



Water Resources LICENCE TO

ABSTRACT

WATER

Environment Act 1995
Water Resources Act 1991 as amended
by the Water Act 2003
Water Resources (Abstraction and
Impounding) Regulations 2006
Natural Resources Body for Wales (Functions)
Order 2012

IMPORTANT NOTES

Need for safekeeping

This licence is an important document. The permission or right to abstract water may be valuable to your landholding. So -

- **Keep the licence safe, preferably with your deeds etc.**
- **Take careful note of the comments below about "transfer and apportionment" and "death and bankruptcy".**

This is to ensure that the permission and any rights granted by the licence continue if you need to pass it on to someone else.

If you want to:

- **revoke (cancel) the licence;**
- **vary (change/amend) the licence in any way or**
- **change your contact address (but you continue to hold the licence).**

Please write to us at your local Natural Resources Wales office.

Details of this licence are placed on a register, kept by Natural Resources Wales and open for inspection by the public. The public may also obtain further details about it by virtue of the Environmental Information Regulations 2004 (see also Disclosure of Information) except in special cases (for advice please contact us at the address shown on the front page of the licence).

Transfer and apportionment

If you need to pass this licence or any part of it to someone else, you must contact Natural Resources Wales and obtain the appropriate application forms. Temporary licences cannot be transferred or apportioned. The licence holder remains responsible for compliance with the terms of the licence and any charges payable until the licence has been transferred or apportioned.

Death or bankruptcy of the licence holder

If a licence has been 'vested' in you, as a result of the death or bankruptcy of the licence holder, please contact Natural Resources Wales in writing, telling us the licence number(s) and the date that the licence vested in you as a personal representative or trustee of the licence holder. This is necessary in order to enable you to subsequently transfer the licence.

'Vesting' is the transfer of responsibility and ownership of a licence when an existing licence holder is no longer able to hold the licence either through death or bankruptcy.

You do not have to complete a form, but you must notify us in writing within 15 months of the date of vesting, giving the full names of all personal representatives or trustees and a contact address.

Time limits

Your licence may be subject to a time limit (stated on the front of your licence). All new abstraction licences are legally required to include a time limit. For variations to licences, time limits are added in accordance with our policy.

The duration of a time limit is determined in accordance with our time limiting policy. The time limit is linked to the next or subsequent review of water resources within a Catchment Abstraction Management Strategy (CAMS).

There will be a presumption of renewal providing three tests are met: environmental sustainability is not in question; there is continued justification of need; and water is being used efficiently. Any application for renewal will still be subject to the normal statutory considerations.

If your licence is time limited and you wish to renew it when it expires, you will need to apply for a new licence to replace the existing one. You are advised to submit this application at least three months before it expires. To allow you to give early consideration to this, we will send you a reminder approximately 18 months before the expiry date.

If your licence cannot be renewed, we will endeavour to give at least six years notice. We will also endeavour to give at least six years notice where the licence is likely to be renewed on different terms and will significantly impact upon the use of the licence.

In exceptional circumstances, for example where there are other overriding statutory duties such as the Habitats Regulations, it may not be possible to provide six years notice.

Charges

Unless specifically exempted, we may levy an annual CHARGE for water AUTHORISED to be abstracted by this licence, in accordance with our abstraction charges scheme in force at the time.

The licence may be revoked if charges are not paid.

Quantity and quality of water

You must not abstract more than the quantity specified in the licence.

Natural Resources Wales does not, by issue of this licence or otherwise, in any way guarantee that the source of supply will produce the quantity of water authorised to be abstracted by this licence, nor that the water is fit for its intended use.

The quantity of water authorised for abstraction is given in cubic metres. One cubic metre is approximately 220 gallons.

(The precise conversion is 1 cubic metres = 219.969 gallons).

Source of supply and authorised point of abstraction

You may abstract from the point(s) specified in the licence and from no other points. If you want to add or change the authorised point(s) of abstraction, you must apply to us to vary the licence.

Land on which water is authorised to be used

Where this condition applies, you may only use the water you abstract on the area specified in the licence. You must apply to us to vary the licence if you wish to extend or alter this area or remove it.

Purpose for which water is authorised to be used

You may only use the water for the purpose(s) specified in the licence. You must apply to us to vary the licence if you wish to add to or change the purpose(s).

Offences

Under the Water Resources Act 1991 it is an offence:-

- to abstract water, or cause or permit any other person to abstract water, unless the abstraction is authorised by and in accordance with an abstraction licence, or is subject to an exemption;
- to do anything to enable abstraction, or to increase abstraction, except in accordance with an abstraction licence or exemption;
- to fail to comply with the conditions of an abstraction licence.
Note in particular that it may be a condition of the licence to maintain the meter or other measuring device etc. and failure to do so will be an offence;
- to interfere with a meter or other device which measures quantities of water abstracted so as to prevent it from measuring correctly;
- to fail to provide information which we have reasonably required for the purpose of carrying out any of the Natural Resources Wales water resources functions;
- to knowingly make false statements for the purpose of obtaining a licence or consent or in giving required information.

The requirement for a licence is subject to some exemptions, set out in the Water Resources Act 1991 as amended. If in any doubt as to whether you need a licence, contact us at the address shown at the bottom of the front page of the licence.

Right of appeal

If you are dissatisfied with our decision on your licence application, you may appeal.

If you are in England, you should write to the Secretary of State for the Environment, Food and Rural Affairs, care of The Planning Inspectorate at: Room 4/19 Eagle Wing, Temple Quay House, 2 The Square, Temple Quay, Bristol, BS1 6PN.

If you are in Wales, you should write to Welsh Government care of The Planning Inspectorate at: Crown Buildings, Cathays Park, Cardiff, CF10 3NQ.

You must serve notice of appeal within 28 days of the date of receipt of this licence (although the Secretary of State and The Welsh Government have power to allow a longer period for serving notice of appeal). See Water Resources Act 1991, section 43.

Disclosure of information

Information about this licence is available in the public Register held by Natural Resources Wales. Members of the public are also entitled to ask us for other "environmental information" it holds, including any activities likely to affect "the state of any water" or any "activities or other measures designed to protect it". That would include the information additional to the licence document e.g. any related agreement or abstraction returns. In certain restricted circumstances it is possible to claim that information should be kept confidential. If you require more information about keeping this information off the public register because it is confidential, please contact us by writing to the address shown on the front page of the licence within 28 days of receiving this licence.



**Cyfoeth
Naturiol
Cymru
Natural
Resources
Wales**

| | |
|---|------------------|
| Licence serial number | WA/054/0001/0115 |
| Please quote the serial number in all correspondence about this licence | |

TRANSFER LICENCE TO ABSTRACT WATER

The Natural Resources Body for Wales (hereafter referred to as "NRW") grants this licence to:-

Felindre Hydro Ltd ("the Licence Holder")
Felindre Mill
Felindre
Llanidloes
Powys
SY18 6PH

Company Registration Number: 09185891

This licence authorises the Licence Holder to abstract water from the source of supply described in the Schedule of Conditions to this licence and subject to the provisions of that Schedule. The licence commences from the effective date shown below and shall remain in force until the date of expiry shown below.

Signed:

Ashley Lansdown
Permitting Team Leader
Permitting Service
Natural Resources Wales
Cambria House
29 Newport Road
Cardiff
CF24 0TP

Date of issue.....31 March 2022

Date effective.....01 April 2022

Date of expiry.....31 March 2034

Date of original issue.....28 February 2014

This licence should be kept safe, and its existence disclosed on any sale of the property to which it relates. Please read the 'important notes' on the cover to this licence.

Note: References to "the map" are to the map which forms part of this licence.
References to "NRW" are to the Natural Resources Body for Wales or any successor body.

SCHEDULE OF CONDITIONS

1. SOURCE OF SUPPLY

- 1.1 Inland water (river) known as the River Severn at Felindre Mill, Glan-Y-Nant, Llanidloes.

2. POINT OF ABSTRACTION

- 2.1 At National Grid Reference SN 94227 83968 marked 'Point A' on the map.

3. MEANS OF ABSTRACTION

- 3.1 Gravity flow to a leat intake with a width not exceeding 1.2 metres controlled by a new automated control system including level sensor and automated sluice gate.

4. PURPOSES OF ABSTRACTION

- 4.1 Transfer for the purpose of ornamental flows.
4.2 Transfer for the purpose of power production.

5. PERIOD OF ABSTRACTION

- 5.1 All Year.

6. MAXIMUM QUANTITIES OF WATER TO BE ABSTRACTED

- 6.1 146,880 cubic metres per day
53,611,200 cubic metres per year
At an instantaneous rate not exceeding 1,700 litres per second.

Note: A day means any period of 24 consecutive hours and a year means the 12 month period beginning on 1 April and ending on 31 March.

7. MEANS OF MEASUREMENT OF WATER ABSTRACTED

- 7.1 (i) The Licence Holder shall determine the quantity of water abstracted for the purpose of power production by reference to the kilowatt-hours generated, as measured by a kilowatt-hours meter multiplied by the conversion factor determined using the calculation checklist attached to this licence.
(ii) The Licence Holder shall retain supporting documentation relating to details of the methodology and calculations used to convert electricity generated to the quantities abstracted and make them available to NRW on request.

8. RECORDS

- 8.1 (i) The Licence Holder shall record readings of the electrical output and the corresponding quantity of water abstracted at the same time each week, as determined using the calculation checklist attached to this licence or at such other intervals as may be approved by NRW in writing.

- (ii) The Licence Holder shall send to NRW a copy of the records required by Condition 8.1 (i) above within 28 days after 31 March in each year, and also within 28 days of being so requested in writing by NRW.
- (iii) The Licence Holder shall keep all records for at least 6 years, and shall allow NRW to inspect them during all reasonable hours.

9. FURTHER CONDITIONS

- 9.1 For the purpose of this licence, references to 'hydropower scheme' shall mean all works consisting of an automated control system including level sensors and an automated sluice gate, gauge boards, leat intake with a width not exceeding 1.2 metres, a 3-blade Archimedean type turbine with a diameter of 2.25 metres and a maximum rotational speed not exceeding 32 RPM, and a removable outfall screen with 60 millimetre bar spacings.
- 9.2 The Licence Holder shall construct, operate, and maintain the hydropower scheme in accordance with the specifications and drawings:
- 'Fish Protection Modifications 1',
 - 'Fish Protection Modifications 2',
 - 'Outline details of dam' (COG-FELINDRE-13-02) dated 25/01/2014,
 - 'Site Survey' (FM/CG/1) dated 12/05/2013,
 - 'Plan of hinged screen' (COG/FELINDRE/14-SO1) dated 06/06/2014; and
 - 'Details of hinged screen' (COG/FELINDRE/14-SO2) dated 06/06/2014
- copies of which are appended to this licence, or such minor amendments to those documents that are accepted in writing by NRW prior to the date of commencement of construction.
- 9.3 The Licence Holder shall, as far as is reasonably practicable, ensure that no water flows through the turbine if the Licence Holder is unable to generate power.
- 9.4 The Licence Holder shall return all of the water abstracted in pursuance of this licence to the River Severn at National Grid Reference SN 94345 83935 marked 'Point Q' on the map, or at any other discharge points located upstream of this point.
- 9.5 (i) No abstraction of water shall take place unless the rate of flow in the River Severn immediately downstream of the authorised point of abstraction, marked as 'Point A' as specified in Condition 2.1, is equal to or greater than 160 litres per second and the abstraction shall not cause the flow immediately downstream of said abstraction point to fall below that rate.
- (ii) From 01 September to 31 January inclusive each year, the quantity of water abstracted shall not exceed 50% of the available flow in the River Severn in excess of 160 litres per second.
- (iii) From 01 February to 31 August inclusive each year, the quantity of water abstracted shall not exceed 100% of the available flow in the River Severn in excess of 160 litres per second.
- 9.6 (i) No abstraction of water shall take place unless the Licence Holder has undertaken the following measures, in accordance with the specifications and drawings referred to in Condition 9.2:

- (ii) No changes will be made to the first ornamental cascade at National Grid Reference SN 94260 83960 supplied by two 100 millimetres submerged pipes.
 - (iii) The sluice to the second ornamental cascade at National Grid Reference SN 94267 83958 will be operated as an undershot sluice with a maximum opening of 10 millimetres.
 - (iv) The sluice to the third ornamental cascade (also referred to as the “ancient by wash”) at National Grid Reference SN 94285 83951 will be closed during normal operation and shall only be opened when the turbine requires dewatering for maintenance and repair works.
 - (v) The pipe work and passage route to the existing Kaplan turbine at National Grid Reference SN 94316 83937 will be blocked and the supply to the Kaplan turbine shut off.
 - (vi) The vertical discharge pipe from the Kaplan turbine housing at National Grid Reference SN 94316 83937 to the leat will be removed.
 - (vii) The existing drop in the leat bed upstream of the Kaplan turbine at National Grid Reference SN 94315 83937 location will be removed.
- 9.7
- (i) No water shall be abstracted for the purpose of hydroelectric power generation unless the fish protection modifications have been made to the Archimedean type turbine, as detailed in drawings ‘Fish Protection Modifications 1’ and ‘Fish Protection Modifications 2’ attached here to.
 - (ii) The Licence Holder shall maintain, repair, and replace the fish protection modifications so as to remain effective as to prevent physical damage to fish.
- 9.8
- (i) From 01 September to 31 January inclusive each year, no abstraction shall take place unless the Licence Holder has installed a screen with spacing no greater than 60 millimetres no more than 2 metres from the leat discharge to prevent the entrapment, entrainment, or impingement of fish.
 - (ii) The Licence Holder may raise the outfall screen to prevent the build-up of debris when the tailrace upstream of the outfall screen is inundated with flows from the River Severn. At all other times the outfall screen shall remain in place as specified in Condition 9.8 (i).
 - (iii) The outfall screen shall remain in a vertical position.
 - (iv) The outfall screen shall be designed and installed in accordance with the specifications and drawings referred to in Condition 9.2.
 - (v) The Licence Holder shall maintain the outfall screen in accordance with the manufacturer’s specifications and keep records of such maintenance available for inspection.
 - (vi) During the period 01 February to 31 August inclusive each year, the outfall screen must be removed.

- 9.9 (i) No abstraction shall take place unless the Licence Holder has installed a level sensor in the River Severn immediately upstream of National Grid Reference SN 94231 83976.
- (ii) No abstraction shall take place unless the Licence Holder has installed a level sensor immediately downstream of the point of abstraction specified in Condition 2.1.
- (iii) The Licence Holder shall ensure that the level sensors specified in Conditions 9.9 (i) and (ii) are working at all times when abstraction takes place.
- (iv) The Licence Holder shall maintain the level sensors specified in Conditions 9.9 (i) and (ii) in such a condition, and if necessary replace them, so as to ensure that accurate measurements of levels are recorded at all times when abstraction is taking place.
- 9.10 (i) No abstraction shall take place unless the Licence Holder has installed an automated control system, including an automated sluice gate controlled by the level sensors specified in Conditions 9.9 (i) and (ii).
- (ii) The level sensors specified in Conditions 9.9 (i) and (ii) and the automated control system shall be used to secure the residual flow specified in Condition 9.5 (i).
- (iii) In the event that the level sensors and / or the automated control system fail the Licence Holder shall cease operation immediately and notify NRW of this fact.
- (iv) No abstraction shall recommence unless the level sensors and automated control system are fully operational and NRW has been notified of this fact.
- 9.11 (i) The Licence Holder shall test the operation of the automated control system by simulating the following scenarios:
- A rate of flow in the River Severn of equal to or less than 160 litres per second.
 - A power failure.
- (ii) The Licence Holder shall perform this test in accordance with the recommendations of the manufacturer of the automated control system, or at any time when required by NRW.
- (iii) The Licence Holder shall retain evidence of current certification of the automated control system for inspection by NRW.
- 9.12 (i) No abstraction shall take place unless the Licence Holder has installed a gauge board in the River Severn immediately upstream of National Grid Reference SN 94231 83976.
- (ii) No abstraction shall take place unless the Licence Holder has installed a gauge board immediately downstream of the point of abstraction specified in Condition 2.1.
- (iii) The Licence Holder shall ensure that the gauge boards specified in Conditions 9.12 (i) and (ii) are working at all times when abstraction takes place.

- (iv) The Licence Holder shall maintain the gauge boards specified in Conditions 9.12 (i) and (ii) in such a condition, and if necessary replace them, so that they accurately present an indication of the flow at all times when abstraction is taking place.
- 9.13 The Licence Holder shall maintain a flow of at least 160 litres per second, at all times during the installation of the hydropower scheme and any subsequent maintenance works.
- 9.14 The installation of the hydropower scheme authorised by this licence shall not be carried out in the watercourse between 01 September and 30 April in any year.

ADDITIONAL INFORMATION

Note: the following information is provided for information only. It does not form part of the licence.

REASONS FOR CONDITIONS

The licence is time-limited to a date to reflect the timing of a future review of the catchment resources availability.

Conditions 7 and 8: the Licence Holder is required to record readings of the electrical output and the corresponding quantity of water abstracted to demonstrate compliance with the conditions of this licence and to provide information on actual water usage for water planning purposes.

Conditions 9.1 and 9.2: to ensure the hydropower scheme is constructed, operated, and maintained in accordance with the drawings and specifications agreed by NRW during the determination of the licence.

Condition 9.3: to secure the proper and efficient use of water resources.

Condition 9.4: to ensure the abstraction can be classed as non-consumptive.

Conditions 9.5 and 9.13: to ensure a flow is maintained in the watercourse in order i) to maintain the riverine habitat for the conservation of the flora and fauna, ii) to ensure safe passage for fish through the depleted reach and maintain the efficiency of the existing fish pass, which has been designed to operate at specific flows; and iii) to ensure that the water environment is not impacted during construction and subsequent maintenance.

Condition 9.6: to ensure the safe downstream passage of fish through the leat and hydropower turbine.

Condition 9.7: to prevent damage or injury to fish caused by them coming into contact with the moving blades of the hydropower turbine.

Conditions 9.8 (i), (iii), (iv) and (v): to prevent upstream migrating fish attempting to pass the site via the leat and being delayed in their migration as a result.

Condition 9.8 (ii): to allow the removal of the outfall screening during high flow conditions to prevent the build-up of debris.

Condition 9.8 (vi): to facilitate the downstream migration of fish via the leat during the specified period.

Conditions 9.9, 9.10, 9.11 and 9.12: to ensure compliance with Condition 9.5.

Condition 9.13: to ensure that the water environment is not impacted during installation and subsequent maintenance of the hydropower scheme.

Condition 9.14: to avoid damage to fish during vulnerable life stages such as spawning, migration, emergence, and early maturation.

IMPORTANT NOTES

No impoundment licence is required to facilitate the abstraction of water for the hydropower scheme authorised by this abstraction licence.

For the purposes of Conditions 9.2 and 9.10, the Licence Holder shall contact:

Senior Officer
People and Places Team
Natural Resources Wales
Maes y Ffynnon
Penrhosgarnedd
Bangor
Gwynedd
LL57 2DW

Tel: 0300 065 3000

Email: Mid.People.Places.Team@cyfoethnaturiolcymru.gov.uk

Water efficiency note

The Licence Holder should use water abstracted under the terms of this licence in an efficient manner. NRW may refer to its guidance on water efficiency (or equivalent guidance) in determining whether water is being used efficiently and may offer advice on any measures considered necessary to meet particular recommendations.

Screening

NRW will have regard to its Screening for Intakes and Outfalls: A Best Practice Guide (or equivalent guidance) in agreeing where, how, and what type of fish screens should be installed and together with the results of any monitoring in determining whether the fish screens are properly effective and maintained, and in judging whether it is necessary to require repair or replacement of the fish screens.

Eel screening

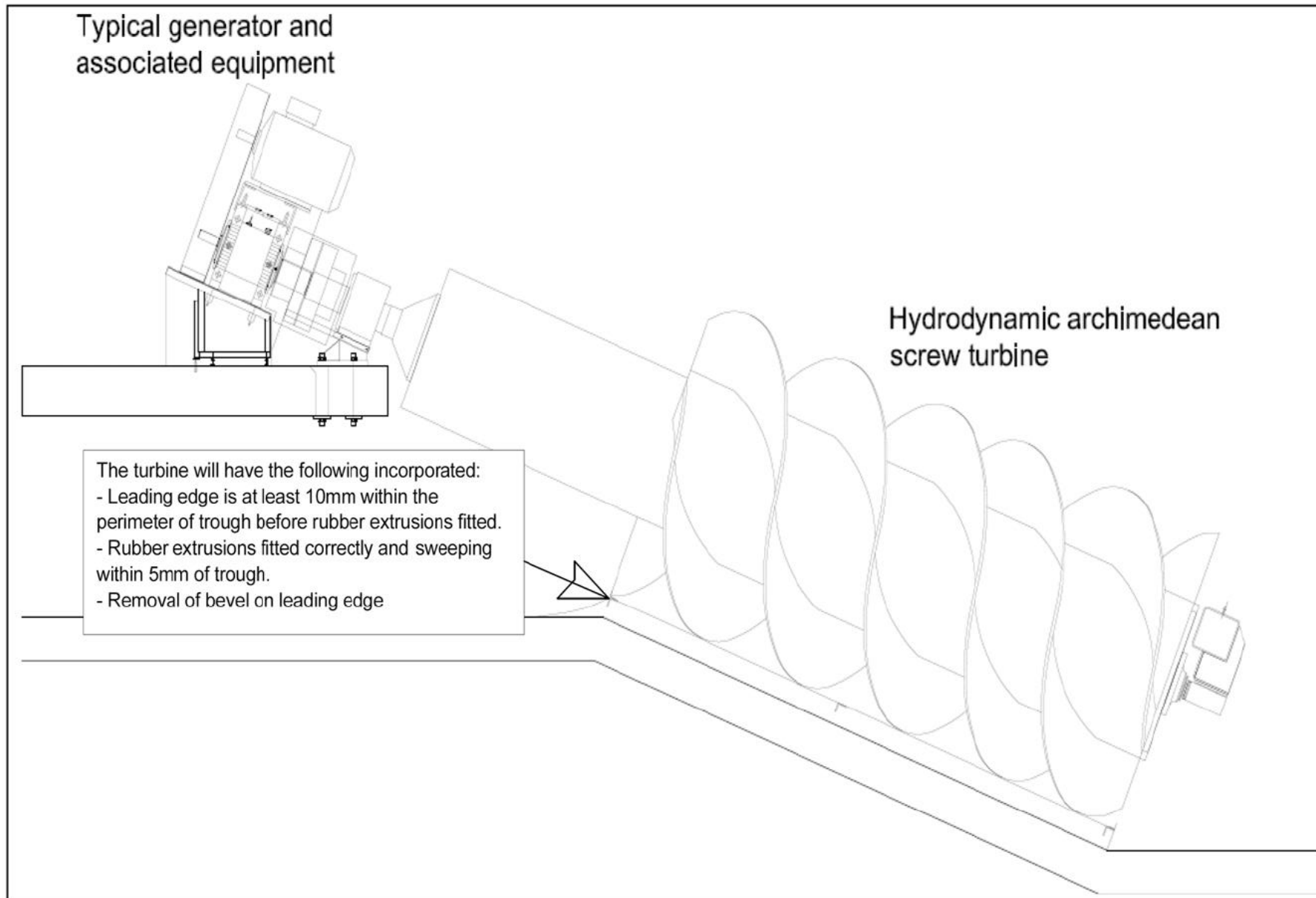
NRW may have regard to its Eel Manual: Screening at intakes and outfalls: measures to protect eel (or equivalent guidance) in agreeing where, how, and what type of eel screen should be installed and together with the results of any monitoring in determining whether the eel screen is properly effective and maintained, and in judging whether it is necessary to require repair or replacement of the eel screen.

Licence history

| Licence Serial number | Issue & Effective Date | Expiry date | Summary of changes |
|-----------------------|---|-------------|--|
| MD/054/0001/049 | 28/02/2014 | 31/03/2022 | WPCC742 Original licence issued. |
| MD/054/0001/049 | 03/07/2014 | 31/03/2022 | WPCC 1754 Licence varied to remove requirement for intake screening. New conditions added to specify what changes are required to ensure leat is safe for downstream fish passage. |
| MD/054/0001/049 | 08/08/2014 | 31/03/2022 | WPCC 2216 Licence varied to revise the requirements for screening at the outfall. |
| MD/054/0001/049/V003 | 30/10/2015 | 31/03/2022 | WPCC2461 Removal of level sensor above fish pass and transfer of Licence Holder. |
| WA/054/0001/0115 | Issued: 31/03/2022 Effective: 01/04/2022 | 31/03/2034 | PAN-01644 Same terms renewal of licence with removal of: Schedule A and Conditions 9.14 to 9.16. |

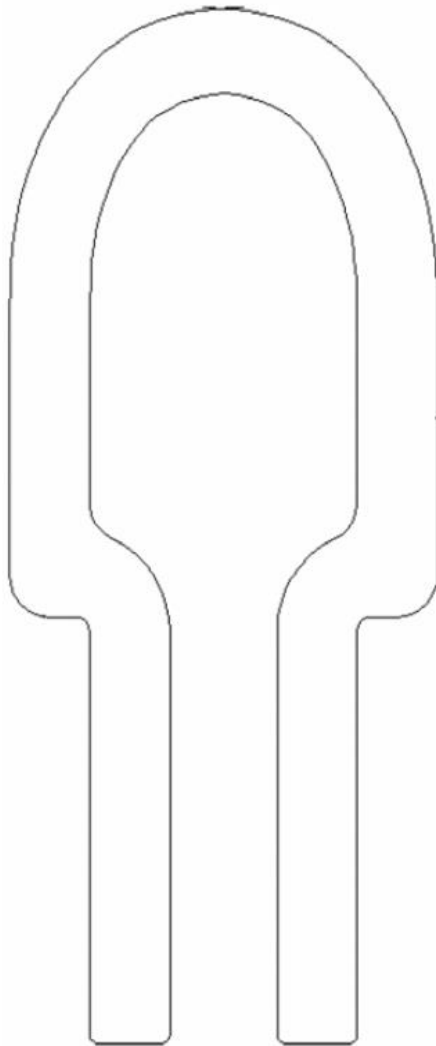


| | | |
|---|--|----------|
| <p>0.3 0 Distance / 2 0.3 Kilo metre rs</p> | <p>MAP ACCOMPANYING LICENCE NUMBER / MAP I GYFEILIO TRWYDDED RHIF WA/054/0001/0115 Scale I Graddfa 1:5,000</p> <p>© Crown Copyright and database rights Ordnance Survey. Natural Resources Wales, 100019741, 2015. © Hawlfraint y Goron a hawl cronfa ddata Arolwg Ordans. Cyfoeth Naturiol Cymru, 100019741, 2015.</p> | <p>N</p> |
|---|--|----------|

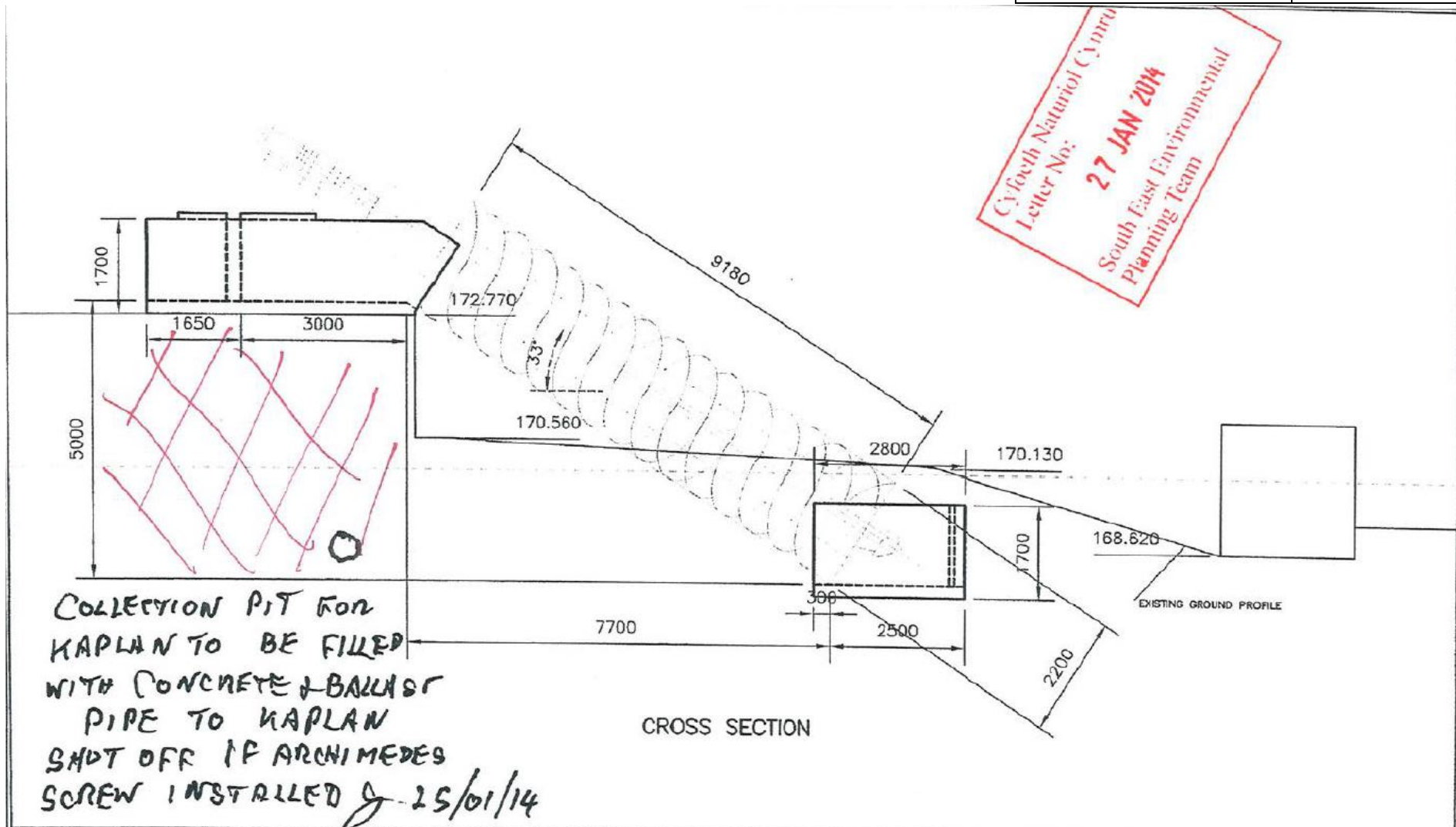


Fish Protection Modifications 2

Not to scale

DRAWING 2.Specification of EPDM rubber extrusion

35mm of compression with a force of 2Kg per cm² applied. All fixing bolts must be sub flush to the clamp plates.



DESIGN NOTES

Designer : Christopher Williams
 Date : 17/07/2013
 ALL DIMENSIONS ARE TO BE CONFIRMED ON SITE

DRAWING TITLE

OUTLINE DETAILS OF DAM
 CROSS SECTION SHEET 2 OF 4

SCALE 1:100 (A4) UNLESS OTHERWISE STATED

Drawing No. : COG/FELINDRE/13/02
 REV 'O'

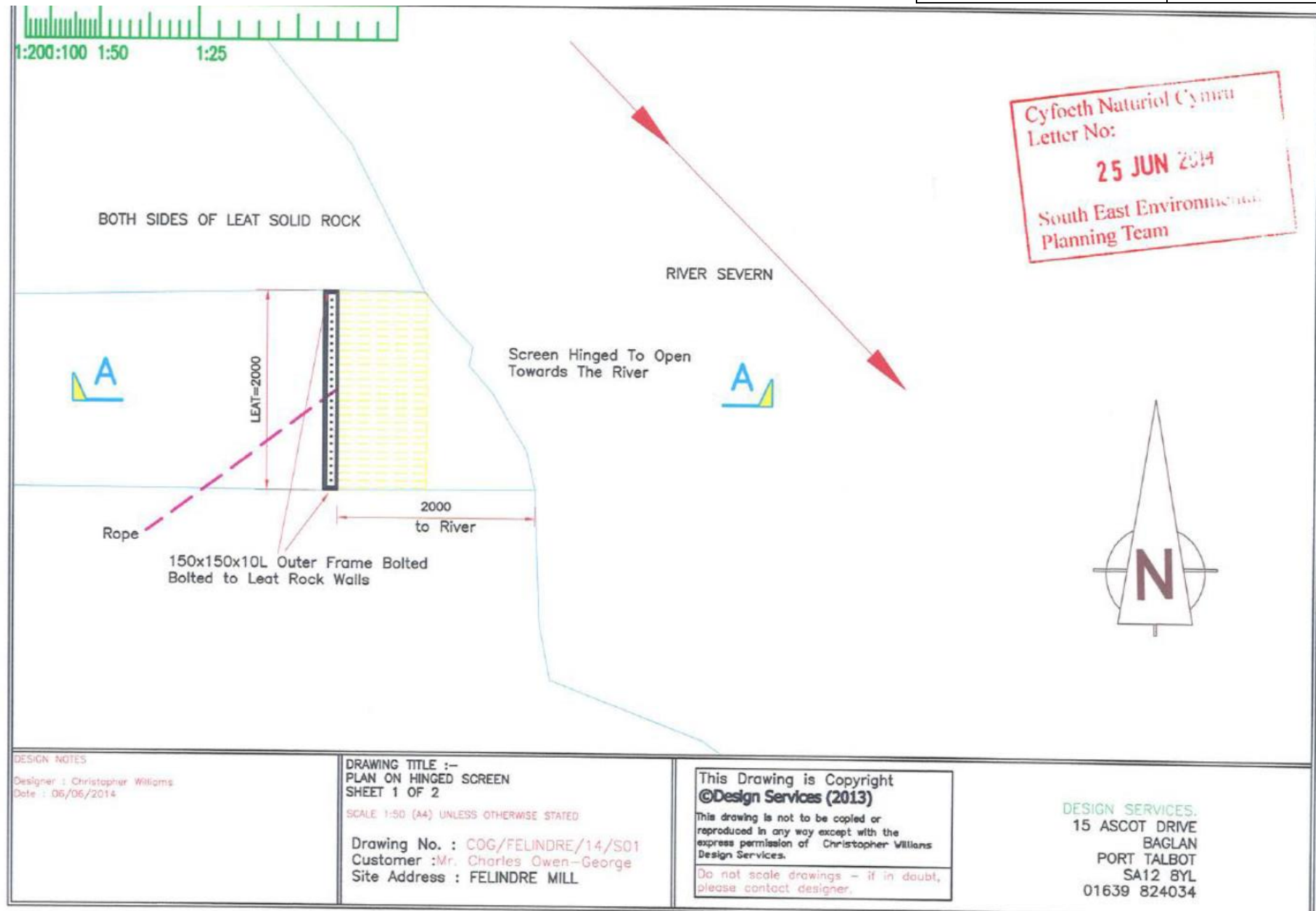
Customer : Mr. Charles Owen—George
 Site Address : FENLINDRE MILLS

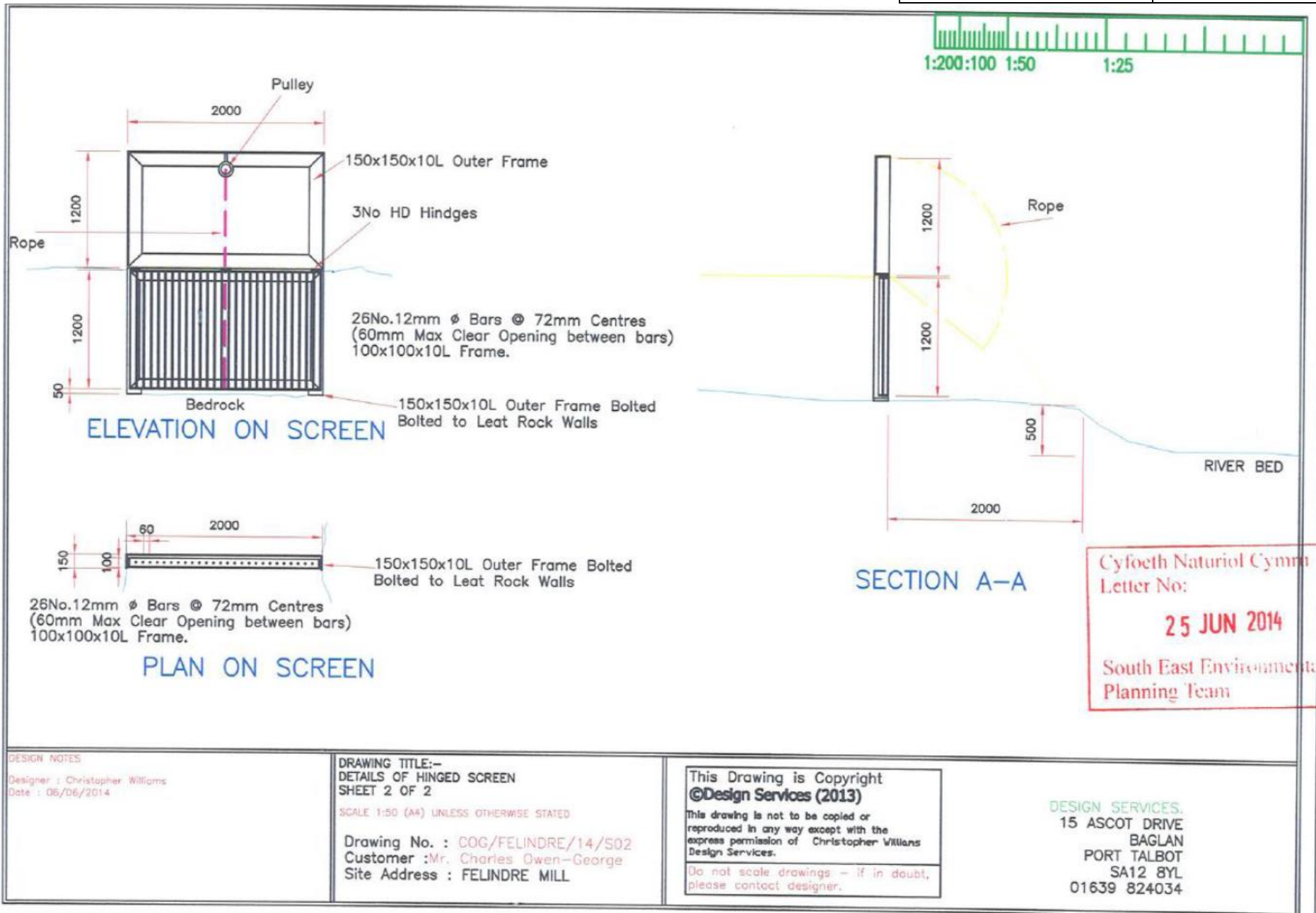
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Do not scale drawings – if in doubt, please contact designer.

DESIGN SERVICES.
 15 ASCOT DRIVE
 BAGLAN
 PORT TALBOT
 SA12 8YL
 01639 824034





Calculation Checklist

This checklist shall be used to record the site data and calculate the Hydro Abstraction Factor for the site (HAF_{site}) to allow conversion of electrical output to quantities abstracted. **The HAF_{site} is the amount of water used in m^3 per kWh generated for any period.**

| Site Data | |
|---------------------------------|--|
| Site name | |
| Address | |
| Licence serial No. | |
| Contact name | |
| Contact telephone | |
| Contact email | |
| Turbine manufacturer | |
| Turbine type | |
| Turbine serial no. | |
| Number of jets (where relevant) | |
| | |

| Performance Data | | |
|--|-------|-----------------------------------|
| Parameter | Value | How was the parameter determined? |
| Net operating head of the system at maximum power output ($H_n (P_{max})$) in metres | | |
| Turbine/water wheel efficiency at maximum power output ($e_{turbine/water\ wheel\ (P_{max})}$) | | |
| Transmission system efficiency at maximum power output ($e_{transmission\ (P_{max})}$) | | |
| Generator efficiency at maximum power output ($e_{generator\ (P_{max})}$) | | |

Calculation of overall system efficiency of the rotating parts of the hydro system, at maximum power output ($e_{system\ (P_{max})}$)

$$e_{system\ (P_{max})} = e_{turbine/water\ wheel\ (P_{max})} \times e_{transmission\ (P_{max})} \times e_{generator\ (P_{max})}$$

$$= \boxed{} \times \boxed{} \times \boxed{}$$

$$e_{system\ (P_{max})} = \boxed{}$$

Calculation of HAF_{site}

HAF_{site} = Hydro Abstraction Factor for the site in question

$$= 366.972 / (H_n (P_{max}) \times e_{system\ (P_{max})})$$

$$= 366.972 / (\boxed{} \times \boxed{})$$

$$= \boxed{} \text{ (m3/kWh)}$$

Where:

$H_n (P_{max})$ = net head at max. power.

366.972 = a constant in order to bring the final HAF into the correct unit of m^3/kWh (it is arrived at by dividing the number of seconds in an hour (3600) by gravity ($9.81\ m/s^2$))

The volume of water abstracted for any period (V_{period}) can then be calculated by simply multiplying the HAF_{site} by the number of kiloWatt hours generated thus:

$$V_{period\ (m3)} = kWh_{period\ (kWh)} \times HAF_{site\ (m3/kWh)}$$

See example:

(*kWh is a measure of energy, whilst kW is a measure of power: at full efficiency, a 50 kW*)

turbine will produce 50 kWh of energy in one hour, 100 kWh in two hours, 150 kWh in three hours etc.).

| Performance Data | | |
|---|-------|-----------------------------------|
| Parameter | Value | How was the parameter determined? |
| Net operating head of the system at maximum power output ($H_n (P_{max})$) in metres | 150 | Site survey |
| Turbine/water wheel efficiency at maximum power output ($e_{\text{turbine/water wheel}} (P_{max})$) | 0.9 | From manufacturer |
| Transmission system efficiency at maximum power output ($e_{\text{transmission}} (P_{max})$) | 0.85 | From manufacturer |
| Generator efficiency at maximum power output ($e_{\text{generator}} (P_{max})$) | 0.85 | From manufacturer |

Calculation of overall system efficiency of the rotating parts of the hydro system, at maximum power output ($e_{\text{system}} (P_{max})$)

$$e_{\text{system}} (P_{max}) = e_{\text{turbine/water wheel}} (P_{max}) \times e_{\text{transmission}} (P_{max}) \times e_{\text{generator}} (P_{max})$$

$$= 0.9 \times 0.85 \times 0.85$$

$$e_{\text{system}} (P_{max}) = 0.65$$

Calculation of HAF_{site}

HAF_{site} = Hydro Abstraction Factor for the site in question

$$= 366.972 / (H_n (P_{max}) \times e_{\text{system}} (P_{max}))$$

$$= 366.972 / (150 \times 0.65)$$

$$= 3.764 \quad (\text{m}^3/\text{kWh})$$

The volume of water abstracted for any period (V_{period}) can then be calculated by simply multiplying the HAF_{site} by the number of kiloWatt hours generated thus:

$$V_{\text{period}} (\text{m}^3) = \text{kWh}_{\text{period}} (\text{kWh}) \times HAF_{\text{site}} (\text{m}^3/\text{kWh})$$

If, for example your total export of electricity for the period was 68400 kWh, then you would have abstracted a total volume of water of:

$$V_{\text{period}} (\text{m}^3) = 68400 \text{ kWh} \times 3.764 \text{ m}^3/\text{kWh} = 257457.6 \text{ m}^3$$

**Would you like to find out more about us,
or about your environment?**

**Then call us on
0300 065 3000 (Mon-Fri 9-5)**

**email
enquiries@naturalresourceswales.gov.uk**

**or visit our website
www.naturalresourceswales.gov.uk**

**incident hotline 0300 065 3000 (24hrs)
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