Qube Report Q969/24

February 2024

Flow Estimate for Meece Brook at NGR: 383700, 332850

Ayesa

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For and on behalf of Wallingford HydroSolutions Ltd.

Client	Ayesa
Prepared by	Joseph Bentley
Approved by Position	Sam Pucknell *Senior Consultant*
Invoice value	£195 (excl. VAT)

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1 Introduction

This report presents the annual and monthly flow statistics for the site(s) requested using the WHS Qube water resource modelling system. The site location(s) have been confirmed using a digital map and copies of the correspondence are contained within Annex 1.

Qube is the online evolution of the LowFlows Enterprise water resource modelling system to move beyond the estimation of natural and influenced flow statistics. Qube enables the seamless modelling of both flow statistics and time series anywhere in the UK and Ireland.

Developed by WHS in partnership with the Environment Agency, Qube is used as a best practice tool for the estimation of flows in ungauged catchments by the Environment Agency, Natural Resources Wales, Scottish Environment Protection Agency, Northern Ireland Environment Agency, Environmental Protection Agency and the UK water industry.

The Qube underpinning science has been widely published in the scientific literature.

Section 2 presents the methods for the derivation of catchment characteristics and the annual and monthly flow estimates. Following the results for each site, Sections 4 and 5 present the assumptions and uncertainties within the flow estimates, followed by the consideration for use in section 6 and the warranty and liability in section 7.

WHS is committed to continuously improving company performance and customer satisfaction. We are proud of our ISO9001 quality certification and ISO14001 environmental management certification for the provision of environmental consultancy services, development of hydrological software and associated training. For further information on all of our services and software, please visit our website www.hydrosolutions.co.uk.

2 Derivation of the Qube Flows Results

The flow statistic estimates contained in this report have been produced by Qube using models and relationships that relate these flow statistics to the climatic and hydrological characteristics of the catchment of interest. Qube is the evolution of LowFlows Enterprise[1]. All flow statistics provided in this report are for natural flows, thus do not contain any artificial influences such as abstractions, discharges or impounding reservoirs.

The following catchment characteristics and flow statistics are provided:

- Catchment Area: The catchment boundary may be derived using either a Digital Terrain Model (DTM) to determine the topographic boundaries of the catchment or imported by the user.
- Annual Mean Flow (MF): The estimation of Mean Flow is based on a 1km grid of long term average annual runoff for the given period of record (POR). The POR runoff grids were modelled using the CERF rainfall runoff model and calibrated to the UK Centre for Ecology and Hydrology 1961-1990 runoff grid (an output of a deterministic water balance model using observed data from over 500 gauged catchments[2]).
- Mean Monthly Flows (MMF): The MMF for each month are derived from the natural MF estimate by distributing the total average flow volume for the year between the months of this year. This distribution is based upon observed data from hydrologically similar gauged catchments.
- Annual Flow Duration Curve (FDC) statistics: The flow duration curve statistics are estimated using a procedure based on measured flow data from hydrologically similar gauged catchments. The methodology was initially developed in 2002[3] and has been subsequently further refined. Where nested local data gauges (LDG) are available, the FDC is improved using naturalised gauged FDCs for the given period of record.
- Mean Monthly Flow Duration Curves (MFDC): The MFDC for each month is estimated using gauged MFDCs from hydrologically and climatologically similar catchments and the estimate of MMF for that month. Where LDG have been used, the MFDC's are adjusted using the LDG improved annual FDC.
- Base-Flow Index (BFI): The proportion of a hydrograph occurring as base flow, hence varying between zero and unity. BFI is indicative of catchment permeability with values approaching unity associated with highly permeable systems. BFI is estimated from a revised form of the BFIHOST multivariate linear regression equation[4].

If these long term natural flow statistics were calculated directly from a gauged flow record the annual statistics would be equivalent to those calculated using all of the daily flow data from all years of record and the monthly statistics for a month equivalent to those calculated from the gauged data for that month from all years.

[1] Young A. R., Grew R. and Holmes M.G.R. 2003. Low Flows 2000: A national water resources assessment and decision support. Water Science and Technology, 48 (10).
[2] Holmes, M.G.R., Young, A.R., Gustard, A.G. and Grew, R. 2002. A new approach to estimating Mean Flow in the United Kingdom. Hydrology and Earth System Sciences. 6(4) 709-720.
[3] Holmes, M.G.R., Young, A.R., Gustard, A.G. and Grew, R. 2002. A Region of Influence approach to predicting Flow Duration Curves within ungauged catchments. Hydrology and Earth System Sciences. 6(4) 721-731.
[4] Boorman, D.B., Hollis, J.M. and Lilly, A. 1994. Hydrology of Soil Types: a Hydrologically-based Classification of the Soils of the United Kingdom. IH Report 126.

3 Flow Results for Meece Brook at NGR: 383700, 332850

3.1 Catchment Characteristics

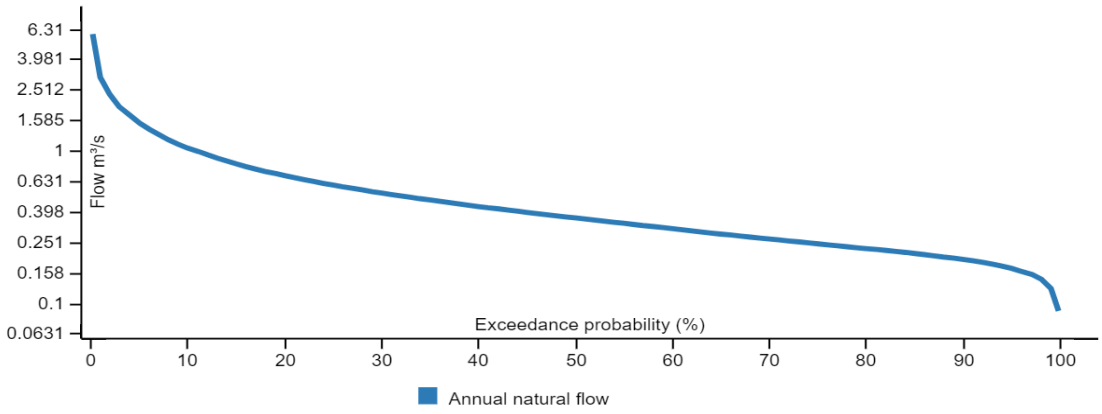
The catchment characteristics and map for this catchment are presented in the table and figure below. The catchment is underlain by bedrock consisting largely of mudstones, sandstones, and conglomerates. Superficial deposits of alluvium, till, glaciofluvial deposits and river terrace deposits are also present within the catchment.

Catchment name	Catchment at 383700,332850	Catchment area	56.38 km²
Location	383700, 332850	Hydrometric area	28

Catchment Boundary Map (Contains Ordnance Survey data © Crown copyright and database right 2024)

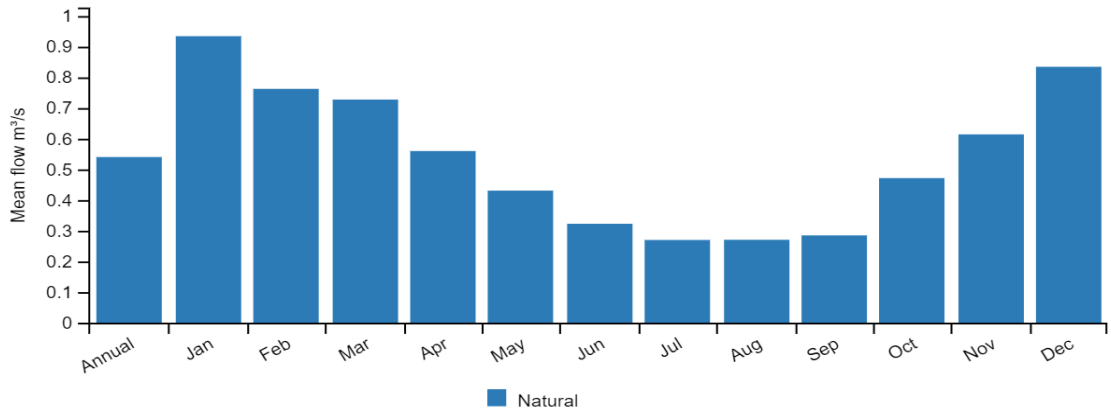
3.2 Long Term Flow Statistics

Period of record	Full period of record	Runoff (Period of record)	301.3 mm
BFIHOST	0.635		



Annual Flow Duration Curve

Flow Estimate Q969/24



Annual and Monthly Mean Flow

Annual Flow Duration Curve Statistics (m³/s)

Percentile	Natural Flow
5	1.508
10	1.04
20	0.684
30	0.526
40	0.429
50	0.361
60	0.307
70	0.263
80	0.227
90	0.193
95	0.169
99	0.124

Annual and Monthly Mean Flows (m³/s)

	Natural Flow
Annual	0.539
January	0.932
February	0.76
March	0.725
April	0.558
May	0.43
June	0.322
July	0.269
August	0.27
September	0.284
October	0.47
November	0.612
December	0.832

Region of Influence Stations

Reference number	Weight (%)	Q95 % MF
54041	23.4	40.45
45003	19.7	27.56
45005	19.3	29.71
52003	19	24.4
101002	18.6	32.62

Local Data Gauges - On

Gauge	Location	Area km²	MF m³/s	Q95 m³/s
No local data gauges.				

Lake Adjustment - Off

No lakes were found in the catchment area.

Natural Monthly Flow Duration Curve Statistics (m^3/s)

Percentile	January	February	March	April	May	June
5	2.269	1.836	1.603	1.178	0.845	0.583
10	1.738	1.406	1.255	0.895	0.644	0.467
20	1.223	0.975	0.927	0.661	0.504	0.373
30	0.962	0.753	0.744	0.552	0.435	0.33
40	0.788	0.624	0.638	0.488	0.391	0.298
50	0.673	0.541	0.565	0.439	0.359	0.275
60	0.581	0.478	0.502	0.404	0.33	0.255
70	0.505	0.414	0.445	0.37	0.305	0.236
80	0.423	0.357	0.387	0.34	0.277	0.216
90	0.337	0.295	0.322	0.293	0.245	0.185
95	0.271	0.25	0.277	0.244	0.221	0.158
99	0.225	0.204	0.234	0.197	0.167	0.124

Percentile	July	August	September	October	November	December
5	0.421	0.454	0.566	1.272	1.619	2.063
10	0.356	0.36	0.396	0.866	1.164	1.559
20	0.303	0.296	0.3	0.559	0.793	1.087
30	0.273	0.266	0.259	0.426	0.612	0.842
40	0.252	0.247	0.238	0.343	0.487	0.681
50	0.234	0.231	0.222	0.286	0.407	0.57
60	0.217	0.215	0.209	0.249	0.345	0.482
70	0.201	0.197	0.195	0.223	0.295	0.41
80	0.185	0.179	0.18	0.205	0.25	0.351
90	0.161	0.155	0.16	0.186	0.21	0.286
95	0.139	0.131	0.146	0.169	0.192	0.251
99	0.111	0.105	0.116	0.149	0.169	0.204

4 Assumptions

Assumptions implicit in the estimated flow estimates are:

- Only natural flow statistics have been estimated and the impact of any artificial influences (for example abstractions, discharges or impounding reservoirs) is not included.
- The topographic catchment area identified is assumed to accurately reflect the true catchment area contributing to flows at the catchment outlet.
- The flow estimates are based on long term average records.

5 Model Uncertainty

The figures for factorial standard error of estimate for long term mean flow and Q95 are shown in the below table. So, as an example the uncertainty in the estimate of mean flow in Scotland will generally be less than 11%. These standard errors are presented as a general guide only and should be considered in the context of the information presented within section 6. These errors are broadly comparable to the sampling errors that might be expected if mean flow was calculated from two to three years of error free gauged data and Q95 for in the order of five years error free gauged data.

If these estimates are to be used for high value decision making we would recommend that the estimates are corroborated through appropriate local flow measurement. For advice on flow measurement please contact us at info@hydrosolutions.co.uk.

Model Factorial Standard Error (FSE)

Regions of the UK	FSE Mean Flow	FSE Q95
England and Wales	16	42
Scotland	11	35
Northern Ireland	11	30

6 Consideration for Use

The predictive performance of the Mean Flow and FDC Estimation Models may vary according to local conditions. The following is a list of significant, but not comprehensive, issues that need to be considered when estimating flows within ungauged catchments:

- Care needs to be taken when interpreting the results in smaller groundwater catchments in which river flows may be strongly influenced by point geological controls (such as spring lines and swallow holes).
- A catchment water balance is assumed, which may be incorrect in smaller groundwater fed catchments where part of the regional groundwater flow bypasses the surface water catchment.
- The estimation of Mean Flow is based on a 1km grid of long term average annual runoff, derived using the CERF rainfall runoff model and calibrated using the outputs from a deterministic water balance model using observed data from over 500 gauged catchments. The predictive performance of the model may therefore be reduced in areas of low rainfall gauge density.
- Care needs to be taken when interpreting the result in very small catchments as the size of the catchment approached the spatial resolution of the underlying catchment characteristic datasets

(1 km²). For very small catchments it is recommended that the topographic contributing catchment is confirmed by a site walkover to identify any unmapped features that might modify the catchment area.

- Where available local measured flow data should be used to corroborate the flow estimates, which is good practice when using any generalised hydrological model.

7 Warranty and Liability

1. The assumptions and uncertainties associated with the flow estimation methods must be considered when making use of flow estimates produced by the system.
2. You are responsible for the interpretation of the Results presented within this report and training in the use of the estimation methods is strongly recommended.
3. Subject to 1 and 2 above, WHS do not seek to limit or exclude liability for personal injury or death arising from our negligence.
4. Except for 3 above our entire liability for any breach of our duties, whether or not attributable to our negligence, is limited to the fee that you have paid for this report.
5. Except for 3 and 4 above, in no event will WHS be liable to you for any damages, including lost profits, lost savings or other incidental or consequential damages arising on your use of the results even if we have been advised of the possibility of such damages.
6. Should any of these provisions be ruled invalid under any law or Act of Parliament, they shall be deemed modified or omitted only to the extent necessary to render them valid and the remainder of these provisions shall be upheld.

Annex 1: Copies of key correspondence with the client

On Tue, 27 Feb 2024 at 08:56, Kathryn Wright <KathrynWright@ayesa.com> wrote:

Hi,

Please use PO 143237 for these works.

Kind regards

Kathryn

From: LowFlows <lowflows@hydrosolutions.co.uk>
Sent: Monday, February 26, 2024 11:37 AM
To: Kathryn Wright <KathrynWright@ayesa.com>
Subject: Re: Meece Brook Low Flows Report [Filed 26 Feb 2024 14:43]

Hi Kathryn,

Thanks for your email, I can advise that a flow estimate here will cost £195 +VAT at 20%. As an existing customer WHS will require either a formal PO number or formal go ahead in advance before commencing the works.

If you wish to make payment of our invoice by credit, debit or AMEX cards, please can you confirm and I can arrange for our accounts team to provide you with a 'PAY NOW' invoice which has an embedded link to the secure Sage Pay portal. Alternatively, payment can be made via BACS by your accounts team: By BACS Account- Wallingford Hydrosolutions Ltd Sort Code- 40-34-27 Account- 52177145

Once go ahead is received we will begin progressing the report and will look to deliver the report within 10 working days.

Kind Regards,

Qube Estimation Service

On Mon, 26 Feb 2024 at 10:46, Kathryn Wright <KathrynWright@ayesa.com> wrote:

Hello,

Please could you provide me with a price and timescale for providing a flow estimate report for the Meece Brook at National Grid Reference SJ 83706 32818 (postcode: ST21 6LX), near Swynnerton Training Camp.

See pictures below.

Kind regards

Kathryn