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AN ASSESSMENT OF THE IMPACTS OF ARTERIAL DRAINAGE ON WETLAND VEGETATION IN THE DUNKELLIN/LAVALLY CATCHMENTS, CO. GALWAY.

by

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Table of Contents

Page No.

Summary

The impacts of a proposed arterial drainage scheme on wetland vegetation in the Dunkellin/Lavally catchments are assessed. The present status of the wetland vegetation has already been described (Lockhart, 1984). In estimating likely impacts of drainage, account is taken of the early vegetational development in the area and its probable evolution in the absence of the proposed scheme. The nett effects of the scheme are likely to result in the extinction of 12 wetland plants from the catchments, 8 of them considered to be rare, major losses of the more hydrophilous vegetation types, particularly those associated with turloughs, and the irreversible loss of 4 sites of scientific interest, 3 of which are turloughs, most notably the internationally rated Rahasane Turlough.

General recommendations, illustrated by examples, are given regarding safeguards which should be carried out to minimise damage to wetland vegetation during arterial drainage operations. The hydrological feasibility of safeguarding Rahasane Turlough by omitting the downstream section of the Dunkellin river below Craughwell needs to be investigated in the light of the forthcoming report on the hydrology of the area by Dr. D. Drew.

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1. INTRODUCTION

This is the second of two reports on the wetland vegetation of the Dunkellin/Lavally catchments. The first (Lockhart, 1984, herein referred to as Part 1) was produced at the behest of the Forest and Wildlife Service and described the major wetland vegetation types. A vegetation map at a scale of 1:25,000 was produced and several sites of botanical importance were identified. This second report considers the likely impacts that a proposed Office of Public Works arterial drainage scheme will have on wetland vegetation. These impacts are examined at several levels, i.e. the probable effect on the range and distribution of certain rare species, the overall effect in terms of nett loss in area of the principle vegetation types and the likely effect on selected sites of botanical importance. The evolution of the area in the absence of drainage, involving a brief scenario of its recent historical development, is taken into account when considering the nett impacts of the proposed scheme. Specific recommendations regarding the omission of sites of botanical importance and the implementation and maintenance of arterial drainage works are also given.

2. ADDITIONAL DATA

Since the first report (1984), subsequent visits to the catchments have yielded additional data. Another rare plant species was found and a further three sites have been identified as scientifically important. These are described below.

2.1 Additional Rare Species

Twenty-one rare or threatened species were described from the catchments in Part 1 of this report. A return visit to the area in July 1985 added *Eriophorum latifolium* (Broad- leaved Cotton-grass) to the list. This was found at Carrowmunna Marsh, about 3 miles west of Lough Rea. It can be rated as locally rare (i.e. occurs in less than two 10 km grid squares in south-east Galway) and is described as widespread but rare in Ireland (Webb, 1977). It occurs throughout most of Europe but is local in the south (Tutin *et al.,* 1980).

An additional site was also found for the regionally rare *Viola persicifolia* (Fen Violet). A small population of these diminutive plants were growing at the upper flood level of Moyode Turlough, 2 miles north-east of Craughwell. It had previously been recorded for the catchments only from Rahasane Turlough (Macgowran *et al.,* 1979).

2.2. Additional Sites of Scientific Interest

Three more sites of scientific interest have been added to the list of five which are discussed in Part 1 of this report. Their rating in terms of importance follows the criteria used by An Foras Forbartha (Cabot *et al.*, 1981).

a) Poulatauvally Turlough

Area: 27 ha

Rating: National Importance

Description: This is a small, intact turlough in the south-west of the Dunkellin catchment. It has two, more or less permanent, open water areas in it's centre in which calcareous Chara beds have formed. The seasonally flooded grasslands are unusual for a turlough in having developed over thin peat. The sward is dominated by *Molinia caerulea* (Purple Moor Grass) and species of sedge and has been classified, for mapping purposes, as Drysedge type. (See Part 1).

Value: Turloughs in general have become increasingly rare in Ireland due to drainage. An intact example, such as this, is therefore of scientific importance. The rich aquatic communities and the well developed grass/sedge swards make it of specialised educational importance.

b) Moyode Turlough

Area: 23 ha

Rating: National Importance

Description: Another small, intact turlough situated on the Dunkellin/Lavally catchment boundary, about 2 miles north-east of Craughwell. A large swallow hole at the northern end contains permanent water and well developed Chara beds. Open, seasonally flooded ground supports a rich limestone grassland flora including Galium boreale (Northern Bedstraw) and the regionally rare Viola persicifolia (Fen Violet). Much of the turlough is bordered by semi-natural scrub woodland, mostly Corylus avellana (Hazel), Crataegus monogyna (Hawthorn) and Prunus spinosa (Blackthorn), but with significant amounts of Rhamnus catharticus (Buckthorn) and Euonymus europaeus (Spindle).

Value: As an intact example of a turlough this site merits scientific importance. The occurrence of the regionally rare Viola persicifolia (Fen Violet) adds to its importance and makes the site of specialised educational value. The surrounding scrub adds diversity to the site as a whole and is noteworthy in itself for the abundant occurrence of Rhamnus catharticus (Buckthorn).

c) Carrowmunna March (South)

Area: 5 ha

Rating: Local Importance

Descpription: This is a small, spring-fed marsh situated at the southern boundary of the Dunkellin catchment about 3 miles west of Loughrea. The vegetation is dominated by Schoenus nigricans (Black Bog Rush), Phragmites australis (Reed) and Carex lepidocarpa (Sedge) with open water Chara beds developed between tussocks. Species of note which were found there include Juncus subnodulosus (Blunt-flowered Rush), Sparganium minimum (Small Bur-reed) and the locally rare Eriophorum latifolium (Broad-leaved Cotton-grass).

Value: This is a good example of a spring-fed marsh with well developed aquatic and emergent vegetation. As such it is of local importance. The presence of the locally rare Eriophorum latifolium (Broad-leaved Cotton-grass), it's only station in the catchments, adds to it's value and makes the site of specialised educational importance.

3. ECOLOGICAL CHARACTERISTICS AND CLASSIFICATION OF VEGETATION TYPES

3.1 Ecological Characteristics of Vegetation Types

Wetland vegetation types were described and mapped in Part

1 of this report under the following 12 categories:

a) Reedbed

b) Marsh

c) Bog

d) Cutaway Bog

e) Salt Marsh

f) Drygrass

g) Wetgrass

h) Drysedge

i) Wetsedge

j) Floodgrass

k) Mixed woodland and scrub

l) Conifers

The ecological characteristics of these categories are summarised in Table 1. These figures were obtained by examining the relevés (vegetation samples), upon which the classification was based, and averaging the indicator values of their species (Ellenburg, 1979). It should be noted, however, that the Ellenburg method was developed for use in central Europe and that indicator scores cannot be taken as absolute in Ireland due to differences in climate and plant behavioural responses. They are useful, nevertheless, for highlighting the relative ecological differences between vegetation types. and thus improving the accuracy of with which drainage impacts can be predicted.

In reference to Table 1, the values for Moisture, Soil Reaction and Soil Nitrogen are briefly defined below:

Moisture - 3 dry soils

5 fresh soils (intermediate)

7 moist soils which do not dry out

9 wet, often not well aerated soils

10 frequently inundated soils

11 emergent aquatic vegetation

12 submergent aquatic vegetation

Soil Reaction - 3 mostly acid soils

5 mostly weakly acid soils

7 mostly in neutral soils, but also in acid and basic ones

9 only in neutral or basic soils

Soil Nitrogen - 1 only in soils very poor in mineral nitrogen

3 mostly in poor soils

5 mostly in intermediate soils

7 mostly in soils rich in mineral nitrogen

8 nitrogen indicator

Figures for periodic moistening and flooding are the percentages of species in a vegetation type that indicate those conditions. Anatomical structure is expressed as the percentage of species in a vegetation type showing particular adaptations with regard to water balance and gas exchange.

Hydromorphic - water plant
Helomorphic - with aeration tissue mainly in the underground organs
Hygromorphic - with soft shadow leaves
Mesomorphic - intermediate leaves
Scleromorphic - with hard leaves and roots
Leaf Succulent - with succlent leaves
Facultative Helophyte - mostly in saline soils

Table 1: Relationship between vegetation and major ecological factors

VEGETATION TYPE	ECOLOGICAL BEHAVIOUR					ANATOMICAL STRUCTURE						
	MOISTURE	% PERIODIC MOISTENING	% FLOODING	SOIL REACTION	SOIL NITROGEN	% HYDROMORPHIC	% HELOMORPHIC	% HYGROMORPHIC	% MESOMORPHIC	% SCLEROMORPHIC	% LEAF SUCCULENT	% FACULTATIVE HALOPHYTE
a) Reedbed	9.1	27	40	5.2	4.3	17	90	30	15	5	0	0
b) Marsh	8.7	29	34	4.8	3.8	19	74	31	11	9	0	0
c) Bog	8.6	17	18	1.8	1.5	4	74	0	24	63	8	0
d) Cutaway Bog	7.8	32	9	2.4	2.1	1	0	34	58	6	0	
e) Salt Marsh	7.0	42	24	7.3	5.0	7	69	4	44	11	31	47
f) Drygrass	6.3	29	4	4.8	4.4	2	36	18	75	14	0	0
g) Wetgrass	7.0	40	6	4.4	4.3	1	56	24	61	13	0	0
f)i Turlough Drygrass	6.3	30	10	5.5	5.2	0	40	35	75	5	5	3
g)i Turlough Wetgrass	7.3	41	18	6.3	6.0	12	71	41	47	0	0	0
h) Drysedge	7.5	39	12	5.0	3.1	2	62	11	51	26	1	0
i) Wetsedge	8.1	40	27	4.7	3.3	6	86	25	29	14	0	0
j) Floodgrass	8.4	33	48	5.4	4.9	30	97	39	12	0	0	0
k) Mixed woodland & scrub			Insufficient Data									
l) Conifers			Insufficient Data									

3.2 Classification and Description of Ecosystems

The 12 wetland vegetation types can be further grouped into 5 major ecosystems: Lakes, Rivers, Bogs, Turloughs and Salt Marshes (see Table II). These are discussed in the following chapter. It will be noted that several vegetation types occur in two or more ecosystems. The variation within vegetation types which accounts for this will be described under the appropriate ecosystem heading.

(I) Lakes

The lacustrine ecosystem is defined as including the open water areas of the lakes themselves, their surrounding reedbeds and marshes and their winter flooded margins.

Lough Rea is the only lake of any significant size in the catchments. Although the lake itself was poorly investigated in this study it is known to be oligotrophic and marl depositing with extensive beds of Stoneworts (Characeae). For its size (260 ha) and unique position within the catchments it has been rated as regionally important in Part 1 of this report. An Foras Forbartha have also rated it as regionally important for it's wintering wildfowl populations (Cabot et al., 1981).

Sparse Reedbeds of Scirpus lacustris (Bulrush) and Phragmites australis (Reed) occur in the sheltered bay of the south-east corner of the lake, and to a lesser extent, on the western shore. These lacustrine Reedbeds differ from those described for the type in Part 1 by having mostly aquatic vegetation in association i.e. Chara spps. and Potamogeton (Pondweed) spps. One species of note which was found abundantly amongst Reedbed vegetation at Lough Rea was Sparganium minimum (Small Bur-reed). Behind these Reedbeds occur large stands of Wetsedge and Marsh communities, and in places, patches of birch/willow scrub woodland. These vegetation types require permanently high water tables and are probably subject to annual winter flooding from the lake. Elsewhere the shoreline is exposed and often stoney. Here the wetland vegetation is confined to a narrow strip of seasonally flooded Drysedge. This lake shore community differs from the bulk of Drysedge type (which usually occurs on the cut-away margins of bogs) by growing on peat which is subject to prolonged flooding. This is evidenced by the occurrence of species characteristic of Wetsedge type amongst the sward e.g. Mentha aquatica (Water Mint) and Hydrocotyle vulgaris (Marsh Pennywort).

Table II: Wetland Ecosystems and Vegetation Types

ECOSYSTEMS	VEGETATION TYPES
LAKES	a) Reedbeds b) Marsh i) Wetsedge
RIVERS	a) Reedbeds f) Drygrass j) Floodgrass k) Mixed Woodland and Scrub l) Conifers
BOGS	a) Reedbeds b) Marsh c) Bog d) Cutaway Bog f) Drygrass g) Wetgrass h) Drysedge i) Wetsedge k) Mixed Woodland ansd Scrub l) Conifers
TURLOUGHS	f) Drygrass g) Wetgrass h) Drysedge j) Floodgrass
SALT MARSHES	a) Reedbeds e) Salt marsh

Two other lakes occur in the catchments but both are rather small in comparison to Lough Rea. Brick Lough is a marl lake of approximately 2 ha extent and is sited less than a mile south-east of Lough Rea. When visited during summer 1984 the only aquatic emergent species seen was Hippuris vulgaris (Mare's Tail) and the surrounding seasonally flooded land had been reclaimed for pasture.

Lough Kinlea is also a small (1 ha) marl lake and is situated about 5 miles west of Lough Rea, near the southern boundary of the Dunkellin catchment. It's aquatic vegetation is more interesting with extensive Chara beds and patches of Potamogeton crispus (Curled Pondweed), P. natans (Floating Pondweed) and Polygonum amphibium (Amphibious Persicaria). The marginal vegetation around this lake is turlough-like with Potentilla anserina (Silverweed) and Carex hirta (Hairy Sedge) amongst the Drygrass sward and the moss Cinclidotus fontinaloides on the occasional boulder.

Reedbed and Marsh types have been included for discussion under the lacustrine ecosystem as most of these have developed in situations where small lakes have become overgrown by vegetation. Reedbeds of this kind are scarce in the catchments as a whole and perhaps the best example is to be found at Graigabbey Marsh, near Athenry. Here, a small lake (3 ha) has been virtually completely overgrown by Phragmites australis (Reed), Carex rostrata (Bottle Sedge), Agrostis stolonifera (Creeping Bent-grass) and

Equisetum fluviatile (Water Horsetail). It was amongst these Reedbeds that the regionally rare Equisetum variegatum (Variegated Horsetail) was found.

Marsh vegetation is mostly confined to the southern part of the Dunkellin catchment. Several plant communities, each dominated by a different compliment of species, are included under this heading. These are best exemplified at Parkslevabaun Marsh where a series of overgrown lakes show several stages in fen/bog development. The wettest areas contain standing water all year round and are dominated by Equisetum fluviatile (Water Horsetail), Menyanthes trifoliata (Bogbean) and Carex rostrata (Bottle Sedge). Amongst this are localised patches of vegetation dominated in turn by Carex elata (Tufted Sedge) and Cladium mariscus (Fen Sedge). The drier parts where fen peat has developed, but where summer water levels remain at or near the surface, support species rich communities which are dominated by calicole mosses and herbs such as Juncus subnodulosus (Blunt-flowered Rush) or Carex diandra (Two-stemmed Sedge). It was amongst these fen communities that several rare species were found e.g. Epipactis palustris (Marsh Helleborine), Carex limosa (Mud Sedge), Carex curta (Pale Sedge) and Galium uliginosum (Fen Bedstraw).

Another variant of Marsh vegetation occurs at Carrowmunna Marsh, where an overgrown lake is vegetated by Schoenus nigricans (Black Bog Rush) and Phragmites australis

(Reed). This site is the only station in the catchments for the locally rare <u>Eriophorum latifolium</u> (Broadleaved Cotton Grass).

(II) <u>Rivers</u>

The riverine ecosystem includes the channels of the rivers and drains and the bordering lands affected by river flooding. The vegetation of channels is discussed in Part 1 under 4 headings: (a) Drains and Ditches, (b) Riffles and Pools, (c) Canal-like Reaches and (d) Karst Reaches. At least seven plant communities were recognised from the various types of river channel, ranging from the entirely aquatic moss communities of the fast flowing riffle stretches to the floating-leaved and tall emergent vegetation of the canal-like reaches. Riverine Reedbeds, which occur along the margins of undisturbed slow-flowing stretches, differ from lacustrine Reedbeds by being subject to stronger fluctuations in water levels and higher nutrient inputs. Such vegetation is dominated by <u>Phalaris arundinacea</u> (Reed Canary Grass), <u>Scirpus lacustris</u> (Bulrush) and <u>Sparganium erectum</u> (Branched Bur-reed), amongst others, and is perhaps best exemplified on the stretch downstream of Beech Hill Bridge, north-west of New Inn. Although Reedbeds of this kind occur elsewhere in the catchments they are generally too small in area to have been included on the 1:25,000 Vegetation Map.

River floodplain vegetation types are also influenced by high, fluctuating, water tables and high nutrient inputs, brought in as silt. However, much of these former callow-lands have been reclaimed for pasture, by arterial drainage in the 1850's and, more recently, through the efforts of local farmers. The present vegetation of these areas has been classified as Drygrass and represents the more strongly modified (fertilized and often reseeded) grasslands found frequently throughout both catchments. Although some of these areas may still flood in winter there is little riverine influence evident amongst the species compliment of the swards. Drygrass type occurs mostly on mineral soils, or on peaty soils with a high silt content. At lest 5 Drygrass communities were recognised (see Part 1). The most interesting of these are the unfertilized, species-rich limestone grasslands which occur on the thinner soils of the karst area, downstream of Athenry and Craughwell.

Riverine Wetgrass type represents the less well managed or partially reclaimed grasslands. These areas are also widespread, especially in the upper Dunkellin catchment, and show a more pronounced riverine influence. Most Wetgrass vegetation occurs on mineral soil or silty peat and is subject to high winter water-tables and occasional flooding. Water tables probably remain relatively high throughout the summer. Typically, this type of vegetation is dominated by Juncus effusus (Soft Rush) or Deschampsia caespitosa (Tufted Hair Grass), which form tussocks, with low herbs such as Agrostis stolonifera (Creeping BentGrass) and Ranunculus repens (Creeping Buttercup) in between. An interesting example of the type, containing significant amounts of Alopecuris geniculatus (Marsh Foxtail), occurs along the 5 mile stretch of river downstream of Beech Hill Bridge. The largest area of Wetgrass type is found at Rahasane Turlough, but this differs from the vegetation described above and will be discussed later under turlough ecosystems.

Floodgrass represents the wettest and most nutrient-rich type of river floodplain vegetation in the catchments. These areas occur on mineral soils which are flooded for prolonged periods during winter and where the summer water-table remains high. High levels of nutrients, brought in as silt, support a relatively fertile, wet grassland vegetation usually dominated by Glyceria fluitans (Floating Sweet-grass). By far the largest example of this occurs at Rahasane Turlough where the old river channel still floods and deposits it's silt over a wide area.

Floodplain woodland is relatively rare within the catchments. Two major types, both dominated by Alnus glutinosa (Alder), are described in Part 1. One of the few examples of such woodland occurs along the westward-flowing channel which joins the Lavally River above Craigabbey. Planted coniferous woodland also occurs in the riverine ecosystem and, although not examined for this study, several large blocks are found in the central Dunkellin catchment.

(III) Bogs

The bog ecosystem includes all remaining bogs, cutaway bogs and the various vegetation types that have developed on cutaway peat. The bogs themselves occur mostly in the north and east of the catchments and are of the Midland Raised Type (Hammond, 1978). All have been adversely affected by marginal drainage, burning and peat cutting, which has resulted in the drying out of peat surfaces and the loss of the wetter pool systems. Despite this, many of the species which typify Raised Bogs (e.g. Sphagnum magellanicum, S. imbricatum and S. fuscum) can still be found growing on the largest examples.

Cutaway Bog is also widespread in the north and east of the catchments. Included here are the large areas of unvegetated bog that are currently being worked by Bord na Mona. Where Cutaway Bog is left undisturbed, a drier, heath-like vegetation re-establishes, dominated by Molinia caerulea (Purple Moor Grass), Calluna vulgaris (Heather) and Erica tetralix (Cross-leaved Heath). This type of vegetation is common around the margins of the remaining 'intact' bogs. At a later stage these cutaway margins may be colonised by scrub woodland dominated by Betula pubescens (Birch) but stands of this type of woodland are not extensive in the catchments. In a few places, where peat has been cut down to the marl layer, a wetland vegetation has re-established. These areas can become colonised by sparce Reedbeds of Phragmites australis (Reed) and Carex rostrata (Bottle Sedge) or by Marsh vegetation dominated by Schoenus nigricans (Black Bog Rush). Examples of these occur at Cloonoo Bog, 2 miles west of Lough Rea and at Killeenmunterlane Marsh, south-west of Kilcolgan.

Reclaimed bogs can support a variety of vegetation types, depending on the degree of drainage and the land management practices used. Wetsedge vegetation, dominated by Carex nigra (Common Sedge), Agrostis stolonifera (Creeping Bent Grass) and several other sedge species, occurs in the wettest and least managed areas, where peat has been cut down to near the marl layer. It requires a high water-table during summer and is probably subject to flooding in winter. In some cases Wetsedge type may have developed from Marsh or Reedbed communities and indeed it is frequently found in association with these types today. It is quite widespread in the Dunkellin catchment although rather restricted in the Lavally.

Drysedge vegetation is usually dominated by Molinia caerulea (Purple Moor Grass), Succisa pratensis (Devil's

Bit Scarious) and Carex panicea (Carnation Grass) and often occurs on the drier margins of cutaway bogs. It is generally drier than the Wetsedge type and probably receives less winter flooding. In association with bogs it appears that Drysedge vegetation may develop from the Molinia caerulea (Purple Moor Grass)/Calluna vulgaris (Heather) dominated cutaway and perhaps represents formerly reclaimed and fertilized cutaway that has reverted to more semi-natural vegetation through lack of recent management. This type of vegetation is very widespread in the middle and upper reaches of the drainage network. Variants of the type also occur around Lough Rea and in two turloughs in the south-west of the Dunkellin catchment. In these situations a similar Molinia caerulea (Purple Moor Grass) domianted vegetation has developed on thin peat which receives nutrient inputs from winter flooding.

Reclaimed cutaway can also support Wetgrass and Drygrass vegetation. These types represent the better drained and better managed reclaimed peatlands. Wetgrass of this type differs from the riverine Wetgrass by being generally poorer in nutrients, which can be reflected in the species composition of the sward by the replacement of Agrostis stolonifera (Creeping Bent Grass) by Agrostis tenuis (Common Bent Grass), and by the addition of a few calcifuge species such as Erica tetralix (Cross-leaved Heath). This type of vegetation is fairly frequent in the north and east of the Dunkellin catchment.

Drygrass occurs on well drained peat where the sward has been reseeded and is heavily fertilized. This type of vegetation, dominated by agricultural grasses, requires intensive management, without which it can quickly revert to the poorer Wetgrass or Drysedge types. Such vegetation is rather uncommon in the boggy areas of the north and east of the catchments.

Reclaimed bogs have also been utilized for forestry and, although not floristically examined in this study, several blocks of coniferous plantation occur on drained peat in the Dunkellin catchment. These plantations require significant inputs of fertilizer.

(IV) Turloughs

Turloughs (literally 'dry lakes') are wetlands characterised by strongly fluctuating water levels, which flood for prolonged periods during winter and generally dry out severely in summer. They are thought to be unique to the limestone areas of western Ireland and several, including the largest remaining example in the country (Rahasane), occur in the karst area of the catchments. Typically they occur in isolated depressions fed by underground drainage channels. Two intact examples of this kind are Moyode Turlough and Poulatauvally Turlough, both of which have been rated as nationally important. However, this situation has been compl~~e~~icated in some cases by the cutting of overground drainage channels, which can effectively reduce the amount and duration of flooding. This has caused the virtual disappearance of wetland vegetation from Coldwood Turlough in the Lavally catchment, for example. On the other hand, Rahasane Turlough, despite attempts at drainage, still receives sufficient water inputs from the Dunkellin catchment to flood extensively in winter. It has been rated as internationally important.

The vegetation of turloughs is primarily dependent on hydrology, particularly the duration of flooding, and the level of nutrient input. In isolated turloughs, where drainage is through underground channels, semi-permanent water areas may persist throughout summer in the lower sink holes. This is the case at Moyode and Poulatauvally Turloughs where aquatic submergent and emergent vegetation dominated by Chara spp.. (Stoneworts), Potamogeton spp . (Pondweeds) and Apium inundatum (Floating Marsh-wort) was seen during summer 1985. The vegetation of the seasonally flooded turlough margins is also influenced by the level of the summer water table (O'Connell et al., 1984). At Moyode Turlough a species rich limestone Drygrass vegetation, with species such as Linum catharticum (White Flax) amongst the sward, occurs on thin soil which probably dries out severely in summer. A thicker, peaty soil has developed in Poulatauvally Turlough where a higher summer water table supports a damp Molinia caerulea (Purple Moor Grass) domianted Drysedge community. This Drysedge variant differs from the type found in association with bogs by the occurrence of significant amounts of Agrostis stolonifera (Creeping Bent Grass) and Potentilla anserina (Silverweed), both indicative of periodic inundation.

The vegetation of Rahasane Turlough shows a pronounced riverine influence, for as well as receiving water inputs from underground channels, this turlough also acts as a silt trap for the Dunkellin River. Permanent open water exists throughout the year in the main river channel and in the old northern channel. These areas support a rich aquatic submergent and emergent vegetation with such species as Zannichellia palustris (Horned Pondweed), Myriophyllum verticillatum (Whorled Water Milfoil), Oenanthe fluviatilis (River Water Dropwort) and Nuphar lutea (Yellow Water Lily) amongst others. In parts that are ungrazed a sparce channel margin community of Phalaris arundinacea (Reed Canopy Grass), Sparganium erectum (Branched Bur-reed) and Hippuris vulgaris (Mare's Tail) has developed. A broad band of Floodgrass vegetation, dominated by Glyceria fluitans (Floating Sweet Grass), occurs in association with the old river channel indicating that this area remains wet for most of the year and receives high nutrient inputs from silt.

The lower parts of the turlough basin support Wetgrass vegetation, dominated by Agrostis stolonifera (Creeping Bent Grass), Potentilla anserina (Silverweed) and Ranunculus repens (Creeping Buttercup), which is subject to prolonged flooding in winter and is heavily grazed in summer. These areas probably retain a high summer water table, as is evidenced by the occurrence of Myosotis scorpioides (Water Forget-me-not), Mentha aquatica (Water Mint) and Hydrocotyle vulgaris (Marsh Pennywort) amongst the swards. The frequent occurrence of Alopecuris geniculatus (Marsh Foxtail) in this type of vegetation also indicates some nutrient input from the Dunkellin River during times of flood.

The upper margins of the turlough support Drygrass vegetation, dominated by elements of the Wetgrass community (into which it grades) such as Agrostis stolonifera (Creeping Bent Grass) and Potentilla anserina (Silverweed), as well as drier type herbs such as Lotus corniculatus (Bird's-foot Trefoil), Plantago lanceolata (Ribwort Plantain), Trifolium repens (White Clover) and Bellis perennis (Daisy). The absence of many of the hydrophilous plants probably indicates that these areas are subjected to more severe drying out in summer.

Another turlough that shows a riverine influence is Gortakeeran Turlough, in the north of the Dunkellin catchment. A small overground stream flows through the turlough and disappears underground down a series of sink holes at it's southern end. The vegetation of the channel and it's environs reflects the rich nutrient conditions brought about by the input of silt, with such species as Alisma plantago-aquatica (Water Plantain) and Phalaris arundinacea (Reed Canary Grass) growing in the channel itself and Polygonum hydropiper (Water Pepper) and Rorippa palustris (Marsh Yellow Cress) colonising it's muddy banks. The surrounding Drygrass vegetation is dominated by Agrostis stolonifera (Creeping Bent Grass), Potentilla anserina (Silverweed) and Ranunculus repens (Creeping Buttercup) together with ruderal species such as Plantago major (Great Plantain) and Rumex crispus (Curled Dock).

(V) Salt Marshes

The salt marsh ecosystem includes the lands affected by tidal flooding where the vegetation shows, to varying degrees, a saline influence. Although a small area of salt marsh vegetation occurs at the outlet of the Lavally River, below Clarinbridge, this type of vegetation is most extensive and best developed on the Dunkellin River estuary, downstream of Kilcolgan. Several plant communities are included in the Salt Marsh type, ranging from the Juncus maritimus (Sea Rush) and Juncus gerardii (Salt Mud Rush) dominated salt meadows of the lower salt marsh zone to the Schoenus nigricans (Black Bog Rush)/ Festuca rubra (Red Fescue) dominated communities of the upper, less saline zone. On the muddy creeks and ditches which criss-cross the area, localized patches of Scirpus maritimus (Sea Club-Rush), Scirpus tabernaemontani (Glaucous Club-Rush) and Carex riparia (Great Pond Sedge) can be found. Several rare plants have their only stations in the catchments in the Salt Marsh communities below Kilcolgan, including Puccinellia distans (Reflexed Salt Marsh Grass), Apium graveolens (Wild Celery), Ruppia maritima (Beaked Tassel Pondweed), Carex riparia (Great Pond Sedge) and Carex extensa (Long-bracted Sedge). Carex pendula (Pendulous Sedge), which has one other site in the catchments, near New Inn, can also be found here.

4. ESTIMATION OF IMPACTS

When estimating the likely impacts of arterial drainage on vegetation some consideration must be given to the past trends of vegetational development. By doing this the changes in vegetation which would occur in the absence of drainage can be taken into account when considering the impacts of the proposed arterial drainage scheme. Consequently the following discussion has been divided into three major sections, the first dealing with historical development of vegetation, the second with its likely evolution in the absence of drainage and the third with the expected impacts of the proposed scheme. As in the preceeding section, this discussion is based upon the vegetation types and communities described and mapped in the first report (Lockhart, 1984), considered under the headings of the ecoystems in which they occur. Rare species and areas of scientific interest are dealt with where appropriate. In the historical development section little attempt has been made to estimate the possible status of species now considered to be rare, although, as all are wetland plants, most were probably more widespread in the past.

In the concluding section on expected impacts a brief outline of the technical aspects of the drainage scheme is given and the nett effects of the scheme on species, vegetation types and sites of scientific interest are discussed.

4.1 Historical Development of Vegetation

4.1.1 Early Vegetational Development

During the latter part of the last Ice Age much of Ireland was covered by thick sheets of glacial ice. In the area now drained by the Dunkellin and Lavally Rivers moving ice scoured the underlying carboniferous limestone and deposited glacial till to form the gently undulating topography which characterises the catchments today. With the advent of warmer conditions water became free to percolate through the newly exposed mineral soils and brought about the chemical and structural changes that initiated the formation of the present soil profiles.

Polynological evidence from several localities in Ireland suggests that Willows (*Salix spp*) and Birches (*Betula spp*) were the first trees to colonise much of the country after the ice had retreated around 10,000 BP* (Mitchell, 1976). As climatic conditions ameliorated many other trees became established in Ireland and by 8,000 BP it is probable that

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* Before Present

the upland soils in the Dunkellin and Lavally catchments were wooded by Oaks (Quercus spp), Elmus (Ulmus spp), Hazel (Corylus avellana) and possibley Ash (Fraxinus excelsior). Woodlands continued to dominate the Irish landscape until about 5,500 BP when the first Neolithic farmers began clearing the land for agriculture ([illegible], 1976). When glacial ice finally melted the numerous basins and depressions in the Dunkellin and Lavally catchments were probably filled with open water to form a network of lakes. Only the deepest of these, Lough Rea, has survived through to the present. Virtually all the remainder, through a combination of marl deposition, accumulation of undecomposed plant debris and siltation, became overgrown by vegetation to form reed swamps and fens. This sequence of events (Figure 1) is still in evidence in the catchments today, notably at Parkslevabaun Marsh and Graigabbey Marsh. Peat accumulation and fen development probably also took place in low lying areas flooded by the rivers and in these situations trees may have established to form fen woodlands.

Most of the early Post Glacial fens, however, have since been overgrown by acid peat bogs. Radio carbon dating of peat cores indicates that bogs had started to form in the midlands and north of Ireland at least 7,000 years ago (Mitchell, 1976; Hammond, 1968) and some of the bogs in the catchments may date from this time. The transition from calcareous fen to acid peat bog (Figure 1) occurs when fens, through accumulation of peat, grow above the level of the ground water table. Whilst plants on the peat surface are still in contact with nutrient rich calcareous ground water, either through direct contact with mineral soil underneath or through flooding, the vegetation will be primarily calicole. When this ground water contact is lost, however, the peat surface becomes available for colonisation by less nutrient demanding, and more calcifuge plants and acid bog development commences. Once initiated, bog growth probably became self-perpetuating, depending only upon nutrients and water brought in by rainfall. The bogs in the Dunkellin and Lavally catchments, which can be classified as Midland Raised types, have probably been growing more or less continuously since early Post Glacial times.

Little is known about the early history of turloughs. If in fact they date back to post Glacial times some of the shallower and less frequently flooded ones may have at some stage been wooded, possibly by Alders (Alnus glutinosa). The deeper ones may have always remained free of woodland and thus their present vegetation may have developed more or less undisturbed for thousands of years. Equally little is known about the development of the rivers in the catchments. It is probable that in early Post Glacial times drainage was largely overground and that the underground channels, so characteristic of limestone geomorphology, developed through subsequent solution of the limestone.

4.1.2 Early Impacts on Vegetation

The gradual decline of Irish woodlands can be traced by the fossil record from the early attempts at land clearance by Neolithic farmers around 5,500 BP through the Bronze and Iron Age cultures to 300 AD. At this date there appears to have been a dramatic expansion of agriculture attributable to the introduction of the coulter plough (Mitchell, 1976). Large areas of remaining secondary woodland were cleared resulting in the modern, relatively treeless landscape of Ireland. Only in more recent times, through the planting of exotic trees such as Beech (Fagus sylvatica), Sycamore (Acer pseudoplatanus) and Horse Chestnut (Aesculus hippocastanum) in estate woodlands during the 18th and 19th centuries, and afforestation with exotic conifers in the present century, have woodlands to some extent re-emerged.

Peat bogs in the catchments have probably had a long history of disturbance by turf cutting. In many cases peat has been cut down by several meters to the fen peat or marl layers underneath and this has given rise to some of the vegetation types now found in the catchments e.g. Wetsedge. Large scale disturbance, however, probably only began with the extensive arterial drainage schemes of the 1850's and more recently through the activities of Bord na Mona and mechanised private turf developers.

4.1.3 Impacts of the 1850's Drainage Scheme

Wetland vegetation in the Dunkellin and Lavally catchments has been greatly influenced by numerous attempts at drainage in the past. One of the most intensive drainage schemes took place in the 1850's, at a time when population density and demands upon land for agriculture were considerably higher than today. This scheme was largely responsible for the drainage network that exists at present. Some idea of what vegetation may have existed prior to 1850 was gained by examining the 1838 6-inch Ordnance Survey maps at the National Library in Dublin. The impact that the 1850's drainage work had on vegetation is discussed below in terms of the ecosystems - Lakes, Rivers, Bogs, Turloughs and Salt Marshes and their constituent vegetation types (see Table II).

(I) Lakes

The 1838 maps show that the water level of Lough Rea was much the same as it is today and thus it is probable that the aquatic, submergent Chara beds and emergent, littoral Reedbeds have remained relatively unchanged since that time. The area on the western shore now occupied by Birch/Willow scrub was undrained in 1838 and was probably then an extensive Marsh or Wetsedge zone. The cutting of drains, thus lowering the summer water table, and subsequent lack of maintenance possibly aided the colonisation of the area by the woodland that occurs there today. The Wetsedge and scrub woodland area on the south-eastern shore appears to have been already drained prior to the 1850's scheme and is not marked as marsh or rough grazing on the 1838 maps. This would suggest that the unmanaged semi-natural vegetation occurring there today has resulted from lack of drainage maintenance and poor land management practices. Elsewhere along the exposed and stoney shoreline the Drysedge community has probably remained unchanged, assuming that the seasonal fluctuations in lake levels, upon which this type is dependent, were operating as they are at present.

Brick Lough appears to have remained unchanged since 1838. Lough Kinlea, however, was formerly more extensive. Drainage in the 1850's probably caused positional changes in it's marginal turlough-like Drysedge community, a restriction of it's aquatic Chara beds and possibly promoted the growth of the shallow floating plants, such as Potmogeton natans (Floating Pondweed), that colonise much of the lake surface today.

Other small areas of open water formerly existed in the catchments but have since been drained and overgrown by vegetation. One example occurs near Esker, 3 miles east of Athenry, where the 1838 maps show the existence of a lake, Lough Nambraker. The loss of open water in this area, now overgrown by Birch scrub, is probably attributable to the 1850's drainage scheme as subsequent

Ordnance Survey maps mark the area as a marsh. Graigabbey Marsh, however, had already been drained by 1838 as no open water area is shown from that time. The marsh itself though, now vegetation by Reedbeds, has contracted considerably but whether this was caused by the 1850's scheme or by more recent local drainage work is not discernable. At Parkslevabaun Marsh several areas of open water are marked on the 1838 maps where today a series of small marshes occur. The reductions in water level here was probably due to the 1850's scheme as more recent 1933 maps show little or no open water at the site. The consequence of drainage here, apart from the loss of open water, has been the acceleration of the transition from Reedbeds to fen and eventually bog communities. The rare species that are found at the site at present were probably extant prior to the 1950's scheme but whether their populations were adversely or favourably affected is difficult to judge.

The 1850's scheme caused some loss of Marsh vegetation at Carrowmunna Marsh. At present there are two distinct Marsh areas at this site but prior to 1850 there had been three. This is worthy of note as this is the only site in the catchment where Eriophorum latifolium (Broad-leaved Cottongrass) is found today. This plant occurs at both marsh zones and it is feasible to suggest that it had formerly occurred at the third.

(II) Rivers

Perhaps the most dramatic changes noticeable from the 1838 maps is the impact that the 1850's drainage scheme had upon the drainage network. Prior to this scheme both the Dunkellin and the Lavally rivers followed more natural courses, incorporating numerous meanders, especially in their middle reaches. Most striking of all have been the changes to the drainage system in the lower, karst areas. In 1838 the Lavally river is shown going underground at Coldwood Turlough and re-emerging two miles downstream just above Clarinbridge, where today a deep, regraded overground channel connects the river to the sea. The Dunkellin river used to meander along the northern boundary of Rahasane Turlough and disappeared underground at Clochincha. It re-emerged a mile or so downstream at Dunkellin Turlough and meandered as a broad, marshy channel to Kilcolgan Bridge and the sea. Today the river reaches the sea by a rerouted and regraded overground channel which cuts deeply into bedrock for several miles.

It is difficult to assess the impacts that such major arterial drainage works had upon the aquatic vegetation of the channels in the catchments. Undoubtedly the initial impacts would have been severe but to what degree the original flora has re-established is a matter of conjecture. It is interesting to note here that one of the few sections that appears to have been largely unaffected by the 1950's scheme (i.e. the meandering channel from Beech Hill Bridge to Raford Demesne), presently contains the highest diversity of aquatic and emergent river plants noted from the survey, including *Oenanthe aquatica* (Five-leaved Water Dropwort) and *Potamogeton alpinus* (Reddish Pondweed). It is thus tempting to speculate that the loss of river habitat diversity, caused by the straightening and regrading of channels, has had long term and permanent effects upon the diversity of river flora. Channel bank vegetation, such as *Phalaris arundinacea* (Reed Canary Grass) Reedbeds, has almost certainly decreased since the previous drainage scheme due to the loss of slow-flowing, meandering stretches upon which it depends.

River floodplain vegetation types would also have been affected by the drainage scheme. The general lowering of water-tables and the decreases in extent and duration of flooding would have made more land available for agriculture and would have caused the expansion of the present strongly modified Drygrass type. This would have occurred to the detriment of the more semi-natural Wetgrass and Floodgrass types. It is likely that the Wetgrass type (*Juncus effusus* (Soft Rush) dominated, partially reclaimed grasslands) has expanded somewhat in more recent times due to lack of field-drain maintenance but the Floodgrass type has probably suffered a more permanent decline. Floodplain woodland appears to have been as rare in 1838 as it is today but it is interesting to note that the *Alnus glutinosa* (Alder) woodland above

Graigabbey was in existence prior to the 1850's and is therefore of historical import.

(III) Bogs

Although the bogs in the Dunkellin and Lavally catchments have probably had a long history of human disturbance, the 1838 maps show that virtually all of them were considerably more extensive. Arterial drainage in the 1850's would have made more bogland available for turf cutting and reclamation. Some of the smaller bogs, such as the one to the north of Graigabbey, have been completely destroyed, to be replaced by Drysedge communities or unmanaged Brich scrub and cutaway. The larger bogs would have tended to dry out more slowly, their centres remaining intact but their margins replaced by secondary communities. In some cases e.g. Cloonoo Bog, turf cutting was so intense that peat was removed down to the marl layers. Subsequent lack of drain maintenance has meant that these areas have re-flooded and caused the local expansion of replacement Marsh and Wetsedge vegetation. Judging from the 1838 maps it would appear then that the 1850's drainage scheme was indirectly responsible for the decline of intact bogs in the catchments and the expansion of Wetsedge, Drysedge and other replacement communities. It should also be noted that arterial drainage has aided the large scale mechanised peat extraction carried out by Bord na Mona, and the afforestation of bogs with conifers by the

Department of Fisheries and Forestry, in more recent times.

(IV) Turloughs

The 1850's drainage scheme certainly had dramatic effects upon the turloughs in the catchments. The 1838 maps show that several more turloughs formerly existed which have since been reclaimed as Drygrass. On the Lavally river, a turlough used to exist at Willmount, 5 miles upstream of Coldwood Turlough. Coldwood itself was probably more extensive prior to the digging of an over-ground outlet. On the Dunkellin river, turloughs used to occur at Aggard, Killara and several other sites upstream of Craughwell. Rahasane Turlough, and those downstream of it, have all been affected by the digging of outlets, the rerouting of channels and the general lowering of water tables. Permanent open water, for example, formerly occurred in the south western part of Rahasane. Interestingly though, there may have been less change in the more isolated turloughs such as Poulataunvally, Moyode and Gortakeeran. These appear on the 1838 maps much as they are now.

It is particularly difficult to estimate the impacts of the 1850's scheme on vegetation as turloughs are so variable in the extent and duration to which they flood, features that are not discernable from Ordnance Survey maps. In general, however, it is safe to assume that arterial drainage caused a serious decline in all turlough vegetation types.

(V) Salt Marshes

The Salt Marshes below Kilcolgan and Clarinbridge are marked as pasture or rough grazing on the 1838 maps. Salt marsh vegetation almost certain existed in these areas at that time but, if anything, has expanded since the 1850's scheme due to the increased water volume brought down by the rivers in times of flood.

4.2 Evolution of Vegetation in the Absence of the Proposed Drainage Scheme

The present vegetation has already been described in the first report and in Section 3.2 of this report. The likely course of evolution of this vegetation, in the absence of the proposed drainage scheme, is considered here at two possible levels of drainage and agricultural development. The first assumes that there will be no change in the present state of drainage in the catchments and that there will be no further agricultural development of existing wetlands. This is broadly speaking the assumption made by O.P.W. in their cost/benefit analysis of drainage schemes (see Howard, 1980). Under this assumption the only changes which are likely to occur in wetland vegetation are those which can be expected to take place naturally. As a large proportion of wetland vegetation is currently maintained by grazing, natural development will only occur in areas which receive minimal management. The second possibility, which takes into account these possible natural changes, assumes that there will be more regular maintenance of existing drainage channels and that piecemeal reclamation of wetlands will be carried out where possible. This seems to be the more likely possibility of the two and will be discussed here at some length under the headings of the 5 major ecosystems (see Table II). No attempt has been made to put an accurate time scale on the events discussed but in general any changes in vegetation will be slow to occur.

(I) Lakes

Under this assumption the water levels and fluctuations of Lough Rea could be expected to remain as they are at present, in which case there would be little or no change in the existing vegetation unless marginal drainage was improved. Renewed maintenance of channels could enable some reclamation of the wetlands to the west and south-east of the lakes, causing the loss of Brich/Willow scrub, Wetsedge and possibly Drysedge. However, there have been suggestions that the lake may be used as a reservoir, in which case the general level of water may rise and the existing fluctuations increase. A rise in lake level would cause surrounding lands to flood more extensively and may result in an expansion of Wetsedge or Marsh vegetation. Increased fluctuations, however, would be detrimental to vegetation in the shallow littoral zones and this could cause a restriction of the Reedbed community.

Brick Lough, already reclaimed around the margins, is unlikely to change. Lough Kinlea, however, is a rather shallow lake with turlough-like fluctuations. Continued siltation may, in the long term, bring about a change from open water to Marsh vegetation here.

Reedbed vegetation will naturally tend towards Marsh or fen development. If left undisturbed such areas could support Willow scrub woodland. At Graigabbey Marsh, where Reedbed is well exemplified, such changes are being accelerated by local drainage activities and it is thus probable that the existing vegetation will be replaced by Wetsedge or reclaimed for pasture. At Parkslevabaun Marsh, which is not connected to a main drainage channel, the various types of Marsh communities are unlikely to change much in the near future. In the long term these areas may develop into small raised bogs with possibly, if ungrazed, an intervening stage of Willow scrub woodland. Carrowmunna Marsh, however, is more imminently threatened by drainage. The northern marsh area has already been severely affected by local drainage and is likely to be reclaimed as Wetsedge or pasture. The wetter, southern marsh could suffer a similar fate if new drainage channels are extended into it. A number of springs occur in both these areas so remnant, but much reduced, Marsh vegetation may persist. Elsewhere in the catchments Reedbed and Marsh vegetation may endure in isolated pockets but those near main drainage channels may gradually be reclaimed.

(II) Rivers

There are unlikely to be any significant changes in the vegetation of the river channels in the absence of arterial drainage. If there is more regular channel maintenance there may be some suppression of plant growth in some areas, but this is unlikely to be detrimental overall if such maintenance is carried out correctly. Where riverine Reedbed vegetation has survived since the last arterial drainage scheme (i.e. Beech Hill Bridge section), it is likely to remain.

The present extent of river floodplain vegetation types is to some degree the result of lack of maintenance of the 1850's drainage network. If channels were more regularly maintained there may be a slight decrease in the extent of Wetgrass vegetation and a corresponding expansion of Drygrass types. Floodgrass vegetation may also contract somewhat, but the main stand of it, at Rahasane, is unlikely to be affected. Floodplain woodland, exemplified on the channel above Graigabbey, is not likely to be affected by channel maintenance and will remain unless cleared for reclamation.

(III) Bogs

Further drying out of bogs and increasing amounts of turf extraction can be expected. This will lead to an expansion of the area of Cutaway Bog and the various plant communities associated with it. Areas of existing Reedbed or Marsh found on Cutaway Bog are likely to become overgrown and may in the long term form local areas of bog regeneration. Further turf cutting may even create new areas of Reedbed and marsh, but overall the trend will be towards increasing dessication of bogland and it's replacement by drier, heath-like vegetation.

With increasing turf extraction there may be local areas of Wetsedge expansion. However, existing areas of Wetsedge are likely to be reclaimed, if drainage channels are more regularly maintained, to be replaced by Wetgrass or Drygrass vegetation and resulting in a net decline of Wetsedge type. Likewise for Drysedge vegetation, local re-expansion is likely to be offset by increased reclamation and an overall decrease in this type can be envisaged. Both Wetsedge and Drysedge types could, in the long term, support scrub woodland if grazing pressure were removed.

In tandem with the net decline envisaged for the Wetsedge and Drysedge types, an overall increase in the areas of Wetgrass and Drygrass, reclaimed from peatland, can be expected. An increase in the area of planted conifer woodland on peat can also be anticipated.

(IV) Turloughs

There are unlikely to be any major floristic changes in the vegetation of the existing turloughs if present landuse activities are continued. Local drainage maintenance might reduce the duration of flooding in some of the smaller turloughs i.e. Moyode and Poulatauvally, but in general the turloughs are likely to remain much as they are now unless a serious draw-down in catchment water-tables is brought about by arterial drainage.

(V) Salt Marshes

No major change is envisaged in the vegetation of the Salt Marshes if present management practices are continued.

4.3 Impacts of the Proposed Arterial Drainage Scheme

4.3.1 Drainage Design and Implementation

The Dunkellin and Lavally catchments together comprise an area of approximately 47,500 ha, of which an estimated 9,170 ha (19.3%) are described by OPW as damaged lands (land with impeded drainage). This tallies with our own estimates of 9,270 ha damaged land. Of the total area of damaged land, approximately 2,625 (28.6%) are described by O.P.W. as bogland. This differs, however, from our own estimates which indicate that approximately 3,000 ha (32.4%) can be classified as bogland (Bog and Cutaway vegetation types). For the purposes of the following discussion our own estimated figures will be used.

At the time of writing there has been no cost/benefit analysis report produced for this proposed drainage scheme. In the absence of such a report it is assumed here that a full arterial drainage scheme will be implemented and that all damaged lands will be affected. In accordance with O.P.W. practices, damaged lands are here dividied into two categories; benefitting land (6,270 ha of non-bogland) and partially benefitting land (3,000 ha of Bog and Cutaway vegetation types). The design drainage depth for this scheme will probably be 0.75 m (Dudey, pers. comm.), i.e. lands which will achieve full benefit will have their water-tables lowered to 0.75 m below ground surface. The rates at which lands will achieve full benefit can be inferred from the figures published for the Corrib/Mask scheme (Howard, 1980). Thus, arterial drainage alone will be expected to benefit 25% of benefitting land (1,567.5 ha). Of this 25%, approximately 60% (15% of total or 940.5 ha) should benefit in the first year of drainage and 40% (10% of total or 627 ha) in the second. The remaining 75% of benefitting land (4,702.5 ha) will require field drainage. Of this remainder, 55% (2,586 ha) should only require perimeter drains, whilst 45% (2,116 ha) will require both perimeter drains and under drains (pipes, tiles, etc.) to achieve full benefit. The figures used for the Corrib/Mask scheme (Howard, 1980), when applied to the Dunkellin and Lavally catchments, indicate a probable rate of land benefit as follows:

Years after completion of Arterial Drainage	% of total area of benefitting land to achieve benefit
1	15% (940.5 ha)
2	35% (2194.5 ha)
3	45% (2821.5 ha)
4	55% (3448.5 ha)
5	65% (4075.5 ha)
6	75% (4702.5 ha)
7	88% (5408 ha)

The remaining 11.25% (862 ha) would not be expected to achieve full benefit as some farms would probably not enter into the scheme. It is impossible to judge which lands these might be, but as 25% of the total area of benefitting land will benefit directly from arterial drainage, this 11.25% will comprise areas that would require some sort of field drainage.

The increase in density of livestock units on lands that would benefit from the scheme can be expected to cease growing at 2.6 l.u. per hectare (inferred from Howard, 1980). The greatest rate of increase would be in the first few years e.g. 50% of the increase in livestock density, achieved over 50 years, occurs in the first 8 years (Howard, 1980). After this period the rate of increase would be expected to decline. Thus, most of the changes in vegetation caused by scheme would probably occur within the first 8 to 12 years.

2.1.2. ~~4.3.2~~ General Impacts on Vegetation

The impacts of the proposed drainage scheme can be considered in two stages, firstly the impacts of arterial drainage alone and secondly the impacts of subsequent land reclamation by scrub and woodland clearance, installation of field drains and improvement in land management practices.

2.1.2.1 ~~4.3.2.1~~ Arterial Drainage

The affects of arterial drainage on vegetation can be subdivided into direct and indirect impacts. Direct impacts will be caused by the actual carrying out of arterial drainage works through dredging of channels, bank clearance and disposal of spoil, and will primarily affect the vegetation of the rivers and their banks. Dredging will physically remove aquatic vegetation from the rivers and cause an increase in silting in downstream areas. Bank clearance will be necessary, in some cases, to allow dredging machinery access to the rivers and will cause damage to bank vegetation by the removal of obstructing trees and shrubs. The disposal of spoil from dredging, either by spreading on surrounding lands or by mounding into ridges on the river banks, will destroy vegetation and cause long term alterations of soil chemistry and structure. All of these impacts can be regarded as semi-permanent if regular maintenance of arterial drains is carried out.

Indirect impacts will result from deepening and widening river channels, straightening river courses and levelling and smoothing river beds to eliminate obstacles. These activities will cause an overall lowering of water-tables in neighbouring wetlands and the elimination of flooding. This in turn will affect wetland vegetation, most especially the aquatic, semi-aquatic and seasonally flooded vegetation types. Regular maintenance will permanently exclude any possibility of a return to high water tables and flooding.

2.1.2.2 4.3.2.2 Land Reclamation

Land reclamation will take place by clearance of woodland and scrub (where necessary), installation of field drains and improvement of land management practices. The impact of these activities, although important in themselves, can be regarded as secondary as they will generally act upon the drier vegetation types resulting from arterial drainage. Where woodland and scrub clearance takes place the impact on vegetation will be major and direct. The impacts of field drainage, however, will be both direct and indirect. The direct impacts will be caused by the physical disturbance of vegetation during the installation of pipes and tiles. Indirect impacts will result from the decreased waterlogging of the soils and will cause a decline in hydrophilous plants. Once land has been drained, improved land management practices, through ploughing and reseeding, will completely change the composition, structure and relative abundance of species in the vegetation.

Any vestiges of wetland vegetation can be expected to have been removed at this stage. Subsequent use of fertilizers will improve productivity, encourage vigorous growing grasses and clovers and permanently exclude the original species. Widespread use of fertilizer may lead to an increase in plant nutrients in the water courses. This tendency may be exacerbated by the anticipated increase in livestock density and may lead to changes in aquatic vegetation. The use of herbicides for maintenance of drains and channels would also have a major impact on aquatic vegetation. *

4.3.3 Specific Impacts

Specific impacts of the proposed scheme are considered under the headings of Species, Vegetation Types and Sites of Scientific Interest.

4.3.3.1 Impacts on Species

The impacts on species were estimated by examining their ecological behaviour, using Ellenburg (1979), and their known distribution in the catchments. In the event of a full arterial drainage scheme all those species dependant upon high water tables or flooding can be expected to decline in abundance. As a rough estimate, this may affect about 50% of the 384 species recorded from the damaged lands during the survey. Many of those that already have a restricted distribution may be lost entirely from the catchments. Likely extinctions are listed below (those marked with an asterisk have been rated as rare).

Carex curta*
Carex dioica*
Carex limosa*
Carex strigosa*
Eleocharis quinquiflora
Epipactis palustris*
Equisetum variegatum*
Eriophorum latifolium*
Galium uliginosum
Oenanthe lachenalii
Polygonum minus*
Potamogeton alpinus*
Sphagnum fuscum
Sphagnum imbricatum
Sphagnum magellanicum
Stellaria palustris
Viola persicifolia*

It is not considered likely that any native species new to the catchments will become established because of the drainage scheme.

4.3.3.2 Impacts on Vegetation Types

The impacts of vegetation types were estimated by examining their known ecological requirements (Table I) and their known distribution in the catchments (Vegetation Map). These are discussed below under the headings of the ecosystems in which they occur. In general the impacts under discussion are those of arterial drainage. It can be assumed that any subsequent land reclamation will completely destroy wetland vegetation in favour of agricultural grasses. In some cases, even assuming a full drainage scheme, certain vegetation types may re-establish in new areas, replacing existing vegetation. No attempt has been made to estimate the areas of such re-establishment but in general the tendency will be towards a reduction in extent of all the hydrophilous types.

(I) Lakes

Lough Rea is not expected to be affected by the proposed drainage scheme. However, if the suggested reservoir plans are implemented, the level of the lake will probably rise and it's fluctuations be greatly increased. A rise in lake levels will cause surrounding lands to flood more extensively and may result in an expansion of Wetsedge or Marsh vegetation. If undisturbed, such vegetation may become colonised by Birch/Willow Scrub, similar to that which already occurs in places around the lake shore.

Increased fluctuations, however, would be detrimental to aquatic and emergent vegetation in the shallow littoral zones and could cause a restriction of the Reedbed community. This in turn would cause a contraction in the extent of the uncommon Sparganium minimum (Small Bur-Reed) community which presently occurs amongst these Reedbeds.

Brick Lough is unlikely to be supplied with an arterial drainage outlet but nevertheless may be affected by a general lowering of catchment water tables. This may result in a decrease in open water area and an expansion of it's already reclaimed Drygrass margin vegetation. Lough Kinlea may also be indirectly affected by arterial drainage. A decrease in water levels here could accelerate the rate at which this lake is being overgrown by floating-leaf vegetation. A decrease in water fluctuations would result in the contraction, or extinction, of it's turlough-like margin vegetation and it's replacement by reclaimed Drygrass.

Reedbed and Marsh vegetation, which is already scarce in the catchments, will be severely affected by arterial drainage. The Reedbeds at Graigabbey, near Athenry, will be lost, together with the only stand of the regionally rare Equisetum variegatum (Varigated Horsetail) in the catchments. This area could support some form of sedge-dominated Marsh vegetation or Wetsedge type but is more likely to be reclaimed for pasture. Parkslevabaun Marsh will probably not be drained directly but is very likely to be affected by arterial drainage elsewhere. The various Marsh communities here will all contract and some of the wetter types may be lost entirely. The specialised niches of the several rare species that occur here will diminish and many of these plants will face extinction from the catchments. The area will probably remain too wet to be fully reclaimed but may support a form of Wetsedge vegetation. Carrowmunna Marsh will also be severely affected. The northern part of the marsh has already been partially drained and is very likely to be reclaimed if arterially drained. The southern marsh will dry out to be replaced by Wetsedge or, if reclaimed, by Drygrass. This will cause the certain extinction of the locally rare Eriophorum latifolium (Broad-leaved Cotton-grass) from the catchments.

(II) Rivers

The impact of arterial drainage on the vegetation of the rivers themselves will vary depending upon the depth and flow of water in the channels. Initial drainage works will certainly have dramatic effects, with the complete removal of aquatic vegetation, but in most cases these impacts will not be permanent as macrophytic vegetation is likely to re-establish. In stretches which have not previously been arterially drained, however, the loss of meanders and riffle/pool sequences may have more permanent impacts. Regular maintenance of channels may permanently exclude the re-establishment of the slower growing bryophyte and algal communities of the well oxygenated riffle stretches. Riverine Reedbeds, exemplified on the stretch downhill of Beech Hill Bridge, are likely to disappear through the initial drainage works and be permanently excluded from re-establishment with the loss of slow-flowing meanders, unless remedial measures are taken.

The impacts on floodplain vegetation types, which depend upon high water tables and/or periodic flooding, will be dramatic and permanent. Wetgrass and Floodgrass types can be expected to decline in favour of an expansion of reclaimed Drygrass vegetation. Even the main stands of Wetgrass and Floodgrass, at Rahasane Turlough, will be severely reduced in area, or eliminated entirely, if this turlough is successfully drained. Floodplain woodland, exemplified on the channel above Graigabbey, will also be affected by arterial drainage. Although the trees themselves can be expected to survive, unless cut in subsequent reclamation, the ground flora will be replaced by a drier type. Conifer woodland occurring on river floodplains may benefit from drainage but account must be taken of the short term losses caused by removing trees to allow access of dredging machinery.

(III) Bogs

Arterial drainage will effectively accelerate the further decline of the remaining 'intact' bogs in the catchments.

Although these bogs are not expected to fully benefit, most of the larger examples will probably be supplied with arterial drainage outlets. This will cause then to dry out more rapidly than at present and make more peatlands available for turf-cutting and forestry. The result will be an increase in the extent of Cutaway Bog and the vegetation types associated with it. At the same time, existing areas of Cutaway Bog are more likely to be reclaimed for pasture so that there may not be a net increase in Cutaway vegetation types. Wetsedge and Drysedge vegetation, derived from partially reclaimed peatland, will probably be replaced by Drygrass vegetation but may, to a limited extent, re-establish on other drained bogs that are not fully reclaimed. However, the overall tendency will be towards a decline of the wetter and poorer vegetation types in favour of drier and more intensively managed grasslands. With increased dessication of bogs an expansion of the areas of conifers on peatlands can also be anticipated.

(IV) Turloughs

Arterial drainage could have a major and irreversible impact on the turloughs judging from the effects of the previous 1850's arterial drainage scheme. The isolated turloughs, such as Poulatauvally and Moyode, which probably will not be drained directly, may nevertheless be affected by a general lowering of ground water tables. This could cause the loss of semi-permanent open water areas and a severe restriction, or complete elimination, of seasonally flooded margin vegetation from these turloughs. In this event, the regionally rare Viola persicifolia (Fen Violet) would be lost from Moyode Turlough.

The internationally important Rahasane Turlough, the largest remaining example of it's kind, would also probably be severely affected. The further deepening of it's outlet would reduce the extent and duration of flooding, causing dramatic changes in it's vegetation. Although flooding may not be completely eliminated, it may be sufficiently reduced to cause the loss of the extensive areas of Wetgrass and Drygrass vegetation and their replacement by a drier grassland, possibly similar to that which occurs at the already drained Coldwood Turlough. The large stand of Floodgrass vegetation, which occurs along the old northern channel, may also be lost and this may be replaced by a form of Wetgrass. The drainage of Rahasane may also result in the loss of up to five regionally rare species from the catchments.

Downstream of Rahasane, arterial drainage could cause the loss of a further two small turloughs; Dunkellin Turlough and Killeely Turlough. Gortakeeran Turlough will certainly be lost if an overground outlet is dug. The overall affect of arterial drainage will thus be wide ranging and may result in the elimination or severe restriction of all turlough vegetation in the catchments.

Such a loss would be serious in national and international conservation terms.

(V) Salt Marshes

The small areas of Salt Marsh, downstream of Kilcolgan Bridge and Clarinbridge, are unlikely to be affected by the proposed scheme. They may in fact expand somewhat if the anticipated increase in peak flows cause more flooding in these areas.

4.3.3.3 Summary of Impacts on Vegetation Types

Without a cost/benefit analysis report it is not possible to give accurate figures for the areas of vegetation types that may be affected by the proposed drainage scheme. In the foregoing discussion it was assumed that a complete arterial drainage scheme would be fully implemented to a design drainage depth of 0.75 m. The general trends in vegetational development under such an assumption are summarised in Table III.

The most significant points to note from Table III are that major and irreversible declines can be expected in 5 vegetation types; Reedbeds, Bogs, Turlough Drygrass, Turlough Wetgrass and Floodgrass, and a serious decline, with limited re-expansion, will probably occur in Marsh vegetation. All other vegetation types will decline overall with the exceptions of Salt Marsh, which should

Table III: General Trends in Vegetational Development Assuming a Fully Implemented Arterial Drainage Scheme

Vegetation Type	Total Area (ha)	General Trend*	Possible re-establishment
Reedbeds	6.5	<<	x
Marsh	28.0	<<	✓
Bog	1554.0	<<	x
Cutaway Bog	1442.0	<	✓
Salt Marsh	17.5	–	–
Drygrass	3017.0	>>	✓
Wetgrass	1193.0	<	✓
Turlough Drygrass	300.0	<<	x
Turlough Wetgrass	150.0	<<	x
Drysedge	994.0	<	✓
Wetsedge	144.0	<	✓
Floodgrass	47.0	<<	x
Mixed Woodland and Scrub	87.0	<	✓
Conifers	291.0	>	✓
Total area (ha)	9271.0		

* << Major Decline   >> Major Expansion

< Decline   > Expansion

remain unaffected, Drygrass, which can be expected to dramatically expand, and Conifer woodlands which will probably increase regardless of arterial drainage.

4.3.3.4 Impacts on Sites of Scientific Interest

The impacts of arterial drainage on the eight sites of scientific interest, in terms of their vegetation types and rare species, has been largely discussed in the preceeding section. The effects of these impacts on their scientific value can be summarised in Table IV.

Table IV: Impacts of Arterial Drainage on Rating of Sites of Scientific Interest

Site	Present Rating*	Probable Rating After Arterial Drainage
Rahasane Turlough	International	Local or Insignificant
Poulatauvally Turlough	National	Insignificant
Moyode Turlough	National	Insignificant
Lough Rea	Regional	Regional
Kilcolgan Salt Marsh	Regional	Regional
Parkslevabaun Marsh	Local	Local or Insignificant
Graigabbey Marsh	Local	Insignificant
Carrowmunna Marsh	Local	Insignificant

* See Section 4.4 of the first report and Section 2.2 of this report.

It will be seen that six of the eight sites are likely to decrease in scientific value, most to the point of insignficance, whilst two will probably remain unaffected.

4.3.4. Summary of Nett Impacts of the Drainage Scheme

4.3.4.1. Nett Impacts on Species

It was considered in Section 4.3.3.1. that the proposed drainage scheme should be responsible for the possible extinction of 17 species from the catchments, 10 of them thought to be rare (see Part I, Section 4.2). However, taking into account the likely evolution of vegetation in the absence of drainage (Section 4.2.), 5 of these species are likely to decline, or become extinct from the catchments, regardless of the proposed scheme. Sphagnum fuscum, S. magellanicum and S. imbricatum are all raised bog species and are likely to disappear as the bogs dry out from local drainage and turf cutting. Equisetum variegatum, which only occurs at Graigabbey Marsh, and Eriophorum latifolium, which only occurs at Carrowmunna Marsh are both likely to be victims of existing local drainage activities. However, it should be stated that arterial drainage will certainly accelerate the decline of all 5 of these species.

The remaining 12 species, listed below, would all be likely to remain in the catchment in the long term in the absence of drainage. Thus their likely extinction will be solely attributable to the proposed drainage scheme.

Carex curta

Carex dioica

Carex limosa

Carex strigosa

Eleocharis quinquiflora

Epipactis palustris

Galium uliginosum

Oenanthe lachenalii

Polygonum minus

Potomogeton alpinus

Stellaria palustris

Viola persicifolia

4.3.4.2. Nett impacts on Vegetation Types

Although figures regarding areas of vegetation types cannot be given, and taking into account the likely evolution of vegetation in the absence of the proposed arterial drainage scheme (see Section 4.2.), the nett impacts of arterial drainage are summarised as follows. An acceleration in the rate of loss of several vegetation types i.e. Bogs, Cutaway, Marsh, Reedbeds, Wetsedge and Drysedge, many of which are already in decline, can be expected. Dramatic and permanent losses of turlough vegetation and Floodgrass and Wetgrass types associated with rivers which are at present in a more or less stable condition, will be solely attributed to the proposed scheme. With an anticipated increase in land reclamation losses will also probably occur of the already scarce Woodland and Scrub type and a major expansion of the more agricultural Drygrass types can be expected. Little change is expected in the area of Salt Marsh vegetation. Conifer plantations which are likely to expand in area, would probably increase in extent regardless of arterial drainage.

4.3.4.3 Nett Impacts on Sites of Scientific Interest

The proposed scheme will reduce the scientific interest and site ratings of 6 of the 8 sites listed in Table IV. However, two of these, Graigabbey Marsh and Carrowmunna Marsh, both rated locally important, are already in decline from private reclamation. The proposed drainage scheme alone will be responsible for the probable loss of the remaining four, all of which occur in the karst area of the Dunkellin catchment. Three of these sites are turloughs, Poulatauvally and Moyode, both rated regionally important, and Rahasane, rated internationally important and considered to be the most important turlough in the country. The fourth, Parkslevabaun Marsh, also shows turloughoid features and is the only site in the catchments for 3 rare species.

5. RECOMMENDATIONS

5.1 General Recommendations

General measures to safeguard wetland vegetation, regarding the carrying out of arterial drainage works and the subsequent maintenance and agricultural development, are outlined in Section 5.1 of the Vegetation Report of the Pilot Environmental Impact Assessment of Lough Carra East (Lockhart, 1982). It is not intended here to repeat these recommendations at length but the attention of drainage engineers should be drawn to a recent publication produced by the Royal Society for the Protection of Birds and the Royal Society for Nature Conservation, in Britain, entitled "Rivers and Wildlife Handbook: a guide to practices which further the conservation of wildlife on rivers" (Lewis and Williams, 1984). This excellent manual includes a very readable and comprehensive review of the principles behind good river conservation practices and is well illustrated by diagrams and photographs of actual examples where the various techniques have been used successfully in Britain. Many of the practices would be applicable to Ireland and specifically to arterial drainage schemes such as the one proposed for the Dunkellin/Lavally. Instead of attempting to produce specific recommendations for the entire length of each proposed channel in this scheme, a large task beyond the scope of this report, it is intended here to use a number of representative sample stretches to illustrate some arterial drainage practices which should be incorporated into the design of the scheme and applied throughout the drainage network where appropriate. No attempt has been made to cost the various measures discussed but as many simply refer to avoidance of damage to on-site features, additional costs to the drainage scheme should be minimal. In this regard it is therefore recommended in particular that site engineers and machine operators be made aware of the various techniques of good conservation practice through reference to the Rivers and Wildlife Handbook (op. cit.).

Example 1 - Beech Hill Bridge (Diagram 1)

This is a fairly narrow and meandering stretch in the upper part of the Dunkellin system which was not subject to arterial drainage in the 1850's. Thus it still exhibits many natural features in its uneven bed and bank profiles, which lend themselves to vegetational diversity, and which drainage engineers should strive to preserve in as far as possible. The gravel beds immediately upstream of the road bridge, and the occasional boulder and deep pools downstream, should all be retained. If gravel beds or boulders must be removed during dredging operations they should be replaced after the works have been completed. The natural meander of the channel itself should be retained as this allows for slow flowing deep stretches which are suitable for Reedbed development. Limited replacement wetlands could be created by excavating shallow berms on the inner curves of meanders. Berms such as these should be designed to have at least half their width submerged during times of lowest water flow. They not only provide suitable niches for marginal beds of emergent plants, which in turn aid bank stability,

DIAGRAM 1 - BEECH HILL BRIDGE

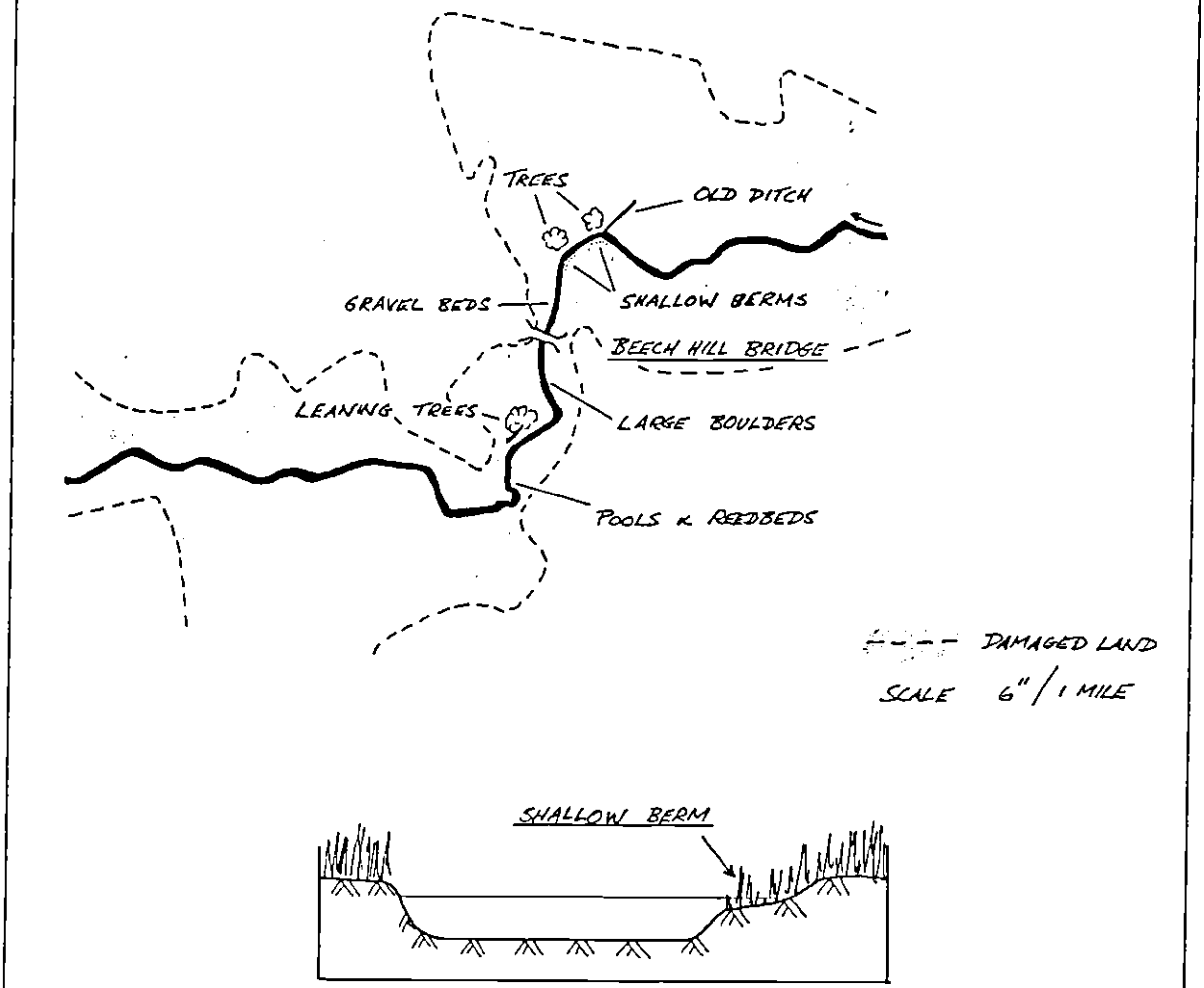
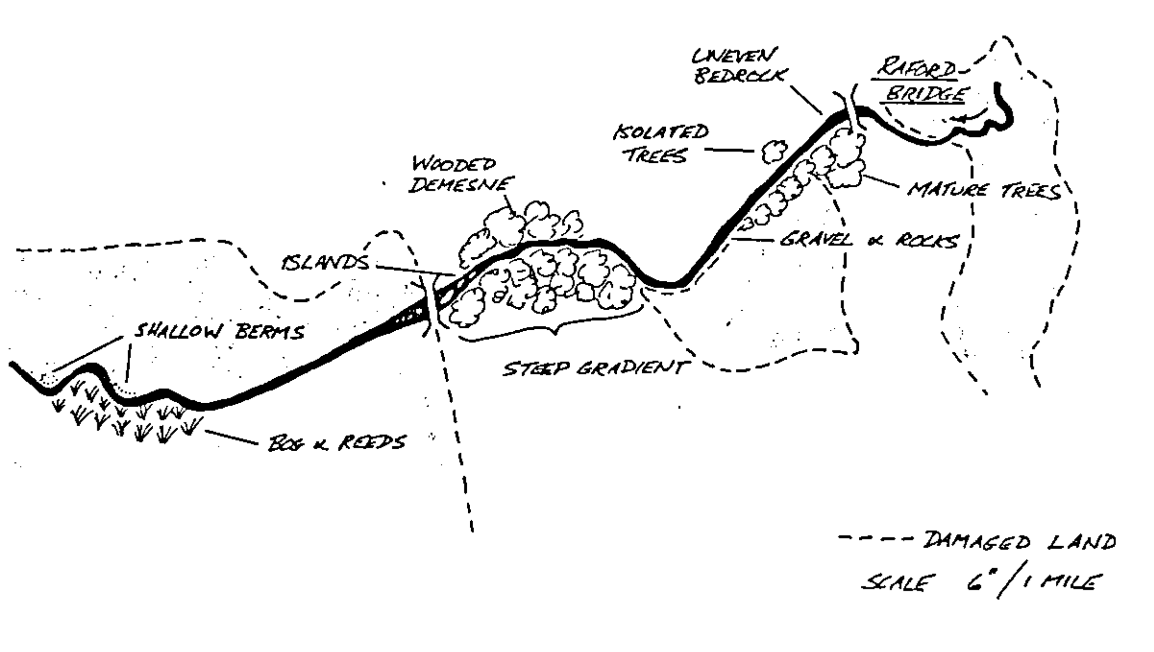


DIAGRAM 2 - RAFORD BRIDGE



but also provide additional flood capacity (see Rivers and Wildlife Handbook, pps. 131-136). Old field ditches and other neglected wet depressions serve as refugia for wetland plants and these should be left and not used to dump spoil. Isolated trees and shrubs, which occur along both banks on this stretch, should be left undisturbed whilst dredging. Where trees lean across the channel and must be removed to avoid obstruction, they should be sawn down and the stumps left to allow regeneration i.e. willows and alder.

Example 2 - Raford Bridge (Diagram 2)

This is another stretch that was not arterially drained in the 1850's, sited a few miles downstream of Beech Hill Bridge on the Raford River. The wide channel at Raford Bridge cuts into bedrock which drops in a step-wise manner to a gravel reach downstream. This wide uneven bed profile, which provides a suitable habitat for a variety of aquatic submergent plants, should be reinstated if rock blasting is required here. The gravel beds downstream should be replaced after dredging. Works should be carried out from the western bank, avoiding damage to the mature woodland on the far side, and where possible, isolated trees in the line of works should be left standing. Where removal of trees is unavoidable, they should be cut to stumps by saw, not bulldozed, to allow for regeneration.

Further downstream the channel drops through a steep gradient and passes through a thickly wooded demesne. There appears to be a sufficient fall here to allow this section to be omitted from the scheme. This would result in a significant saving in drainage costs and allow this particularly interesting stretch to survive damage. Dredging could recommence downstream near the bridge but the wooded islands here should be left, or if bed levels are dropped, lowered to an equivalent height above the new bed levels.

A few hundred metres downstream the channel widens and meanders between reclaimed pasture and meadow, on the northern bank, and semi-natural bogland, on the southern. Work should be carried out from the northern bank, avoiding damage to isolated trees and shrubs. Shallow berms could be created on the inner curves of meanders to provide additional flood capacity and habitat for emergent plants.

Example 3 - Kileelybeg (Diagram 3)

This is a wide, straight section of channel which was deeply regraded in the 1850's scheme, sited downstream of Dunkellin Turlough and about one mile up from Kilcolgan Bridge. The bed is completely strewn with moss-covered rocks and boulders. During dredging these boulders should be removed and at least one layer replaced afterwards to provide seed colonies of moss. The uneven longitudinal profile of the bed, which provides occasional pools when the channel dries out in summer, should be recreated. The northern bank has been walled up to 2 m high in places and these should not be disturbed. Work should be carried out from the southern bank, avoiding damage to isolated trees, and the channel should be deepened rather than widened at this point.

Example 4 - Graigabbey Woods (Diagram 4)

This is an old section of channel that probably escaped arterial drainage in the 1850's. It meanders as a narrow stream through wet Alder woodland, entering the main channel, Graigabbey River, above Graigabbey Marsh. In general, work should be carried out from the less wooded southern bank. Where removal of trees is unavoidable they should be cut by saw to allow the stumps to regenerate.

The channel itself exhibits considerable diversity of habitats in its bank and bed profiles and in its mud, gravel and stoney substrates. Although this stretch may require rock blasting, every effort should be made to follow the original meanders and recreate the uneven beds and banks. Gravels and stones should be replaced after dredging.

Downstream, nearer Graigabbey Bridge, the channel widens and becomes braided. These secondary channels should be retained in as natural a condition as possible. Where the channel widens and traverses open pasture, the width and

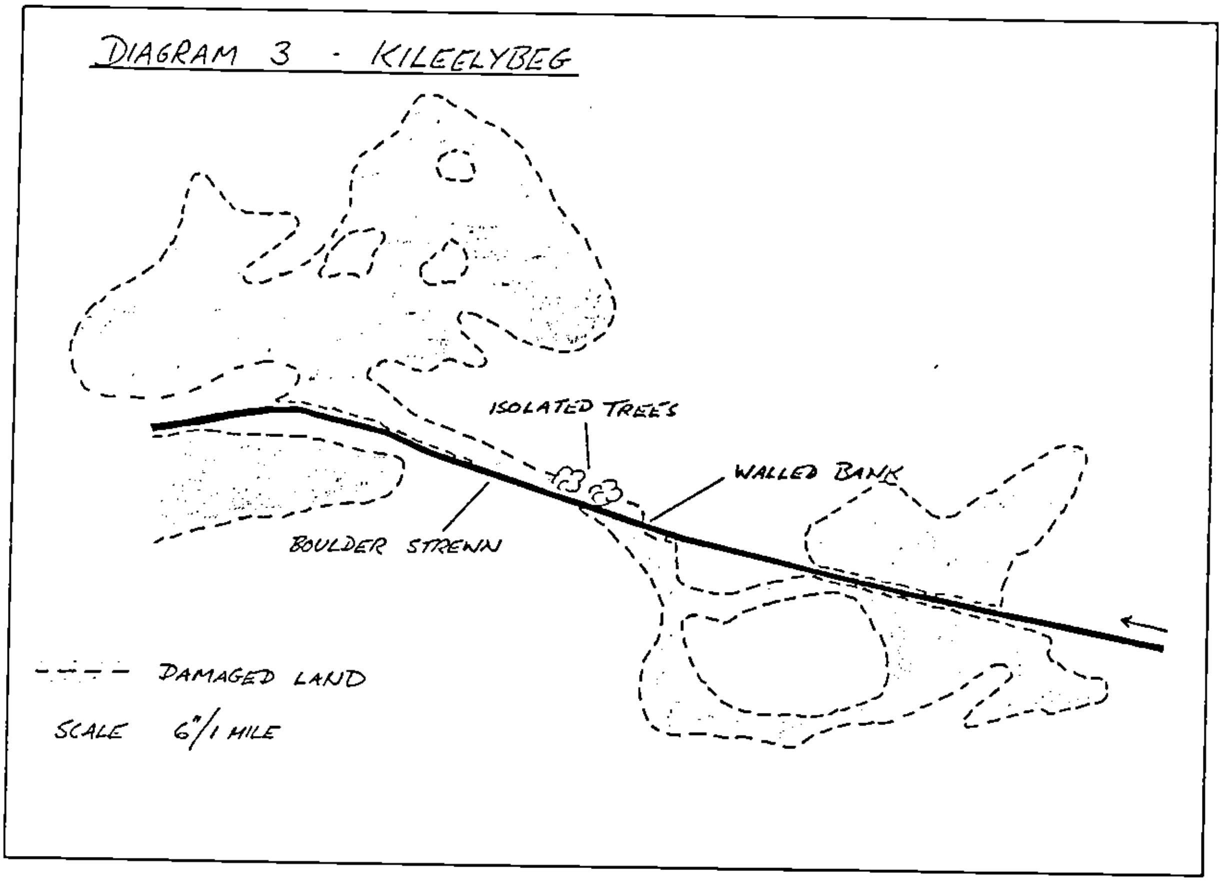


DIAGRAM 3 - KILEELYBEG
ISOLATED TREES
WALLED BANK
BOULDER STREWN
DAMAGED LAND
SCALE 6"/1 MILE

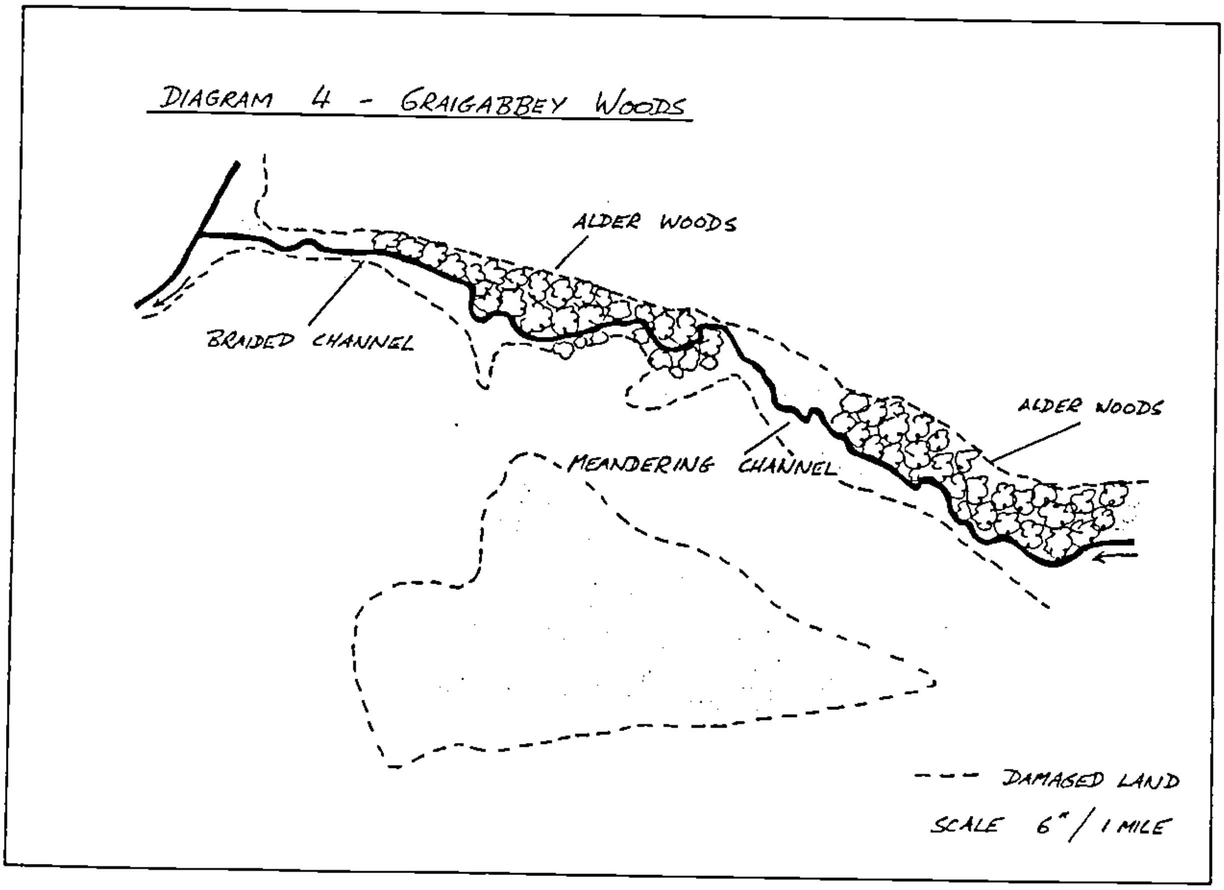


DIAGRAM 4 - GRAIGABBEY WOODS
ALDER WOODS
BRAIDED CHANNEL
ALDER WOODS
MEANDERING CHANNEL
DAMAGED LAND
SCALE 6"/1 MILE

the low banks should be retained. Spoil could be spread, or dumped away from the channel, to form low flood banks.

Example 5 - Graigabbey Marsh (Diagram 5)

This is an example of a channel that has very recently been dredged by local farmers. Situated just downstream of Graigabbey Marsh the channel cuts through coarse glacial gravels and shows some interesting features. Much of the original meander has been retained, enabling eroding and accumulating banks to form and adding diversity to the available niches for plants. A slightly uneven longitudinal bed profile shows evidence of developing riffle/pool sequences, adding diversity for aquatic plants and allowing oxygenation of the water in the fast riffle sections. Steep banks on both sides of the channel appear to have eroded leaving a shelf or natural berm of stoney material available for plant colonisation. Where Alder bushes have been left the banks are more firm, evidencing the bank stabilising ability of the roots of these plants. Large overhanging trees and shrubs have been retained on the channel side of old spoil heaps in some places, aiding bank stability and retaining local pockets of woodland flora. In other places, where fences have been placed too close to the edge of the bank, grazing has excluded Alder sapling development. Lower down such banks, however, many Alder saplings were seen.

DIAGRAM 5 - GRAIGABBEY MARSH

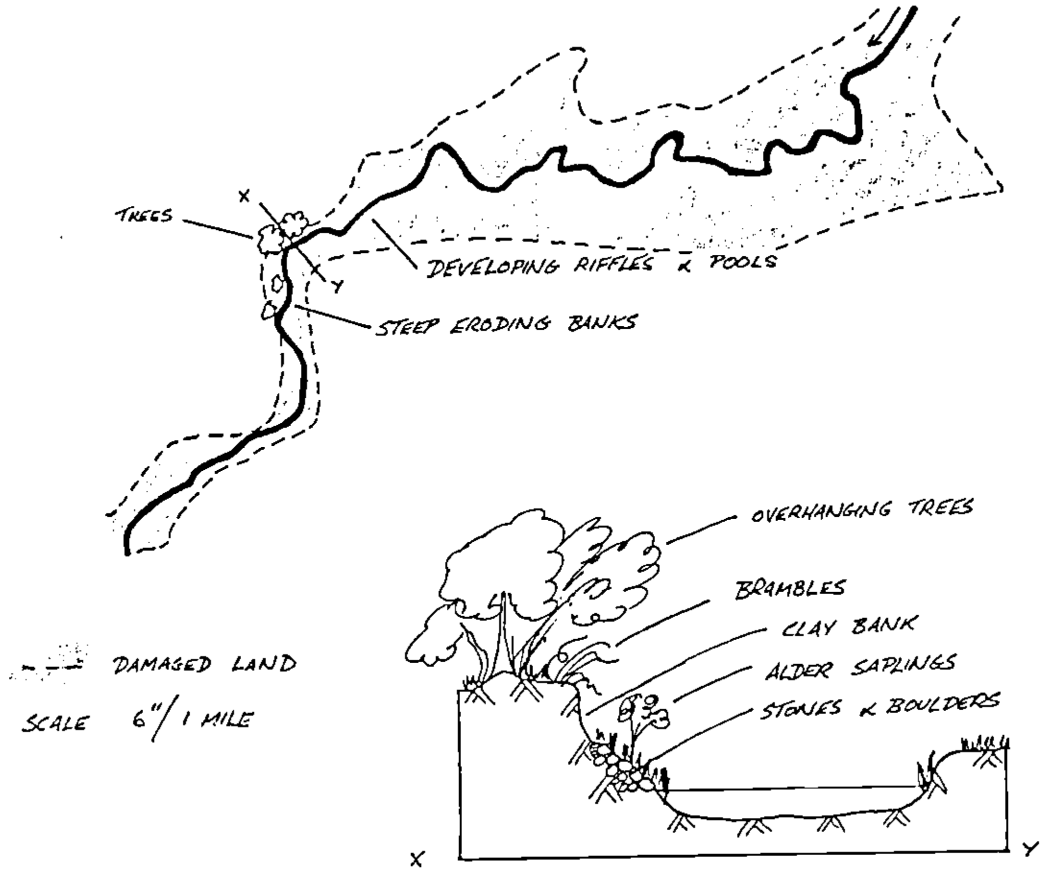
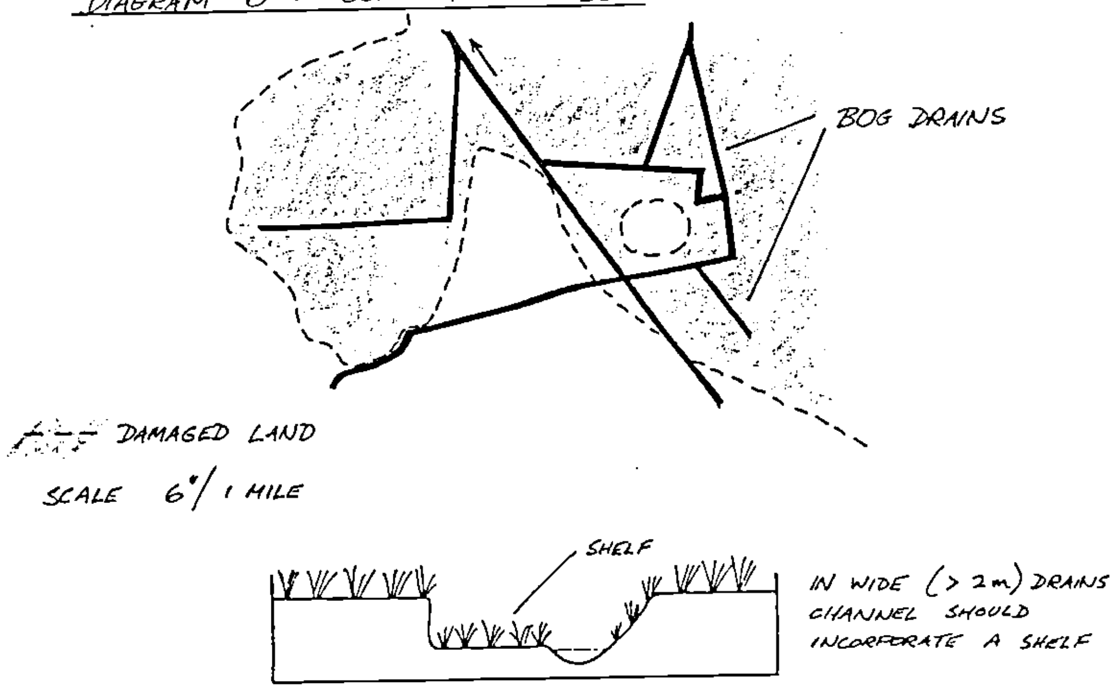


DIAGRAM 6 - GORTNAHOON BOG



Example 6 - Gortnahoon Bog (Diagram 6)

This bog, at the extreme eastern margin of the Dunkellin catchment is used here to illustrate channel design on pure peat substrates. Bog drains should not be overdeepened i.e. not more than 0.5 m below summer water levels, and should be wide enough to prevent collapse of banks. Wide channels i.e. over 2 m wide, should incorporate a step or shelf just above summer water level to allow for some plant regeneration.

5.2 Specific Recommendations

Eight sites have been regarded as scientifically important in the Dunkellin/Lavally catchments (see Table IV). Two of these, Lough Rea and Kilcolgan Salt Marsh, are not expected to be affected by the proposed arterial drainage scheme and a further two, Graigabbey Marsh and Carrowmunna Marsh, are expected to decline regardless of whether the scheme goes ahead or not. The remaining four, Rahasane Turlough, Poulatauvally Turlough, Moyode Turlough and Parkslevabaun Marsh, are all found within the karst region of the Dunkellin catchment. Although Rahasane is the only one of these four that is expected to be directly affected by arterial drainage channels, all four are likely to be affected by the general lowering of water-tables resulting from drainage. If damage to these sites is to be avoided, it is recommended that drainage work should not be carried out below Craughwell on the Dunkellin River. Although this may ensure the survival of Rahasane, Poulatauvally and possibly Parkslevabaun Marsh, the continued survival of Moyode Turlough may require the omission of the northern channel that joins the Dunkellin River above Craughwell. Further information regarding the hydrology of those four sites is required. This may be forthcoming in the Drew report, currently being prepared in connection with this project.

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