Annex A Hydrological information

1 River flow information

Both the scheme developer and SEPA will need information on river flow characteristics, and on the distance and height difference between the intake and the turbine tailrace. The developer will need this information to determine the size and type of turbine, the minimum and maximum turbine flows, and the amount of electricity generated. SEPA will need this information to compare the proposed abstraction regime to the natural flow characteristics of the river and in turn to assess the impact of the proposal on the water environment. This assessment uses the Environmental Flow Standards as outlined in the following Scottish Government Directions: http://www.gov.scot/Publications/2014/08/6532

SEPA has been directed by the Scottish Government to assess the impact on a river's flow regime by looking at how a proposed hydro scheme alters the natural flow duration curve (FDC) as well as the existing FDC if the catchment is already impacted by other CAR authorised activities A FDC is a convenient way of summarising the flow characteristics of a river. It provides information on the probability that a river flow is equalled or exceeded and is derived by portioning the flow hydrograph (as mean daily flows), ranking the flows in descending order and sorting by the probability of a given flow being exceeded. The convention is to refer to the flow corresponding to an exceedence probability x as $Q(x)$. This is usually expressed as the percentage of time that the flow in a river is greater than the stated probability. For example, Q95 is the flow exceeded 95% of the time and is typical of a dry summer flow. Q5 is the flow exceeded 5% of the time and is equivalent to a full spate.

FDCs are best derived using long-term local gauging station data. However, as these are not available for most river reaches, estimates are made by hydrologists using statistical models or by linking short periods of local data to longer data sets. SEPA recognises that all of the methods used to create FDCs come with statistical uncertainty and that steps to improve this, generally require more measured flow data. The extra effort required to collect real data has to be balanced against the scale of the development, the cost of acquiring the data and the risk to the environment.

The hydrological character of a watercourse is influenced by both natural and artificial features upstream. It is important that developers take these into account when deriving flow duration curves. Natural features such as lochs, and artificial features such as existing abstractions, drainage channels and land use should be considered. SEPA will be happy to help developers identify these features.

2 SEPA flow calculations

2.1 SEPA Gauging Station Data

The starting point for estimating a flow duration curve is to refer to SEPA's own gauging station network:

http://www.sepa.org.uk/water/river_levels.aspx

Flow data from a SEPA gauging station may be suitable to transpose directly to the site of a proposed scheme but this depends on proximity and catchment characteristics. Confirmation should be sought from SEPA Hydrology who will advise on suitability and provide the flow data if appropriate.

Natural flow data is used to set licensed mitigation flows and to determine the permitted maximum abstraction rate. Where SEPA gauging stations are impacted by abstractions, impoundments and/or discharges there may be an option to naturalise the flow data based on the licensed activities upstream. SEPA can advise on whether this would be possible and provide the necessary information to carry this out. Only naturalised flow data can be transposed.

Natural flow data will be used irrespective of the length of time any upstream influence has been in place e.g. historical abstractions/ diversions for hydropower or public water supply.
In other instances the applicant should provide hydrological information in accordance with Table 3 in support of the application.

2.2 LowFlows Estimates

For schemes within category A in table 3, SEPA will accept a LowFlow estimate without the need for any further data collection as the risk to the aquatic environment is considered to be low. However if a developer wishes to supply gauged data it must meet the minimum requirements for category B schemes or SEPA will not assess it as part of the application and will default to using a LowFlows estimate. Note that where LowFlows is used the minimum Hands Off Flow required will be Q90.

User licence restrictions mean that SEPA is unable to provide LowFlow derived estimates to a developer. However, Wallingford Hydrosolutions provides a flow retrieval service using the same software:

http://www.hydrosolutions.co.uk/consultancy-3-1.asp

Should a developer choose a different method to estimate a modelled FDC, other than the LowFlows software, then details must be submitted in the supporting information, including any model calibration/verification. The applicant must be aware that SEPA will make a decision based on sound hydrological principles and so which ever flow duration curve is deemed to be the most statistically robust will be selected.

2.3 Local Flow Monitoring

For schemes within category B in table 3, one year of continuous flow data is required in support of the application.

To aid in the processing of flow data, SEPA has produced Excel spreadsheet templates that are available to developers (SEPA Rating Curve and Flow Duration Curve Templates). These spreadsheets allow a stage discharge relationship to be derived for short term data and a FDC to be established. It should be noted that the templates do not constitute legal or professional advice and SEPA does not accept any liability for actions arising from their use, including but not limited to, any business decisions based on flow data derived from them. Copies are available on request by contacting SEPA at: advice@sepa.org.uk

To collect flow data the developer should establish a temporary flow gauging station at the site of interest. A data logger is used to record water level at 15 minute intervals. This is converted to flows through a rating curve derived for the site from a number of calibration gaugings across the range of levels recorded. SEPA stipulates that a minimum of twelve calibration gaugings across an appropriate range of flows should be used to define a rating curve. Any flow data received which does not meet the criteria outlined below will not be accepted for a new application or an application to vary an existing licence.

1. The period of monitoring must be a minimum of 12 months and continuous.

2. There must be a minimum of 15 spot gaugings carried out over the monitoring period in line with British Standards.
3. Multiple spot gaugings carried out on a single day will only count towards the total as one gauging.
4. If a split rating is required then the above rule applies to each rating.
5. The gaugings must cover an evenly distributed range of flows from Q95 to Q20.
6. There must be at least **three** spot gaugings carried out at flows of Q90 and below.

Further details on measuring river flows can be found in the following document:

'WAT-SG-54: Water Resource Technical Guidance to Flow Measurement'

SEPA will require developers to submit details of the calibration gaugings completed and how these were used to derive the rating curve; SEPA recommends the use of their stage-discharge template for deriving a rating if appropriate hydrometric software is not available to the developer.

SEPA will then expect developers to produce a FDC using the flow data collected.

SEPA's FDC template can be used to derive a long term flow duration curve by either the 'rescaling' or 'matching pairs' methods. Both the 'rescaling' or 'matching pairs' approaches link local flow data to the flow duration curve at a neighbouring gauging station (known as the analogue gauging station) with a long-term flow data set. Analogue flow data can be supplied free of charge by SEPA. These methods are summarised below:

1. Matching pairs

> Assign the mean daily flow percentiles from the analogue catchment to the mean daily flows for the site of interest. Each daily record in effect becomes equivalent to a 'spot gauging' assessment. A regression is plotted through the data points (usually by using a log-normal transformation) to give the flow duration curve.

2. Rescaling

> Short record FDCs are constructed for both the site of interest and the analogue catchment. The ratio of the long to short FDC flows are calculated for each percentile point for the analogue catchment and resultant ratios are used to rescale the corresponding short record FDC flows for the site of interest.

It is accepted that there will always be a certain level of uncertainty with either method. In normal circumstances SEPA would advise the use of the average of the matching pairs and rescaling values.

Further information on the 'Matching Pairs' and 'Rescaling methods' can be found in the following publication:

Malcolm, C.E.L., Young, A.R., Willmott, E.R., Holmes, M.G.R., and Gosling, R.D. 'Can we give up gauging? A comparison of statistical certainty of gauged and modelled flows.'

http://www.sepa.org.uk/library/library-search.aspx?q=statistical%20uncertainty

SEPA will review the data collected and the FDC generated. Where there are discrepancies that cannot be accounted for SEPA will discuss with the developer which approach is more robust and whether more data needs to be collected.

SEPA recommend that advice on hydrological data requirements should be sought at the pre-application stage. This may include advising on the amount of supporting information required, together with technical advice about how to collect and analyse the data in order to provide a flow duration curve using the methods described above. This will include advice on

naturalisation where there are impacts from abstractions, impoundments and/or discharges. Note that although influenced flow data can be used by the developer to carry out generation potential calculations, natural flow data will be used to set mitigation flow values and maximum abstraction rate conditions.

Developers can obtain flow data from SEPA's gauging station network, Excel templates and advice on all aspects of flow data requirements by emailing advice@sepa.org.uk in the first instance.

Flow monitoring and subsequent data processing is normally undertaken by a specialist in hydrology. It is not appropriate for SEPA to recommend any particular hydrological consultant. However, directories are given in the websites of the British Hydropower Association, the British Hydrological Society and Scottish Renewables.

Appendix 1 - Flow naturalisation

Background

Any flow data collected in an influenced catchment (i.e. where there are licence level abstraction, impoundment and discharges upstream) the developer would be required to account for this in their data submission. This will involve naturalising the dataset to account for these influences.

This applies regardless of the length of time the influences have been in place and regardless of how the current ecology has adapted to the influenced flows. This reflects the principles of the Water Framework Directive to maintain and recover watercourses to a natural state.

As per SEPA's hydropower Guidance document, developers would be required to carry out the same level of monitoring and data collection. However, the additional step of naturalising the collected data would be required.

Therefore developers must consider catchment influences in their initial site study to tailor their monitoring strategy at an early stage. SEPA can be contacted at the pre-application stage to identify and provide licensed activities within the catchment.

Methodology

There are two methods of calculating naturalised flow data at an influenced location:

Option 1: Monitoring two sites to develop one natural flow dataset and one influenced flow dataset

One gauging station can be set up at the site of interest (i.e. influenced flow). The second gauging station would be set up at a suitable uninfluenced analogue catchment. This can be an adjacent catchment or a nearby tributary if there are not suitable locations in the river in question.

Option 2: Monitoring one site at the influenced location and then naturalised after

If there are numerous or complex CAR activities upstream of site of interest, or where detailed abstraction data are unavailable then this approach can be complicated, potentially less reliable, or unsuitable. This needs to be taken into consideration prior to data collection and consult SEPA hydrology if in doubt.

Existing influenced gauging stations

The same method can be applied where local data are available at an existing gauging station provided the data can be suitably naturalised. This will involve reviewing whether influences have changed over the gauging record.

<u>SEPA review</u>

SEPA hydrology will review the submitted data and assess the proposed flow naturalisation. If the approach is deemed unsuitable then where possible revisions to the method may be advised. If revisions are not possible and the data are unsuitable, the local data should not be used and a Low Flow estimate would be required.