H1 DISCHARGE ASSESSMENT FOR GARWNANT FOREST HOLIDAY PARK LICENCE VARIATION

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1.0 INTRODUCTION

This section provides an introduction and background information for the project, the site, the proposed development and associated foul water system together with details of the adopted assessment methodology, regulator consultation and conditions which govern the use of this report.

1.1 Project Briefing

Forest Holidays are in the process of developing a new holiday centre in the Garwnant Forest, South Wales which given its remote location cannot be connected to a main sewer. Consequently, an off-grid strategy had been pursued for the park's general waste water which entailed the use of a pack treatment system and then discharge of effluent into the Taf Fawr river. This discharge was subject to an earlier H1 assessment and permitting process which led to NRW issuing licence EPR/BB3091CE on 31 October 2018.

However Forest Holidays have, following extensive consultation with Welsh Water and NRW, now reappraised the waste water treatment strategy which is now to be amended given the following reasons-

- The standards associated with licence EPR/BB3091CE for Phosphorus were considered difficult to achieve consistently by Forest Holidays wastewater team specialists, thus there was a concern of not being able to meet the licence requirements. This was against the backdrop of constructive consultation with Welsh Water, which indicated that a treated effluent discharge upstream of the reservoir was not desirable.
- The holiday park includes hot tubs, which for hygiene purposes make use of a Bromide sterilising agent. Weekly, these tubs are emptied, and the water treated to neutralise remaining free Bromide. Originally Forest Holidays had intended to then pass this water through the main treatment system via a balancing tank. However, during the licence determination process for EPR/BB3091CE Welsh Water (who operate the Llwyn-on reservoir downstream of the discharge point) indicated that Bromide agent may react during the drinking water chlorination process and therefore the hot tub effluent could not form part of the treated effluent discharge upstream of the reservoir. Consequently, a separate groundwater soakaway system was investigated for the hot tub water.
- Designing a soakaway field was deemed infeasible for several reasons: Infiltration tests indicated the site had a low permeability rate and hence a large soakaway field would be required. This would cause problems with tree removal and subsequent landscape and visual challenges in a National Park. Consultations with NRW also indicated that the area was subject to geological protection measures thus disrupting a large area of glacial deposits may not be acceptable to the National Park authority. In addition, NRW's geoscience team raised a number of concerns regarding the site suitability for a groundwater soakaway system and potential impact on groundwater.

Given the above a new strategy was developed in which the general and hot tub waste waters would be co-treated (following Bromide neutralisation) and disposed of via the same route at a point immediately downstream of the Llwyn-on dam. Although this strategy would significantly increase the cost of discharge piping, given the long pipe run required, the cost benefits of not requiring two fully separate treatment systems would partly offset this. Additionally as the point is downstream of the reservoir issues regarding bromide during the treatment process would be removed as would concerns raised by Welsh Water regarding additional nutrient inputs into the reservoirs. The original licence had also made use of highly conservative estimates of river flows which in part led to stringent levels being required; as the new location is downstream of a long term NRW gauging station more realistic estimates of flows could be used which in turn led to less conservative standards which may be more consistently achieved.

Detailed discussions have taken place between Forest Holidays and Welsh Water regarding the new proposals and it is reported that the new strategy has been agreed (including the provisional granting of a wayleave for the discharge pipe over Welsh Water land). The strategy has also been discussed with Terry Gulliford of NRW. Feedback from this exercise indicated that the outline approach may be provisionally acceptable, but would be suitable subject to a detailed H1 assessment and permitting process followed by an application for a variation to licence EPR/BB3091CE. Given this Bluengineering (BE) were retained by Forest Holidays to undertake an updated H1 assessment and permitting.

It should be noted that as this work is an update of an existing licence, full details of the early assessments and supporting work are not repeated here.

A staged approach was followed by BE for the updated H1 assessment process. This first entailed undertaking a review of the screening assessment which considered various disposal routes. During the assessment process for the original licence consultation with Welsh Water (see Appendix 1 of BE's Effluent Disposal Initial Options Appraisal For Garwnant Forest Holiday Park, December 2016, Version 2) showed that the only local connection point would be at Llwyn-on, but the treatment plant serving this community was already at capacity and could not accommodate the development. Given this, together with the distance required for the connection (4km), the geographical constraints along the route and land ownership complications, it was concluded that connection to mains sewers was not a valid option.

Given that this original consultation with Welsh water is now dated, Forest holidays undertook an updated consultation which confirmed the original feedback was still valid. It should be noted that although a pipeline run of similar length will be required for this variation, significant disproportionate costs were still required to upgrade the local treatment system at Llwyn-on; consequently, it is still considered more cost effective to have an on-site treatment system and remote discharge point.

The original supporting studies work also showed the site was unsuitable for soakaway disposal given the low permeability of the ground. Watercourses close to the site were also found to be unsuitable given minor flows which would give rise to insufficient dilution. Finally, the report identified the nearby Taf Fawr river as the most likely suitable disposal point given the river's high flow rates and therefore ability to dilute discharges. This work is detailed in the accompanying Effluent Disposal Options Appraisal Report and should be referred to for background information.

Given current information available, the selection of the Taf Fawr river is still considered to be the most suitable disposal point, but given the points raised above, it is now proposed to reposition the discharge location downstream of the Llwyn-on dam.

In order to support the licence and amendment application to reflect the changed discharge location (and the addition of the hot tub effluent), updated H1 modelling has been undertaken to establish clean-up standards for the treated effluent to avoid water quality deterioration within the Taf Fawr. This work is presented in this report together with an appraisal of whether such clean-up standards can be practically/ financially achieved. As the work is for regulatory purposes it has been written in a technical manner and assumes an understanding of the associated technical issues and regulatory guidance.

It should be noted that BE's work primarily focuses on disposal of treated effluent/ waste water arising from foul drainage. Therefore surface (rain water) drainage has not been covered in this report.

1.2 Site Briefing

The site is located within the Garwnant Forest and is a Natural Resource Wales (formerly Welsh Forestry Commission) site. The address is-

Garwnant Forest Visitor Centre
Llwynon
Merthyr Tydfil
CF48 2HU

However, as the Garwnant Forest covers a large area, the grid reference SO 001 141 should be used to identify the location as opposed to the address.

A location plan is given in Appendix 1. The site is primarily a commercial woodland of coniferous trees.

1.3 Outline Development, Treatment & Discharge Proposals

Forest Holidays indicated that a maximum of 40 self-catering holiday chalets would be constructed together with 3 staff cabins and a small coffee shop/ reception centre. The majority of the chalets would also have hot tubs.

It is proposed that a 'foul water only' drainage network would be installed to convey waste water from the chalets and coffee shop to an on-site self-contained treatment system. The specification of the system was dependent on the outcome of the clean-up targets modelled in this report and detailed design will be developed by the installers/manufacturers. However, the system is likely to take the form of a 3 stage Klargester unit.

Waste water from the hot tubs would also pass through the main treatment system. However as hot tubs are treated with a Bromide compound (to sterilise the water during use), the waste water from the tubs requires dosing with Sodium Thiosulphate to neutralise any residual free Bromide to protect functional bacteria within the treatment system and also to prevent wider environmental impacts from effluent discharges. Additionally, as the hot tub discharges would significantly increase the peak loading on the treatment system, buffering is also required in the form of a balancing tank. Consequently, it is proposed to have a balancing tank which would also be used for Sodium Thiosulphate dosing which would gradually release the hot tub waters into the treatment system across the week. Further details of the hot tub management and water disposal strategy are given in Appendix 2.

No rainfall run-off would pass through the foul drainage network or through the foul water treatment system.

Given the above the effluent type is considered to be sanitary which would be discharged at a constant rate without the mixing of surface water drainage.

Discharge would be to the Taf Fawr river (WFD ref Afon *Taf Fawr - source to confluence Taf Fechan, no GB109057033170*) as shown on the site layout plan in Appendix 1 at grid reference SO 01210 11075. Linking the outfall point of the treatment system and the discharge point would be an underground pipe.

1.4 Adopted H1 Guidance & Assessment Methodology

A review of NRW's online permitting and consultations (see 1.5) showed that the Horizontal Environmental Risk Assessment Framework: Annex D [Ref T-3] should be used as a general guide, with Annex D2 [Ref T-4] being used for specific methods of risk assessment and modelling. As the proposal is for a new discharge to a fresh surface water river, will have a constant controlled flow, is classified as sanitary waste and is not a combined system (thus not needing storm overflow), the overall methodology set out on page 6 of Annex D2 was adopted. The Environment Agency's River Quality Planner (RQP) software was used to calculate effluent clean-up targets with Appendix A of Annex D2 being used for guidance.

The original licence had been subject to in-house modelling work by NRW in order to support the first application (see Appendix 3). As a review by BE determined that a number of the input parameters adopted (such as background river quality and standards) would also be applicable to the licence version and would be adopted in order to ensure consistency with values already accepted by NRW.

The remainder of RQP modelling input parameters were gathered in line with guidelines from Annex D2.

It should be noted that as discussed in Annex D2, as the waste water is classed as sanitary a assessment screening process does not need to be followed and the assessment can be advanced to the calculation of clean-up targets as shown in this report. The next stage in the process involved establishing if other more stringent guidelines stemming from the Urban Waste Water Treatment Regulations (UWWT) [Ref T-20] would apply. However as the discharge serves an agglomeration of less than 2,000 persons and [Ref 21] shows the receiving watercourse is not classed as sensitive (in the context of the UWWT Regulations only), this stage has been omitted.

The final stage was to consider the technical viability of the clean-up targets and to make recommendations for a treatment system which would be required to meet them.

1.5 Regulatory Consultations

As part of establishing the viability of the amended drainage strategy Forest Holidays have consulted with Sarah Jones of NRW directly. As discussed in section 1.1, BE have also consulted with Terry Gulliford of NRW regarding the approach to be used for licensing and input parameters for the updated H1 modelling. Consultation has also take place between Forest Holidays and Welsh Water to establish the outline viability of the new strategy and to address wayleave issues. As part of this work Forest Holidays also re-consulted with Welsh Water regarding the viability of using the public water treatment works near the Llwyn-on dam given the new proposal for the extended discharge pipe would be close to this location. However the treatment works is at capacity and the cost of upgrading would be disproportionate and unviable.

1.6 Terms & Conditions of Report Use

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2.0 INPUT PARAMETERS & MODELLING

This section sets out the input parameters and settings used in the calculation of the effluent clean-up targets with the RQP software. The inputs were established based on values previously used by NRW's in-house modelling in relation to the original licence (see Appendix 3), consultations with NRW and guidelines from Annex D2.

2.1 Determinants to be Assessed

Effluent clean-up target values where calculated for-

Ammonia
BOD (Biological Oxygen Demand)
Phosphorus
Bromide (and its compounds)

Ammonia, BOD and Phosphorus were used as they are common sewerage effluent indicators used by regulators as indicated in Annex D2 and WFD targets/monitoring data is available. These indicators were also used and accepted in the original licence.

Bromide has been added given the change in strategy to co-disposal of the hot tub effluent with the standard waste water from the development. Bromide is present in the form of (BCDMH) and is used as a sterilising agent in the hot tubs. As discussed in Appendix 2, any surplus Bromide with be neutralised with Sodium Thiosulphate. The majority of the Bromide will take the form of compounds produced by reactions within the hot tubs or non-reactive stable forms following reactions with Sodium Thiosulphate; therefore little free Bromide would be present. However as limited data is available for such compounds, limits will be set for total Bromide.

A clean-up target was not calculated for suspended solids given the following guidelines in [Ref O-11]-

For discharges from waste water treatment plants, the required control of suspended solids is likely to be met automatically by the action for biochemical oxygen demand and ammonia. In other cases an annual mean of 25 mg/l of suspended solids is used as a check or guideline for use in calculating controls on more or less continuous discharges of suspended solids to waters.

The environment agencies use the Guideline Standard of 25 mg/l to help set controls on discharges of inorganic material from quarries, opencast coal sites, and mines. This will continue.

2.2 Effluent Flow Rate

Forest Holidays indicated that a maximum of 40 holiday chalets may be constructed together with 3 staff cabins with an expectation of near 100% occupancy. From this a daily discharge rate of 66.6m^3 was calculated based on a total of 208 guest spaces and 3 live-in staff, all producing 47.897m^3/day of foul water in accordance with data from British Water's Loads and Flows 4 [Ref T-9] which assumes 227L/day per guest for such developments. The development will also include a coffee shop and reception/recreation centre which on average Forest Holidays expects 60 customers / servings a day (the chalets are self-catering and the client reports low use on other sites of such facilities) which would result in 900L/day of effluent when using [Ref T-9] value of 15L/ servings for snack and bar meal type catering. Some 15 staff may be on-site during normal working hours which gives 1,350L/day based on [Ref T-9] value of 90L/day.

The majority of chalets will also have hot tubs, giving a total of 38 tubes. 50% will be drained down and washed on a Monday and the remaining 50% on a Friday, with each tub producing 1,500L. As the tubs will use a Bromide compound (BCDMH) to sterilise the water during use, the waste water from the tubs will require dosing with Sodium Thiosulphate to neutralise any free Bromide to protect functional bacteria within the treatment system and also to prevent wider environmental impacts from effluent discharges. Additionally, as the hot tub discharges would significantly increase the peak loading on the treatment system, buffering is also required in the form of a balancing tank. Consequently, it is proposed to have a balancing tank which would also be used for Sodium Thiosulphate dosing which would gradually release the hot tub waters into the treatment system across the week. This release would occur after neutralisation had taken place and the waters allowed to cool to ambient temperatures. Further details of

the hot tub management and water disposal strategy are given in Appendix 2. In total, the hot tubs will produce 57m^3/week which equates to a daily discharge of 8.14m^3/day.

The combined daily flow from chalets, staff and coffee shop is 50.147m^3/day. This increases to 58.287 m^3/day with average hot tub discharges of 0.675L/s.

In the previous application the total volume excluding hot tub flows was used (given separate disposal via a soakaway was proposed), consequently the use of the 0.675L/s is one of the main variations of the licence.

For modelling purposes the same approach as used by NRW's in-house modelling was adopted in which the 0.675L/s value was treated as a maximum and Monte Carlo calculations used to give a mean and standard deviation.

A summary table for the above discussed figures is given below.

Source	Unit type	No of units	Flow/Unit /day	Total daily flow in L/day	Flow in L/s
Chalets	guests & live in staff	211	227	47897	0.554
Staff	day staff	15	90	1350	0.016
Coffee shop	servings	60	15	900	0.010
Hot tubs	tubs	38	1,500*	8,140#	0.094
Total	NA	NA	NA	58287	0.675

*weekly flow, # adjusted daily flow to take into account slow release through balancing tank

2.3 Effluent Mass Loading Rates & Type

As the RQP software is used in 'backwards' mode to establish clean-up targets, total mass or concentrations of contaminants are not required for the modelling process. However such information is useful for comparing pre-treated concentrations with clean-up targets to aid in the design of the system and establishing if such a system would be technically feasible.

To calculate the pre-treated concentration the volumes for each class of foul water source was considered separately with contamination load values taken from [Ref T-9]. These values were multiplied to give a total daily rate. The values were then summed to give total concentrations.

Given the nature of the hot tubs, negligible amounts of Ammonia, BOD and Phosphorus were assumed. However, data from hot tub maintenance specialist (see Appendix 2) indicate that each tub would yield approximately 0.0066kg or 6,600mg of Bromide, the majority of which would be converted into stable low reactive states by the neutralisation process.

Additionally, Dalton Drainage (the project specialist wastewater contractors) conducted analysis on wastewater from an operational holiday centre. This holiday centre also had hot tubs treated in a similar manner and analysis was conducted on hot tub water which had been subject neutralisation treatment and added to general pre-treated effluent; this gave a concentration of 2.1mg/L of bromide. Following passage through the treatment system the combined, hot tub and general effluent had a concentration of bromide of below detectable limit which was 1mg/L. See Appendix 2 for details.

	Loading per unit in g/day	Loading in mg/L	Daily mean flow	Daily mass of contaminant in g
Chalets				
Ammonia	10	44.05	47897	2110
BOD	94	414.10	47897	19834
Phosphorus*	NA	NA	47897	NA
Bromide	0	0.00	47897	0
Staff				
Ammonia	5	55.56	1350	75
BOD	38	422.22	1350	570
Phosphorus*	NA	0.00	1350	0
Bromide	0	0.00	1350	0
Coffee shop				
Ammonia	2.5	166.67	900	150
BOD	19	1266.67	900	1140
Phosphorus*	NA	NA	900	NA
Bromide	0	0.00	900	0

Hot tubs				
Ammonia	0	0.00	8,140	0
BOD	0	0.00	8,140	0
Phosphorus*	NA	NA	8,140	NA
Bromide	6	4.00	8,140	32.56
Totals				
Ammonia		40.06	58287	2335
BOD		369.62	58287	21544
Phosphorus*		0.00	58287	0
Bromide		0.56	58287	32.6

*[Ref T-9] does not provide loading factors for Phosphorus

2.4 Upstream Water Quality

Ammonia- The values used by NRW in the original modelling work were deemed to be appropriate and were adopted. This approach was agreed in pre application consultations between NRW and BE. For use in RQP this equates to a mean of 0.02 mg/L and a standard deviation of 0.01.

BOD- Again the values used by NRW in the original modelling work were deemed to be appropriate and were adopted. For use in RQP this equates to a mean of 1.14 mg/L and a standard deviation of 0.41.

Phosphorus – Again the values used by NRW in the original modelling work were deemed to be appropriate and were adopted. For use in RQP this equates to a mean of 0.02 mg/L and a standard deviation of 0.02.

Bromide – This compounded is not monitored for WFD purposes and a data review found no information on common UK background levels in rivers. Given this, background concentrations were assumed to be at a mean value of 0.0045 mg/L, which equates to 90% of the EQS value used as the target as discussed below. Again this approach was agreed in pre-application consultations between BE and NRW.

2.5 Downstream Target Standards

Guidelines in Annex D2 limit the deterioration for each contaminant to 10% of the mean upstream quantity. Furthermore, the deterioration must not lead to a change, or deterioration, in a WFD standard for the waterbody or prevent future targets being met.

Therefore information from 2.4 was primarily used with a 10% adjustment. However, a check was also conducted against WFD standards to ensure compliance.

A check of the targets used by in-house NRW modelling found these values to be compatible with this approach and were therefore adopted. It is noted that the discharge point is within the same WFD water body and therefore the same targets apply.

As Bromide and its compounds are not directly addressed by the WFD standards a review took place to identify appropriate standards.

Ammonia- A comparison of the mean current concentration to the current and target standard shows that a maximum 10% deviation can occur without affecting the WFD standards. Therefore the 0.04mg/L value was adopted (as a 90% percentile).

BOD- Water quality data for BOD (as used by NRW, see 2.4) gives a mean concentration of 1.14 mg/L. When adding a 10% increase this rises to 1.22mg/L.

A comparison of the mean current concentration to the current and target standard shows that a maximum 10% deviation can occur without affecting the WFD standards. Therefore the 1.25mg/L value was adopted.

Phosphorus - A comparison of the mean current concentration to the current and target standard shows that a maximum 10% deviation can occur without affecting the WFD standards. Therefore the 0.022mg/L value was adopted (as a mean).

3.0 RESULTS & INTERPRETATION

Determent	RQP clean-up target required mg/L (mean value)	Tec likelihood of achieving standard?	Is standard suitable?	Adopted standard in mg/L (mean value)
Ammonia	9.85	Normal	Yes	**9.0**
BOD	191.44	High	No	**10**
Phosphorus	3.06	Low	No	**4**
Bromide	0.88	NA	No	1

The above table gives a comparison of values calculated in RQP to pre-treated values based on [Ref T-9] as presented in 2.3. The likelihood of technically achieving the standards was based on BE experience of self-contained treatment systems and consultation with the developers appointed water treatment specialists.

The resulting standard for Ammonia was considered to be in keeping with the normally achieved outputs of private treatment systems and the standard was also comparable to those agreed with regulators for similar size developments and river types. Therefore, the RQP value was recommended for adoption, with the only adjustment being the rounding down of the number to give a whole significant figure.

The result for BOD was relatively high compared to the values normally permitted by regulators and is significantly within the results normally obtained by private treatment systems. Additionally, the value is significantly above those commonly required by an urban waste water treatment regulations which typically leads to values of 10-25 mg/L. Consequently BE recommend that a value of 10 mg/L is used.

For Phosphorus, an assessment of technical likelihood was based primarily on technical advice from the water treatment specialists who indicated that levels below 2.5- 3mg/L for non-utility treatment works would be technically difficult at a small-scale site. Furthermore, treating to such a level would be financially unsustainable. Therefore, a higher value was recommended which the treatment specialists considered plausible to consistently achieve at a realistic cost. Supporting information is provided in Appendix 5.

As discussed in Appendix 2, Bromide would be primarily treated by chemical dosing in order to transform it into a stable non-reactive form. It should also be noted that the bromide target is based on a worst case EQS value with regards to environmental toxicology and does not take into account that the majority of recorded Bromide would be in a stable non-reactive form. Given this, the standard has been rounded up to 1mg/L , partly to offset the conservative nature of its basis. Additionally, this value reflects the minimal detectable limit normally available for routine commercial analysis.

Bromide – As WFD standards are not available for Bromide a literature review was undertaken to find appropriate values. This identified the EA's R&D Technical Report P74 report [Ref T-50] which gave a provisional UK EQS values maximum allowable value of 0.005 mg/L for total Bromide and its compounds. The value was based on toxicology data for hypobromous acid which was used as a surrogate given the available data and the high degree of harm the compound can cause to the natural environment, thus this is a conservative choice.

As discussed in 2.4, no background data was available for Bromide. Therefore it has been assumed that current levels are at 90% of the EQS in order to allow only a 10% decrease in assumed quality.

This approach was agreed with NRW during the pre-application process.

2.6 River Flows

A NRW/EA gauging station (no 57002) was identified on the CEH web site [Ref I-11] which is immediately upstream of the proposed discharge point. Daily mean flow data from the reservoir's spillway was downloaded and processed into a flow duration curve.

This gave an average flow or Q mean of 1104 L/s. In low flow conditions (Q95), the flow is 173 L/s. It is noted that the station does not record high flows which may bypass the gauging station via the dam's main spillway; therefore mean flows may be an underestimate and are therefore a conservative value. The location of the station does allow water storage and upstream abstraction to be taken into account without the need for estimates as required for the original application.

The use of the station's flow values is a major variation compared to the original application given that the discharge location has moved downstream.

2.7 Contaminant Concentration in Discharge

The model requires a concentration of the contaminant which is used as a seed value only. However, in order to further aid in the interpretation of the results and if appropriate support cost effectiveness assessments, values were sourced from the developer's treatment systems specialists. These values were considered to be normal lower range targets which could be achievable by private treatment systems.

Analysis information from a Forest Holidays site suggests bromide is 'lost' during the waste water treatment process. A review suggests this may be partly accredited to losses to the atmosphere of any free reagent. However, as there is only limited data on this aspect and it is unclear if seasonal variation would limit losses to atmosphere, it has been assumed that concentrations would remain the same through the treatment process.

2.8 Running the RQP Model

The mass balance calculation option was run for each of the determinands individually. In order to calculate required discharge standards, the model was run in backwards mode using the input parameters as discussed above. As discussed in 2.7 the model was also run in forwards mode in order to forecast effects on downstream river quality from clean-up targets normally achieved by such treatment systems.

Output sheets which contain all input parameters together with modelling results are given in Appendix 4.

4.0 CONCLUSIONS & RECOMMENDATIONS

A H1 assessment has been conducted in order to set discharge limits for key indicators for a proposed private sewerage treatment facility to support the Garwnant holiday park development. The work is to support a version of the existing licence EPR/BB3091CE which has been issued but not yet implemented.

The original licence was on the basis of hot tub effluent being disposed of separately via a soakaway system and other waste water to the Taf Fawr upstream of the Llwyn-on reservoir. However a new strategy was developed in which all effluent was disposed of to the Taf Fawr, but downstream of the Llwyn-on reservoir in order to reduce nutrient loading in the reservoir whilst avoiding the potential risk of bromide reacting during the drinking water process.

The initial stages of the assessment which normally consider disposal routes to less sensitive environmental receptors such as main sewers and groundwater soakaways was conducted in a separate report (*Effluent Disposal Options Appraisal Report, Bluengineering December 2016*) associated with the original licence application. This showed that the only technically viable option for this development was a discharged to the Taf Fawr river. Recent consultations with Welsh Water have also reconfirmed that a link to the public sewer network would not be feasible given the cost of upgrading the local works.

The H1 assessment work is detailed within this report and resulted in the discharge quality values being calculated using the RQP software for the standards effluent indicators of Ammonia, BOD and Phosphorus. As the development would include a number of hot tubs, Bromide which would be used as a sterilising agent was also assessed.

The next stage was to assess if the RQP values were likely to be technically feasible based on consultations with the developer's water treatment systems specialists. Finally, an assessment was conducted to establish if the standards were in keeping with those normally adopted by regulators and those required by other legislation.

The process has led to the following mean standards being recommended-

Ammonia	**9.0 mg/L**
BOD	**10.0 mg/L**
Phosphorus	**4.00 mg/L**
Bromides	**1.00 mg/L**

REFERENCES

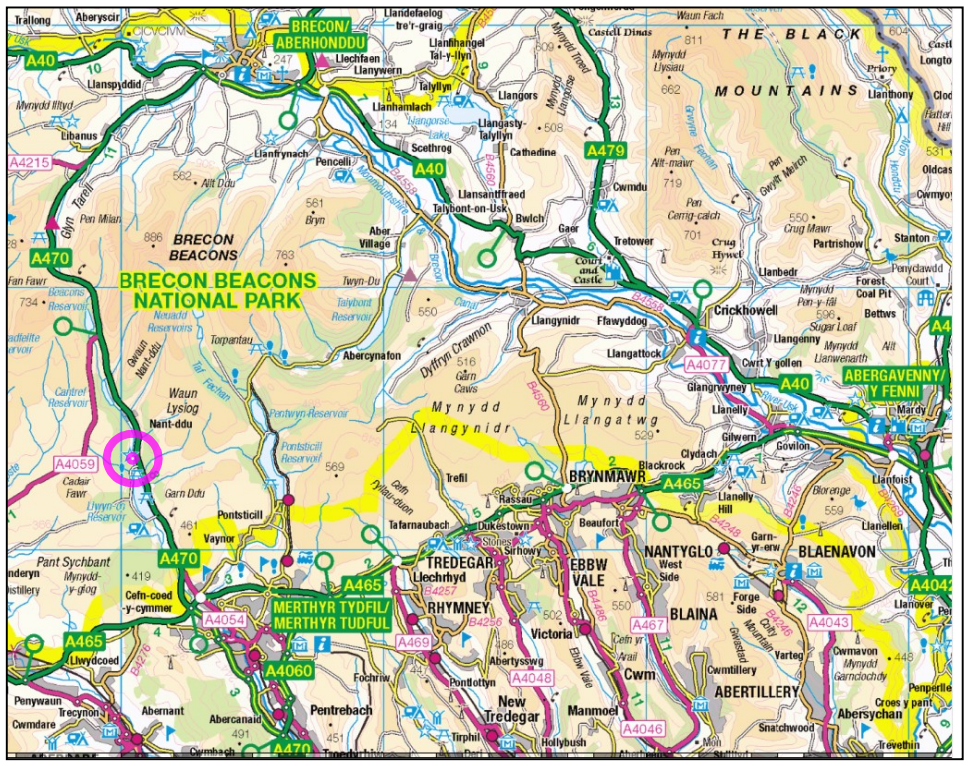
Category	Ref no	Name
A. General Water Resources Licensing Guidance & Policy		Not Required
B. General Planning Guidance & Policy		Not Required
C. General Other Regulatory Guidance & Policy		Not Required
D. General Non-Regulatory Guidance		Not Required
E. Legislation		Not Required
F. General Information, Maps Data & Public Registry	F-9	Catchment Data Explorer web site: http://environment.data.gov.uk/catchment-planning/
G. General Methodologies		Not Required
H. Engineering & Design		Not Required
I. Hydrology	I-2	GreenKenue, Reference Manual, Canadian Hydraulics Centre, National Research Council 2010
	I-11	National River Flow Archive web site: http://www.ceh.ac.uk/data/nrfa/data
J. Ecology		Not Required
K. Fisheries		Not Required
L. Fish Passage & Screening		Not Required
M. Flood		Not Required
N. Geomorphology		Not Required
O. Water Quality & WFD Standards	O-10	UKTAG River Assessment Method, Phosphorus, River Phosphorus Standards, UKTAG
	O-11	UK Environmental Standards & Conditions, Phase 2, UKTAG, March 2008
P. Archaeology & Listed Buildings		Not Required
Q. Construction Phase & H&S		Not Required
R. Financial, Ownership & Legal		Not Required
T. Waste, Contamination & Discharges	T-3	Horizontal guidance H1 - Annex D Basic Surface water discharges, Environment Agency
	T-4	Horizontal guidance H1 - Annex D2, Assessment of sanitary and other pollutants within Surface Water Discharges, Environment Agency
	T-9	Loads and Flows 4, British Water
	T-20	The Urban Waste Water Treatment (England and Wales) Regulations, 1994
	T-21	Waste water treatment in the United Kingdom, DEFRA 2012
Y. Other		Not Required
Z. Project specific		Not Required

APPENDICES

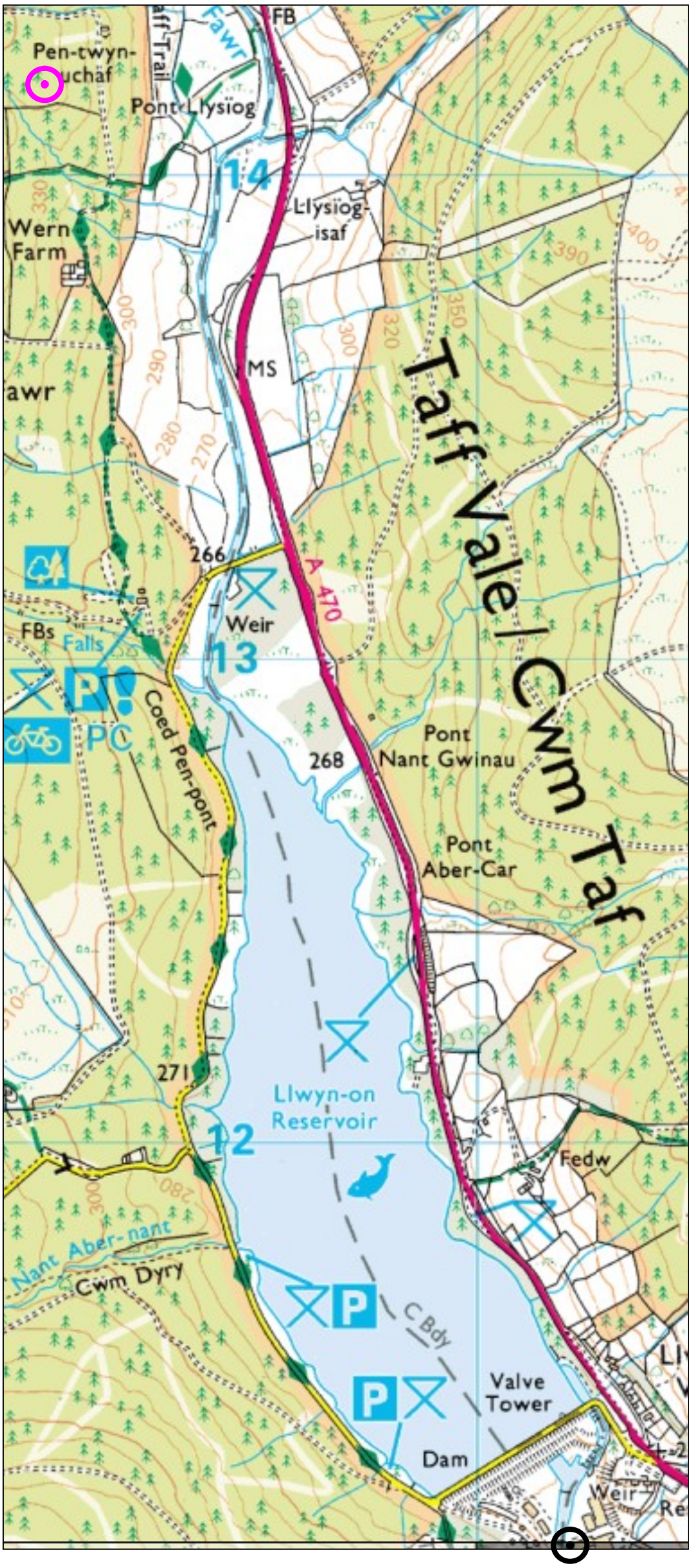
APPENDIX 1

LOCATION PLAN

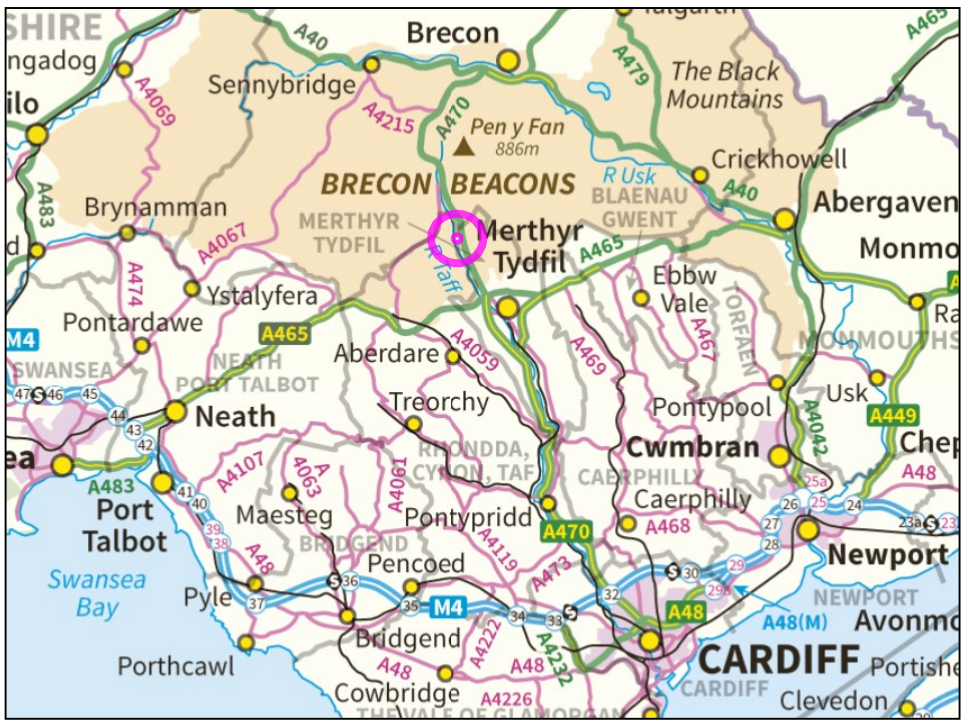
District Map



Local Scale Map 1:10,000



Regional Map



Site Location & Layout Plan for Garwant Forest H1 Discharge

Site Location

Discharge Point

N

Scale @A3
See above

Project Code:	BE15-154
Project Name:	Garwant- H1 v2
Designed By:	E Henshaw of Bluengineering
Date:	27-5-19
Grid Ref:	SO 001 141
Licence:	Local: FindMapping, fnd9995830, Regional: MiniScale, OS OpenData District: 1:250,000, OS OpenData

Bluengineering

APPENDIX 2

HOT TUB SUPPORTING INFORMATION

AECOM
AECOM House
179 Moss Lane
Altrincham
WA15 8FH
United Kingdom
www.aecom.com

+44 (0)161 927 8200 tel
+44 (0)161 927 8299 fax

03 September 2014

Adrian Burn
Concept Town Planning Ltd
Sambrook Hall
Noble Street
Wem
SY4 5DZ

Our Ref: AECOM/080914/bromide

Dear Adrian

Potential Environmental Effects of Bromide release from Hot Tub Discharge.

Forest Holidays will be using Bromine (Bromochloro-5,5-dimethylhydantoin or 'BCDMH') as the primary sanitiser in the proposed hot tubs at the Houghton Forest site. Due to the sensitive location of the site, Concept Town Planning has instructed AECOM to undertake a brief review of the potential environmental effects of the discharge of water from hot tubs direct to the soil, focussing in particular on bromide, which, other than water, will form the main component of the discharge.

It is our understanding that up to 75 hot tubs are proposed at the site. A typical Hot Tub will hold around 1000 litres of water (1 cubic metre) of water and would be treated at a typical active Bromine residual of around 6ppm (6 mg L-1) at a pH of around 7.2. This means that there will be around 6 grammes of Bromine in each hot tub. Even if it is assumed that the hot tubs are to be emptied up to 52 times a year (once a week) the total discharge would be below the threshold of 20m3/day (upper limit of what does not need an Environmental Permit). It is more likely that the hot tubs will be emptied around once every four weeks.

Although BCDMH would be toxic to a range or organisms in its raw form, once dissolved in water BCDMH forms hypobromous acid and hypochlorus acid and, during disinfection, hypobromous acid dissociates into bromide ions. Any hypobromus acid discharged to the soil would be expected to rapidly dissociate into bromide ions.

Bromide and Chloride are frequently used as tracers to study water flow in soils as they do not adsorb to negatively charged particles in the solid phase. Bromide in groundwater is also considered to be relatively conservative (unreactive). There is therefore considered to be little risk of bromide becoming concentrated in soils or the underlying geology.

Flury and Papritz (1993) reviewed a number of bromide toxicity studies for single celled organisms, aquatic invertebrates and aquatic vertebrates. For single celled organisms they reported that the bromide concentrations at which little or no growth reduction was found ranged from 0.1 to 4.6 g Br^- L^{-1}. In invertebrates the concentrations that do not increase the mortality of test animals ranged from 0.078 Br^- L^{-1} in the common house mosquito Culex pipiens to 7.8 g Br^- L^{-1} in water flea Daphnia magna. Bromide has a low acute toxicity in freshwater fish; the lowest LC50 result being reported for rainbow trout at 2.2 g Br^- L^{-1} and the highest reported is for ricefish at 24 g Br^- L^{-1}. Given that the concentrations of bromide in the discharged hot tub water are 0.006 g Br^- L^{-1}it is considered unlikely that the discharge will be toxic to soil organisms, or aquatic organisms in nearby water bodies.

Although the concentration of bromide in the soil is likely to be very small, due to its low adsorption capacity, it can be taken up by plants to an extent that causes phytotoxic effects.

Much of the research on bromide in plants has been undertaken in relation to the use of brominated pesticides and the concentrations of bromide in soil where such pesticides are used is relatively high. Effects on the growth of carrots has been recorded at soil concentrations of 23 g Br^- m^{-3}. No effects on the growth of tomato plants were recorded when bromide was applied at 27-54 g Br-1 m^{-2}.

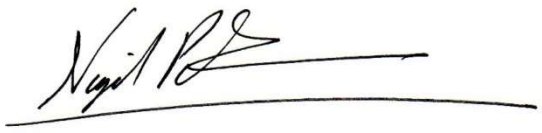
Concentrations of bromide in fresh water typically range from trace amounts to about 0.5 mg/l. Concentrations of bromide in desalinated waters may approach 1 mg/l. There is no UK drinking water standard for bromide; however the World Health Organisation (WHO) standard for a child is 2 mg Br^- L^{-1} and a report from the Drinking Water Inspectorate (DWI) suggests that 3 mg Br^- L^{-1} may be acceptable (http://dwi.defra.gov.uk/about/access-to-info/1539_bromide.pdf). The typical daily dietary intake of bromide in the United States of America is 2–8 mg (Nielsen & Dunn, 2009) from grains, nuts and fish. The average bromide intake from dietary sources in the Netherlands is reported as 8.4–9.4 mg/day (EMEA, 1997). WHO guidance concluded that "*Bromide ion has a low degree of toxicity; thus, bromide is not of toxicological concern in nutrition. Limited findings suggest that bromide may be nutritionally beneficial; for example, insomnia exhibited by some haemodialysis patients has been associated with bromide deficiency*".

Thames Water is reported to have acted to restrict direct trade discharge to a watercourse to 2 mg Br^- L^{-1}.

A discharge of up to 20m3/day (upper limit of what does not need an Environmental Permit) could support up to 89 hot tubs without the water breaching the WHO standard of 2mgBr/l, assuming that background bromide concentration is negligible. This is a reasonable assumption, as bromide occurs in relatively small background concentrations; this being one of the main reasons it is preferred over chloride as a tracer in water transport studies.

In summary, the literature review we have undertaken to date has not identified any circumstances whereby the levels of bromide being discharged from the proposed hot tubs is likely to be toxic to flora or fauna.

Yours sincerely



Nigel Pilkington
Regional Director
M 07540 970024
E nigel.pilkington@aecom.com

References:

Flury and Papritz, 1993. *Bromide in the Natural Environment: Occurrence and Toxicity.* J. Environ. Qual 22:747-758 (1993)

Drinking Water Inspectorate, 2007 *Drinking Water Inspectorate: Summary of Information on Bromide in Drinking Water*

EMEA (1997) Bromide, sodium salt. Summary report. London, European Agency for the Evaluation of Medicinal Products, Committee for Veterinary Medicinal Products.

World Health Organisation (WHO) 2009. *Bromide in Drinking Water: Background document for development of WHO Guidelines for Drinking-water Quality.*

Garwnant hot tub waste water treatment strategy

Background

Forest Holidays cabins are equipped with hot tubs on the outside decking area. They are filled with tap water and heated to a temperature of 38deg C. They are treated with small quantities of Bromide compound (BCDMH) to disinfect the water. The water is changed at a frequency of once a week.

Treatment of hot tub water

There are three main considerations when treating hot tub water –

1. Temperature higher than ambient
2. Residual bromine content
3. Body fats and organics

Proposed method of treatment

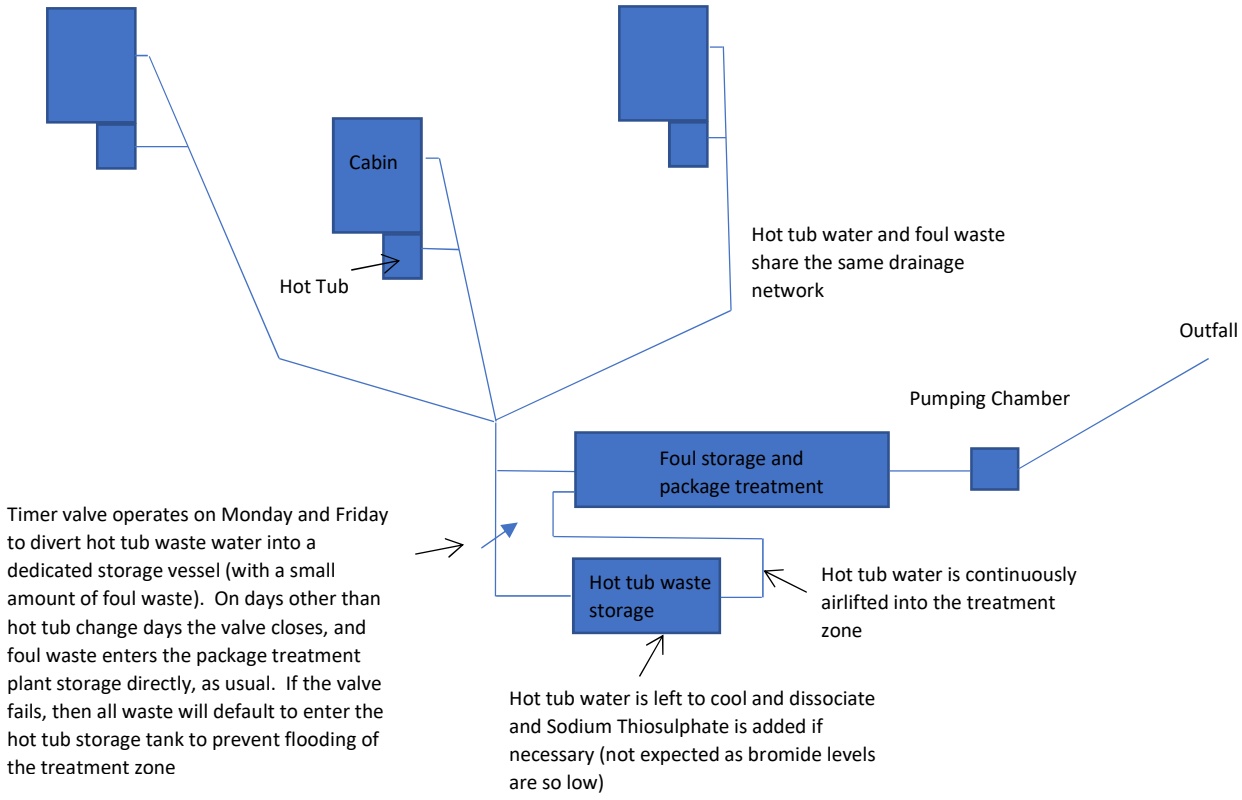
The proposed method of treatment addresses those 3 considerations above. The hot tub water will be stored in a tank to allow the temperature to drop to ambient. This will also allow the Bromide to naturally dissociate. If further neutralisation of Bromide is required, Sodium Thiosulphate can be added. It is proposed to then feed the hot tub water into the foul treatment process.

This has the following advantages –

- The organic matter and any ammonia in the hot tub water are broken down with the treatment process
- The foul waste is diluted to reduce its strength, which helps ensure water is consistently treated to the required standard
- A dedicated drainage system for hot tubs is not required, which reduces the impact on the ground (half the trenching, pipework, pumping stations etc.)
- Allows hot tub water to mix with foul water, which further dissociates Bromide, which should mean Sodium Thiosulphate dosing not required (no chemical storage and handling)
- Tank arrangement provides additional storage if a breakdown occurs

The hot tub water is changed once a week and changeover days are Monday and Friday. This water will be diverted to a dedicated storage vessel. The diversion is carried out by a timer valve. See schematic diagram below. The hot tub water is then allowed to cool and is fed into the treatment zone throughout the week.

Hot tub drainage and treatment schematic



Analytical Report

NWG SCIENTIFIC SERVICES
Northumberland Dock Road, Wallsend, Tyne & Wear, NE28 0QD
Tel: 0191 2968366 Fax: 0191 2968560 www.nwss-labs.co.uk

UKAS TESTING 1181

Customer: Becca Dillon
R A DALTON

Address: Burtree Ford
Cowshill Bishop Auckland
County Durham

Contract Reference: RADALTON-03452
Contract Description: Effluent Analysis
Project Manager: Anthony Moad
Postcode: DL13 1DB

Lab Number: 2140484
Date & Time Taken: 26/07/20 00:00

Sample Name: FOREST HOLIDAYS
Date Received: 28/07/20
Date Started: 28/07/20

Sample Point:
Collected From:

PARAMETER	RESULT	METHOD	SITE
pH	5.3 pH units	H031	HN
BOD (ATU) 5 day	5.2 mg/l	H042	HN
bromide	<1.0 mg/l	H090	HN
ammonium	7.2 mg/l as N	H219	HN
# phosphorus	7.7 mg/l as P	H230	HN

Authorised By: Carol Bidwell
Laboratory Team Leader

Under the authority of
Ian Barnabas
Head of Laboratories and Sampling

This report was compiled by the Customer Department

Date of issue: 11/08/20

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

Results relate only to the items tested and are reported without Uncertainty of Measurement (UOM) applied. UOM data is available upon request.

Tests marked # in this report are accredited within the bounds of UKAS flexible scope of accreditation for this laboratory

Customer provided data is highlighted in grey. Customer provided data may affect validity of results. Samples are analysed and reported 'as received'.

Tests marked HN analysed at Howdon Laboratory, Northumberland Dock Road, Wallsend, Tyne & Wear, NE28 0QD
Tests marked HY analysed at Horsley Laboratory, Horsley, Newcastle upon Tyne, NE15 0PE
Tests marked CD analysed at Chelmsford Laboratory, Middlemead, South Hanningfield, Chelmsford, Essex, CM3 8HS
Tests marked OS analysed On-Site Tests marked SU analysed by subcontractor

Analytical Report

Northumberland Dock Road, Wallsend, Tyne & Wear, NE28 0QD Tel: 0191 2968366 Fax: 0191 2968560 www.nwss-labs.co.uk

1181

Customer: Becca Dillon
R A DALTON

Address: Burtree Ford
Cowshill Bishop Auckland
County Durham

Contract Reference: RADALTON-03452
Contract Description: Effluent Analysis
Project Manager: Anthony Moad

Postcode: DL13 1DB

Lab Number: 2140483
Date & Time Taken: 26/07/20 00:00

Sample Name: FOREST HOLIDAYS
Date Received: 28/07/20
Date Started: 28/07/20

Sample Point:
Collected From:

PARAMETER	RESULT	METHOD	SITE
pH	9.0 pH units	H031	HN
BOD (ATU) 5 day	230 mg/l	H042	HN
bromide	2.1 mg/l	H090	HN
ammonium	200 mg/l as N	H219	HN
# phosphorus	21 mg/l as P	H230	HN

Authorised By: Carol Bidwell
Laboratory Team Leader

Under the authority of
Ian Barnabas
Head of Laboratories and Sampling

This report was compiled by the Customer Department

Date of issue: 06/08/20

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

Results relate only to the items tested and are reported without Uncertainty of Measurement (UOM) applied. UOM data is available upon request.

Tests marked # in this report are accredited within the bounds of UKAS flexible scope of accreditation for this laboratory

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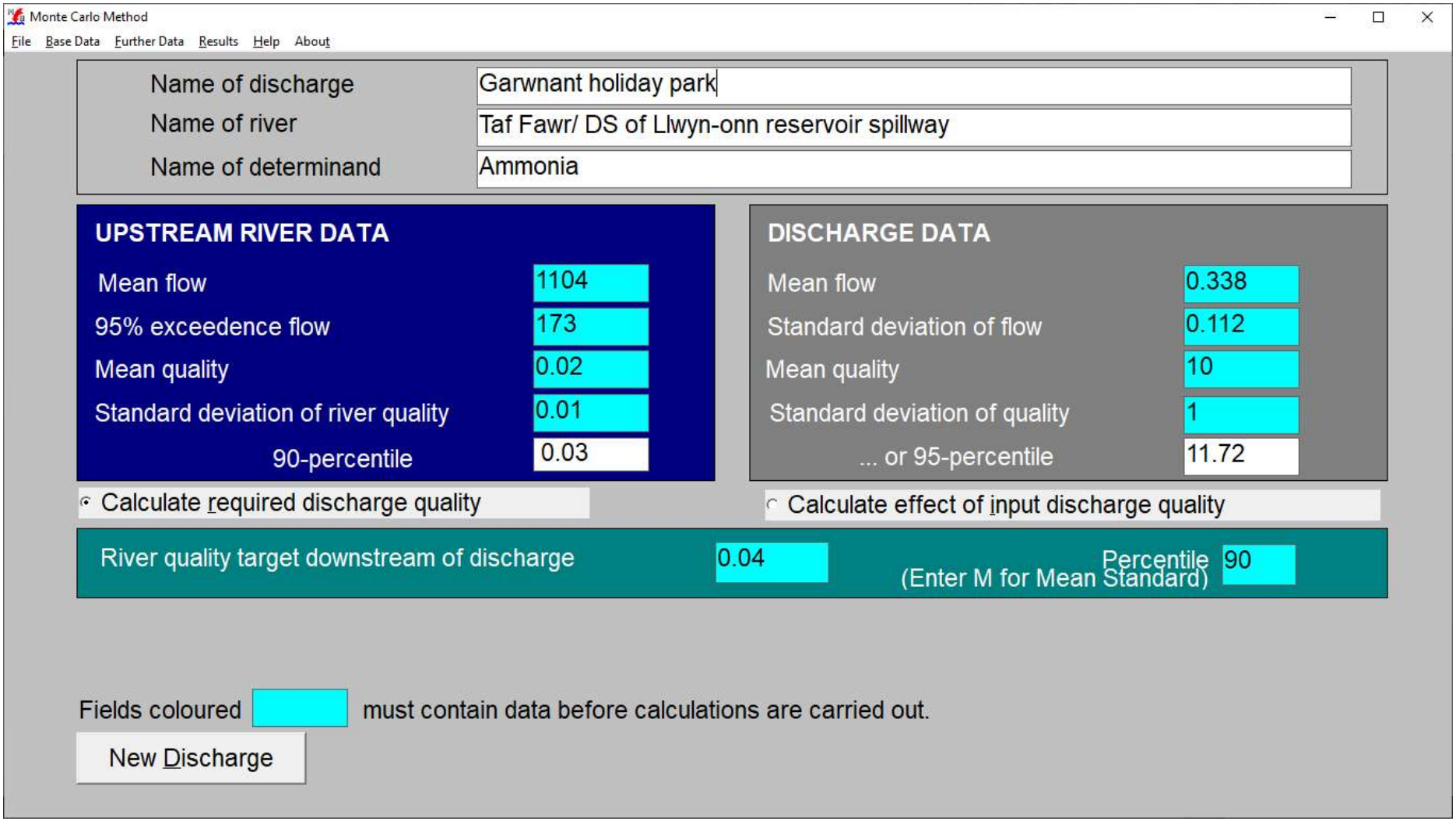
Tests marked CD analysed at Chelmsford Laboratory, Middlemead, South Hanningfield, Chelmsford, Essex, CM3 8HS
Tests marked OS analysed On-Site Tests marked SU analysed by subcontractor

APPENDIX 3

REGULATORY CONSULTATIONS & DATA

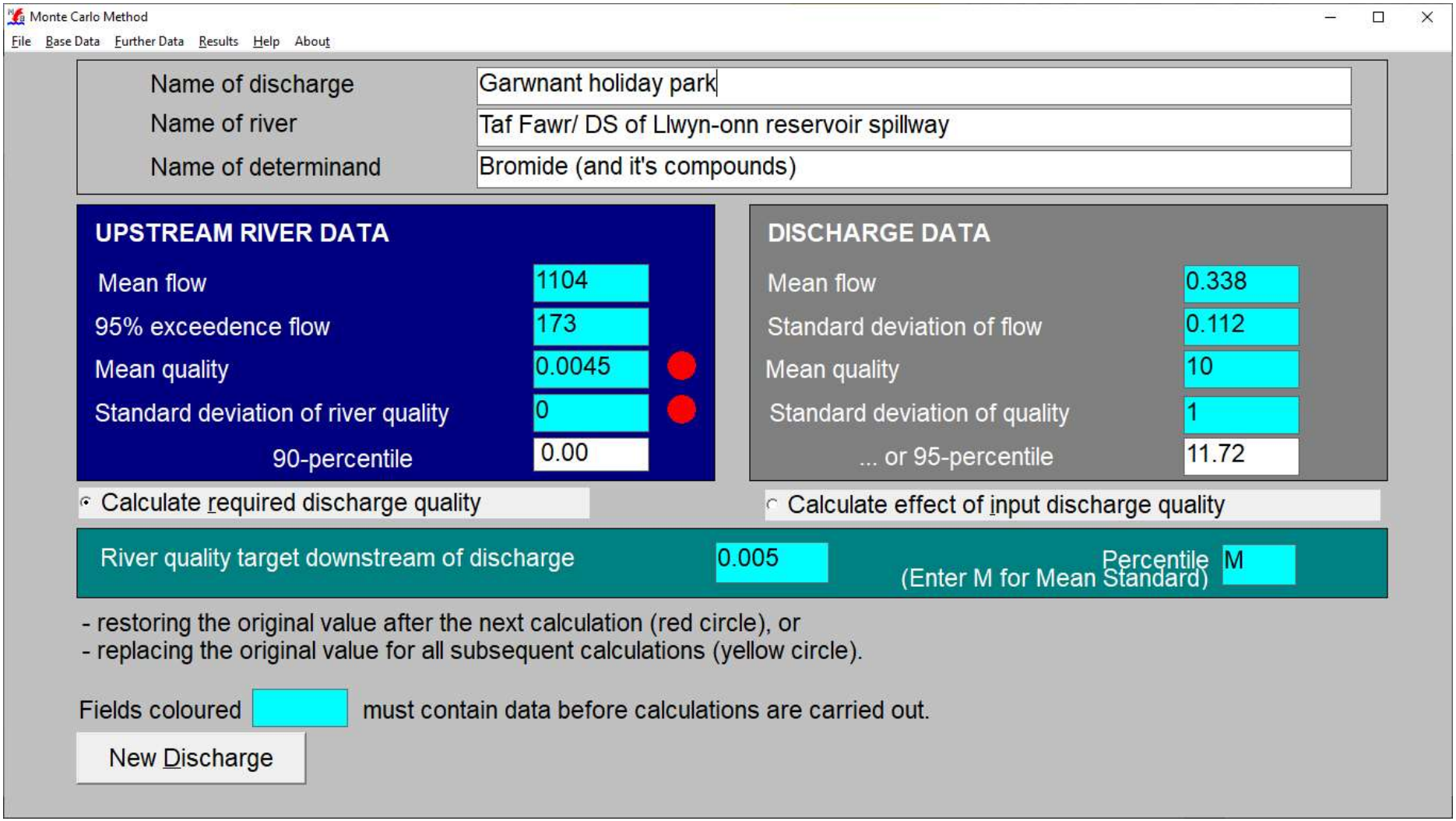
APPENDIX 4

RQP MODELLING OUTPUT SHEETS


Monte Carlo Method
File Base Data Further Data Results Help About
Name of discharge
Garwnant holiday park
Name of river
Taf Fawr/ DS of Llwyn-onn reservoir spillway
Name of determinand
Ammonia
UPSTREAM RIVER DATA
Mean flow
1104
95% exceedence flow
173
Mean quality
0.02
Standard deviation of river quality
0.01
90-percentile
0.03
DISCHARGE DATA
Mean flow
0.338
Standard deviation of flow
0.112
Mean quality
10
Standard deviation of quality
1
... or 95-percentile
11.72
Calculate required discharge quality
Calculate effect of input discharge quality
River quality target downstream of discharge
0.04
Percentile
90
(Enter M for Mean Standard)
Fields coloured
must contain data before calculations are carried out.
New Discharge

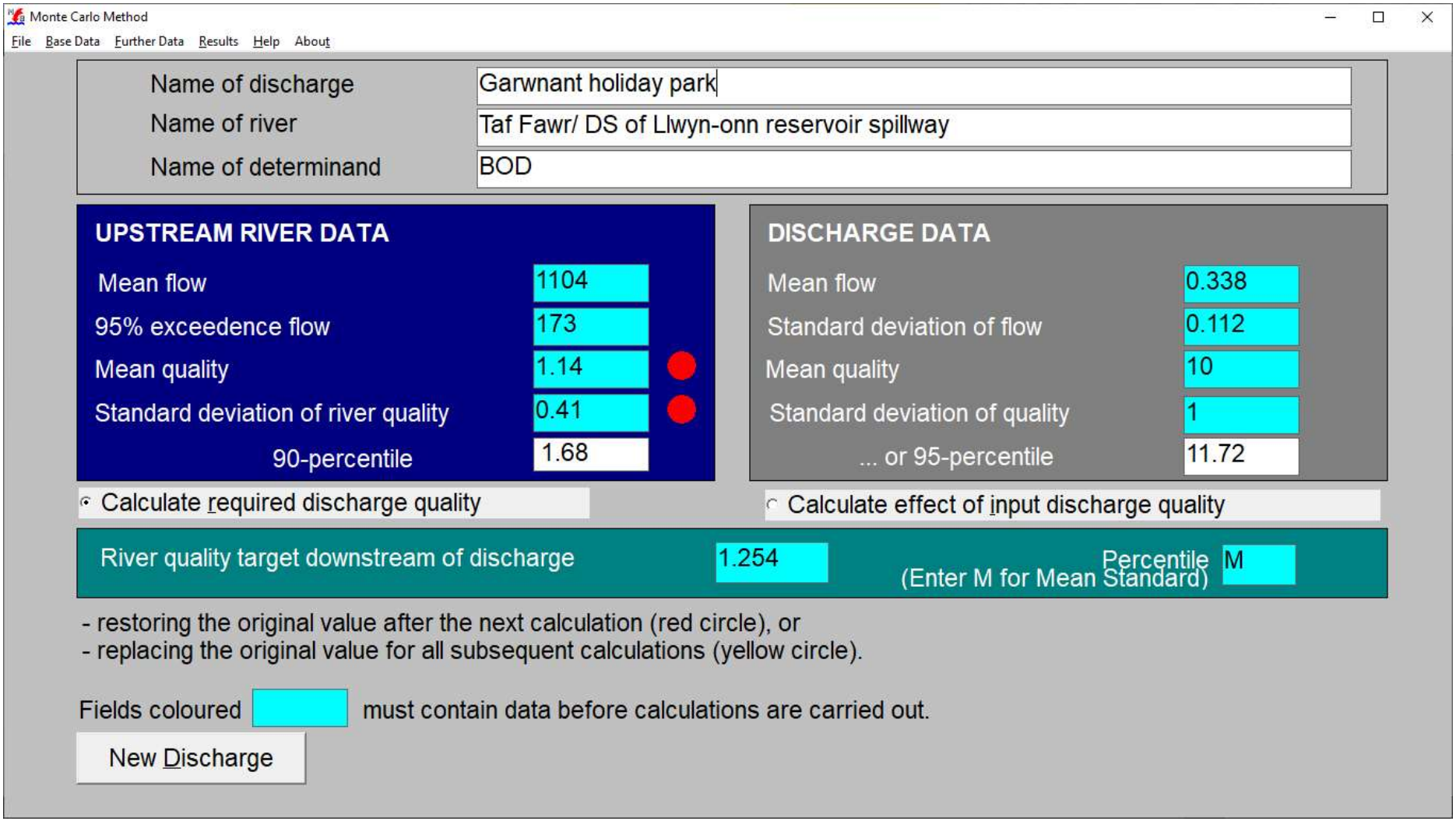
RIVER DOWNSTREAM OF DISCHARGE	
Mean quality	0.03
Standard deviation of quality	0.01
90-percentile quality	0.04
95-percentile quality	0.05
99-percentile quality	0.06
Quality target (90-percentile)	0.04

DISCHARGE QUALITY NEEDED	
Mean quality	9.85
Standard deviation of quality	0.98
95-percentile quality	11.52
99-percentile quality	12.26
99.5-percentile quality	12.47


Monte Carlo Method
File Base Data Further Data Results Help About
Name of discharge
Garwnant holiday park
Name of river
Taf Fawr/ DS of Llwyn-onn reservoir spillway
Name of determinand
Bromide (and it's compounds)
UPSTREAM RIVER DATA
Mean flow
1104
95% exceedence flow
173
Mean quality
0.0045
Standard deviation of river quality
0
90-percentile
0.00
DISCHARGE DATA
Mean flow
0.338
Standard deviation of flow
0.112
Mean quality
10
Standard deviation of quality
1
... or 95-percentile
11.72
Calculate required discharge quality
Calculate effect of input discharge quality
River quality target downstream of discharge
0.005
Percentile
(Enter M for Mean Standard)
M
- restoring the original value after the next calculation (red circle), or
- replacing the original value for all subsequent calculations (yellow circle).
Fields coloured
must contain data before calculations are carried out.
New Discharge

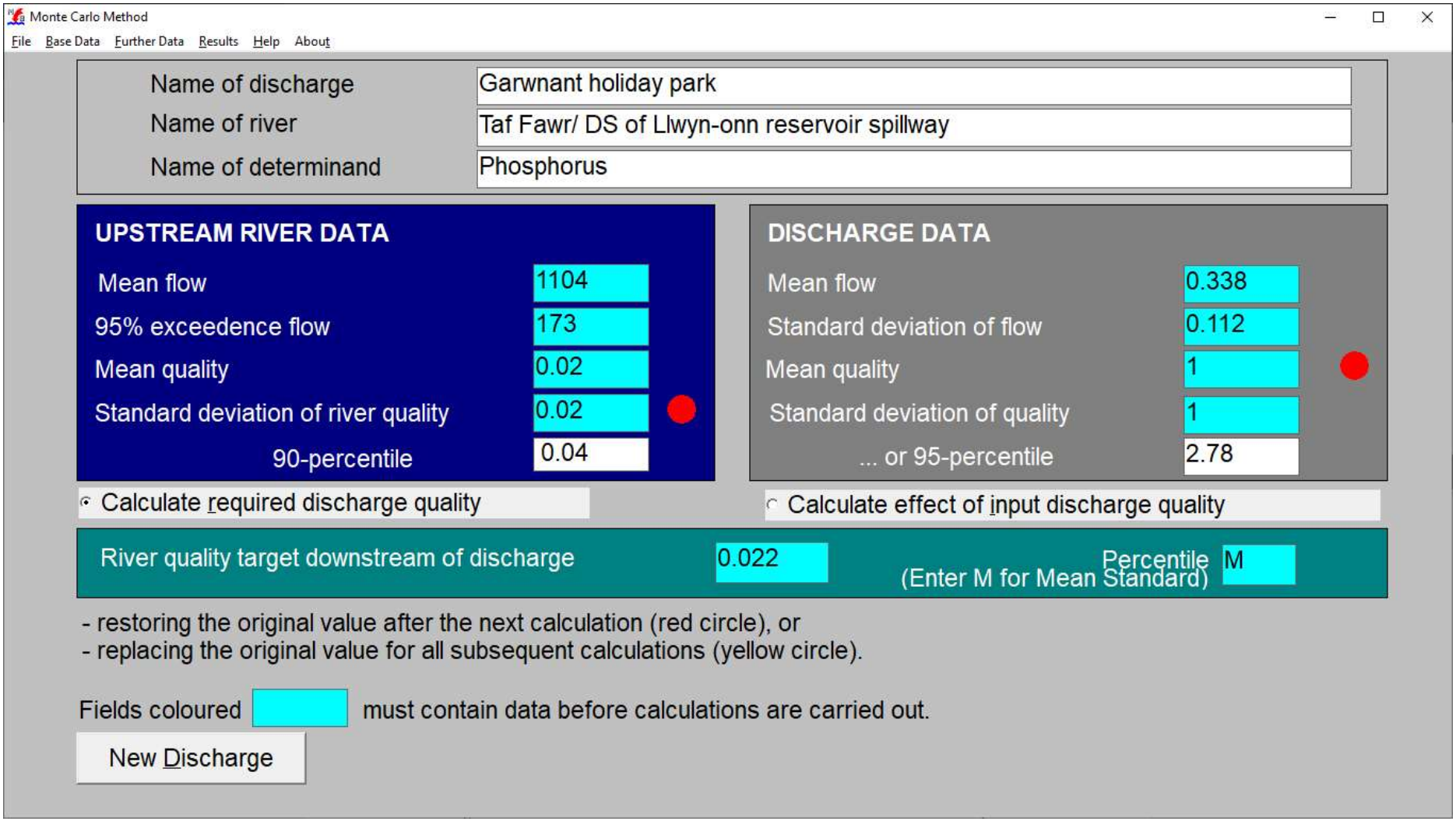
RIVER DOWNSTREAM OF DISCHARGE	
Mean quality	0.01
Standard deviation of quality	0.00
90-percentile quality	0.01
95-percentile quality	0.01
99-percentile quality	0.01
Quality target (Mean)	0.01

DISCHARGE QUALITY NEEDED	
Mean quality	0.88
Standard deviation of quality	0.09
95-percentile quality	1.03
99-percentile quality	1.09
99.5-percentile quality	1.11


Monte Carlo Method
File Base Data Further Data Results Help About
Name of discharge
Garwnant holiday park
Name of river
Taf Fawr/ DS of Llwyn-onn reservoir spillway
Name of determinand
BOD
UPSTREAM RIVER DATA
Mean flow
1104
95% exceedence flow
173
Mean quality
1.14
Standard deviation of river quality
0.41
90-percentile
1.68
DISCHARGE DATA
Mean flow
0.338
Standard deviation of flow
0.112
Mean quality
10
Standard deviation of quality
1
... or 95-percentile
11.72
Calculate required discharge quality
Calculate effect of input discharge quality
River quality target downstream of discharge
1.254
Percentile
(Enter M for Mean Standard)
M
- restoring the original value after the next calculation (red circle), or
- replacing the original value for all subsequent calculations (yellow circle).
Fields coloured
must contain data before calculations are carried out.
New Discharge

RIVER DOWNSTREAM OF DISCHARGE	
Mean quality	1.25
Standard deviation of quality	0.42
90-percentile quality	1.80
95-percentile quality	1.99
99-percentile quality	2.57
Quality target (Mean)	1.25

DISCHARGE QUALITY NEEDED	
Mean quality	191.44
Standard deviation of quality	19.00
95-percentile quality	223.86
99-percentile quality	238.25
99.5-percentile quality	242.31


Monte Carlo Method
File Base Data Further Data Results Help About
Name of discharge
Garwnant holiday park
Name of river
Taf Fawr/ DS of Llwyn-onn reservoir spillway
Name of determinand
Phosphorus
UPSTREAM RIVER DATA
Mean flow
1104
95% exceedence flow
173
Mean quality
0.02
Standard deviation of river quality
0.02
90-percentile
0.04
DISCHARGE DATA
Mean flow
0.338
Standard deviation of flow
0.112
Mean quality
1
Standard deviation of quality
1
... or 95-percentile
2.78
Calculate required discharge quality
Calculate effect of input discharge quality
River quality target downstream of discharge
0.022
Percentile
(Enter M for Mean Standard)
M
- restoring the original value after the next calculation (red circle), or
- replacing the original value for all subsequent calculations (yellow circle).
Fields coloured
must contain data before calculations are carried out.
New Discharge

RIVER DOWNSTREAM OF DISCHARGE	
Mean quality	0.02
Standard deviation of quality	0.02
90-percentile quality	0.04
95-percentile quality	0.06
99-percentile quality	0.10
Quality target (Mean)	0.02

DISCHARGE QUALITY NEEDED	
Mean quality	3.06
Standard deviation of quality	2.82
95-percentile quality	8.43
99-percentile quality	14.18
99.5-percentile quality	16.33

APPENDIX 5

TREATMENT SYSTEM TECHNICAL & FINANCIAL INFORMATION FROM DALTON DRAINAGE

HEAD OFFICE:
BURTREE FORD
COWSHILL
BISHOP AUCKLAND
CO. DURHAM
DL13 1DB

Office: 01388 537030
Fax: 01388 537022
Email: info@radalton.co.uk
Website: www.radalton.co.uk

13th October 2020

Attn: Richard Palmer and Ed Henshaw

Ref: Forest Holidays – Brecon Project

Dear Richard and Ed,

Please find enclosed a copy of the sample results with reference to the incoming and outgoing effluent on site, we can confirm that following our discussions with the manufacturers of the sewage treatment system they have advised that their equipment can achieve the design standards required for the proposed scheme.

As per the report we have looked at the cost structure with a view to reduce the design criteria of the sewage treatment plant, however a reduction in size of the treatment plant would lead to the phosphorus being in excess of 6 mg/l and above. Therefore, it is our and the manufacturer's recommendations that the plant stays as specified to also comply with the BOD and Ammonia level requirements.

Hope this helps regarding the proposed scheme and if you have any questions or if we can be of any further assistance please don't hesitate to give me a call.

Yours Sincerely,

pp. Becca Dillon

Alistair Dalton

Bluengineering are specialists in **river & water** related surveys, environmental assessments, regulator licensing, engineering design, construction & consultancy. Services include-

- Environmental, river & water assessments including geomorphology, fish and ecology
- Abstraction licence returns & metering
- Flood & hydrology
- River & water licencing, planning applications & flood defence consent
- Design of specialist in-river structures
- River restoration & fish passage
- Catchment land & drainage management
- Abstraction & intake screening
- Discharges & waste water treatment
- Hydropower
- Flow & water quality monitoring
- River & groundwater contamination assessment & remediation
- Planning, costing, managing and undertaking in-river & water works

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