

10.0 FLORA & FAUNA

- 10.1 This chapter addresses flora and fauna for the proposed extension to Ballynacarrick Landfill Site. The chapter is subdivided into two parts, the first covering habitats, flora and fauna is detailed in paragraphs 10.2 to 10.91, whilst the second part covering farm animal health is detailed in paragraphs 10.92 to 10.119.

ECOLOGY IN THE EXISTING ENVIRONMENT

Introduction

- 10.2 A study was carried out to assess the effects of a proposed extension to the existing landfill facilities at Ballynacarrick on flora and fauna in the receiving environment. The assessment has focused attention on the habitats, flora and fauna of the proposed development site and adjacent area. It makes reference to a number of designated conservation areas in the relevant locality, and points to the potential or likely effects on certain vulnerable habitats arising from both the current proposal and the existing landfill facility, taking account of other possible contributory impacts. The study period was from September 2002 to June 2003.

Site Description

- 10.3 The 3.5 hectare site at Ballynacarrick lies immediately to the west of the existing landfill facilities, and consists of fields of rough pasture that are periodically grazed by cattle and sheep with some enrichment from manure and possibly fertiliser applications in the past. The site is situated on a gentle south-facing slope, dipping on both the southern and western sides to wetter low-lying ground drained by a small stream. There is an uninhabited cottage with farm buildings in the north of the site, at the top of the small hill ridge, which is oriented west to east. A small copse of broadleaf trees features to the rear of the buildings.
- 10.4 Surface drainage and pasture quality is relatively good on higher ground in the north and west of the site, while rushy grassland and cutover bog with patches of scrub prevail in wet peaty conditions on low ground in the east and south of the site. The site lies within an area of undulating lowland terrain, where pockets of wet grassland, peatland, lakes and swamp alternate with small hills supporting drier pastures and scrub.
- 10.5 In general, the surrounding area has a limestone geology. However, the ridge containing the site has a cap of impermeable metamorphic bedrock, accounting for the peat soil in the east, while local drift provides better soil drainage in the west.

Method of Site Assessment

- 10.6 The ecology of the receiving environment was surveyed and described from a number of visits which involved walks over and around the proposed and existing landfill site. The proposed development site and the habitats associated with this site can be seen in Figure 10.1.
- 10.7 A survey of surface water ecology involved field walks along the course of the stream flowing westward from the site over an extended distance downstream of the site location.
- 10.8 As this stream is poorly represented on any of the map editions currently available, it was necessary to trace its course on foot and plot coordinates using GPS (Global Positioning Systems). The characteristics of the stream were described from direct observations. The ecological condition of the stream was described from the aquatic macro-invertebrate fauna found at various points along its course. The collected data enabled a biological assessment of water quality using the Quality Rating System, the standard method used by the EPA.
- 10.9 Survey information was mapped onto O.S. maps at scales 1:2,500 and 1:10,560, as well as the 1:50,000 Discovery sheet No 11 (at an enlarged scale).
- 10.10 Existing information relating to the ecology of the site and broader locality, including designated nature conservation areas, was assimilated from the Donegal County Council's Waste Licence documentation and reports to the EPA, the Donegal Bay Water Quality Management Plan, Dúchas NHA files, and from consultation with Dúchas NPW, the NRFB and BirdWatch Ireland. Published survey information relevant to the assessment was also referenced.
- 10.11 Based on the data collected and on information available from secondary sources, the assessment of likely and potential impacts of the proposed development was made according to the requirements set out in relevant legislation, the EPA guidelines and best practice guidelines (e.g., Ecoscope, 2000).

Habitats & Flora

- 10.12 Fieldwork to survey the habitats and flora in the site and environs was carried out on 3 and 22 September 2002 with supplementary records from observations made in June 2003. The habitats, depicted in Figure 10.1, are described below in sequence. A full list of the plant species recorded within the site is given in Table 10.1 with reference to the habitats in which they occur. The habitat codes, given in brackets in the habitat descriptions, and in Table 10.1, refer to the classification of the Heritage Council (Fossitt, 2000), set out in Table 10.2.

Improved Agricultural Grassland (GA1)

- 10.13 This pasture is the dominant habitat type, occupying the north and west of the site. It is variable in quality, the most agriculturally-improved part occupying the fenced portion in the south-west corner of the site. It becomes wetter to the east with increasing abundance of rushes. Perennial ryegrass (*Lolium perenne*) is the dominant grass, with frequent Yorkshire-fog (*Holcus lanatus*) and Crested dog's-tail (*Cynosurus cristatus*). Soft-rush (*Juncus effusus*) occurs throughout, its abundance varying according to the dampness of the ground. Overall, the ground was fairly dry underfoot at the time of survey in this area, although the unevenness of the ground in places indicated past poaching by cattle.
- 10.14 As is typical of improved pasture, this area supports only a narrow range of species, although diversity increases in the wettest areas where common sedge (*Carex nigra*), sharp-flowered rush (*Juncus acutiflorus*) and creeping buttercup (*Ranunculus repens*) become locally abundant.

Wet Grassland (GS4)

- 10.15 This area is very wet underfoot in places, in particular to the south. It is dominated in certain places by soft-rush (*Juncus effusus*) and sharp-flowered rush (*J. acutiflorus*), the former occupying the wettest, most poached areas, and the latter in the areas supporting the greatest species diversity, occurring in association with sedges such as common sedge (*Carex nigra*) and star sedge (*Carex echinata*). There is a reasonable diversity of herb species present, those representing wet, marshy habitats being particularly well-represented, such as purple loosestrife (*Lythrum salicaria*), marsh woundwort (*Stachys palustris*) and marsh violet (*Viola palustris*). In the more open areas there is a discernible bryophyte layer, composed of *Rhytidiadelphus squarrosus* among other species. Cattle grazing appears to have helped maintain an open structure and a fairly diverse flora here.

Wet Heath (HH3)

- 10.16 Heath-type vegetation, dominated by heather (*Calluna vulgaris*), common cottongrass (*Eriophorum angustifolium*), *Sphagnum* mosses, carnation sedge (*Carex panicea*), purple moor-grass (*Molinia caerulea*) and cross-leaved heath (*Erica tetralix*), occupies a relatively small area along the eastern edge of the site on a generally south-facing slope. This is the most botanically interesting area within the site and supports a range of species similar to those found on blanket bog, such as bog asphodel (*Narthecium ossifragum*), round-leaved sundew (*Drosera rotundifolia*) an insectivorous species; and common lousewort (*Pedicularis sylvatica*). Some lichen species (*Cladonia* spp.) are also present.

- 10.17 The vegetation in this area has developed over shallow peat and there is some evidence that a layer of peat may have been removed in one patch where the ground appears slightly lower-lying. Here, bog myrtle (*Myrica gale*), a fragrant, shrubby species associated with bog habitats, has colonised. Like the area of wet grassland, cattle were grazing this area at the time of survey and the vegetation had been fairly closely-cropped.

Drainage Ditches (FW4)

- 10.18 The principle stream of the local watershed enters the south of the proposed development site and exits along the western site boundary, having a westward to north-westward flow direction. The stream has the appearance of a drainage ditch and represents field system boundaries as indicated on older maps (O.S. 1:2500 & 1: 10,560 scales). Influent surface waters are received from roadside drains along the south of the existing landfill and from the drain along the west of the existing landfill bordering the site.

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Table 10.1 Vascular Plants, Bryophytes & Lichens recorded from Habitats in the Proposed Development Site

Habitat						Species		
Improved Grassland	Wet Grassland	Wet Heath	Cut-over bog	Existing Landfill area	Scrub Woodland	Streams & ditches		
GA1	GS4	HH3	PB4	ED2 / 3 / 5	WS1	FW1 & FW4	Scientific Name	
							Common Name	
					4		<i>Acer pseudoplatanus</i>	Sycamore
		4		4			<i>Agrostis capillaris</i>	Common Bent Grass
4	4	4			4		<i>Agrostis stolonifera</i>	Creeping Bent Grass
					4		<i>Alnus glutinosa</i>	Alder
4	4						<i>Anthoxanthum odoratum</i>	Sweet Vernal Grass
					4		<i>Betula pubescens</i>	Common Birch
		4					<i>Blechnum spicant</i>	Hard Fern
		4	4				<i>Calluna vulgaris</i>	Ling Heather
				4			<i>Cardamine hirsuta</i>	Hairy bittercress
	4						<i>Cardamine pratensis</i>	Cuckoo Flower
	4						<i>Carex ovalis</i>	Oval Sedge
	4	4	4				<i>Carex echinata</i>	Star Sedge
	4						<i>Carex nigra</i>	Common Sedge
		4					<i>Carex panicea</i>	Carnation Sedge
		4		4			<i>Centaurea nigra</i>	Common knapweed
4	4			4			<i>Cerastium fontanum</i>	Common mouse-ear
				4			<i>Chenopodium album</i>	Fat hen
4	4						<i>Cirsium vulgare</i>	Spear Thistle
	4	4					<i>Cirsium dissectum</i>	Bog Thistle
	4						<i>Cirsium palustre</i>	Marsh Thistle
					4		<i>Corylus avellana</i>	Hazel
					4		<i>Crataegus monogyna</i>	Hawthorn
4	4						<i>Cynosurus cristatus</i>	Crested Dog's tail
	4						<i>Deschampsia cespitosa</i>	Tufted hair-grass
		4	4				<i>Drosera rotundifolia</i>	Round-leaved Sundew
	4						<i>Epilobium palustre</i>	Marsh Willowherb
		4	4				<i>Erica cinerea</i>	Bell Heather
		4	4				<i>Erica tetralix</i>	Cross-Leaved Heath
		4	4				<i>Eriophorum angustifolium</i>	Many-Headed Cottongrass
4	4						<i>Festuca rubra</i>	Red Fescue
		4					<i>Festuca vivipara</i>	Viviparous Fescue
	4						<i>Filipendula ulmaria</i>	Meadowsweet
					4		<i>Fraxinus excelsior</i>	Ash
						4	<i>Glyceria fluitans</i>	Floating Sweet-Grass
4	4			4	4		<i>Holcus lanatus</i>	Yorkshire Fog
				4			<i>Hypericum tetrapterum</i>	Square-stalked St. John's-wort
4	4			4			<i>Hypochoeris radicata</i>	Cat's-ear
					4		<i>Ilex aquifolium</i>	Holly
	4						<i>Iris pseudacorus</i>	Yellow flag

Table 10.1 Vascular Plants, Bryophytes & Lichens recorded from Habitats in the Proposed Development Site (Continued)

Habitat						Species		
Improved Grassland	Wet Grassland	Wet Heath	Cut-over bog	Existing Landfill area	Scrub Woodland	Streams & ditches	Scientific Name	Common Name
	4						<i>Juncus acutiflorus</i>	Sharp-Flowered Rush
		4	4	4			<i>Juncus bufonius</i>	Toad Rush
4	4			4			<i>Juncus effusus</i>	Soft Rush
		4	4				<i>Juncus squarrosus</i>	Heath Rush
	4						<i>Lathyrus pratensis</i>	Meadow pea
				4			<i>Leontodon autumnalis</i>	Autumn hawkbit
4							<i>Lolium perenne</i>	Perennial ryegrass
	4						<i>Lythrum salicaria</i>	Purple loosestrife
				4			<i>Matricaria discoidea</i>	Pineappleweed
	4	4	4		4		<i>Molinia caerulea</i>	Purple Moor Grass
		4					<i>Myrica gale</i>	Bog myrtle
		4	4				<i>Narthecium ossifragum</i>	Bog Asphodel
	4	4					<i>Pedicularis sylvatica</i>	Lousewort
				4			<i>Persicaria maculosa</i>	Redshank
4	4						<i>Plantago lanceolata</i>	Ribwort Plantain
				4			<i>Plantago major</i>	Broad-leaved plantain
				4			<i>Poa annua</i>	Annual Meadow Grass
				4			<i>Poa pratensis</i>	Smooth meadow-grass
		4					<i>Polygala serpyllifolia</i>	Heath Milkwort
		4					<i>Polygala vulgaris</i>	Common milkwort
				4			<i>Polygonum sp.</i>	Knotgrass
	4						<i>Potentilla anserina</i>	Silverweed
	4	4	4				<i>Potentilla erecta</i>	Tormentil
	4						<i>Prunella vulgaris</i>	Self-heal
					4		<i>Prunus spinosa</i>	Blackthorn
	4						<i>Ranunculus flammula</i>	Lesser Spearwort
4	4			4	4		<i>Ranunculus repens</i>	Creeping Buttercup
4							<i>Rumex acetosa</i>	Common Sorrel
	4				4		<i>Rumex acetosella</i>	Sheep's Sorrel
				4			<i>Rumex crispus</i>	Curled dock
4				4			<i>Rumex obtusifolia</i>	Broadleaved Dock
	4				4		<i>Rubus fruticosus</i> agg.	Bramble
		4	4				<i>Salix aurita</i>	Eared Willow
	4				4		<i>Salix cinerea</i> ssp. <i>Oleifolia</i>	Sally (Grey Willow)
				4			<i>Senecio jacobaea</i>	Common ragwort
				4			<i>Senecio sylvaticus</i>	Heath groundsel
				4			<i>Senecio vulgaris</i>	Common groundsel
				4			<i>Sinapsis arvensis</i>	Charlock
				4			<i>Sonchus asper</i>	Prickly sowthistle
					4		<i>Sorbus aucuparia</i>	Rowen
	4						<i>Stachys palustris</i>	Marsh woundwort
				4			<i>Stellaria media</i>	Chickweed
				4			<i>Stellaria uliginosa</i>	Bog Stitchwort
	4	4					<i>Succisa pratensis</i>	Devils-bit Scabious

Table 10.1 Vascular Plants, Bryophytes & Lichens recorded from Habitats in the Proposed Development Site (Continued)

Habitat							Species	
Improved Grassland	Wet Grassland	Wet Heath	Cut-over bog	Existing Landfill area	Scrub Woodland	Streams & ditches	Scientific Name	Common Name
							<i>Taraxacum</i> sp.	Dandelion
4	4						<i>Trifolium pratense</i>	Red Clover
4	4						<i>Trifolium repens</i>	White Clover
				4			<i>Tussilago farfara</i>	Colt's-foot
			4		4		<i>Ulex europaeus</i>	Gorse
				4			<i>Urtica dioica</i>	Nettle
				4			<i>Vicia sativa</i>	Common vetch
	4						<i>Viola palustris</i>	Marsh Violet
							Mosses, Liverworts, Lichens & Fungi recorded from site	
			4				<i>Campylopus introflexus</i>	Moss species
		4	4				<i>Cladonia portentosa</i>	A lichen species
				4			<i>Coprinus comatus</i>	Shaggy ink-cap (a toadstool)
		4					<i>Hylocomium splendens</i>	Moss species
		4	4				<i>Polytrichum commune</i>	Moss species
		4					<i>Rhyidiadelphus squarrosus</i>	Moss species
		4	4				<i>Sphagnum capillifolium</i>	Bog moss species
		4	4				<i>Sphagnum subnitens</i>	Bog moss species
		4	4				<i>Sphagnum recurvum</i>	Bog moss species

HABITATS ADJACENT TO THE PROPOSED DEVELOPMENT SITE

- 10.19 Several habitats of varying ecological interest lie adjacent to the site and represent both hinterland and buffer zone of the existing and proposed landfill. These were given a cursory examination on field visits and are characterised below.
- 10.20 Wet heath and wet grassland extend over the ridge top and down the north-facing slope from the northern periphery of the proposed site, contiguous to similar habitat within the site. The surface is rather poached by livestock and hence the habitat is somewhat degraded. The slope descends into a depression containing wet rushy grassland with drainage ditches on the west side, while peat, fen and reedbed occupy the east side. This low-lying wet area occupies approximately 3ha between the two public roads. The depression may have been formed by glacial scouring and marks the transition from the impermeable metamorphic bedrock underlying the site and porous limestone extending northward. This is apparent from the presence of a low limestone escarpment oriented roughly east to west along the north margin of the depression.

- 10.21 The bottom of the depression is very wet and contains peat and fen habitat with tussocks of Purple Moor-grass and Cotton Grass (*Eriophorum* spp.) above an extensive cover of bog moss (*Sphagnum* spp), accompanied by sedges (*Carex* spp), rushes (*Juncus* spp.) and other herb species. Outer parts are somewhat drier, dominated by bushy *Calluna* with Bog Myrtle (*Myrica gale*) and some small patches of Gorse (*Ulex europaea*) and willow (*Salix* spp.) scrub. The Spotted Orchid species (*Dactylorhiza maculata* subsp *fuchsii*) was very frequent. Great Butterfly Orchid (*Platanthera chlorantha*) and Pale Butterwort (*Pinguicula lusitanica*) occurred in places around the edge of the fen, and on the wet heath. The very wet centre contains peaty fen (PF1) vegetation fringing small pools and swampy channels connected via the reedbed to a pond that appeared to be fed by rising calcareous water. Species here included Marsh Cinquefoil (*Potentilla palustris*), Bog bean (*Menyanthes trifoliata*) and Pondweed (*Potamogeton* sp.). The main pond is surrounded by a reedbed of Common Reed (*Phragmites australis*) within which Tufted vetch (*Vicia cracca*) and Bush vetch (*V. sepium*) were frequent and Grass of Parnassus (*Parnassia palustris*) increased in abundance towards the pond edge.
- 10.22 Along the north-west margin of the depression there are outcrops of limestone and stoney substrate. An abrupt transition to a grassy strip occurs along the fault below the low limestone escarpment. Here, a small area (c.0.5 ha) of calcareous heath (HH2) supports a diverse mixture of both calcifuge and calcicole flora. The vegetation is dominated by Ling heather with frequent Purple Moor-grass and Bell heather (*Erica cinerea*) as well as Devil's bit (*Succisa pratensis*), Heath Milkwort (*Polygala serpyllifolia*) and Spotted Orchid. Juniper (*Juniperus communis*) is locally abundant, spreading over rock outcrops where Burnet Rose (*Rosa pimpinellifolia*), Thyme (*Thymus praecox*) Mouse-ear Hawkweed (*Hieracium pilosella*), Cat's foot (*Antennaria dioica*) and Fir Club moss (*Huperzia selago*) were also recorded. Damp grassy hollows host Lesser Club moss (*Selaginella selaginoides*), Common Yellow Sedge (*Carex viridula* subsp. *oedocarpa*), Common sedge (*C. nigra*), Carnation Sedge (*C. incarnata*), Butterwort (*Pinguicula vulgaris*), Fairy flax (*Linum catharticum*), and Eyebright (*Euphrasia* agg.), while drier parts support Quaking Grass (*Briza media*), Blue Moor-grass (*Sesleria caerulea*), Twayblade (*Listera ovata*), Harebell (*Campanula rotundifolia*) and Fragrant orchid (*Gymnadenia conopsea*). Plants noted along and below the crag include Honeysuckle (*Lonicera periclymenum*), Ivy (*Hedera helix*), Bird's foot (*Lotus corniculatus*), Hart's tongue fern (*Phyllitis scolopendrium*), and Bloody Cranesbill (*Geranium sanguineum*). A band of scrub along the field boundary above the crag was composed largely of Hazel, Blackthorn, Holly, Willow spp. and occasional Guelder Rose (*Viburnum opulus*).

- 10.23 To the east of the proposed development site, some former degraded bog (as described by NEC, 1998) has been replaced by a new lined landfill cell, which has been commissioned in 2003. Adjacent to this is the active tip head at the time of field work, temporary capped landfill, spoil heaps for use in covering and capping the working face and gravelled hard-standing, access road and site office (Figure 10.2). As already seen in Figure 10.1, a small area of scrub woodland occupies the north-east corner of the current landfill site. Patches of similar scrub adjoin the road to the south-east and south of the existing landfill site. The main tree species are Alder, Willow spp., Blackthorn, Hawthorn, Hazel, Birch and occasionally Holly. Understorey of Gorse and Bramble was evident in places. Wet grassland occurs throughout the open low-lying ground south of the current and proposed sites. It appeared quite varied in terms of plant communities, composed largely of Purple moor grass, Sharp-flowered rush, Yorkshire Fog, Bent (*Agrostis* spp.), other grasses and sedges (*Carex* spp.). Character species such as Wild Angelica (*Angelica sylvestris*), Meadowsweet (*Filipendula ulmaria*), Marsh Thistle (*Cirsium palustre*), Cuckoo flower and Devil's-bit were frequent or locally abundant. Some of the fields were of lay meadow that was beginning to be colonised by scrub and bramble. Here, as along the roadside verge, Spotted Orchid was widespread and locally abundant. Quaking Grass and Fox Sedge (*Carex otrubae*) were also noted.
- 10.24 To the east of the existing landfill site, east of the public road, the prevalent habitat appears to be blanket bog, extending for some distance eastward. To the west of the proposed site there is roadside scrub with several larger trees such as Ash. Beyond this, wet grassland pasture with patches of rushes (*Juncus effusus*) is the predominant habitat type.

Table 10.2 Habitats Referred to in the Text using the Habitat Classification Scheme Produced by the Heritage Council

F Freshwater	FL Lakes and Ponds	-
	FW Watercourses	FW4 Drainage ditches
	FS Swamps	FS1 Reed and large sedge swamps
G Grassland and Marsh	GA Improved grassland	GA1 Improved agricultural grassland
	GS Semi-natural grassland	GS1 Dry calcareous & neutral grassland
	-	GS4 Wet grassland
H Heath and Dense Bracken	HH Heath	HH2 Dry calcareous heath
	-	HH3 Wet heath
P Peatlands	PB Bogs	PB3 Lowland blanket bog
		PB4 Cutover bog
	PF Fens and Flushes	PF1 Rich fen and flush
W Woodland and Scrub	-	PF3 Transition mire & quaking bog
	WN Semi-natural woodland	WN6 Wet willow-alder-ash woodland
	WS Scrub/transitional woodland	WS1 Scrub
	WL Linear woodland/scrub	WL1 Hedgerows
E Exposed Rock and Disturbed Ground	-	WL2 Treelines
	ER Exposed rock	ER2 Exposed calcareous rock
	ED Disturbed ground	ED1 Exposed sand, gravel or till
	-	ED2 Spoil and bare ground
	-	ED3 Recolonising bare ground
	-	ED4 Active quarries and mines
B Cultivated and Built Land	-	ED5 Refuse and other waste
	BL Built land	BL1 Stone walls and other stonework
	-	BL2 Earth banks
	-	BL3 Buildings and artificial surfaces

Source: The Heritage Council (Fossitt, 2000)

FAUNA

10.25 Birds and other fauna in the site and surrounding area were recorded during field visits in each of the months, September, November, December 2002 and February, May and June 2003. The method used was similar to that of the CBS - Countryside Bird Survey (Marchant, 1983). On each visit, survey recording was carried out in a similar manner by way of a walk-over of the proposed and existing landfill area and boundary zone. Additional time was spent, where circumstances necessitated, viewing the proposed development site area from a vantage point on high ground to the south-west. This enabled accurate counting of birds in often mobile, dispersed gull and corvid (crow species) flocks in particular, as well as attaining supplementary information on other local fauna incidentally.

Results

- 10.26 The varied habitats in the site and boundary areas support a moderate diversity of birds, comprising a range of mainly passerine species including summer migrants. In addition, several scavenger species tend to congregate in and around the site. In total, 42 bird species were recorded throughout the survey period. The results of survey counts are presented in Table 10.3 indicating the relative abundance of species in and out of the breeding season. Thus, two basic bird groups may be differentiated: (a) the avifauna of local habitats and (b) mobile scavenger species occurring in variable numbers, attracted by operation of the existing landfill.
- 10.27 Wooded areas, hedgerow and scrub hosted typical farm / woodland birds. In late summer / autumn, parties of Long-tailed Tit were noted moving through scrub, as were broods of Great Tit and Blue Tit, while rough grassland bordering scrub held small parties of Reed Bunting, Goldfinch and Redpoll feeding on plant seed, as well as a brood of Stonechat. Grassland also hosted an abundance of Meadow Pipit in summer, while Swallows were observed feeding on the wing.
- 10.28 The territories of 23 breeding species were mapped (Appendix 10.1) and quantified in Table 10.3. Wren, Willow Warbler Robin and Meadow Pipit ranked most abundant among the breeding passerines in the survey with eight or more territories identified. Next most abundant were Blue Tit, Blackbird, Dunnock, Reed Bunting, Sedge Warbler and Whitethroat, each holding three or more territories. Coal Tit, Linnet and Song Thrush each held two territories each while the remaining breeders, notably Greenfinch, Bullfinch, Grasshopper Warbler, Blackcap, Chaffinch, Goldcrest, Magpie, Mistle Thrush and Wood Pigeon held one.
- 10.29 Numbers of Chaffinch increased through the winter period from 4 to around 30, and Pied Wagtail from 1 to 12. These species in particular were observed flocking to the tip-head area of the existing landfill, feeding amongst the refuse. A brood of Grey Wagtail was observed feeding in and about the polluted open drain on the eastside of the landfill in September.
- 10.30 The influence of the operating landfill was also evident from the abundance of scavenger birds prevalent in the area. Gull numbers and species composition varied markedly over the survey period. This variation is likely to relate partly to seasonal factors in respect of each species such as the location and proximity of breeding colonies, as well as other factors such as the availability of alternative feeding sites. Up to c.100 gulls were counted in early September at the tip head, comprising an estimated 60% juveniles and 40% adults. Species composition was estimated to be 80% Herring Gull, 15% Lesser Black-backed Gull and 5% Great Black-backed Gull.

10.31 In late November, the flock comprised 60% Black-headed Gull and 40% Herring Gull. Survey results from December and February also show Black Headed Gull to be the dominant gull species at the landfill over winter, out-numbering Herring Gull which were the only other *Larus* species present. In the breeding season, Lesser Black-backed Gull was the dominant species present at the landfill numbering 35 to 30 birds, while other species varied in number, with numbers of Herring Gull falling from 20 to 1 and Great Black-backed Gull falling from 20 to 10 birds between the May and June counts. Black-headed Gull was not recorded in the summer period.

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Table 10.3 Bird Species Counted and number of Breeding Territories at the Current and Proposed Landfill Sites and surrounding boundary zone

Species Code	Common Name (alphabetical listing)	Scientific Name	Number of birds counted on Survey Dates						Breeding Territories
			03/09/02	20/11/02	09/12/02	14/02/03	21/05/03	28/06/03	
B.	Blackbird	<i>Turdus merula</i>		5	2	8	2	6	4
BC	Blackcap	<i>Sylvia atricapilla</i>					1	1	1
BH	Black-headed Gull	<i>Larus ridibundus</i>		c.50	c.35	c.45			0
BT	Blue Tit	<i>Parus caeruleus</i>	4	1	1			9	6
BF	Bullfinch	<i>Pyrrhula pyrrhula</i>					2	2	1
CH	Chaffinch	<i>Fringilla coelebs</i>	4	c.20	c.25	c.30	2		1
CT	Coal Tit	<i>Parus ater</i>	1			3		4	2
CG	Common Gull	<i>Larus canus</i>					1		0
D.	Dunnock	<i>Prunella modularis</i>	1				1	6	4
GC	Goldcrest	<i>Regulus regulus</i>						1	1
GO	Goldfinch	<i>Carduelis carduelis</i>	2	4					0
GH	Grasshopper Warbler	<i>Locustella naevia</i>					1	1	1
GB	Great Black-backed Gull	<i>Larus marinus</i>	3				20	c.10	0
GT	Great Tit	<i>Parus major</i>	2						0
GR	Greenfinch	<i>Carduelis chloris</i>					2	3	1
GL	Grey Wagtail	<i>Motacilla cinerea</i>	4	1					0
HG	Herring Gull	<i>Larus argentatus</i>	c.40	c.40	2	c.20	18	1	0
HC	Hooded Crow	<i>Corvus corone cornix</i>	c.10	6	3	12	22	15	0
JD	Jackdaw	<i>Corvus monedula</i>	c.10	c.30	c.40	c.35	c.40	c.150	0
LB	Lesser Black-backed Gull	<i>Larus fuscus</i>	6				35	c.30	0
LN	Linnet	<i>Carduelis cannabina</i>						8	2
LT	Long-tailed Tit	<i>Aegithalos caudatus</i>	10	16	6				0
MG	Magpie	<i>Pica pica</i>		4	2	1	3	1	1
MP	Meadow Pipit	<i>Anthus pratensis</i>	5	2	1		1	9	8
MT	Mistle Thrush	<i>Turdus viscivorus</i>		1		1	1		1
PW	Pied Wagtail	<i>Motacilla alba</i>	1	2	12	12			0
RN	Raven	<i>Corvus corax</i>	2			1			0
LR	Redpoll	<i>Carduelis flammea</i>		5		4		2	0
RB	Reed Bunting	<i>Emberiza schoeniclus</i>	2	4		5	2	5	3
R.	Robin	<i>Erithacus rubecula</i>	5+	4	1	8		12	8
RO	Rook	<i>Corvus frugilegus</i>	c.10	c.30	c.60	c.55	c.60	c.250	0
SW	Sedge Warbler	<i>Acrocephalus schoenobaenus</i>					2	4	3
SN	Snipe	<i>Gallinago gallinago</i>		1	4				0

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**Table 10.3 Bird Species Counted and number of Breeding Territories at the Current and Proposed Landfill Sites and surrounding boundary zone
(Continued)**

Species Code	Common Name (alphabetical listing)	Scientific Name	Number of birds counted on Survey Dates						Breeding Territories
			03/09/02	20/11/02	09/12/02	14/02/03	21/05/03	28/06/03	
ST	Song Thrush	<i>Turdus philomelos</i>	1				2	1	2
SH	Sparrowhawk	<i>Accipiter nisus</i>		1					0
SG	Starling	<i>Sturnus vulgaris</i>	c.150	c.150	c.90	c.120		2	1
SC	Stonechat	<i>Saxicola torquata</i>		4				2	1
SL	Swallow	<i>Hirundo rustica</i>	2					3	0
WT	Whitethroat	<i>Sylvia communis</i>						4	3
WW	Willow Warbler	<i>Phylloscopus trochilus</i>					4	12	9
WP	Woodpigeon	<i>Columba palumbus</i>	2				3	2	1
WR	Wren	<i>Troglodytes troglodytes</i>	6	3	1	1	3	12	8

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- 10.32 Over the winter survey, corvids were consistently present in loose flocks at the landfill, numbers tending to increase somewhat over the winter. Species included up to 12 Hooded Crow, up to 60 Rook and up to 40 Jackdaw. Up to 150 Starlings foraged about the landfill gathering on the over-head power-line or on the rope suspending the netting screens. Rook and Jackdaw increased sharply in the June count with the combined flock numbering c.400 birds. This may have included a high proportion of juveniles. Starlings were few in summer and the winter foraging flock must have dispersed widely to breed. Hooded Crow numbers increased to 22 birds in May, falling to 15 in June. Two Raven were also noted in the area west of the site in September and a single bird was observed in much the same area in February, but none were seen at the landfill.
- 10.33 Two main loafing places were noted during the September visit, in cropped pastures on relatively high ground intervisible with the landfill. The first was located in a field of cattle pasture on the neighbouring low hill ridge, about 350m to the north of the existing landfill site. Here, a mixed-species flock of c.50 gulls were at rest during the early hours of the visit, and subsequently flew over to the landfill, joining with other gulls in the melee. The second was located about 750m WSW of the landfill on high ground (~100m above datum) overlooking the site. Here, Hooded Crow and other corvids as well as gulls were more sparsely spread around the area, which contained rocky unimproved sheep pasture on limestone with patches of Hawthorn scrub. At other times loafing gulls tended to congregate at the edge of the tip head and were dispersed in groups on the cross-members of 110kV overhead power-lines which criss-cross the area. Flocks were often mobile and birds were observed flying to and from the area, numbers tending to increase through the morning as refuse tipping commenced. The main loafing places of corvids were the taller tree and scrub canopies to the south and north-east of the existing landfill and, to a lesser extent, also in the trees and scrub within the proposed site.
- 10.34 According to site staff, the numbers of gulls present during the field visits were about average. A gas operated bird scaring device is activated when the gull numbers are high or causing a nuisance. The scaring device was activated during the February 2003 visit causing a reaction whereby the majority of gulls flew to the north of the landfill with smaller numbers dispersing towards the hills to the south. The fishing port at Killybegs, located just 20km to the north-west of Ballynacarrick, is another attraction for foraging gull flocks on the north-west coast. It is likely therefore that the landfill represents one of a number of alternative foraging sites and that numbers here may fluctuate relative to scavenging opportunities at the port or elsewhere.

- 10.35 A large proportion of corvids were noted foraging widely about the landfill site and adjacent pastures, even when no operations were being carried out. Gulls were mainly loafing or circling in flight with bursts of foraging during and after tipping episodes. Cleptoparastic behaviour was observed, with gulls attempting to rob corvids of food items.
- 10.36 Mammal species included Rabbit, *Oryctolagus cuniculus* (including the black variant), Irish Hare, *Lepus timidus hibernicus* and Fox (*Vulpes vulpes*), all observed from the vantage point south-west of the site. Fox scats were also found in the proposed site close to the landfill boundary. Badger (*Meles meles*) was not seen but is likely to occur in the area. In the fields to the north-east of the site, fur thought to be Badger's was entangled on a low stand of barbed-wire fence. Stoat (*Mustela erminea*) and American Mink (*Mustela vison*) are also likely to occur, given the suitable habitat characteristics and food availability in the area. Tracks of a small mammal noted on soft ground towards the centre of the landfill were most likely those of Stoat or Mink. Brown Rat (*Ratus norvegicus*) is a known vermin species at the site, but is controlled through a vermin control programme and was seen only once at the road, west of the site, in September.
- 10.37 Both Frog (*Rana temporaria*) and Viviparous Lizard (*Lacerta vivipara*) were recorded in the fen and heath habitat within 200m north of the site.
- 10.38 A detailed survey of invertebrates was not carried out. Familiar insects such as butterfly and dragonfly taxa were recorded mainly in areas peripheral to the site/operational landfill in the course of field visits, adding to the measure of species diversity in the habitats examined. Butterfly species included Speckled Wood (*Pararge aegeria*), Meadow Brown (*Maniola jurtina*), Small Heath (*Coenonympha pamphilus*), Ringlet (*Aphantopus hyperantus*), Common Blue (*Polyommatus icarus*) and Peacock butterfly (*Inachis io*). A single Drinker Moth was also observed. Dragonflies recorded mainly around the fen area (just north of the site) included the Four-spotted Chaser (*Libellula quadrimaculata*), Common Hawker (*Aeshna juncea*), Common Darter (*Sympetrum striolatum*) and Large Red Damselfly (*Pyrrhosoma nymphula*), as well as a crane fly species, a grasshopper species and hoverfly species. Pest species including Housefly (*Musca domestica*) and Bluebottle (*Calliphora vicina*) were noted to be abundant near the landfill in June.

AQUATIC ECOLOGY

- 10.39 Surface water emanates from the site and flows, by drainage channel and stream, westward five to six kilometres until it reaches Durnesh Lough, at the coast of Donegal Bay. A study of the ecological quality of this stream was conducted as part of the study of flora and fauna in the area of the landfill site.
- 10.40 The dates of survey were the 9 October, 20 November 2002 and 14 February 2003 (only SS8 sampled on the last date - see below). GPS (Global Positioning Systems) readings were taken using a Garmin 12 receiver. Sediment cores were sieved through a 1 mm mesh at sample sites SS1 and SS2. Kick-samples were made using a hand net for two to three minutes at sample sites SS3 through to SS8. The mesh size in the hand net was 900 µm. Rock washes were also taken. The specimens collected were stored in bags and identified in a laboratory using a binocular microscope.
- 10.41 The biological assessment of river water quality was made using the Irish biotic score index, Q rating (Flanagan and Toner, 1972; McGarrigle et al. 1992). The assessment procedure places macro-invertebrates into five broad classes or 'Indicator Groups' A-E, of which group A is the most sensitive, B is less sensitive, C is relatively tolerant, D is tolerant and E comprises the most tolerant forms. The categories for the Irish Biotic Index and River Quality are shown in Figures 10.4 and 10.5.

Table 10.4 Categories for Irish Biotic Score Index (Q)

Biotic Index (Q Value)	Water Quality
Q5 (diversity high)	Good
Q4 (diversity slightly reduced)	Fair
Q3 (diversity significantly reduced)	Doubtful
Q2 (diversity low)	Poor
Q1 (diversity very low)	Bad

- 10.42 Four categories of water quality are calculated:

Table 10.5 Q values assigned to categories of river quality

Q Value	Category of River Quality
Q5, Q4-5, Q4	Unpolluted
Q3-4	Slightly polluted
Q3, Q2-3	Moderately polluted
Q2, Q1-2, Q1	Seriously polluted

Results

10.43 Biological sampling points were located as follows (see Figure 10.3). Additional reference points charting the course of the main stream channel are also given:

Table 10.6 Biological sampling sites as indicated in Figure 10.3

Sampling Site	O.S. GPS Grid Coordinates
SS1	G 93403 / 67556
SS2	G 93398 / 67552
SS3	G 93250 / 67750
SS4	G 93000 / 67900
SS5	G 92450 / 68390
SS6	G 91174 / 68677
SS7	G 90599 / 69246
SS8	G 88414 / 68496
c. 500m downstream of site	G 92976 / 68176
Near entrance to Roadstone quarry	G 91758 / 68554
Less than 1km upstream of Durnesh Lough	G 88796 / 68536
c. 150m upstream of Durnesh Lough	G 88426 / 68470

Sample Site SS1

10.44 Here the stream was contained in drainage ditch channel approximately 0.5 m in breadth and 0.3 m in depth. A layer of black digesting sludge coated the bottom to a depth of about 0.7 m. This had a mouldy smell. The water was very turbid and grass growing from the banks of the stream had a dirty orange colour. The water had a dirty grey colour. This sample site was about 10-15 m downstream of the existing landfill site at the proposed site south boundary, bordering on the same side of the public road.

10.45 No organisms were found at sample site SS1 whatsoever.

Q value of 1

Sample Site SS2

10.46 This was a drainage channel stream bordering the opposite side (south side) of the road at the sites' south boundary, which subsequently flows into the stream emanating from the existing landfill, a short distance downstream of SS1. Vegetation growing in the stream and on the bank side was green in colour. A layer of sediment on the bottom was approximately 0.5 m thick. It did not appear anoxic nor was there any unpleasant odour. The organisms found at Sample Site SS2 are shown in Table 10.7.

Table 10.7 Organisms Found at SS2

Latin Name	Common Name	Abundance
<i>Gammarus</i> species.	Shrimp	Abundant
Family Sphaeriidae	Pea Mussel	Scarce
Family Chironomidae	Midge Larva	Fairly Common
Order Copepoda	Water Flea	Common
Family Nemouridae	Stonefly	Rare

Q value of 3

Sample Site SS3

10.47 This sample site was approximately 100-200 m downstream of the landfill site. The stream water had a dirty brown-grey colour and had an unpleasant odour. The stream ran through a field adjacent to a small road. It was approximately 0.2 m deep and was fairly fast flowing. The substrate of the stream was shallow gravel and sand deposits. The organisms found at this Sample Site are shown in Table 10.8.

Table 10.8 Organisms Found at Sample Site SS3

Latin Name	Common Name	Abundance
Family Chironomidae	Midge Larva	Dominant
Order Copepoda	Water Flea	Fairly Common

Q value of 2

Sample Site SS4

10.48 This sample site had been channelised. It was fast flowing and shallow to about 0.2 m and had a stone and gravel bottom. The water here was turbid and had a dirty brown colour. A clear spring joined the stream downstream of the site. Adjoining the site were fields, some of which had cattle. The organisms found at Sample Site SS4 can be seen in Table 10.9.

Table 10.9 Organisms Found at Sample Site SS4

Latin Name	Common Name	Abundance
Family Polycentropidae	Caseless Caddis Fly Larva	Fairly Common
Family Chironomidae	Midge Larva	Fairly Common

Q value of 2

Sample Site SS5

10.49 This was approximately 300-400 m off road. Both upstream and downstream of the site, the stream had begun to flow underground in parts. Also limestone pavements had begun to appear. The stream was approximately one metre wide and was shallow to about 0.3 m. The substrate consisted of small rocks and some gravel. The stream still had a dirty colour though the smell was not as bad as at SS1-SS4. The organisms found at Sample Site SS5 are illustrated in Table 10.10.

Table 10.10 Organisms Found at Sample Site SS5

Latin Name	Common Name	Abundance
Family Chironomidae	Midge Larva	Abundant
Family Polycentropidae	Caseless Caddis Fly Larva	Fairly Common
Gammarus species	Shrimp	Scarce

Q value 2

Sample Site SS6

10.50 This sample site was downstream of a small bridge and was approximately one kilometre downstream of SS5. It was between the townlands of Drumaneel, Ballymagrorty and Ballynacarrick. The stream was approximately one and a half metres wide and shallow to 0.3 m. It flowed over limestone pavement and contained some stones and gravel as bottom sediment. The flow was slow to medium in intensity. The stream was in farmland and had a lush margin of trees and bushes. Algae were evident in the abundance in the stream at this stage. The organisms found at Sample Site SS6 are illustrated in Table 10.11.

Table 10.11 Organisms Found at Sample Site SS6

Latin Name	Common Name	Abundance
Class Oligochaeta	Segmented worm	Scarce
Family Chironomidae	Midge larvae	Fairly common
Order Hydracarina	Water mite	Common
Family Lymnaeidae	Pond snail	Fairly common
Order Coleoptera	Beetle	Scarce

Q value of 2-3

Sample Site SS7

10.51 This sample site was another 500 m downstream of SS6. The stream flowed through agricultural land. It was shallow to 0.4 m and was fast flowing. It still had a slight dirty colouration but had little odour. The site was where the stream flowed through a field used by grazing livestock. Algae and macrophytes (higher plants) were fairly abundant in the stream. The organisms found at Sample Site SS7 are shown in Table 10.12.

Table 10.12 Organisms Found at Sample Site SS7

Latin Name	Common Name	Abundance
<i>Baetis rhodani</i>	Mayfly	Common
Order Tricladia	Flatworm	Common
Order Copepoda	Water Flea	Common
<i>Hygrobates longipalpis</i>	Water mite	Common
Phylum Nematoda	Worm	Common
Helobdella species	Leech	Scarce
Glossiphonia species	Leech	Scarce
Family Lymnaeidae	Pond snail	Scarce
Family Tipulidae	Cranefly larva	Scarce
Amphinemura species	StoneFly	Scarce
Dipteran species	Fly larva	Scarce
Elmis species	Beetle	Fairly common
Order Coleoptera	Beetle	Scarce
Class Oligochaeta	Segmented worm	Scarce
Chironomus species	Biting midge larvae	Scarce

Q value of 2-3

Sample Site SS8

10.52 This site was about 150 m upstream of Durnesh Lake. The stream was one to two metres wide with a depth of about half a metre. The water was clear and had no odour. The substrate had a dirty brown colour. Some algae grew underwater on rocks. A flounder, *Platichthys flesus*, was captured at this site. The organisms found at Sample Site SS8 are illustrated in Table 10.13.

Table 10.13 Organisms Found at Sample Site SS8

Latin Name	Common Name	Abundance
<i>Baetis rhodani</i>	Mayfly larvae	Common
<i>Glossiphonia complanata</i>	Leech	Common
<i>Gammarus pulex</i>	Freshwater shrimp	Fairly common
Amphinemura spp.	Stonefly larvae	Fairly common
<i>Ilybius fuliginosus</i>	Water beetle	fairly common
Order Trichoptera	Caseless caddisfly	Scarce

Q value of 3

Chemical Data from Ballynacarrick Surface Waters

10.53 Chemical data are available from a number of sources and provide relevant parameters of the conditions affecting aquatic ecology. The main source is monitoring undertaken for 2002 by Donegal County Council for the existing Ballynacarrick landfill, under the Waste Licence 24-1. Relevant chemical parameters, measured at various locations around the site, are reproduced in the Tables 10.14, 10.15 and 10.16. The location of these points on the site is illustrated in Figure 10.3.

Table 10.14 Mean Values of Chemical Data from Surface Water Monitoring Point SW3 at Ballynacarrick Landfill Site (source: Annual Environmental Report for 2002).

Parameter	Mean
Ammoniacal nitrogen (mg l ⁻¹)	23.1
BOD (mg l ⁻¹)	31.87
SS (mg l ⁻¹)	29.02
Copper (mg l ⁻¹)	<0.05*
Zinc (mg l ⁻¹)	<0.05*
Mercury (µg l ⁻¹)	<0.05*
Nitrite (mg l ⁻¹)	0.456
Potassium (mg l ⁻¹)	32*
Electrical Conductivity (µs/cm)	638.2

* Parameters measured on an annual basis only

Table 10.15 Data taken from Surface Water c.180 m Downstream of Ballynacarrick Landfill Site, 5/5/1998 (Mr. Brendan Maguire, Northern Regional Fisheries Board, Pers. Comm.)

Parameter	Concentration
Total Phosphorous (mg/l ⁻¹)	0.08
Molybdate Reactive Phosphorous (mg/l ⁻¹)	0.036
Total Nitrogen (mg/l ⁻¹)	19.485
Total Oxidized Nitrogen (mg/l ⁻¹)	1.282

Table 10.16 Data from Surface Water c.150 m Upstream of Durnesh Lough on the Stream Rising at Ballynacarrick Landfill Site, 5/5/1998 (Mr. Brendan Maguire, NRFB, Pers. Comm.).

Parameter	Concentration
Total Phosphorous (mg/l ⁻¹)	0.054
Molybdate Reactive Phosphorous (mg/l ⁻¹)	0.034
Total Nitrogen (mg/l ⁻¹)	3.488
Total Oxidized Nitrogen (mg/l ⁻¹)	3.337

DISCUSSION

- 10.54 The surface water immediately downstream of the landfill site is considerably polluted. This is borne out by the colour, smell, turbidity and anoxicity of the sediment, and by the fact that the stream is lifeless (site description and results for SS1) at SS1. The area of considerable pollution seems to extend to the area of SS3 (where the chironomid family completely dominate the fauna) and SS4. SS2 is relatively unpolluted, not being connected to the main stream in question. At this stage in a polluted river a rapid putrefaction process occurs and ammonia, hydrogen sulphide and carbon dioxide are produced as end products of degradation. This is borne out by chemical data (Table 10.14, values for ammoniacal nitrogen). As a note, maximum admissible values for the un-ionized form of ammonia in salmonid waters is 0.025 mg/l^{-1} . The surface water monitoring point SW3 is 30m downstream of SS1 (Table 10.14).
- 10.55 From sample sites SS5 to SS8, faunal diversity improves somewhat.
- 10.56 From our observations it would appear that agricultural pollution may enter the stream between SS5 and SS6. It may also have inputs further downstream. This is a known source of nutrients such as phosphate, nitrate and nitrite.
- 10.57 Periodic episodes of eutrophication (especially concerning nitrogenous compounds) which occur in the Birra Stream are quite severe until the date 11/12/01, but thereafter are not nearly as severe (Tables 10.15 and 10.16; the Annual Environmental Report (AER) for Ballynacarrick Landfill, (Donegal County Council, 2002) and 2002 surface water monitoring data collected for 2003 AER; and KMM data for Birra Stream, 2003). Within the nitrogen cycle, ammoniacal compounds may eventually be converted to nitrites and nitrates. Nitrates and nitrites, along with ammoniacal compounds, are of concern as the stream enters Durnesh Lough (a pSAC) within several kilometres. The lake is eutrophic and shallow with an average depth of one to one and a half metres. The un-ionized form of ammonia is highly toxic to fish and forms more readily as alkalinity increases (eutrophic lakes have higher alkalinities). The lake contained sea trout and brown trout [Donegal Bay Management Plan, Appendices, (data from 1981) - Holohan, 2002].

- 10.58 Also of concern in surface water emanating from Ballynacarrick Landfill are the concentrations of suspended solids [which exceed maximum admissible levels in the Freshwater Fish Directive (78/659/EEC) in 2000/2001 but not latterly, in 2002] and the Biochemical Oxygen Demand (B.O.D.). Electrical conductivity values for 2000/2001 also indicate pollution episodes. The levels of metals in surface water at Ballynacarrick do not exceed the limits set in the Freshwater Fish Directive. The apparent improvements in levels of potential pollutants in surface water at Ballynacarrick, between 2000/2001 and 2002, are probably due to the pumping out and removal of leachates from the landfill site.

SITE EVALUATION

Naturalness

- 10.59 The site has evidently been managed as enclosed grazing for a long time, though not intensively. The greatest botanical interest was found in the east of the site in wet heath and a small remnant of cut-over bog. These habitats are degraded partly past by cutting and drainage and partly by, poaching and nutrient enrichment by livestock in recent times. Some natural succession to scrub has occurred in patches.
- 10.60 A woodland copse was probably developed to shelter the dwelling and does not appear to be a relic of native woodland. It was noted that a portion of the copse was felled recently (c.15 trees cut and removed) on its western side. The site therefore comprises a number of modified and semi-natural habitats. By reason of its nature, the existing landfill facility inherently lowers the ecological quality of the area. The adjacent areas around the site contain a mixture of natural and semi-natural farmland habitats.

Size

- 10.61 The site is very small in area and is too limited to represent a discrete ecosystem of local importance. Habitats of local ecological interest however lie adjacent to the site. The existing landfill, while small in area, is locally significant in attracting disproportionate numbers of scavenger species and in the release of polluting substances into the external environment.

Diversity

- 10.62 There is some habitat variety and a fair range of plant species was found in the site, though all of them are common in Ireland. Diversity is limited due to its small size, unremarkable inherent characteristics and rather poor ecological condition. A greater diversity of habitats and a moderately high diversity of species was noted from the environment surrounding the site, wherein pockets of natural or semi-natural habitat exist in a broadly agricultural zone.

Species Rarity

- 10.63 No protected, threatened or scarce plant species - as listed in the Irish Red Data Book (Curtis & McGough, 1988) or in relevant legislation - was found in or near the proposed development site. Bloody Cranesbill (*Geranium sanguineum*), recorded 200m north of the site, is locally frequent in Clare and Galway (e.g. the Burren), but 'very rare elsewhere' (Webb *et al*, 1996). The rare and protected plant species, Common Rockrose (*Helianthemum nummularium*) was not found in the survey area (i.e. in the habitat area mapped in Figure 10.1).
- 10.64 Lesser Black-backed Gull was dominant in the flock of scavenging gulls at the site during the breeding season. This migratory species is listed in Annex II of the EU Birds Directive and in the Irish Red Data Book (Whilde, 1993). It breeds at various inland sites with Ireland holding about 6% of the European population of the race *Larus fuscus graellsii* (Way *et al*, 1993), a large proportion of which is protected within the SPA network. A nationally important breeding colony exists in the Lough Derg SPA, not far to the east of Ballynacarrick landfill.

Habitat Rarity

- 10.65 There are no rare habitat types within the site although wet heath is listed in Annex I of the EU Habitats Directive and good examples are conserved in the region through SAC designation.
- 10.66 A small area of calcareous heath (HH2 - see Table 10.2) lies approximately 200m to the north of the site, and forms part of a local assemblage of habitats including a basin mire with base-rich fen and adjoining reed bed. The corresponding EU Annex I habitat, '*Juniperus communis* formations on heaths or calcareous grasslands (5130)', is scarce in the region. The adjacent fen habitat is also uncommon and is of ecological interest.

Representivity

- 10.67 While the site retains some botanical interest and wildlife value, it does not contain good, representative examples of any of the habitat types identified. The vegetation appears to be very similar in character to that of the surrounding area and the habitats present are also well represented generally in this region.

Proximity to Designated Sites of Ecological Interest

- 10.68 The bedrock geology of the locality, characterised by karst limestone and associated groundwater systems, gives rise to habitats and ecosystems of scientific interest. A number of sites are being designated in the vicinity of the existing and proposed landfill. Ballintra pSAC (site code 115) is located on a hill 800m to the north-west and covers an area of around 50ha. It is the most northerly location of limestone pavement in Ireland and is an EU priority habitat. It occurs among other habitats such as dry heath, hazel-hawthorn scrub and calcareous grassland. Ballintra pSAC is the only Irish location of the protected species Common Rockrose (*Helianthemum nummularium*) (Flora Protection Order, 1999).

10.69 Lough Golagh and Breezy Hill pSAC (site code 2164) is a medium size site located 2.5km to the south-east of the proposed development site. It contains several mesotrophic lakes and wetlands as well as extensive, well developed blanket bog. A high diversity in the wetland flora of the area is owing to the varied geology of both basic and acid bedrock. Important colonies of Black-headed Gull and Common Tern have declined on Lough Golagh over recent decades and the cause of this is uncertain. Carricknahorna Lough and Lough Gorman is a pNHA with marl lakes and shallow flats surrounded by limestone pavement and grassland with hazel scrub. The site supports a rich and diverse flora, with fen-type vegetation and reed-beds fringing the lakes. Durnesh Lough pSAC (site code 138), located 5km to the west of the proposed development site, is a large, sedimentary lagoon - an Annex I EU Habitat. It is separated from the sea by drumlins and sand dunes with the remains of a cobble barrier in places. Underlain by limestone, the site has a highly diverse ecology with several rare and protected plant species. It hosts significant numbers of wintering migratory birds including Greenland White-fronted Goose, Bewicks Swan and Whooper Swan, which are all listed in Annex I of the EU Birds Directive. Otter and Sea trout are other important species occurring here. The diversity of species make this area a site of national and international importance. Other sites of relevance include the Pettigo plateau and Lough Derg. There are three overlapping designations applying to this area, a pSAC, a pSPA and a pNHA. Of relevance is the pSPA site on Lough Derg (site code 57) as it hosts a breeding colony of Lesser Black-backed Gull.

Sensitivity to Disturbance and Vulnerability

10.70 The loss of site habitats is an inevitable outcome of the proposed development. Some elements of the ecology of the wider environment are sensitive and vulnerable to the existing and potential effects of the landfill facilities. The aquatic ecology of the stream flowing westward from the site is subject to current and potential pollution from landfill leachate. The ecology of the receiving environment of Durnesh Lough is sensitive and vulnerable to the impacts of water pollution.

10.71 Local populations of some sensitive bird species may be vulnerable to direct or indirect impacts. The prevalence of scavenger species such as crows and gulls gathering at and around the landfill increases the threat of predation on other species.

EFFECTS OF THE PROPOSED DEVELOPMENT ON FLORA AND FAUNA

10.72 The proposed development will result in the phased loss of most areas of habitat which currently exist within the site. It is intended to retain some habitat features in the site, including the remaining wooded copse and scrub woodland at the top of the hill.

- 10.73 The loss of habitats within the site is not regarded as significant as the site area is small and the habitats and plant communities found therein are well represented in the surrounding areas of the locality and more extensively in the region.
- 10.74 It is expected that habitat loss will be phased and gradual, so that some portions of the site will remain relatively unaffected, until required for the development of additional cells. Once individual cells are full to capacity and are capped, a gradual recovery of vegetation will enable semi-natural habitat to re-develop, reinstating some value to wildlife such as birds.
- 10.75 The proposed landfill development will be an engineered lined facility designed (to legally required standards and specification) to contain, control, remove and treat the resultant pollutants. The release of polluting substances, which could adversely affect the ecology of the surrounding environment, will be minimal.
- 10.76 Habitat loss in the proposed development site will have some localised impact on breeding birds due to the displacement of current breeding territories and loss of feeding areas. This will not however result in a significant decline in any species in the local countryside. Indeed, the pattern of usage of the area by birds does not attach great importance to the site itself, and adjacent areas appear to hold a greater diversity and richer natural feeding habitat. However, Grasshopper Warbler, Reed Bunting and Snipe are vulnerable to habitat loss since their populations are declining (Newton et al, 1999).
- 10.77 Operational noise is likely to have some adverse effect on the ecology of fauna near the site (Ecoscope, 2000). Due to the current level of operational noise, it was not possible to assess the effects of noise in the context of the current baseline. Compared with current levels, operational noise is unlikely to increase significantly in the future operation of the proposed development.
- 10.78 Gulls and corvids are likely to continue scavenging at the proposed landfill extension as per current numbers and activity. This pattern of behaviour is unlikely to change greatly unless more effective bird control is implemented in the future. The landfill is of local foraging value to small birds over the winter, Chaffinch and Pied Wagtail in particular. Raptors such as Sparrowhawk are evidently attracted by these flocks, which present prey-capture opportunities. The use of netting for litter control presents a potential hazard to Sparrowhawk giving chase to prey. Juveniles unaccustomed to the hazard are likely be at greater risk of collision. There was no general evidence of birds being entrapped in the netting. Learnt avoidance behaviour lessens the possibility of chance collisions with the netting screens. The relatively large mesh size also lessens the hazard to smaller birds.

- 10.79 The accumulation of scavenger birds in the area poses a predation threat to sensitive species in the surrounding environment. Hooded Crows are probably quite common in the area regardless of the landfill, but gulls could seek alternative foraging opportunities particularly when food is unavailable at the landfill or when bird control is in operation. Large gull species may frequent lakes in the surrounding area of Ballynacarrick. Nesting Common Tern and Black-headed Gull colonies at nearby Lough Golagh could be vulnerable to predation by larger species such as Herring Gull. The tern colony declined between 1984 and 1995 which coincides with the operational period of the landfill. No terns were recorded at the former colony in 1995 (Hannon, 1997). This prompts the question as to whether predation by gulls contributed to the decline, which if so, could be indirectly attributable to the existence of the landfill. There is no data to indicate that this was a possible or likely factor. However between 1984 and 1995, declines in inland tern colonies have occurred in some counties, while numbers increased in other counties. The reasons for these changes may be complex and multiple and not clearly determined. It is worthy of note that the total number of tern colonies has decreased over that period and that the proportion of tern colonies co-existing with gull colonies (notably large gull species) has also decreased (Hannon, 1997).
- 10.80 Established food sources for gulls, particularly foraging opportunities linked to offshore fishing and at landing stations, have been reduced by decreases in fleet size and modernisation at onshore facilities. Meanwhile, a reduction in arable agriculture has decreased foraging opportunities for species such as Black-headed Gull. This may have had the effect of increasing reliance on sources such as landfill sites. Landfill foraging has however resulted in adverse effects on gulls and is linked to an increased incidence of diseases, in particular botulism, which is stated among the threats to both Lesser Black-backed Gull and Herring Gull (Gibbons et al, 1993; Way et al 1993).
- 10.81 It is not possible to state the extent to which the various gull species are dependent on the landfill as a food source. Gulls will travel over 50km from breeding or roosting sites to daily feeding areas (Ecoscope, 2000). Ballynacarrick is therefore within easy reach of both coastal and inland gull haunts. Overall, the counts indicate relatively low gull numbers and the landfill may simply distract these birds from a more normal feeding pattern. The fact that Lesser Black-backed Gull was quite abundant in the breeding season, but largely absent for the remainder of the year, suggests that the birds visit from nearby breeding colonies, namely Lough Derg. Adequate food supply in the breeding season is essential to ensure breeding success and survival of the colony. The low numbers of other gull species during the breeding season and seasonal fluctuation in their numbers outside the breeding season suggests that they have a low dependence on the landfill for food.

- 10.82 A degree of pollution from wind-blown litter was noted around and beyond the existing landfill boundary fence, particularly to the north and east. The site is quite exposed to the south and west while sheltered conditions in the low (lee-side) areas beyond cause the litter to settle here. Likewise, landfill gas and particulate matter could be detected by odour downwind and effects on vegetation outside the northern perimeter of the existing landfill were evident in the form of 'burning' and algal films.
- 10.83 All necessary measures to prevent and avoid contamination of water courses during construction will be taken. This may include settlement lagoons and oil / fuel interceptors and appropriate standards for works aimed at limiting effects on the environment.

CONCLUSIONS ON LIKELY SIGNIFICANT EFFECTS

- 10.84 The proposed landfill extension is in itself unlikely to give rise to significant adverse effects on the ecology of the receiving environment relative to its current condition. Given the environmental sensitivity of some areas, which may be geographically removed though hydrologically linked to site, the existing landfill in combination with intensive agriculture and possibly housing with uncontained sewage disposal, are likely to have significant adverse effects on the environment. This may be affecting the coastal zone wetlands including the ecology and status of species of the Durnesh Lough system.

MEASURES TO MITIGATE ADVERSE EFFECTS

- 10.85 Implement fully and timely the environmental management system set out in the Annual Environmental Report upon which the waste licence for the existing site is conditional.
- 10.86 Broaden the scope of environmental monitoring to include the full area of the affected catchment, including Durnesh Lough and the aquatic ecosystem. It will be necessary to isolate the main individual sources of pollution of ditches and streams (taking account of the interplay of surface with groundwater systems) in order to attribute and apportion the causes of pollution clearly and coherently.
- 10.87 Following from the above, take remedial action to remove or correct the causes of water pollution affecting the ecosystem. Set targets and time-frame for the improvement of the biological quality of the water downstream as far as Durnesh Lough, as indicated in section 5.6 of the Waste Management Plan (Donegal County Council, 2000) and section F of the Donegal Bay Water Quality Management Plan (Donegal County Council, 2002).

- 10.88 In addition, consider the incorporation (below site) of a constructed wetland if the contamination in the watercourse from the existing site does not improve after the site has been capped and restored. This may include a reed-rock filtration area (Mulamootil et al, 2000; Ecoscope 2000) with the aim of treating residual leachate seepage to water courses and removal (by dissociation and natural filtration) of polluting and toxic substances. This is known to be effective in the removal of heavy metals and organic pollutants.
- 10.89 In conjunction with the above, incorporate compensatory habitats in the landscape design of the proposed site development, to include replacing scrub loss where space permits. Reinststate capped full landfill areas by appropriate habitat management (e.g. scrub woodland and species rich grassland) valuable to wildlife such as the existing bird species of the area. Strategic shelter belts may assist the control of litter spread and reduce exposure to operational noise by screening as well as mitigating landscape and visual impacts. Technical guidance, case studies and experimental results are documented (e.g., Bending & Moffat, 1997; Ecoscope, 2000). Plans for habitat restoration should be kept under review in light of published research and updated guidance. Expert advice on planning habitat creation should be sought in advance of finalising restoration plans and utilised in their implementation.
- 10.90 The effectiveness of bird control measures (section 7.20) should be assessed independently by spot checks and monitoring of scavenger bird flocks at Ballynacarrick.
- 10.91 The local breeding colony of Lesser Black-backed Gull at Lough Derg (NHA/SPA) should be monitored and any detected decline should be checked against food availability and trends at the Ballynacarrick landfill. Ecological monitoring in designated conservation sites and of listed species is normally conducted by Dúchas NPW (Dept of Environment).
- 10.92 Monitor the local bird populations periodically in relation to habitat conditions and the landfill operation in the future. It is suggested that this may be carried out at three or five year intervals to assess future trends against the current baseline information on birds.
- 10.93 Improve the control of wind-blown litter outside of the site above current standards. Conduct independent monitoring of litter in the surrounding environment on an annual basis. Organise increased effort of litter collection in these areas twice per year, suggested in October and March following seasonal storms and when ground vegetation is low. This measure is suggested as a supplement to the standard operational measures stated in section 7.21.
- 10.94 The provision of a gas flares should reduce the effects of landfill gases and particulate matter on adjacent vegetation and habitats in the long term.

ANIMAL HEALTH

INTRODUCTION

10.95 This chapter deals with the potential impact that the development may have on farm animal health in the surrounding area.

EXISTING FARMING PRACTICE

10.96 Farming practice in the area surrounding the proposed landfill site is that of a mixed grazing of drystock, suckler cows and sheep. The area is composed of "rough" grazing and both cattle and sheep are "extensively" grazed. Landfill sites, by their very nature, contain a number of hazards, which if not adequately contained and controlled could have detrimental effects on animal health. However the "extensive" nature of the farming practices in the immediately surrounding area will, in itself, help mitigate many of the potential animal health hazards associated with landfilling.

10.97 A hazard in this context is any item, procedure or operation that has the capacity to harm, and a policy of risk management is designed to reduce the level of risk to the lowest attainable level in real life situations.

POTENTIAL CONCERNS FROM LANDFILL SITES RELATED TO ANIMAL HEALTH.

10.98 The features of landfill sites, which make them potentially hazardous to animal health, include the following:

- The nature of the material being landfilled, given that it will contain small quantities of animal remains (meat scraps, bones), has the potential to harbour pathogenic organisms.
- The site may attract scavenging birds who may pick up material from the site and carry it off site. This material, deposited on adjacent farmland, may come into contact with livestock. Large numbers of birds may contaminate adjacent farmland with their droppings. These droppings may contain pathogens which may contaminate livestock.
- The site may attract vermin such as rats and mice. The organic food content of the waste may act as a food source. Rats are carriers of a number of livestock diseases and they may also act as mechanical carriers of any pathogens which they come in contact with. Larger wild mammals such as foxes and badgers may also carry pieces of organic material off site.
- The site may attract flies that lay their eggs in the organic content of the waste leading to increased fly populations in the area. Flies may act as mechanical carriers of pathogens such as *Salmonella* spp.
- Wind borne debris and plastic may be blown on to adjacent farmland where it may be ingested by livestock.

- Dust and air borne pathogens may be blown off site and act as respiratory irritants for animals.
- Noxious weeds (e.g. Ragweed) may grow on the site and seed the surrounding farmland
- The natural breakdown products (gases, leachate) of the material on site may escape off site and contaminate surface water, ground water or surrounding air.

MITIGATING MEASURES

10.99 Risks to animal health from landfill sites may be managed and reduced by the application of a Hazard Analysis and Critical Control point approach.

10.100 The operation, having been analysed and the potential hazards identified, can be adjusted to take account of the potential hazards in order to reduce, mitigate or eliminate them.

10.101 The following list enumerates the identified potential hazards and the measures that will be taken to mitigate them.

The Nature Of The Material Being Landfilled.

10.102 The site will be for the acceptance of household, commercial, non-hazardous industrial and construction and demolition waste only. Although this may contain physical hazards (e.g. plastic bags, broken glass), chemical hazards (household detergents, cleaners etc.) and biological hazards (household food waste) the nature of the material being accepted is of a low order of risk.

10.103 Random checking procedures will be operated to ensure that material being received at the landfill meets the acceptance criteria.

10.104 Records will be kept of loads of waste entering the site, including details of carrier, type of waste, quantity etc.

Scavenging Birds

10.105 The presence of scavenging birds such as crows and gulls will be continuously monitored. Potential animal health nuisance resulting from the activities of scavenging birds on the landfill site will be controlled and minimised by the following measures:

- The site will be for the acceptance of household, commercial, non- hazardous industrial and construction and demolition waste and therefore will contain no high risk condemned, diseased or high risk biodegradable fraction likely to give rise to contamination of the surrounding farmland.
- The active working faces will be kept as small as possible and all other areas will be covered so as to decrease the potential food supply for scavenging birds.

- Daily cover material such as hessian, biodegradable geosynthetic sheeting or soil will be placed on the working faces at the end of each working day.
- Control measures such as gas cannons, visual deterrents, distress calls, physical barriers, birds of prey and flying kites will be employed as required. These measures will be varied so as to prevent birds becoming accustomed to any one method and these will be reviewed to ensure effective control.

Vermin And Fly Infestations

- 10.103 It is recognised that landfill sites have the potential to attract vermin such as rats and flies. Rats are reservoirs for a number of infectious diseases transmissible to humans and animals and in addition may physically transport, on their feet and bodies, disease organisms off site. Flies may also carry disease organisms off site.
- 10.104 It is proposed to put in place strict control procedures at the proposed facility in order to control the population of vermin.
- 10.105 A firm of professional vermin control experts will be employed to control vermin using standard methods. Baiting with rodenticides will be undertaken on at least a monthly basis. The baiting will be undertaken in a professional manner and every precaution will be taken to avoid non-target species. In particular the bait will be placed in areas, which are not accessible to non-target species and where possible dead or dying vermin will be removed as soon as possible. It should be noted however that vermin such as rats normally return to their nests to die.
- 10.106 In order to mitigate the effects of re-infestation from surrounding farms it is proposed to offer the services of the vermin control experts for a consultation and assessment service in relation to farmyards and /or farm buildings up to ½ km. from the boundary of the site. Following this assessment, compliant farmers will be supplied with bait boxes and bait as per the consultant's recommendation and bait renewal will be made available to the farmers on a regular basis as required.
- 10.107 The active working face will be kept as small as possible and the face covered on a daily basis to decrease the potential food supply.
- 10.108 In very dry weather, which may give rise to events of fly infestation on the site, industrial sprays will be used to mitigate against these nuisances. The active working face will be kept as small as possible and the face covered on a daily basis to decrease the potential area available for breeding.
- 10.109 Pest control specialists will be employed to deal with any infestations.

10.110 Ensuring a secure perimeter fence on the site will control larger mammals such as foxes and badgers and control specialists will be employed to ensure that no resident population becomes established on site.

10.111 A record will be kept of all treatments and occurrences, if any, of vermin at the site.

Wind Blown Debris

10.112 Wind blown litter is potentially the most visible contamination of surrounding grassland, hedges and fences and presents a physical hazard when ingested by livestock. The following measures will be employed to control wind blown litter:

- The active working face will be kept as small as possible and all other areas will be covered.
- Daily cover material such as hessian, biodegradable geo-synthetic sheets or soil will be placed on the working face at the end of each working day.
- Modern wind blow netting systems will be employed at the working face of the landfill.
- In the event of failure of the wind blow netting system the proposed fencing around the site will also prevent litter from being blown off site. This fence will be regularly inspected by site operatives and cleaned if required.
- Regular inspection and litter collection will be undertaken at the site and adjoining land if and when necessary.
- All waste entering the landfill will be in covered vehicles.
- The approach roads will be monitored on at least a daily basis and in the event of litter being found on these roads, site staff will promptly remove it and deposit it in the appropriate manner at the landfill site.
- A general clean-up and attendance work will be carried out on a weekly basis by site staff around the entire perimeter of the landfill footprint, on all internal haulage roads and on approach roads.

Dust

10.113 Landfill sites can present a problem in relation to potential dust emissions. Due to the granular nature of some of the material required for the construction and operation of the landfill and the particulate nature of some dried organic materials found in household waste, wind blown dust and air borne bacteria may be blown off site and impact on the health of livestock in the surrounding area by acting as a respiratory irritant or by direct ingestion. This may be a particular problem during periods of dry windy weather.

- However the measures detailed will mitigate their impact.
- Disposal and immediate burial of dry and dusty wastes (9.86).
- The use of, and careful choice of, daily cover material such as hessian, biodegradable geo-synthetic sheets, soil etc. to be placed on the working face at the end of each working day.

- A tractor and brush will sweep site roads on a regular basis (7.38). In periods of dry weather, the site and adjoining roads will be inspected on a daily basis for evidence of excessive generation of airborne dust. This inspection will be carried out by Donegal County Council personnel and by the site contractor during the various construction phases, who will also be responsible for taking any remedial action, such as spraying of the access routes and other exposed areas to help reduce dust emissions. In particular the haul route between the clay borrow area and the landfill footprint will be sprayed as required.
- All embankments and soil stockpiles will be vegetated immediately following placement to anchor the soil and reduce the surface area open to the environment. A stockpile of cover material will be made available on site for emergency use.
- The permanent wheelwash on site will ensure that dust emission is not caused from the tyres of vehicles using the landfill site. (7.39, 7.40, 7.41) The wheel-wash at the landfill facility is to be positioned to ensure that waste vehicles leaving the site do not carry excess soil and material.
- A complaints register will also be maintained on-site and should any complaints relating to dust emissions be submitted, then these will be immediately dealt with.

Noxious Weeds

10.114 Weeds such as Ragweed can be toxic to livestock when ingested.

10.115 Weed control will be employed on site and monitored by regular inspection by site staff. A record of these inspections, and any treatments used, will be kept.

Gases and Leachate

10.116 The site will be engineered on a containment basis to prevent the uncontrolled migration of leachate and landfill gas. Leachate will be transported off-site for treatment at a suitable wastewater treatment plant.

10.117 Landfill gas generated within the waste will be collected and either vented to the atmosphere or flared.

10.118 A surface water management system will be established in the vicinity of the site and on going monitoring of surface water quality at the site will continue.

CONCLUSION

10.119 The “extensive” nature of farming enterprises in the immediate area reduces the likelihood of any individual animal’s health being compromised by activities at the landfill. By identifying potential hazards and implementing management systems as indicated above, the probability of such hazards being expressed will be reduced to a minimum. Details of the mitigating measures referred to above are to be found in Sections 7, 9, 10 and 12 of the body of the EIS.

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FIGURES

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- KEY:
- IMPROVED GRASSLAND
 - WET GRASSLAND
 - WET HEATH/ CUTOVER BOG
 - CALCAREOUS HEATH
 - REEDBED SWAMP
 - DITCH / STREAM / OPEN WATER
 - RICH FEN
 - SRCUB / HEDGEROW
 - TALL MATURE TREES

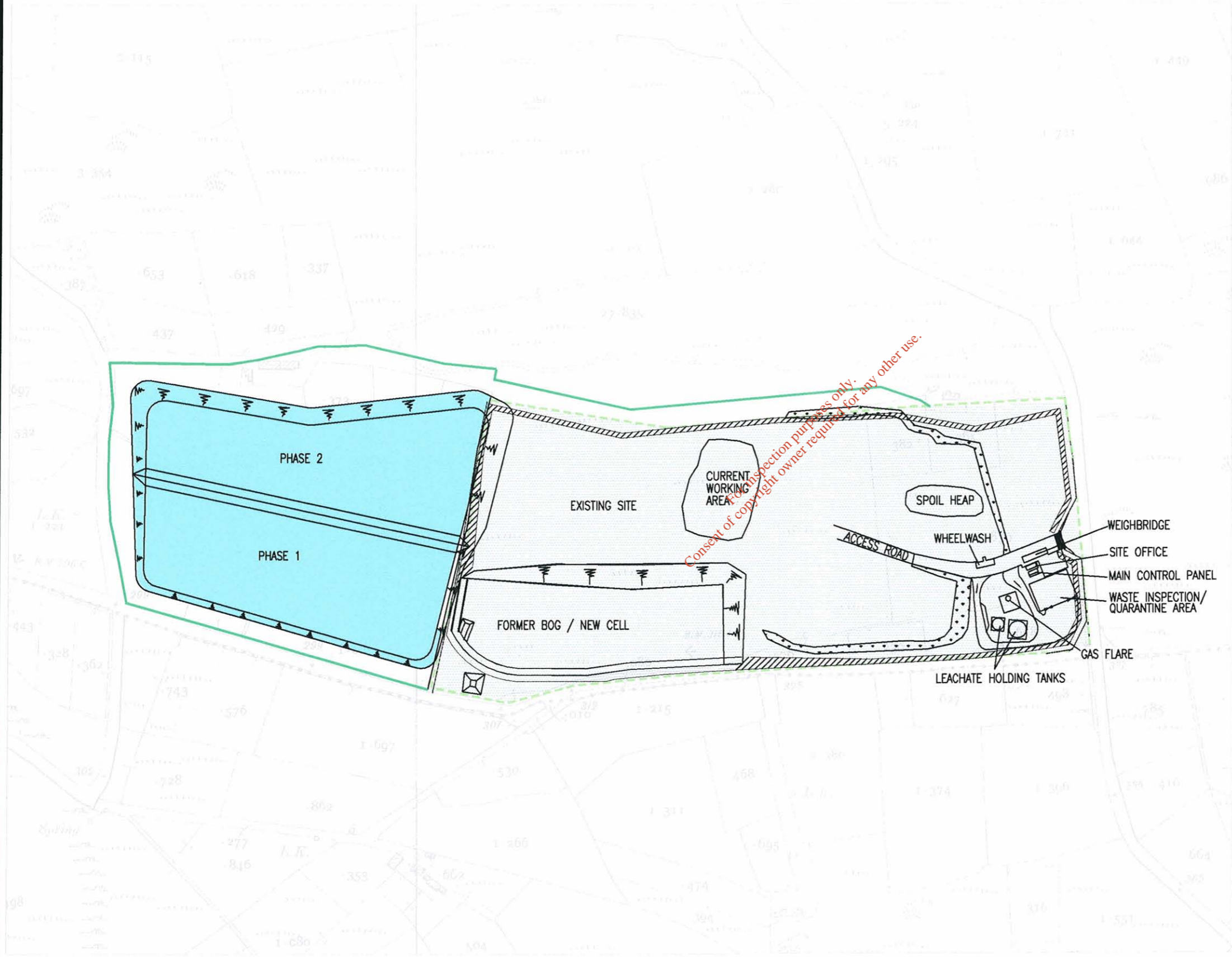
SCALE: 1:2500

 <p>KIRK McCLURE MORTON CONSULTING ENGINEERS</p>	 <p>Comhairle Chontae Dhún na nGall Dunegal County Council</p>
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PROJECT
BALLYNACARRICK LANDFILL PROJECT

TITLE HABITATS OF THE STUDY AREA	FIGURE 10.1
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- KEY
- BOUNDARY OF EXISTING LANDFILL
 - BOUNDARY OF PROPOSED EXTENSION
 - LIMIT OF PROPOSED LANDFILL EXTENSION
 - LIMIT OF EXISTING SITE

SCALE: 1:2500

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PROJECT
BALLYNACARRICK LANDFILL PROJECT

TITLE
SITE INFRASTRUCTURE &
OPERATIONAL LAYOUT

FIGURE
10.2

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KEY

- BALLYNACARRICK LANDFILL SITE
- SS5 SAMPLE SITE
- OTHER REFERENCE POINT ON STREAM CHANNEL (SEE TEXT SECTION 10.36)

SCALE 1: 20,000

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PROJECT
BALLYNACARRICK LANDFILL PROJECT

TITLE SAMPLE SITES FOR AQUATIC ECOLOGY	FIGURE 10.3
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11.0 GEOLOGY AND SOILS

INTRODUCTION

11.1 This section of the environmental impact statement examines the geological setting of Ballynacarrick Landfill site and its proposed extension. It describes the nature and distribution of the subsoil and bedrock stratigraphy that underlies the site and assesses the impact that the landfill extension site will have on geological features and soils in the locality, during the construction, operation and restoration of the waste disposal facility.

METHODOLOGY

11.2 The environmental impact of any landfill development is implicitly linked to the geological and hydrogeological setting of the site. The design of a landfill is therefore determined on a site specific basis, related to the characteristics of the prevailing ground conditions. Following this, in accordance with the requirements of the Environmental Protection Agency (EPA) Landfill Site Design Manual, the design of the proposed landfill extension at Ballynacarrick has been based on a detailed site investigation, the scope of which is outlined below.

11.3 The geological setting of the landfill was determined using a 3 stage approach:

- Desk Study
- Walkover Survey
- Site Investigation

11.4 A desk study review of the 1:100,000 scale bedrock series map (Sheet 3) and accompanying memoir for South Donegal published by the Geological Survey of Ireland was carried out to provide an indication of the structure, characteristics and stratigraphy of the bedrock formations and the location of geological features such as faults. A drift geological map for the area is not presently available, however a description of drift deposits is included in the geological memoir and a detailed description of the glacial sedimentology of the South Donegal area is given by McCabe (McCabe 1992).

11.5 In addition to the above, a walkover survey of the site and the surrounding areas was undertaken to establish the geomorphology of the landscape features and facilitate an assessment of the nature, thickness and distribution of the overburden deposits. This included an inspection of the structure and petrology of any evident bedrock exposures. The walkover survey was used to verify the preliminary desk study findings and plan follow-up intrusive ground investigations.

- 11.6 The ground conditions that underlie the site were investigated by a series of intrusive site investigations, that were undertaken for the Waste Licence Application of the existing landfill facility and the hydrogeological assessment and engineering design of the proposed extension. The scope of the various phases of exploratory works is outlined below and indicated by Figure 11.1.
- Stratex Ltd (1998) – 4Nr shell and auger boreholes in existing landfill
 - Glover Site Investigations Ltd (1999) – 3Nr rotary drilled boreholes at locations upgradient and downgradient of existing landfill
 - Kirk McClure Morton (2002) – 23Nr trial pits opened by mechanical excavator within the proposed landfill extension
 - Glover Site Investigations Ltd (2002) – 6Nr shell and auger boreholes, with 5Nr continued by rotary core drilling and 21Nr probeholes
- 11.7 The ground conditions were characterised in accordance with BS5930 the Code of Practice for Site Investigations. The exploratory boreholes were also used to recover samples for laboratory analysis and to facilitate in situ testing of the geotechnical and hydraulic properties of the subsoil and bedrock materials. Borehole standpipes were installed on completion of the borehole to facilitate groundwater monitoring and geochemical analysis of recovered samples. Descriptive borehole and trial pit logs and associated test results are included in Appendix E.

SITE DESCRIPTION

- 11.8 Ballynacarrick Landfill Site, is situated inland of the low lying coastal area of Donegal Bay in the marginal uplands to 'The Pullans' mountain range. The site is confined to a broad linear hollow that is surrounded by Ballynacarrick Hill to the west, Garvanagh Hill to the southwest and Ummeracom Hill to the south. The ground surface of the landfill hollow falls under a slight to moderate gradient in a westerly direction away from an area of blanket bog that is situated directly upgradient of the site access. The northern boundary of the landfill is flanked by a prominent linear ridge that rises to a maximum elevation of 103mOD some 20m beyond the site margins. Beyond this ridge the ground surface falls steeply through an elevation of some 10m into a low lying area of blanket bog that drains to the north west.
- 11.9 The proposed extension to the landfill encloses an area of approximately 3.5 hectares of unimproved agricultural land that extends some 200m from the western site margin of the existing site down the broad hollow. To the west the extension is bounded by a minor road beyond which the ground rises under a shallow gradient toward Ballynacarrick Hill with an elevation of 120mOD. The extension will be engineered as a fully lined containment landfill facility which will be divided into 2 phases of 2 cells. This will provide an estimated 8 ½ years additional disposal capacity at the current rate of waste input.

GEOLOGY

- 11.10 The geology of a site is generally characterised in terms of the nature and stratigraphy of the solid (bedrock) geology and the drift (overburden) geology.

The Regional Setting

- 11.11 The south Donegal region is generally reflected by two main landscape units, namely the lowland area surrounding Donegal Bay and surrounding upland area which extends between the 100mOD and 500mOD contours. The lowland areas define the extents of the Donegal syncline, a basin which represents a folded depression of the crust. As shown in Figure 11.2, this basin is underlain by limestones, shales and sandstones of the Lower Carboniferous Period. The outer margins of the basin are characterised by increasing relief that is underlain by coarse sandstones, grits and conglomerates which occur at the base of the Carboniferous sequence.
- 11.12 These sedimentary rocks rest on metamorphic rocks of the Dalradian and Monian formations which form the uplands of the region. The metamorphic rocks comprise of schists, quartzites, psammites and gneiss which are more resistant to weathering and erosion than the sedimentary Carboniferous rocks.
- 11.13 Numerous displacement faults occur across the region which trend in a predominantly west to southwesterly direction. There are also a significant number of subordinate southerly orientated faults associated with the main structural faults.
- 11.14 The drift geology of the region principally reflects the erosional and depositional effects of the last ice age which ended some 10,000 years ago. At this time an ice sheet, centered over the Barnesmore area, advanced southwestwards from the uplands into Donegal Bay, where it merged with other glaciers advancing from the Tyrone and Erne areas (Dury 1958). As the ice sheet advanced, thick accumulations of glacial drift were deposited in the low lying area surrounding Donegal Bay, which is dominated by drumlin landforms with heights of up to 50m in the Laghy and Ballintra area (McCabe 1992). However, on the margins of the upland area the drift cover is generally thin, discontinuous or absent.
- 11.15 In the study area the landscape is characterised by extensive areas of bare rock, low relief rock ridges orientated parallel to the direction of ice flow, with localised deposits of glacial till, characterised by smooth rounded hills and ridges within a number of valleys (McCabe 1992).

Solid Geology

11.16 The geological map for the area indicates that three principal rock formations underlie the proposed landfill extension as outlined below:

Carboniferous

- Lower Ballyshannon Formation (Muddy Limestone)
- Basal Ballyshannon Formation (Gritstone)

Monian

- Lough Derg Formation (Psammites)

11.17 Figure 11.2, indicates that Ballynacarrick Landfill Site is located on the eastern margins of the Donegal Bay syncline, where it crosses the structural unconformity between the Carboniferous strata (Ballyshannon Limestone) and the Monian strata (Lough Derg Psammites). The bedrock geology beneath the site was confirmed by an exploratory ground investigation. The distribution of the bedrock formations recorded by this investigation are shown in Figure 11.3 and described in more detail below.

11.18 The Lower Ballyshannon Formation comprises a sequence of muddy limestones divided by thin shales. These rocks outcrop in the western extents of the proposed landfill extension where they were exposed in a number of trial pits and boreholes. The strata are also exposed in a low cliff face that is located approximately 100m southwest of the crossroads that adjoin the landfill extension boundary. In this exposure the bedding is defined by medium to widely spaced planes that are inclined to the southwest at an angle of around 5°. The muddy limestones are generally considered to be unkarstified and groundwater flow is restricted to a slow circulation through cracks and fissures in the rocks. This was confirmed by an inspection of a number of intact cores of the rock recovered from boreholes put down in the extension. The rocks are classified by GSI as a locally important aquifer.

11.19 The muddy limestones are underlain by coarse gritstones of the Basal Ballyshannon Formation. These rocks outcrop in a broad band through the centre of the proposed extension area and are exposed at surface over the prominent spur of elevated ground which projects from the western boundary of the existing landfill. The strata, were also exposed in trial pit excavations where they were described as massive to thickly bedded units with medium to widely spaced joints that break the rockmass into very large tabular blocks with a typical 0.5m thickness.

11.20 The Monian Lough Derg Psammites are similar in character and appearance to the overlying gritstones as they are metamorphosed sandstones. They were exposed in a number of trial pit excavations and boreholes, opened close to the existing landfill boundary, and were described as a strong, pale grey, fine to coarse, slightly to moderately weathered schistose psammite with close to medium spaced joints.

11.21 A northeast to southwest trending fault, strikes along to the linear ridge that bounds the northern landfill margins. This fault offsets the rock formations that underlie the landfill against younger rocks assigned to the Upper Ballyshannon Limestone formation which outcrop to the north of the site beyond the linear ridge. The Upper Ballyshannon Formation typically comprises of massively bedded clean limestones that are free of shale bands. These clean limestones are often karstified, where dissolution of the rock by percolating groundwater leads to the formation of small voids and cavities, which can store and transmit large quantities of groundwater. The Upper Ballyshannon Limestone is therefore classified by the Geological Survey of Ireland (GSI) as a regionally important aquifer.

Drift Geology

11.22 On the basis of the ground investigation records the general stratigraphy of the drift geology is summarised sequentially below and illustrated by Figure 11.4.

- Peat [RECENT]
- Organic Clay [RECENT ALLUVIUM] – locally
- Stratified sand, silt and clay deposits [GLACIAL TILL] – locally
- Boulders [GLACIO-TECTONISED BEDROCK]
- ROCK

11.23 Peat deposits are widespread within the proposed extension area, where they range in thickness from 0m to 1.5m, with a mean of 0.5m.

11.24 The deposits are however thin or absent over the spur of elevated ground that protrudes from the existing landfill boundary. The greatest thickness was recorded locally in a 5m deep infilled depression in the rock surface that is centred on the southern boundary of the extension. Here the peat is underlain by alluvial deposits, comprising a bluish grey, organic silty clay. The peat and alluvial deposits are very soft and compressible and represent an inadequate foundation subsoil. They will therefore be excavated during the construction of the landfill cells.

11.25 Glacial deposits that underlie the recent subsoil are generally thin or absent within the greater site area, but increase in thickness below the linear ridge along the northern site boundary. Beneath the ridge the deposits range in thickness from 3m to 10m with a general increase in thickness to the east. The deposits reflect a stratified sequence of alternating medium dense sands, compact silts and firm to stiff clay horizons with variable stone contents. The bearing characteristics of the deposits indicate they would be a suitable substrate for the construction of the landfill banks. The compaction characteristics of the excavated materials also indicate it would be suitable for reuse as general fill in landfill bund earthworks.

- 11.26 In the low-lying western and southern areas of the site the rockhead surface and overlying glacial till is locally mantled by a layer of angular cobbles and large tabular shaped boulders. The nature of this deposit apparently reflects the in situ fracturing of the rock by the advancing ice sheet and its localised rafting over the glacial till that mantles the rock surface. This material will be excavated during construction of the landfill cells and may be reused as aggregate fill following its crushing.

SOILS

- 11.27 The proposed extension area is mantled by peaty topsoils that are classified as surface water gleys of wetness class 3 (SWG3). Peat is formed from the anerobic decay of plant materials leached of minerals and nutrients in saturated ground conditions. The deposits are associated with very poor drainage conditions and are typically waterlogged for most of the year, being fully saturated to ground surface. In agricultural terms the soils are of very poor amenity being generally only suitable for rough grazing purposes. The textural limitations of the soil also inhibits any attempt to improve the drainage of the material.

PROPOSED DEVELOPMENT

- 11.28 The ground conditions underlying the proposed site are geotechnically suitable for its development as a landfill and any subsoil materials requiring excavation will either be deployed directly in engineered earthworks or stored on-site in material stockpiles for reuse in landscaping and restoration operations, are detailed below.

Site Construction

- 11.29 During the development of each of the phases of the landfill, construction will begin by stripping the topsoil and excavating compressible deposits. The excavated topsoil will be stored in the existing landfill development and allowed to drain. If the material is suitable for reuse in landscaping operations it will be re-used as a soil improver in restored areas. Any unsuitable materials will be spread over non-structural areas in the existing landfill.
- 11.30 Following the topsoil stripping operations glacial subsoils above formation levels will be excavated to expose the rockhead surface. The glacial deposits that underlie the northern ridgeline will also be excavated to formation level and the exposed surface graded and prepared to receive the side slope lining system. The materials produced by these excavations, will be used to construct containment and landscaping bunds around the landfill extension. Along the northern boundary of the site as much of the glacial subsoils as possible (between 3-10 m) will be left in place.

11.31 Rockhead levels will then be excavated to reduce the ground surface to the proposed formation surface for the landfill. This will necessitate hydraulic breaking and ripping to loosen the rock for excavation. In addition a limited amount of controlled blasting may be necessary to mechanically fracture and loosen the rock. If the rock material produced by these breaking processes are of a suitable size, they will be processed by crushing and grading operations for reuse as aggregate materials in the construction of drainage and engineering works.

Site Operation

11.32 Any suitable material generated during the development of site will be used as cover material or in the case of the peaty topsoil, as a soil improver for the final restoration layer. Some imported materials such as quarry dust or sand imported from the locality will be stockpiled, within the landfill area or in adjacent phases, to ensure continuity of supply for covering on site.

11.33 The quantities of cover materials required are estimated to be approximately 15-20% of the waste input, equating to between 3,600-4,800 tonnes/year. These stockpiles could also be used to construct temporary bunds or as emergency cover material during high wind conditions.

11.34 Any stockpiles of soil material that are not for immediate use will be planted with grass seed to reduce the possibility of dust production.

IMPACTS AND MITIGATING MEASURES

Impacts

11.35 The construction of a landfill by the excavation of cells and formation of bunds has the potential to destroy any features of geological interest that may exist within the site.

11.36 Notwithstanding the above, bedrock exposures within the site are poor in quality, being limited to patchy outcrops that penetrate the veneer of drift deposits. Geological outcrops of more significance are exposed in the surrounding areas and are common throughout the region.

11.37 The bedrock exposures within the site would not therefore constitute features of special geological or scientific interest. In addition no mineral assemblages of economic importance are known to be associated with the sedimentary and metamorphic rock formations that outcrop within the site.

- 11.38 No drift exposures or geomorphic landforms of significant interest were identified during the walkover survey and exploratory investigation of the site. Consequently the site would not be considered as one of special interest with respect to Quaternary geology.
- 11.39 On this basis the construction of the landfill extension and resultant loss of geological exposures would not represent a significant environmental impact. All excavated materials will be reused in the construction of engineered earthworks, landfill restoration and landscaping operations.
- 11.40 The development of the landfill site extension will inevitably lead to the disturbance and/or loss of soil over an area of 3.5 hectares. However, the waterlogged peaty gley soils found over the site are of limited agricultural use, being generally only suitable for rough grazing. Therefore the loss of the soils over the area will not be significant in terms of the quality of the land or proportional loss of these types of soils in the area.

Mitigating Measures

- 11.41 Improper storage of soils can cause damage to the soil's integrity and processes. The topsoil will be stored in a heap no higher than 3m, to prevent excessive compaction, and will be re-used as soon as practicable. The stored topsoil will be kept free from the passage of vehicles and intermixing with other materials.
- 11.42 To mitigate the effects of wetting and weathering on the workability and mechanical properties on excavated subsoils, the materials will either be reused directly in engineered earthworks or deposited in stockpiles with graded banks to promote surface run-off. These will be sited away from streams to avoid their potential siltation.

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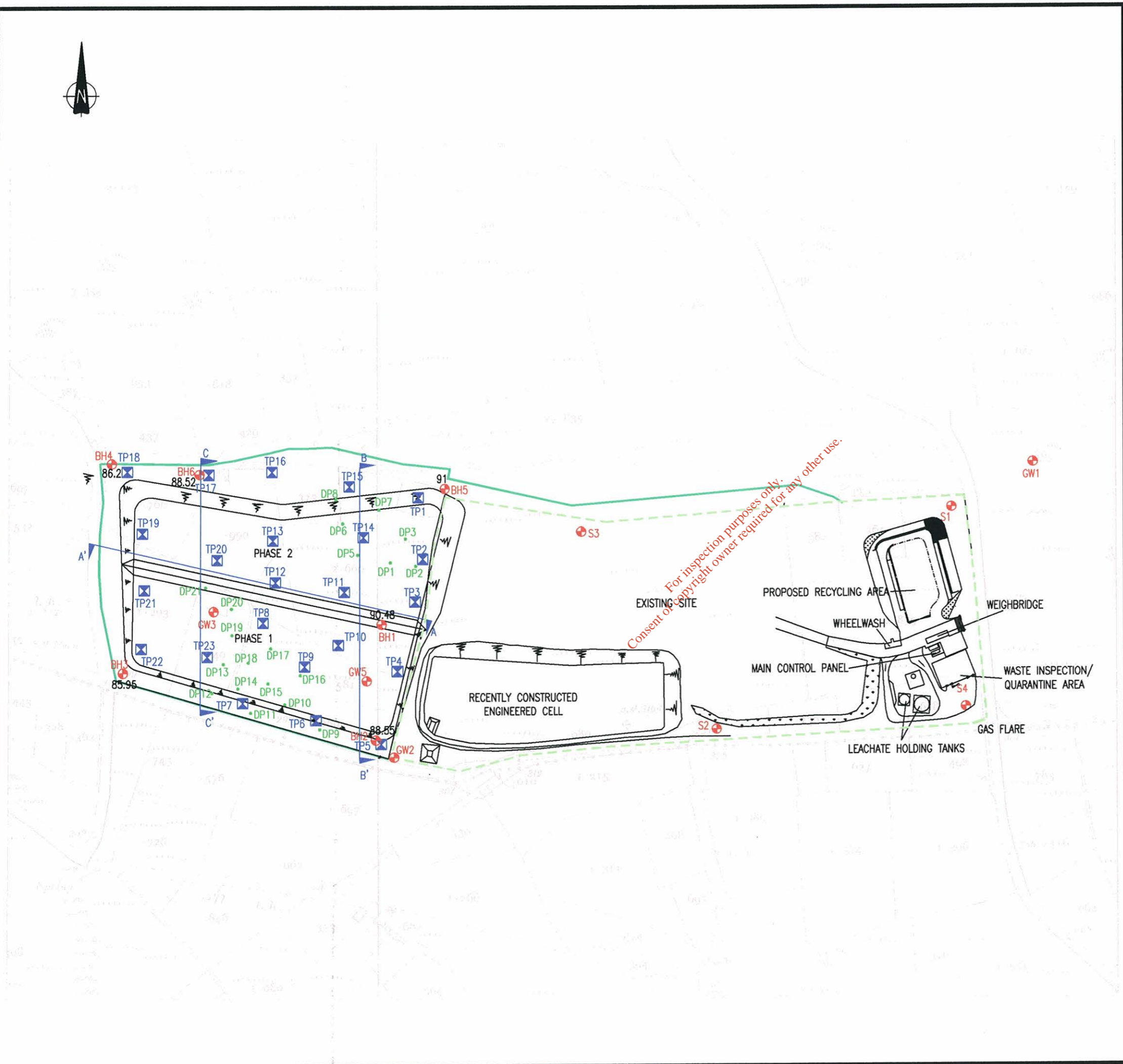
Glacial Morphology of the Blue Stalk Area, Donegal. Dury G M (1958). Irish Geography Chapter 3

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FIGURES

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KEY

- BOUNDARY OF EXISTING LANDFILL
- BOUNDARY OF PROPOSED EXTENSION
- ⊠ TRIAL PIT KMM 2002
- ⊕ BOREHOLE
 - S1 TO S4 STRATEX LTD. 1996
 - GW1 TO GW3 GLOVERS LTD. 1999
 - BH1 TO BH6 GLOVERS LTD. 2002
- DYNAMIC PROBE GLOVERS 2002

SCALE: 1:2500

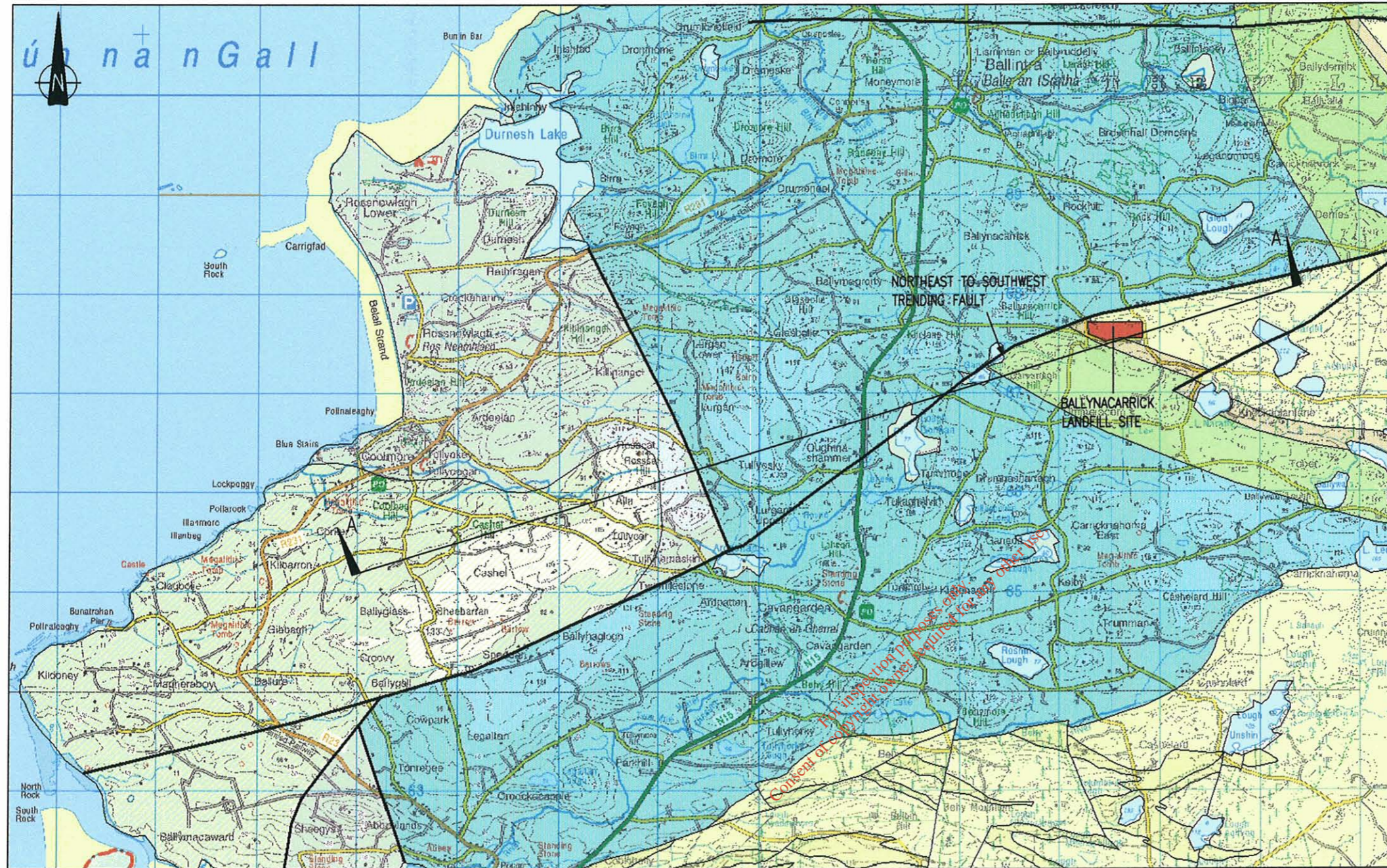


PROJECT
BALLYNACARRICK LANDFILL PROJECT

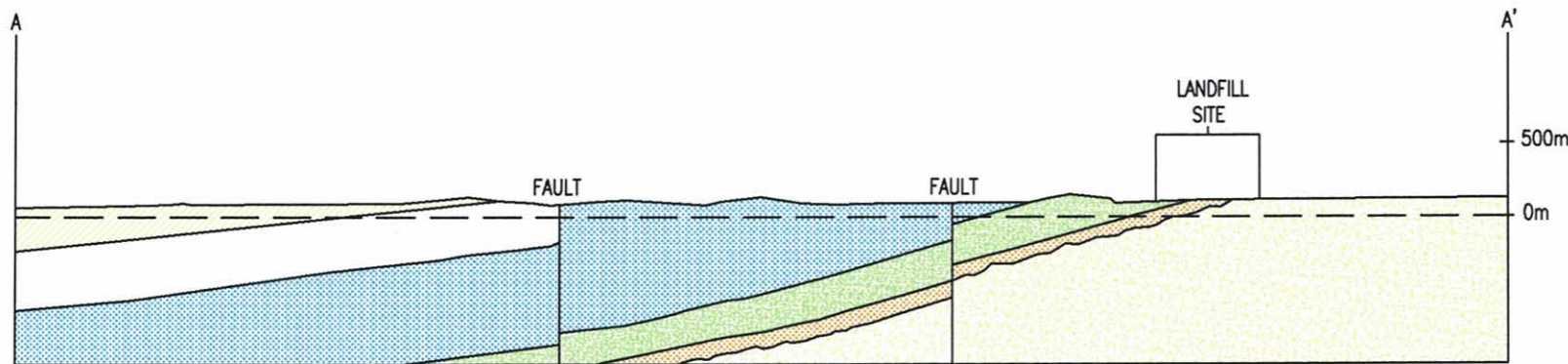
TITLE
SITE INVESTIGATION PLAN

FIGURE
11.1

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- KEY
- MULLAGHMORE SANDSTONE
 - BUNDORAN SHALE
 - UPPER BALLYSHANNON FORMATION - LIMESTONE
 - LOWER BALLYSHANNON FORMATION - MUDDY LIMESTONE AND CALCITIC SHALES
 - BASAL BALLYSHANNON FORMATION - GRITSTONES, SANDSTONES, LIMESTONES AND SHALES
 - SEMI-PELTIC BIOTITE SCHIST
 - LOUGH DERG PSAMMITE
 - FAULT



GEOLOGICAL SECTION

HORIZONTAL SCALE 1:50,000

VERTICAL SCALE 1:50,000

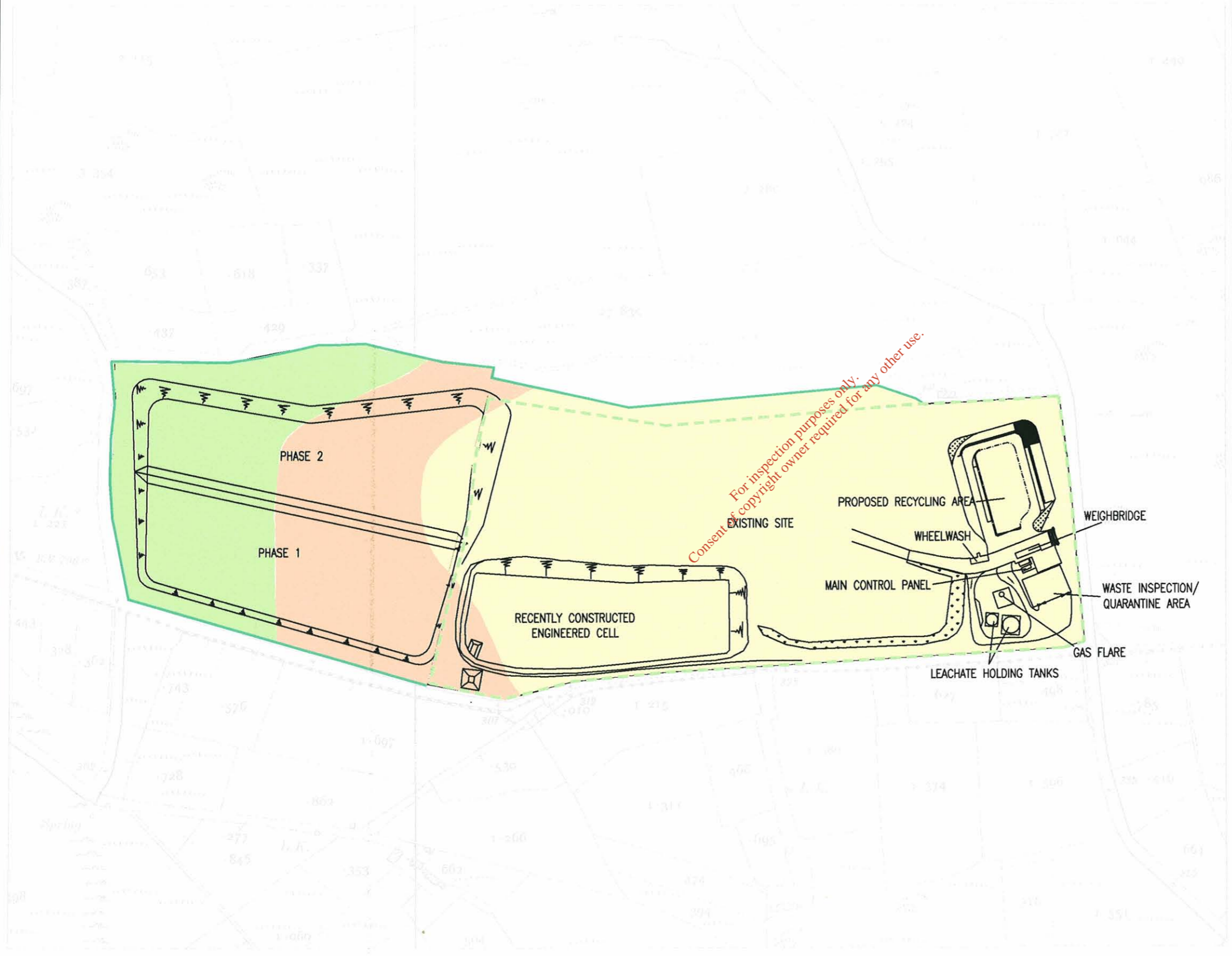
SCALE: 1:50 000

<p>KIRK McCLURE MORTON CONSULTING ENGINEERS</p>	<p>Comhairle Chontae Dhún na nGall Donegal County Council</p>
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PROJECT
BALLYNACARRICK LANDFILL PROJECT

<p>TITLE SOLID GEOLOGY MAP AND SECTION</p>	<p>FIGURE 11.2</p>
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- KEY
- BOUNDARY OF EXISTING LANDFILL
 - BOUNDARY OF PROPOSED EXTENSION
 - LOWER BALLYSHANNON FORMATION (MUDDY LIMESTONE)
 - BASAL BALLYSHANNON FORMATION (GRITSTONE)
 - LOUGH DERG PSAMMITES

SCALE: 1:2500

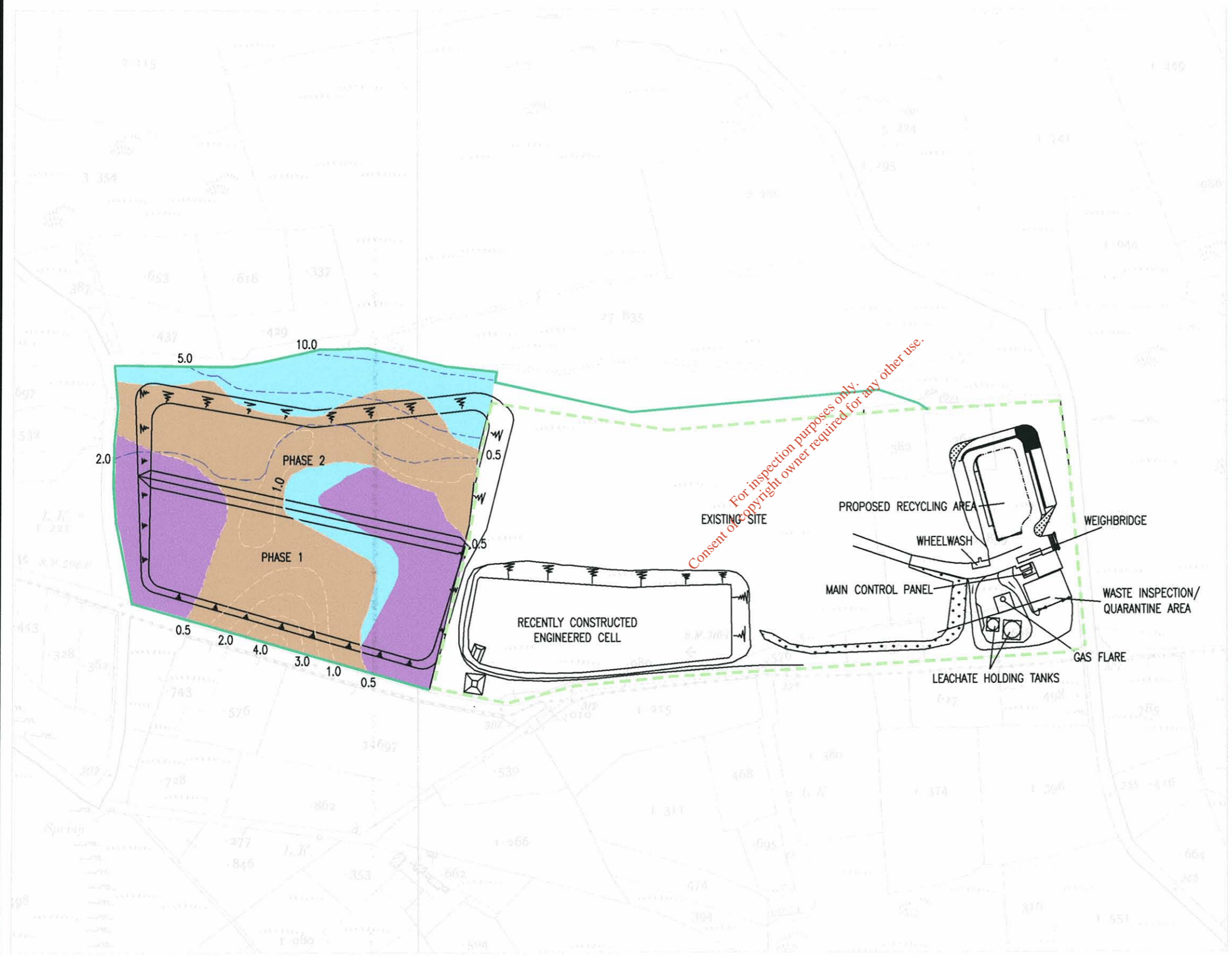
 KIRK McCLURE MORTON CONSULTING ENGINEERS	 Comhairle Chontae Dhún na nGall Donegal County Council
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PROJECT
BALLYNACARRICK LANDFILL PROJECT

TITLE
SOLID GEOLOGY PLAN

FIGURE
11.3

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- KEY
- BOUNDARY OF EXISTING LANDFILL
 - BOUNDARY OF PROPOSED EXTENSION
 - PEAT ISOPACHYTE CONTOUR
 - GLACIAL TILL ISOPACHYTE CONTOUR
 - PEAT
 - GLACIAL TILL AT OR NEAR SURFACE
 - ROCK

SCALE: 1:2500

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PROJECT

BALLYNACARRICK LANDFILL PROJECT

TITLE

DRIFT GEOLOGY PLAN

FIGURE

11.4

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12.0 HYDROLOGY

INTRODUCTION

12.1 This Section of the Environmental Statement discusses, firstly, the existing surface water regime in the Ballynacarrick area, secondly, the impact of the development on the quantity and quality of the surface water regime, and thirdly, how potentially adverse impacts of the development can be mitigated against. The section outlining mitigation measures is based upon the guidelines prepared by the Environmental Protection Agency (EPA 2000 & 2001). Datasets regarding the watercourses were gathered from Environmental Protection Agency and Donegal County Council water quality monitoring regimes, Ordnance Survey maps, hydrometric information (provided by the Office of Public Works and EPA), climate data (from Met Éireann) and on-site surveys and data collection exercises.

PHYSICAL CHARACTERISTICS – RELIEF, DRAINAGE AND SOIL COVER

- 12.2 The study area is situated in a region of extreme Blanket Bog, which is bounded by an area of elevated relief to the south and east of the site. The topography of the site varies between 86m - 96m in elevation. The highest point is the north-eastern corner of the site with the ground falling away to the west.
- 12.3 The surface area of the catchment at the downstream limit of the proposed site is 0.45km² as presented in Figure 12.1.
- 12.4 Surface gradients in the study area are generally low with a slight fall towards the west.
- 12.5 The drainage of the soils within the Study Area is influenced by the high water table and the impermeable underlying drift deposits (boulder clay). The soil cover material at the site is classified as a Blanket Peat, which is typically characterised by poor drainage (i.e. low infiltration and predominantly surface runoff). The study area is drained by a network of natural and man-made surface and sub-surface watercourses.
- 12.6 The area of Blanket Bog to the East of the landfill site is drained by linear man-made drainage ditches, which have been cut into the peat. Flows in these ditches are low as are water volumes. Ultimately drainage channels from this area combine and discharge into a culverted pipeline to the south-eastern boundary of the site. The subsurface culvert allows the upstream watercourse to pass through the site. The culverted section enters a surface water lagoon at the south-western corner of the existing landfill as presented in Figure 12.2. Surface water from the lagoon discharges to an unnamed watercourse which flows to the south of the site.

Existing Landfill

- 12.7 Surface water run-off at the existing operational landfill site is relatively low in volume as surface water infiltrates the landfill to form leachate. Leachate is collected at the existing landfill through the installation of a vertical pumping drain system. The collected leachate is transported to a local Waste Water Treatment plant for treatment. This system will help limit the volume of leachate escaping to the adjacent watercourse.

Proposed Extension

- 12.8 Surface water at the site of the proposed extension generally drains in a westerly direction into a small watercourse, which flows through the lower quadrant of the site.
- 12.9 The watercourse is a small stream less than 1m in width at its lower end. The stream rises to the East of the site in an area of Blanket Bog. Downstream of the proposed extension the watercourse alternates between surface and sub-surface flow; a typical feature of Karst hydrogeology. Surface water draining from the proposed extension finally discharges to Durnesh Lake 5-6km away, as presented in Figure 12.3.
- 12.10 The intermittent manner in which the watercourse varies between surface and subsurface flow created difficulty in defining the specific drainage path which the watercourse undertakes. However, a dye test undertaken by Donegal County Council in March 2003 (KMM, 2003) demonstrated that surface water from the study area enters Durnesh Lake at its southern boundary west of Foyagh Bridge. A GPS device was used to accurately determine the grid co-ordinates of the watercourse.
- 12.11 Lake Durnesh is a candidate Special Area of Conservation (cSAC).
- 12.12 The watercourses downstream of the landfill are not used as surface water drinking supplies for human consumption.

RAINFALL

- 12.13 Rainfall data for 56 stations within Co Donegal are available from the Meteorological Office, Dublin. The location of each of the rain gauges is shown in Figure 12.4. The mean annual rainfall for County Donegal is mapped on Figure 12.5.
- 12.14 The average annual rainfall at the study area is generally within the range 1200 to 1400mm. Spatial variations in rainfall are noted across the County, with the highest rainfall expected to occur in the upland regions (>2600mm in the central plain area) and the lowest within the eastern area of the catchment (967mm at Newtowncunningham).

12.15 Met Éireann provided mean monthly potential evapotranspiration data, for the period 1968-1997, for Malin Head. The total mean annual loss is estimated at 577mm.

RIVER FLOWS

12.16 River flows in the Donegal Bay Catchment are currently monitored at 5 recording/gauging stations operated by the ESB and Donegal County Council. The locations of the hydrometric stations (active and inactive) in the Donegal Bay Catchment are presented in Figure 12.6.

12.17 The hydrological characteristics of the nearest gauging station, on the Bridgetown River (Station no. 37009), were used to verify estimated flows for the river at Ballynacarrick. The flow characteristics resulting from the hydrological analysis are summarised in Tables 12.1 and Table 12.2.

Table 12.1 Comparison of Storm Flows

River	Flow (1:5 Yr)	
	m ³ /s	m ³ /s per 100 km ²
Bridgetown	21	70
Ballynacarrick	0.4	88

12.18 Flow estimation for the 1:5 year storm discharge at Ballynacarrick compares favourably with the recorded flow of equivalent return period on the Bridgetown river.

Table 12.2 Comparison of Low Flows

River	Flow Q95 (10)	
	m ³ /s	m ³ /s per 100 km ²
Bridgetown	0.11	0.36
Ballynacarrick	0.002	0.48

12.19 Low Flow estimation, Q95 (10), for the watercourse at Ballynacarrick yields flows similar to the recorded Low Flows on the Bridgetown River.

12.20 The allocation of effective rainfall between surface runoff and groundwater largely depends on the nature of the surface water material and relief. Geological assessment has established the presence of drift material at the study area. Consequently the upper reaches of the river system are expected to respond rapidly to both rainfall and drought periods and are referred to as 'flashy' in character.

WATER QUALITY

Biological Water Quality

12.21 A detailed analysis of the aquatic ecology was undertaken within Section 10 of the Environment Impact Statement (EIS). The status of the aquatic ecology was used to make an assessment of the corresponding biological water quality based upon the Irish biotic score index, Q rating. (Flanagan and Toner, 1972; McGarrigle et al., 1992). Results of the analysis showed that biological water quality improved from 'Seriously Polluted' (Q1) 10-15 m downstream of the existing landfill site, to 'Moderately Polluted' (Q3) 150m upstream of where the watercourse enters Durnesh Lake.

Chemical Water Quality

12.22 A comprehensive analysis of the chemical quality of the surface water from the Ballynacarrick Landfill site has also been undertaken within Section 10 of the EIS. Chemical data was sourced from the Annual Environmental Report for Ballynacarrick Landfill site (2002) and Northern Regional Fisheries Board (1998). Results of the Chemical analysis showed that surface water was 'considerably polluted' immediately downstream of the landfill. However, the chemical status of the surface water changed to 'moderately polluted' 3 km further downstream.

POTENTIAL IMPACTS

12.23 This section identifies the predicted impact of both the proposed extension and the existing landfill in comparison to the 'do-nothing' scenario. The impacts of the quantity and quality of surface waters are considered in accordance with guidelines prepared by the EPA. Mitigation measures with regard to surface water are discussed in the following section. The impact of leachate leakage on surface water is considered in Section 13. Surface water assessment considers the portion of incident rainfall that falls upon the landfill cap or lining system and drains to the surrounding watercourses. The limited portion of rainfall, which may penetrate the landfill system, is separately collected as leachate and treated prior to disposal.

COMPARISON OF IMPACTS

Do-nothing Impacts (Proposed Extension)

12.24 The existing land-use of the proposed landfill extension is pastoral farmland. Agricultural pollution can potentially have a significant influence on the physical and chemical characteristics of adjacent watercourses, influencing water quality, water yield and fishery status. Potential impacts can include:

- increased rate of surface run-off due to drainage;
- contamination from fertilisers;
- increase in suspended solids due to ploughing.

12.25 The increased load of phosphorus in streams derived from artificial fertilisers is of particular concern to water quality in Ireland. Environmental quality standards and objectives have been proposed in "Managing Ireland's Rivers and Lakes" (DoE, 1997) to reverse this trend in declining water quality in freshwater courses.

Do-nothing Impacts (Existing Landfill)

12.26 Landfill sites can potentially have a significant influence on water quality of adjacent watercourses. Of greatest concern with respect to the existing landfill site at Ballynacarrick is the potential escape of leachate to local watercourses. Ballynacarrick landfill site is currently uncapped. Analysis of local surface water quality has demonstrated that water quality adjacent to the site has been unsatisfactory in the past. However, Donegal County Council has recently undertaken remedial measures at the site which are designed to remove leachate at source. These measures will improve the overall environmental performance of the site.

PREDICTED IMPACTS

12.27 The predicted impacts from both the existing landfill and the proposed extension are considered with respect to the short-term and long-term consequences.

12.28 It is proposed to cap the existing landfill in the near future.

12.29 The proposed extension to the landfill will be developed as a containment site and the volume of leachate escaping to the local watercourses will be negligible. The extension will be operated in a series of four cells. The entire site will initially be cleared (3-4 weeks) after which individual cells shall be progressively lined, filled and temporarily capped. Final capping and permanent reinstatement will occur on a phased approach as discussed in Section 8.

SHORT TERM IMPACT (CONSTRUCTION AND OPERATION)

Existing Landfill

- 12.30 Prior to the capping of the existing landfill, leachate generation will continue. This will result in the potential for leachate to escape to local watercourses. The installation of a leachate collection system should however significantly reduce the volume of leachate which can escape from the site.

Proposed Extension

- 12.31 During the initial construction phase, when the entire site will be exposed, incident rainfall could, as a worst case, collect sediment from the clay/rock material which forms the base of the site. This could directly impact upon the water quality of local watercourses due to high suspended solid levels. If proprietary geo-textiles are used to cover the site instead of inert clays, this would result in a minimal sediment transport.
- 12.32 During the operational phase surface water run-off from the site is expected to be negligible. Incident rainfall will infiltrate the landfill material where it shall be collected by the leachate collection system.
- 12.33 As the cells are finally capped, topsoil and grass seed will be applied as the final surface finish. Grass establishment will depend upon the time of year that the cell is completed. It is also envisaged that hedgerows and trees will be planted to provide the site with a natural appearance. Slightly increased levels of suspended solids are likely until grass/pasture is established. The soil cap and surface gradient will produce similar surface run-off characteristics to the present condition.
- 12.34 Manning's equation was used to model the effect of the proposed extension on stream water levels. Results indicated an additional 6mm of stage during the design event compared to the existing regime. However, the loss of cover will slightly reduce evapotranspiration loss and 'on-branch' storage resulting in moderately increased peak run-off rates until the grass/pasture and soil structure becomes well established. The overall impact upon surface water quantity is therefore not considered to be significant.

LONG TERM IMPACTS (POST OPERATION)

- 12.35 Once the grass/pasture land is established post operation there is likely to be minimal long-term impact at either the existing landfill or the proposed extension. Sediment/suspended solid levels will be low level and runoff characteristics will be similar to the existing regime

WORST CASE SCENARIO

- 12.36 The most extreme event which could significantly impact upon the quality and quantity of surface water would be a severe rainfall event during the initial site clearance operations at the proposed extension. This would generate high suspended solids concentration in run-off to the stream, however, the stream flow itself will have increased during the event yielding significant dilution. The mitigation measures detailed below will be designed to cope with a severe design storm event.
- 12.37 A high rainfall event during the operational phase would infiltrate the landfill material and be collected by the leachate collecting system thus resulting in a minimal adverse impact.
- 12.38 With the case of drought conditions low flows in the river will coincide with low run-off from the site. This will result in low suspended solid concentrations in the stream. Mitigating measures to reduce suspended solid concentrations from the site are also discussed below.

MITIGATION MEASURES

- 12.39 An improved surface water management system will be established in the vicinity of the site to minimise the impacts on water quality in the adjacent watercourses. Design of the surface water management system will also consider the need to minimise adverse impacts on the National Heritage Areas in the vicinity of the site.
- 12.40 A cut-off drain will be excavated around the perimeter of the entire site, including the extension. It will be designed to collect the clean surface water which will run-off from both the capping layers of the landfill and the surrounding catchment.
- 12.41 Surface water from the upstream catchment is currently culverted through the landfill. It is envisaged that water discharging from the culverted section will enter the surface water collection pipeline along the southern boundary of the site. The surface water collection pipeline will be designed to accommodate a realignment of the existing stream, which currently passes through the area of the proposed extension. The extension will consist of a perforated pipeline, which will terminate along the western boundary of the site where the piped stream will merge with the downstream tributary system.

- 12.42 During the construction period it will be necessary to install a storm water collection system. The system will be designed to carry flows (including the 1:25 year design event) from the landfill cells to the storage lagoon. The storage lagoon will be designed for 1:25 year design events and will fulfil two purposes:
- During storm events the outflow from the site will be controlled so that the storage lagoon and collection system will provide storage volume so as to reduce peak flows to the adjacent watercourse; and
 - In average/low flows the storage lagoon and collection system will retain flows allowing sediments to settle out, reducing loadings to the watercourse.
- 12.43 Post-operation the lagoon will not be required as the site will be returned to its original condition and run-off characteristics will be similar to the existing regime.
- 12.44 The ongoing monitoring of surface water quality at the landfill site will be continued, ensuring effective management of the drainage system. The programme will be agreed with the EPA.
- 12.45 The facility will be managed and operated so that capping and permanent grassed reinstatement will be carried out as soon as possible after the extension has reached capacity. This will reduce the area which has not been reinstated and this could increase suspended solid load to the river. Material from the newly excavated cells will be recycled and used to form the capping layer.
- 12.46 Earth-bunds will be constructed between the site and the adjacent cut-off drain to prevent surface water flooding of the facility caused by increased storm water levels in the cut-off drain.
- 12.47 The drainage system of the proposed extension will be designed to ensure that surface water from paved maintenance and fuelling areas will pass through oil interceptors. Similar drainage provisions currently exist at the operational landfill.

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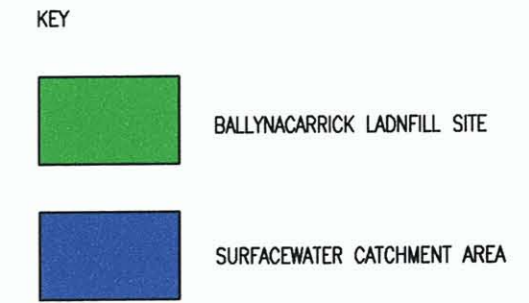
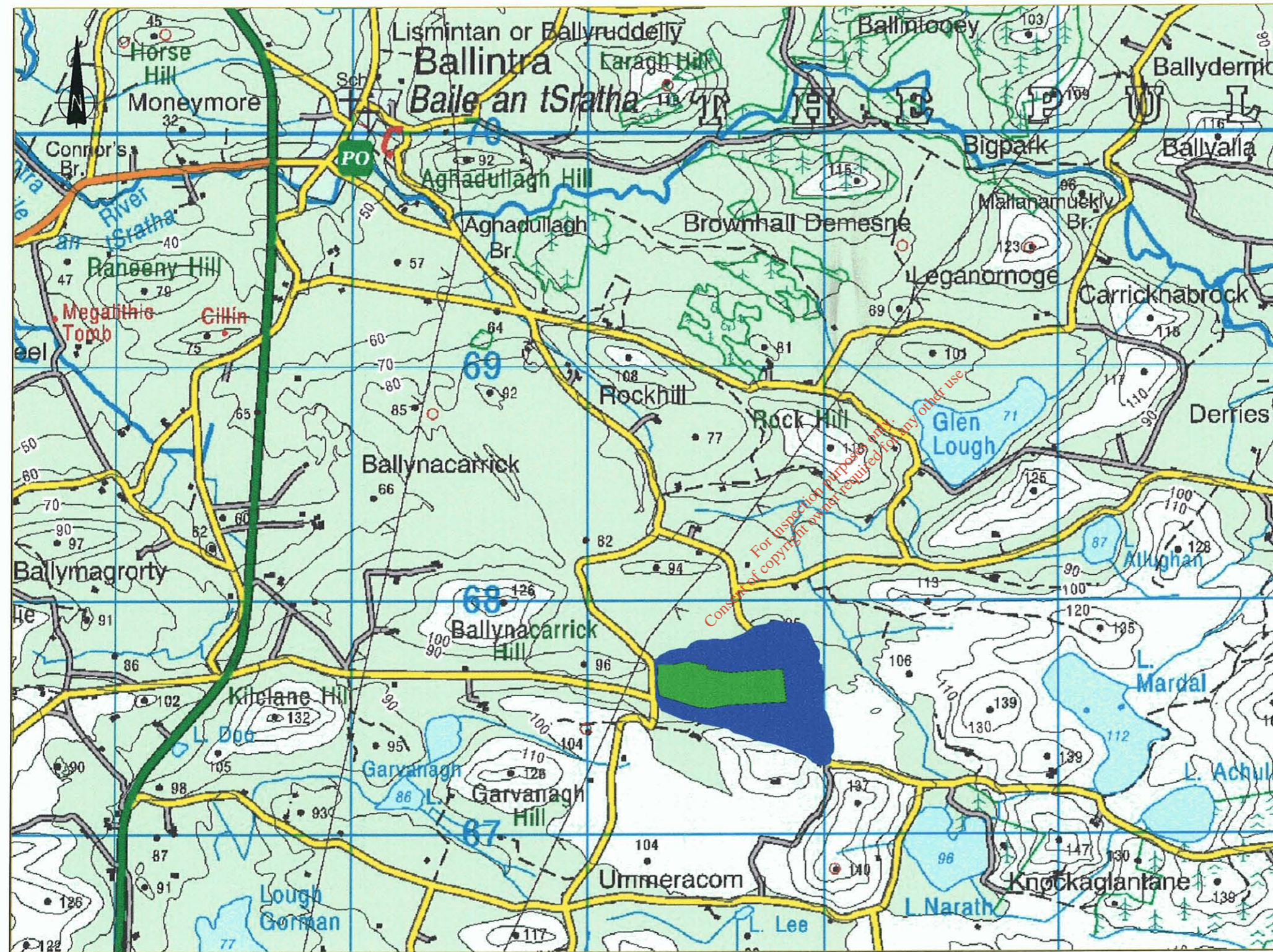
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FIGURES

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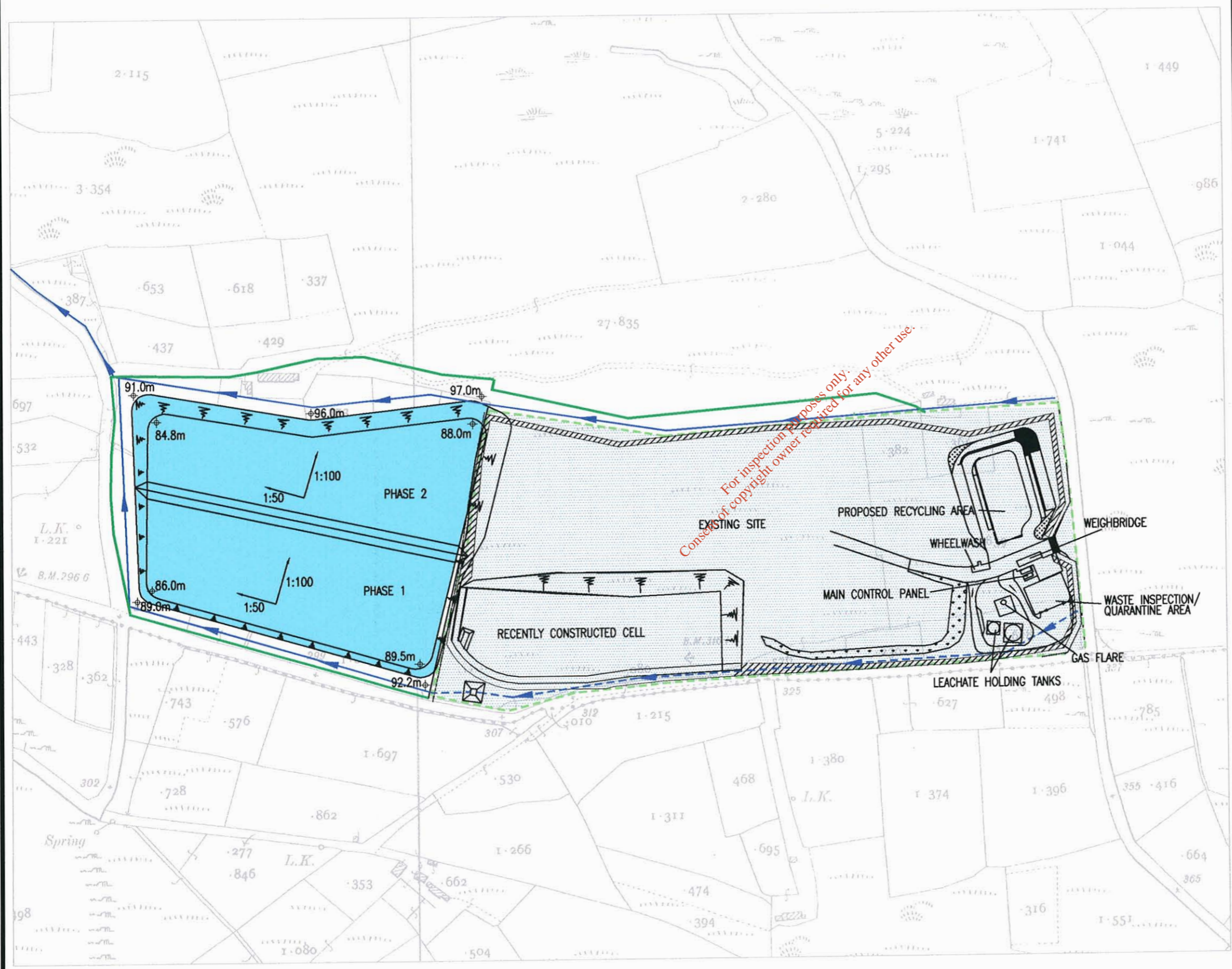
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PROJECT
 BALLYNACARRICK LANDFILL PROJECT

TITLE SURFACE WATER CATCHMENT AREA	FIGURE 12.1
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- KEY**
- BOUNDARY OF EXISTING LANDFILL
 - BOUNDARY OF PROPOSED EXTENSION
 - LIMIT OF PROPOSED LANDFILL EXTENSION
 - ▶ SURFACE WATER DRAINAGE PIPELINE
 - ▶ SURFACE WATER PIPED DIVERSION
 - LIMIT OF EXISTING SITE
 - ⊕ 84.8m FORMATION LEVELS

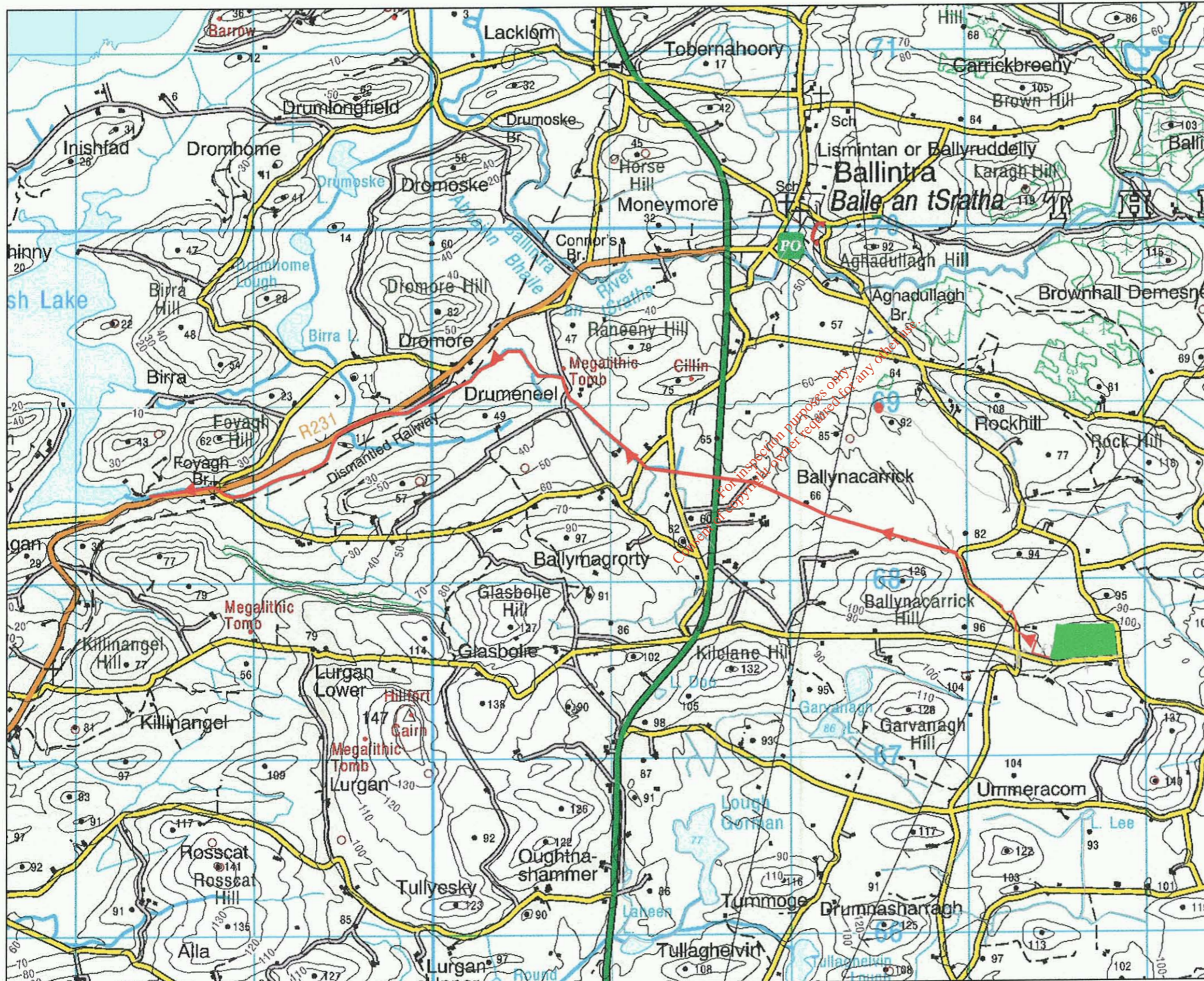
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PROJECT
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TITLE SURFACE WATER MANAGEMENT	FIGURE 12.2
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KEY



BALLYNACARRICK LANDFILL SITE



WATERCOURSE

SCALE 1:25,000



PROJECT

BALLYNACARRICK LANDFILL PROJECT

TITLE

SURFACE WATER
DRAINAGE LAYOUT

FIGURE

12.3

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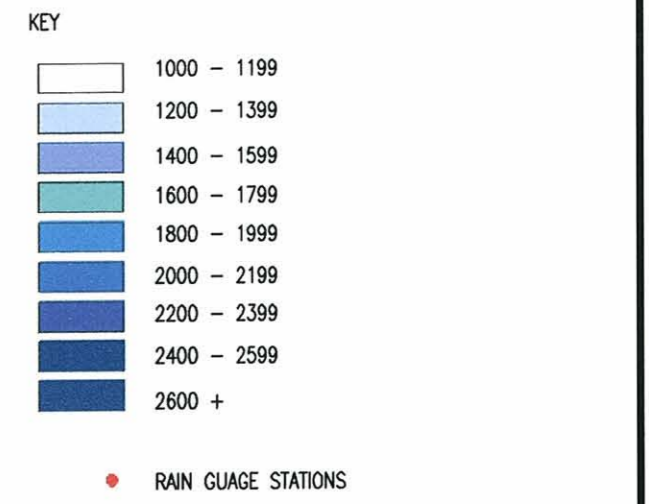
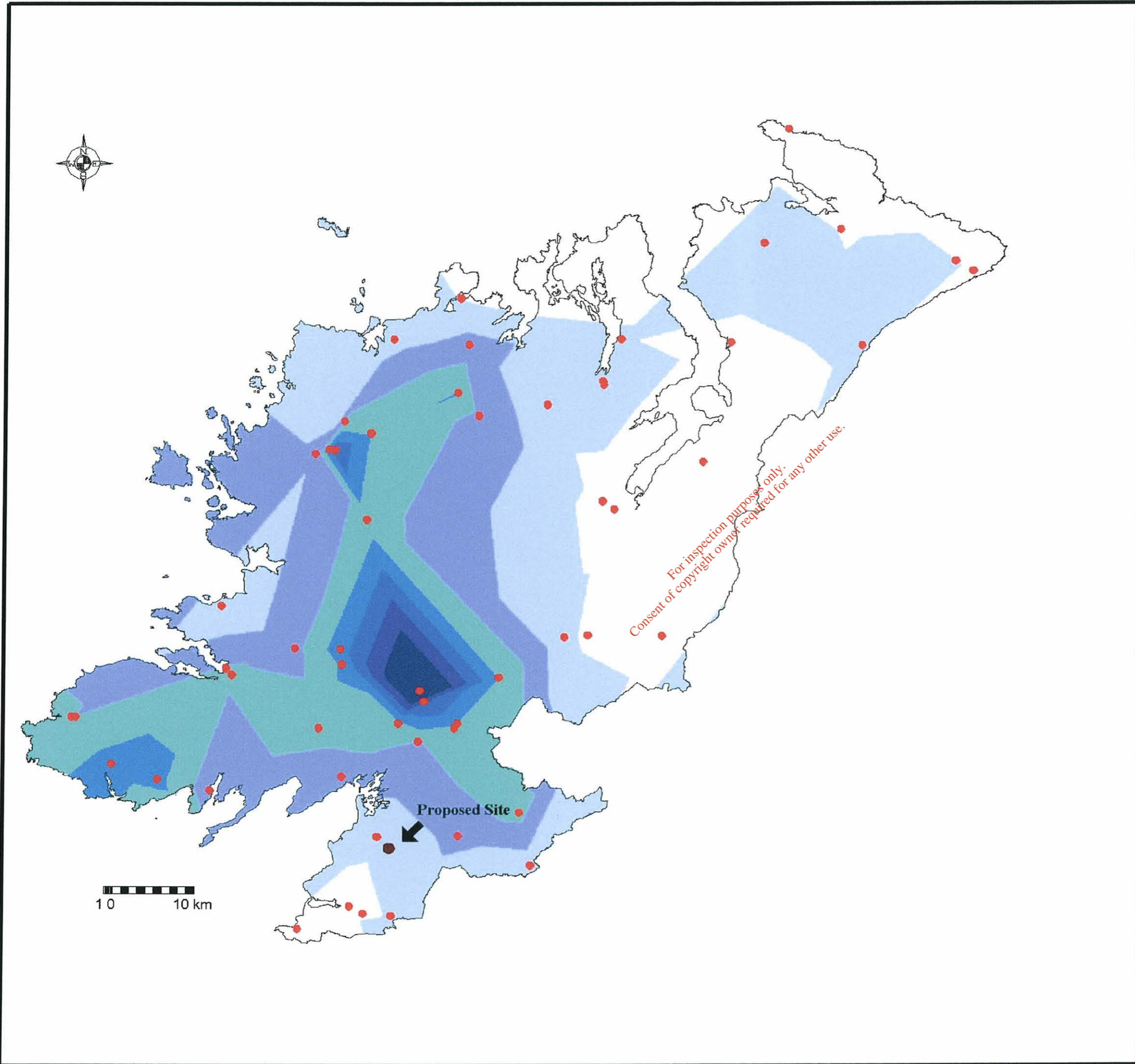
- KEY
- △ RAIN GAUGE STATIONS
 - TOWNS
 - PROPOSED LANDFILL SITE (BALLYNACARRICK)

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PROJECT
BALLYNACARRICK LANDFILL PROJECT

TITLE LOCATION OF RAIN GAUGES	FIGURE 12.4
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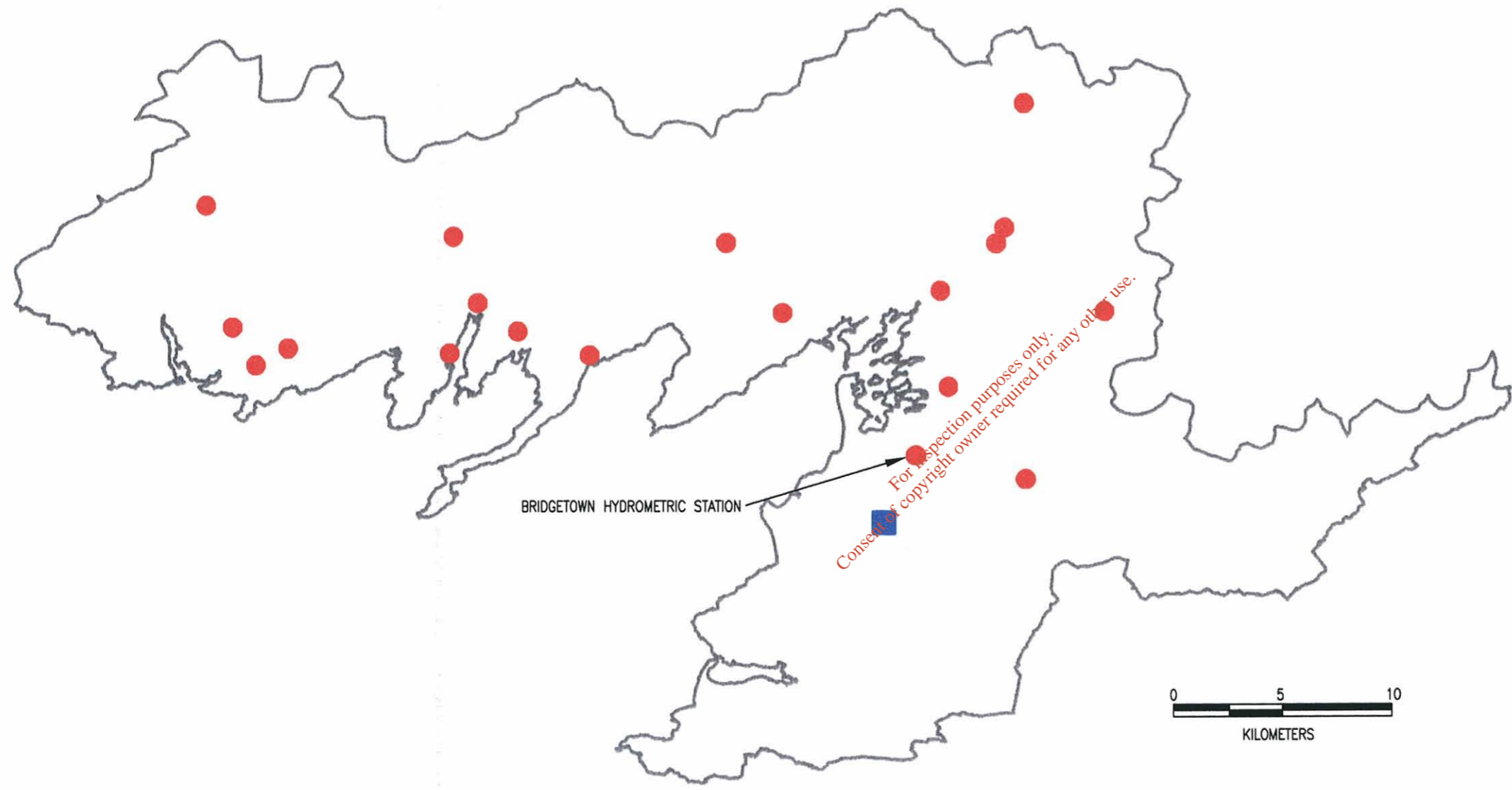
THE SITE AT BALLYNACARRICK IS SITUATED IN A REGION WITH 1200 - 1399mm OF ANNUAL AVERAGE RAINFALL

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PROJECT
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TITLE MEAN ANNUAL RAINFALL FOR Co DONEGAL	FIGURE 12.5
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- KEY
- HYDROMETRIC STATION
 - PROPOSED SITE

SCALE 1:250,000
FIGURE TAKEN FROM HOLOHAN, 2002

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PROJECT
BALLYNACARRICK LANDFILL PROJECT

TITLE
HYDROMETRIC STATIONS WITHIN
THE DONEGAL BAY CATCHMENT

FIGURE
12.6

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