Offshore Sand and Gravel Deposits

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Contract Report

Offshore Sand and Gravel Deposits
Desktop Study

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Section I

Sea Bed Sediment Maps

Seabed Sediment Maps

1. Use of the Maps

These maps contain data compiled from both map and point sources, at a variety of scales and from a variety of dates. Primarily, they are intended to show the general distribution of seabed sediments in offshore waters rather than coastal and inshore areas. They are not intended to be site-specific, and should not be used as such. As far as was possible within the limitations of the contract period, however, they represent the present state of knowledge regarding sediment distribution in Irish offshore waters.

2. Compilation

Maps were compiled at the scale of the appropriate British Admiralty Chart, using the relevant chart as a base map for compilation. Transfer of data was carried out by hand, using lat/long grids for reference. Priority was given to more recent data in all areas, although in some cases this data was at such a scale as to be useful only as a general outline, in which case the more detailed data may be significantly older.

Point data, such as the information on the Admiralty Charts, has been interpreted by the author, taking account of the bathymetry and current information available (Berthois 1971, Bowden 1980, Cooper 1967, Flather 1987, Howarth 1975, Lee & Ramster 1981, Orford 1989, Pingree & Griffiths 1978, Pingree & Griffiths 1979, Ramster & Hill 1969).

In general, the maps of the western offshore (Maps 5-8) are based almost entirely on information from the relevant Admiralty Charts (see Figure 3). Where the original charts (published 1860-1890) were available, these were used by preference,

as the sediment information represented on the modern charts is generally a summary of the older surveys. In some cases, however, portions of the charts have been resurveyed since the original publication ; the more recent information has been given preference. Dates of surveys represented in the charts are given on each chart.

The eastern maps, together with the eastern portion of Map 9 (Maps 1-3, 9) are based almost entirely on the appropriate BGS 1:250,000 Sea Bed Sediment maps (see Figure 3), which represent a compilation of various surveys, including BGS, GSI, and University data. These maps have been amended by the inclusion of more detailed surveys where these were available.

Map 4, which is based on the BGS Nymphe Bank map in the east, and a combination of Admiralty and other data (B.Ball 1987) in the west, shows a change from the Quaternary and rock (QR) of the BGS map to mud (M) at 8° West, the latter derived from the Admiralty Chart data. It seems probable that the mud noted is Quaternary.

Shell information has been taken from a variety of sources including the Admiralty Charts, and is represented as broken or whole shell, with an abbreviation of the class dominant where this is known.

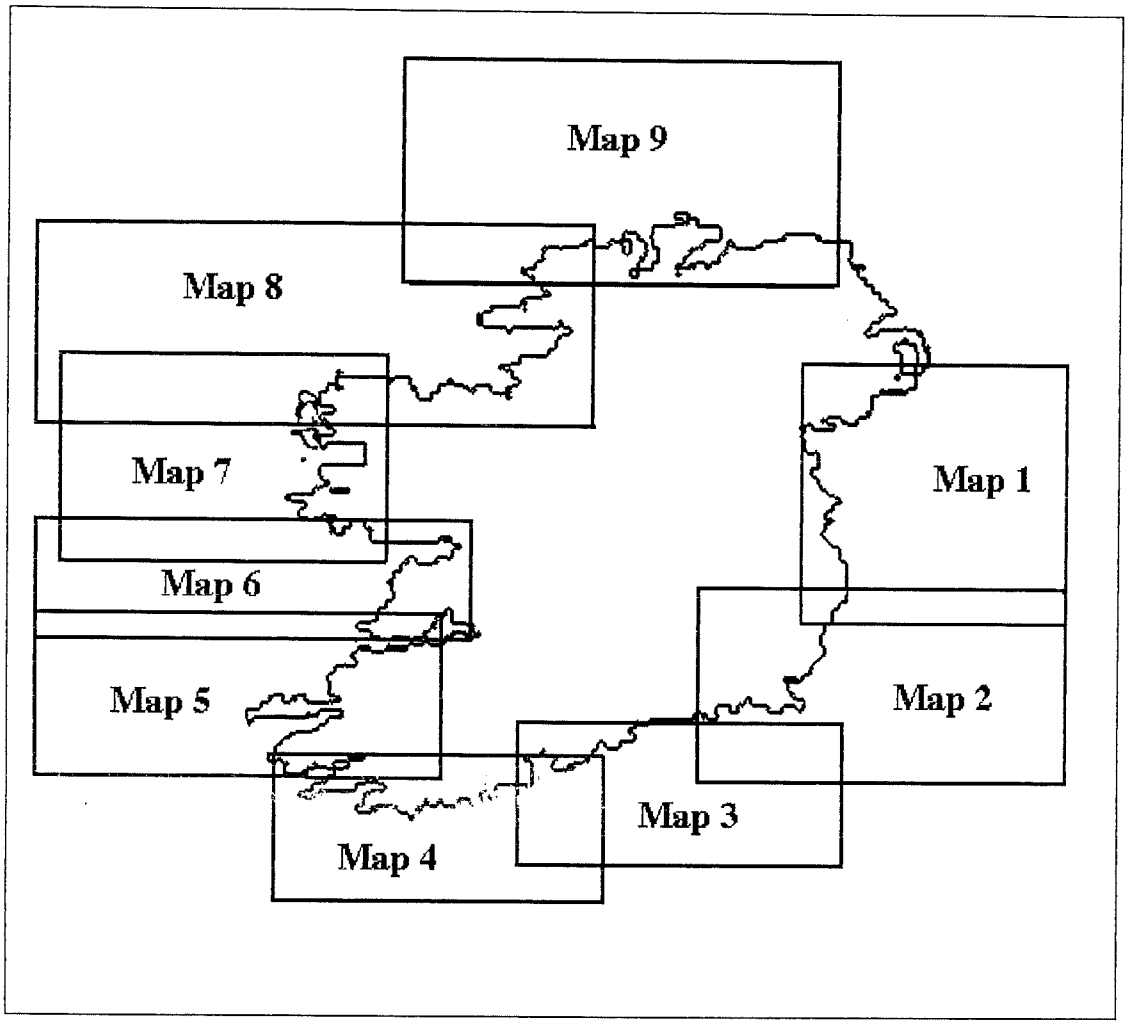

Figure 1. Sea Bed Sediment Maps.

3. Classification of Sediments

Classification of sediments shown in the map set is based on the modified Folk diagram as shown below (Figure 2). These classes are consistent throughout the map set, with one important modification. Where data is derived solely from the Admiralty Charts, there exists no accurate numerical information on the sediment proportions. In these areas (see figure 3), the same sediment classes are used as in other areas, but the classification is based only on the order of importance of the constituents. In Maps 4-9, sediment defined as muddy sandy Gravel represents a sample containing more gravel than sand, and more sand than mud.

While this produces a difference in accuracy of classification across the map set, it was felt that the loss of comparability was balanced by the gain in representational consistency.

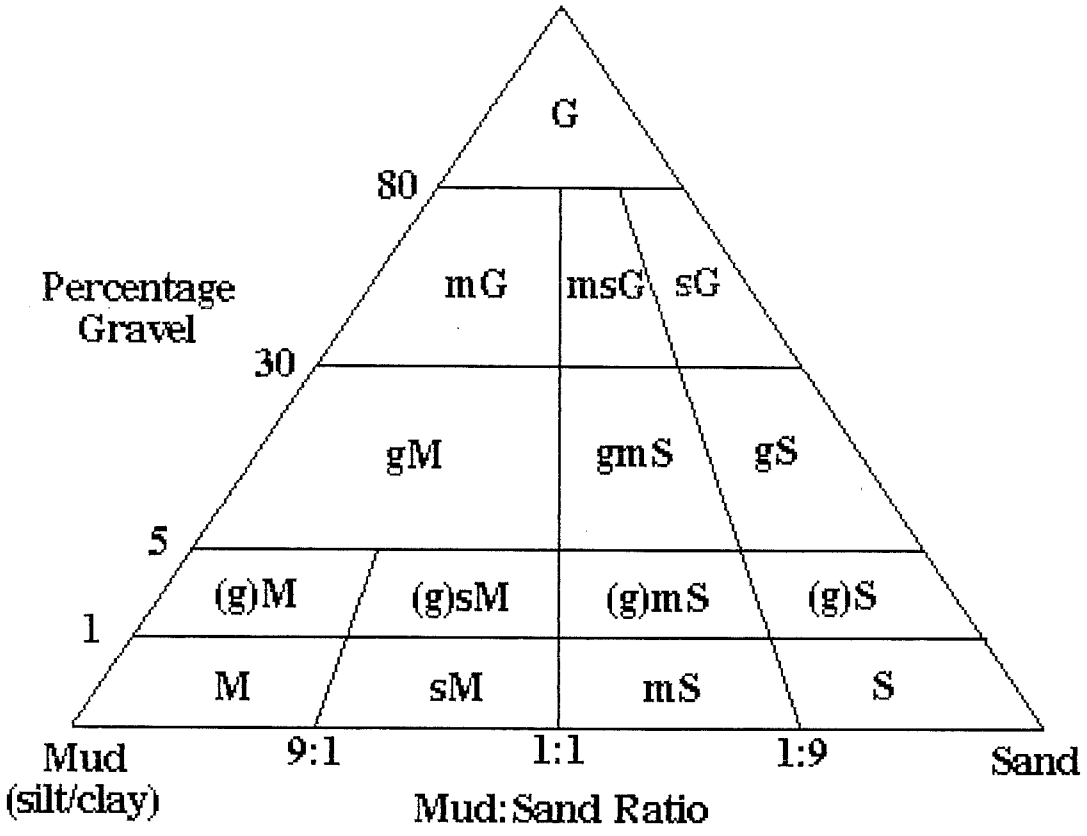

Figure 2. Exact classification of sediments. Modified after Folk 1954.

Explanations of the abbreviated class names

M	Mud
sM	Sandy Mud
(g)M	Slightly gravelly Mud
(g)sM	Slightly gravelly sandy Mud
gM	Gravelly Mud
S	Sand
mS	Muddy Sand
(g)S	Slightly gravelly Sand
(g)mS	Slightly gravelly muddy Sand
gmS	Gravelly muddy Sand
gS	Gravelly Sand
G	Gravel
mG	Muddy Gravel
msG	Muddy sandy Gravel
sG	Sandy Gravel

4. Sources for the Maps.

The majority of sources used in compiling the maps are publically available, and these are cited below, together with academic theses and the sources of commercial company surveys. Company reports are cited only by company, unless the author used a published version of the report. Where confidential data has been used, the source is not cited.

The main sources of data for Irish waters are shown below in Figure 3. This is followed by a detailed list of sources and references for each map.

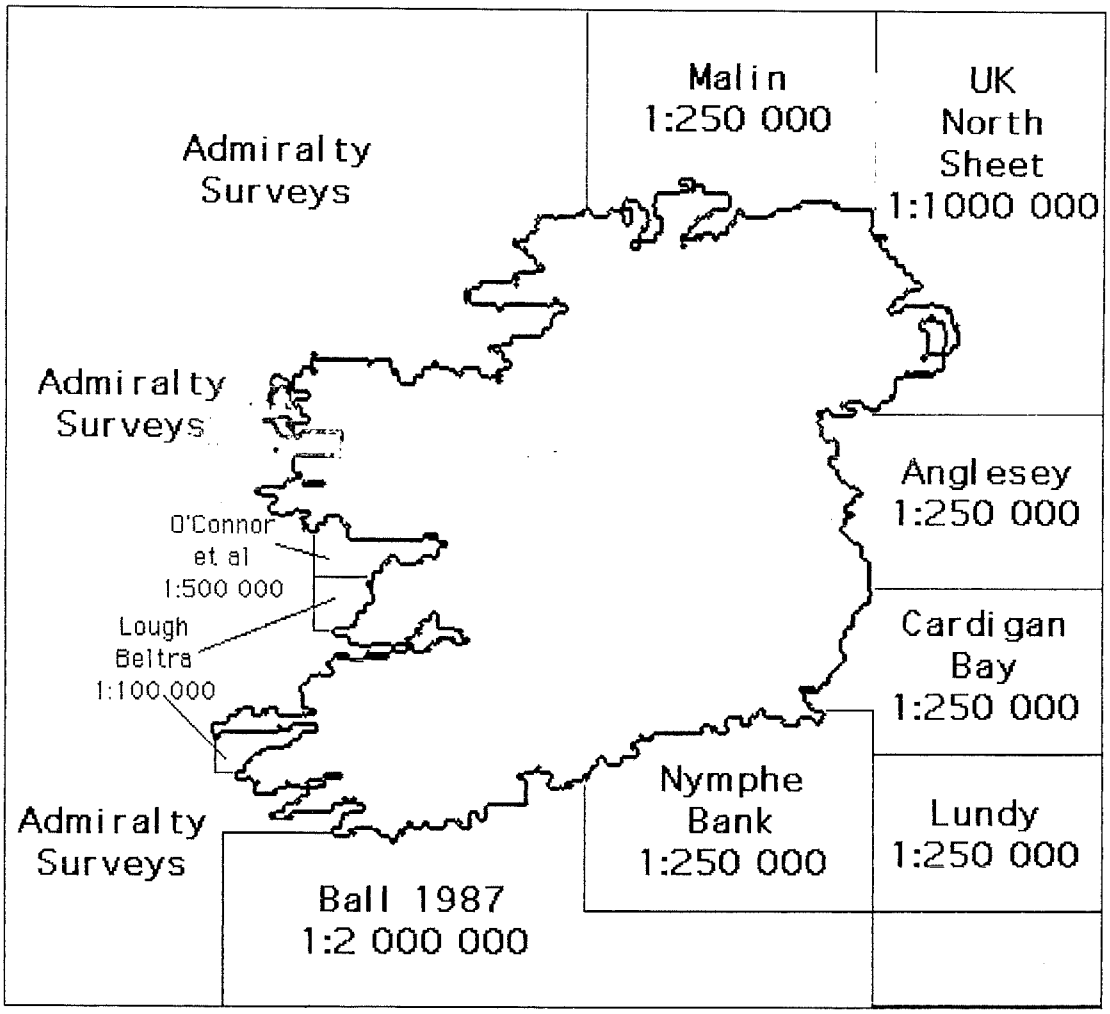

Figure 3. Main information sources.

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Map 1

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Map 9

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Section II

Offshore Sand and Gravel Deposits

Offshore Sand and Gravel Deposits

Map 1

Overall, Map 1 can be described as being generally muddy in Irish waters north of 53°30N, with the exception of a strip of sandy bottom from Clogher Head down to Lambay Island. East of Dublin to the limit of Irish waters, the bottom is almost entirely sandy (area roughly bounded by 53°10N / 6°7W to 53°30N / 6°7W at the western end to 53°10N / 5°20W to 53°30N / 5°20W at the eastern end) coarsening east from Dublin through fine to medium sand. Below 53°10N, the seabed becomes more complex, with streams of sand, gravelly sand, and Quaternary lying parallel or sub-parallel to the coast on a background of sandy gravel.

There is a gravel-dominated complex off Wicklow Head, comprising several larger gravel bodies associated with sandy gravel and gravelly sand. These gravel deposits are generally, with one main exception, parallel or sub-parallel to the coast :

52°49 / 6°1 - 52°57 / 6°	**lying 10-20m deep**
52°58 / 7°58 - 53°4 / 7°58	**lying 10-20m deep**
52°52 / 7°55 - 52°58 / 7°49	**lying 20-25m deep**
53°8 / 7°55 - 53°5 / 7°37	**mostly 10-20m deep**

Map 2

Map 2 is dominated by sandy gravel, interrupted by sand, gravelly sand, and Quaternary areas lying parallel or sub-parallel to the coast, which die out towards Carnsore Point. From Mizen Head (52°52N / 6°4W) to Greenore Point (52°15N / 6°18W) there is a coastal fine-medium sand strip from 1-12km wide parallel to the coast out to about 20-30m depth and interrupted by muddy sand, gravelly sand, and occasional sandy gravel and gravel bodies. Parallel to this is a second narrower

medium sand stream from 2-7km wide running from 52°35 / 5°55 to 52°50 / 5°48 in water depths from 30-80m. The two streams are joined by the sand body of Arklow Bank, which runs from 52°40 / 5°59 to 52°54 / 5°56, coarsening from medium to coarse northwards. Further offshore again two medium to coarse sand streams originating at 52°48 / 6°41 and 52°33 / 6°36 run north and join around 52°56 / 6°35, continuing north onto Map 1 - these are again sub-parallel to the coast.

Around Carnsore Point (52°10 / 6°21) the sandy gravel closer to the coast dies out to be replaced with fine to medium sand, although sandy gravel and gravelly sand continues east of 6°10. The sand runs from the line 52°06 / 6°50 - 52°07 / 6°12 south towards the Celtic Deep at 51°26 / 6°32 - 51°36 / 6°03, generally coarsening towards the east and west edges and fining towards the south. West of this sand area is a large area of gravelly sand, fringed by slightly gravelly sand. To the east the sand is replaced by sandy gravel north of 52°N and gravelly sand south of 52°N.

Small gravel bodies (1-10 km^2) are scattered throughout the map, and these are generally given single reference points below :

52°49 / 5°59	**c.25m deep**
52°44 / 5°53	**c.55m deep**
52°40 / 6°03	**c.33m deep**
52°38 / 6°02	**c.38m deep**
52°32 / 6°12	**c.12m deep**
52°21 / 6°18	**c.12m deep**
52°20 / 6°16	**c.10m deep**
52°17 / 6°11	**c.30m deep**
52°18 / 5°39	**c.95m deep**
52°20 / 5°35	**c.95m deep**
52°08 / 5°37	**c.95m deep**
52°09 / 6°26 - 52°09 / 6°20	**20-40m deep**
52°06 / 6°16	**c.65m deep**
52°08 / 6°35	**c.5m deep**

Map 3

The eastern edge of map 3 is dominated by the sand body referred to in map 2 above, and this, as noted, dies away to the south in the muddier sediments of the Celtic Deep, and to the west of 52°06 / 6°50 - 51°26 / 6°32 by gravelly sand fringed with slightly gravelly sand, lying perpendicular to the coast and interfingering parallel to the coast. This gravelly sand area contains a number of barchan-form sand patches, generally of coarse sand. West of 7°30 the gravelly sand is replaced by medium-coarse sand (north of 51°36) and sandy gravel (south of 51°36). Slightly to the west of 8°W (limit of the BGS Nymphe Bank Sheet) these are in turn replaced by muddy gravel (Admiralty Chart data). Southeast of 51°25 / 8°25 there is a body of fine-coarse sand lying sub-perpendicular to the coast, interfingering north-east with sandy gravel and gravelly sand parallel to the coast.

Only two small gravel bodies, of similar size to those of map 2, are noted, with the exception of those occurring in the overlap to map 2 (noted above). In both cases these are surrounded by sandy gravel.

51°49 / 7°14	**c.75m deep**
51°59 / 7°20	**c.50m deep**

Map 4

The eastern edge of map 4 shows the muddy gravel and sand bodies referred to in map 3. Southwest of the sand body is a complex of gravel, sandy gravel, gravelly sand and muddy gravel, which, together with the muddy gravel area north of the sand, terminates against a strip of mud (?Quaternary) lying north-south about 8°40 - 8°55 and widening northwards to join the coastal mud/Quaternary strip which runs from 8°W to 9°25. Between 8°55 and 9°30 (north) - 9°50 (south) is an area of medium sand

with isolated patches of rock, sometimes associated with gravel. West of this again the map shows sand mud, with one fine sand body from 50°19 / 10°10 to 50°17 / 10°05, and a few occurrences of sand around bays.

In general, gravel in the western portion of the map is associated with rocky outcrop, and is close inshore. In the eastern portion there are some large gravel bodies lying offshore, and these are generally sub-parallel to the coastline :

51°38 / 8°18 - 8°10	**lying 45-70m deep**
51°07 / 8°23 - 51°12 / 8°09	**lying 90-100m deep**
51°13 / 8°40 - 51°16 / 8°30	**lying 95-100m deep**
51°15 / 9°30 - 51°16 / 9°23	**lying 90-100m deep**
51°23 / 9°37 - 51°27 / 9°25	**lying 50-75m deep**
51°29 / 10°18 - 51°35 / 10°05	**lying 40-100m deep**

Map 5

Map 5 shows a complex coastal area with a wide range of sediments fringing and infilling the extensive rocky platform north of the Dingle Peninsula. Northwest of this platform, however, there is an extensive region of fine sand (northwest of a line from 52°20 / 11°15 - 52°40 / 10°30), probably grading to muddy sand in some parts. A fine sand body enters the west edge of the map at 52°01-10 / 11°16 and extends north-east to 52°10 / 11°14 and 52°07 / 11°10, and another enters the south edge of the map at 51°52 / 11°14 - 10°57 and extends north-east to 51°55 / 10°55.

Within the more complex area of sediments, there are sand bodies along the south of the Dingle/Blaskets rocky shelf (fine-medium sand and shell running c.4-5km wide 51°54 / 10°40 north-east to 52°05 / 10°18, where it terminates in a north-south lobe lying across Dingle Bay), fringing the west of the northern rocky platform (medium-coarse sand and shell / coral around 51°08 / 10°45 and 52°15 / 10°45 in a complex shape), and within the rocky platform area (medium sand centred around 52°27 / 10°25). Smaller sand bodies occur coastally and as rock fringing bodies. The area off the mouth of the Shannon marked 'Hard' may be packed fine sand or fine muddy sand, but this is uncertain.

Gravel appears both fringing the rock shelves and in deeper water, ranging in extent from 2km^2 to several tens of square kilometres. Smaller bodies are again noted by a single reference point:

51°58 / 10°40	**c.100m deep**
52°01 / 10°31-26	**c.60m deep**
52°02 / 10°12	**c.40m deep**
52°02 / 10°41	**c.45m deep**
52°02 / 10°50-43 - 51°59 / 10°45	**lying 100-120m deep**
52°04 / 10°48 - 52°09 / 10°38	**lying 100-130m deep**
52°09-13 / 10°49	**lying 110-130m deep**
52°12-17 / 10°39 - 52°15 / 10°30	**lying 85-105m deep**
52°13 / 10°25 - 52°24 / 10°10	**lying 55-80m deep**
52°15-23 / 11°16 - 52°18 / 11°06	**lying 120-130m+ deep**
52°17 / 10°55	**c.120m deep**
52°23 / 10°50	**c.115m deep**
52°25 / 10°40	**c.100m deep**
52°15 / 10°48 - 52°20 / 10°41	**lying 100-115m deep**
52°25 / 10°37 - 52°29 / 10°30	**lying 90-100m deep**
52°25 / 10°23	**c.105m deep**

Map 6

Map 6 shows sand west of 10°30W, broken by a belt of muddy sand / sandy mud around 53°55N with medium sand to the north and fine sand to the south. Together with sand bodies starting at 52°42 / 9°55 and 52°48 / 9°55, which join at 52°50 / 9°35 to form a strip running up the Clare coast and along to the southwest of the Aran Islands (ie. to 53° / 9°30 running north-east from origins and then running north-west to 53°04 / 9°45), these are the only extensive areas of 'clean' sand on the map. There is a small patch of medium sand on the rocky shelf at 53°13 / 10°06, at c.90m depth,

another slightly to the north of Loop Head (52°35 / 10°) and a sand body running north (parallel to the eastern edge of the main sand body) from 53°15 / 10°20 to the north edge of the map.

There is one extensive area of gravel in the southern portion of the map (part of which appears on the previous map) running sub-parallel to the Clare coast, and smaller bodies generally associated with rock along the Connemara coast :

52°40 / 10°30 - 52°47 / 9°45	**lying 70-110m deep**
53°11 / 10°04	**c.60m deep**
53°14 / 9°48	**lying 50-65m deep**
53°18 / 10°08	**c.95m deep**

Map 7

The south edge of map 7, which overlaps map 6 to the south, shows the entry of the medium sand area west of 10°30W and the narrower coastal sand body running north from 53°15 / 10°20 parallel to the eastern edge of the main sand body. This coastal strip joins the main sand area at around 53°32 / 10°30. The main sand body continues to the west of 10°20-30 as far north as 54°20, going from medium sand into coarse at about 53°30, fining north and west to fine sand around 53°45, with medium sand fining westwards north of 53°55. A lobe of fine to medium sand extends east to 10°02W at about 53°42, with a complex outline defined by the rock shelf, which here appears to be 'breached'. The lobe grades to coarse sand in the nearshore. To the north of this lobe, at 53°04, a similar fine-medium sand lobe extends in to Blacksod Bay (from 53°04 / 10°30 to 53°05 / 10°).

From Clew Bay (53°50 / 9°50) a strip of medium sand extends along the southwest coast of Achill Island as far as Achill Head (53°57 / 10°15), and aother extends from Broadhaven Bay (54°18 / 9°55) north-west to the northern edge of the map. part from these there are isolated sand patches lying generally inshore on the rocky shelf, as at 54°10 / 10°08.

Gravel is not extensive in the southern part of the map, with one exception, being generally fringing pockets associated with rock, but in the north there are both smaller lenses of gravel c.2-6km^2 and extensive areas of gravel. Since these larger bodies extend north of the map, they are covered in map 8.

53°18-26 / 10°27	**lying 85-105m deep**
53°34 / 10°25 - 53°36 / 10°13	**lying 50-105m deep**
53°28-36 / 10°50	**lying 105-120m deep**
53°46 / 9°46	**c.15m deep**
53°51 / 10°03	**c.35m deep**
53°55 / 10°16	**c.60m deep**
53°59 / 10°22 - 54°01 / 10°18	**lying 60-90m deep**
54°10 / 10°42	**c.180m deep**
54°12 / 10°33	**c.125m deep**

Map 8

The southwest corner of map 8 contains the fine sand area noted on map 7. This is interrupted by an area of rock and gravel (from 54°20 / 10°20 to 54°22 / 10°50 and 54°45 / 10°05) after which it continues as a broad band divided by a narrow strip of gravelly sand, rock, and gravel (from 54°45 / 10°05 to 55° / 9°30) to approximately 9°30W in the east, where it is replaced by rock and gravel (to the north of 54°40) or sandy mud (south of 54°40). Otherwise, the eastern half of the strip terminates in the south just north of the complex coastal sediments (north of 54°22), and the western half of the strip ends in the west at the shelf edge, where it rapidly gives way to muddy sediments, and continues north off the map edge (55°17 / 9°40-59).

Smaller fine sand areas are noted toward the south of Donegal Bay, running along the coast from 54°20 / 8°40 to 54°32 / 8°16 with a rock interruption centred around Inishmurray (54°27 / 8°35-40) ; around Dawros Head (54°50 / 8°45) ; off Bloody Foreland (55°15 / 8°30) ; and offshore (55°08 / 9°08).

Gravel areas are quite extensive in the map, associated with large areas of rock shelf lying both coastally and offshore. There are also smaller (c.10km^2) rock-fringing bodies of gravel around the coast in shallower waters. A wide and complex north-north-west trending area of gravel runs from 54°40 / 9°20 (c.105m deep) on this map, extending to its widest at about 55°03N, where it runs from 8°40 to 9°20 in water depths of 65 to 115m, before narrowing to run north bounded by 8°59 on the west and 8°37 on the east in water depths of 75-100m.

54°19 / 10°	**c.40m deep**
54°22 / 10°-9°40	**lying 70-95m deep**
54°21 / 9°48	**c.60m deep**
54°20 / 9°31	**c.45m deep**
54°22 / 9°24 - 54°19 / 9°13	**lying 45-60m deep**
54°21-30 / 8°55	**lying 40-70m deep**
54°20 / 10°14 - 54°22 / 10°40 - 54°45 / 10°	**lying 95-160m deep**
54°50 / 10°48 - 54°53 / 10°38	**lying c.100m deep**

Map 9

Map 9 shows a single extensive sand area in the north-west quadrant of the map, fining east and south-east from the coarse sand at the shelf edge in the north-west corner (56°10 / 9°26), and bounded by coarser sediments to the south (approximately along a line from 55°40 / 9°25 to 56°02 / 7°20. Within the sand area, there are lobes of gravelly sand (probably fine gravel), and muddy sand lying along the 56°N line, and north of these coarser sediments surrounding the Stanton and Blackstones Banks, which are centred on 56°08 / 7°55 and 56°05 / 7°06 respectively.

Apart from this area, there is a fine sand body lying off Bloody Foreland, which runs from 55°14 / 8°37 to 55°29 / 8°35 to 55°20 / 8°20, with a lobe extending south-east to 55°12 / 8°25 ; lenses at 55°38 / 7°31 and 55°43 / 7°04 ; and small sand bodies lying in Inishtrahull Sound (55°24 / 7°11-20) and on Hempton's Turbot Banks (53°27 / 7°01-05).

Gravel areas are again extensive in this map, reflecting the high energy environment. A wide and complex north-north-west trending area of gravel runs from 54°40 / 9°20 (c.105m deep) on map 8, extending to its widest at about 55°03N, where it runs from 8°40 to 9°20 in water depths of 65 to 115m, before narrowing to run north bounded by 8°59 on the west and 8°37 on the east in water depths of 75-100m to terminate at 54°20. North of this body is an area of fringing gravel which runs from 55°22 / 9°26 at the west edge of the map eastwards to 55°22 / 9°09 and then north-north-west to 55°37 / 8°58. East of these bodies the map is dominated by sandy gravel and gravelly sand, with a single large gravel body lying into British waters to the north-north-east of Hempton's Turbot Banks (running from 55°28 / 7° and 55°27 / 6°48 in the south to 55°45 / 6°55 and 55°43 / 6°43 in the north), and a smaller gravel body to the south-west of the Turbot Banks (running from 55°22 / 7°02 to 55°23 / 6°54 and 55°21 / 6°52), both lying in about 30-70m of water.

Section III

Literature Review

Review of the Biological Literature

This section of the contract consists of two parts : review and annotation of the Biomar journal database (Part I) ; and a sourced review of literature in addition to the journals in the Biomar database (Part II). The first part covers approximately 500 to 600 references, divided by Biomar sector ; the second part covers 91 references including some of those used in compilation of the map set, divided by map number.

All the references are arranged in eight-column tables in Microsoft Word, with the following column headers :

AUTHOR	YR	TITLE	PUBLICATION	KEY	TYPE	AREA	MAP/ SECTOR

which represent respectively : the name of the author(s) ; the year of publication ; the title of the article ; a keyword describing the main subject of the article ; a keyword describing the main format of the article or the type of information therein ; a keyword noting the area of application of the paper ; and the Biomar sector number (Part I) or the map number (Part II). Explanations of the (abbreviated) keywords are given below.

Due to the late availability of the Biomar database, much of the biological literature reviewed by the author was found to be duplicated therein : duplicated reviewed articles are included in Part I, rather than Part II.

Part I : Biomar

Annotation of the Articles

Articles reviewed in both Part I and Part II are annotated by the same set of keywords, allowing the list of articles to be sorted by subject and type of information as well as by year and author (<SORT> table by appropriate column in alphabetical

order to group similar articles). The keywords are abbreviated, and may have a qualifying term attached. These keywords are arranged by three columns, whih are shown below in order of appearance in the table ; in each case the relevant qualifiers are shown at the bottom of the table. Key terms used in the tables are shown on the left, with the explanation on the right.

Keyword Terms and Explanations
Column 5 : KEY (Main Subject)

KEY	Main Subject of Article
BIOGEOG	Biogeography and zoogeography.
BLOOM	Phytoplanktonic blooms.
CLASS	Fauna at the Class level (not taxonomically exact).
COMM	Faunal communities and assemblages.
ENV	Conservation, pollution, and heritage.
FAMILY	Fauna at the Family level (not taxonomically exact).
FAUNA	Fauna in general.
FLORA	Plant species or groups, except algal blooms.
FSH	Fisheries and commercial species.
GEN	General.
GENUS	Fauna at the Genus level.
GEOL	Sea bed sediments, geology/geomorphology, wrecks.
INFO	Information sources.
LOC	Particular locality.
SEA	Hydrographic / bathymetric / other marine physical data.
SHELL	Shells or shell debris.
SP	Fauna at the Species level.

QUALIFIER	Explanation
(PK)	Planktonic.
(P)	Pelagic.
(D)	Demersal.
(EB)	Epibenthic.
(B)	Benthic.
/L	Larval.
/R	Rare or unusual.

Keyword Terms and Explanations

Column 6 : TYPE (Type of Information)	
TYPE	**Main Type of Information**
DIST	Distribution.
ECOL	Ecology, life-cycles, response to environment.
LIST	Lists and catalogues.
MAP	Maps.
NOTE	Short note or informal observations.
OCC	Occurrence or records.
PAR	Parasites and parasitology.
REP	Report, containing a variety of information.
RES	Research and experiment.
SURVEY	Surveys, generally with numerical data.
SYN	Synoptic and review of prior data.
TAX	Taxonomic work.

QUALIFIER	Explanation
/STR	Strandings.
/L	Larval.
/R	Rare or unusual.

Note : an article may contain several types of information. This column describes the main format or type of information offered only. The reader's view of the main type of information may differ.

Keyword Terms and Explanations

Column 7 : AREA (Area covered)	
AREA	**Area covered by Article**
INT	International.
EUR	European.
BRIT	Britain Isles and Ireland.
NAT	National.
REG	Regional : Irish Sea, West Coast etc.
LOC	Local : Galway Bay, Dublin Bay, Shannon Estuary etc.
MUS/	National, Regional, Local Museums.

QUALIFIER	Explanation
/OFF	Offshore waters.
/CST	Coastal waters.
/LITT	Littoral-sublittoral.
/IN	Brackish & inland.

Note : the terms LOC and REG may cover more than one locality or region as long as these do not join to form regional or national coverage. BRIT may refer to a specific British mainland locality in some few cases.

Part II : Additional Reviewed Articles

Articles reviewed in this section are in addition to the articles noted in the Biomar database. They are presented here in the form of a standard reference list with the addition at the end of the reference of three keyword terms similar to those presented for the Biomar articles : the list is available in the form of a Microsoft Word table in digital format, in which format the remarks pertaining to the Biomar data (Part I) also apply to this list.

The reference list below is organised according to the map number to which the reference is relevant, and there is, therefore, some duplication. Articles referring to no specific map are noted first, then those referring to all the maps.

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