

APPROPRIATE ASSESSMENT OF PREDICTED INCREASE IN DRAWDOWN OF THE WATER LEVELS IN LOUGH GUITANE



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Appendix II	Water Abstraction Order
Appendix III	Hydrological Report
Appendix IV	Char Survey Results

Section 1 Introduction

1.1 Introduction and Terms of Reference

Kerry County Council have abstracted water from the combined sources of Lough Guitane and the Owgariff River since the early 1980s. These are both on the Finow River sub-catchment of the River Flesk on the River Laune / Lough Leane catchment. There is an existing treatment plant which provides a basic level of treatment but requires substantial upgrading. The works involved in the upgrading are the subject of an Environmental Report which has been prepared as part of a procedure to get consent for the development under Part 8 of the Planning and Development Regulations.

The scheme presently operates under the terms of a Water Abstraction Order (WAO) which was issued by the Minister for the Environment in 1979. The upgraded works will continue to operate under the same WAO terms but will treat the abstracted waters to a higher standard than is presently the case. The management regime for abstraction from the two sources will be adjusted to improve security of supply while continuing to satisfy the terms of the WAO.

No increase in the rate of water abstraction is proposed. However, due to climate change effects, combined with more accurate modelling techniques than were available when the WAO was granted in the late 1970s, it is now predicted that there will be a greater drawdown of the surface level of Lough Guitane during drought conditions than was previously anticipated.

Environmental Impact Services has been commissioned by consulting engineers Nicholas O'Dwyer Ltd to prepare this Appropriate Assessment (AA) of the effects of the increased drawdown on the lake's ecology.

1.2 Appropriate Assessment Requirement

AA arises as a provision of the EU Habitats Directive (92/43 EEC). It is an assessment of a proposed project or plan's effects on the conservation objectives of any Natura 2000 site. Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) are Natura 2000 sites. Lough Guitane is part of the Killarney National Park, Macgillicuddy's Reeks and Caragh River SAC/NHA (site code 000365). The development site is immediately adjacent to the SAC but is not itself included in the designated area (see Figure 1.1).

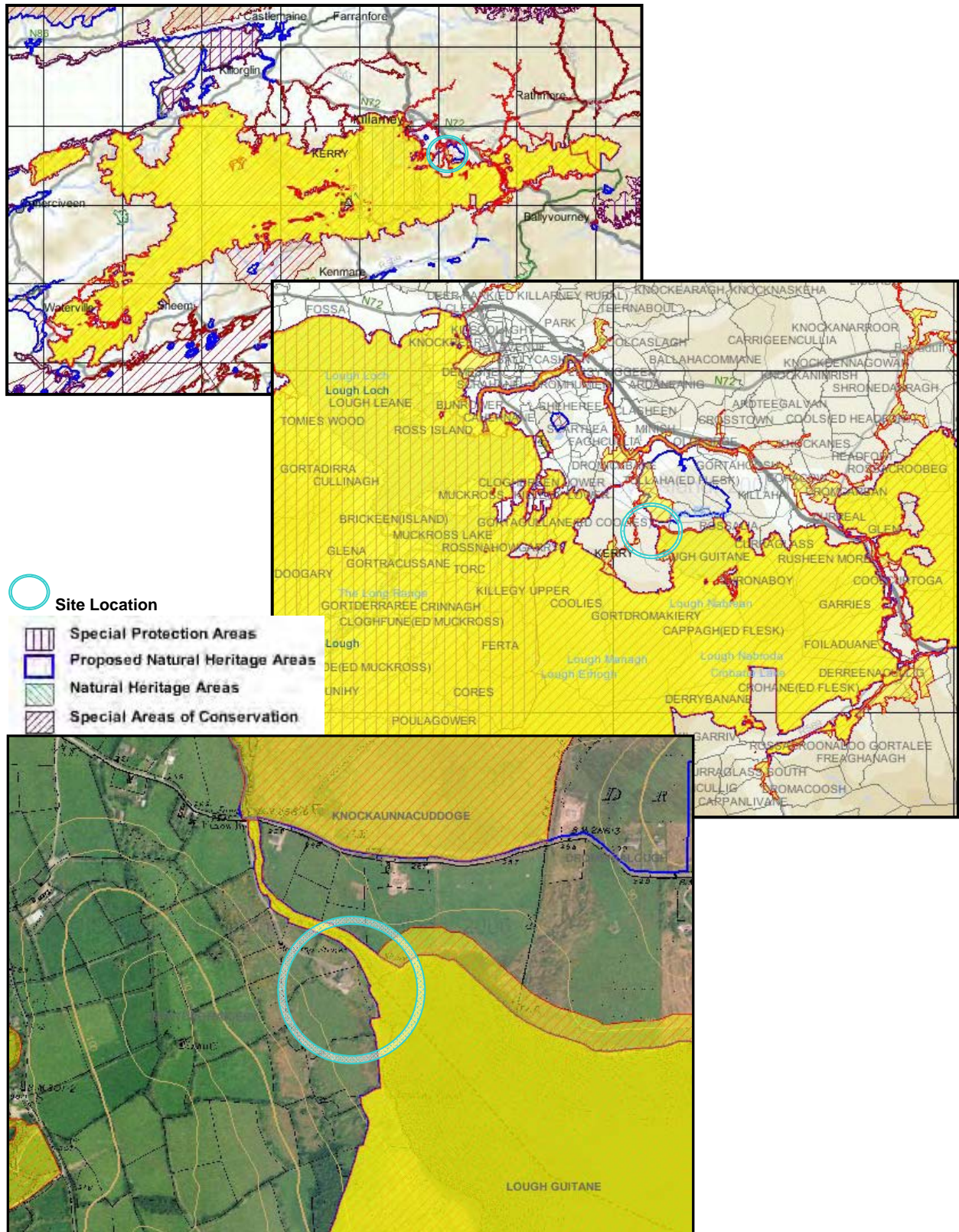


Figure 1.1 Ecological Designations

N.B. The Killarney National Park, Macgillycuddy's Reeks and Caragh River SAC is highlighted in yellow

Article 6(3)¹ of the Directive sets out the formal AA requirements. This provision of the Habitats Directive has not yet been transposed into Irish Law. Circular L8/08 issued by the Water Services Section of the Department of the Environment, Heritage and Local Government (DEHLG) on 2/9/08 draws the attention of local authorities to this provision in the specific context of water services projects. A copy of this circular is included as Appendix I to this report.

The prediction of increased drawdown at Lough Guitane is, as stated above, due to climate change effects combined with more accurate modelling techniques than were available when the WAO was issued. It is not due to the upgrade and expansion of the water treatment plant and abstraction works that is now the subject of a Part 8 consent procedure. Notwithstanding this, Kerry County Council have followed a prudent path and sought legal opinion on the question. This has recommended the preparation of an AA of the effects of the increased drawdown.

1.3 Scoping

Scoping is the process of determining which environmental issues are important during an environmental assessment and which are not. To do this, the statutory authority with responsibility for management of Ireland's Natura 2000 sites, the DEHLG, was consulted. The Department responded with a detailed letter setting out the following scoping requirements.

The table at the end of section 1.4 below shows where each of these requirements is addressed in this report.

¹ Article 6 (3) Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

Article 6 (4) If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.

Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.

The following is recommended for an appropriate assessment of the effects of changes in water levels on the conservation value of Lough Guitane:

- (1) A survey of the affected shores of Lough Guitane for the marsh clubmoss, and for lowland oligotrophic lake and upland oligotrophic lake habitat types, carried out during natural drawdown of water levels in Spring, by a competent, experienced botanist.
- (2) A prediction of the changes in seasonal water level regime, taking into account climate change projections, as a result of the proposed future water abstraction.
- (3) An assessment of the effects of any predicted changes in water levels below the abstraction point on the freshwater pearl mussel, salmon and lamprey populations in the River Finnow.
- (4) An assessment of any effects of predicted changes in lake water levels which might expose barriers to upstream migration by fish species at river mouths on the lake margin, if these are likely to exist;
- (5) An assessment of the effects of changes in water level regime, taking into account projected climatic changes, on the marsh clubmoss, lowland and upland oligotrophic lake habitats, if any of these are found to occur on the margins of Lough Guitane;
- (6) An assessment of any effects of exposure of lake shore to breeding otters;
- (7) A description of mitigation measures for any adverse effects predicted for (2) – (6) above.

The Environmental Officer of the South Western Regional Fisheries Board (SWRFB), Patricia O'Connor, was also consulted through various correspondences, telephone conversations and meetings at Lough Guitane on 24/7/2008 and 22/1/2009. The principal stated concerns of the SWRFB relate to the maintenance of compensation flows in the Owgariff and Finow Rivers and the operation of the fish pass at the outflow from Lough Guitane as well as the potential exposure of barriers on the lake margins to upstream migration of fish (as raised by the DEHLG at point (4) above). The potential fishery effects of the existing practice of discharging water from the Owgariff into the Finow was also raised as were possible effects on spawning in gravels around the lake's margins. The potential for Artic Char *Salvelinus alpinus* to be affected was particularly highlighted as this species spawns in lake gravels, unlike trout and salmon which largely spawn in flowing waters.

On advice from Ms O'Connor, William Roche of the Central Fisheries Board and Fran Igoe of the Shannon Regional Fisheries Board were also contacted. They provided background information on the fishery status of the catchment. Some of the Fisheries Board's concerns relate to the operation of the abstraction works and the treatment plant rather than to the drawdown of Lough Guitane's surface water level. In particular, they made a submission regarding the operation of the fish pass at the outflow from Lough Guitane (prepared by the Department of Agriculture, Fisheries and Food on their behalf) which expressed reservations about the compensation flow regime. However the required compensation flow is prescribed in the Water Abstraction Order (WAO, copy contained in Appendix II) granted by the Minister for the Environment in 1979 and the current proposal provides for upgrading of the treatment facilities while staying within the terms of the existing WAO. This report does not therefore examine the adequacy of the compensation flow. Measures which are being undertaken as part of this proposal to ensure compliance with the compensation flow requirements of the WAO are set out in sections 2.2.2, 2.4.1 and 2.4.4 of the Environmental Report.

This Appropriate Assessment Report concentrates on issues directly related to the drawdown effects that are not covered in the Environmental Report.

1.4 The Layout of this Report

The principal sections of this report are as follows.

Section Number	Topic
Section 2	Hydrological Background
Section 3	Otter Survey
Section 4	Flora Survey
Section 5	Fish Migration Effects

A detailed hydrological report is included as Appendix III. This includes examinations of flow duration curves, yield assessment and climate change factors.

The seven items specified in the letter from the DEHLG (ref. section 1.3 above) are addressed in the sections set out below.

DEHLG Item Number	Section(s) of this report
(1)	Section 4
(2)	Section 2 & Appendix III
(3)	This has not been assessed because the proposal will ensure that compensation flows comply with the terms of the existing WAO therefore there will be no changes in water levels below the abstraction point ²
(4)	Section 5
(5)	Section 4
(6)	Section 3
(7)	Where required, mitigation measures are proposed in sections 3 to 5

The SWRFBs concerns about discharge from the Owgarriff into the Finow and about compensation flows are addressed in the Environmental Report for the proposed upgrade to the treatment plant and abstraction works. Their concerns about potential effects on any char population have been addressed by a detailed char survey, the results of which are contained in Appendix IV to this report.

1.5 Project Team

This assessment has been co-ordinated by Paul Fingleton of Environmental Impact Services. Paul has some 20 years experience in the carrying out of environmental assessments for a wide range of project types, including water abstraction projects from sensitive waterbodies. He previously worked as the manager of a sea-trout fishery in Connemara comprising a catchment of four lakes and interconnecting river system as well as two more lakes on an adjacent catchment. Paul also prepared Section 5 which examines Fish Migration Effects.

Nicholas O'Dwyer Ltd, in association with Tobin Consulting Engineers, provided all engineering input to the assessment including the hydrological background (Section 2).

Ecological expertise was provided by Dr Chris Smal of Ecological Solutions who is a National authority on otters and by consultant ecologist, Dr Catherine Farrell, who examined the lakeshore habitats.

Char specialist Fran Igoe co-ordinated a team to carry out a detailed char survey.

² The WAO is included as Appendix II to this report and discussed in sections 1.1, 1.3 and 2.4.4 of the Environmental Report.

Section 2 Hydrological Background

2.1 Water Abstraction Order

A copy of the approved WAO is contained in Appendix II. The order permits the abstraction of 54,540m³/day from the combined sources of Lough Guitane and Owgariff River (see Figure 2.1). A compensation flow of 9,092m³/day is to be provided downstream of the Lough Guitane barrage and a compensation flow of 1,136 m³/day is to be provided downstream of the Owgariff Intake, provided there is at least that quantity in the river.

The estimated lowest summer level pre-works in Lough Guitane was 77.42mOD. The overflow level of the Lough Guitane barrage was set at 78.79mOD, 1.37m above the estimated lowest summer level.

The WAO indicated that the maximum estimated future draw-down level resulting from the proposed abstraction from the two sources was 77.417mOD, which is 0.003m below the estimated pre-works summer level.



Figure 2.1 Map showing Intake Locations

2.2 Hydrological Report

A copy of the Hydrological Report is included as Appendix III to this AA. The demand assessment for the scheme amounts to 51,000 m³/day which is slightly less than the permitted abstraction of 54,540m³/day. Accordingly, there is no requirement to obtain a new Water Abstraction Order. As it is proposed to recycle filter washwater etc. through the plant, virtually all of the abstracted water will be used for supply.

As indicated in the Hydrological Report which takes account of more recent hydrological data, the abstraction of 51,000m³/day will involve a maximum additional drawdown of 0.39m to a level of 77.077mOD in a 20 year drought situation. An abstraction of 54,540m³/day in a similar drought is expected to involve a drawdown to a level of 76.547mOD (0.87m below the previously estimated maximum drawdown level of 77.417mOD). For the purposes of the "Appropriate Assessment" we have assumed that the lake level would drop to the lower level i.e. 76.547mOD to allow for minor losses at the treatment plant and to provide a margin for potential climate change impacts.

2.3 Fish Pass at Lough Guitane

A fish pass has been in place since the construction of the existing plant. Details of the pass and the barrage at the lake's outflow are included as Appendix 3 to the Hydrological Report contained in Appendix III to this document.

The pass includes a fish ladder arrangement and was designed in conjunction with the Department of the Marine and the Inland Fisheries Trust. It allows for fish migration at water levels from the estimated minimum level of 77.417mOD (the invert of the lowest gate is actually 77.05mOD). A minimum water level of 77.417mOD with a cill level of 77.05mOD, was considered acceptable at design stage as the cill level was equivalent to the existing downstream bed level. In addition it should be noted that water levels lower than 77.417mOD would only arise in an extreme drought when fish migration would be unlikely.

The fish pass comprises a series of four manually operated sluice gates at alternate levels on the lake side and its outflow discharges into a pool on the downstream side of the barrage. It is designed so that one gate is open at a time, to suit the lake's water level. The 77.05mOD invert of the lowest gate is the original river bed level and it would not be practical to provide for fish migration below this level.

The pass is also designed to control and channel the compensation flow downstream which is required under the WAO to be maintained at 9,092m³/day.

The compensation flow for the Owgarraff is specified in the WAO as 1,136m³/day.

The following works will be carried out to facilitate the operation of the fish pass and to ensure the provision of the required compensation flows:

- 1) Re-establishment of automatic flow metering device within fish pass to ensure that the required compensation flow (9,092 m³/day) is maintained.
- 2) Re-establishment of staff gauge for water level monitoring on Lough Guitane.
- 3) Channel cleaning and maintenance of required depths on lake side of fish pass to allow migration of fish per original design. Required depth at lowest gate is 77.05mOD. The length of this channel will be adequate to connect main body of lake to fish pass at a lake water level of 77.417mOD.

2.4 Owgarriff Intake

The Owgarriff Intake will be upgraded under the new scheme as follows:

- 1) Provision of mechanical screens with self cleaning mechanism
- 2) Re-establishment of measuring flume and compensation water system, ensuring that the required compensation water flow of 1,136 m³/day is maintained
- 3) Regular dredging of inlet pool
- 4) Normal Health and Safety provision including lighting for night time inspections

The original design concept for the existing scheme provides for the abstraction of the maximum quantity possible from the Owgarriff River by gravity and to supplement this supply from Lough Guitane as required. Supply from the Owgarriff intake would be reduced or suspended on the occasions of high colour/turbidity, in which case the supply from Lough Guitane acts as the main or the sole source of supply.

At the existing intake on the Owgarriff River, the river is channelled in a concrete structure comprising two side walls, floor, control weir, intake chamber and compensation flow channel incorporating a flume. The raw water enters the intake chamber via coarse and fine screens which are manually cleaned. After screening, the raw water outlets to a 500mm raw water trunk main to the Lough Guitane site. At the Lough Guitane site the 500mm main is cross-connected to the 700mm trunk main to Sheheree Reservoir. However, at present, water from the Owgarriff River is used to generate electricity at the Lough Guitane site and the power generated is used to partially drive the high lift pumps at the Lough Guitane Pumping Station. The tail water from the turbine is discharged to the Finow River, which is the river flowing out of Lough Guitane. The Owgarriff water is currently not used as a water supply source. Owgarriff Water has not been used for water supply since 1999 due to unacceptable levels of colour and turbidity.

It is possible for water from the high level Owgarriff Intake to gravitate to the main service reservoir for the scheme at Sheheree (approximately 4km NW), while water abstracted from Lough Guitane is transferred to Sheheree Reservoir by pumping.

2.5 SCADA System

The new site SCADA (Sequence Control and Data Acquisition System), in addition to monitoring the water treatment operations, will continuously monitor the level of Lough Guitane, the compensation flows to the Finow River from Lough Guitane and to the Owgarriff River downstream of the Owgarriff Intake. Alarm set points will be established to immediately notify Council Supervisory Staff if the minimum compensation flows are not being provided. Such data can be made available to other bodies on request.

2.6 How the Abstraction System will operate

Details of the proposed abstraction strategy from the two sources (Owgarriff River and Lough Guitane) are given in the Hydrological Report (Appendix III).

In general, the Owgarriff will be used as the primary source and abstraction shortfalls will be augmented by abstracting from Lough Guitane. We set out hereunder a number of scenarios to serve as an example as to how the system will operate. In each case it is assumed that the total abstraction requirement is 51,000m³/day – Current Demand Assessment.

i. Winter/ Spring Scenario

Assume total flow in Owgarriff River: 40,000m³/day, level in L Guitane at Crest Level 78.79mOD.
 Compensation Flow from the Owgarriff: 1,136m³/day
 Abstraction Rate from Owgarriff: 38,864m³/day (40,000–1,136m³/day)
 Balance from Lough Guitane: 12,136m³/day
 Total: 51,000m³/day
 Compensation Flow from Lough Guitane: 9,092m³/day

ii. Average Summer Scenario

Assume total flow in Owgarriff: 10,000m³/day, level in Lough Guitane: 78.6mOD. (below crest level).
 Abstraction Rate from Owgarriff: 8,864m³/day (10,000–1,136m³/day)
 Balance from Lough Guitane: 42,136m³/day
 Total: 51,000m³/day
 Compensation flow from Lough Guitane: 9,092m³/day

iii. Dry Summer Scenario

Assume total flow in Owgarriff River: 1,136m³/day, level in Lough Guitane: 78mOD.
 Abstraction from Owgarriff: 0m³/day (1,136m³/day = Compensation Flow).
 Balance from Lough Guitane: 51,000m³/day
 Compensation Flow: 9,092m³/day

In scenarios 2 and 3, as the lake level is gradually drawn-down below the weir crest level, the operator will progressively open the lower inlet gates to the fish pass as required to maintain the required compensation flow of 9,092m³/day. Under the proposed abstraction strategy, all Owgarriff raw water delivered to the Lough Guitane site will be used in the treatment process and not discharged to the Finow River.

Section 3 Otter Survey

3.1 Introduction

Lough Guitane provides the primary source of drinking water for County Kerry (Kerry County Council Planning Policy Unit). The lake is situated in south Co. Kerry, to the south-east of Killarney town.

A proposal has been made to increase the water drawdown from the lake:

- Before the abstraction order was granted in 1979 and a weir was built at the outflow - the Lake's low water level was 77.42mOD
- The weir crest is 78.79mOD
- The estimated maximum drawdown as stated in the WAO is 1.37m which results in a surface level of 77.417mOD (which is similar to the pre 1979 low water level)

Following a recent Hydrological Review of the sources, a drawdown of 1.37m is predicted to occur every 5-7 years and the max drawdown will be 2.24m (to 76.55mOD) which is predicted to occur once every 20 years. This is 0.87m more drawdown than the estimated figure in the Water Abstraction Order.

Any departures from the WAO are outside of the scope of this report.

The increased drawdown is not a result of the proposed water treatment plant but is actually due to the predicted consequences of climate change and would thus occur in a 'do nothing scenario' whether the plant is built or not.

Lough Guitane is completely within the Killarney National Park, MacGillycuddy's Reeks, and Caragh River catchment candidate Special Area of Conservation (cSAC site code 365).

The Department of the Environment, Heritage, and Local Government have requested an assessment of the effects of exposure of lake shore to breeding otters *Lutra lutra*.

This report details the results of an otter survey conducted at Lough Guitane and also along the Finow River, with consideration of otter populations, otter diet, and potential impacts on otters resulting from the proposal to increase drawdown.

3.2 Site Location and Access

The area is covered by Ordnance Survey Discovery Series Map number 79. There is ready access to Lough Guitane at several locations along the shores. The survey of the lake was conducted in two stages; firstly, from the treatment plant to the south-east of the lake, and the remainder then surveyed from the treatment plant to the east shores of the lake. The Finow River was accessed from Finow Bridge which is present along the local road from Muckross to Glenflesk just to the north of the present water abstraction plant.

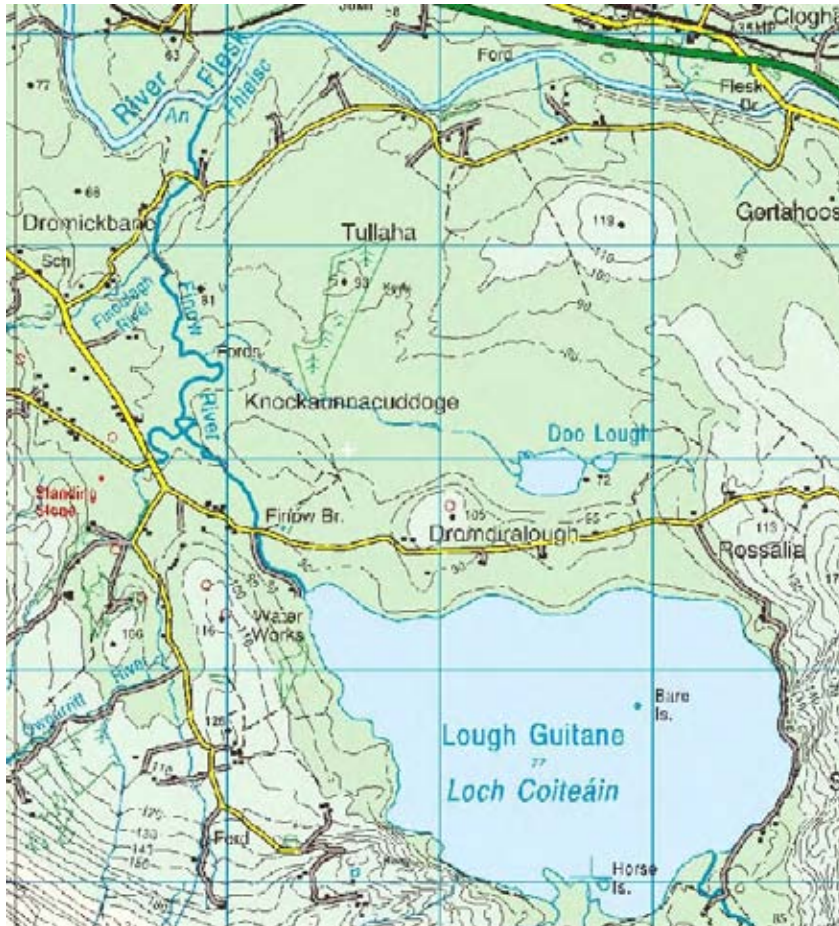


Figure 3.1 OS map of Survey Area and Vicinity.

3.3 Study Methodology

This report includes assessment of otters only. The signs of otters and other mammal species of interest observed are indicated in section 3.16.3.

The otter survey was undertaken over 3 days from 30th April to 2nd May 2008. Weather conditions were good overall: sunny spells, usually overcast and with periods of light drizzle. Conditions on the 2nd of May were very windy with light rain.

Survey of otters was carried out by means of a thorough search along the shores of the lake and river banks. Presence of mammals is indicated principally by their signs, such as dwellings, feeding signs, or droppings - though direct observations are also occasionally made.

All of the shores of Lough Guitane were searched for otter signs with search extended along streams and small rivers entering the lake. The Finow River and its banks were also searched for otter signs. Thigh-high waders were worn throughout, allowing easy access to the shores and banks along most of the survey area. The Finow River is shallow along most of its length.

The field surveys were supplemented by evaluation of relevant literature and the authors' existing knowledge of the area. Information on otters and other species in the area was also provided by Dr. Tim Burkett, NPWS Wildlife Conservation Ranger. There was brief communication with Dr. Jervis Good (NPWS) also.

The format of this report is in accordance with guidelines recommended by the EPA (2002) - *Guidelines on the Information to be contained in Environmental Impact Statements*. Recommendations and Advice notes on current practice (in the preparation of Environmental impact statements (EPA, 2003).

Evaluation techniques utilised are in general accordance with *Guidelines for Baseline Ecological Assessment* (Institute of Environmental Assessment, UK, 1995), *Wildlife Impact: the treatment of nature conservation in environmental assessment* (RSPB, 1995) and *Guidelines for ecological evaluation and impact assessment* (Regini, M. 2000).

3.3.1 Survey Constraints

Otters can be adequately surveyed at most times of year, whilst finding otter holts and dens of various mammal species would have been constrained by dense vegetation along portions of the survey corridor – mainly along the Finow River at some sections. The survey corridor was restricted to the lake and river margins in the main; otter holts are often well away from waterbodies.

Several islands at the south of Lough Guitane could not be accessed; holts may be present on these islands.

Reference has been made to a water treatment plant at Lough Guitane. This survey did not include any areas proposed for any new buildings or works proposed that would presumably be located at or near the location of the existing water abstraction facility. It is possible that (protected) mammal resting or breeding places might be present in areas due to be developed for additional structures, road access, storage areas etc.

3.3.2 Notes on Otter Survey Methodology

A detailed search for otter signs was conducted along the shores of the lake and the banks of the Finow River. The most frequently observed signs are spraints (otter faeces). Otters have regular sprainting locations but, specifically, they also use spraints to mark their territories or for some form of inter-specific communication.

Significant physical features are often marked. These may include ledges under bridges, stream/river junctions, significant promontory positions, or large rocks etc. The number of spraints is a poor indicator of otter numbers but they do provide a guide to otter activity and range use. Spraints are easily distinguished from mink *Mustela vison* scats or faeces of other species by their sweet or spicy smell, which is not unpleasant. Spraints may be washed away by rain but can persist for several months, by which time much of their scent has disappeared.

Otter footprints also reveal presence of otters in an area. Unlike spraints, footprints do not persist for long.

Otter holts vary in size from small burrows to more extensive tunnel and chamber systems akin to those of badgers *Meles meles* (setts). Otters will make use of burrows made by other mammals – e.g. badger setts, fox dens and rabbit burrows. Whilst holts may be located near to the shore, many are located at some distance inland – up to 200m or more away, whilst most are within 100m (data from Scottish isles).

GPS co-ordinates were obtained for most of the sprainting sites and potential holts or otter resting places identified (using a Garmin GPS CS Colour, accurate to c. 5m max. depending on local conditions). Details are given in the Appendices.

In order to place GPS references as accurately as possible, the National Grid was superimposed on the accompanying Figure and all GPS locations then plotted.

3.4 General Description of Area

The surface area of Lough Guitane is approximately 2.5km². The main portion of the site is comprised of Old Red Sandstone, whilst most of the Finow River flows through an area underlain by Carboniferous Limestone. There is, therefore, some considerable variety in the landscapes around the lake and along the Finow River.

The adjoining mountainous, rocky, habitats extend to the shores of Lough Guitane at the south and south-west of the lake and also along its eastern margin. There are some wooded portions there. Birch *Betula* sp. and willow *Salix* sp. fringe the shore.

At the south-east, pasture grasslands extend along the small river valley there. The Lake is very shallow at the south with substantial reed beds fringing the several small islands there; one of the islands could be accessed with waders (this was dominated by birch, heathers, gorse *Ulex europaeus* and *Molinia caerulea*). Improved pastures also extend to the shore at the west of the Lake. There are shallow waters at the west also, with remnant partially submerged field walls present. Areas of scrub and low willow woodland fringe the shore also, and there are areas of bog and heath habitat along the margins there.

Lands along the north shore are mainly of blanket peat, some of which has been, or is being, reclaimed for pasture. The shore is mainly comprised of large boulders. Similarly, much of the east and south-east of the lake is fringed by large boulders alongside the small farm access road, whilst there are areas of sandy and stony beach at the north-east.

There is some ribbon housing development along the local road (Muckcross to Glenflesk road), but, otherwise, housing development is sparse in the area.

The lands to the east of the Finow River are mainly of blanket bog, whilst there is good agricultural pasture grassland to the river's west. The river is mainly shallow, with riffles and some deeper pools. The river is fringed with willows and, often, gorse scrub. There are small portions of deciduous woodland also, comprised of ash *Fraxinus excelsior*, oak *Quercus* sp., birch, willow, hawthorn *Crataegus mongyna*, and occasional holly *Ilex aquifolium*. There is one area of coniferous plantation near to the road bridge at Dromickbane.

3.5 Conservation Designations

Lough Guitane and the Finow River are in a candidate Special Area of Conservation (cSAC) (site code 00365 – see Figure 1.1). The same area is designated as an NHA also.

The study area is near to the Killarney National Park (SAC, NHA and SPA, site code no. 4038).

3.6 Fauna

The survey area is likely to include many of the mammalian species present in the Killarney area. Sika deer *Cervus nippon* signs were frequent along the Finow River. Red deer *Cervus elaphus* signs were observed at the south-west of the lake in the more mountainous portions of the site. Fox *Vulpes vulpes* signs were relatively infrequent but were noted at several locations along the lake margins and along the Finow River.

Two badger setts were found, both along the banks of the Finow river. Neither was a main sett. A badger latrine was found at the north of the Finow River and badger feeding signs were frequent in that area. There is clearly a badger social group in that area, with no evidence of badgers found along the Lough shores.

No frog *Rana temporaria* breeding sites were found. Whilst the lake shore does have some wetland margins, no pools were found suitable for frog breeding habitat.

A brook lamprey *Lampetra planeri* was observed in one of the small streams feeding into Lough Guitane at the south-west (GPS W 02685 83769).

3.7 Otter Survey Results

A total of 46 otter sprainting sites were identified (see Figure 3.36). These varied in age from fresh and recent to older spraints that may have been there for some months. In addition to occasional sprainting locations, several significant sprainting sites were also found: these are used by otters on a frequent basis. Details of all sprainting sites are given in the Appendices.

No detailed assessment was made of the content of spraint remains; when checked, all appeared to contain only fish bones and almost no frog remains were seen – whilst such prey can often be common in otter spraints especially at season of this survey. Only one spraint was found with frog remains and that was located at the south end of the Finow River.

Only one otter resting place was found, and that was located on an island, accessed with waders, at the south of Lough Guitane. Otter holts are hard to find and are often located well away from the main river courses or lake areas. Few otter paths were found that could be followed. One path led away from the Finow River into bogland to its east; otter holts could well be present in the expanse of bog habitat there. There are several other islands just off-shore at the very south of Lough Guitane; holts could be present on these islands, which may be left accessible on foot at proposed low water levels.

The results show that otter use of all portions of the Finow River is frequent, whilst there were some 'gaps' between finds – even where sprainting locations looked favourable. No portion of the River Flesk was searched for otter spraints.

Around the lake, it is clear that there is a concentration of otter activity at the south-west and south, with several sprainting locations along the west side also.

In contrast, the north shore of the lake revealed just a few sprainting locations and none at all were found along the east shore. To some extent, at least, this reflects the nature of the shorelines present there; the eastern shore is in large part poorly vegetated (providing limited cover) and is characterised by large boulders that protect the local farm access road, which runs close to the lake for a good distance (and which may result in some increased disturbance to otters). Also, the north and eastern shores appear to be more exposed to strong winds and wave action, which would reduce suitability of these areas for foraging by otters. Any spraints on exposed boulders would also be more likely to be washed away by rains, whilst many of those found on the south-western shores were protected to some extent by riparian vegetation.

No mink signs were found during surveys. This species is known to be present in the Killarney area (Smal; 1988, 1991) and Dr. Burkett (NPWS) has reported evidence of the species in the study area (pers. comm.).

3.7.1 Spraint Surveys and Otter Numbers

The present study assessed otter activity in the vicinity of Lough Guitane and along the Finow River by means of survey of otter signs – principally spraints.

These have indicated that otters range over much of the Lough with concentrations of activity particularly at the south and south-west, where cover and relative lack of disturbance are believed to contribute to this pattern of range use. At the Finow River, spraints were identified at fairly regular intervals along the section of the River included in the study area, signifying their presence along the entire watercourse.

Kruuk (1995) reported seasonal variation in sprainting activity, with otters sprainting far more often on land in winter, producing fewer spraints in summer and also often defaecating in the water in summer.

The abundance of spraints is not necessarily indicative of the numbers of otters in the area and it is not feasible to assess otter density in the area from these signs alone (Kruuk *et al*, 1986). However, Mason & Macdonald (1987) evaluated spraint surveys and suggested that they may be used to provide a reliable

indication of the status of otters. O'Sullivan (1993a) also considered that survey of spraints was effective in determining otter distribution.

Otters are essentially solitary, with groups of otters usually consisting of a female plus young; the sexes normally remain separate except during courtship. Ranges vary enormously; in the north-east of Scotland, between 20 and 80km of stream. The overall median density of otters in the Rivers Dee and Don and their tributaries was 1 otter per 15.1km, but it varied from between 1 per 3 and 1 per 80km of stream, or 1 otter per 2 - 50ha of water (Kruuk, 1995).

The breeding season of otters is variable, with a peak of births from May to August – though cubs may be born at any time of year. Young become active at 2 months and swim at 3 months.

It may be considered that Lough Guitane provides refuge for one 'pair' of adult otters at most, along with their young (until the latter mature and are performed to seek territories elsewhere). Their range is certain to include the streams and small rivers that flow into Lough Guitane at the south, including the small loughs there, such as Lough Nabrean.

It appears certain that there are breeding adult otters at Lough Guitane.

Given the large range sizes of otters, it is entirely possible that the same otters frequent the Finow River – and, therefore, that the population of otters under study is comprised of just 2 or so adults. It is also likely that additional otters are present on the River Flesk in the vicinity of the confluence with the Finow River and that these have a range that includes part of the Finow River.

3.8 Overall Assessment

As discussed earlier, the distribution, quantity, and quality of otter spraints found at Lough Guitane and along the Finow River suggest that there are likely to be just one 'pair' of otters on the Lake, with additional adult otters probably present at the north of the Finow River. These will be accompanied by young for a period before the young leave to search for new territories. In addition, there will occasionally be transient otters passing into these territories in search of mating opportunities or free territories.

Otters are known to be present within most of the watercourses and lakes in the Killarney area (pers. obs., Dr. Burkett, NPWS, Smal [1988, 1991] and other information). They may be relatively scarce in upland lakes and along smaller upland rivers, but are known to traverse open moorland habitats from one stream to another in upland areas. Range sizes in upland area may be very large.

Whilst otters are relatively common in Ireland and they do occur on most rivers and coasts in this country, maintenance of their numbers within Ireland's rivers and lakes is one of substantial interest. The otter is a protected species under the Wildlife Act (1976, and Wildlife [Amendment] Act, 2000) and is also listed in Annex II and Annex IV of the EU Habitats Directive. It is also listed as requiring strict protection in Appendix II of the Berne Convention. Ireland is a European stronghold for the species, whilst the species is recovering in numbers in Britain after declines believed to have been caused by organochlorines-based insecticides and heavy metals.

Otters are widespread in Ireland and their presence can be confirmed on most watercourses in the country (Smal, pers. obs.) but little is known of their densities either on freshwater systems or coastal habitats. A study of the distribution of feral American mink in Ireland also included observations of otter distribution (Smal, 1988, 1991) and a national otter survey was conducted by Chapman & Chapman (1982). There has been a more recent study of the distribution of otters in Ireland also (Bailey & Rochford, 2006).

The detailed study of otters is both difficult and time-consuming. Studies in Shetland (Kruuk, 1995) were conducted over several years by a team of researchers and provide invaluable information on the nature of otter behaviour, sprinting activity, and holt use. In Ireland, O'Sullivan (1991; 1993a, 1993b) conducted studies on the Blackwater River system in Co. Cork, whilst Kyne *et al* (1989) investigated diet of otters at locations in the Irish Midlands.

Lough Guitane and the Finow River are within the cSAC designated conservation area. This element adds additional need to ensure that the proposed 'development' will maintain the quality of these waters for a range of species of interest and that the impacts should be limited so as to preserve these species within the site – and to do so with as little negative impact on overall numbers as possible.

DEHLG have, therefore, advised various studies on species of especial interest, such as freshwater pearl mussel *Margaritifera margaritifera*, brook lamprey, river lamprey *Lampetra fluviatilis*, salmon *Salmo salmo*, otter, and marsh clubmoss *Lycopodiella inundata* (see Appendices).

3.9 Potential Impacts on Otters

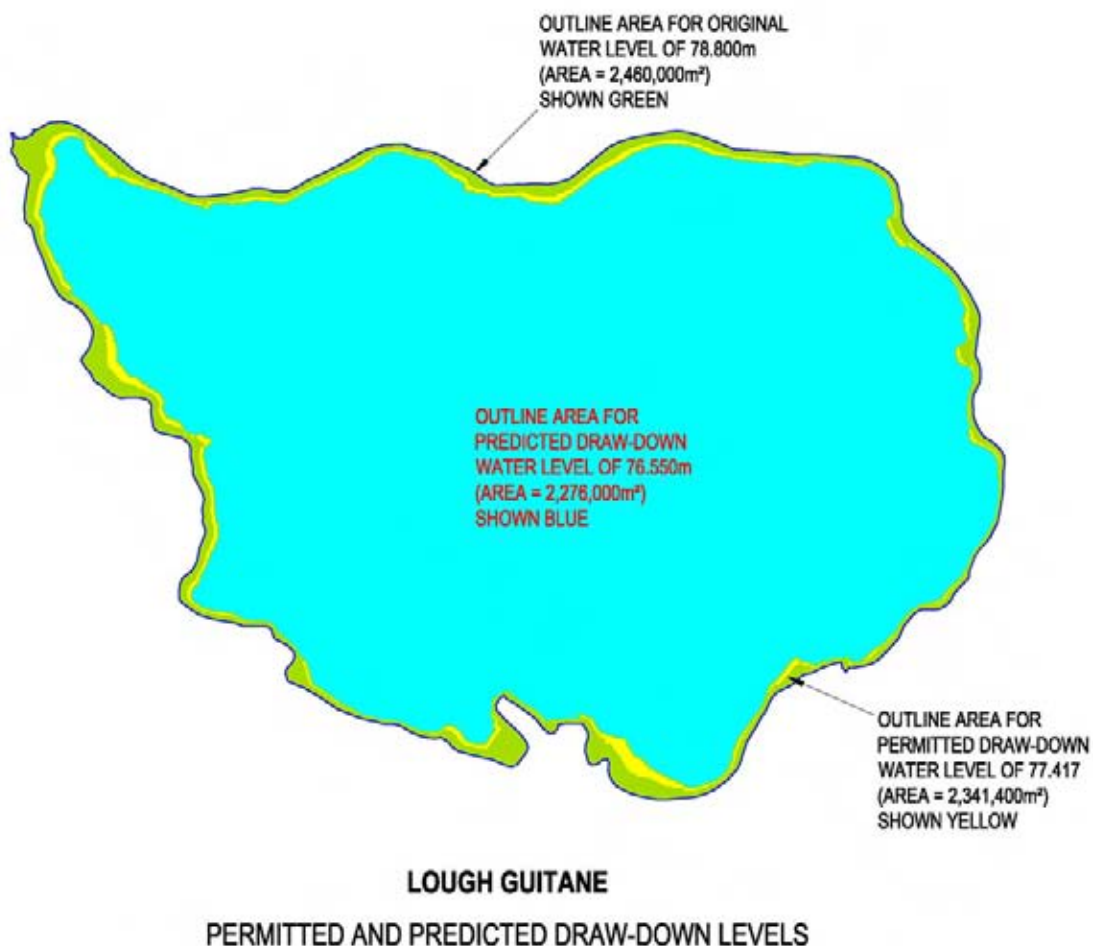


Figure 3.2 Extent of Existing Permitted and Future Predicted Drawdowns

No baseline survey of otters was conducted prior to the establishment of the water extraction scheme at Lough Guitane when it was created in the early 1980's. Therefore, it is not possible to gauge the impacts of the existing scheme on the prior otter population.

Very low water levels were recorded at Lough Guitane in August 2003 and September 2006. Those levels reached the maximum permitted abstraction level of 77.4m OD and slightly below.

The recent Hydrological Assessment indicates a maximum drawdown to a level of 76.55m OD, an event which is predicted to occur every 20 years. The map above illustrates the area of the lakeshores that will be exposed at this maximum drawdown level.

The following information has been supplied:

The existing permitted drawdown exposes 118,600m² which is equivalent to approx 5% of the area at a 78.8mOD water level (approx weir crest level).

The future predicted maximum drawdown will expose 184,000m² which is 7.48% of area at 78.8mOD.

Re. Finow River flows: Compensation flows will need to be maintained per the terms of the abstraction order which states that a compensation flow of 9,092 cu.m/d (0.105m³/s) is to be provided as a matter of guarantee. By way of comparison this is equivalent to approx ¾ of the estimated 90 Percentile Flow which is 12,067 cu.m/d (0.14m³/s) and is equivalent to 13.6% of the estimated average flow.

Otters present at Lough Guitane have already been subjected to low levels, for example in August 2003 and in September 2006. Below are some photographs taken at those times.



Figure 3.3 Photographs showing Exposure of Lake Margins in September 2006



Figure 3.4 Photographs showing Exposure of Lake Margins in August 2003

Otters are adaptable to altered circumstances and new environments. For example, otters are present in many urban areas in Ireland, including the Grand Canal in Dublin. They also commute along relatively polluted waters, whilst they do need, of course, good foraging areas within their territories or foraging ranges.

3.9.1 Potential Impacts on Otters in Study Area

Potential impacts on otters as a result of the scheme proposal are considered as follows:

- 1 water abstraction or naturally occurring low water levels can reduce prey abundance and prey availability. Fish are the predominant prey of otters at the Lough Guitane area. Trout do spawn in shallow waters so there may be some impacts on trout and other fish stocks in the lake as a result of increased drawdown or fluctuating water levels. Migratory fish (salmon and sea trout) are believed to access the lake and the downstream and upstream habitats. It is understood that an appraisal of impact on fish migration will accompany this application.
- 2 low water levels will expose relatively large areas of present lake especially at shallow portions at the north-west and south. Otters will have to travel across these muddy or

shingle 'flats' to reach foraging areas. Otters are shy creatures and their need to be so exposed could potentially reduce their foraging time or areas that they use for foraging as a consequence. Given the relatively isolated location and low levels of human disturbance, such impact may be considered slight or insignificant. Also, otters often prefer to forage in shallow waters; the present survey of spraint distribution suggests this. The proposal could possibly increase the amount of shallow waters available to otters at Lough Guitane.

- 3 otters always prefer to situate breeding holts at inaccessible and hidden locations. Often, such are on islands in lakes. It was only possible to inspect one island in this survey, and that had an otter resting place on it (not a breeding holt). Other small islands present at the very south, presently inaccessible, could become accessible at low water levels. Whilst it is unlikely that humans or other mammals such as foxes would regularly access these islands at low water levels, otters may perceive some risk and could potentially reduce their use of such islands accessible at low water levels.
- 4 fish populations may potentially be reduced as a result of lower water levels in pools present in streams and rivers entering the Lough, whilst water flow in these tributary streams will not be affected. The guaranteed water flow to the Finow River is noted.
- 5 water quantity is important to otters, especially where low flows (in rivers) reduce the food base, namely fish (Mason, 1995).
- 6 there are not likely to be other major impacts on otters. Food supply (fish in particular) is a major factor for maintenance of otters at Lough Guitane. Other prey, such as frogs, are not frequent in the immediate vicinity and reduced water levels are not expected to impact on frog populations in the vicinity to any marked extent – whilst there is potential for additional drying out of wetland habitats along lake margins that may provide some foraging habitats for frogs. Some short-term disturbance may be entailed to otters as a result of site works (as required for the treatment plant).

3.9.2 Consideration of Potential Impacts on Otters within the Study Area

It has been noted in the Introduction that the increased drawdown required at Lough Guitane is not a result of the proposed water treatment plant but arises from a predicted consequence of climate change.

It is an expectation, therefore, that low water levels will occur in the future at Lough Guitane regardless of the presently proposed scheme.

There is a continued presence of otters on Lough Guitane. No baseline survey of otters was conducted prior to the implementation of the present water abstraction scheme at the Lough (early 1980's) so the impacts (on otters) of the current situation/abstraction at the Lough cannot be gauged.

It has been considered above that any reduction in food supply such as fish could affect otter populations (e.g. breeding success) and otter behaviour (foraging areas) to some extent. The area is situated in a relatively remote locality. Impacts, other than those on prey availability, may be considered as slight. Increased human access to islands at the south, at low water levels, could cause some potential disturbance to holts; presence of such holts on these small islands could not be verified during this survey.

Low water levels to the estimated maximum drawdown level of 77.417m in the WAO are expected to occur every 5-7 years. Levels to the predicted drawdown level of 76.550m are expected to occur once in every 20 years. It is probable that it is not so much water level *per se* that affects fish and otter populations as much as do fluctuating water levels (that result in relatively rapid changes to the aquatic flora, invertebrate abundance, and fish breeding areas – leading to a diminution in fish availability for otters).

As above, the continued presence of otters on Lough Guitane has been maintained – whilst low water levels were experienced, as illustrated earlier, in years 2003 and 2006.

Thus, given the circumstance of previous low and fluctuating water levels (and continued otter presence at the Lough), it is considered highly improbable that otters will cease to use the Lough as a major feeding area and as an area which almost certainly provides for a small otter breeding population.

Exceptional low water levels could lead to some reduction in prey availability and reduction in breeding success in the years that these low water levels occur. Even in the instance of low water levels occurring during dry periods over several years, otter use of the area is certain to continue. In such instance, otters would be expected to adapt to altered circumstances but continue to maintain a presence on the lake.

3.10 Potential Impacts on Surrounding Areas

Otters may seek to revise their territorial or range limits if there is a significant reduction in prey availability within their present foraging areas at Lough Guitane and Finow River. This could lead to some 'downstream' impacts on otters in adjoining areas (e.g. the River Flesk). This outcome is conjectural; the most likely outcome is that otters in adjoining areas will maintain their ranges and territories.

3.11 Significance of Potential Impacts on Otters

Otters are present on most watercourses, waterbodies, and coasts in Ireland. Ireland is a European stronghold for this species. Maintenance of their numbers within Ireland's rivers and lakes is one of substantial interest.

The major threats to Ireland's otter populations arise from pollution of watercourses (and loss of food supply), mortality on roads, fragmentation of habitats and territories (e.g. by major road schemes), and loss of foraging habitat (e.g. road, residential and industrial developments; also agricultural land improvement and forestry). The impacts of such developments can often be considerable, leading to significant loss of otter presence (or reduction in numbers) in localities.

In this context, the proposal at Lough Guitane is considered as one that does not entail any such major or significant impacts on otters. Lough Guitane is within a designated conservation area so this context is relevant.

Fluctuating or low water levels could affect prey availability for otters. It has, nevertheless, been considered that otter presence and numbers will, most likely, be maintained at Lough Guitane. Results of survey suggest that there are present at Lough Guitane only 2 or so adult otters, with others present nearby.

Breeding success of the few individual otters at Lough Guitane may be lower in certain years, should prey availability be reduced as a result of lower or fluctuating water levels. Numbers of otters are likely to be maintained at Lough Guitane and vicinity in the short (1-7 years) to medium (7-15 years) to long-term (15-60 years) periods [EPA, 2003]. The overall impact of the scheme on otters may be considered as Imperceptible or Slight Negative (EPA, 2003).

Impacts on otter populations in the locality (Killarney National Park, River Flesk, SAC and NHA areas on site or adjoining) may be considered to be as Imperceptible or Slight Negative (EPA, 2003).

3.12 Recommendations and Mitigation Measures

- 1 Any works that need to be undertaken for the creation of the water treatment plant (and associated works) should be surveyed for badger setts or resting/breeding places of other protected species prior to works being conducted, and appropriate mitigation measures taken should there be any impacts on protected species.
- 2 It is advised that a monitoring programme be established to assess otter use in the Lough Guitane area post commencement of the scheme and after periods of low water levels. The scope of such a programme should be agreed in conjunction with the NPWS.
- 3 There is a need to provide improved access for otters and other mammals at the present weir. Prevailing conditions are poor for mammal access there presently. Ramps alongside the weir and river would be helpful or an adjustment of the bank environment and removal of some fencing could be considered. Planting along the shores there would also assist in providing some cover for mammals. Such measures require some detailed advice from a mammal specialist which can be provided by qualified ecologists.
- 4 There should be in place a requirement that water levels be reported to the relevant authorities on a regular basis. NPWS should be advised when water abstraction results in low water levels so that they are in a position to consider impacts on the cSAC – especially at crucial periods of maximum drawdown.
- 5 There are constraints as to how much the existing habitats along the shores of Lough Guitane and the Finow River can be improved for otters as mitigation for the proposed scheme as most of the shore areas are in private ownership. An absence of frog breeding sites was noted during the present narrow corridor survey. However improvement of frog habitat at the south west of the site will increase the diversity and availability of prey for otters especially during the frog breeding season. The location for these ponds is shown on the proposed site layout drawings and their details will be agreed with the National parks and Wildlife Service prior to construction. Frogs can be a major prey for otters in spring (Smal, various studies, pers. obs., and refer literature referenced) so this mitigation will off-set potential loss of fish stocks available to otters, if such were to occur as a result of the proposal.

3.13 Conclusions and Residual Impacts

There is limited scope for amelioration or mitigation of the proposed additional drawdown or low water level impacts (Lough Guitane, Finow River) on otters. In any case, it has been noted that there is an expectation that climate change will, in any case, lead to periodic low water levels at Lough Guitane.

The proposal at Lough Guitane is considered as one that does not entail significant impacts on otters. Lough Guitane is within a designated conservation area and this context is noted.

Fluctuating or low water levels could affect prey availability for otters. It has, nevertheless, been considered that otter presence and numbers will, most likely, be maintained at Lough Guitane.

Breeding success (of otters) may be lower in certain years, should prey availability be reduced as a result of low or fluctuating water levels. The overall short to long-term impact on otters may be considered as Imperceptible or Slight (EPA, 2003).

Impacts on otter populations in the locality (Killarney National Park, River Flesk, SAC and NHA areas on site or adjoining) may be considered to be as Imperceptible or Slight (EPA, 2003).

In a worst case scenario, it is potentially feasible that otters will measurably and significantly reduce their use of the Lough Guitane area. However, it is not likely that the scheme will not lead to abandonment of

the area as a foraging area for otters. This study has suggested that there is a breeding population (however small) present at Lough Guitane. The proposed scheme's impact could lead to loss of the small breeding population at the Lough in a worst case scenario – if prey supply (fish stock) is significantly diminished.

3.14 Photographic Record



Figure 3.5 Existing Water Abstraction Plant Building



Figure 3.6 Weir at North of Lough Guitane next to Abstraction Plant



Figure 3.7 the Weir looking from West to East



Figure 3.8 North-West Shore of Lough Guitane



Figure 3.9 Sandy Beach at North-West Shore of the Lake



Figure 3.10 West Shore of Lough Guitane with Grasslands extending to the Shore



Figure 3.11 Significant Sprainting Site at South-West of Lough Guitane



Figure 3.12 Significant Sprainting Site at the South-West



Figure 3.13 Rough Access Track at South-West with Fringing Vegetation



Figure 3.14 Small Stream at the South-West of Lough Guitane



Figure 3.15 Horse Island at South West of the Lake



Figure 3.16 River Channel at South-West



Figure 3.17 Reed Beds in Shallow Lake Margin at South



Figure 3.18 Shallow Areas and Wetlands at the South



Figure 3.19 Shore at South



Figure 3.20 River entering the Lake at the South



Figure 3.21 Sprainting site at Divide of River



Figure 3.22 View of Lough Guitane Shore at South-East



Figure 3.23 Access Road and Shore with Boulders at South-East



Figure 3.24 Stony Shore at East



Figure 3.25 Shore at North, just East of the Finow River



Figure 3.26 Shore at North



Figure 3.27 Shingly Shore at the North-East



Figure 3.28 Finow Bridge



Figure 3.29 Finow River



Figure 3.30 Bog Habitat East of the Finow River



Figure 3.31 Finow River



Figure 3.32 Confluence of the Finow and Owgarriff Rivers



Figure 3.33 Riffles along the Finow River



Figure 3.34 Boulder in middle of Finow River; used by Otters as a Sprainting site



Figure 3.35 River Flesk at its Confluence with the Finow River

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3.16 Appendices to Otter Section

3.16.1 Appendix 3A: Badger Setts and Signs Identified within the Study Area

Reference as shown on Figure	Location and habitat	Status and description
BS1	W 00898 86358	single entrance, disused, on small cliff on eastern side of river
BS2	W 00762 86649	single entrance, has been in use by foxes; bones present. close to river bank. Large spoil, old bedding; no latrines. Open. Subsidiary sett.
BL	W 00890 87677	badger latrine: large site, fresh; by confluence with River Flesk

3.16.2 Appendix 3B: Otter Holts/Resting Places identified within the Study Area

Reference as shown on Figure	Location and habitat	Status and description
H1	W 02503 84012 See Figure 3.36	small 'cave' under large boulders, old spraints at entrance. Disused. Not a breeding holt. Otter resting place.

3.16.3 Appendix 3C: Details of Otter Spraints identified within the Study Area

Spraint reference as shown on Figure	GPS co-ordinates National Grid	Notes
S1	W 03255 84031	significant large sprainting site near mouth of river. Fresh and old spraints at 3 locations next to each other.
S2	W 01144 85701	No spraints at Finow Bridge. Spraints at location 100m below. Next to moorland and otter path into moor/bog habitat.
S3	W 01104 85854	on rock in 'eastern' stream of divided river
S4	W 01042 85889	old spraint on rock in stream
S5	W 01000 85929	2 old spraints on rock in river
S6	W 00954 85997	old spraint remains on large rock at side of river
S7	W 00770 86509	one fresh spraint on rock in middle of river
S8	W 00729 86782	on large rock; single fresh spraint
S9	W 00714 86789	several older spraints on large rock
S10	W 00679 86834	very old spraint fragments under large overhang of 'cliff'
S11	W 00703 86914	old spraint on rock
S12	W 00716 87176	old spraints on rock at channel with red algae
S13	W 00733 87231	small old spraint on rock on east side
S14	W 00808 87295	2 old spraints, c. 25m south of road bridge, on rock in river
S15	W 00858 87344	c. 50m north of road bridge, 2 old spraints on east side of river
S16	W 00841 87380	old spraint on rock
S17	W 00824 87435	old spraints on rock on east side of river
S18	W 00860 87525	boulder in river, several old spraints
S19	W 01145 85580	regular sprainting site, large rock in centre of river; fresh smear, old spraints. Frog remains.
S20	W 01156 85571	small old spraint not far from S19 on east side
S21	W 01302 85427	old spraint, west side, on boulders below outfall from weir
S22	W 01377 85169	on old field stone boundary wall partially submerged
S23	W 01433 85055	2 old spraints on 'pier' close to shore, and 2 more with smears, showing a regular sprainting site
S24	W 01537 84889	very fresh smear and 1 fresh spraint 1m away; regular sprainting site as indicated by grass kill
S25	W 01793 84442	regular major sprainting site at base of tree with mossy stump in water at lake's edge
S26	W 01842 84234	grassy knoll with evidence of old spraints
S27	W 01917 84216	major sprainting site; large slab boulder, moss covered; old spraints present
S28	W 01960 84223	another large boulder nearby to S27. Several old spraints
S29	W 01964 84207	nearby to S28; fresh spraints on large rock.
S30	W 02027 84095	major sprainting site on shore next to tree and next to small access track. Grassy rock.

Spraint reference as shown on Figure	GPS co-ordinates National Grid	Notes
S31	W 02073 84074	Several spraints of different ages and grass die-off. 10m west of large stream not marked by otters (stream at W 02038 84089)
S32	W 02088 84060	group of rocks, small promontory. " rocks marked; regular sprainting site; fresh and old.
S33	W 02286 83984	tree stump near S31, marked with old and fresh spraints.
S34	W 02397 83926	smear on boulder west of 'islands'
S35	W 02502 84022	fresh smear with small fresh spraint, under hawthorn tree
S36	W 02511 84055	on island at west; spraint on big rock with grassy knoll
S37	W 02503 84012 (see Figure 3.36)	single fresh spraint on boulder at lake shore at north of island
S38	W 02682 83842	old spraints at entrance to small 'cave' and otter resting place; not a breeding holt.
S39	W 02682 83796	river, deep. Old sprainting site, grassy knoll. Appears to be a regular spraint site in past.
S40	W 03103 83997	small rock by river under holly tree; west bank. Major but small sprainting site. Fresh
S41	W 03212 84038	sprainting site on grass knoll, regular site; only old spraints present.
S42	W 03244 84040	grass knoll on west side of wet inlet; old sprainting site.
S43	W 03248 84020	old spraint site on grass knoll by river on west side; old spraint.
S44	W 02462 85269	10m south of S1, on grass knoll by bank. Several old and fresh spraints and grass die-off.
S45	W 02540 85259	large promontory boulder; significant. Several old spraints with fish remains.
S46	W 03033 85347	one fresh spraint, fish bones
		old spraints on boulder

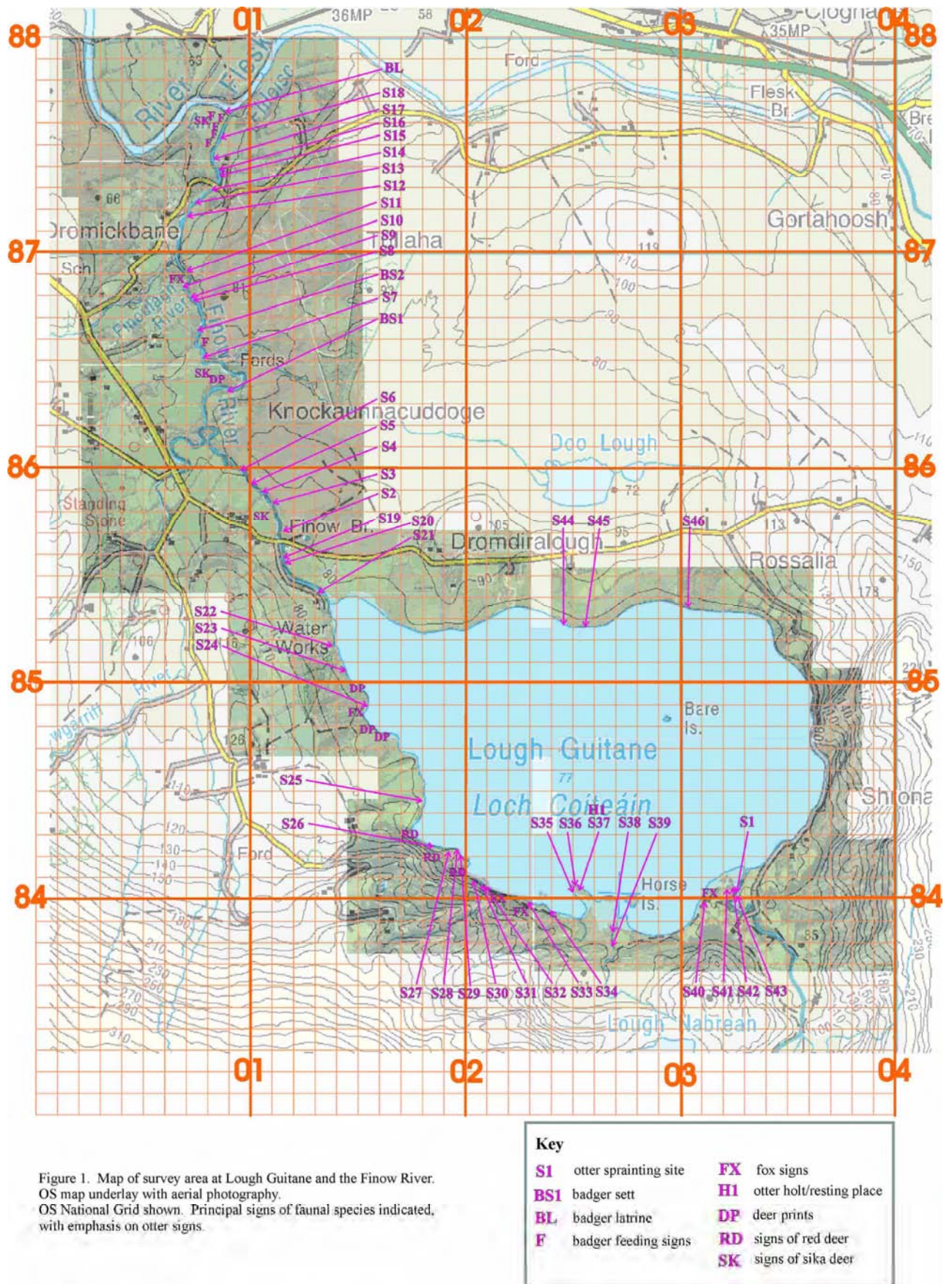


Figure 3.36 Otter Survey Map

Section 4 Flora Survey

4.1 Introduction

An application is being prepared by Kerry County Council to develop a water treatment works at the established Lough Guitane water abstraction facility. The planning application outlines the proposed development and associated works. C.A. Farrell was commissioned to undertake an ecological assessment of the proposed development site to evaluate the ecology and potential impacts. This was submitted in November 2007.

Following from that study the NPWS submitted a request for further assessment of ecological features of the site. This study focuses on the actual lake habitats and considers the combined potential effects of the Water Abstraction Facility and climate change, in particular changes in the drawdown levels of water in Lough Guitane. The changes considered are in terms of extent, frequency and duration of drawdown period.

4.2 Scope

This study focuses on aspects relating to flora and habitats that contributes to a wider study on each the qualifying conservation interests of Lough Guitane and the Finow River and the River Flesk, an extensive hydrological unit that is part of the Killarney National Park, Macgillycuddy's Reeks and Caragh River SAC/NHA (site code 000365). The Finow flows from Lough Guitane and further into the River Flesk, both of which are classified as salmonid rivers. There are also populations of Freshwater Pearl Mussel *Margaritifera margaritifera* recorded from the Finow River and the River Flesk.

While a Water Abstraction Facility has been operating at Lough Guitane since the 1980s, the current study concerns the potential effects of changes in hydrological fluctuations, in particular:

- (a) potential effects on the Flora Protection Order species Marsh Clubmoss (*Lycopodiella inundata*) and
 - (b) the occurrence of lowland oligotrophic lake (3110) and upland oligotrophic lake habitat types (3130).
- These are listed habitats under Annex I of the EU Habitats Directive.

4.3 Methodology

The site was visited in June 2008. The methodology was agreed with J. Good, Regional Ecologist, NPWS. The main work involved a habitat survey of the lake and lake shore. This comprised a full walking survey of the perimeter of the lake. The lake shore habitats were investigated for the presence/absence of the Marsh Clubmoss *Lycopodiella inundata*

Following from the field survey an assessment of the effects of changes in water level regime on the above habitats and species (where present) was carried out using data provided by and projections of future water level fluctuations generated by Nicholas O'Dwyer and Tobin Consulting Engineers. The Lough Guitane site is considered to be of International ecological significance (SAC). The potential impacts of the development are evaluated using the *Guidelines for Ecological Evaluation and Impact Assessment* (Regini 2000). An outline of the decision framework is provided in Tables 1, 2 and 3 (see section 4.10).

4.4 Habitat Survey: Lowland Oligotrophic Lakes, Upland Oligotrophic Lakes

4.4.1 Conservation Interests of SAC

Lough Guitane and the Finow River are part of the Killarney National Park, Macgillicuddy's Reeks and Caragh River SAC (site code 000365). This site comprises an extensive land area and a range of habitats. The boundary of the designated area with the water abstraction and treatment works is marked by the natural boundary of the freshwater habitats of Lough Guitane and the Finow River. A brief overview of the qualifying conservation interests is provided here, with a full site synopsis of this and other conservation areas outlined in Appendix III.

The Killarney National Park, Macgillicuddy's Reeks and Caragh River site encompasses the mountains, rivers and lakes of the Iveragh peninsula, and the Paps Mountains which stretch eastward from Killarney towards Millstreet. It is the most mountainous region in Ireland and includes Carrauntoohil (1039m), the highest peak in the country.

The site is of great ecological interest, with at least ten habitats which are listed on Annex I of the EU Habitats Directive. The site is a candidate SAC selected for blanket bog, Yew wood and alluvial woodlands, priority habitats on Annex I of the E.U. Habitats Directive. The site is also selected as a candidate SAC for lowland oligotrophic lakes, upland oligotrophic lakes, floating river vegetation, alpine heath, dry heath, wet heath, *Molinia* meadows, old Oak woodlands, Rhynchosporion, Calaminarian grassland and Juniper scrub, all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive – Killarney Fern, Slender Naiad, Freshwater Pearl Mussel, Kerry Slug, Marsh Fritillary, Killarney Shad, Atlantic Salmon, Brook Lamprey, River Lamprey, Sea Lamprey, Lesser Horseshoe Bat and Otter.

4.4.2 Freshwater Lakes (3110 and 3130): vegetation descriptions

The descriptions of freshwater habitats (3110 and 3130) as provided by the Interpretation Manual of European Union Habitats are outlined below.

Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) (3110)

Shallow oligotrophic waters with few minerals and base poor, with an aquatic to amphibious low perennial vegetation belonging to the *Littorelletalia uniflorae* order, on oligotrophic soils of lake and pond banks (sometimes on peaty soils). This vegetation consists of one or more zones, dominated by *Littorella*, *Lobelia dortmanna* or *Isoetes* (all zones may not be found at a given site).

Plants: *Isoetes lacustris*, *I. echinospora*, *Littorella uniflora*, *Lobelia dortmanna*, *Deschampsia setacea*, *Subularia aquatica*, *Juncus bulbosus*, *Pilularia globulifera*, *Luronium natans*, *Potamogeton polygonifolius*. In France and Ireland this habitat occurs, in particular, in heathland of sandy plains on podzols, where the water table occurs at the surface

Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea (3130)

Aquatic to amphibious short perennial vegetation, oligotrophic to mesotrophic, of lake, pond and pool banks and water-land interfaces belonging to the *Littorelletalia uniflorae* order.

Plants: *Littorella uniflora*, *Luronium natans*, *Potamogeton polygonifolius*, *Pilularia globulifera*, *Juncus bulbosus* ssp. *bulbosus*, *Eleocharis acicularis*, *Sparganium minimum*.

Heritage Council Classification – Acid oligotrophic lakes FL2

Lakes and ponds low in nutrients, base-poor and acidic. These lakes support communities of submerged and floating aquatic plants. Small submerged aquatics such as Shore weed (*Littorella uniflora*), Water Lobelia (*Lobelia dortmanna*) and Bulbous rush (*Juncus bulbosus*) occur in shallow water. Quillworts

(*Isoetes* spp.) may be abundant in deep water. Floating aquatics include Bog Pondweed (*Potamogeton polygonifolius*), Alternate Water-milfoil (*Myriophyllum alterniflorum*) and Floating Club-rush (*Eleogiton fluitans*).

Condition Assessment of Freshwater Lakes in Ireland

As part of the National obligation to comply with conservation and protection of habitats listed under Annex I of the EU Habitats Directive, NPWS recently published a Habitat Assessment for lake habitats (NPWS 2007). It is noted in the report that the classification and selection of lake habitats for SAC designation in Ireland was primarily based on vegetation communities. In the absence of any comprehensive survey of lakes, the information available to NPWS when selecting and designating lake sites was extremely limited and the overlap between the vegetation communities associated with lowland oligotrophic lakes habitats (3110) and (3130) did not allow for a clear distinction between the two habitats, and therefore they are generally considered together. Habitat type (3110) is considered rare throughout the Atlantic Biogeographic Region of Europe and there is a high probability of misclassification of sites designated for this habitat type in Ireland owing to the limited extent of initial vegetation survey and supporting geological information (NPWS 2007).

The combined area of lake types (3110) and (3130) in Ireland is estimated at 678km². Risk assessment suggests that for 64% of total area of lake types (3110) and (3130), the structures and functions of these lakes will be negatively affected (main threats: forestry, peat cutting, agriculture) and therefore conservation status of habitat structures is deemed *Unfavourable / Bad*. Furthermore, given the limited survey data on lake types 3110 and 3130, the conservation status of typical species of this habitat is unknown (NPWS 2007). There is no consideration in the report of the potential effects of climate change.

4.4.3 Lough Guitane Vegetation Survey

Lake vegetation

Lough Guitane is a relatively large lake (250ha.) (Fig.1). The lake supports extensive vegetation cover which is continuous around the lake. The vegetation surveyed occurs within the shallow water zone, which is subject to annual fluctuations.

The dominant species is Shore weed (*Littorella uniflora*), with higher frequency of Bulbous rush (*Juncus bulbosus*) on sandy substrates (Figs 2). Where water is shallow Water Lobelia (*Lobelia dortmanna*) is abundant. Other species present included floating aquatic plants such as Alternate Water-milfoil (*Myriophyllum alterniflorum*) and Chara spp.

On the northern shore of the lake, the substrate is pre-dominantly gravel and Shore weed (*Littorella uniflora*) forms largely mono-dominant stands, that vary in extent between patchy and dense with occasional Water Lobelia (*Lobelia dortmanna*) (Fig. 3).

Along the southern shore the vegetation was most variable, relating to variations in the substrate type. There were more sandy areas on the southern shore, and more diverse communities with higher frequency of Water Lobelia (*Lobelia dortmanna*) and Bulbous rush (*Juncus bulbosus*) (Fig. 4). Other species recorded along the southern shores included occasional patches of Bog Pondweed (*Potamogeton polygonifolius*), Water Crowfoot (*Ranunculus aquatilis*) and Common Spike-Rush. (*Eleocharis palustris*). There are also occasional stands of tall Reed (*Phragmites australis*) and Saw Sedge (*Cladium mariscus*): these occur on the south west shore adjacent Horse Island (Fig. 5).

The deeper areas of the lake were not surveyed, but it is expected that there is fragmented occurrence of Shore weed (*Littorella uniflora*), Chara spp. and Quillworts (*Isoetes* spp.).

Habitats surrounding Lough Guitane

Main land-uses in the catchment are agriculture and amenity. The north shore is characterised by wet grassland (GS4) with some areas of improved agricultural grassland (GA1) grading into degraded

heathland and bog communities which are largely dominated by Gorse (*Ulex europaeus*) scrub and/or Purple Moor Grass (*Molinia caerulea*). The edge of the lake is largely fringed with Gorse scrub (WS1) (Fig. 6). In the townland of Rossalia, the vegetation is characterised by fragmentary woodland (WN1) with a fringe of riparian woodland (WN7). The eastern shore is bound by a narrow track-way and grassy verge that is relatively diverse in species (GS2).

At the inlet of the river in the south east corner of the lake the vegetation is more typically woodland (Fig. 7), with patches of Ash (*Fraxinus excelsior*), Hawthorn (*Crataegus monogyna*) and Holly (*Ilex aquifolium*) (WN1), again with a fringe of Willow (*Salix spp.*) scrub (WS1) and riparian woodland (WN5) with Willow (*Salix spp.*) and Alder (*Alnus glutinosa*). Holly (*Ilex aquifolium*) is very frequent along the lake edge, with some evidence of more extensive riparian woodland as evidenced by stumps of trees below the water level along the southern lake shore. Habitats along the southern shore are a mix of wet grassland (GS4), woodland dominated by Birch (*Betula pubescens*) and Holly (WN2) and riparian woodland.

There is a diverse area of poor fen/bog habitat just south of Horse Island, with a mix of bog species (Bog Cotton (*Eriophorum angustifolium*), Purple Moor Grass (*Molinia caerulea*), and Black Bog Rush (*Schoenus nigricans*) and poor fen species Soft Rush (*Juncus effusus*), Bulbous Rush (*Juncus bulbosus*), Lesser Spearwort (*Ranunculus flammula*). Between this wet peaty area and the townland of Ford, the contours are steep and slopes are covered in woodland dominated by Birch (*Betula pubescens*) and Holly (WN2), patches of dry heath (HH1) and dense bracken (HD1). In the townland of Ford the main habitat is improved agricultural grassland, with a diverse stand of marsh (GM1) and wet woodland dominated by Willow (*Salix spp.*) (WN6), just south of the Water Works Facility (Fig. 8). Other habitats present in the surrounding area are dry heathland dominated by Ling (*Calluna vulgaris*) (HH1) and areas of dense bracken (*Pteridium aquilinum*) (HD1).

4.4.4 Condition Assessment

The plant communities recorded are assigned to the listed habitat *Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)* (3110). The vegetation is extensive within the shallow oligotrophic waters, which vary in substrate from peaty to sandy to gravel, and in some places rocky. There is a zonation in species with Water Lobelia (*Lobelia dortmanna*) and Bulbous rush (*Juncus bulbosus*) more common on shallow sandy shore edges, with Shoreweed (*Littorella uniflora*) extending into deeper waters.

At the time of survey the water was between 5m and up to 20m from the interface of terrestrial and aquatic habitats of the lakeshore and exposed vegetation was subject to drying effects. The vegetation is considered to be in a good and stable condition. Habitats along the margins of the lake are a mix of grassland, woodland and scrub with some diverse areas, particularly along the southern shore.

4.5 Marsh Clubmoss (*Lycopodiella inundata*) Survey

4.5.1 Plant description, habitat and distribution, causes of decline

Marsh Clubmoss is a perennial species of wet heaths, often on bare peaty soil, and occasionally on the margins of lakes and in sand and clay pits, favouring areas which are under water in winter and spring. It often grows in places where human activities provide disturbance and maintain areas of bare, seasonally flooded peat. These include unmade tracks, old peat cuttings and wet areas subjected to poaching by cattle. It forms long leafy prostrate strands that meander along the soil surface, but in the autumn develops vertical 'spikes' with tiny, pale brown spore cases at the tips (see photos below; source: <http://www.ukbap.org.uk/UKPlans.aspx?ID=431>).



Although found at several other scattered sites, its principal home is the west side of Britain and Ireland. In the UK, this species is mainly found the New Forest, Dorset and Surrey, and is also found in Wales and Scotland. Attempts have been made to re-introduce it to Norfolk in 1999. Its global range includes Europe, where it is known to be in decline, North America and Asia. This species is restricted to a single site in Northern Ireland (Peatlands Park, Co Armagh) where it was first found in 1964. It has been recorded from a total of 22 sites in Ireland mainly in the south and west (Curtis & McGough 1988).

In Ireland, the plant is listed in the Flora Protection Order, 1999 (S.I. No. 94 of 1999), and was recorded from the shores of Lough Guitane in the late 19th Century. While it has not been recorded since, it may be easy to overlook. Potential causes of decline include habitat loss through building development or improvement of unmade trackways, drainage, cessation of traditional management practices such as peat cutting and grazing, and the associated successional changes, nitrate and phosphate pollution, and the associated increase in growth of competitive vegetation, atmospheric pollution, including heavy metals, nitrogen and sulphur dioxide may be important factors, although further research is required.

4.5.2 Survey Results

While there were areas of suitable habitat present, particularly in the wet peaty area south of Horse Island, no plants were recorded.

The northern, eastern and western shores largely comprise unsuitable habitat and these are also the most intensively managed and disturbed areas around the lake.

4.6 Changes in Water Level Fluctuations

Potential impacts on the vegetation will be related to extent, frequency and duration of drawdown periods. Data on water level fluctuations for 2002 to 2007 has been provided by Kerry County Council (see Appendix IV). Predictions of future water drawdown levels were calculated by Nicholas O'Dwyer Ltd and Tobin Consulting Engineers and incorporate the combined potential effects due to the Water Abstraction Facility and potential effects based on current climate change trends.

4.6.1 Extent and Frequency of Drawdown

The low water level of the lake prior to construction of the weir in 1986 was 77.42m. This is the value provided in the Water Abstraction Order (estimated maximum drawdown of 1.37m). The level of the weir crest is 78.79m. It is noted that recorded changes in water level between 2002 and 2007 show that the lowest levels occur in late summer and autumn. Levels generally remain above 77.4m, dropping below

77.4m in Sept 2006 for a couple of days. Outside of these periods the water level remained at or above 78.4m for the greater part of the year.

Under the proposed regime a drawdown of 1.37m is predicted to occur every 5-7 years and the max drawdown will be 2.24m (to 76.55mOD) which is predicted to occur once every 20 years. This is .87m more drawdown than currently experienced.

An indicative map (Figure 3.2) showing the lake's approximate surface area at weir crest level, current max drawdown and predicted max drawdown level is shown. The changes in area of surface water of the lake are approx.

- 2,341,400m² at the estimated maximum drawdown level as stated in the Water Abstraction Order, resulting in a reduction in area of approximately 4.8% compared to area of the lake at weir level.
- 2,276,000m² at predicted maximum drawdown level following increase due to proposed development, resulting in a reduction in area of approximately 7.5% compared to the area of the lake at weir level.

The expected decrease in surface area from 4.8% to 7.5% at maximum drawdown levels is relatively small. The measured effect will involve an increase in the exposure of the lake communities within a band of between 0m and up to 20m (average 5m to 10m) from the current levels with greatest effect in the shallow water area around Horse Island (based on the map shown in Appendix IV). The frequency of the event is predicted to occur once every 20 years.

4.6.2 Duration of Drawdown

Based on water monitoring records (2002 to 2007) the frequency and timing of max drawdown periods is confined to autumn periods, namely between the period of mid-July to September. Outside of this general period the water level stayed at or above 78.4m throughout the year except for more than one to two weeks during summer and autumn months.

The duration of the max drawdown periods was a couple for weeks, except in 2006 and 2003 when the duration of the drawdown period lasted for up to two months.

4.7 Impacts of Water Level Fluctuations on Lake Communities

4.7.1 Current Impacts

Lough Guitane is a relatively large water body with good examples of vegetation assigned to *Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)* (3110). There are annual and seasonal variations in water level largely relating to abstraction of water combined with variation in climatic conditions. Seasonal and annual variations are features of natural systems and the occurrence and distribution of lake communities is a product of the vegetation's ability to tolerate these fluctuations. Based on the assessment of the lake and lakeshore habitats, their condition is considered to be good and there are no apparent current threats. This is also reflected in the high water quality and presence of populations of Freshwater Pearl Mussel in both the Finow and Flesk.

4.7.2 Potential Impacts due to Climate Change

A change in water level fluctuations in Lough Guitane is predicted to result in an increase of drawdown by 0.87m and an increase of the area affected by max drawdown period by 2.85% (with reference to map in Appendix IV), and this will occur once every 20 years. This change is considered to be of very low magnitude relative to the area of the lake and the current levels of seasonal and annual variation.

Potential Impacts

N.B. It is noted that given the lack of data and results of monitoring the effects of increased water drawdown levels on established stands of the *Littorelletalia uniflorae* in the Irish context, the potential

impacts are speculative. The worst case scenario is presented and considered relative to the least/no impact scenario.

Worst case scenario: decrease in extent of vegetation of *Littorelletalia uniflorae* by 2.8%.

This would result in loss of vegetation of the *Littorelletalia uniflorae* within a band of 5m to 15m around the perimeter of the lake. The vegetation would remain stable in the areas that will not be exposed (92.5% of lake surface area). Vegetation in surrounding areas would encroach onto the exposed shore. It is proposed that this would result in an expansion of lake shore vegetation such as riparian woodland (WN7), and reedbed (FS1). It is probable that the stands of Reed and Saw Sedge at Horse Island would expand in response to drier conditions.

Least Impact: no change.

Given the ability of the *Littorelletalia uniflorae* vegetation to recover from current fluctuations in water level, and the predicted frequency of max drawdown to a one in 20 year frequency, it is proposed that the changes in water level fluctuations will not result in a loss of cover of vegetation of *Littorelletalia uniflorae* by 2.8%. It is predicted that any impacts will be short term drying effects and the vegetation will recover from increased exposure, resulting in no impact on the extent of vegetation.

In both scenarios, the potential effects of the predicted changes will be restricted to a narrow fringe around the lake shore.

4.7.3 Effects on Marsh Clubmoss

While no plants were recorded, suitable habitat for the Marsh Clubmoss is present. These habitats are not considered to be threatened by changes in water level fluctuations in the lake.

4.8 Conclusions

There is extensive cover of vegetation assigned to the listed habitat *Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) (3110)*. The vegetation is considered to be in good and stable condition. The Marsh Clubmoss was not recorded from habitats around Lough Guitane, despite suitable habitat present (most notably in the area adjacent Horse Island).

The current extent of the *Littorelletalia uniflorae* vegetation has developed in response to current fluctuations in water level, relating to the extent, frequency and duration of max drawdown levels.

Predicted changes in water fluctuation as a result of climate change will result in an increase of drawdown by 0.87m and an increase of the area affected by max drawdown period by 2.85% and this will occur once every 20 years. This change is considered to be of very low magnitude relative to the size of the lake, the present extent of vegetation cover and current levels of seasonal and annual variation.

It is proposed that a long term monitoring programme is established to determine actual effects of predicted and/or actual changes in water level fluctuations. The monitoring should include:

- An annual appraisal of water level fluctuations relative to current and predicted fluctuations
- Establishment of fixed reference points around the lake to monitor changes in extent and composition of *Littorelletalia uniflorae*.
- Regular monitoring and appraisal of reference points and actual changes.

4.9 References

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4.10 Guidelines for Ecological Evaluation and Impact Assessment

Outline of decision-making framework within the Regini (2000) *Guidelines for Ecological Evaluation and Impact Assessment*.

Table 1. Levels of Ecological Value

Ecological Value	
A	International value
B	National value
C	Regional Value
D	High local value
E	Moderate local value
F	Low local value
G	Negligible

Table 2. Impact Magnitude

High magnitude Loss of most of the site (i.e. >50% of the site area). Other effects (e.g. disturbance or damage arising from pollution) including indirect impacts having an adverse impact equivalent in nature conservation terms to a loss of >50% of the site area
Medium magnitude Loss affecting 20-49% of the site area. Other effects (e.g. disturbance or damage arising from pollution) including indirect impacts having an adverse impact equivalent in nature conservation terms to a loss of 20-49% of the site area.
Low magnitude Loss affecting 4-19% of the site area. Other effects (e.g. disturbance or damage arising from pollution) including indirect impacts having an adverse impact equivalent in nature conservation terms to a loss of 5-19% of the site area
Very low magnitude Loss affecting 4% of the site area. Other effects (e.g. disturbance or damage arising from pollution) including indirect impacts having an adverse impact equivalent in nature conservation terms to a loss of 4% of the site area

Table 3. Impact Significance Matrix

Impact Magnitude	Value of Feature					
	International	National	Regional	High Local	Moderate Local	Low Local
High	Critical	Major	Major or Moderate	Moderate or Major	Minor or Moderate	Minor
Medium	Critical	Major	Major or Moderate	Moderate	Minor or Moderate	Minor
Low	Critical	Major or Moderate	Moderate	Moderate or Minor	Minor	Negligible or Minor
Very low	Critical	Moderate	Moderate	Moderate or Minor	Negligible	Negligible

4.11 Photographs



Figure 4.1 Submerged Plants of *Litorella uniflora* Rosettes
These are growing patchily on mixed substrates



Figure 4.2 Exposed Shore of Lake
Note the exposed stumps of trees (former riparian woodland)



Figure 4.3 Exposed Shore of Lake

*Showing extensive *Littorella uniflora*, *Lobelia dortmanna* (right foreground) and *Juncus bulbosus*.*



Figure 4.4 Horse Island

*Note stands of *Cladium mariscus* to right, forming a stand in relatively shallow waters on peaty soils*



Figure 4.5 Northern Shore

This is dominated by scrub on degraded peat soils.



Figure 4.6 The South East Shore of Lough Guitane

Wet grassland, woodland and scrub habitats.



Figure 4.7 The West Shore of Lough Guitane
Wet woodland and marsh bordering the lake



Figure 4.8 Suitable Habitat for Marsh Clubmoss
Adjacent Horse Island on the south shore of Lough Guitane.

Section 5 Fish Migration Effects

5.1 Introduction

Lough Guitane is part of the River Flesk subcatchment of the Laune catchment, which includes Lough Leane. The Flesk can be seen at the top of Figure 5.1 as can the full length of the Finow River, which flows from Lough Guitane to the Flask.

Following the consultations referred to in section 1.3, a survey of the outflows from all the streams that discharge into Lough Guitane was undertaken. There are four such streams. They all flow into the southern side of the lake. Three are quite minor streams and one, called the Cappagh River is more sizeable.

The mouth of each stream was surveyed in chest waders to enable a thorough examination of the bed levels and variations, down to a depth of approximately 1.5m. Beyond this depth a staff was used to check for potential obstructions such as sudden drops in level.



Figure 5.1 Map of Lough Guitane showing Inflowing Stream Locations

5.2 Background Data

The Central Fisheries Board / South Western Regional Fisheries Board undertook a survey of the Flesk subcatchment in July/August 2000⁴. This found high densities of salmon fry and parr throughout the sub catchment.

The Finow was found to be particularly productive with good numbers of both salmon fry⁵ and parr⁶ recorded. Trout numbers were lower⁷, as was found to be the case through most of the larger channels in the catchment.

Upstream of Lough Guitane, the Cappagh River was surveyed and lesser numbers of salmon parr were found while no salmon fry were found. This shows that there was little or no successful recruitment from the previous season (late 1999) while there was some from the season before that (late 1998). Trout numbers⁸ were in a similar range to those found in the Finow.

Data on trout stocks was also gathered as part of the char survey (see Appendix IV) and indicates a good stock of small trout.

The lake has been thoroughly surveyed as part of this Assessment for presence of Artic Char *Salvelinus alpinus* (char) and no evidence of a population was found. As their name suggests, char are found at high latitudes. Ireland is along the southern part of the species range and populations here are largely confined to deeper and colder lakes such as Lough Guitane. They require clean cold water and are very sensitive to changes brought on by eutrophication processes so Lough Guitane would be considered a likely habitat.

Anglers who reported on fishing the lake since the 1950s stated that they had never caught nor has they heard of any char⁹ being caught and anglers tend to catch some char in lakes where they do occur¹⁰. This concurs with the findings of the survey that is documented in Appendix IV to this report.

5.3 Stream #1

This is the westernmost of the four streams. It is generally less than 0.3m wide. Its lower stretch has a steep profile. It has a mixed rocky to gravelled bottom. On date of this survey¹¹ there was a sharp drop of approx 0.4 m in its bed level, approximately 1m upstream from the lake's edge (Behind the dead branch to the rear left of the photograph in Figure 5.2.). The top of this drop was obstructed by a number of scrub bushes, dead branches and a large boulder. The lakeshore below this drop is stony and gradually shelving. The stream channel does not continue below this drop. Of all the streams this one is the least likely to provide significant spawning and nursery potential. Its accessibility to migrating fish is also the most difficult. During periods of low water its accessibility is likely to be significantly reduced due to the lack of a channel between the drop described above and the lake.

⁴ Roche, W. (2001) *Summary Report on Electrofishing Results from the Lough Leane Catchment 2000. Report for Southwestern Regional Fisheries Board.* Central Fisheries Board, Dublin

⁵ min. densities of .613 to .778/m²

⁶ min. densities of .298 to .377/m²

⁷ min. fry densities of .029 to .062/m² and min. parr densities of 0 to .019/m²

⁸ minimum density of .014/m² fry and .035/m² parr

⁹ pers. comm.

¹⁰ e.g. Lough Inagh, Co. Galway

¹¹ On 24/7/2008 when the lake's surface level was at 78.5mOD, which is .29m below the barrage crest level.



Figure 5.2 Mouth of Stream #1¹²

5.4 Stream #2

This stream is approx 0.3m wide. Its lower reaches have a fine gravel bottom which gradually falls deepens and becomes more sandy, opening out into a shallow sandy bottomed bay behind Horse Island. During periods when the lake's water level is drawn down, it is unlikely that there will be any significant additional obstacles to migrating fish.



Figure 5.3 Mouth of Stream #2¹³

¹² (See Figure 3.14 in Section 3.14 for alternative view.)

¹³ See Figure 3.16 in Section 3.14 for alternative view.

5.5 Stream #3

Approximately 100m upstream of the lake the bed of this small stream is made up of mixed size gravel and small rocks, as shown in Figure 5.4.



Figure 5.4 View of Stream #3 approx. 100m u/s from Lake

Below this level its flow rate slows down and the bed gradually becomes more weed covered. As it approached the lakeshore the stream is still and reed fringed. It flows out into a shallow sandy bay behind Horse Island as shown in Figure 5.5. During periods when the lake's water level is drawn down, it is unlikely that there will be any significant additional obstacles to migrating fish.



Figure 5.5 Mouth of Stream #3

5.6 Cappagh River

This is the largest of the four streams. Its main channel is approximately 6km long. The stretch closest to the lake has bushes and trees along both banks which overhang a slow flowing channel, approximately 1 – 1.5m in depth¹⁴. The depth gradually increases towards the lake and with the exception of fallen tree branches, there are no significant obstructions along the bed, such as sudden drops that might create falls during periods of additional drawdown (i.e. 77.417 to 77.077mOD).



Figure 5.6 Mouth of Cappagh River¹⁵

5.7 Spawning Gravels on Lake Margins

Salmon and trout generally spawn in flowing water. Trout have been documented¹⁶ as spawning on gravelly lake shores in a limited number of small, unproductive lakes in various parts of Ireland where other spawning facilities are poor or absent.

There are ample areas of the tributary streams, particularly the Cappagh River, with suitable flow, depth and gravels that are suitable for spawning. Any potential effects on the spawning success of salmon and trout due to lowered water levels during periods of additional drawdown on lake margin gravels is unlikely to be significant.

Any use of gravels at the Lake's outflow, upstream of the barrage, for spawning purposes is likely to have been curtailed by the construction of the scheme because the flow of water would have been slowed down leading to poor oxygenation and washing of the gravels. The combination of still/slow flowing water with sedimentation at this location now makes this an unlikely spawning area.

5.8 Conclusion

The additional drawdown of the lake's surface level by 0.87m (to a level of 76.547mOD) which is predicted to occur in a 20 year drought situation is unlikely to create significant new obstructions to the migration of fish from Lough Guitane into its tributary streams.

¹⁴ With lake surface level at 78.5mOD

¹⁵ See Figure 3.20 for alternative view

¹⁶ Kennedy and Fitzmaurice (1971)

APPENDIX I

TO

APPROPRIATE ASSESSMENT OF PREDICTED INCREASE IN DRAWDOWN OF THE WATER LEVELS IN LOUGH GUITANE

CIRCULAR L8/08

**Water Services Investment and Rural Water Programmes –
Protection of Natural Heritage and National Monuments**

1. The purpose of this Circular is to provide local authorities with basic guidance on identifying potential issues relating to protection of natural heritage (including sites, habitats and species) and archaeological heritage in order to prevent avoidable delays in the planning and implementation of individual schemes under the Water Services Investment and Rural Water Programmes. Where necessary, local authorities may secure professional ecological or archaeological advice and related costs may be charged to the individual scheme involved.
2. Ireland's natural heritage is afforded legal protection through the network of NATURA 2000 or European sites, Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Natural Heritage Areas (NHAs) and through the protection of species and their habitats, including those listed in Annexes to the Habitats and Birds Directives, in Schedules to the Wildlife Acts, 1976-2000, and in the Flora Protection Order 1999.
3. The Department advocates a general policy of not building treatment plants in active floodplains. It is also inadvisable to build such plants in former floodplains because of possible future needs to re-activate same.
4. Ireland's archaeological heritage is protected through the National Monuments Acts, 1930 – 2004, and through the various Planning and Development Acts. The policy of the Department in relation to the protection of archaeological heritage is set out in *Framework and Principles for the Protection of the Archaeological Heritage* (published by the former Department of Arts, Heritage, Gaeltacht and the Islands in 1999). The Department's policy with regard to excavation is outlined in *Policy and Guidelines on Archaeological Excavation* (D.A.H.G.I., 1999). Both documents may be downloaded from the Departmental Website www.archaeology.ie.

5. In order to identify potential ecological or archaeological constraints, all water services projects, including pipework proposals, should be subjected to initial screening in accordance with:

- the checklist in Appendix 1 for natural heritage, and
- the checklist in Appendix 2 for archaeological heritage.

Where initial screening reveals, or cannot exclude with certainty, a likely significant ecological or archaeological impact, an assessment of impacts will need to be undertaken. For natural heritage in general, this will involve an ecological impact assessment. In the case of potential impacts on Natura 2000 or European sites (SACs and SPAs, including any candidate sites), AA (appropriate assessment) is required under Article 6(3) of the Habitats Directive. Consideration should also be given to alternative sites at an early stage.

6. AA will entail preparing a full assessment and statement of the potential direct, indirect and cumulative impacts on any Natura 2000 site and its conservation objectives - it must include measures to avoid or mitigate the impact. In addition to professional ecological expertise, which will be necessary in this context, other expertise may also be required (e.g. hydrological or hydrogeological).

In the event that the potential effect of such an impact on a Natura 2000 site cannot be avoided or fully mitigated, a further process may apply under Article 6.4 of the Habitats Directive and would include examining all available alternatives, communication with the EU Commission and preparation of compensatory measures. Such measures will inevitably result in significant delay. Early identification and avoidance of potential impacts is, therefore, the best option. Useful guidance is available from the EU Commission's website:

http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/guidance_art6_4_en.pdf

To avoid as far as possible further delays where the impacts of a selected site cannot be avoided or fully mitigated, alternative sites/options need to be examined so there can be confidence the site selected has the least environmental impacts. A cost and design analysis of the alternative sites and their environmental impacts should be undertaken.

7. In the case of archaeology, assessment will entail preparing a full statement of the potential impact on known and previously unrecorded archaeological material. Firstly recommendations should be made on how to avoid impacts on the archaeological

resource. If it is not possible to re-align or redesign to avoid impacting on archaeological material, proposed mitigation measures, including geophysical analysis, test excavation, preservation-by record, post-excavation and publication of the results of excavation, should be detailed. Professional archaeological expertise would be necessary in this context.

Known monuments can be identified from the record of monument and places for each county and from the website *www.archaeology.ie*. National monuments that are in State ownership or guardianship, and monuments subject to preservation orders or temporary preservation orders, should be identified and zones of visual amenity defined for them. It should be noted that indirect and direct impact on national monuments in State or local authority care, or subject to a preservation order, will require the consent of the Minister for the Environment, Heritage and Local Government under section 14 of the National Monuments Act, 1930, as amended by Section 5 of the National Monuments (Amendment) Act, 2004.

Areas of previously unrecorded archaeological potential, i.e. within or adjacent to constraint areas for known monuments, wetland locations, areas with a distinctive topography indicative of high archaeological potential, should be identified.

The primary aim of all recommendations for mitigation should be to minimise further archaeological excavation while preserving archaeological material.

8. Following initial assessment in accordance with Appendix 1 or 2, as appropriate, any proposal likely to have an impact on protected habitats or species or on a national monument should immediately be notified to:

*Development Applications Unit
Department of the Environment, Heritage and Local Government
Dún Scéine
Harcourt Lane
Dublin 2*

and copied to the Department's Water Services Section.

DAU will endeavour to make a co-ordinated response to the Planning Authority within a period five weeks from date of receipt of the proposal.

9. More detailed procedural guidance is being prepared and will be notified to local authorities as soon as possible. In the meantime, enquiries in relation to this Circular may be addressed, as appropriate, to:

- Tom Walsh, Water Services Section, Tel 01-8882168, e-mail *tom.walsh@environ.ie*
- or
- Dr Elizabeth Sides, NPWS Conservation Systems & Marine Tel 01-8883288, e-mail *elizabeth.sides@environ.ie*

Terry Allen
Principal Officer
Water Services Section
Bl. 1 Fl. 2
Irish Life Centre
Lr. Abbey St.
Dublin 1

To: Directors of Services (Water Services)

APPENDIX 1

Water Services Schemes - Natural Heritage Checklist for Local Authorities

This screening methodology is designed to assist those planning and designing water services solutions when determining whether AA for Natura 2000/European sites or habitats & species listed in the annexes of the EU Birds and Habitats Directives is necessary or not. It should also be applied to NHAs

Water Services infrastructure projects relate to the provision, operation and management of drinking water and wastewater services. These projects hold a high health and safety value for the public as well as being of benefit for biodiversity - it is therefore essential that such projects are screened at the earliest stage to avoid situations where nature conservation and human health and safety are pitched as competing interests.

This screening methodology will be reviewed regularly to ensure it remains consistent with the programmes of measures and River Basin Management Plans (RBMPs) currently being developed under the Water Framework Directive (WFD).

What projects must be screened?

For new projects and significant changes to any existing operations, if the answer is 'yes' to any of the following, the project (i.e. construction, operation and maintenance) must be screened for its impacts:

1. Is the development in or on the boundary of a nature conservation site NHA/SAC/SPA?
2. Will nationally protected species be directly impacted? Wildlife Acts (1976 and 2000), Flora Protection order (S.I. 94 of 1999)?
3. Is the development a surface water discharge or abstraction in the surface water catchment¹, or immediately downstream of a nature conservation site with water dependant qualifying habitats/species²?
4. Is the development a groundwater discharge or abstraction in the ground water catchment¹ or within 5 km of a nature conservation site with water-dependant qualifying habitats/species²?
5. Is the development in the surface water or groundwater catchment of salmonid waters?
6. Is the treatment plant in an active or former floodplain or flood zone of a river, lake, etc?
7. Is the development a surface discharge or abstraction to or from marine waters³ and within 3km of a marine nature conservation site?
8. Will the project in combination with other projects (existing and proposed) or changes to such projects affect the hydrology or water levels of sites of nature conservation interest or the habitats of protected species?

NB Please use the Diagram below to work through the screening requirements.

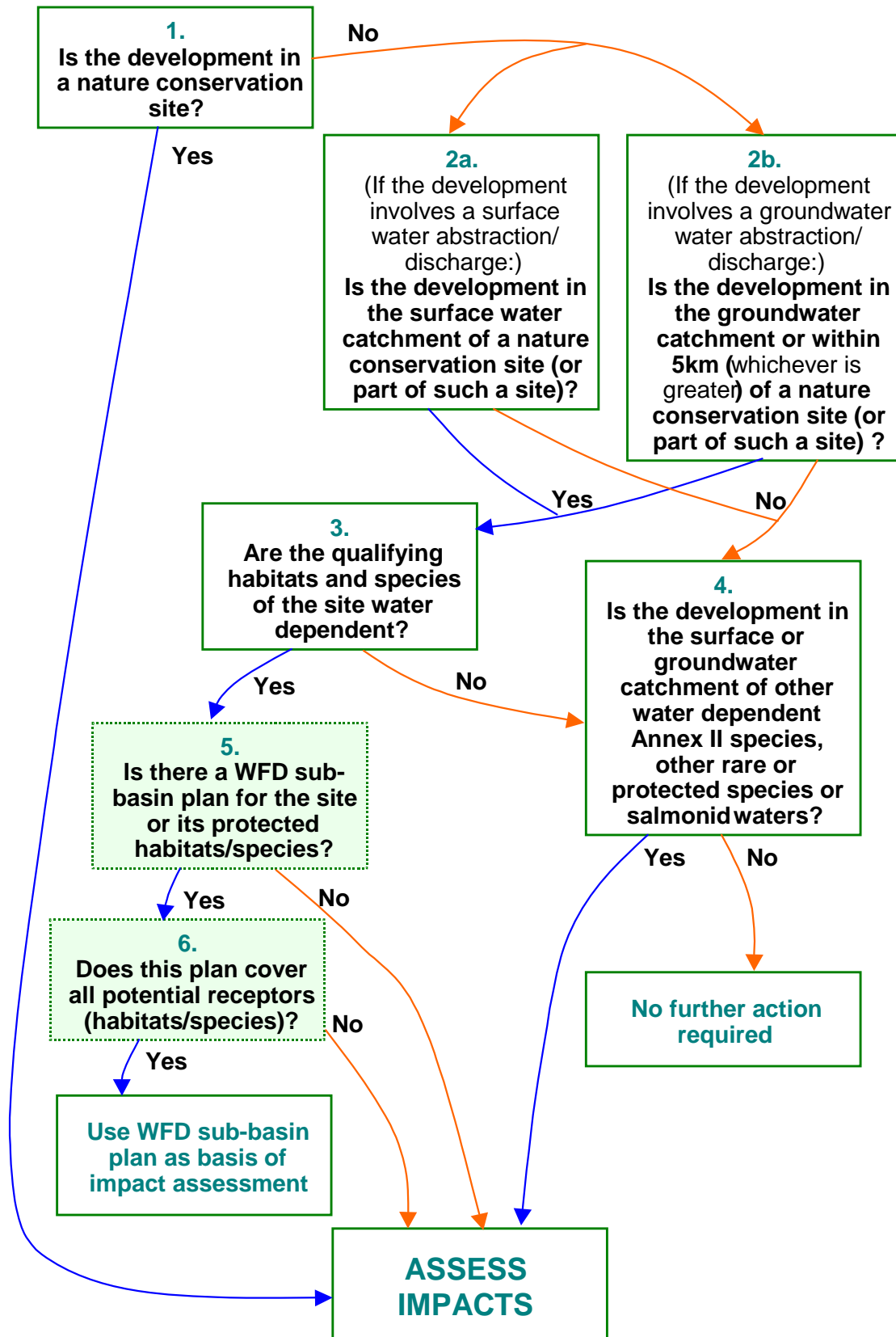
Note ¹. If there is a WFD sub basin plan for the sites or its protected habitats and the plan covers all potential receptors, i.e. habitats and species, this plan can be used as the basis for screening and impact assessment.

Note ². Estuaries are considered part of a catchment.

Note ³. Any marine area including estuaries

Below is a flow diagram for screening water services infrastructure projects, followed by explanatory notes on the diagram and other points of information. If the conclusion of the screening outlined in this **Natura 2000 Screening Protocol** is to “**ASSESS IMPACTS**”, then the plan or project must be referred to the Department of the Environment, Heritage and Local Government’s Development Applications Unit.

NB Catchments of habitats and species of conservation value are addressed here as it is only through examining catchment-wide pressures that hydrological, water pollution and cumulative impacts can be properly assessed.



Notes on flow diagram (Numbers correspond to question numbers in the Figure 1):

1. This question relates to direct impacts only and, therefore, all habitats and species of nature conservation value must be considered. If the development is within a Natura 2000 site, there is potential for direct loss of habitats and/or species of conservation value within the footprint of the development. The footprint includes all temporary and permanent access roads, trenching etc. The standard guidelines for the referral of all development applications that are adjacent to SACs to NPWS (i.e. within 500m), should also be followed here.
2. This and subsequent questions relate to indirect impacts, which are transmitted through water and, therefore, only have the potential to impact upon water dependent species. All projects in the catchments of conservation sites (i.e. both within and upstream of the site) have the potential to impact on the site and to contribute to the cumulative impacts on the site. The 5km stipulation is placed in Question 2b as it was used in the groundwater risk assessments for groundwater dependent conservation sites. Groundwater catchments are the zones of a groundwater body that contribute water to a receptor such as a conservation site. These catchments can be altered, however, through very large abstractions in certain aquifer types. Because these groundwater divides can change, the extra protection of 5km was included.
3. Habitats Directive Annex I habitats and Annex II species have been divided into water dependent (see tables 1 and 2 below) and non-water dependent for the purposes of the WFD. The list of water dependent birds will be finalised shortly. Within most conservation sites, particularly the large SAC-complexes, some areas will contain water dependent habitats/species and others will not. This means that the SAC boundary cannot be taken as indicative of the location of the relevant habitat or species. As a result, the local authority will require the specific locations of the habitats and species in order to screen these projects. These data will need to be collected through surveys where the information is not available from NPWS or other sources. NPWS do not generally have the locations of habitats and species on a single GIS, or other readily available formats. Useful information will be available through NPWS monitoring programmes and databases, such as the rare flora database, as well as through NPWS management plans. NPWS has a public mapviewer tool in place at <http://www.npws.ie/en/MapsData> and is planning the development of a GIS that will be accessible to local authorities.
4. The data for Annex II species in the wider countryside and other protected/rare species (outside designated sites) is less complete and requires further field surveys and data collection. Furthermore, as these species could extend even further downstream than the nature conservation sites, the downstream area that would need to be assessed for potential impacts could be significantly extended by this question.
5. No WFD sub-basin plans have yet been developed. However, 27 *Margaritifera* sub-basin plans will be drafted before the end of 2008. Further such catchment plans will be developed for other species and habitats in SACs. These will set specific nature conservation and water quality/quantity targets for the sites and will prescribe the management measures that need to be undertaken within their catchments.
6. These sub-basin plans are likely to be species/habitat specific so that, even when such plans exist, all potential receptors may not be assessed and further assessments may be required for water services projects. Where sub-basin plans exist, it is likely that these can be used in combination with further impact assessments.

Many water services projects are likely to require assessment. This is particularly the case because of the occurrence of Annex II species (EU Habitats Directive 1992) in the wider countryside, other rare/protected species (Wildlife Acts) and salmonid waters.

APPENDIX 2

Water Services Schemes – Archaeological Heritage Checklist for Local Authorities

Any scheme that extends within or impinges upon the confines of the “black line” drawn around a monument on the Record of Monuments and Places map

Any scheme that is likely to have an adverse impact on the setting and amenity of a monument on the Record of Monuments and Places map

Any scheme that may not be in proximity to known monuments but is large in scale

Any scheme that may be unduly close to archaeological complexes

Any scheme that will impact on rivers, lakes, the inter-tidal zone, the foreshore or any underwater area where historic shipwrecks or other other underwater archaeological objects e.g. ships’ timbers, may be located

Any scheme that requires an Environmental Impact Statement

Any scheme that may have an adverse impact on the setting and amenity of any national monument in the ownership or guardianship of the Minister for the Environment, Heritage and Local Government or any national monument in the ownership or guardianship of a local authority or any national monument that is subject to a preservation order

APPENDIX II

TO

APPROPRIATE ASSESSMENT OF PREDICTED INCREASE IN DRAWDOWN OF THE WATER LEVELS IN LOUGH GUITANE

WATER ABSTRACTION ORDER

KERRY COUNTY COUNCIL

CENTRAL REGIONAL WATER SUPPLY SCHEME

WATER SUPPLIES ACT, 1942.

PROPOSAL

Section 2. Kerry County Council acting in accordance with the provisions of the Water Supplies Act, 1942 proposed to use the lake known as Lough Guitane and the Owgarriff River, near Killarney, in the County of Kerry as a source for the Central Regional Water Supply Scheme.

Section 3. - (1)

- (a) The sources of water from which the supply of water is proposed to be taken are Lough Guitane and the Owgarriff River near Killarney, in the County of Kerry.
- (b) The places at which the supply of water is proposed to be taken are (1) the outlet from Lough Guitane and (2) at level 500.00ft. Over Datum (152.40m O.D.) on the Owgarriff River
- (c) Part only of the water is proposed to be taken at the places referred to in subparagraph (b) above.
- (d) The maximum proposed rate at which part only of the water at such places is proposed to be taken will not exceed 12.0 million gallons per day from both sources combined.

- (e) A low level concrete barrage will be constructed across the outlet from Lough Guitane. In this structure will be incorporated sluice gates, a fish pass and a device for measuring the quantity of compensation water.

The estimated lowest summer level of the lake is 254.0 ft. O.D. (77.42m O.D.). It is calculated that in an extremely dry year the level of water in the lake will fluctuate by 4.51 ft. (1.375m).

The overflow level of the barrage will be 258.5 ft. O.D. (78.79m O.D.) which is 1.3 feet (0.40m) higher than the level of 257.2 ft. O.D. (78.39) shown on the O.S. sheets for 20/12/1893, 2.06 feet (0.63m) higher than 256.44 feet O.D. (78.16m O.D.) which was the level on 26/8/1974 and 4.5 feet (1.37m) above the estimated lowest summer level of 254.0 ft. O.D. (77.42m O.D.).

The maximum estimated future draw-down level will be 0.01 feet (0.003m) below the estimated lowest summer level.

A minimum quantity of 2.0 million gallons per day (9092 cubic metres per day) compensation water will be made available downstream of the Lough Guitane barrage.

- (f) The minimum quantity of water flowing past the proposed abstraction point in the Owgarriff River was 19,000 gallons per day (86.4 cubic metres per day) on a number of days during September, 1972.

250,000 gallons per day (1136 cubic metres per day) compensation water will be allowed downstream of the Owgarriff Intake, provided that there is at least this quantity in the river. When the flow in the Owgarriff falls below this quantity, abstraction from the river will cease.

- (g) Ancilliary works will consist of the construction of a barrage incorporating regulating sluices and a fish pass across the outlet from Lough Guitane and the construction of a low concrete weir across the Owgarriff River and an Intake chamber in the river bank. These works will also include the laying of pipelines from both the barrage and the Intake chamber.

I certify the above to be a true copy of the proposal made by the Kerry County Council acting in pursuance of their powers as a Sanitary Authority for the County Health District at the Meeting held on the 27th day of July, 1975 and deposited at the office of the said Council on the 8th day of August, 1975.

Signed. B. Treacy
County Secretary

DEPARTMENT OF THE ENVIRONMENT

WATER SUPPLIES ACT, 1942.

WHEREAS in pursuance of Section 2 of the Water Supplies Act, 1942, the Council of the County of Kerry (hereinafter called "the Council") on the 28th day of July 1976 made a proposal for the taking of a supply of water from Lough Guitane and the Owgarriff River for the purposes of the Central Regional Water Supply Scheme.

AND WHEREAS the Council have applied to the Minister for the Environment (hereinafter called "the Minister") for a Provisional Order declaring that the said proposal may come into force.

NOW THEREFORE the Minister, in exercise of the powers vested in him by Section 9 of the Water Supplies Act, 1942, hereby orders and declares as follows:-

- (1) The said proposal may come into force without alteration.
- (2) This Order may be cited as the Central Regional Water Supply Scheme Provisional Order, 1979.

GIVEN under the Official Seal of the
Minister for the Environment this
23rd day of January 1979.

Sylvester Barrett
Minister for the Environment.

APPENDIX III

TO

APPROPRIATE ASSESSMENT OF PREDICTED INCREASE IN DRAWDOWN OF THE WATER LEVELS IN LOUGH GUITANE

HYRDOLOGICAL REPORT

Document Amendment Record

Client:	Kerry County Council
Project:	Kerry Central Regional Water Supply Scheme
Title:	Hydrological Review of the Preliminary Report for Central Kerry Regional Water Supply Scheme

PROJECT NUMBER: 3284				DOCUMENT REF: 3284 Central Kerry RWSS Hydrological Review RevD			
D	Revised & re-issued to NOD's	MFG	14/08/08	MFG	14/08/08	MFG	14/08/08
C	Revised & re-issued to NOD's	MFG	13/08/08	MFG	13/08/08	MFG	13/08/08
B	Issued to NOD's	MFG	04/02/08	MFG	04/02/08	MFG	04/02/08
A	Issued to NOD's	MFG	31/10/07	MFG	31/10/07	MFG	31/10/07
Revision	Description & Rationale	Originated	Date	Reviewed	Date	Authorised	Date
TOBIN Consulting Engineers / Nicholas O'Dwyer Consulting Engineers							

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Hydrological Review of the Preliminary Report for Central Kerry Regional Water Supply Scheme

1.0 INTRODUCTION

1.1 BACKGROUND

The Scheme is supplied from a combined abstraction from two sources, the Owgariff River, and Lough Guitane, which is impounded. There is an intake structure on both sources, but the intake on the Owgariff is elevated, at 150 mOD, which allows Owgariff water to gravitate to the main Service Reservoir for the scheme at Sheheree. The outflowing stream from Lough Guitane forms the Finow River, into which the Owgariff flows a short distance downstream.

There is some flow data available for the Owgariff, derived from ESB water level data, for the period 1943-1966 from which a Flow-Duration Curve was derived (EG Pettit Preliminary Report page 17). Processed data from the EPA for the years 1978-1981 has been obtained and reviewed for the Owgariff, but there are significant gaps in the record. In our discussions with the EPA, they have indicated that the station could be readily reactivated on request by Kerry County Council to the EPA. There is no equivalent flow data available, for the Lough Guitane outflow, other than that provided in the EG Pettit Preliminary Report.

The Water Rights Order (WRO) permits abstraction of 54,540 cu.m/d from the combined sources of Lough Guitane and the Owgariff River and has independent constraints with respect to each source. Compensation water on the Owgariff is set at 1136 cu.m/d (0.013 m³/s), below which outflow rate the water abstraction must cease. It is noted that this does not amount to a guarantee of compensation flow at this rate at all times.

On Lough Guitane, the maximum estimated future drawdown level indicated in the Water Abstraction Proposal is 77.417mOD, 1.373m below the weir crest level of 78.79 mOD. A compensation flow of 9,092 cu.m/d (0.105 m³/s) is to be provided as a matter of guarantee alongside the water supply abstraction. Levels in the WRO are quoted related to Poolbeg OS Datum, the Preliminary Report and its associated drawings have held this approach, and we follow in the same approach to maintain consistency.

Water is drawn from the lake via twin 1200 mm diameter Inlet Pipes, which enters the sump at an invert level of 75.91 mOD, though the invert of the twin pipes in the lake is quoted at 76.10 mOD in the Preliminary Report.

1.2 OWGARRIFF RIVER

1.2.1 *Hydrological Characteristics*

Table 1(a) below contains hydrological details relating to the Owgariff River upstream of the existing intake. The Owgariff catchment area is quoted at 6.92 sq.km by EPA and at 7.2 sq.km in the PR; we conservatively assumed the smaller value to be correct. Long Annual Rainfall has been quoted by EPA at two significantly different values in different periods of the record; the higher value has been used in the Preliminary Report. Our approach is not based on rainfall, but on scaling the recorded flows on the Owengarriff at Torc pro rata on catchment area.

EPA quote the 95 Percentile Flow at a value very close to the compensation water rate of flow in the Water Rights Order.

		Preliminary Report	EPA Hydrometric Stations (Stn 22005)
Water Supply Intake Level		152.00 m OD	
Catchment Area to Intake		720 ha 7.2 sq.km	692 ha 6.921 sq.km
30 Percentile Flow (ESB 1943-1966)		0.44 cu.m/s 38,016 cu.m/d	
90 Percentile Flow (ESB 1943-1966)		0.06 cu.m/s 5,184 cu.m/d 13.6% of average flow	
95 Percentile Flow (EPA)			0.015 cu.m/s 1,296 cu.m/d
Long Average Rainfall on Catchment	1941-1960 1971-2000	2,800 mm	2,800 mm 2,007 mm
Evapotranspiration on Catchment		500 mm	
Average Runoff		2,300 mm 45,370 cu.m/d	43,612 cu.m/d

Table No. 1(a) – Owgariff River: Summary Statistics

Lowest daily flows provided by the EPA are tabulated below in Table 1(b), but the individual years were not particularly dry ones and the record is too short to accurately infer low flows at long return periods.

1978	0.033 m ³ /s	2,884 cum/d
1979	0.031 m ³ /s	2,712 cum/d
1980	0.093 m ³ /s	8,051 cum/d
1981	0.028 m ³ /s	2,453 cum/d

Table No. 1(b) – Low Flows 1978 – 1981 (EPA)

The ESB gauging station is located downstream of the intake on the Owgarriff, and is no longer operational. Prior to the commissioning of the water supply intake, flows passing the ESB weir would have measured total flow from the catchment of the Owgarriff to that point. If this weir is reactivated as a flow measurement location, it will be necessary to also record daily water quantities abstracted at the upstream intake, since flow from the Owgarriff catchment would in current circumstances be the sum of the water abstracted, and the residual water allowed to pass the ESB weir site.

Because the water supply abstraction was not in place at that time, the above flows in Table 1(b) are true low flow figures from the catchment, albeit in unexceptional years.

In the late 1990's, Kerry County Council decided to use the Owgarriff water supply as a means to generate power for the Lough Guitane Plant. The intake on the Owgarriff, is at 150m OD, from where a 500mm raw water main conducts flow towards the WTP. At the WTP site, a by-pass now directs flow to the turbine. Outflow from the turbine discharges directly to the Finow River. This configuration means that, at present, water for water supply is taken primarily and preferentially from Lough Guitane, and water taken through the turbine is not impounded, even if Lough Guitane water level is below the weir crest.

1.2.2 Water usage in power generation

We have examined the revenue profile generated from hydroelectricity production, making some assumptions on turbine efficiency, as a means of inferring approximate quantities of water which have been taken through the turbine over the period from 2001- 2007.

It can be seen from Appendix No. 1 that calculated mean flows discharged to the Finow River vary, up to a maximum of about 0.3 m³/s in wintertime, to flows more in the range 0.17 m³/s -0.22 m³/s at other times, except when limited by available water, and at such times generation can cease. It is interesting to note however, that often in late spring, and even in dry years such as 2005, significant water quantities were being taken through the turbine, and discharged to the Finow River, in excess of the compensation flow requirement. If, as seems likely, Lough Guitane water level would have been drawn down to some degree at such times, then this represents water which need not have been withdrawn for water supply

from storage, if the tailrace flows were directed to the water supply intake, instead of being discharged below the impounding weir..

1.3 LOUGH GUITANE

The principle hydrological statistics for Lough Guitane are tabulated below in Table No.2, as abstracted from the Preliminary Report. The lake area is given as 250 ha; and earlier reports have remarked on the relatively steep sides, and the presence of depths over 30 m close to the shoreline, so that we have assumed that lake area would vary approximately 10% over a 2m water level range.

Weir Crest Level		78.80 m OD
IL of Intake Pipe (2 No 1200mm diam)		76.10 m OD
Floor level of Intake Sump		75.30 m OD
Estimated Maximum Drawdown level in WRO		77.417 m OD
Estimated Summer Level pre-impoundment		77.420 m OD
Lake Level Range (2001)	max	79.00 m OD
	min	77.60 m OD
Water Depth Range (WRO)		1.383 m
Estimated Stored Water over this range		3,457,500 cu. m.
Catchment Area to Intake		1900 ha 19.0 sq.km
Lake Surface Area		250 ha
Average Flow		NA
Estimated 90 Percentile Flow (ESB 1943-1966)		0.14 cu.m/s 12,067 cu.m/d
	based on assumed fraction of:	13.6% of average flow
Long Average Rainfall on Catchment		2,200 mm
Evapotranspiration on Catchment		500 mm
Average Runoff		1,700 mm 88,493 cu.m/d

Table No. 2 – Lough Guitane Summary Statistics (Preliminary Report)

1.4 WATER RIGHTS ORDER

The principal constraints in the existing water Rights Order from 1979 are as follows:

Abstraction Rate from the combined sources	54,540 cu.m/d
Estimated Lowest Summer Level on Lake pre-impoundment	77.42 m OD
Expected range on the lake	1.373 m
Lowest Flow rate naturally (September 1972)	86.4 cu.m/d
<i>Projected Infrastructure details in Proposal</i>	
Weir Overflow level	78.79 m OD
Max estimated future drawdown level	77.417 m OD
<i>Compensation Water commitments</i>	
Downstream of weir on Lough Guitane	9,092 cu.m/d 0.105 cu.m/s
Downstream of Owgarriff Intake provided there is at least this quantity in the river	1,136 cu.m/d 0.013 cu.m/s
Abstraction from Owgarriff ceases when flow is below this	
Expected Durations of individual abstraction:	
<i>Owgarriff River</i>	
Demand	54,540 cu.m/d
Compensation Water on Owgarriff	1,136 cu.m/d
Target Flow	55,676 cu.m/d
Estimated %-ile of this flow on Owgarriff	18%
Estimated Duration of drafts on storage	82%
<i>Lough Guitane</i>	
Demand	54,540 cu.m/d
Compensation Water on Owgarriff	9,092 cu.m/d
Target Flow	63,632 cu.m/d

Table No. 3 – Water Rights Order Summary Statistics

The Water Rights Order was developed from the flow statistics of the 1969 -1973 period, which included the three driest years on record, and from a cumulative run-off plot for 1972, the driest year of record at the time.

1.5 ADJOINING CATCHMENTS

We have examined the likely relationship between flow and duration on the Owgarriff and Lough Guitane catchments, by reference to adjacent catchments of comparable size, with the Owengarriff at Torc also having a similar Long Average Rainfall.

	Long Average Rainfall		Catchment Area
	1941-1960	1971-2000	
Owgarriff	2800 mm	2007 mm	6.661 sq.km
Lough Guitane	2200 mm		19.0 sq.km
Owengarriff At Torc Weir	2504 mm	1944 mm	8.234 sq.km
Deenagh at White Bridge	1329 mm	1586 mm	31.2 sq.km
Flesk at White Bridge	1747 mm	1834 mm	325.0 sq.km

Table No. 4 – Adjoining Catchments

A recent report prepared by Fehily Timoney for the Council in relation to a proposed hydroelectric facility in Hags Glen noted the extent to which rainfall in the Magillicuddy Reeks, just west of the Mangerton range, is heavily dependent on elevation, with recorded rainfall at Lough Callee in Hags Glen being double that for the same period at Valentia Synoptic Station. Water-balance techniques used in that report, relating runoff to rainfall, showed further evidence that rainfall on the slopes above the sites of the rainfall gauges was significantly higher than that recorded by the gauges.

2.0 ABSTRACTION STRATEGY

The main strategy to minimise drafts on the impoundment would be to abstract all required water from the Owgarriff in the first instance, while maintaining its' compensation water, and supplementing any shortfall from Lough Guitane. Later in the season, when the compensation water constraint begins to impose itself on the Owgarriff, all of the required water would be drawn from Lough Guitane, again while maintaining the compensation water flow from there.

Features of this strategy are:

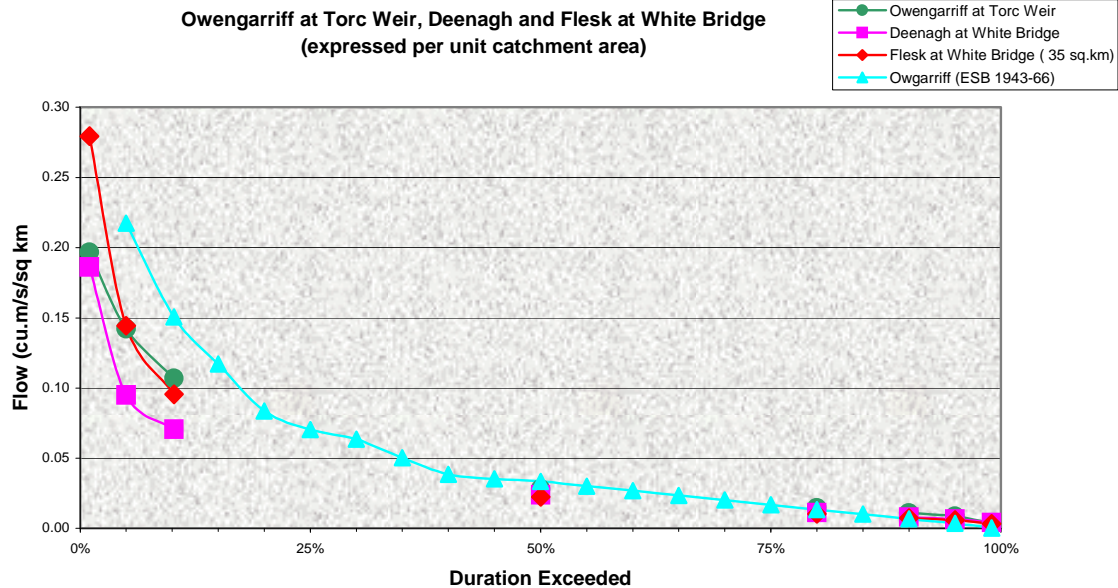
- The Lough Guitane impoundment band is not called upon, except as secondary support, and this is done at the latest possible date,
- Surplus flows on Lough Guitane will be lost over the weir crest, unless the impoundment has been drawn down sufficiently below the weir crest to capture additional water during partial recovery periods,
- Hydroelectricity generation is not compromised by this strategy,
- No other strategy would better manage both sources to maximise the combined yield, while maintaining the required compensation flows (with the constraints that apply in the Order.).

This strategy assumes that the pipework bringing raw water from the intake on the Owgariff, through the hydroelectricity generator, into supply, can carry the full 54,540 cu.m./d water demand when that water is available. The original design report for the turbine installation confirms that this is the case.

3.0 EXAMINATION OF THE FLOW/DURATION CURVES

- 3.1 We do not have a Flow Duration Curve (FDC) for Lough Guitane outflow, and the FDC provided in the Preliminary Report for the Owgariff River is taken over a multi-year record. This tells us about runoff from the Owgariff in an average sense, it does not tell us how it performs in drier-than-average years, (although these years contribute to the average). The available processed record for the Owgariff is both short and unremarkable as regards dry weather.
- 3.2 We have looked at the Flow Duration Curves for a number of other catchments, to get a sense of whether there is consistency between them, and whether they could be used to infer a Flow Duration Curve for Lough Guitane, and for the Owgariff, in those years when no direct records are available for the river.
- 3.3 Figure 1 shows the whole-record Flow Duration curves for:
- a. The Owgariff (from the Preliminary Report)
 - b. The Owengariff at Torc Weir
 - c. The Deenagh at White Bridge, and
 - d. The Flesk at White Bridge

They have been expressed in terms of flow per unit catchment area, so that they can be compared more easily.

**Figure 1**

- 3.4 There is some suggestion that the Owengarriff Flow Duration curve in the Preliminary Report may slightly overestimate the amount of water available, by comparison with a calculation based on a longer record on adjoining catchments. This may be accounted for by the larger number of significant droughts which have occurred since 1970, which are incorporated in the record of the other catchments, but which are missing from the Owengarriff data, which originate from an earlier period.
- 3.5 We have examined the Flow Duration Curves in 1995 for the Owengarriff at Torc Weir and the Deenagh at White Bridge (Figure 2). These depart significantly from the long-average Flow Duration Curves for these sites shown in Fig 1, as we would expect, and it is reasonable to suggest that the Flow Duration curves for the Owengarriff and Lough Guitane would behave in the same way, in a drought as severe as that experienced in 1995.

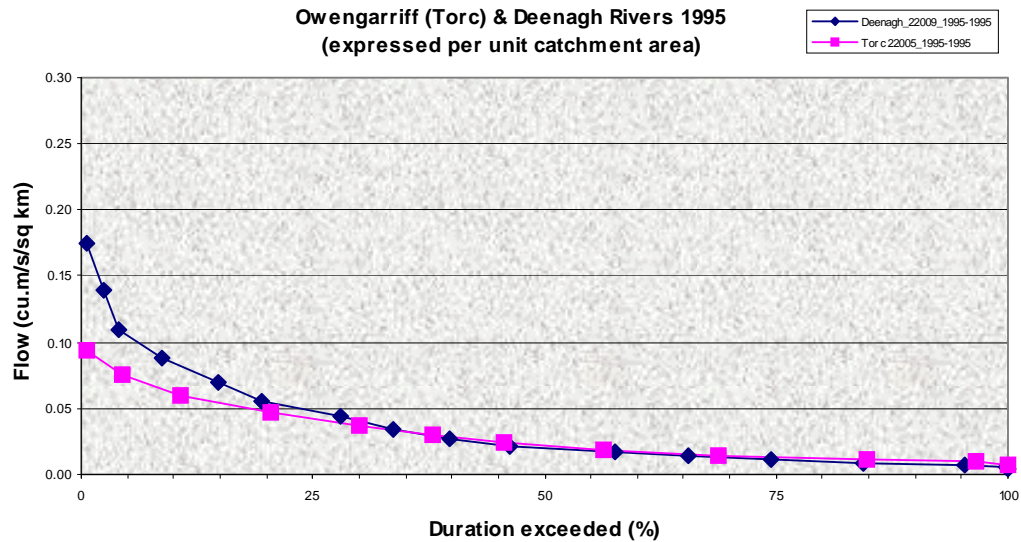


Figure 2

4.0 AN APPROACH TO YIELD ASSESSMENT

Given the position on flow records, we have looked at the yield of the combined system in the following manner:

- 4.1 The nearby Owengarriff River at Torc Weir has a processed record from 1989 to 2002 inclusive. It has a catchment area similar to the Owgarriff, and annual rainfall is not greatly dissimilar. The record commenced in 1989 at a point too late in that year, and has subsequent gaps, which make that particular year unusable, and 2001 is similarly unreliable due to the number of gaps in the record.
- 4.2 We have scaled the flows on the Owengarriff, pro-rata on catchment area, to produce an inferred parallel flow record for the Owgarriff and for the outflow from Lough Guitane, which is effectively 12 years in length.
- 4.3 Taking the lake surface area at 250 ha, and assuming that the lake level corresponds to the weir crest level at the onset of dry weather, we have applied the abstraction strategy set out above, for a demand of 54,540 cu.m/d, and we have looked at the demands on storage necessary to sustain it, in each year from 1990 to 2002, with the exception of 2001. We have assumed that any water taken through the hydropower generator on the Owgarriff, can be captured for supply, once the required compensation flow is maintained in the Owgarriff River.
- 4.4 The maximum draw from storage in each of those years is a statistic which varies between wet and dry years, and which can be computed and plotted on an Extreme

Value statistical plot. Figure 3 shows such a plot, where each data point represents the maximum drawn in an available year of record. In wetter than average years, the storage range required is small, perhaps less than 100,000 cu.m., but in dry years such as 1990 or 1995, the working storage range will be much larger, in excess of 4 million cubic metres.

- 4.5 Figure 3 shows the storage deficit statistics plotted, with return period on an EV1 statistic superimposed. Caution needs to be used in projecting 20 year and 50 year statistics from a 12 year record, and the underlying hydrology assumes that flows at Lough Guitane can be reasonably well inferred from scaling the Owengarriff record. With those constraints in mind, we expect that, at full development of projected demand, the estimated lower water level indicated in the Water Rights Order would be exceeded on average once in five to seven years.

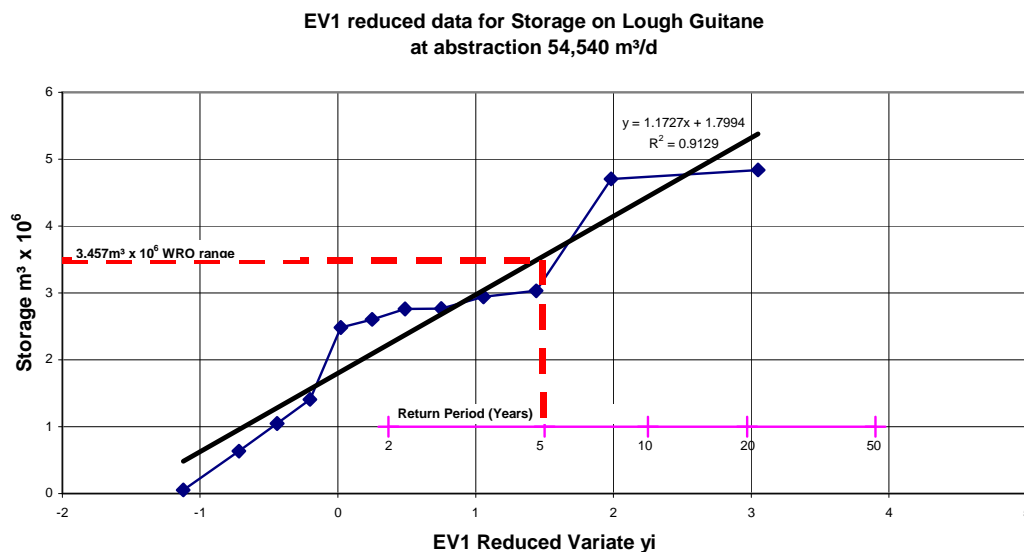


Figure 3 (a) Storage on Lough Guitane at abstraction 54,540 m³/d

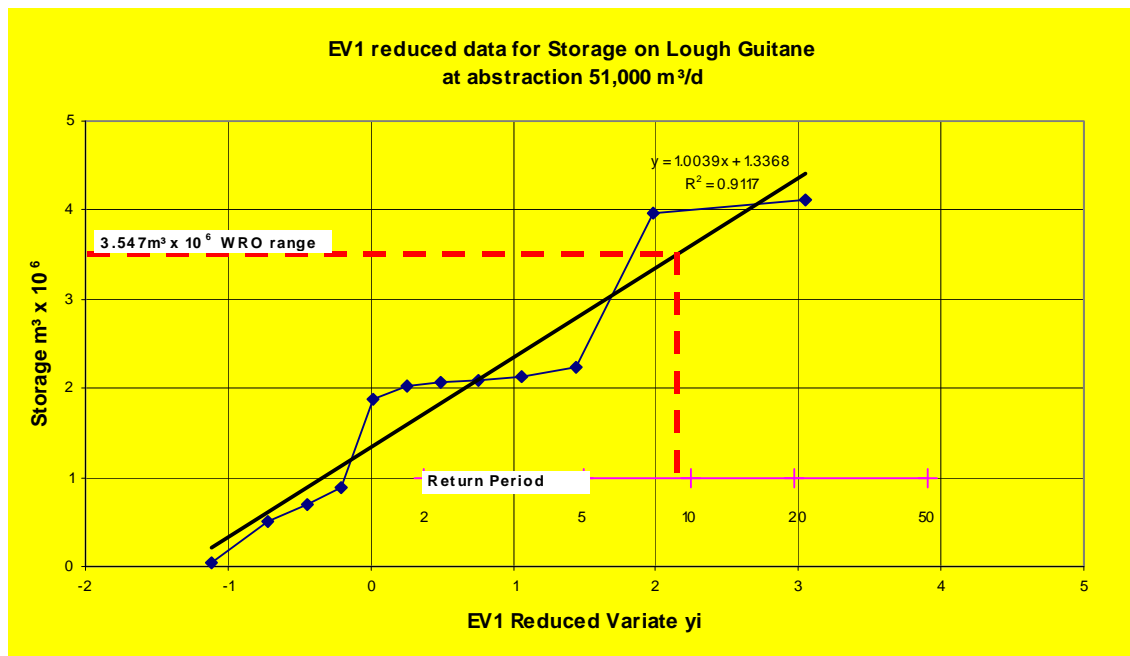


Figure 3(b) Storage on Lough Guitane at abstraction 51,000 m³/d

- 4.6 A volume of working storage of 5.4 million cubic metres (Figure 3(a)) would be needed to cater for the drought expected once in 20 years, at an abstraction of 54,540 cu.m./d plus compensation water, and this would exceed the lower level limit on the lake by an estimated 0.87 m, with due allowance for the fact that the lake area would be less at a drawdown over 2 metres below crest level. The water intake pipework could accommodate this additional drawdown. With recirculation of treated washwater and supernatants, the required draft from storage would be 4.32 million cubic metres in a 20 year drought (Figure 3 (b)), and the lower level limit on the lake would be exceeded to a lesser degree, by an estimated 0.39m. The environmental benefit of recirculation of treated supernatants and washwaters is accordingly a lesser drawdown on the lake.

5.0 CLIMATE CHANGE

The recent ICARUS Report produced by Dr John Sweeney and others at NUI Maynooth, has highlighted the emergence of global warming as a significant trend in current hydrological statistics in Ireland, and it suggests that the rate of temperature rise here may be higher than elsewhere in Europe. Appendix No. 2 provides an overview of the current knowledge and predictability for SW Ireland.

The Owgariff and Lough Guitane catchments are small and elevated, rainfall in such areas is heavily influenced by elevation and catchment orientation with respect to prevailing south westerlies, and Regional Climatological Models have a much more coarse unit scale than

these typical catchment sizes of 20 sq.km area, or less. It must be remembered too that the hydrological record from 1990 to 2002, and storage calculations based on it, already statistically includes for as much of the warming trend as was already under way in that period. We nonetheless conclude the following from the work done to date:

- (a)* The increase in temperatures annually, and especially in summer, will act with reducing relative humidity to affect evapotranspiration on the whole catchment.
- (b)* The reduction in amounts of summer precipitation will reduce summer inflows to Lough Guitane, and will reduce summer runoff from the Owgarriff.
- (c)* The increase in winter rainfall will not work to any advantage on yield, because the impoundment will quickly reach full in that season and all surplus water then spills over the weir. It may marginally accelerate recovery of the lake after a drought extending late into the autumn the previous year.
- (d)* In a small upland catchment like Lough Guitane and the Owgarriff, the three factors of temperature, humidity and rainfall will combine in a manner that reinforces their impact on reduction in yield. Higher temperature with reduced humidity will increase evapotranspiration, and will increase the development of Soil Moisture Deficit (SMD) in short dry weather periods. Flows on small catchments strongly reflect local climate and rainfall patterns, and frequency of small, high-ground rainfall events is a major factor in the preservation of yield on small-reservoir catchments. In future, such spring and summer rainfall will increasingly have to replenish increased SMD before generating usable runoff, so that less of it will be available to replenish storage. This will be partly offset by a tendency for isolated summer rainfall events to be more intense, and if the storage is drawn down at the time, such direct runoff will be captured.

Overall, we consider that we should plan for a 10% reduction on rainfall over the drought season. This will be combined with increased evapotranspiration and reduced soil moisture offsetting any partial recovery events arising from low intensity rainfall. Overall these effects would be expected to give a 10-15% reduction in the combined yield of the Lough Guitane-Owgarriff system (in a drought as severe as 1975) by the year 2030, or a reduction of 7%-10% within the design horizon of the Scheme. Introduction of recirculation of treated washwater and supernatants, as referred to above, would more than compensate for any requirement for increased drafts from storage due to climate change, so that the projected once in 20 year drawdown, below the lower limit of the operating range at present, of 0.87m would remain unchanged.



APPENDIX NO. 1

Inferred Monthly Flows from Hydropower Returns

Lough Guitane Hydro-Electric Plant: Power Output and Revenue

	2001		2002		2003		2004		2005		2006		2007	
	Output (kWh)	Value	Output (kWh)	Value	Output (kWh)	Value	Output (kWh)	Value	Output (kWh)	Value	Output (kWh)	Value	Output (kWh)	
January			91,870	€6,890.25	116,272	€10,348.21	119,119	€11,554.54	133,757	€14,847.03	77,361	€9,128.60	80,143	€10,418.59
February			97,006	€7,275.45	81,561	€7,258.93	63,622	€6,171.33	78,821	€8,749.13	40,192	€4,742.66	98,881	€12,854.53
March			97,575	€8,879.33	68,493	€6,301.36	98,489	€9,553.43	73,477	€7,898.78	98,069	€10,591.45	116,956	€16,841.66
April			62,858	€6,720.08	52,565	€4,835.98	95,213	€9,235.66	91,568	€9,843.56	70,236	€7,585.49	10,147	€1,461.17
May			107,700	€10,877.70	112,340	€10,335.28	27,757	€2,692.43	84,354	€9,068.06	95,953	€10,266.97	39,767	€4,016.47
June			96,360	€9,732.36	44,283	€4,074.04	36,354	€3,526.34	47,130	€5,066.48	867	€2.77	77,034	€7,780.43
July			35,222	€3,134.76	102,165	€9,399.18	32,767	€3,178.40	39,679	€4,265.49			57,011	€6,758.11
August			72,269	€6,431.94		€0.00	90,849	€8,812.35	39,679	€4,265.49	10,694	€1,112.18	108,432	€10,951.63
September			26,858	€2,390.36		€0.00	100,843	€9,781.77	97,775	€10,510.81	119,022	€13,092.42		
October	46,841	€3,513.08	103,095	€9,175.46	7,128	€655.78	127,478	€12,365.37	105,033	€11,291.05	108,368	€11,920.48		
November	58,928	€4,419.60	133,684	€11,897.88	145,635	€13,398.42	53,010	€5,884.11	98,187	€10,555.10	110,673	€12,174.03		
December	80,366	€6,027.45	94,030	€8,368.67	87,017	€8,005.56	106,526	€11,824.39	101,890	€10,953.18	127,598	€14,035.78		
Total	186,135	€13,960.13	1,018,527	€90,774.23	817,459	€74,612.73	952,027	€94,580.12	991,350	€107,314.15	859,033	€94,742.82	588,371	€70,082.60

Inferred Mean Monthly Flows to Generator from Power Output

Power	Eff	Density	Gravity	H
P	90%	1000	9.81	67.45 m

	2001		2002		2003		2004		2005		2006		2007	
	Flow	cu.m/d	Flow	cu.m/d	Flow	cu.m/d	Flow	cu.m/d	Flow	cu.m/d	Flow	cu.m/d	Flow	cu.m/d
January			0.207	17915	0.262	22674	0.269	23229	0.302	26083	0.175	15086	0.181	15628
February			0.242	20944	0.204	17609	0.159	13736	0.197	17017	0.100	8677	0.247	21348
March			0.220	19028	0.155	13357	0.222	19206	0.166	14328	0.221	19124	0.264	22807
April			0.147	12666	0.123	10592	0.222	19186	0.214	18451	0.164	14153	0.024	2045
May			0.243	21002	0.254	21907	0.063	5413	0.190	16450	0.217	18711	0.090	7755
June			0.225	19417	0.103	8923	0.085	7326	0.110	9497	0.002	175	0.180	15523
July			0.079	6868	0.231	19923	0.074	6390	0.090	7738	0.000	0	0.129	11117
August			0.163	14093	0.000	0	0.205	17716	0.090	7738	0.024	2085	0.245	21145
September			0.063	5412	0.000	0	0.235	20320	0.228	19702	0.278	23984		
October	0.106	9134	0.233	20104	0.016	1390	0.288	24859	0.237	20482	0.245	21132		
November	0.137	11874	0.312	26938	0.340	29346	0.124	10682	0.229	19785	0.258	22301		
December	0.181	15672	0.212	18336	0.196	16969	0.240	20773	0.230	19869	0.288	24882		



APPENDIX NO. 2

The Impact of Climate Change on Yield in the Owgarriff & Lough Guitane System

THE IMPACT OF CLIMATE CHANGE ON THE YIELD OF THE OWGARRIFF-LOUGH GUITANE SYSTEM

A2.1 Climate Change-General

Climate change will impact upon the ability of existing impoundments and river catchments to deliver an historic safe yield in circumstances of an evolving rainfall, temperature, SMD and evapotranspiration statistical distribution. The effect on each variable will be gradual, and will be buried in the natural variability, but it will be noticeable over the next several decades. It is necessary to form a view of the likely impacts on upland small catchments in the south west of Ireland, in order to define suitable operating policies to maximise the sustainable yield of existing infrastructure.

We also need to keep in mind that minor infrastructural adjustment may be necessary in order that advantage can be taken of springtime flows on the Owgariff, when Lough Guitane water level has been drawn down from a previous winter dry spell, to take opportunities to replenish the lake reservoir for later in a developing drought.

A2.2 Approach on Climate Change

We have adopted the following approach in reviewing the current position on climate change:

- 1.** The results of the Hadley Centre (UK) Model RCM3 will be used here for climate change as it affects water resources policy for Kerry County Council and the river catchments in the NE.
- 2.** The UKCIP02 Medium – High (A2) SRES scenario will also be referenced here as the working assumption used for climate change policy.
- 3.** Ireland, through the ICARUS centre at NUI Maynooth has carried out work to customise climate change modelling for Ireland, and has published work in 2007 under commission from the EPA. Our planning horizon for the Owgariff and Lough Guitane is just over two decades, and the climate change influences will be gradual over that period.

A2.3 Climate Change Modelling

A2.3.1 General Approach

Circulation Models of the earth's atmosphere and the ocean currents, incorporating the evolving energy balance of the earth as temperature, albedo, and key ocean current heat transfers are changed, have been used to give global predictions of sea level, temperature, precipitation and evolution of land use boundaries as plant species will in future determine. These global models are by their nature relatively coarse in terms of grid resolution for one geographic area. In the UK, the Hadley Centre and the UKCIP Research programmes have improved the resolution of circulation models to a grid size of approximately 50 km square, and these models have been extended to cover Ireland for the key outputs of temperature and rainfall. The UK Hadley Centre Regional Climate Change (RCM3) model results, have been used for this review but with due regard for the ICARUS centre work particular to Ireland. The Hadley Centre houses the UK Met Office research into climate change and the Hadley model is generally regarded as a “good” model on the basis that it reproduces current climate over the standard UN historic data comparison period (1961-1990) quite well.

The Hadley Model can therefore be envisaged as a regional model for Europe embedded within a global General Circulation Model. This GCM sets the boundary conditions for the inner Hadley Regional Climate Model (RCM3) which focuses on Europe, using four CO₂

input scenarios; Low, Medium-Low, Medium-High, and High. These scenarios are themselves selected from an international evaluation of CO₂ and other gas emissions projections based on human and socio-economic behaviour. We have reviewed the predictions of this Model, together with the UK Climate Impact Programme results, as it affects Ireland. The earlier Hadley (RCM2) model, based on the UKCIP '98 GCM boundary conditions, has now been superseded by the Hadley (RCM3) embedded in the later UKCIP02 General Circulation Model.

Substantial differences were found between the two sets of results which were developed four years apart are indicative of the uncertainties of modelling such complexity.

A2.3.2 Modelling Scenarios

Without going into the detail of each of the scenarios, they can be broadly evaluated in terms of their predicted temperature changes, and the range of atmospheric CO₂ which results from the degree of greenhouse gas emission discipline implied in each. For the purposes of this review, the A2 Scenario will be adopted as the working assumption.

SRES Emissions Scenario	UKCIP02 Climate Change Scenario	Increase in Global Temperature (°C)	Atmospheric CO₂ Concentration (ppm)
B1	Low Emissions	2.0	525
B2	Medium-Low Emissions	2.3	562
A2	Medium-High Emissions	3.3	715
A1FI	High Emissions	3.9	810

Table A2.1 Changes in global temperature and atmospheric carbon dioxide concentration for the 2080s period (2071-2100 average)

A2.4 Temperature, Humidity and Rainfall

A2.4.1 Temperature

In broad terms, the expected impact on temperatures on the south west coast of Ireland are for a rise in temperature by 1 degree C by the 2020s, between 1.5 and 2 deg C by the 2050's and by 2.5 to 3 degrees C by the 2080s, with a margin of error of +/- 1.5 deg C by the year 2100. The latest ICARUS Report to the EPA (2007) indicates that this trend may, if anything, underestimate the warming under way in Ireland.

Looking at the seasonality of temperature change, and referring to Figure A2.1, winter will be 0.5 deg warmer and all other seasons' temperatures will be between 0.5 and 1 degree warmer on the south west coast in the 2020s. By the 2050s, differences in variability between seasons will have emerged, with summer and autumn being up to 2 deg C warmer, and winter and spring up to 1.5 deg C warmer. By the 2080's, this seasonal variability will have become much more pronounced. Summer and autumn temperatures in south west Munster will by then be 3 to 3.5 deg warmer, whereas Spring will be 2 to 2.5 deg C and winter 1.5 to 2 deg C warmer.

A2.4.2 Humidity

Figure A2.2, abstracted from the UKCIP02 Model Report, shows the expected changes in atmospheric humidity in the 2080s, for the different scenarios. In the case of the A2 Scenario, or M-H Emissions, annual relative humidity in south western Ireland is expected to fall by between 3% and 6%. Spring, autumn and winter will experience less change, up to 3% reduction, but Summer will have between 6% and 9% reduction.

A2.4.3 Rainfall

Rainfall changes and changes in the seasonal distribution of changing annual rainfall totals are directly relevant to our work on water resources planning for Central Kerry. Unfortunately even the Hadley RCM climate models have limited resolution, both temporally and spatially, and therefore there is considerable uncertainty in using them.

The UK Climate Impacts Programme 2002 (UKCIP02) suggests the following changes in rainfall for the A2 (Medium-High) scenario. In the first place, and referring to Figure A2.3, the annual precipitation change shown for the south west of Ireland in the 2020s falls within the yellow coloured shading, which implies change up to 10% reduction in annual rainfall. The model shows that seasonal effects are different with winter rainfall becoming 0 to 10 percent greater and summers getting drier by between 10 and to 20 percent. Spring and Autumn conditions are again mainly in the grey shading, but Central Kerry is close to a region of slight rainfall reduction in spring, with the possibility of small reductions below "normal" in spring at that decade.

Moving out to the 2050s, annual rainfall will have declined by up to 10%, and behind this, more pronounced seasonal variability will have emerged. Winter rainfalls will be 10% higher, spring rainfall 10% lower and summer rainfalls between 20% and 30% lower. Autumn rainfall will be up to 10% less. In passing, the ICARUS Report to EPA (2007) establishes that these modelled trends in winter rainfall, though small, are already statistically significant in the 1960-2005 data. The EPA reported rainfall data for the Lough Guitane area, when partitioned at 1970, shows significant reduction in annual rainfall in the period since then, compared to the period prior to then.

In the 2080s, the model predicts somewhat similar decline in annual precipitation to the 2050s, but the seasonal variability will be much more pronounced. Winter rainfalls by then will be 10%-15% higher, and summer rainfalls will be between 40% and 50% less. Spring and Autumn seasonal variability in precipitation will not be much more marked than in the 2050s scenario. This is also supported by the latest ICARUS predictions for Ireland.

Collectively, the picture emerging is one of widening contrast between winter and summer in a gradual annual decline, with spring and autumn maintaining something like current variability, but summer rainfalls being severely reduced.

A2.4.4 Reliability

In assessing the foregoing UKCIP02 model predictions for the A2 Scenario, it is important to keep in mind the degree of confidence which the modellers have in making these predictions. In a qualitative way, this is set out in Table A2.2

Indicator	Prediction	Confidence
Rainfall		
Winter daily depth	Increase	High
Winter season	Wetter	High
Summer season	Much Drier	Low
Contrast between Summer and Winter	Greater	High
Variability in winter and summer	Greater	Low
Soil Moisture summer and autumn	Decrease in SE UK	High
Soil Moisture winter and spring	Increase in NW UK	Medium

Table A2.2 Reliability of Predictions of the UKCIP02 Model on precipitation

An indication of certainty of the predictions is also reflected in the range allocated to predicted changes. The values contained in Table A2.3 are suggested in the UKCIP02 report for any location in the modelled area.

Indicator	Range
Winter precipitation Medium-High Scenario	+/- 15 %
Summer precipitation Medium-High Scenario	+/- 30 %

Table A2.3 Climate Change Indicators

When the expected variations in seasonal precipitation for the Kerry River Catchments are compared with these ranges, it can be accepted that prediction of the change in a dependent variable as complex as water supply yield, in a design period focussing on the mid 2020s, is itself subject to a wide margin of error.

A2.5 Impact on the Owgarriff and Lough Guitane Catchments

The task of combining the various climatological changes into a collective impact on water resources on the Owgarriff and Lough Guitane is extremely difficult, they are small, elevated catchments, in a model which ought not to be expected to have fine scale predictability at 20 sq.km area, or less. We first summarise the changes expected in the input variables:

- (a) The increase in temperatures annually, and especially in summer, will act with reducing relative humidity to affect evapotranspiration on the whole catchment
- (b) The reduction in summer precipitation will reduce summer inflows to Lough Guitane
- (c) The increase in winter rainfall will not work to any advantage on yield, because the impoundment will quickly reach full in that season and all surplus water spills over the weir. It may marginally accelerate recovery of the lake after a drought extending late into the autumn the previous year.
- (d) In a small upland catchment like Lough Guitane and the Owgarriff, the three factors of temperature, humidity and rainfall will combine in a manner that reinforces their impact on reduction in yield. Higher temperature with reduced humidity will increase evapotranspiration, and will increase the development of Soil Moisture Defecit (SMD) in short dry weather periods. Flows on small catchments however strongly reflect local climate and rainfall patterns, and frequency of small, intense, high-ground rainfall events is a major factor in the preservation of yield on small-reservoir catchments. In future, less intense spring and summer rainfall will increasingly have to replenish increased SMD before generating usable runoff, so that less of normal rainfall will be available to replenish storage. However the increasing intensity of summer rainfall events will counterbalance that effect.

Overall, we consider that we should plan for a 10% reduction on rainfall over the drought season. This will be combined with increased evapotranspiration and reduced soil moisture offsetting any partial recovery events arising from normal, low intensity rainfall, but increased runoff from high intensity summer rainfall. Overall these effects would be expected to give a 10-15% reduction in the combined yield of the Lough Guitane-Owgarriff system (in a drought as severe as 1975) by the year 2030, or a reduction of 7%-10% within the design horizon of the Scheme .Introduction of



recirculation of treated washwater and supernatants, as referred to above, would compensate for any requirement for increased drafts from storage due to climate change, so that the projected once in 20 year drawdown, below the lower limit of the operating range at present, of 0.87m would remain unchanged.

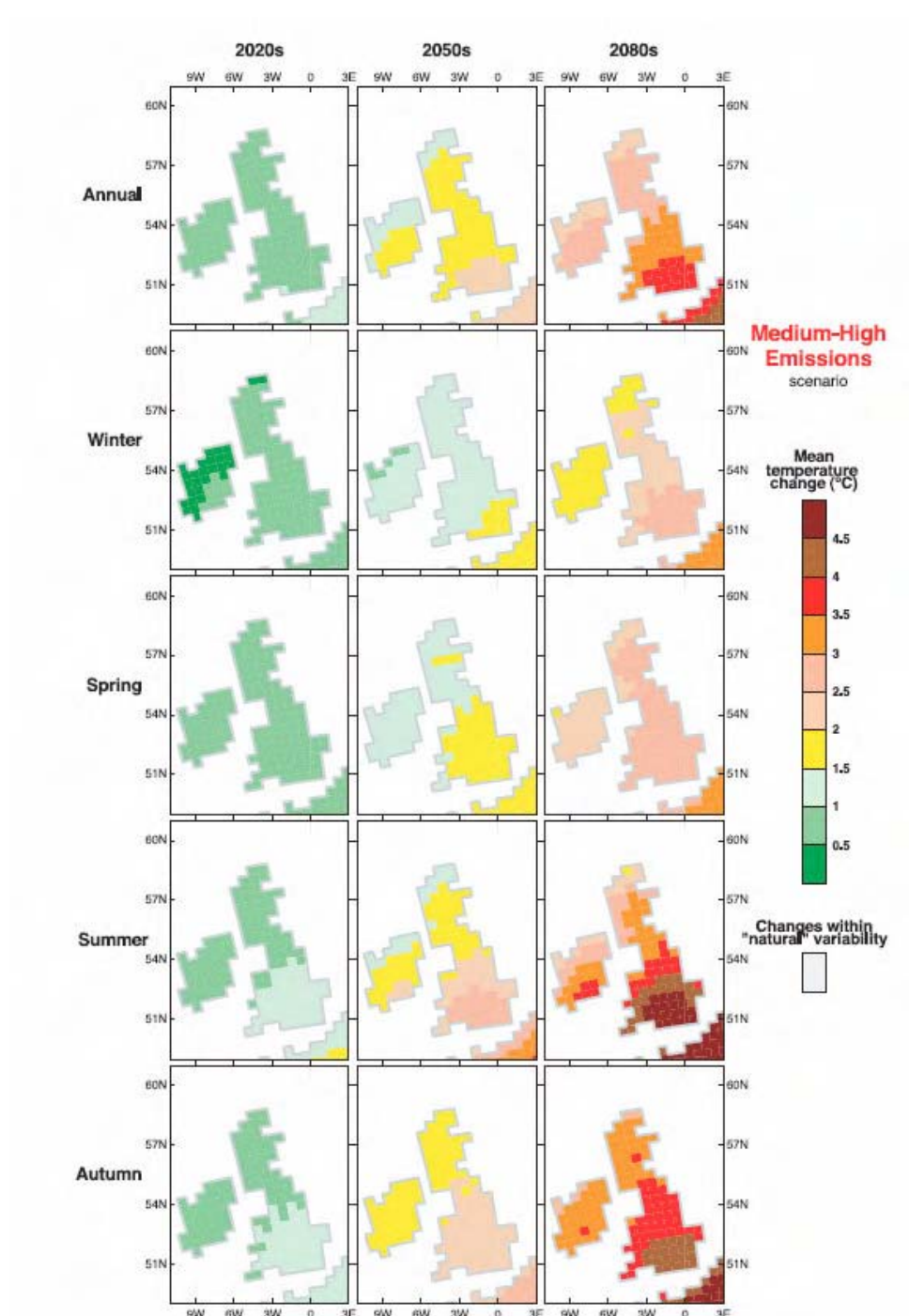


Figure A2.1 - Change in average annual and seasonal temperature (with respect to the model-simulated 1961-1990 climate) for thirty-year periods centred on the 2020's, 2050s and 2080s for the Medium High Emissions scenario. Grey areas show changes within an estimate of "natural" variability, one standard deviation of model-simulated 30-year average climates(courtesy UKCIP02 Report)

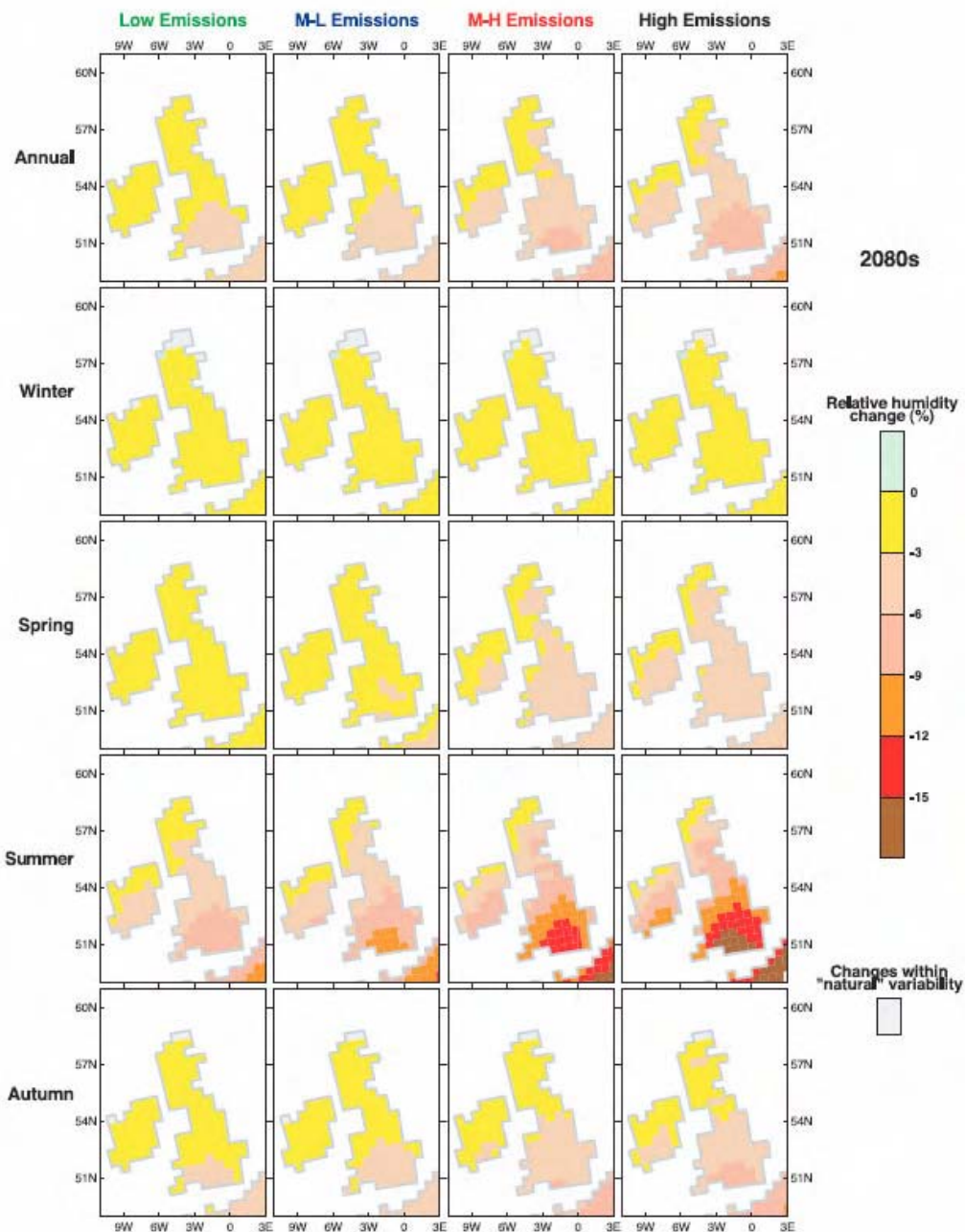


Figure A2.2 - Change in average annual and seasonal relative humidity (wrt. 1961-1990) for the four scenarios for the 2080's. Grey areas show changes within an estimate of "natural" variability, one standard deviation of model simulated 30-year average climates. The resolution of the HadRM3 model output is 50km by 50km. (courtesy UKCIP02 Report)

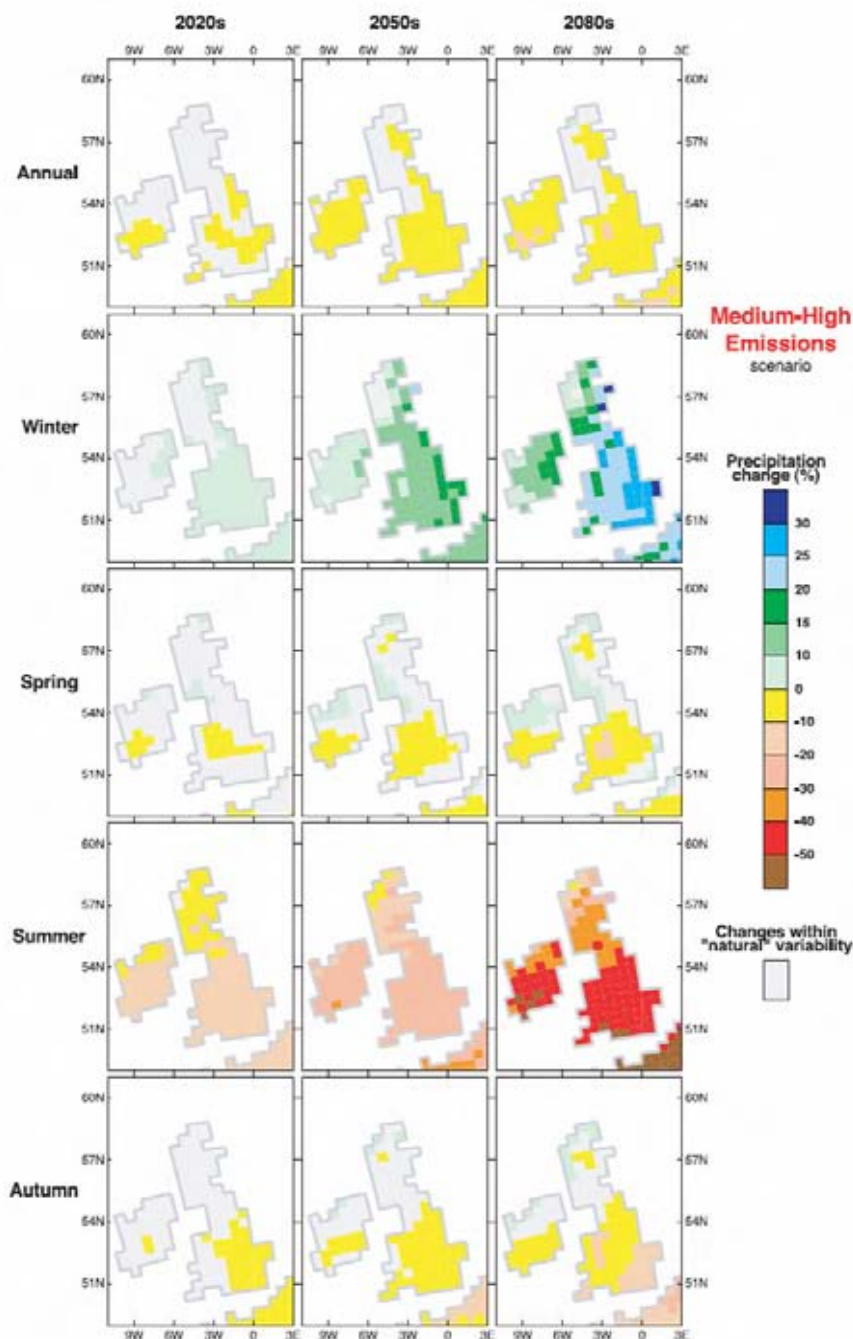


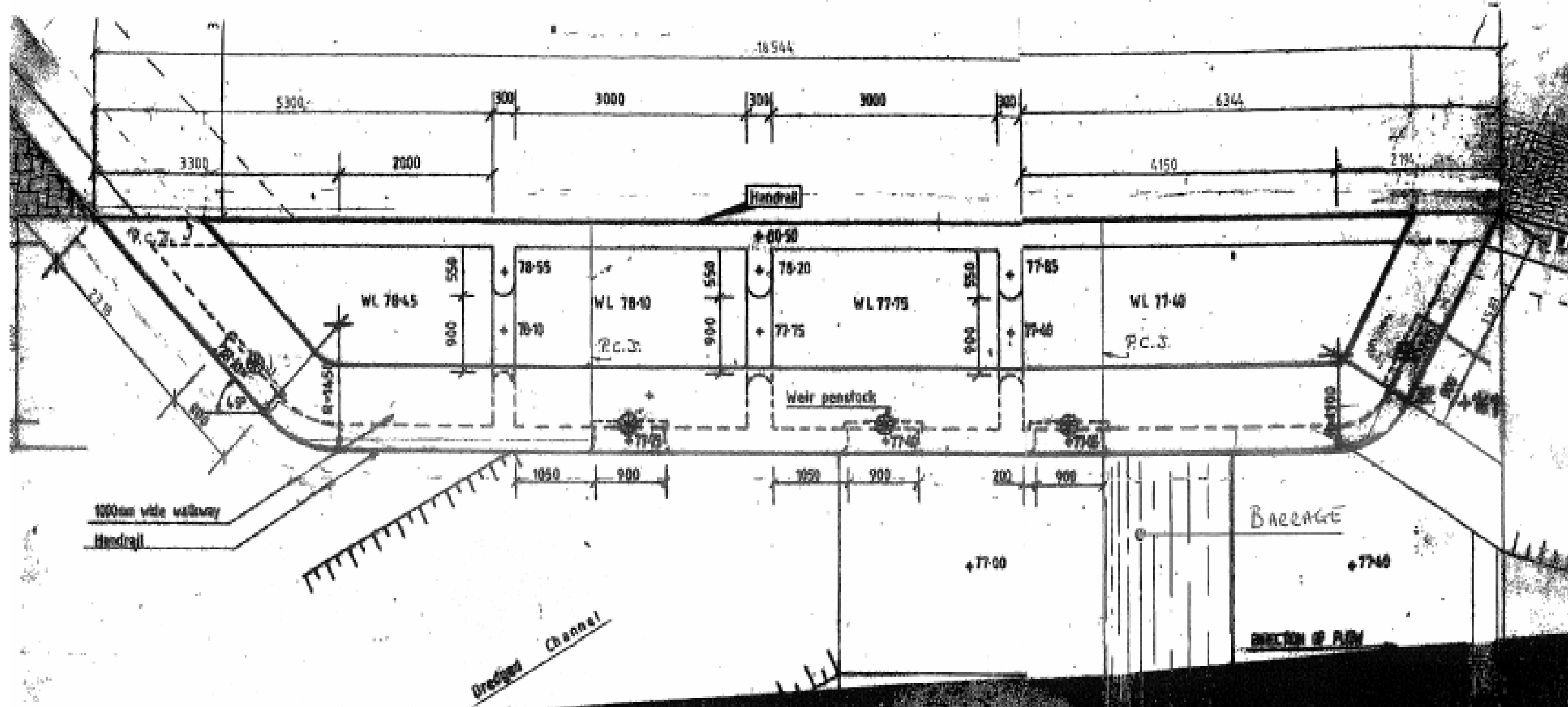
Figure A2.3 - Change in average annual and seasonal precipitation (with respect to model-simulated 1961-1990 climate) for thirty-year periods centred on the 2020's, 2050s and 2080s for the Medium High Emissions scenario. Grey areas show changes within an estimate of "natural" variability, one standard deviation of model-simulated 30-year average climates. Note the asymmetric scale (courtesy UKCIP02 Report

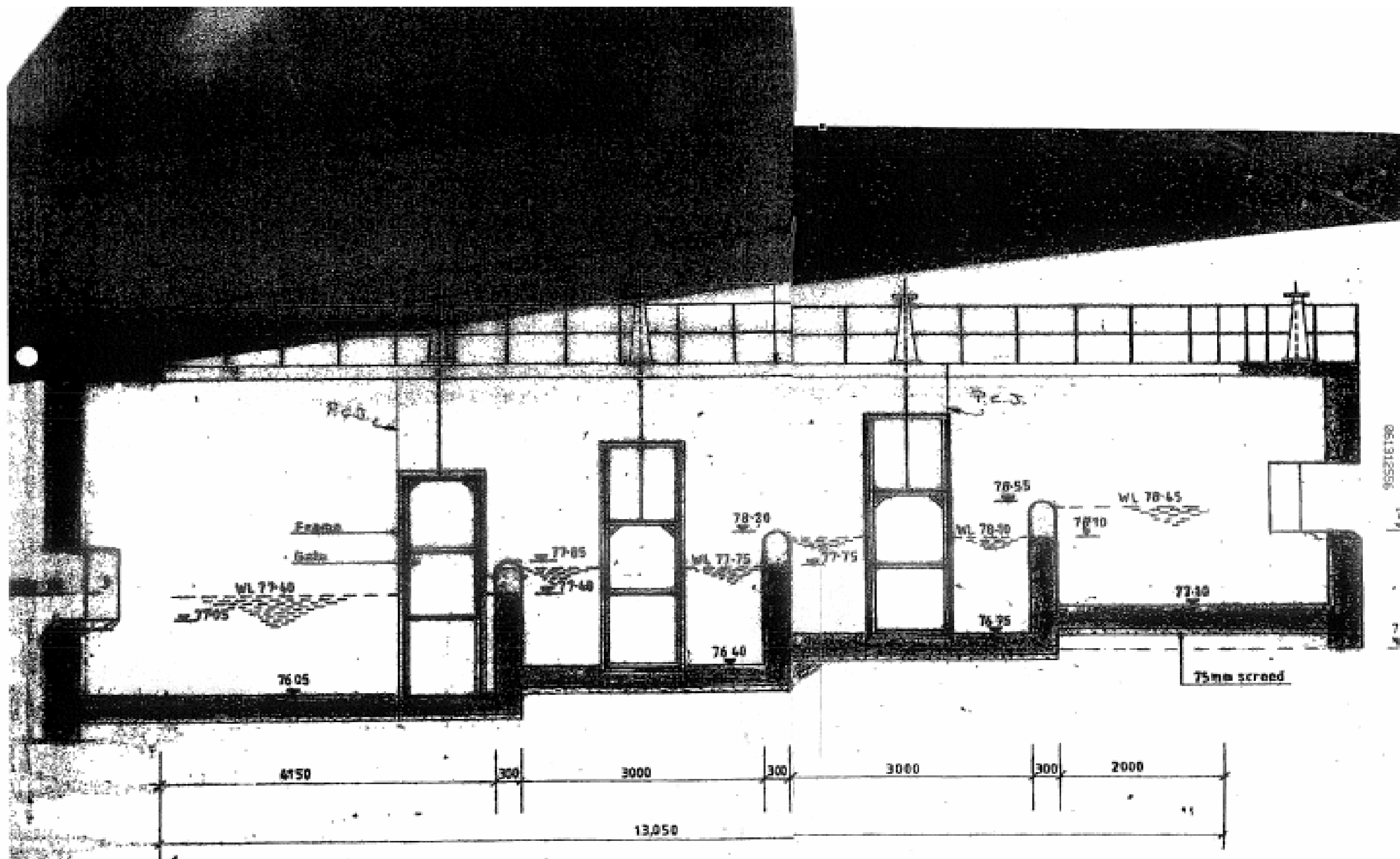
APPENDIX 3 – DETAILS OF FISH PASS AND BARRAGE AT LOUGH GUITANE

B

PLAN OF LOUGH GULITANE.

BARRAGE & FISH PASS





SECTION THROUGH LOUGH GUINING FISH PASS.

APPENDIX 4 – PLAN OF OWGARRIFF INTAKE

APPENDIX IV

TO

**APPROPRIATE ASSESSMENT
OF PREDICTED INCREASE IN DRAWDOWN OF THE
WATER LEVELS IN LOUGH GUITANE**

CHAR SURVEY RESULTS

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry.

Final report

February 2009



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Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

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Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Executive summary

- This report outlines the findings of fish surveys of Lough Guitane carried out by fyke netting and gillnetting in December 2008. A subsequent snorkel survey of potential spawning substrates in the lough carried out in January 2009 is also report on.
- This report provides information on catch per unit effort and depth distribution of the fish community in Lough Guitane during the period of sampling.
- The brown trout were the only salmonid and were well distributed in the littoral or shallower strata of the loughs surveyed.
- Although there Arctic char are found in nearby loughs (e.g., Lough Leane, Killarney National Park), their presence was not confirmed for Lough Guitane despite significant survey effort.
- No evidence of spawning by Arctic char was recorded in a follow up snorkel survey.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Background

Lough Guitane is a deep oligotrophic lough close to the Killarney National Park. Ecological conditions of the lough are characteristic of freshwater loughs often associated with the presence of Arctic char in Ireland. No information exists on the status of the species within the lough although they are known to occur within two loughs in the Killarney National Park.

The Irish Char Conservation Group were approached to survey the lough and determine as far as is practicable whether Arctic char are present or not. Concerns about fish mortalities due to the preferred survey method (gill netting) from the South Western Regional Fisheries Board led to the application of a phased approach incorporating non-destructive methods in an effort to minimize fish mortalities where possible. The surveys were carried under Section 18 Authorisation of the South Western Regional Fisheries Board.

The protocol undertaken is as follows

1. Fyke netting (non-destructive technique) over areas where lake typology was similar to that where Arctic char might spawn during anticipated spawning season (December for Kerry). Non-destructive approach with aim to record Arctic char presence without resulting in mortalities. If this fails move to step 2.
2. Gill netting (non-destructive technique but minimum no of nets used see methods section) using recognized international survey standard for the survey of Arctic char populations. Destructive method but usually effective.
3. Snorkelling (non-destructive technique) of potential spawning beds to cover the possibility that the above two methods failed in the identification of the presence of Arctic char within the lake.

Typical fish communities of glacial loughs

In Ireland the fish community of glacial loughs (loughs left behind by the retreating glaciers of the last Ice Ages) have usually escaped the more negative consequences of human interferences, e.g., nutrient pollution, non-native fish introductions. Therefore they still retain native fish communities and are important from a native fish

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

biodiversity perspective. These communities are of both national heritage importance and are important internationally from scientific and conservation perspectives (Igoe and Hammar 2004).

For millennia these native fish communities, the longest surviving of Ireland's native animal communities, were the sole fish species in the country's freshwaters. Typically they are dominated by salmonids such as brown trout and Arctic char. Three spined stickleback and to a lesser extent nine spined stickleback may also occur. Where access to sea is still permitted, migratory salmonids (Atlantic salmon and sea trout) and European eel usually occur. These fish species are part of the early postglacial fauna, and are reflective of freshwater fish communities that must have been prevalent throughout much of northwestern Europe immediately after the last Ice Age. In essence they reflect the Irish fish fauna first encountered in loughs and rivers by our early ancestors during the Megalithic period. As such, these native freshwater fish species are highly significant, not just for Ireland, but also for much of western Europe, where many such communities have been lost or replaced (Igoe 2004).

The biodiversity value of these species, in particular brown trout, is now being recognized and their taxonomic status under review (Ferguson 2004) as genetic studies are illustrating that they are far more diverse than previously thought. Recent studies on the genetics of brown trout from glacial loughs in other regions of Ireland suggest that their genetic diversity is high and in some cases certain populations can be considered as being unique (Paulo Prödohl, Queens University Belfast). Although less work has been carried out on Arctic char in Ireland, similar analogues probably pertain to this species also. In Ireland each Arctic char population has been confined to their respective lough for up to 17,000 years ago and no mixing of DNA between populations from different (even adjacent) loughs has occurred in most catchments since the last Ice Age. The broad phenotypic diversity of the species here in Ireland has already been reported (Igoe and Hammar 2004) and the species is recognized for its general plasticity globally (Johnson 1980). Recent studies, mostly on Scottish populations, confirm large genetic divergence between populations even from lochs close to one another.

In summary brown trout and Arctic char are some of the most important elements of Ireland's fauna from biodiversity, conservation, heritage and economic perspectives.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Knowledge to date

However the fish fauna of most Irish loughs have yet to be studied thoroughly and there is still a paucity of information on the genetic relationships between their brown trout populations. In addition the genetics of Arctic char populations are largely undescribed. These genetic information gaps must be filled if Ireland is to make informed choices about water use and prioritize conservation efforts. Even basic information is lacking for most glacial loughs in Ireland such as a description of the species composition, e.g., what species are present? Little information is available on the behaviour of brown trout and Arctic char in Ireland at critical stages of their lifecycles. For example, their diet in most cases is superficially described, based on one off stomach analysis rather than more useful food web analysis techniques (stable isotopes techniques), age data is either non-existent for most loughs or inaccurate. Critically information is lacking or incomplete on the spawning behaviour and requirements of both species in Ireland. For example, where do Arctic char spawn on an Irish lough? What substrate do they use and at what depths and time of year do they lay their eggs in these substrates etc? Do brown trout only spawn in rivers or can they also utilize substrates in loughs for spawning? We know that in Lough Melvin different species of brown trout are faithful to different tributary streams and do not interbreed. What about other and smaller Irish loughs?

Information is available on the above for only a few Irish loughs (e.g., Igoe et al 2004, Ferguson 1996) and these data are clearly inadequate for generic decision making with regard to water use and protection of fish life in these lough types. Information needs to be collected on a lough-by-lough basis, particularly where proposals to utilize a glacial lough for human uses may alter the lough level or hydraulic cycle. Such impacts often occur in schemes designed to abstract water for domestic or industrial use or hydropower. Baseline data will also provide information on the biodiversity importance of the fish species present and their heritage and conservation value both locally and nationally.

Water abstraction impacts on fish communities

To date little is known of the impacts that various water abstraction schemes are having on fish communities in Ireland. These schemes range from the supply of water to cattle feeders to more large-scale projects supplying large towns and industrial areas. Some will have minimal or no impact, whilst some of the larger ones clearly

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

will have major impacts. The extent of impact will depend on the amount of water required relative to the water body and its rate of recharge, the profile of the water body, the fish species present and the water quality itself, the underlying geology and the time of year. Local climatic factors such as rainfall and even temperature are important considerations. In order to carry out a risk analysis with regard to a scheme or a proposed scheme it will be necessary to collect the above information and establish baseline data for the fish community present (i.e., describe the reference condition).

In Ireland baseline data is also limited with respect to fish communities living in glacial loughs in Ireland and prior to this study no information was available on four out of the five loughs addressed in this study. Internationally, however, studies have shown that water regulation impacts can be particularly severe on salmonids such as Arctic char, e.g., Fürst and Hammar 1984, Milbrink and Holmgren 1984.

Methods

4. Fyke netting

Fyke nets (1m aperture) were set along littoral areas identified by the survey team as potential Arctic char spawning areas based on experience from surveys of other Arctic char loughs in Co. Kerry. The lead net curtain was set at an angle to channel fish into the conical net where fish then became trapped. This technique is non-destructive and all fish captured in the survey were released alive after routine statistics were collected together with photographs. All nets were fitted with otter guards to prevent ingress mammals or birds which would drown once trapped.

5. Gill netting

Experimental gill netting surveys were carried out using the standard benthic Nordic multimesh monofilament nylon gillnets, which are composed of different mesh sizes following a geometric series with a ratio between mesh-sizes of 1.25. The gill nets are 30m long and 1.5 m deep and are composed of 12 different mesh panels ranging from 5 to 55 mm knot to knot, each panel about 2.5 m wide. The netting is carried out according to protocols described by Appelberg (2000) and is a proposed standardized European method for a stratified random sampling procedure. Nets were set along lough contours as recommended by Hammar and Filipsson (1985), sampling the range of depth strata for each respective lough, with effort diminishing with depth.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Appelberg (2000) outlines two quantitatively different approaches. The first is an intensive sampling effort, which allows the detection of 50% changes in the fish community between sampling occasions on a water body. The second is less intensive and is designed as an inventory sampling method, i.e., identify the species present and gives basic information such as length frequency distributions. The latter method is strongly recommended in natural, unexploited and unknown fish communities particularly where Red Data Book species such as Arctic char are present. The inventory method is generally effective in catching a wide range of species across the spectrum of the spatial subdivisions within a lough, ranging from shallow littoral-benthic and profundal-benthic areas to the pelagic zone. In most loughs, netting effort was in excess of that recommended for inventory sampling and therefore meet the criteria necessary to ensure an adequate sampling intensity sufficient for species identification.

Table 1. Mesh-size distribution and monofilament diameter of multiple mesh size gillnets of the Nordic type.

Mesh no	Mesh size, knot to knot (mm)	Thread diameter, mm
1	43	0.20
2	19.5	0.15
3	6.25	0.10
4	10	0.13
5	55	0.23
6	8	0.10
7	12.5	0.13
8	24	0.16
9	15.5	0.15
10	5	0.10
11	35	0.20
12	29	0.16

6. Snorkeling

Snorkeling was carried out along littoral areas to determine if spawning by salmonids including arctic char had occurred. The methodology employed is one currently being developed by the Irish Char Conservation Group for the monitoring of spawning of Arctic char in Irish loughs. The main inflowing stream was also snorkeled.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Routine fish measurements

Each fish was photographed and labelled in the field. They were measured for length. Fish samples were retained for subsequent work at a later date in the laboratory.

Muscle tissue samples were extracted for genetic work. The analysis is being carried out by Queens University Belfast.

Results of the gill netting programme

This report covers results from data collected during the fyke netting, gillnetting and snorkel surveys. Information is provided on species identified, relative abundance (catch per unit effort CPUE), CPUE along depth zones and length frequency distribution for the five loughs.

Lough Guitane: Fish population surveys

Lough Guitane , Co. Kerry

Lat:Long	52 00 20 45 , 9 25 16	Maximum Depth: -	
		53 70	
Survey Dates:	Dec 2008 to Jan 2009	Volume:	N/A



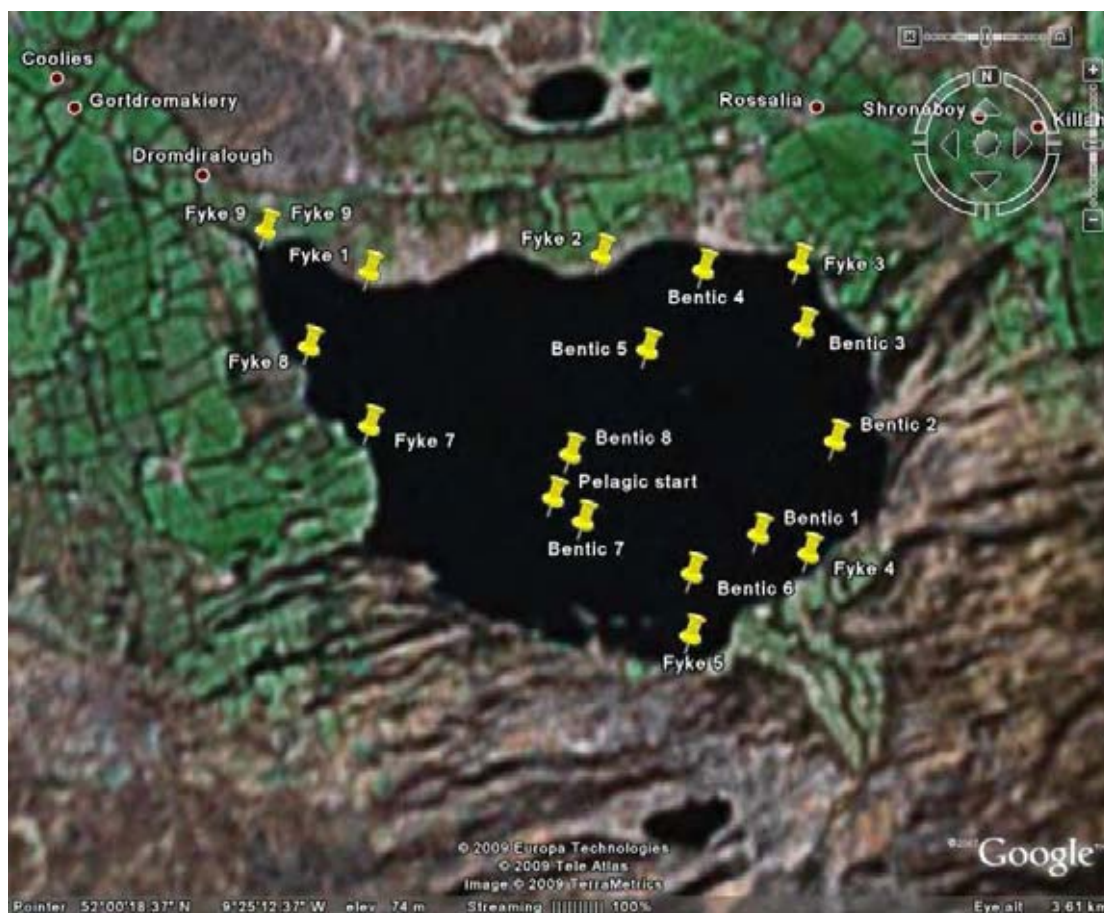
Setting fyke nets on Lough Guitane.

Historical records of fish in Lough Guitane

The lake was first surveyed by the Central Fisheries Board in the 1980's. No Arctic char were recorded in this survey although the survey gear was not employed to specifically target this species. Brown trout were identified in this survey.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Results of ICCG fish fyke netting survey



Google Earth image of Lough Guitane showing location of sampling points for both fyke net and gill net surveys.

Non-destructive fyke netting was employed on December 20th at preselected areas deemed by the survey crew as potential Arctic char spawning areas base of site characteristics. Nine double fyke nets (4 more than originally planned) were set and left overnight. All nets had otter guards to prevent drowning of non-target species including mammals and birds.

Most nets were set in depths between 1.5m and 3m. One net (double) was set in deeper water (5m). No more than 1 fish were recorded per net. Three had one trout respectively, two contained eel and the remained (n=4) were empty. Trout lengths (240mm;212mm;116mm were similar to those recorded in gill nets).

No Arctic char were recorded and therefore the gillnetting survey was commenced on December 28th.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Table 1. Results of fyke netting in December 2008. CPUE =catch per unit effort, i.e., average number of fish per net.

Survey results: Fyke nets (n=9)				
	Arctic char	Brown trout	Perch	Eel
Number	0	9	0	2
CPUE	0	0.33	0	0.22

Results of ICCG fish gill netting survey

A total of 8 benthic gill nets and one pelagic gill net were set on the evenings of December 28th and lifted the following morning.

Table 2. Results of gill netting in December 2008. CPUE =catch per unit effort, i.e., average number of fish per net.

Survey results: Benthic nets (n=8)				
	Arctic char	Brown trout	Perch	Eel
Number	0	49	6	0
CPUE	0	6.15	0.75	0

Survey results: Pelagic net (n=1)				
	Arctic char	Brown trout	perch	Eel
Number	0	1.0	3.0	0.0
CPUE	0	1.0	3.0	0.0

Brown trout were the dominant fish species recorded in Lough Guitane. Perch were also recorded in smaller numbers. Arctic char were not recorded in any of the nets set. No other fish species were taken.

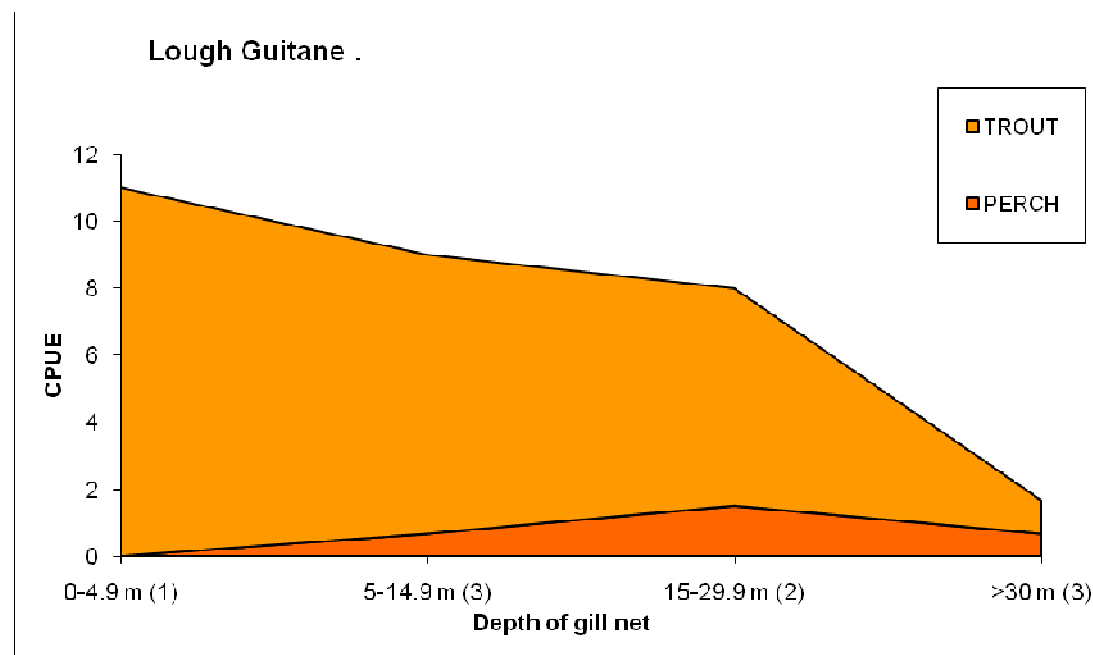


Fig. 1 The relative abundance (catch per unit effort) of brown trout and perch over the range of depth zones.

When the relative CPUE data is examined by depth zone it is apparent that the greatest concentrations of brown trout occurred in the shallower depths. This probably reflects greater feeding opportunities in benthic littoral areas compared to the deeper less productive profundal area (which makes up most of the lake floor). Perch were concentrated in deeper water areas.

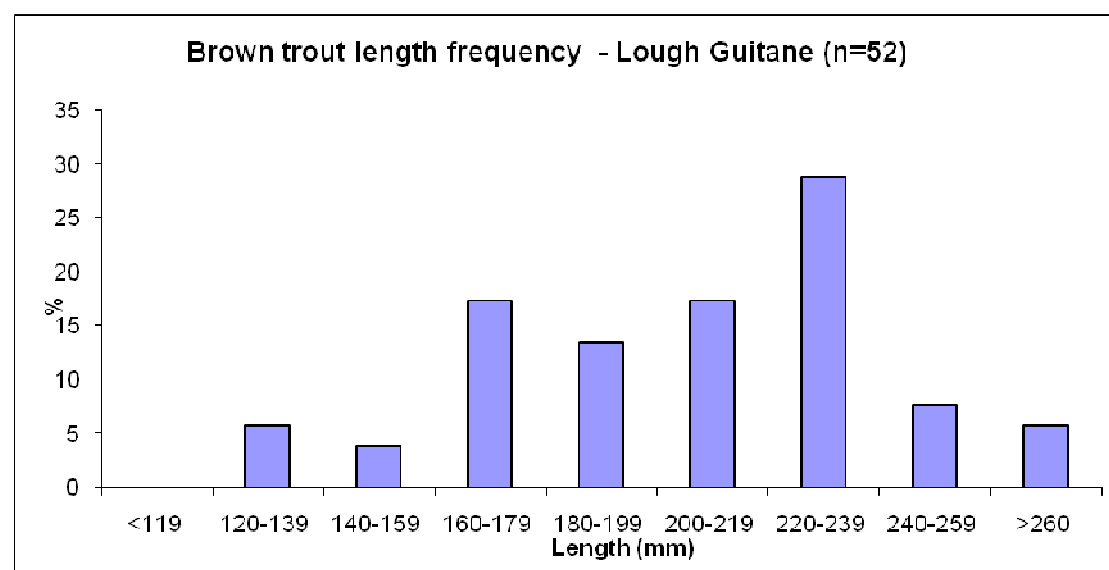


Fig 2. Basic length statistics for brown trout recorded.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Individual size of brown trout was small compared to more productive loughs normally fished by Irish anglers (e.g., L. Derg).



Brown trout caught in a fyke net.

Results of snorkeling survey

A snorkel survey (diving crew = 2 divers) was carried out covering half of the lough shore line. Particular attention was made to examine substrates typical of potential char spawning areas. Interestingly much of the gravel areas were only recently submerged and no evidence of spawning (by either Arctic char or brown trout) within the lough. The main inflowing stream was snorkeled and substantial numbers of ova (most likely brown trout ova) were noted at a number of locations within the river itself.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry



Conclusion

Lough Guitane is relatively unspoilt and snorkel surveys revealed that the substrates were in good condition.

Catches in the fyke nets were low compared to surveys carried out in the Hags Glen (also in December). However the collective benthic and pelagic sample illustrates that the status of brown trout is excellent. Highest densities were in the benthic nets set off littoral areas probably reflecting higher feeding opportunities in these areas.

lough.

No Arctic char were recorded although conditions seem to be ideal for the species.

Appendices



Snorkeling of potential Arctic char spawning bed (however as with other possible spawning areas examined, bed slope profiles were not consistent with most other Arctic char loughs studies by the ICCG).



Submerged farm roller

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry



Inflowing river where ova (probably brown trout) were found.



Probable brown trout ova (centre) photographed in situ in the bed of the inflowing river.

Gill net, fyke net and snorkel surveys of Lough Guitane, Co. Kerry

Acknowledgements

This study was funded by Kerry Co Council. We wish to thank all those who assisted with the survey work especially volunteers of the Irish Char Conservation group. Senior Environmental Officer, Patricia O'Connor of the South Western Regional Fisheries Board provided the necessary authorizations for carrying out the study. Paul Fingleton, CAAS, kindly provided background information. Paul Cremin, Kerry Co. Council kindly provided local access information.

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