bird	2011	1.8
Turdus torquatus	Ring Ouzel	bird	2013	3.1
Turdus viscivorus	Mistle Thrush	bird	2013	0.3
Vanellus vanellus	Lapwing	bird	2008	0.3

Appendix D – UK Habitat Classifications Map


Legend
Target notes
Red Line Boundary
River
Priority Habitat
Habitats
Bracken
Gorse scrub
Other neutral grassland
Other woodland; broadleaved
Other woodland; mixed
Upland acid grassland
Upland mixed ashwoods
Other coniferous woodland
1
Project: Needlehouse Hydro PEA Survey
Project code: PC21074
Drawing: UKHABS Overall Site Map
Drawing No.: PBA.NH.PEA.1
Scale: 1:1500
Drawn: AM Date: 07/03/22
Checked: DC Date: 07/03/22
Approved: NW Date: 07/03/22
Client
Mr Adam Cropper
Target Note 1: Bryophyte spring.
Eastern redline boundary was surveyd on the second site visit.
PBA
applied ecology

Appendix E – Photographs and Target Notes

TN#	Photograph	Notes
1		Bryophyte spring
		Needlehouse Gill.
		Deciduous woodland and grassland on site.

	Bracken slope
	Large waterfalls on site that may prevent fishes from colonising the site.