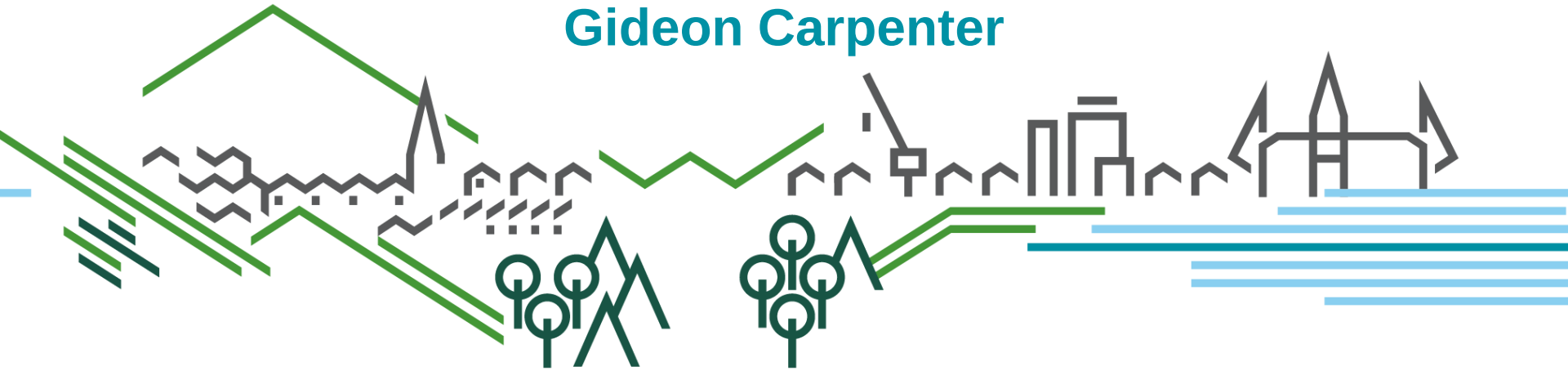
NRW Hydropower licensing & compliance

Wales Fisheries Forum

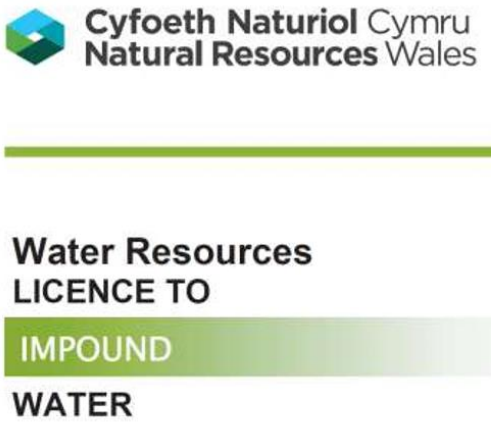
14 November 2019

Gideon Carpenter



Licensing background

- Water resources regulation established in England and Wales with Water Resources Act 1963
- Water Resources Act 1991 (as amended)
- Most hydropower schemes will require an:
  - Impoundment Licence
  - Abstraction Licence



Licensing background

- Focus on big hydro
- Financing in 1990's – limited expansion of run-of-river hydro (RoR)
- Limited National Rivers Authority/ EA guidance
- Feed-in-Tariffs 2010 – rapid expansion of RoR
- EA guidance focused on low head – N Wales flow variability
- Good Practice Guidelines review
- NRW establishment – NRW HEP guidance 2014
- Water Framework Directive & WG Environment Bill

Run of river hydropower schematic

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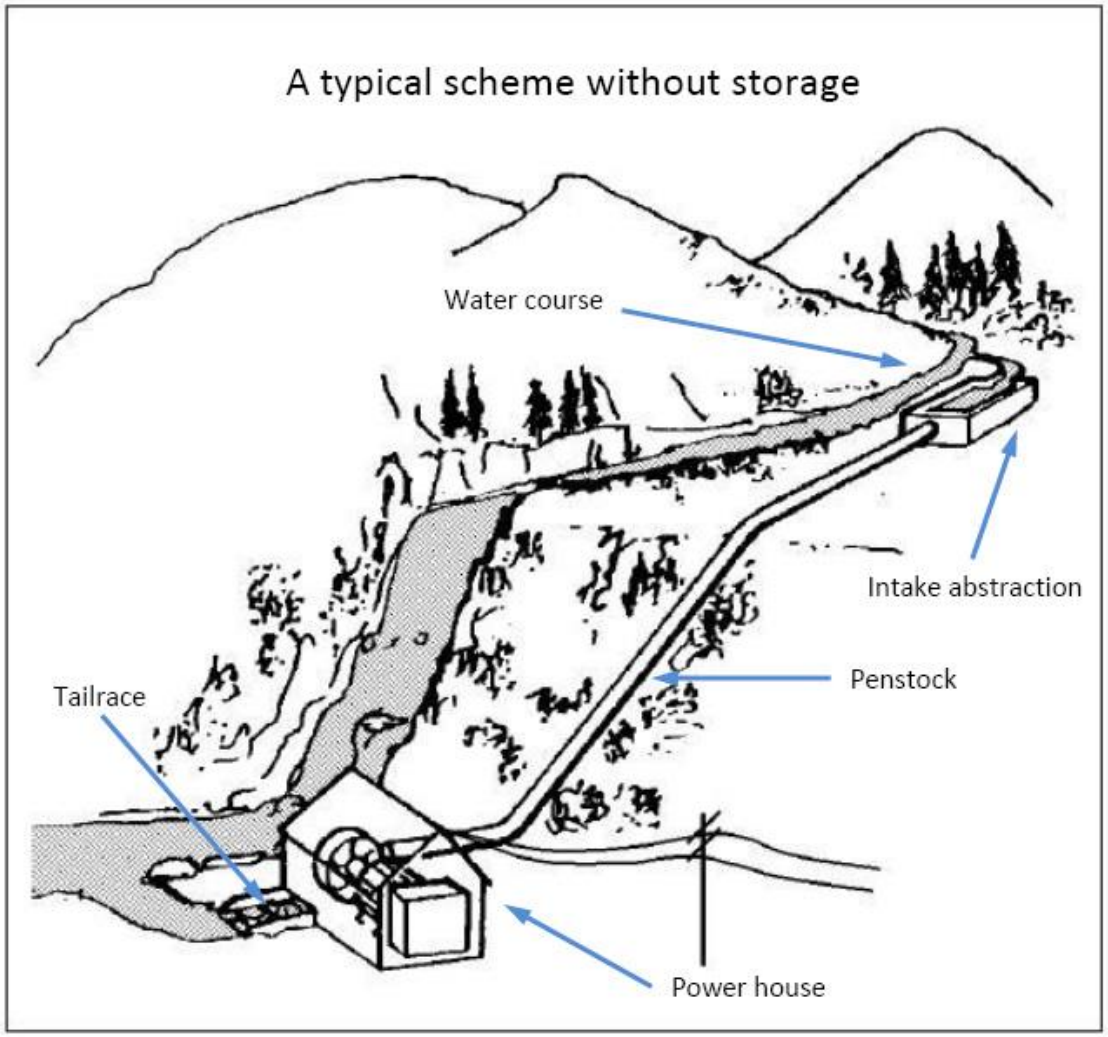

Figure 1: Depicts the typical layout of a scheme with minimal water storage capacity

Run of river high head

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So what are the main impacts?

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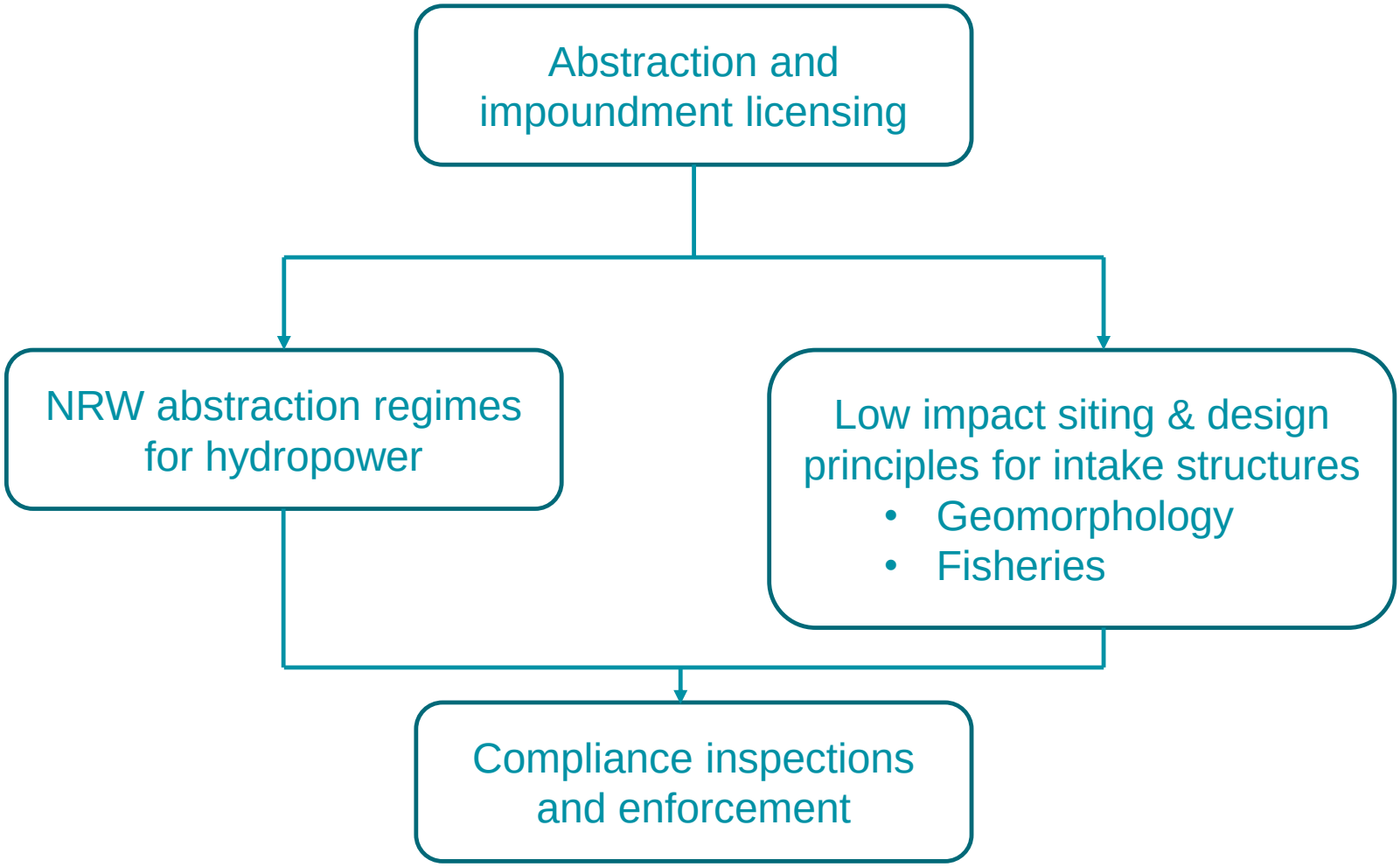
- **Changes to reach hydrology**
  - Creation of impoundment
  - Creation of depleted reach
  - Changes to hydraulic conditions (depths, velocities, wetted perimeter) (hydrological barrier)
- **Creation of physical barrier**
  - Disruption of ecosystem connectivity (inc fish migration)
  - Disruption of geomorphological processes
- **Changes to physical habitat & channel morphology**
- **Physical damage to fish (& other wildlife)**

How do we address these?



Low impact abstraction regime

- NRW Guidance - introducing the flow split
- Zones 1, 2 & 3 – 10%, 40%, 50% and 70% take
- Maintains flow variability in the low/medium flow range
- Important for ecology and geomorphological processes
- Influences spatial distribution of schemes
- Protects our high value sites for nature conservation

Ecological Limits to Hydrological Alteration

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Uncertainty in quantifying river flow-ecology relationships

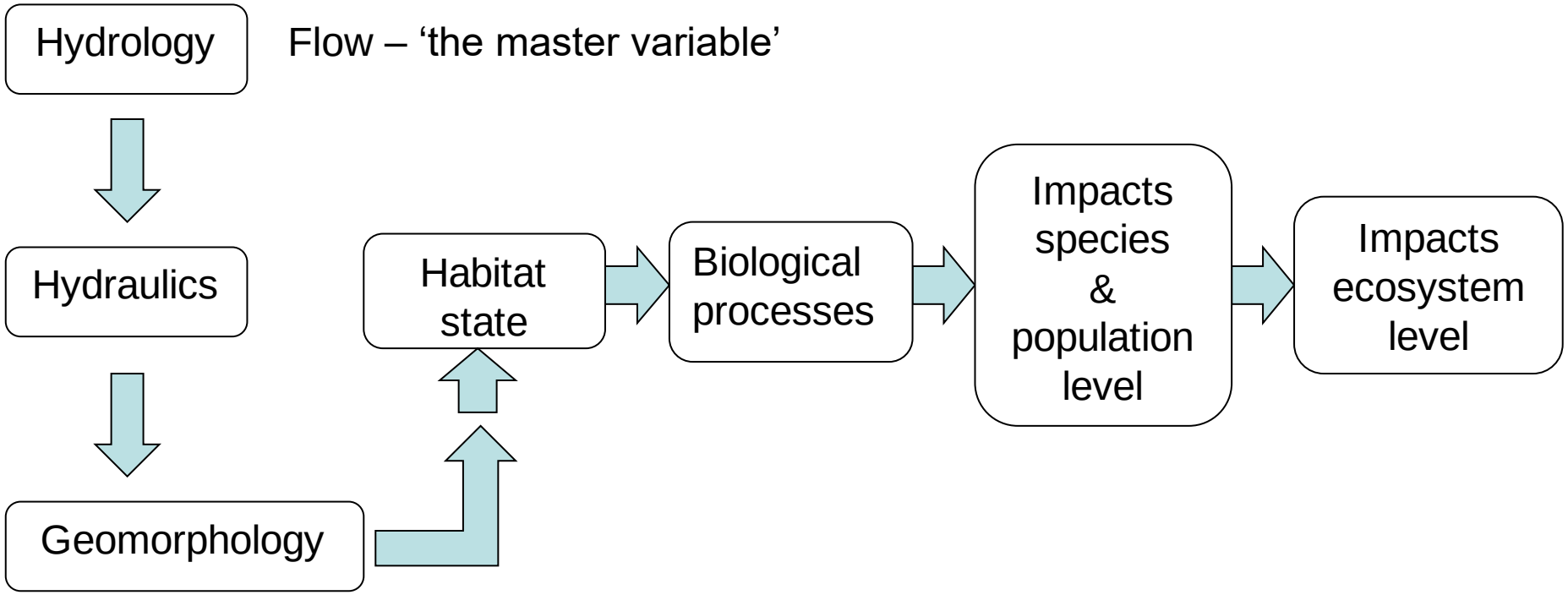
BUT

Ecosystems adapted to natural flow regimes

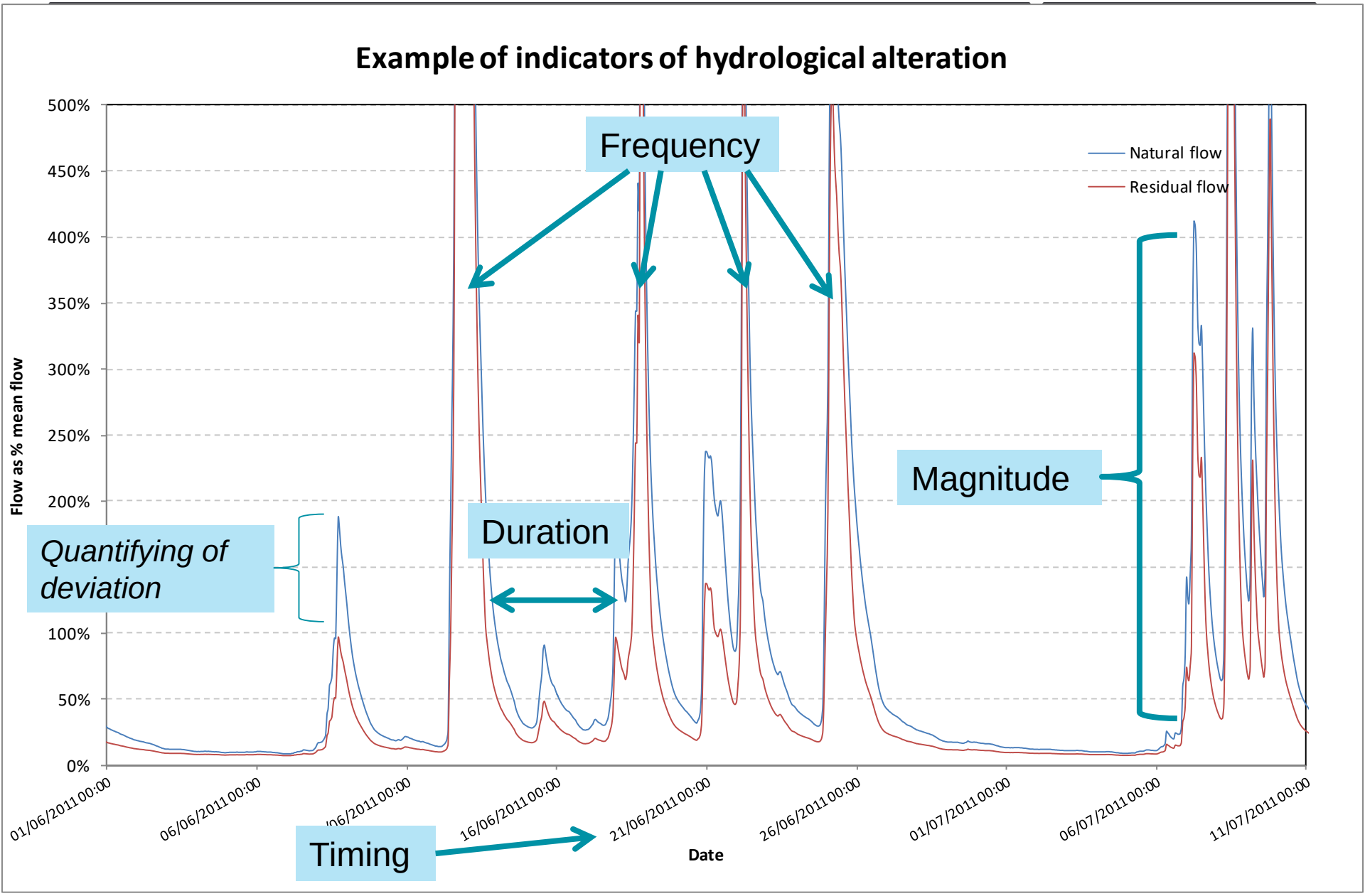
Restrict deviations from the natural flow regime

Ecological Limits to Hydrological Alteration (ELOHA)

Impacts of hydrological change - conceptual model

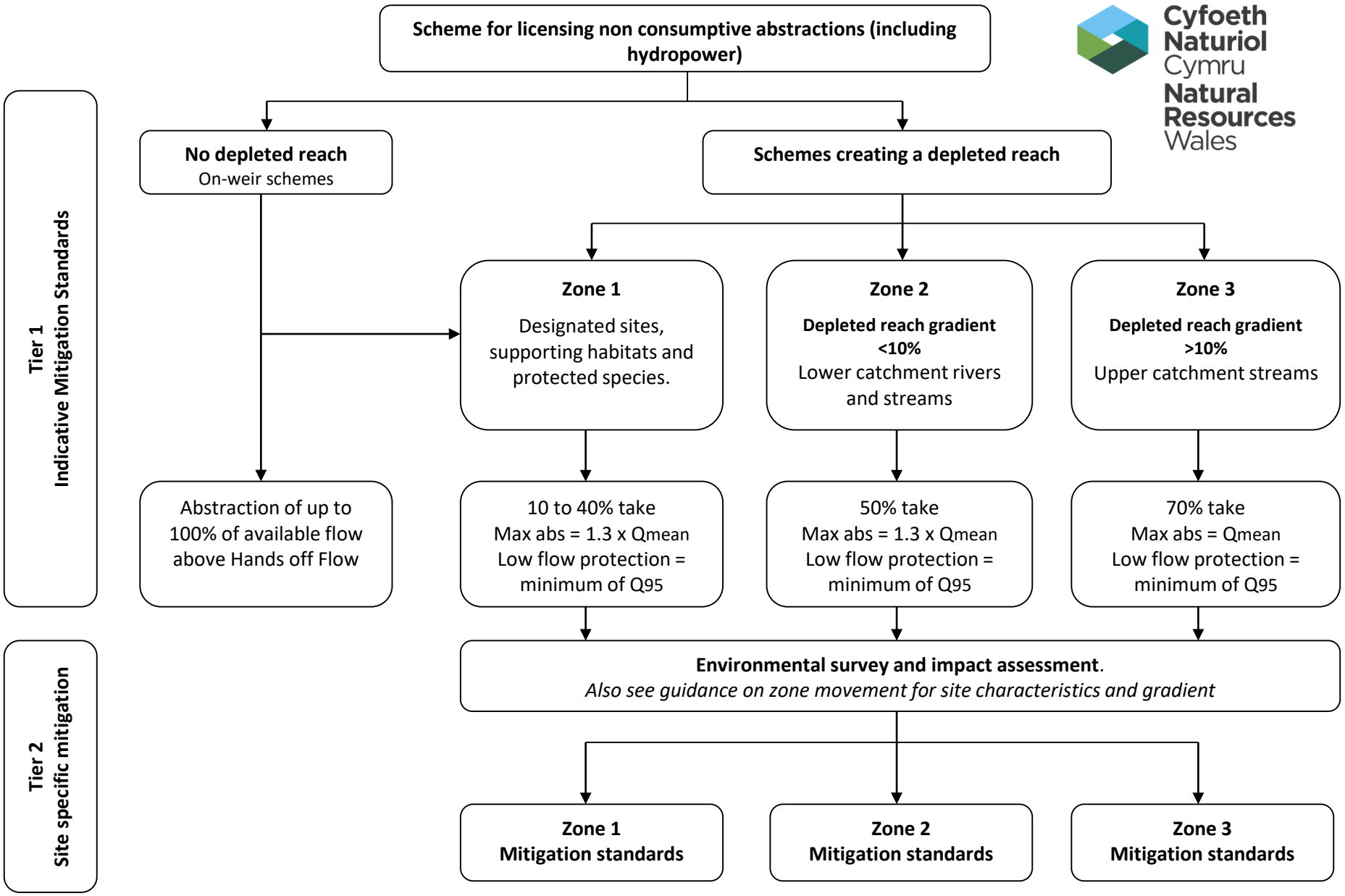


Source: Ecological indicators of the effects of abstraction and flow regulation and optimisation of flow release from water storage reservoirs WFD 21d SNIFFER 2012


Example of indicators of hydrological alteration
Frequency
Natural flow
Residual flow
Magnitude
Duration
Quantifying of deviation
Timing
Flow as % mean flow
Date
500%
450%
400%
350%
300%
250%
200%
100%
50%
0%
01/06/2011 00:00
06/06/2011 00:00
16/06/2011 00:00
21/06/2011 00:00
26/06/2011 00:00
01/07/2011 00:00
06/07/2011 00:00
11/07/2011 00:00

Components of abstraction regime

- **Low flow protection (Hands off Flow)** – fixed flow rate
- **Flow variability –** fixed % take of available flow
- **Maximum abstraction rate** – intake and conveyance capacity limits


Scheme for licensing non consumptive abstractions (including hydropower)
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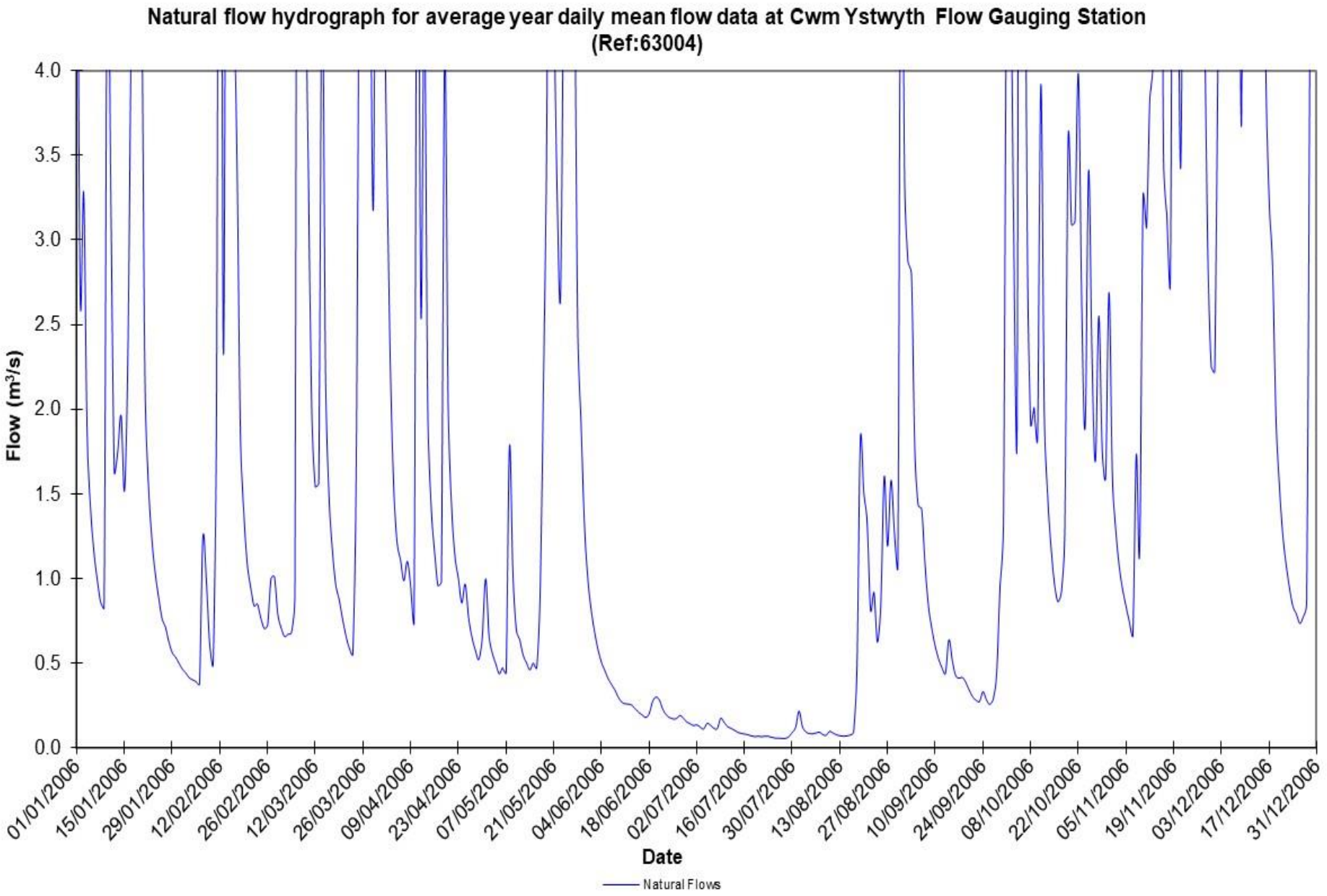
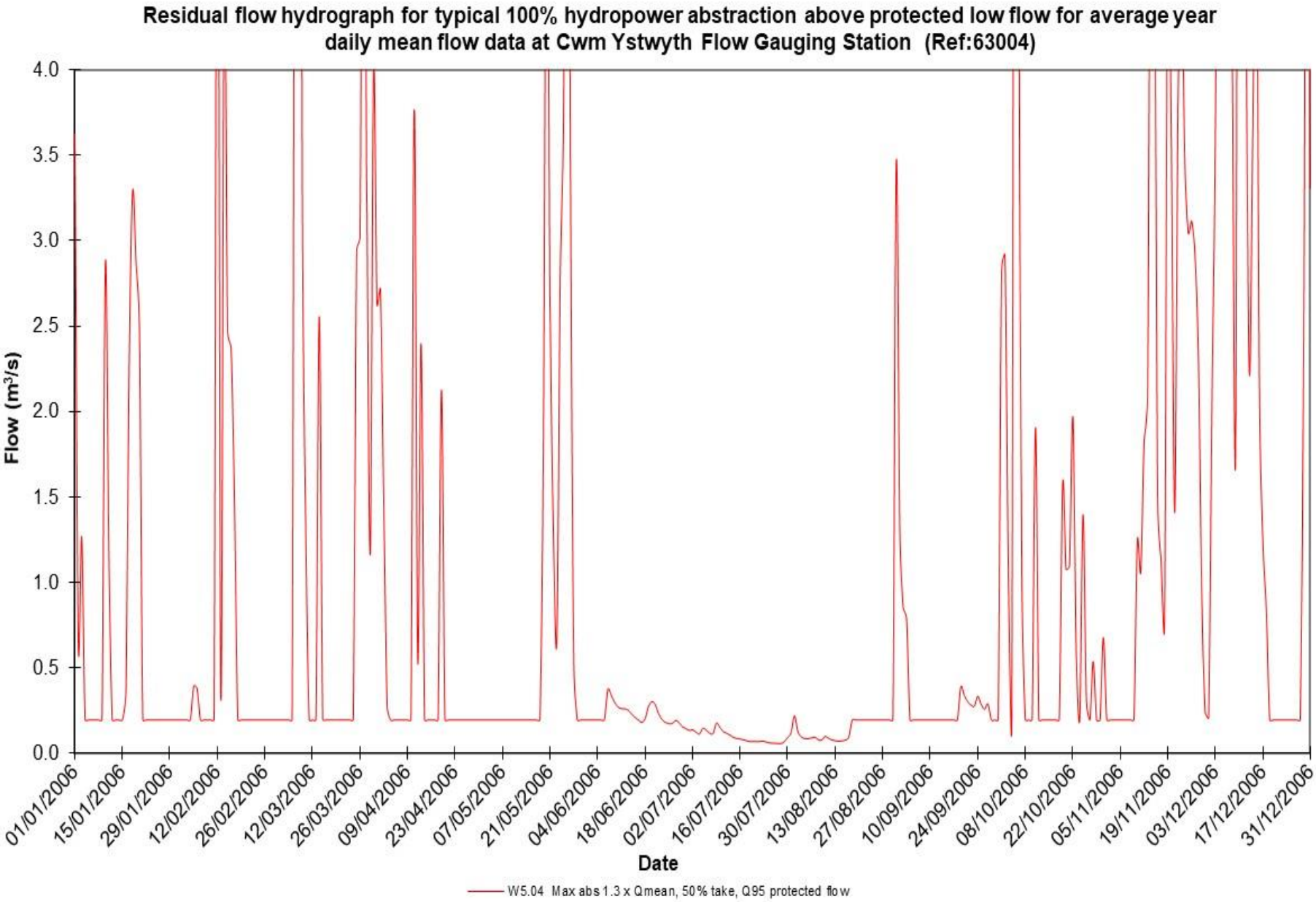
Tier 1
Indicative Mitigation Standards
No depleted reach
On-weir schemes
Schemes creating a depleted reach
Zone 1
Designated sites, supporting habitats and protected species.
Zone 2
Depleted reach gradient <10%
Lower catchment rivers and streams
Zone 3
Depleted reach gradient >10%
Upper catchment streams
Abstraction of up to 100% of available flow above Hands off Flow
10 to 40% take
Max abs = 1.3 x Qmean
Low flow protection = minimum of Q95
50% take
Max abs = 1.3 x Qmean
Low flow protection = minimum of Q95
70% take
Max abs = Qmean
Low flow protection = minimum of Q95
Tier 2
Site specific mitigation
Environmental survey and impact assessment.
Also see guidance on zone movement for site characteristics and gradient
Zone 1
Mitigation standards
Zone 2
Mitigation standards
Zone 3
Mitigation standards


Natural flow hydrograph for average year daily mean flow data at Cwm Ystwyth Flow Gauging Station
(Ref:63004)
Flow (m³/s)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
15/01/2006
29/01/2006
12/02/2006
26/02/2006
12/03/2006
26/03/2006
09/04/2006
23/04/2006
07/05/2006
21/05/2006
04/06/2006
18/06/2006
02/07/2006
16/07/2006
30/07/2006
13/08/2006
27/08/2006
10/09/2006
24/09/2006
08/10/2006
22/10/2006
05/11/2006
19/11/2006
03/12/2006
17/12/2006
31/12/2006
Date
Natural Flows


Residual flow hydrograph for typical 100% hydropower abstraction above protected low flow for average year daily mean flow data at Cwm Ystwyth Flow Gauging Station (Ref:63004)
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07/05/2006
21/05/2006
04/06/2006
18/06/2006
02/07/2006
16/07/2006
30/07/2006
13/08/2006
27/08/2006
10/09/2006
24/09/2006
08/10/2006
22/10/2006
05/11/2006
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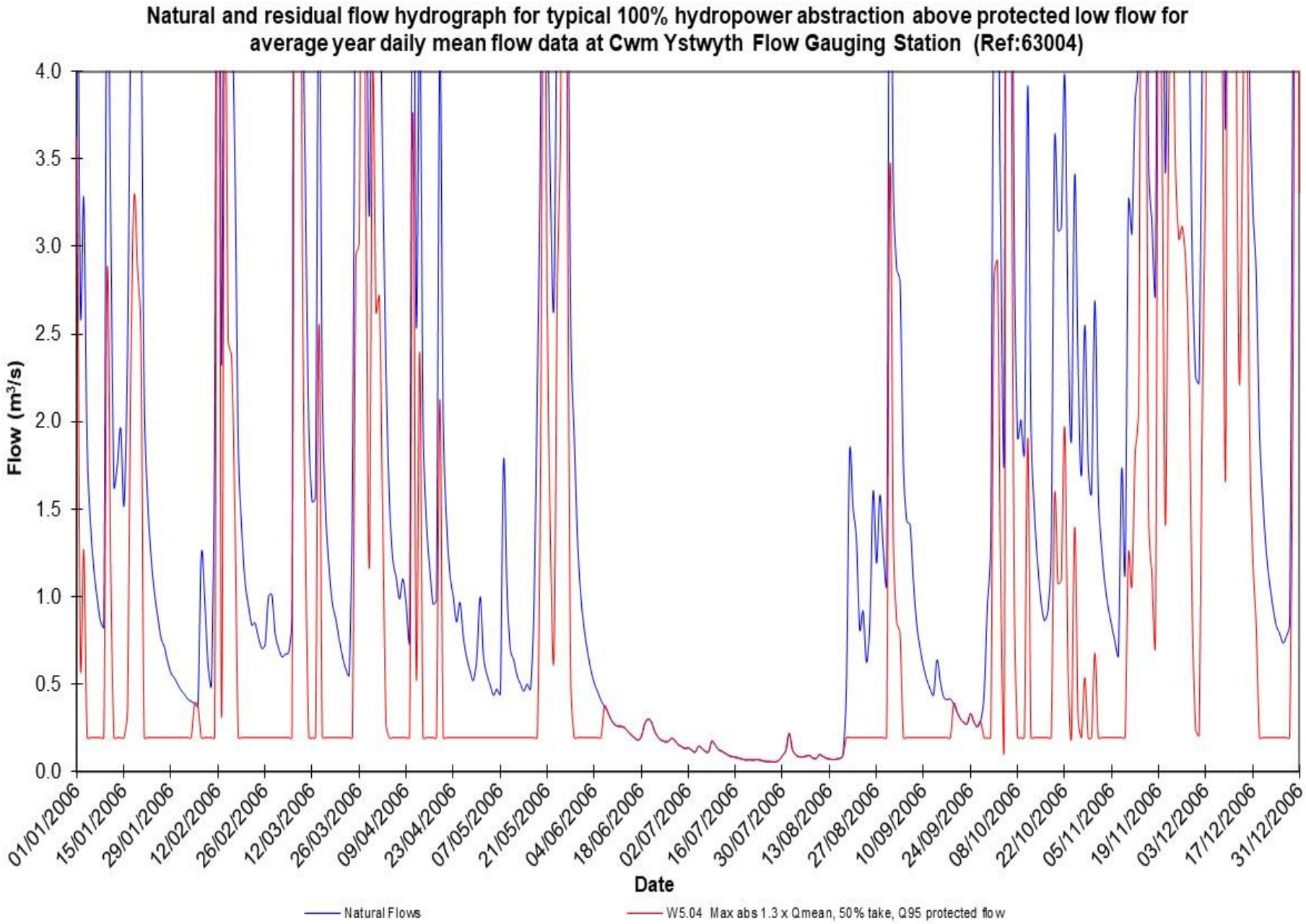
Date
W5.04 Max abs 1.3 x Qmean, 50% take, Q95 protected flow


Natural and residual flow hydrograph for typical 100% hydropower abstraction above protected low flow for average year daily mean flow data at Cwm Ystwyth Flow Gauging Station (Ref:63004)
Flow (m³/s)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
15/01/2006
29/01/2006
12/02/2006
26/02/2006
12/03/2006
26/03/2006
09/04/2006
23/04/2006
07/05/2006
21/05/2006
04/06/2006
18/06/2006
02/07/2006
16/07/2006
30/07/2006
13/08/2006
27/08/2006
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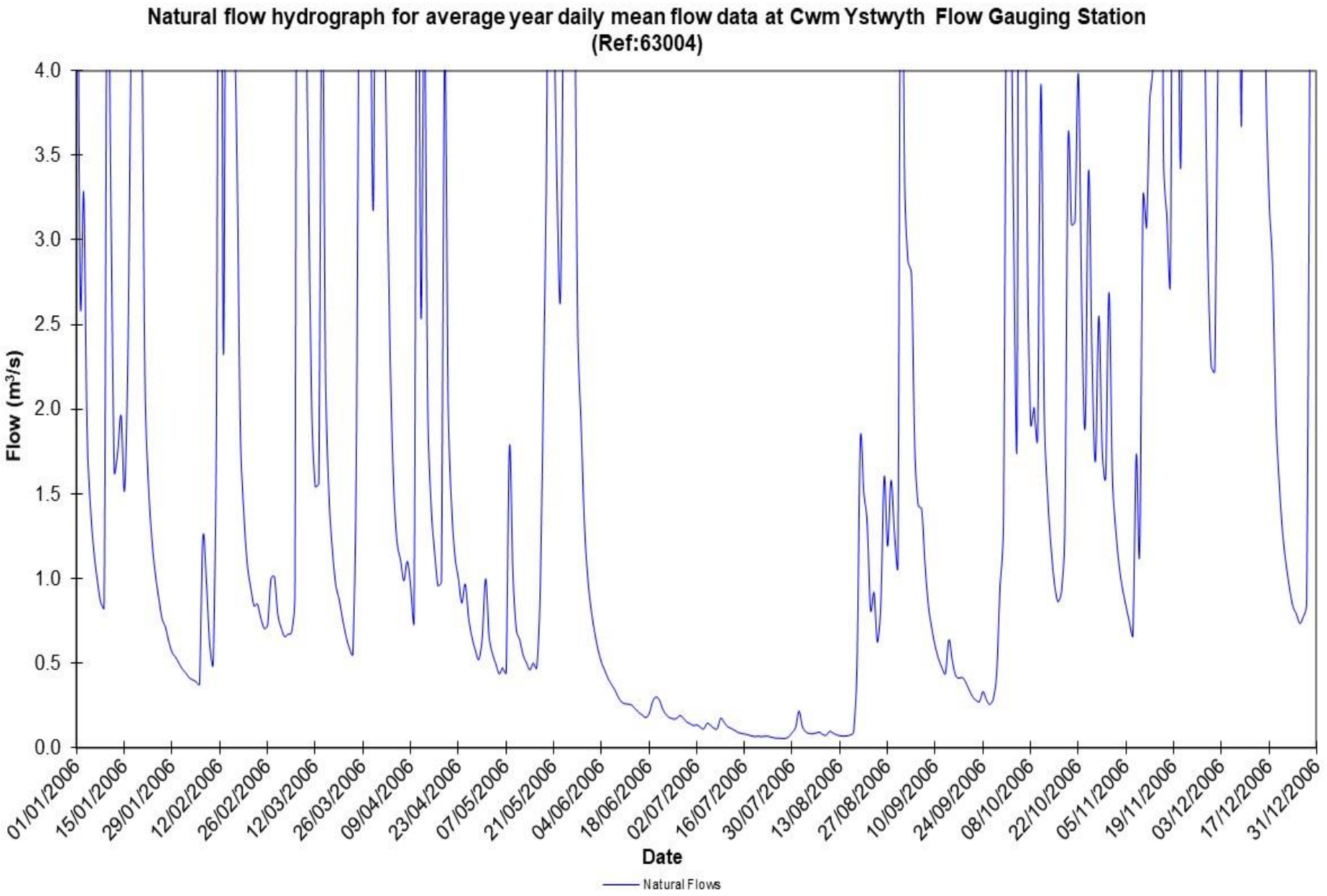
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1.0
0.5
0.0
01/01/2006
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04/06/2006
18/06/2006
02/07/2006
16/07/2006
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13/08/2006
27/08/2006
10/09/2006
24/09/2006
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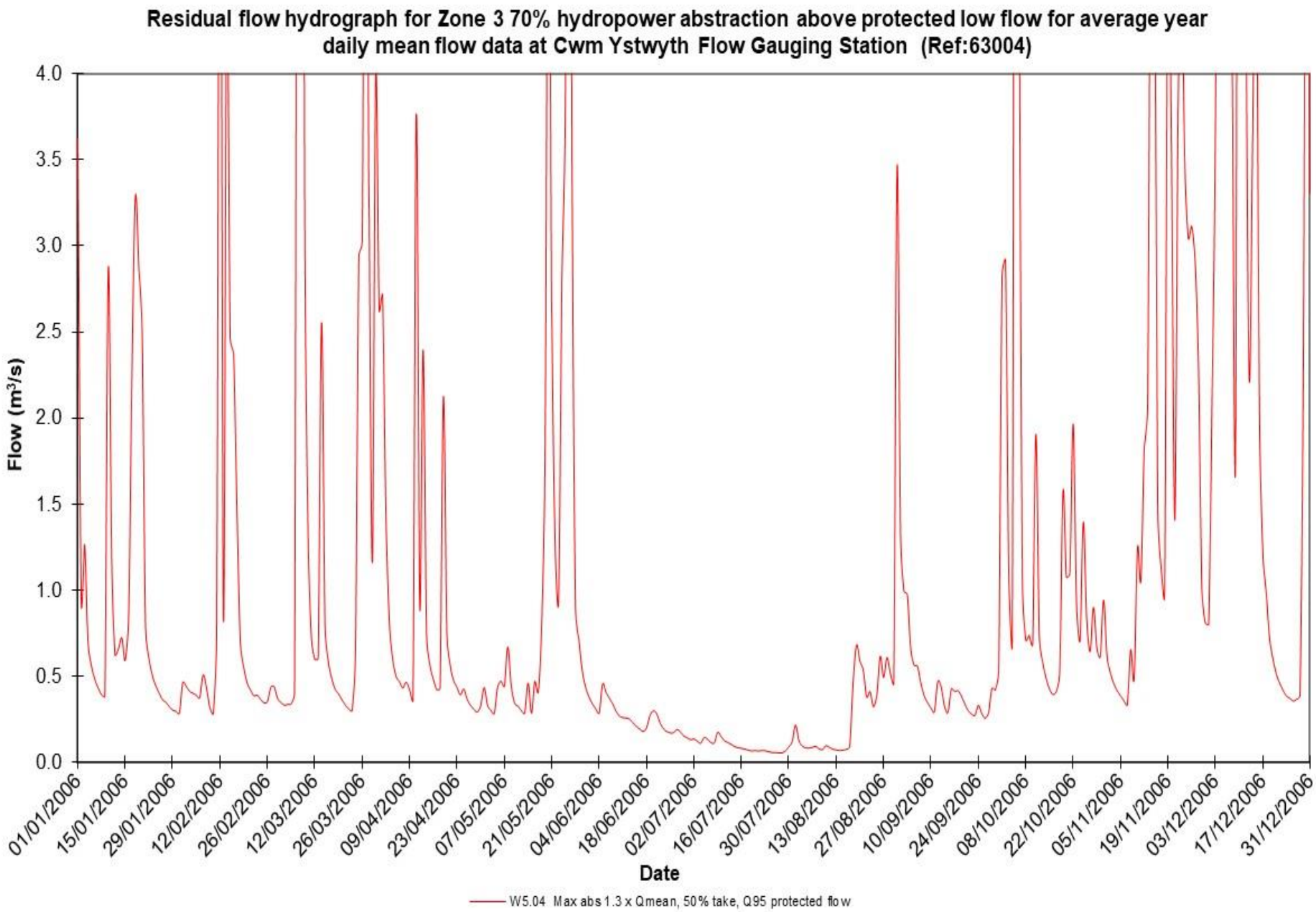
Residual flow hydrograph for Zone 3 70% hydropower abstraction above protected low flow for average year
daily mean flow data at Cwm Ystwyth Flow Gauging Station (Ref:63004)
Flow (m³/s)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
15/01/2006
29/01/2006
12/02/2006
26/02/2006
12/03/2006
26/03/2006
09/04/2006
23/04/2006
07/05/2006
21/05/2006
04/06/2006
18/06/2006
02/07/2006
16/07/2006
30/07/2006
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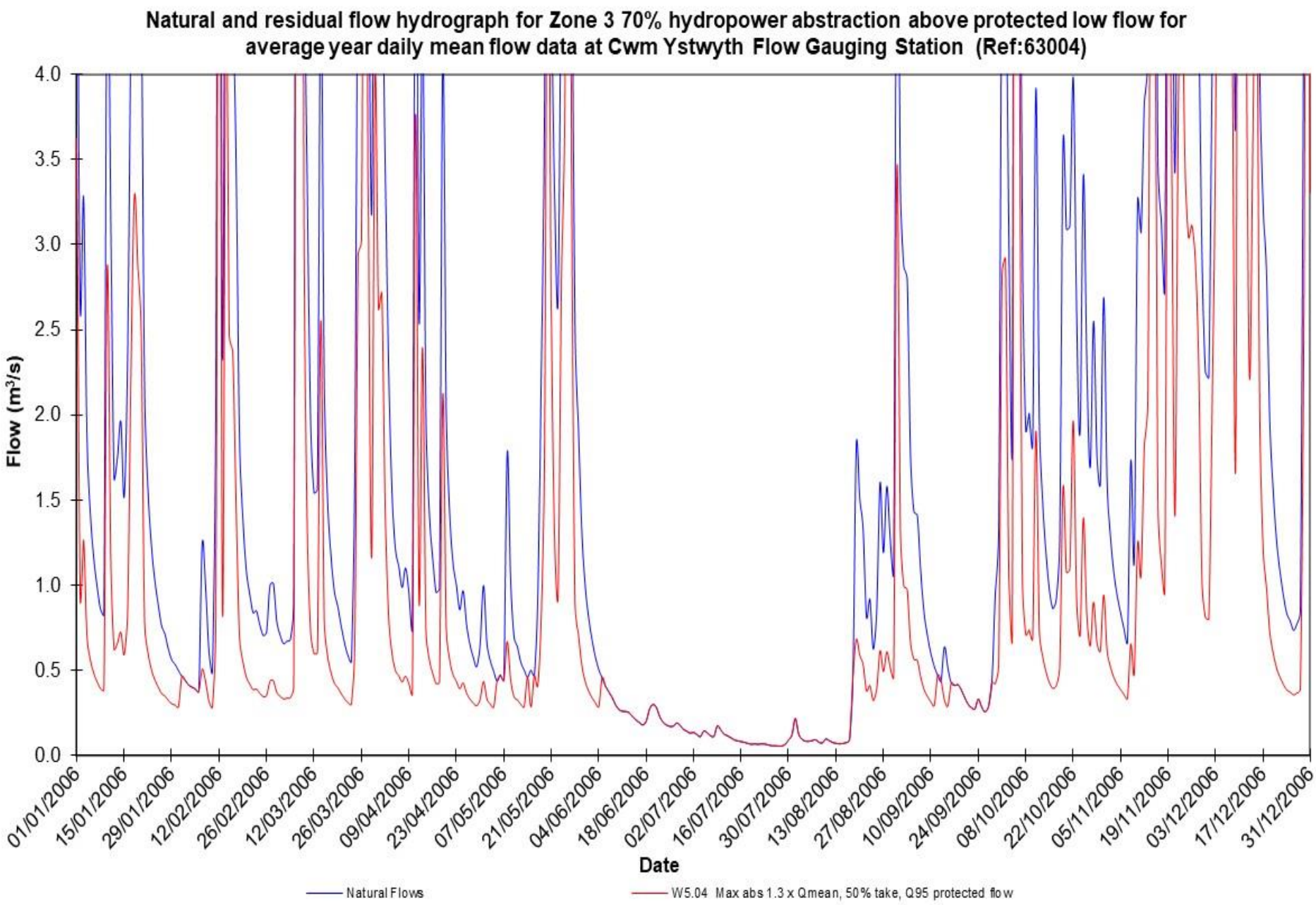
Natural and residual flow hydrograph for Zone 3 70% hydropower abstraction above protected low flow for average year daily mean flow data at Cwm Ystwyth Flow Gauging Station (Ref:63004)
Flow (m³/s)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
15/01/2006
29/01/2006
12/02/2006
26/02/2006
12/03/2006
26/03/2006
09/04/2006
23/04/2006
07/05/2006
21/05/2006
04/06/2006
18/06/2006
02/07/2006
16/07/2006
30/07/2006
13/08/2006
27/08/2006
10/09/2006
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22/10/2006
05/11/2006
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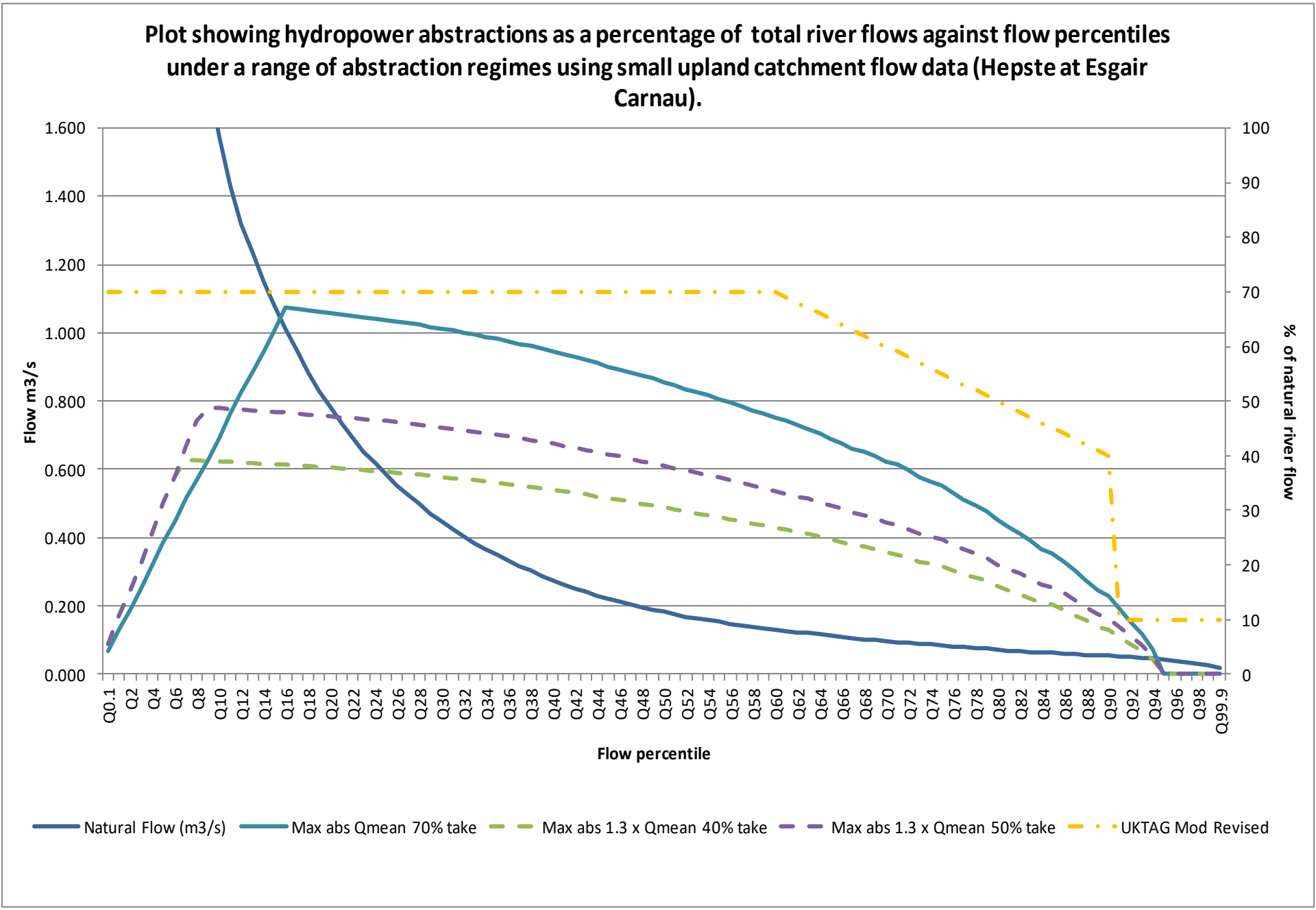
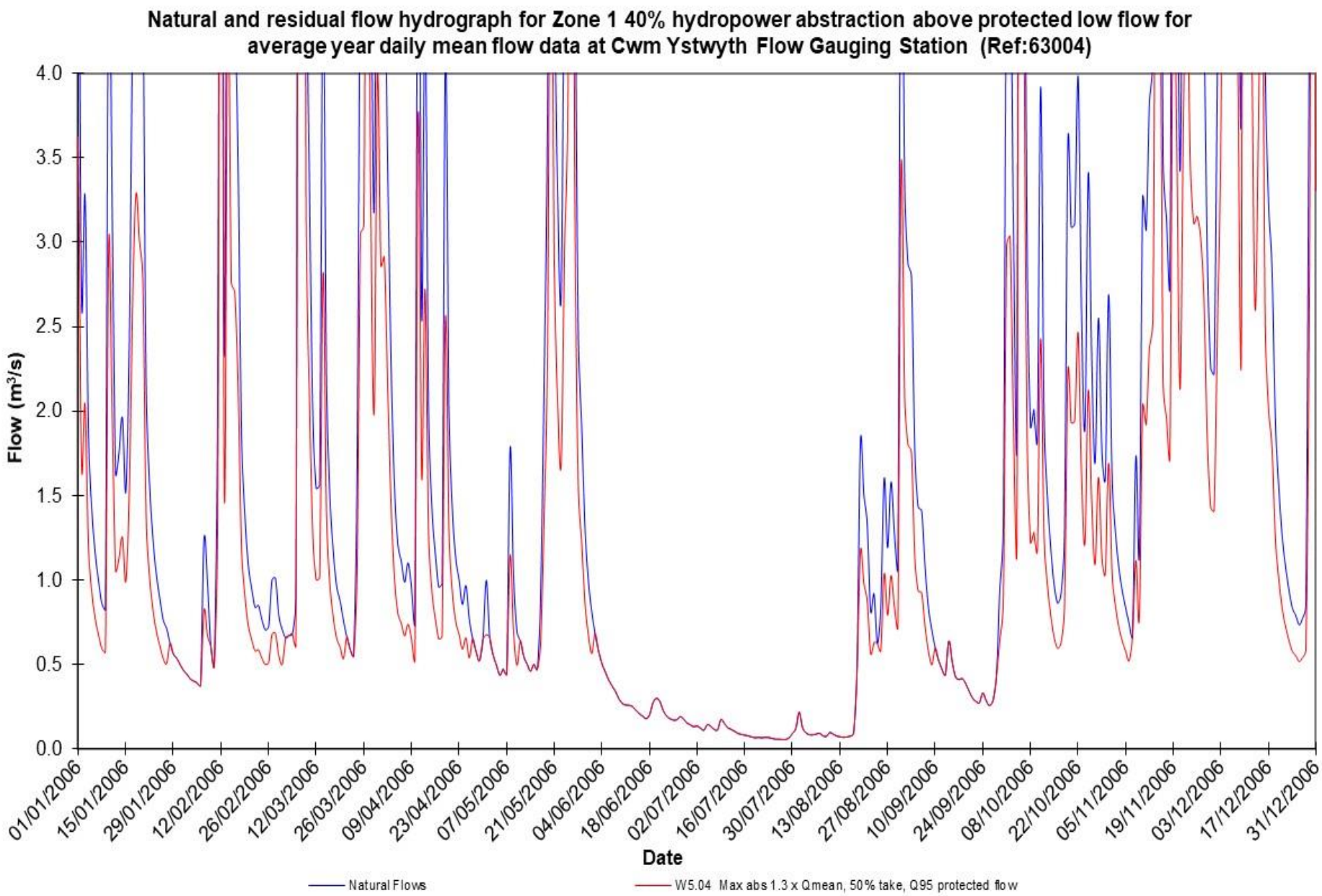

Plot showing hydropower abstractions as a percentage of total river flows against flow percentiles under a range of abstraction regimes using small upland catchment flow data (Hepste at Esgair Carnau).
Flow m3/s
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
% of natural river flow
100
90
80
70
60
50
40
30
20
10
0
Q0.1 Q2 Q4 Q6 Q8 Q10 Q12 Q14 Q16 Q18 Q20 Q22 Q24 Q26 Q28 Q30 Q32 Q34 Q36 Q38 Q40 Q42 Q44 Q46 Q48 Q50 Q52 Q54 Q56 Q58 Q60 Q62 Q64 Q66 Q68 Q70 Q72 Q74 Q76 Q78 Q80 Q82 Q84 Q86 Q88 Q90 Q92 Q94 Q96 Q98 Q99.9
Flow percentile
Natural Flow (m3/s)
Max abs Qmean 70% take
Max abs 1.3 x Qmean 40% take
Max abs 1.3 x Qmean 50% take
UKTAG Mod Revised


Natural and residual flow hydrograph for Zone 1 40% hydropower abstraction above protected low flow for average year daily mean flow data at Cwm Ystwyth Flow Gauging Station (Ref:63004)
Flow (m³/s)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
15/01/2006
29/01/2006
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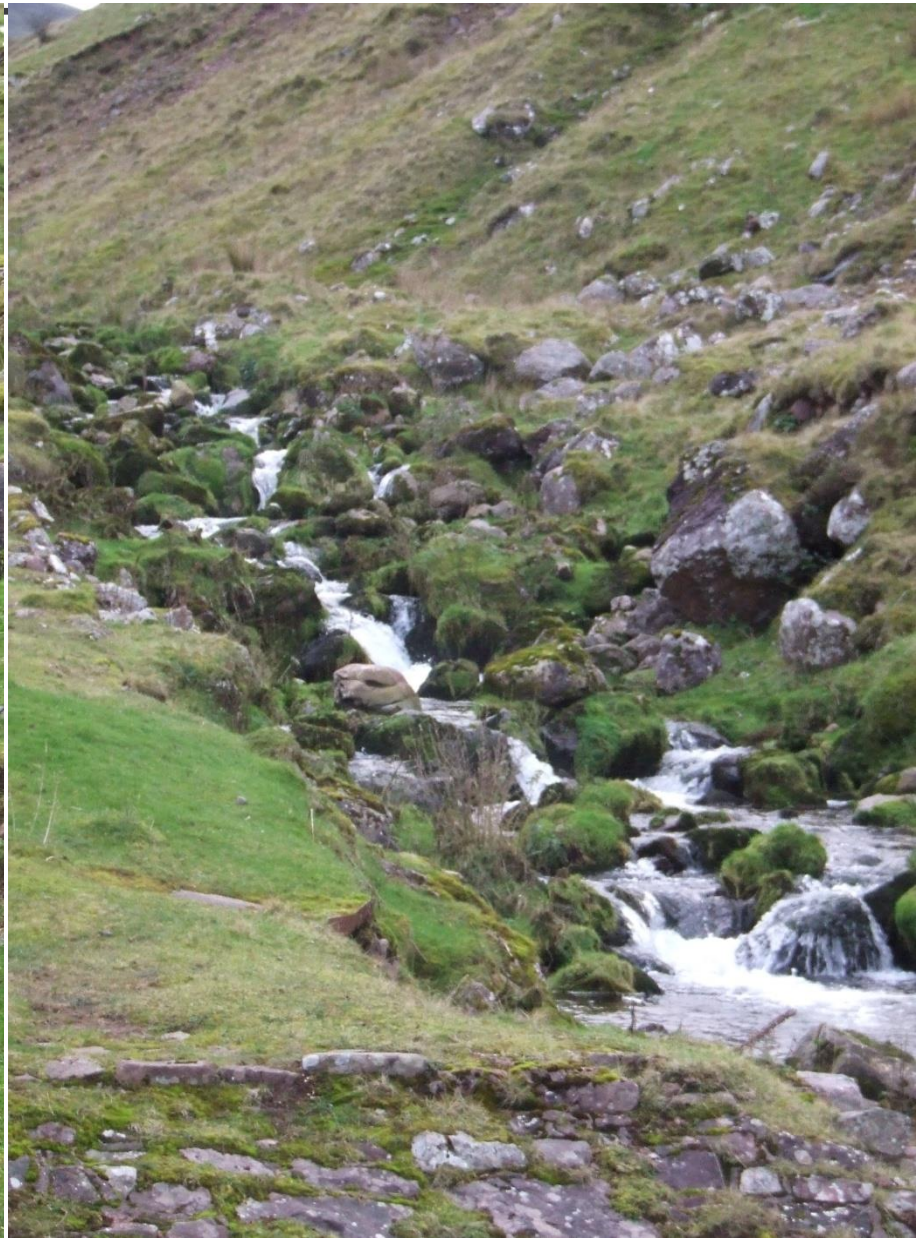
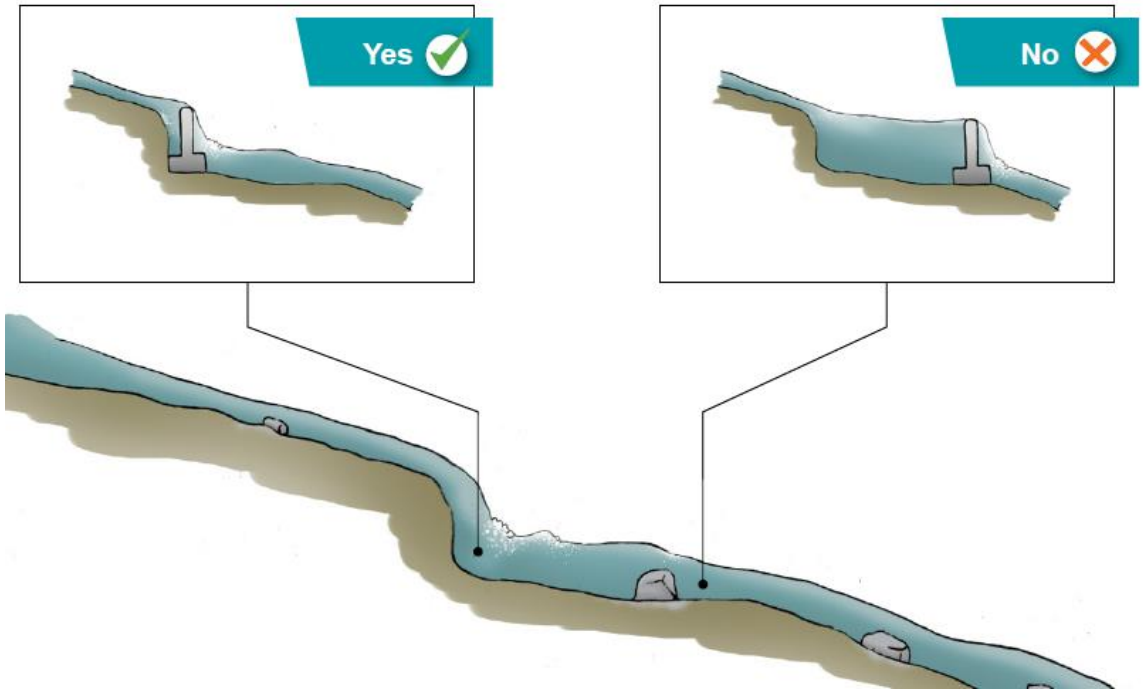


Low impact siting and design principles

- **WFD – consider hydro-morphological response**
- **Consider geomorphological setting of any structure location – '*siting*'**
- **Work with nature - replicate / mimic natural features**

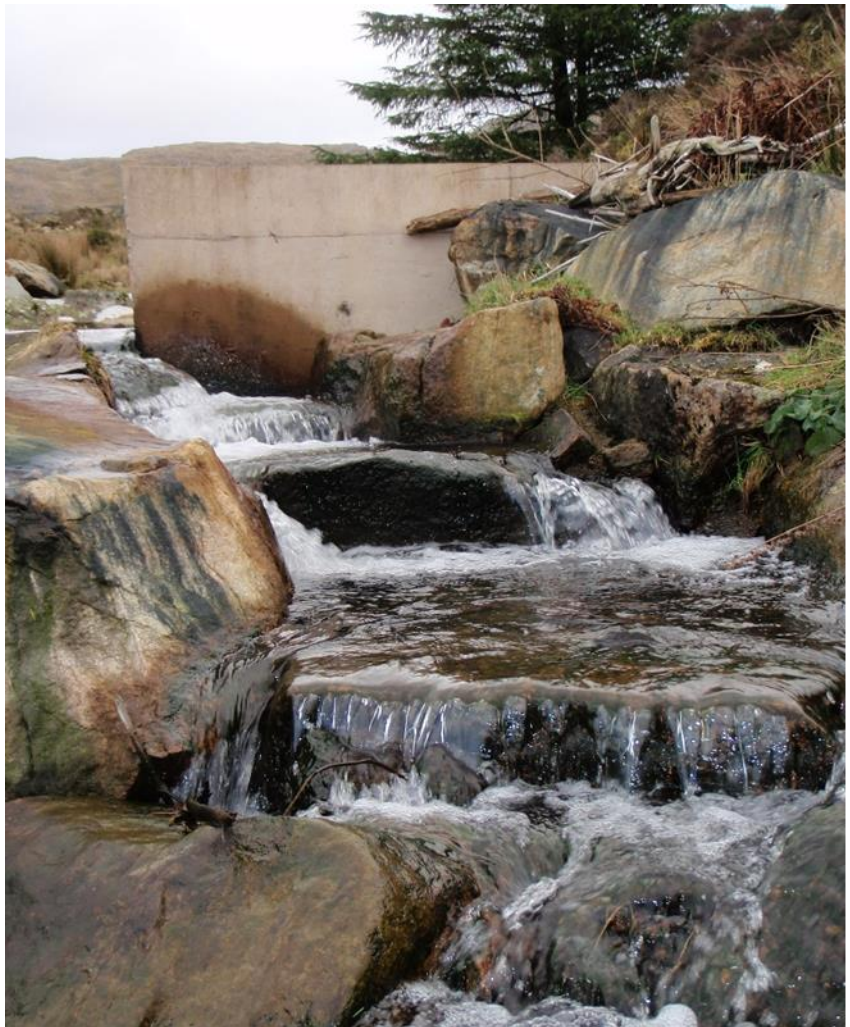


Low impact siting and design principles

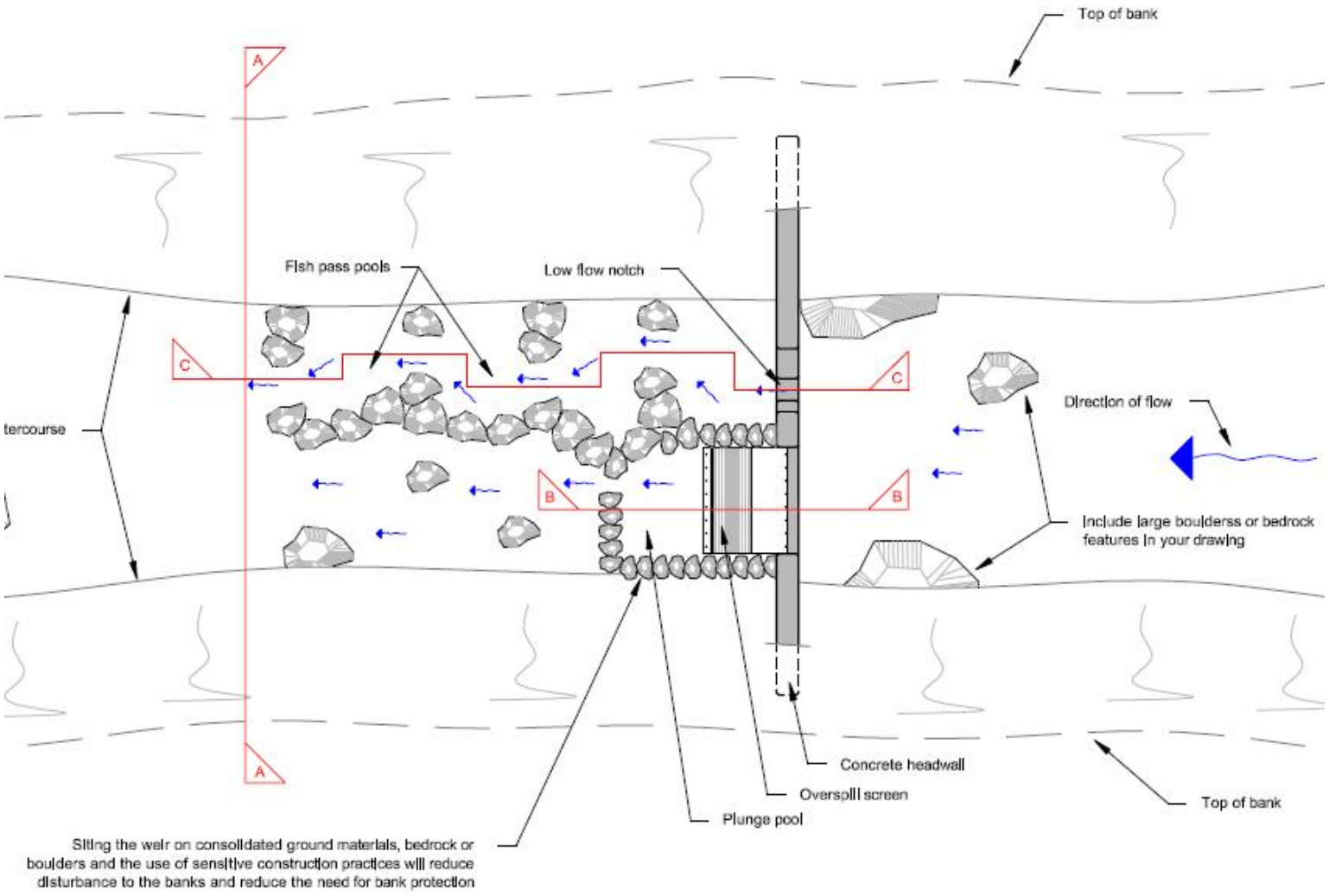
- *Design* to minimise disruption of natural geomorphological processes
- Minimise structure size and associated works
- Upstream and downstream fish passage – ‘nature-like’ easement – design principles
- Intake screening
- Plunge pools

Fish passage

Fish passage easement for resident brown trout



Generic design



Generic design

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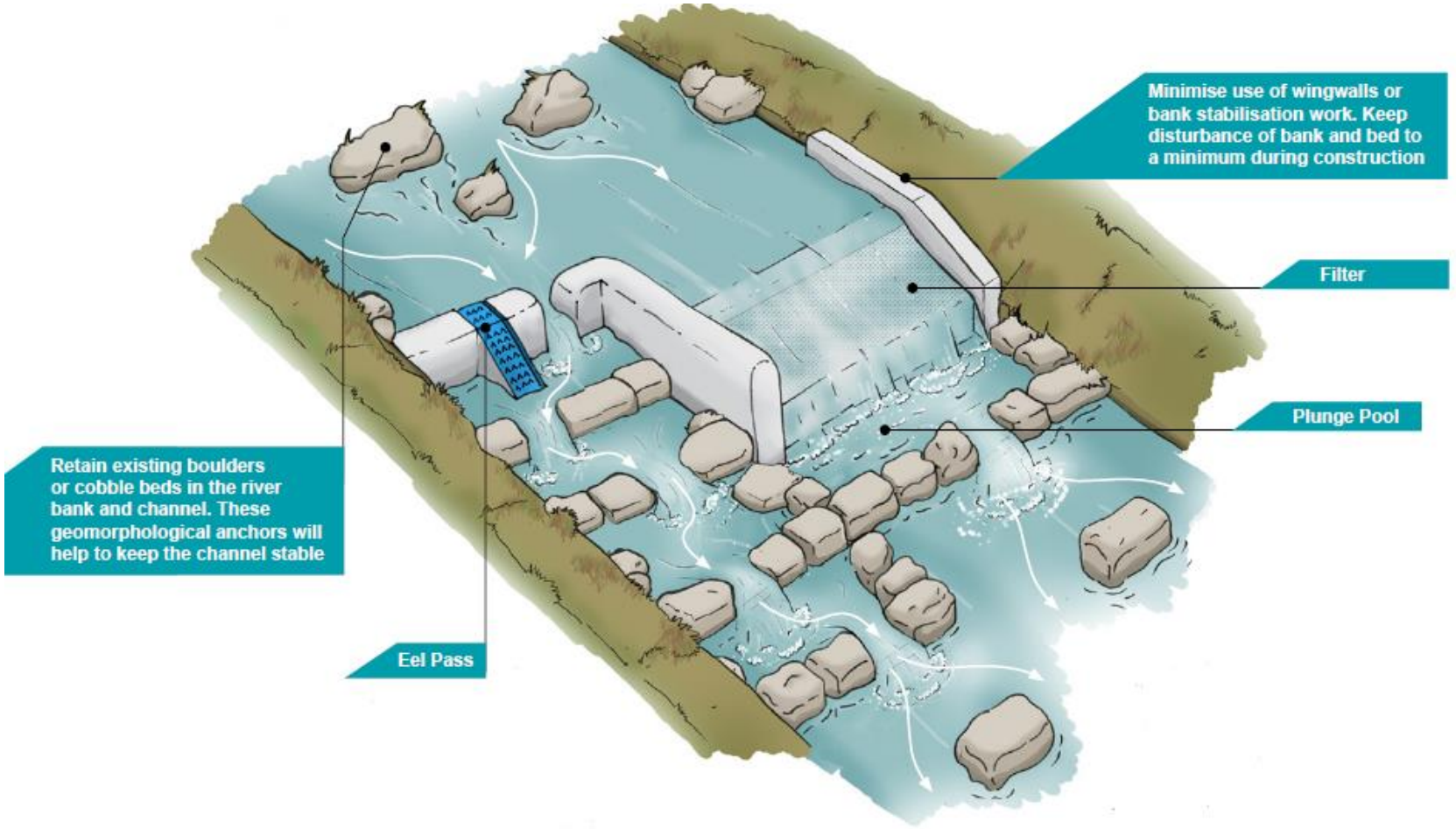

Eel passage – boss type

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Compliance challenges

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- Intake structures not built to approved design (WR & T&C Planning)
- Intake structures built to approved design but subsequently modified (temporary or permanent)
- Intake structures built to approved design but poorly maintained
- Compliance focus moving forward
- Inspections - Enforcement and prosecutions policy
- Work with regulatory partners

In summary

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- NRW flow standards – flow variability
- Spatial aspect of HEP development
- Protects our high value sites for nature conservation
- WFD & Env Act – geomorphology and ecological continuity – ‘ecosystems approach’
- Focus on low impact siting & design
- Hiatus in financial support – no new licence applications
- Guidance review
- Ongoing compliance activities

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