British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

The **strategic importance** of the **marine aggregate industry** to the UK

BRITISH GEOLOGICAL SURVEY

RESEARCH REPORT OR/07/019

The strategic importance of the marine aggregate industry to the UK

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Preface

The construction industry is an important sector of the UK economy. It uses large quantities of construction aggregates, which are obtained from a variety of sources. Amongst these are marine aggregates dredged from the sea bed. The construction industry will continue to require an adequate and steady supply of aggregates over the long term. Aggregate supply issues are, therefore, important and ongoing.

This report has been commissioned by the British Marine Aggregate Producers Association (BMAPA) to examine the strategic role and importance of marine aggregates to the overall supply of aggregates in the UK. It focuses on the socio-economic issues associated with the production and use of marine aggregates, and their contribution to national and regional supply. The report compliments the sustainable development strategy (*Strength from the depths*), which BMAPA has produced. Like all forms of mineral extraction, marine dredging also has environmental impacts and the industry is strictly controlled. These effects, and their monitoring and mitigation, have been described in detail elsewhere and are only briefly considered here.

The UK is fortunate in having large resources of marine aggregates, which make an important contribution to supply, not only to the construction industry but also to coastal protection. This report is intended to provide a better understanding of this contribution and to inform future policy developments arising from the Marine Bill and the proposed new system of marine spatial planning.

Acknowledgements

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Introduction

The offshore areas that surround the UK have made a crucial contribution to Britain's mineral wealth over the last 35 years. Most notably this has been through the development of the large oil and gas resources they contain. Less well known, perhaps, is the contribution that offshore areas have also made in helping to underpin a major sector of the economy — the construction industry — through the supply of marine aggregates.

Aggregates are the most widely used construction minerals and account for about 85 per cent of the non-energy minerals extracted in the UK. After energy minerals, they are also the most critical to the national economy and are essential for creating and maintaining the structural framework of the built environment and key infrastructure developments.

The UK is fortunate in that a wide range of aggregate sources contribute to overall supply and this diversity provides benefits in terms of security of supply. Maximising the use of recycled and secondary sources is very important but these are neither sufficient in quantity nor quality to meet all demand. It is, therefore, essential to maintain primary aggregate supplies. Resources of land-based sand and gravel and, notably, crushed rock are unevenly distributed and increasingly constrained by environmental designations and other forms of land use. This makes finding environmentally acceptable sites to work increasingly difficult. Permitted reserves, particularly of sand and gravel, are declining — notably in the areas of high demand such as the South East and London. The Government is committed to a system of managed aggregates supply to meet future anticipated need. It is also committed to a policy 'to encourage the supply of marine-dredged sand and

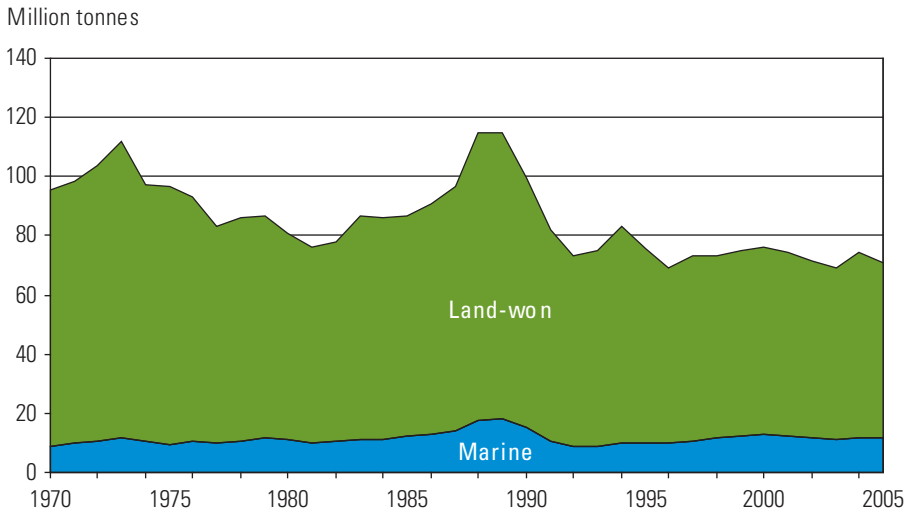


Figure 1 Sales of land-won and marine sand and gravel in England, 1970–2006.

Source: Annual Minerals Raised Inquiry, Office for National Statistics.

gravel to the extent that environmentally acceptable sources can be identified and exploited within the principles of sustainable development.' (Mineral Planning Policy Statement 1: *Planning and Minerals*).

The UK's marine aggregate industry is one of the largest in Europe and the world. It is highly capital intensive, with the industry's fleet of 28 specialised aggregate dredgers having a replacement value of around £1 billion. The industry had its origins in the 1920s but since the 1960s it has made a substantial and increasing contribution to UK aggregates supply (Figure 1 and 2). In 2005 marine sand and gravel accounted for eight per cent of total primary aggregates sales in England and Wales, but more significantly for 19 per cent of total sand and gravel sales in England and 46 per cent in Wales. Regionally the industry is even more important. In particular it makes a crucial contribution to aggregate supply for the rapidly growing economies of London and the South East, which together account for over one third of construction and economic activity in the UK. However, supplies to other regions, notably South Wales, are also very important.

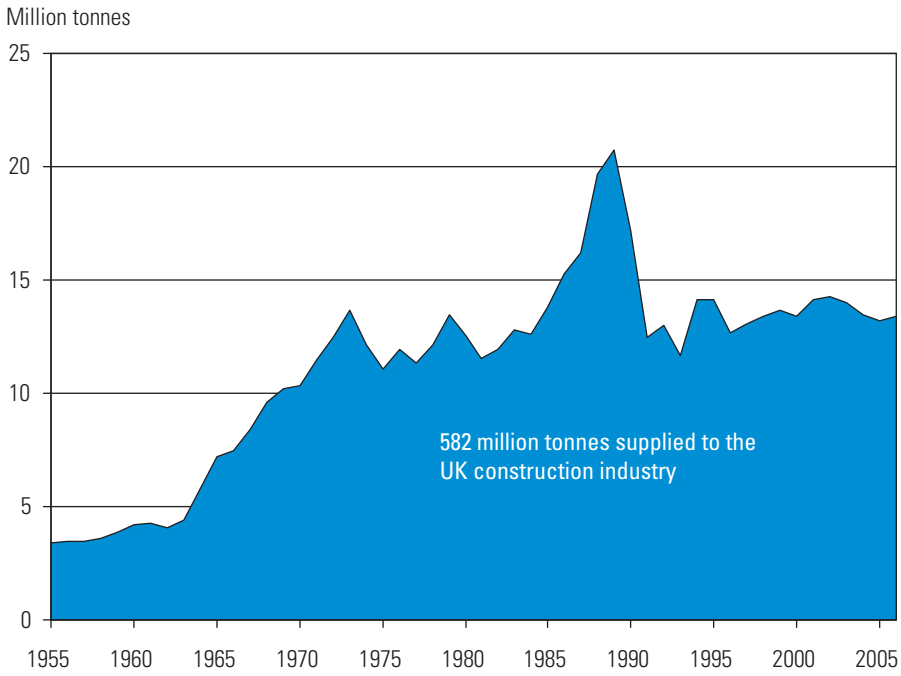


Figure 2 UK landings of marine-dredged sand and gravel for construction, 1955–2006.
Source: The Crown Estate.

This report provides an overview of the marine aggregates industry and its strategic importance in maintaining national and regional supplies of aggregates on which society so depends.

Marine aggregates — contribution to wider aggregate supply

The three main sources of aggregates in the UK are:

- **land-won aggregates** — crushed rock, and sand and gravel
- **marine-dredged sand and gravel** and
- **alternative aggregates** — recycled and secondary materials.

In addition, modest quantities of crushed rock are imported from Europe. Maintaining a diverse mix of aggregate supplies is strategically very important to ensure future continuity and security of supply.

The distribution of land-based and marine resources of aggregates fundamentally reflects the underlying geology. Southern and eastern England are essentially devoid of hard rock resources, from which most aggregate is produced, and aggregate production in these regions is dominated by sand and gravel.

Demand for aggregates is driven by activity in the construction industry and the economy as a whole. It arises principally within large centres of population, especially in the South East and London. This regional imbalance in supply and demand for aggregates requires that large transfers of aggregates are made from net-producing areas, such as Leicestershire and the Mendip Hills in Somerset, to net-importing regions, most notably into London and the South East. Imports into these regions of high demand are

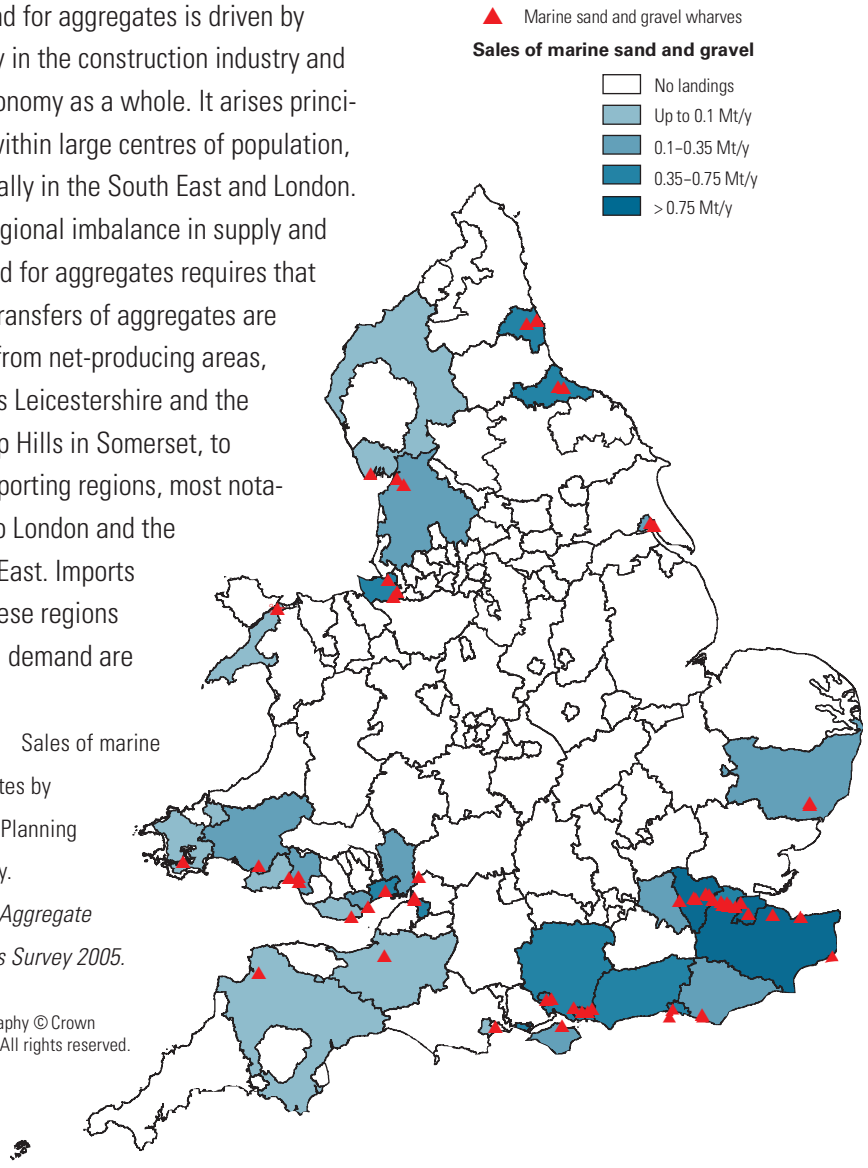


Figure 3 Sales of marine aggregates by Mineral Planning Authority. *Source: Aggregate Minerals Survey 2005.*

also augmented by supplies of marine aggregates.

Significant quantities of marine aggregates are also landed in other major coastal urban areas such as Merseyside, north Lancashire, Tyneside, Teesside, Humberside and South Wales (Figure 3).

A system of national managed aggregates supply has been in operation since the 1970s to ensure that planning policies at regional and local level in England reflect the need for an adequate and steady supply of aggregates to deficient areas. The *National and Regional Guidelines for Aggregates Provision in England for 2001 to 2016,* published in 2003 by the former Office of the Deputy Prime Minister, indicate how provision for the supply of aggregates should be made to meet anticipated need to 2016 (Table 1). Only assumptions based on past trends are made for marine aggregates and currently there is no planned allocation. Of a total marine aggregate requirement of 230 million tonnes (14.4 Mt/y), 75 per cent is destined for London and the South East.

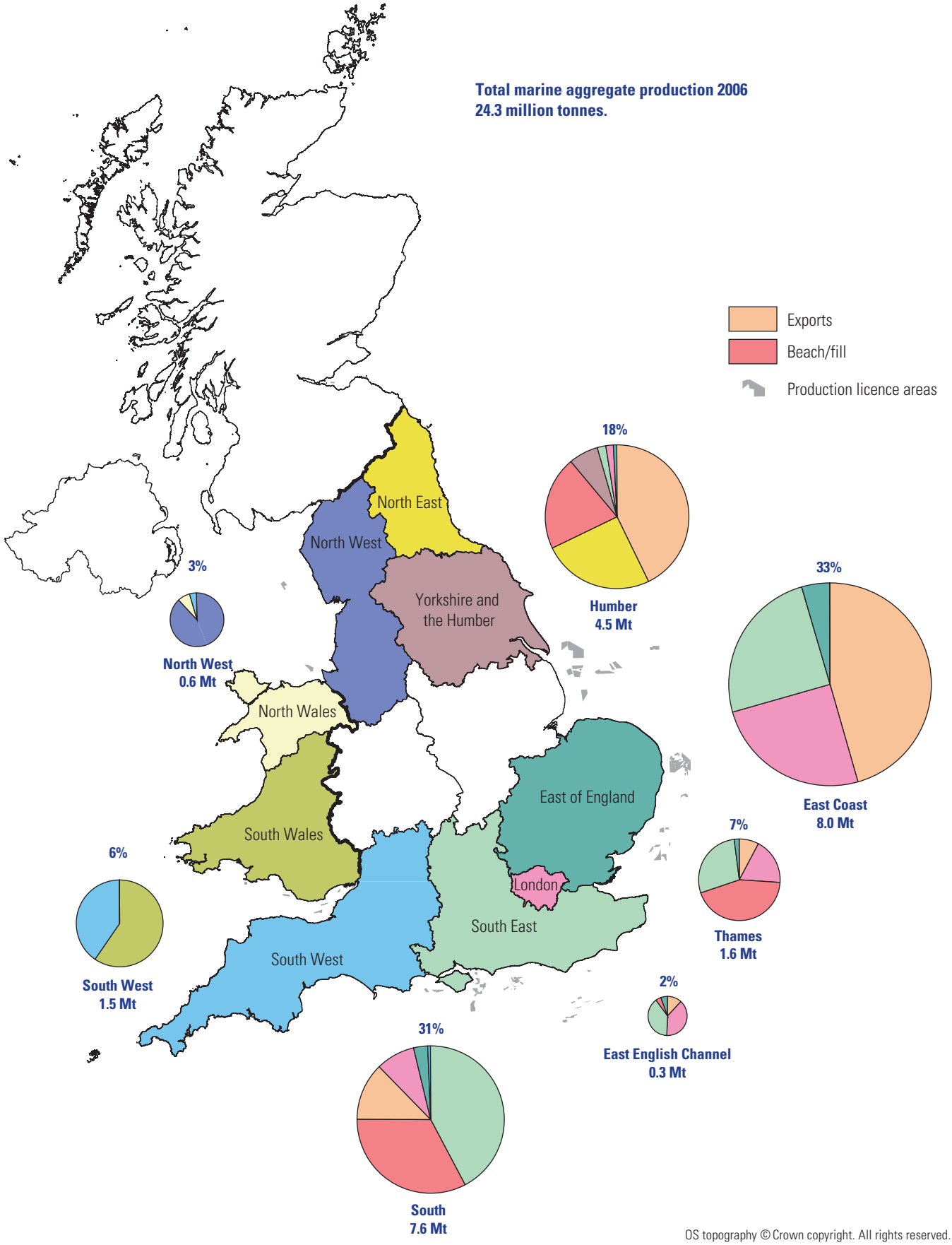
Marine aggregates are principally dredged off the coast of England with smaller amounts off the South Wales coast. Currently there is no dredging in Scottish or Northern Ireland waters. The production of marine aggregates by dredging area is shown in Figure 4, together with landings by region. The relative importance of dredging areas has changed with time as reserves have become depleted and new reserves developed. Production from the Thames estuary has declined as reserves have become depleted but in 2005 production started in the East English Channel where large resources have been discovered. This area will become increasingly important as a source of supply in the future.

Regions	Guidelines for land-won production		Assumptions		
	Million tonnes				
	Land-won sand & gravel	Land-won crushed rock	Marine sand & gravel	Alternative materials	Net imports to England
South East	212	35	120	118	85
London	19	0	53	82	6
East of England	256	8	32	110	8
East Midlands	165	523	0	95	0
West Midlands	162	93	0	88	16
South West	106	453	9	121	4
North West	55	167	4	101	50
Yorkshire & the Humber	73	220	3	128	0
North East	20	119	9	76	0
ENGLAND	**1 068**	**1 618**	**230**	**919**	**169**

Table 1 National and regional guidelines for aggregate provision in England 2001–2016. *Source: Department for Communities and Local Government (DCLG).*

Figure 4 Regional production and destination of marine aggregates, 2006.

Source: The Crown Estate.



Markets for marine aggregates

Sand and gravel dredged from the UK Continental Shelf is landed in three main market areas:

- ports in England and Wales for construction use (there are no landings in Scotland or Northern Ireland)
- ports in Europe for construction use (i.e. exports)
- at numerous coastal and waterfront locations for beach nourishment and contract fill.

Total annual sales of marine aggregates for all markets have been in the range 17 to 27 million tonnes over the last 25 years (Figure 5). UK and export landings have been relatively uniform over the last 10 years, essentially reflecting market need and latterly the capacity of the dredging fleet. The relative importance of these markets in 2006 is shown in Figure 6.

Assessing the precise contribution that marine aggregates make to overall aggregates supply, particularly on a regional basis, is complicated by the fact that different statistical sources give slightly differing figures. These sources are compared in the text box *Statistical sources*, but for the purposes of this report a combination of The Crown Estate figures and those collected for the *Aggregate Minerals Survey* for 2005 have been used. Marine aggregate supplied to the UK construction market is subject to the Aggregates Levy but material for export, beach nourishment and contract fill is not.

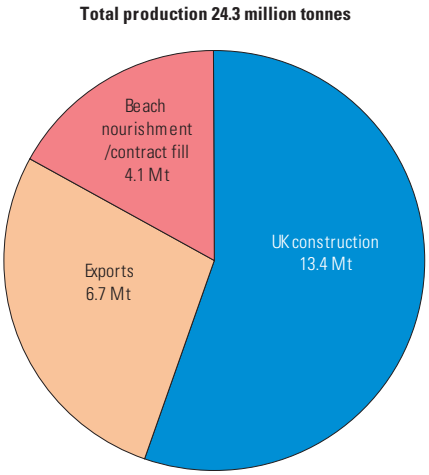


Figure 6 Landings of marine aggregates by principal market, 2006.

Source: The Crown Estate.

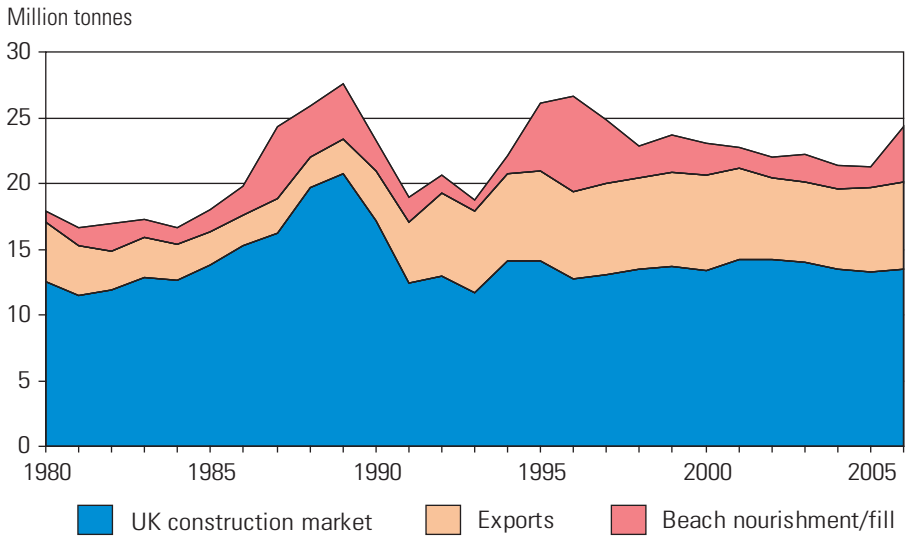


Figure 5 Landings of marine aggregates 1980–2006.

Source: The Crown Estate.

UK construction market

Marine aggregates are an important source of high quality sand and gravel, accounting for about 20 per cent of total sand and gravel supply in England and Wales (Figure 7). They are used principally as a source of concrete aggregate, which is the premium product of the sand and gravel industry. Concrete is a versatile, durable and cost-effective building material, which is often referred to as the 'backbone' of UK construction. It is the most widely used building material with even structures made of steel or timber being built on concrete foundations. Concrete and concrete products are the principal value-added building materials manufactured from marine aggregates and many wharves have associated plants. This readily allows the product to be delivered to urban areas with the minimum of road transport.

Concrete aggregate is the principal market for all primary aggregates (sand and gravel, and crushed rock). Total sales of concrete aggregate were 62.3 million tonnes in 2005, accounting for 36 per cent of total primary aggregate sales in England and Wales. Marine aggregates supplied 18 per cent of this total demand (Figure 8). About 79 per cent of marine sand and gravel is sold as concrete aggregate (Figure 9), and in London and the South East this proportion increases to 89 per cent. In comparison 60 per cent of land-won sand and gravel and 16 per cent of

Statistical sources

Sound statistical data on sales, movement and consumption of aggregates are required by Government to monitor and develop planning policies for the managed supply of aggregates.

The two primary annual surveys that collect data on landings and sales of marine-dredged sand and gravel are carried out by (a) The Crown Estate and (b) through the Quarterly Department of Trade and Industry (now Business, Enterprise and Regulatory Reform) Building Materials Inquiry.

The Crown Estate figures relate to 'landings' of sand and gravel removed from the sea bed in the Territorial Sea and UK Continental Shelf under licence from The Crown Estate. The vessel operators formally declare the landings as discharged material at wharves. These are audited on an annual basis by The Crown Estate's offshore agent, Haskoning UK Ltd. Output from areas outside the ownership of The Crown is not included, but is relatively small (less than 150 000 t/y). The Crown Estate figures are collected on a volume basis in cubic metres but are expressed in tonnes by applying a conversion factor[1]. This factor is slightly less than the actual density and is one of the main reasons for the difference between 'landings' at a wharf and subsequent 'sales' after processing at a wharf and recorded by a weighbridge.

The Quarterly Building Materials Inquiry is conducted by the Office for National Statistics (ONS) on behalf of the Department for Business, Enterprise and Regulatory Reform (BERR, formerly Department of Trade and Industry). The results of this inquiry, which covers only sales of marine-dredged sand and gravel landed at British ports, are published with figures for land-won sales in *Monthly Statistics of Building Materials and Components, BERR* and also in *Mineral Extraction in Great Britain* Business Monitor PA1007, ONS.

In addition, the four-yearly *Aggregate Minerals Survey* (AM) carried out on behalf of the Department for Communities and Local Government (DCLG) and the Welsh Assembly Government collect data on sales of marine aggregates from wharves in the same way as land-won aggregate quarries. These surveys are used to inform Government on the sales, flows and consumption of primary aggregates in order to monitor and revise, as necessary, the *Aggregate Guidelines*, which support Minerals Policy Statement 1: *Planning and Minerals*.

There are some differences between the three surveys (see table) and marine aggregates supply is believed to be somewhat understated. This is because of either incomplete coverage of wharves (ONS data and AM2005) or the conversion factor used. Based on 2005 AM data, 14.36 million tonnes of marine aggregate were supplied to the UK construction market.

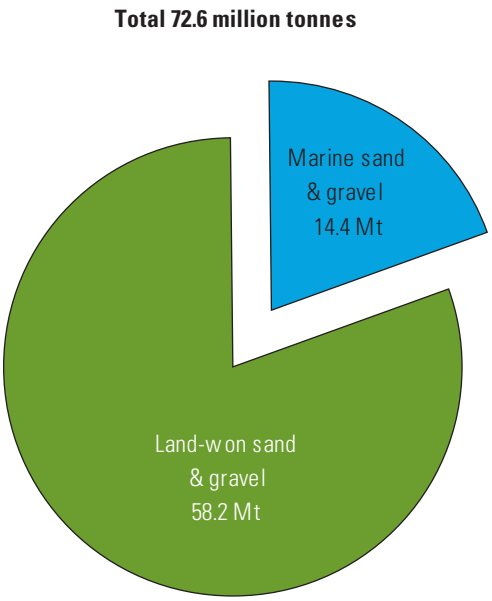


Figure 7 Sales of land-won and marine sand and gravel in England and Wales, 2005.
Source: Aggregate Minerals Survey, 2005.

crushed rock is sold as concrete aggregate. Concrete recovered from demolition waste can be readily recycled and is an important source of alternative aggregates.

Concrete is a mixture of water, cement and aggregate, where the aggregate acts as an inert filler. Aggregate is the principal constituent of concrete, accounting for 60–80 per cent by volume and influences both its properties and its cost. The clean and durable nature

Landings/sales marine sand & gravel	Thousand tonnes			
	Crown Estate	ONS PA1007	BERR Monthly Statistics	AM surveys
2001	14 158	13 611	13 611	15 862
2002	14 249	12 832	12 833	
2003	14 012	12 131	12 249	
2004	13 477	12 996	12 996	
2005	13 216	13 024	13 025	14 361

[1] A conversion factor of 1.73 and 1.66 for sand and gravel, and 1.5 for sand is used to convert cubic metres to tonnes. The 1.66 factor was applied to historical licences. In 1999 it was replaced by 1.73.

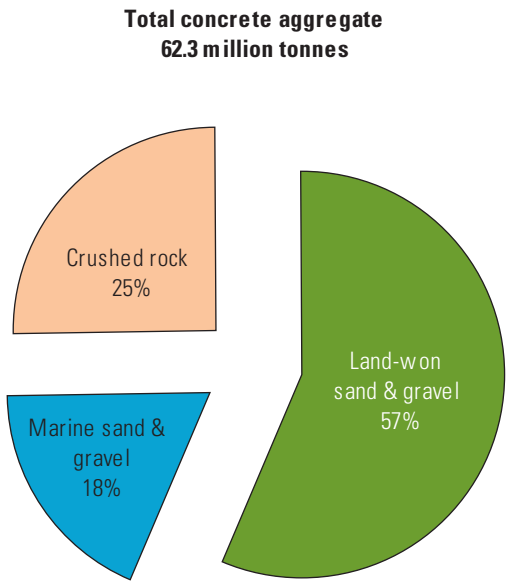


Figure 8 Sales of concrete aggregate by aggregate type in England and Wales, 2005.

Source: Aggregate Minerals Survey, 2005.

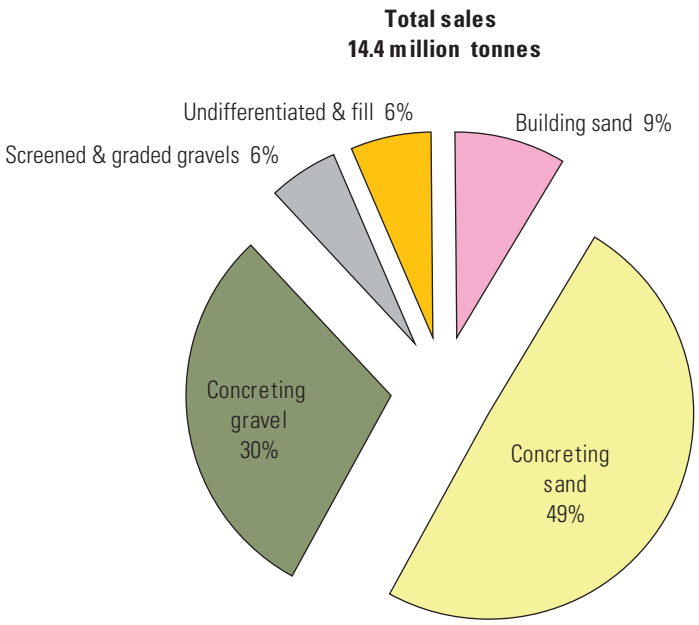


Figure 9 Sales of marine-dredged sand and gravel by product in England and Wales, 2005.

Source: Aggregate Minerals Survey, 2005.

of marine sand and gravel makes it an excellent concreting aggregate. Importantly the generally rounded nature of marine aggregates, particularly compared with crushed rock, reduces the amount of cement required for a given water content. As cement is the most costly component of concrete the use of marine aggregates may bring economic and environmental benefits, as cement manufacture is very energy intensive.

Regional importance

Marine aggregates account for about eight per cent of total primary aggregates supply in England and Wales. Regionally, however, the industry makes a crucial contribution to sand and gravel supply in London, the South East, North East, North West and South Wales (Table 2), as well as to total primary aggregates consumption in these areas.

The high dependency of London and the South East on marine aggregates and crushed rock imports is shown in Figure 10. Marine aggregate accounts for 32 per cent of the total primary

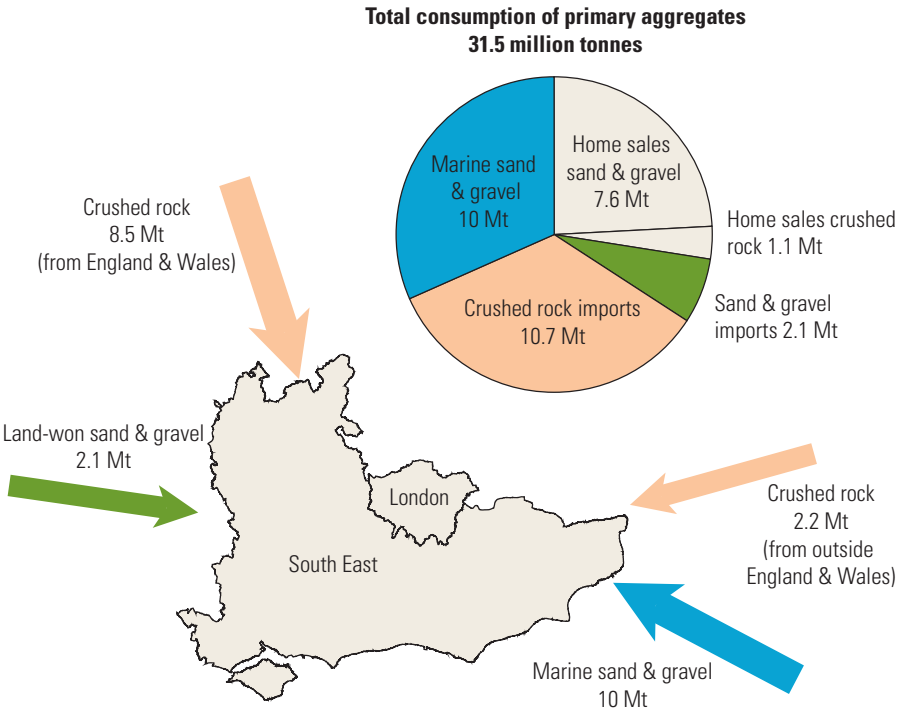


Figure 10 Consumption of primary aggregates and aggregate flows into London and the South East, 2005.

Source: Aggregate Minerals Survey, 2005.

Examples of construction projects using marine aggregate

Channel Tunnel Rail Link

£4.2 billion total project cost.

500 000 m^3 of concrete.

109 km of new high speed track alignment (300 km/hour).

Three major tunnel sections (North Downs, Thames and London tunnels), total length 25 km.

Four railway station developments (St Pancras International, Stratford, Ebbsfleet and Ashford).

Major bridge across the River Medway (the longest span high-speed rail viaduct in Europe).

152 bridges and structures along the route in a wide variety of ground conditions.

Queen Alexandra Hospital, Cosham, Hampshire

£200 million redevelopment to provide state-of-the-art healthcare facilities for residents in Portsmouth and south-east Hampshire.

Contract signed in December 2005, and final phase to be complete Summer 2010.

Liverpool Paradise Street Development Area

Regeneration project covering 17 hectares in the heart of the city.

Large, retail-led, mixed-use development that will result in six districts, each with their own distinctive character.

Project costing £500 million and involving 3300 construction jobs.

Final development will create 4400 permanent jobs.

To be completed in 2008.

Region	Thousand tonnes			
	Land-won	Marine	Total	% Marine
South West	4 603	661	5264	13
South East	9 573	5 952	15 526	38
London	1 038	4 035	5 073	80
East of England	13 720	*154	13 875	1
East Midlands	10 014		10 014	0
West Midlands	9 105		9 105	0
North West	2 932	838	3 770	22
Yorkshire & the Humber	4 398	298	4 695	6
North East	1 360	1 140	2 500	46
England	**56 743**	**13 078**	**69 821**	**19**
South Wales	304	1 238	1 542	80
North Wales	1 192	45	1 237	4
Wales	**1 496**	**1 283**	**2 779**	**46**
England & Wales	**58 239**	**14 361**	**72 599**	**20**

Table 2 Sales of sand and gravel by region in England and Wales, 2005.

Source: Aggregate Minerals Survey, 2005.

**Landings of 631 893 tonnes at wharves on the Thames in Thurrock are excluded from AMS figures, but are reported in the Thames estuary landings in The Crown Estate statistics.*

aggregates consumed in London and the South East, and about 70 per cent of total UK sales of marine sand and gravel are landed in these two regions.

Regional sales of marine aggregate by major end use are shown in Table 3. In the North West and South Wales, sand is the principal product reflecting the shortage of natural land-won sand in local aggregate markets. South Wales, in particular, is uniquely dependent on marine-dredged sand, which accounts for 85 per cent of the market for

Region	Thousand tonnes				
	Concrete sand	Concrete gravel	Building sand	Other uses	Total
South West	505	44	98	14	661
South East	2 817	2497	1	637	5 952
London	1 909	1651	40	435	4 035
*East of England	101	-	-	53	154
East Midlands	-	-	-	-	-
West Midlands	-	-	-	-	-
North West	558	-	238	42	838
Yorkshire & the Humber	103	92	3	100	298
North East	667	88	-	46	1140
England	**6 660**	**4 372**	**380**	**1 666**	**13 078**
South Wales	348	-	848	42	1 238
North Wales	-	-	45	-	45
Wales	**348**	**-**	**893**	**42**	**1 283**
England & Wales	**7 007**	**4 372**	**1 273**	**1 709**	**14 361**

Table 3 Sales of marine sand and gravel by region and major end use in England and Wales, 2005.
Source: Aggregate Minerals Survey, 2005.
**Landings of 631 893 tonnes at wharves on the Thames in Thurrock are excluded from AMS figures, but are reported in the Thames estuary landings in The Crown Estate statistics.*

concreting sand and 97 per cent of building sand supply, and there are no realistic alternatives. In the North West, marine landings of construction sand have almost trebled over the last seven years, with new landing points being established to meet market need.

Exports

As in the UK there is a large market for construction aggregates in Continental Europe where, in many areas, there are similar constraints on land-based extraction. Extraction of marine aggregate for construction purposes does take place from the continental shelves of other European nations — particularly Belgium and Netherlands. The continental shelves of both these countries have no substantive deposits of gravel or coarse sand, consequently production is dominated by fine to medium sand. Exports of marine aggregates (particularly gravel) from UK licensed areas started in the late 1960s and account for about one third of total production (Figure 6). The principal export market is the Netherlands but substantial quantities are landed in Belgium and France, mainly for use in concrete. Most ports (for example Amsterdam, Ostend and Dunkirk) have no tidal restrictions which is an advantage for accommodating the larger dredgers. The export market is important to the UK dredging industry as many of the parent companies have interests in continental wharves.

Marine aggregate exports make a modest, positive contribution to the UK balance of payments and because of these, the UK is a net exporter of aggregates (HM Revenue & Customs).

Beach nourishment and contract fill

The recharge of beach material that has been naturally eroded by the sea is a well-established market for marine aggregates dating back to the 1960s. It peaked in the mid 1990s and since then there has been a continuous programme of replenishment to sustain both work previously carried out and any new schemes. The tonnage used varies from year to year (Figure 5), reflecting requirements for individual schemes. These are mainly located on the Lincolnshire and north Norfolk coasts, which are most at risk, but there have also been numerous schemes in East Anglia and along the south coast. Over 80 million tonnes of marine aggregates have been supplied for beach nourishment and contract fill since the late 1960s. The latter includes schemes other than sea defence, such as land reclamation projects.

Coastal erosion is a growing problem with increased storminess and gradual sea-level rise resulting from climate change. Coastal protection is, therefore,

a major issue. The Department for Environment, Food and Rural Affairs (Defra) has overall policy responsibility for flood and coastal erosion risk in England, while the Environment Agency oversees management and funds coast protection works. Healthy beaches absorb the energy of waves as they approach land and thus reduce their capability to erode the coast. Beach recharge can represent a cost-effective option for protection, particularly where man-made structures are preventing the natural movement of sediment along the coast.

A crucially important factor, which has both environmental and economic advantages, is that large volumes of marine material can be sourced in relative proximity to the scheme and be pumped directly from dredger to the beach. In most cases the large volumes involved mean that the use of road transport is impractical. There will be continuing investment in beach recharge schemes for which the requirements could increase in the future. This market will be dependent on a continuing supply of marine aggregates for which there is no viable alternative.

Material for beach recharge has to meet strict specifications. It varies from pure sand to pure gravel, the principal objective being to replicate the existing beach materials for aesthetic (beach quality is crucial to attracting visitors) and engineering purposes. In addition, marine aggregate deposits often closely resemble coastal sands and gravels in their colour and composition. There appears to be a trend towards increasing the coarser fraction, which results in a more stable beach that does not erode as rapidly. 'As-dredged' material can have a higher sand content and, consequently, screened material may be preferred in some cases. Ideally material unsuitable for construction should be used but in many cases high-quality aggregate is necessary to meet engineering design requirements.

Major contract fill projects include the Cardiff Bay Barrage and Sizewell B nuclear power station in Suffolk. As well as construction fill, projects such as these also require large volumes of construction aggregate delivered directly to site on a contract basis.

Many existing nuclear power stations are located on vulnerable coastlines. Given the threats of coastal erosion and flooding, there will be a requirement to ensure that these assets are adequately protected throughout their full life cycle — including the extensive decommissioning phase.

Furthermore, the future role of nuclear power in Britain's energy mix is currently being considered. This will depend in part on the availability of suitable sites, with the favoured option being in conjunction with existing nuclear power stations. Given the location of many of these, new build would have to be accompanied by the upgrading and maintenance of coastal defences over the 100-year lifecycle of a new station, spanning construction, operation and decommissioning. It is therefore likely that marine aggregates would play an important role not only in the provision of construction aggregate for new builds, but also the long-term coast protection of sites.

The future contribution of tidal power is also under review as this represents a significant untapped renewable energy resource in Britain that would contribute to the twin challenges of climate change and security of supply. Tidal barrage schemes, whether large or small scale, would require large volumes of aggregate for both fill purposes and for construction. Given the coastal locations of such developments and the scale of supply required, marine dredged sand and gravel would represent an obvious source.

Beach replenishment projects

2006

Skegness, Lincolnshire	948 105 t
Southwold, Suffolk	146 733 t
Whitstable, Kent	149 293 t
Bournemouth, Dorset	1 505 000 t
Poole, Dorset	672 000 t
Swanage, Dorset	143 592 t

2005

Skegness, Lincolnshire	862 270 t
Heacham, Norfolk	324 768 t
Pevensey Bay, East Sussex	139 308 t
Shoreham, West Sussex	204 148 t

2004

Skegness, Lincolnshire	198 737 t
Happisburgh, Norfolk	311 236 t
Folkstone, Kent	565 418 t
Shoreham, West Sussex	323 141 t

2003

Skegness, Lincolnshire	181 238 t
Happisburgh, Norfolk	664 536 t
Shoreham, West Sussex	122 801 t
Poole, Dorset	104 611 t

2002

Skegness, Lincolnshire	312 346 t
Southend, Essex	356 692 t
Pevensey Bay, East Sussex	357 564 t


© Cardiff Harbour Authority

Contract fill

Cardiff Bay Barrage

Cardiff Bay is a sheltered inlet covering about 200 hectares on the Bristol Channel at the mouths of the Rivers Taff and Ely.

The Cardiff Bay Barrage itself is 1.1 km long and extends from Cardiff docks in the north to Penarth in the south. This major civil engineering construction project has created a freshwater lake with over 13 km of waterfront. The £220 million project has been the catalyst for the £2 billion regeneration of the old docklands of Cardiff and Penarth.

Royal assent for the Cardiff Bay Barrage Act was granted in November 1993 and construction commenced in May 1994. It was completed in November 1999, at a cost of £120 million, when a saline impoundment was created. Freshwater impoundment commenced in the Spring of 2001.

The main operational section of the Barrage, which includes the locks, sluices and fish-pass, was constructed in the dry, in a sand cofferdam. The sand used was dredged from the Bristol Channel, and was then re-used for completing the embankment.

The concrete caissons for the outer harbour breakwaters were constructed in the dry dock at Cardiff and floated into position.

The following materials were used for the Barrage construction:

Concrete 135 000 m^3
Rock armour 700 000 t
Sand 2 550 000 t
Silt dredged 3 000 000 t

Sizewell B Nuclear Power Station

The UK's first Pressurised Water Reactor cost £2 billion to build. Work started in 1987 and was completed in 1994. Some 341 000 m^3 of concrete was used in the construction of the new power station while further concrete was used in the overall development of the site. Concern about the extra lorry traffic generated by the construction, resulted in 1.46 million tonnes of marine sand and gravel being delivered by sea via an offshore pumping station and pipeline ashore.


© British Energy Sizewell B

Marine aggregate industry

There are 11 companies currently involved in the production of marine aggregates in the UK. In addition, there are a number of other companies that are indirectly involved through joint-venture operations. Most of these companies are members of the British Marine Aggregate Producers Association (BMAPA), which is a constituent body of the Quarry Products Association, the principal trade association representing the UK aggregates industry.

The parent companies of the principal marine aggregate operators also have significant land-based interests.

The marine aggregate industry is highly capital intensive and operates 28 dredgers with a replacement value of up to £1 billion. The industry directly employs about 640 staff, 500 of which are ships' officers and crew with the balance providing shore-based support. As dredgers operate around the clock, virtually all of the dredging vessels have two sets of crew, operating on a two- to three-week cycle. A further 600 staff are employed directly on the wharves in England, Wales and Continental Europe which receive UK marine aggregates. BMAPA estimates that an additional 550 jobs can be directly related to the primary delivery of British marine sand and gravel.

The marine aggregates industry also supports jobs in the manufacture of value-added ready-mixed concrete and concrete products, and the distribution of these products to consumers in the construction industry. In addition to direct employment, the industry supports a range of other jobs through the goods and services it purchases from other UK businesses. These include survey ships and associated equipment and personnel to carry out prospecting work, as well as environmental assessment and monitoring studies. Ships are docked for routine maintenance and this also employs contracted staff.

Dredging fleet

The British marine aggregates industry operates 28 purpose-built marine aggregate dredgers with a total hopper capacity of 112 000 tonnes. These are predominantly British registered. Smaller vessels (less than 3000 tonnes capacity) supply local ports and have a 12–24 hour turnaround, while the larger vessels (4000 to 8000 tonnes) travel further afield and have a 24–36 hour turnaround. Typically a 5000 tonne capacity vessel will produce up to 1 million tonnes of aggregate a year, more than the largest sand and gravel quarries on land.

The key constraint on the ability of the industry to deliver more aggregate is the capacity of the dredging fleet. In the past, more vessels were available for recommissioning as and when demand required. Today, however, the dredging fleet is operating to capacity so the potential to increase production is limited. If UK demand for aggregates increased, economics would dictate that there is potential for some increase in home landings by reducing exports. Generally, the shorter turnaround times in transporting aggregates to UK ports, rather than more distant European ports, would effectively increase the productivity of a vessel. However, there are obstacles to this approach as many operators have interests in Europe. Although there are few suitable vessels to draw upon, capacity could also be increased by chartering third-party vessels. This already happens on a limited basis for construction aggregates, and larger, faster and more powerful ships are used frequently for the supply of sand and gravel for beach replenishment and coastal defence projects.

Some operators have chosen to expand the capacity and capability of their existing dredging fleet. For example, the cargo capacity of the CEMEX UK dredger *Sand Falcon* was increased by adding another section to the vessel's hull — a more cost-effective option than building a new ship.

Marine aggregate extraction causes considerable wear and tear on the ships. The age profile of the dredging fleet shows that 81 per cent are more than 15 years old, and 26 per cent of vessels are older than the generally accepted working life of 25 years. Consequently, to maintain the capacity of the sector there will be a requirement for significant investment in the not too distant future. The cost of building a new vessel is currently in the range £25–40 million, so to replace all ships that will be more than 25 years old in the next ten years would involve capital investment of £600–900 million. To invest in a new vessel is a complex decision for operators, as the working life of a vessel has to be considered not only against licensed reserves, but also the predicted market conditions and the regulatory and policy environment in which the sector will be operating in the future.

Marine wharves

Adequate wharf facilities at appropriate locations to allow the landing, processing, storage and distribution

Region	Marine sand and gravel wharves
South West	5
South East	28
London	7
East of England	4
East Midlands	0
West Midlands	0
North West	5
Yorkshire & the Humber	1
North East	5
England	**55**
South Wales	12
North Wales	1
Wales	**13**
England and Wales	**68**

Table 4 Distribution of marine aggregate wharves.

of marine aggregates are an integral and crucial part of the supply chain. Many wharves are also integrated with valued-added manufacturing facilities in the form of ready-mixed concrete and concrete block plants. Their water front location means that marine aggregate wharves could potentially be under pressure from other industrial activities and residential development. The strategic importance of wharves to the future supply of marine aggregate imports has thus prompted wharf safeguarding strategies, notably in London and the South East. Policies for safeguarding wharves are also included in MPS1: *Planning and Minerals.*

Marine aggregates are landed at 68 wharves in 45 ports in England and Wales. Landings vary widely between wharves, with annual landings ranging between 20 000 tonnes and 1.7 million tonnes. Wharves are mainly located in specific regions where there is a shortfall in land-won supplies and/or there are economic advantages because of river access and proximity to the market. About half of the wharves are located in southern and eastern England (Table 4 and Figure 3), but other concentrations are in South Wales, Merseyside and on the Tees, Tyne and Humber.

In addition, there are 13 landing ports and 17 wharves in Europe (Belgium, France and the Netherlands).

Currently the specialised wharves which receive marine aggregate have spare production capacity and are generally sufficiently flexible over a 12-month period to be able to increase their throughput by continuous processing and extending working hours. In this respect, the industry considers that wharf capacity will not limit its ability to supply additional marine aggregate to the UK in the short to medium term. There are other issues, however, that can affect the potential to supply. One constraint is the ability to deliver the right quality and volumes of aggregate to the landing point, which in turn is influenced by the capacity of the dredging fleet and the location of permitted reserves. Another is the ability to deliver the processed product to the final point of demand, an issue related to the limitations of the road and rail infrastructure at marine wharves.

Companies currently directly involved in marine aggregates extraction

Britannia Aggregates
CEMEX UK Marine (incorporating British Dredging)
DEME Building Materials
Hanson Aggregates Marine
Kendall Brothers (Portsmouth)
Northwood (Fareham)
Norwest Sand and Ballast
Severn Sands
United Marine Dredging
Volker Dredging
Westminster Dredging (incorporating Westminster Gravels and Llanelli Sand Dredging)

The marine aggregate dredging fleet

	Vessel	Built	Length (metres)	Maximum dredging depth (m)	Hopper capacity (m^3)	Hopper capacity (tonnes)	Age (years as of 2007)
Britannia Aggregates	Britannia Beaver	1991	99	43	2 775	4 800	16
					2 775	**4 800**	
CEMEX UK Marine	Sand Falcon	1998	120	50	5 000	8 500	9
(British Dredging)	Sand Fulmar	1998	99.9	50	4 000	6 920	9
	Sand Harrier	1990	99	33	2 700	4 671	17
	Sand Heron	1990	99	33	2 700	4 671	17
	Welsh Piper	1987	69	24	790	1 367	20
	Sand Serin	1974	65	27.4	900	1 557	33
	Sand Weaver	1974	97.5	30	2 400	4 152	33
					17 490	**30 258**	
DEME	Charlemagne	2002	101.3	60	5 000	8 650	5
					5 000	**8 650**	
Hanson Aggregates Marine	Arco Dijk	1992	113.2	32	5 100	8 800	15
	Arco Dart	1990	67.7	30	700	1 250	17
	Arco Dee	1990	67.7	30	700	1 250	17
	Arco Axe	1989	98.3	45	2 890	5 000	18
	Arco Beck	1989	99.6	32	2 600	4 500	18
	Arco Adur	1988	98.3	45	2 890	5 000	19
	Arco Arun	1987	98.3	45	2 890	5 000	20
	Arco Avon	1986	98.3	45	2 890	5 000	21
	Arco Humber	1972	107	30	4 600	8 000	35
					25 261	**43 800**	
Norwest Sand and Ballast	Sand Swan	1970	65.73	16	840	1 453	37
					840	**1 453**	
Northwood (Fareham)	Donald Redford	1981	53.4	25	510	880	26
	Norstone	1971	67.2	25	1 075	1 860	36
					1 585	**2 740**	
Severn Sands	Argabay					1400	
						1400	
United Marine Dredging	City of Cardiff	1997	72	35	1 300	2 300	10
	City of Chichester	1997	72	35	1 300	2 300	10
	City of London	1990	99.9	46	2 775	4 800	17
	City of Westminster	1990	99.7	46	3 000	5 200	17
					8 375	**14 600**	
Westminster Dredging	Sospan	1990	57	15	970	1 700	17
(Westminster Gravels and	Sospan Dau	1978	68	28	1 500	2 595	29
Llanelli Sand Dredging)					**2 470**	**4 295**	
Fleet total						**112176**	**20 (average)**

Marine aggregate extraction and processing

Dredging

Dredging is the process by which sediments are removed from the sea bed and deposited into a vessel's hold. It involves lowering a suction pipe, typically 0.7 to 1 m in diameter and up to 85 m long, to the sea bed in the licensed area. The draghead, at the end of the pipe, rests on the sea bed and sand, gravel and sea water are lifted by powerful pumps and deposited into the vessel's hopper. These have capacities of between 1200 and 8500 tonnes. The hold is filled with water and a process of settling occurs with excess water and suspended fines overflowing the hopper and back into the sea.

There are two basic types of dredging process; trailer suction dredging and static suction dredging. Trailer suction dredging is the principal method used for extracting marine aggregates in British waters, although static suction dredging is also employed. The former involves trailing the draghead across the sea bed at slow speed (1.5 knots). The process is used for deposits that occur as extensive sheets and results in a series of grooves 2 to 3 m wide and typically 0.25 to 0.5 m deep. Repeated passes progressively deepen the sea bed and over time several metres (over 6 m) can be removed. Dredging zones are typically 3 km long and 250 m wide but they do vary. During static dredging the vessel is anchored or dynamically positioned over the deposit and extracts the material whilst stationery. This is particularly useful where more localised, thicker sand and gravel deposits (up to 10 m) are being targeted. Over time it results in a more localised shallow depression.

Both methods use proven technology, also routinely employed in both maintenance and capital dredging[1] operations. However, while the general principles are similar — a centrifugal pump lifting a mixture of sediment and water from the sea bed via a dredge pipe into a storage hopper — there are two major factors unique to those dredgers which only undertake aggregate extraction for construction purposes: screening and self-discharging a dry cargo.

Firstly, as well as loading 'as-dredged' or 'all-in' material, many aggregate

[1] Capital dredging — excavation of material to deepen or create new navigational channels and berths to provide additional harbour infrastructure or provide access for deeper draught vessels. Maintenance dredging — removal of accumulated sediments from existing harbour channels and berths to ensure a safe depth of water for navigational purposes. Capital and maintenance dredging produces material that is largely unsuitable for construction aggregate use.

dredgers have the ability to process the sediment while loading operations are underway. This involves a process of 'screening' in which the proportion of sand to gravel in the cargo is adjusted to meet customer requirements. This is particularly useful where the in situ composition of the sea-bed sediments falls outside specifications for construction or beach replenishment. The preferred gravel to sand ratio for construction aggregate is 60:40, although construction sand remains an important product in its own right.

The screening process returns a significantly greater volume of sediment to the water column during loading operations. As such, the environmental implications of this activity have to be very carefully considered through the consenting process. However, screening does allow more marginal deposits to be worked, thus maximising the use of the resource and thereby reducing the need for new dredging sites.

The second key difference is that the majority of purpose-built construction aggregate dredgers are designed to self-discharge a dry cargo. This requires the dredged material retained in the hopper to be dewatered before

Case study – Sand Falcon operated by CEMEX UK Marine Ltd

Length – 120 m

Maximum dredge depth – 50 m

Hopper capacity – 8500 tonnes.

The *Sand Falcon* was built 1998 in Merwede, Rotterdam at a cost of £15 million. In 2003, a further £2.5 million was invested to increase the vessel's cargo capacity by 'stretching' the hull length and replacing the original in-board dredge pump with a pipe-mounted overboard dredge pump to increase the vessel's dredge depth.

The vessel takes between 3 and 8 hours to load and four hours to self-discharge using a bucket wheel discharge system, with each cargo taking between 24 and 36 hours to dredge and deliver.

During the course of a typical year, the vessel will load over 1.5 million tonnes of sand and gravel from production licence areas off the South and East coasts, and deliver to a range of wharves located in the Thames estuary and on the near Continent.

The vessel operates with two crews of 12, working on three-week rotation.

Case study – Greenwich Wharf, London

The wharf is operated by United Marine Aggregates Ltd, a joint venture between Hanson and Tarmac, and is located on the south side of the River Thames, between the Thames Barrier and Millennium Dome. It covers a total area of 1.6 hectares. The wharf has the largest landings of marine aggregates in Europe and supplies over 1.5 million tonnes of processed sand and gravel every year, serving a market of 32 km radius. The wharf also has a railhead, which distributes about 500 000 t/year, with individual trains taking 1500 tonnes.

The site can stock 50 000 tonnes of unprocessed material (ballast as dredged) and 40 000 tonnes of processed product.

The wharf can receive vessels of up to 10 000 tonnes capacity, though 5000 tonnes is the norm, and the wharf receives 5–7 cargoes a week. Vessels berth on a rising tide alongside mooring piers which are in the deeper water of the river, and unload into a hopper which is connected to the wharf by a conveyor belt system. After completion of discharge (about four hours) the vessels depart on the falling tide.

unloading. There are a range of discharge techniques from grab cranes, scraper buckets and bucket wheels to unload the cargo directly on to the wharf, with discharge rates of up to 2000 tonnes/hour.

Processing

Wharves in southern and eastern England have advanced screening and washing facilities, whilst those in South Wales and North West England operate without the need for processing as only a sand product is landed. The principal products are coarse and medium sand and for 4/10 mm, 10/20 mm and 20/40 mm gravel. Any oversize gravel is usually crushed before being re-screened into the smaller grades. The material is carried by conveyor to a screening plant where it is washed and separated on a

Processing

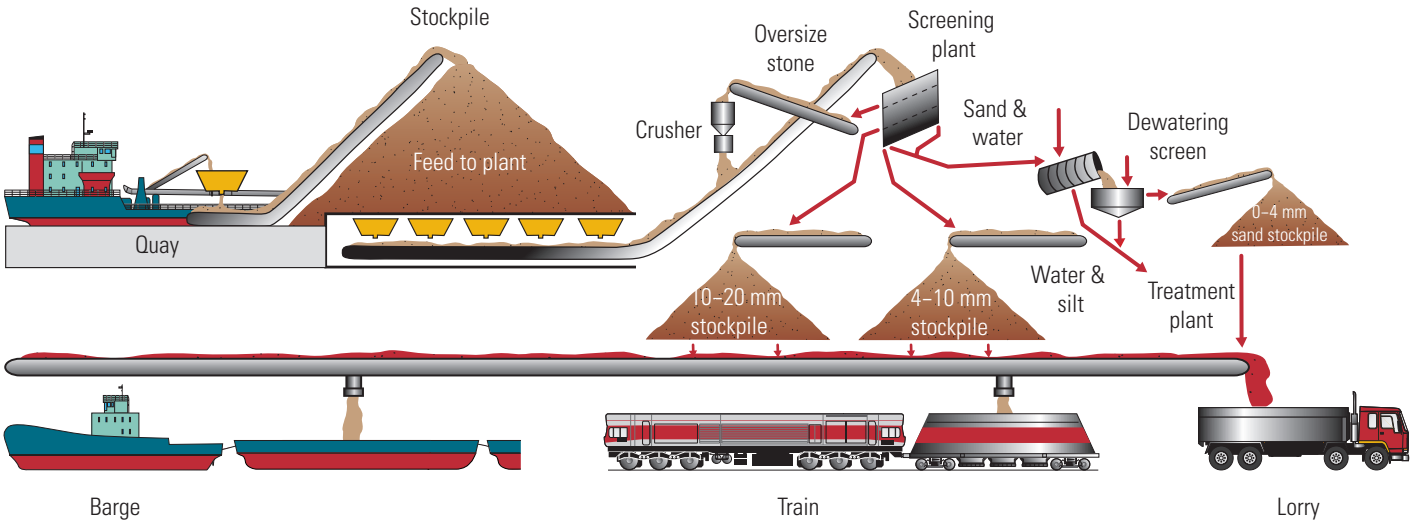


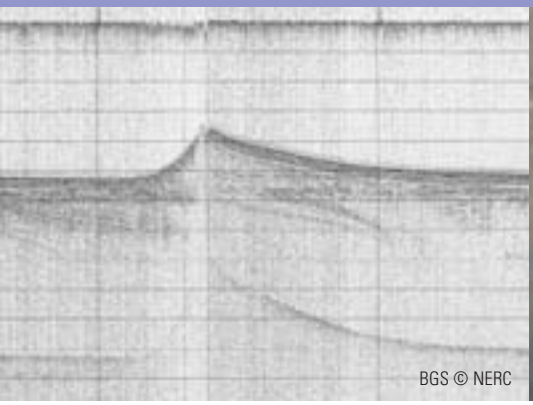
Figure 11 Marine aggregate processing.

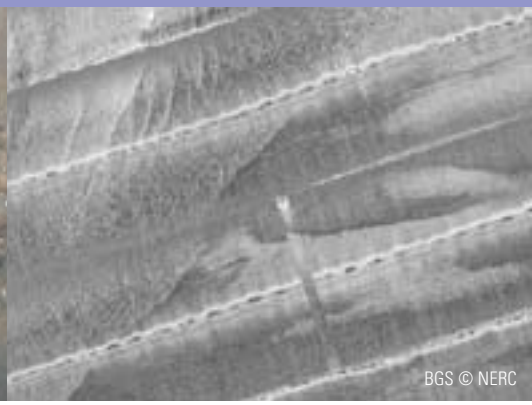
succession of vibrating screens. These separate the material into sand and specific grades of gravel. The sand fraction is dewatered and the material is stockpiled (Figure 11).

Due to its origin and composition, virtually all of the marine aggregate landed is able to be used, there being very limited silt or oversize content.

One of the great benefits of the marine aggregate industry is its ability to deliver large volumes of aggregate close to the heart of urban areas. This greatly reduces the impact of heavy lorries and brings clear environmental benefits by relieving traffic congestion, and air and noise pollution. The use of trains from some wharves further reduces the need for road transport, and barges are used to deliver to some riverside projects.

The production of ready-mixed concrete and concrete products is the main use of marine aggregates, and many wharves now incorporate concrete manufacturing facilities.



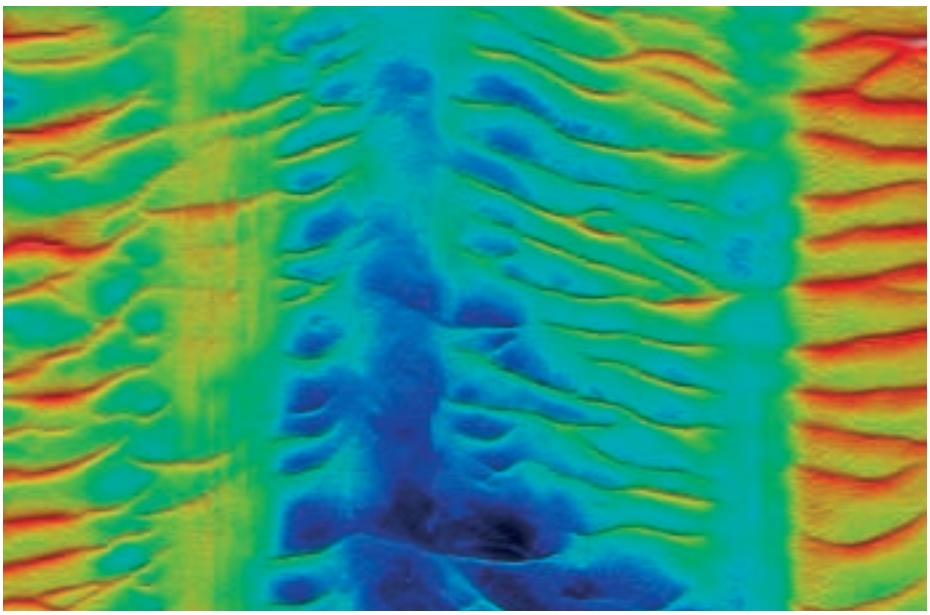


Marine aggregate resources

Sea-bed sand and gravels are widespread around Britain but many deposits are either too thin to be commercially dredged, or are dominated by unsuitable grain sizes (i.e. fine sand, silt or clay) and therefore not viable for construction aggregate use. Gravelly resources are related to the extent of ancient river channels and terraces, glacial outwash or submerged beaches, and are not as extensive as sand resources. The latter commonly occur as extensive sheet and sand wave deposits or large sand banks. The industry believes that resources of marine sand and gravel are sufficient for at least 50 years production at current rates of extraction.

Resources vary in their thickness, composition and grading, and in their proximity to both the shore and potential markets. Most dredging takes place in coastal waters less than 25 km offshore, and in water depths of between 18 m and 35 m. The technology of the current aggregate dredging fleet means that the maximum depth that resources can be practically worked is around 50 m, thus water depth represents a controlling factor on resources that can currently be worked.

The origins of gravel-bearing sediments offshore are directly comparable to those of land-based deposits. They are relict Quaternary deposits formed by ancient river systems or glaciofluvial processes but modified superficially by the major postglacial sea-level rise which took place after the last ice age. They represent a range of former depositional environments, including river channel-fill and terrace deposits, glaciofluvial meltwater plain deposits, sea-bed lag gravels and degraded shingle beach or spit deposits, as well as modern marine tidal sand banks and sand wave deposits. Gravels (greater than 4 mm material) are essentially



An example of multibeam bathymetry over a marine aggregate production licence in the Southern North Sea.

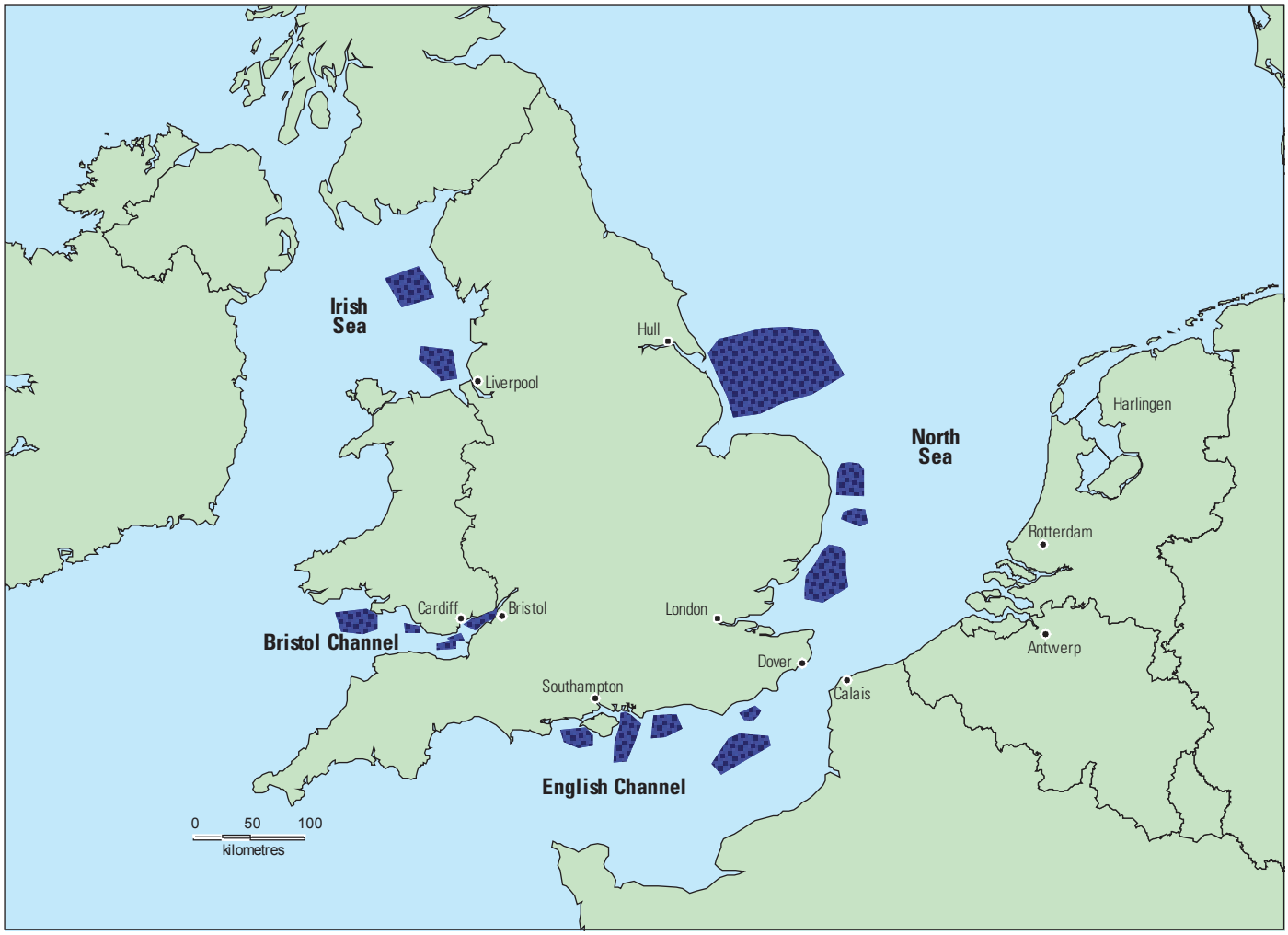


Figure 12 Marine aggregate resources. *Source: BMAPA.*

immobile in the water depths that dredging takes place, and given their relict nature are not replenished after extraction. Most sand deposits are also immobile, but some may be partly replenished as sand is naturally moved across the sea bed by wave and tidal currents.

The most important resource areas are the East Coast (offshore Great Yarmouth-Southwold), the South Coast, including the East English Channel, the Humber–Wash area, the South West coast area (chiefly the Bristol Channel) and the North West coast area (chiefly Liverpool Bay – Irish Sea). There are considerable regional variations in the composition of the sand and gravel deposits. The focus of most commercial extraction is off south-east England in thick gravel-bearing deposits. This material may require screening to produce a marketable product with roughly equal proportions of gravel and clean medium- to coarse-grained sand. In the Irish Sea and Bristol Channel, only sand is required by the local market so thick accumulations of medium to coarse sands are targeted.

The location of known aggregate resources off England and Wales is shown in Figure 12 and the contribution of the different areas to regional supply in Figure 4. Currently the East Coast and South Coast dredging areas are the principal sources of supply, together accounting for about 65 per cent of production. However, the recently developed deposits in the East English Channel will make an increasingly important contribution to supply in the future.

Access to marine **aggregate** resources

A number of factors determine where marine aggregates can be worked. These are fundamentally determined by two critical factors:

- the presence of a viable aggregate resource
- permission to access the resource.

There are large resources of sand and gravel on the UK Continental Shelf that could be commercially viable to extract. However, as onshore, the presence of an otherwise economically viable aggregate deposit is not, in itself, sufficient to ensure that mineral extraction will ever take place. In common with mineral extraction onshore, a legal permission is required for marine aggregate extraction. Without a permission, dredging cannot occur. To ensure an adequate and steady of supply of marine aggregate, a succession of permissions is required.

The development process for marine aggregate extraction has three main phases:

- **prospecting** — exploration for new aggregate deposits, including securing exclusive options to extract from the mineral owner (The Crown Estate)
- **permitting** — obtaining legal permission to extract newly identified deposits from the regulator (Marine and Fisheries Agency and the Welsh Assembly Government)
- **resource management** — managing production, payment of royalties and, importantly, environmental monitoring of the impacts of dredging activities and compliance with licence conditions.

Whilst onshore aggregate resources are mainly in private ownership, offshore the situation is different. The rights to marine sand and gravel are principally vested in the Crown, which owns most of the sea bed out to the 12-mile territorial limit and the rights to explore for, and extract, non-energy minerals on the remainder of the UK Continental Shelf. These rights are managed by The Crown Estate and almost all of the 24 million

tonnes of sand and gravel dredged annually from the sea bed around England and Wales is obtained from areas licensed by The Crown Estate. Operators pay a royalty to The Crown Estate for every tonne dredged from licences. Royalties paid on marine sand and gravel landings were some £15.8 million in 2006/7, the major proportion of which was passed to HM Treasury.

At present, marine aggregate extraction is concentrated in English and Welsh waters. The first application was recently received proposing dredging in Northern Ireland waters. It has yet to be determined and it remains to be seen whether other proposals follow in these waters.

Commercial marine sand and gravel extraction can only occur if the operator is in possession of both a licence from the landowner and a permission from the regulator.

Licensing

Marine aggregate operators must obtain a licence from The Crown Estate to carry out both prospecting and

Policy background and regulatory guidance

Minerals Policy Statement 1: Planning and Minerals (MPS-1) (Department for Communities and Local Government, November 2006) sets out Government's key overarching policies and principles for minerals planning in England. Annex 1 of MPS-1 focuses on aggregates, and within this the following statement is made with respect to marine sand and gravel supply:

'It is Government policy to encourage the supply of marine-dredged sand and gravel to the extent that environmentally acceptable sources can be identified and exploited within the principles of sustainable development. 'Environmentally acceptable' in this context is in terms of both the natural and historic environments. Subject to this overriding consideration, it is assumed that marine dredging of sand and gravel is likely to continue to meeting part of the national and regional demand for aggregates at a proportion no lower than that of the recent past, currently about 8% of total demand for primary aggregates.'

Marine Mineral Guidance Note 1: Guidance on the Extraction by Dredging of Sand, Gravel and Other Minerals from the English Seabed (MMG1) (Office of the Deputy Prime Minister, July 2002) describes the policies and procedures for marine minerals dredging in English waters. It provides guidance to regulators, their scientific advisors, industry and wider stakeholders as to how marine minerals extraction should be undertaken so that it is consistent with the principles of sustainable development.

Marine Minerals Guidance Note 2: The Control of Marine Minerals Dredging from the British Seabed (MMG2) (Defra, May 2007) explains the statutory procedures contained in the *Environmental Impact Assessment and Natural Habitats (Extraction of Minerals by Marine Dredging) (England and Northern Ireland) Regulations 2007* (the 2007 Regulations) and defines the procedures that are followed in making decisions on marine minerals dredging. The Regulations transpose into UK law in relation to British waters the requirements of the European Directives on the assessment of the effects of certain projects on the environment (the EIA Directive), and the conservation of natural habitats and of wild flora and fauna (the Habitats Directive) in relation to the extraction of marine minerals.

Interim Marine Aggregates Dredging Policy (Welsh Assembly Government, November 2004) define the Welsh Assembly Government's interim policy for marine minerals dredging in South Wales. This seeks to ensure sustainable, objective and transparent decision making to meet society's needs for aggregates dredged from the Bristol Channel and Severn Estuary.

Interim Strategic Policy 1 states: *'While other alternative sources of supply of suitable fine aggregates will continue to be investigated, the use of marine dredged sand and gravel will continue for the foreseeable future but only where this remains consistent with the principles of sustainable development.'*

commercial dredging activities. *Prospecting licences* provide developers with an exclusive option on an area of sea bed to carry out the necessary geological and geophysical investigations to establish whether a viable aggregate resource is present. This is a commercial arrangement, and exclusive options are awarded through a process of competitive tendering in which potential developers submit bids based on the proposed term, extraction rate and royalty payment for their defined areas.

If prospecting identifies a viable deposit, the developer has an option to apply for an exclusive *production licence*. However, the production licence will only be granted by The Crown Estate if the developer obtains a dredging permission through the appropriate regulatory regime.

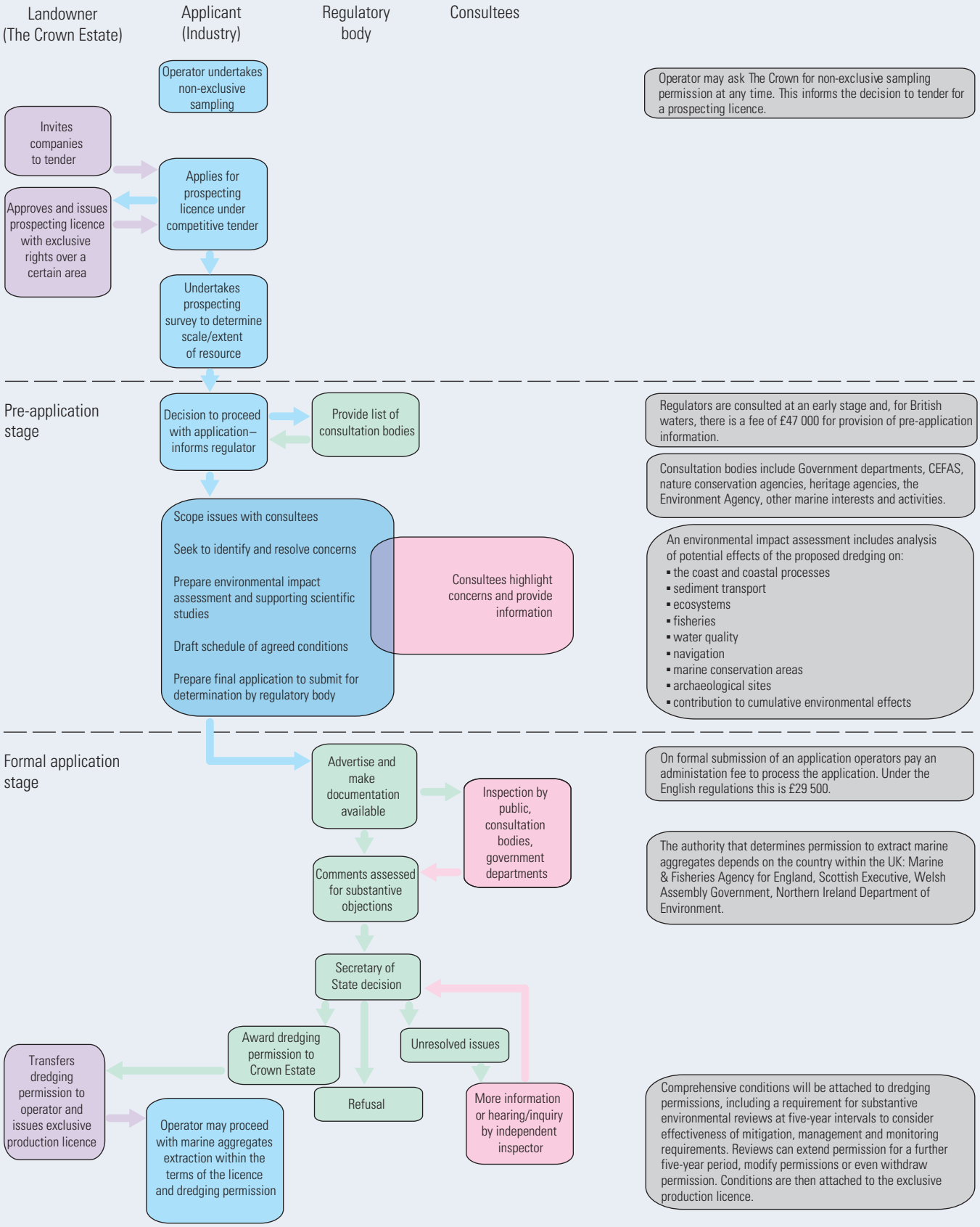
Permitting

Statutory regulations transpose the requirements of the European Environmental Impact Assessment (EIA) and Habitats directives in relation to marine mineral dredging in UK waters. This requires applications from industry to be subject to comprehensive environmental impact assessment, supported by various scientific studies. A dredging permission will only be issued if the application is not considered to result in unacceptable environmental impacts. Under the regulations, dredging permissions will include comprehensive dredging conditions to mitigate and monitor the environmental effects of the extraction. This includes the requirement for all dredgers to have an Electronic Monitoring System (EMS) that continually records the position of all dredging activity using information from GPS satellites. Each dredging permission is monitored on an annual basis, with a substantive review every five years to determine whether the permission will be extended or modified.

The English regulations are administered and enforced by the Marine and Fisheries Agency, an Executive Agency of the Department for Environment, Food and Rural Affairs (Defra). Similar regulations are in preparation for Scottish and Welsh waters.

A Marine Bill is currently being developed by Defra, to deliver a more integrated and holistic approach to planning, managing and protecting Britain's seas. As well as proposing to develop a system of marine spatial planning, the Bill includes proposals to streamline marine consents (including marine minerals dredging) in order to achieve a more consistent approach for the control of marine development activities.

The tendering, permitting and licensing process



Regulation continues throughout the term of a dredging permission. The following administration fees are charged by the MFA to perform these functions:

- for considering monitoring reports prepared in respect of the pre and post dredging and operational periods, £6 500 per annum
- interpreting and assessing the Electronic Monitoring System data produced during the operational dreding period, £11 500 per annum
- for processing variations which constitute relevant projects or habitats projects, £21 500
- for processing all other variations, £6 000.

All fees relate to England only (2007). Fees to be charged in relation to Northern Ireland, Welsh and Scottish waters are not finalised.


Marine aggregate reserves

The economic potential of an aggregate resource, whether on land or offshore, can only be determined by detailed prospecting work. Offshore this involves geophysical surveying and sampling (grab samples and vibrocores) with associated test work to prove whether a sand and gravel deposit of sufficient quantity and quality is present. Such an investigation is an essential precursor to applying for a dredging licence and the associated dredging permission.

That part of an aggregate resource, which has been fully evaluated and is commercially viable to work, is called a reserve. In the UK, reserves need to meet not only the requirements of geological certainty and economic viability, but also legal access. For onshore extraction this is a legal agreement with the mineral rights owner and a planning permission from the relevant Mineral Planning Authority (i.e. permitted reserves). Offshore a dredging licence is issued by The Crown Estate following permission from the relevant regulatory body (i.e. licensed reserves). The total area of sea bed licensed for marine aggregate extraction in 2006 was 1316 km^2 (Figure 13), comprising about 70 production licence areas. The total area actually dredged was only 141 km^2 and, of this, 90 per cent of dredging effort took place within 49 km^2.

Securing new, long-term marine aggregate reserves is crucially important for a number of reasons. At national, and particularly regional and local level, marine aggregates are a vital component of current and future aggregates supply, without which increasing demands on declining land-based reserves would be required. For the marine aggregates industry, sufficiently large reserves are required to justify the continuing and substantial investment required to update the dredger fleet.

In 2005, the declared primary reserve of permitted coarse marine aggregate was 114 million tonnes (*Marine Aggregate Reserves: Crown Estate Licences* – 31 March 2006), equivalent to around seven years' production. The capability of marine aggregates to maintain supply over the medium to longer term was therefore in doubt. However, these concerns have been significantly reduced with the award of 11 new dredging permissions over the period 2006/07, including new licence areas in the East English Channel. Permitted reserves of coarse aggregate in these new licences are 47 million tonnes. Although this represents a significant improvement, there remain regional weaknesses in the industry's reserve position, for example in the Bristol Channel. Furthermore, many of the practical issues concerned with the commercial extraction of new reserves have yet to be fully understood. These include the practical operational problems that may occur in working new, less well-known areas, together with the environmental impacts of extraction. Depending on the outcome of the annual monitoring and substantive five-year review of new licence areas the possibility exists that dredging permissions could be withdrawn. For this reason the newly permitted licence reserve of 47 million tonnes is limited to the maximum permitted production during the first five years of the licence only. The total volume of workable marine aggregate within these licensed areas is very much larger but whether this is permitted to be worked will depend on the outcome of the review process.

Land-based reserves of sand and gravel are declining in England because new permissions are not fully replacing material extracted and sold. The position is most acute in the South East where reserves have declined from 207 million tonnes in 1995 to 81 million tonnes in 2005 and 53 per cent of total sales were not replaced by new permissions. The reasons for this appear to be a combination of planning refusals and a reduction in planning applications, related to the availability of suitable areas of unconstrained resources. Consequently in the South East, marine aggregates are accounting for a greater proportion of sand and gravel supply as land-won sales decline.

Regional marine aggregate dredging statistics, 2006

	Area licensed[1]	Permitted removal[1]	Area dredged[2]	Actual removal[2]
	(km^2)	(tonnes)	(km^2)	(tonnes)
Humber	483.68	4 650 000	28.26	4 471 173
East Coast	268.00	12 200 000	51.31	8 006 736
Thames	102.87	2 950 000	15.92	1 595 011
East English Channel	53.83	6 490 000	3.60	338 900
South	211.89	11 125 000	31.93	7 613 510
South West	141.11	2 616 000	8.34	1 545 275
North West	54.95	1 384 999	1.24	608 314
	1 316.33 km^2	**41 415 999 t**	**140.6 km^2**	**24 178 919 t**

[1] As of the 31st December 2006

[2] For the period 1st January-31st December 2006

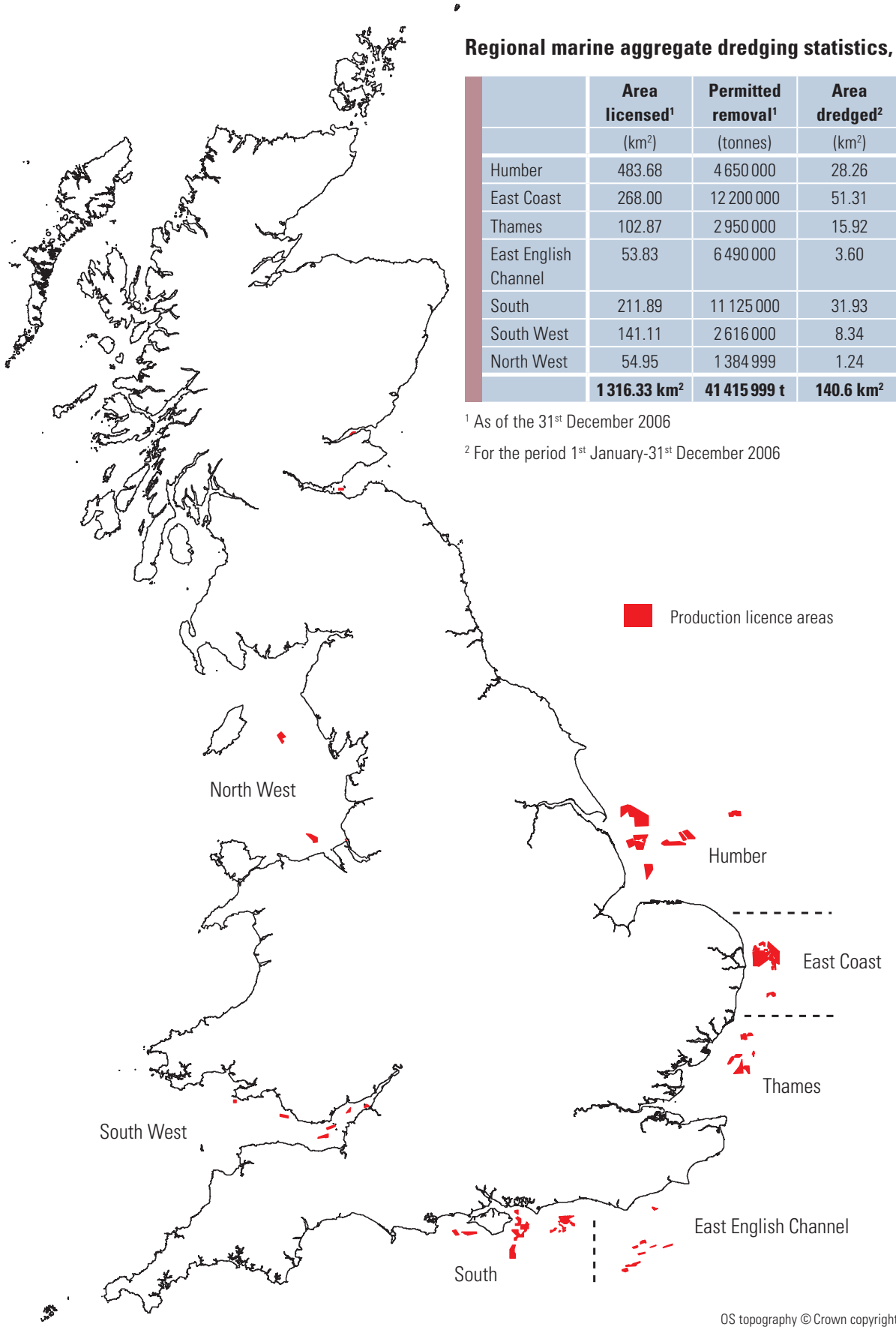


Figure 13 Location of licensed reserves. *Source: The Crown Estate.*



Marine aggregates — the economic contribution

Indigenous minerals production brings obvious benefits to the economy in terms of employment, investment and national income, and also in providing security of supply. However, the economic importance of the marine aggregates industry is not solely attributable to the value of production and the number of people who are directly or indirectly employed by the industry. Account also needs to be taken of its position in the value chain and to its role as a supplier of essential raw materials to the construction industry. The range of activities involved in the British marine aggregates industry, the key processes involved in producing and adding value to the raw material, and its end uses are shown in Figure 14.

The total value of marine aggregates sales, including exports and beach nourishment, is estimated to be over £250 million in 2006. However, this figure considerably undervalues the contribution that marine aggregates make to the construction industry in particular and also, indirectly, the economy as a whole. Like minerals in general, aggregates lie at the start of the supply chain and support the manufacture of a number of value-added products, which contain aggregates as essential raw materials. The gross value added (GVA) of the most important of these — concrete products and ready-mixed concrete — is shown in Table 5, although land-won aggregates are also used in the manufacture these products. The GVA of an industry is the difference between the value of its output (e.g. income from sales) and the cost of bought-in inputs, including raw materials (but not labour).

Industry Standard industrial classification (SIC) code	Number of firms	Number of employees	Total sales £ million	GVA 2005 £ million
26.61 Manufacture of concrete products for construction purposes	668	23 000	2 618	1 130
26.63 Manufacture of ready-mixed concrete*	192	8 000	1 663	555

** Data for 2004*

Table 5 Number and gross value added (GVA) at current basic prices of selected downstream industries, 2005. *Source: Office for National Statistics, Annual Business Inquiry.*

However, the ultimate value of construction aggregates resides in their essential use by the construction industry to create, maintain and enhance Britain's built environment and infrastructure. The construction industry is one of the most important sectors of the economy. Its products and services underpin all other UK economic and social activity and it consists of over 220 000 businesses employing 1.4 million people. The GVA of the construction industry was £63.2 billion in 2005, accounting for about six per cent of total UK gross domestic product (Office for National Statistics). This figure does not take account of the value to society of outputs such as homes, hospitals, schools and general infrastructure for transport, energy, water and waste.

Demand for aggregates is fundamentally driven by activity in the construction sector. The industry will continue to require large quantities of construction aggregates, even though modern construction methods may use proportionally less than previously. The total value of construction output in Great Britain in 2005 was £107 billion at current prices: £59.4 billion was for new work and £47.6 billion for repair and maintenance. Moreover, the value of construction output continues to grow in real terms (Figure 15) and growth is forecast to outstrip the economy as a whole over the next three years (Construction Products Association).

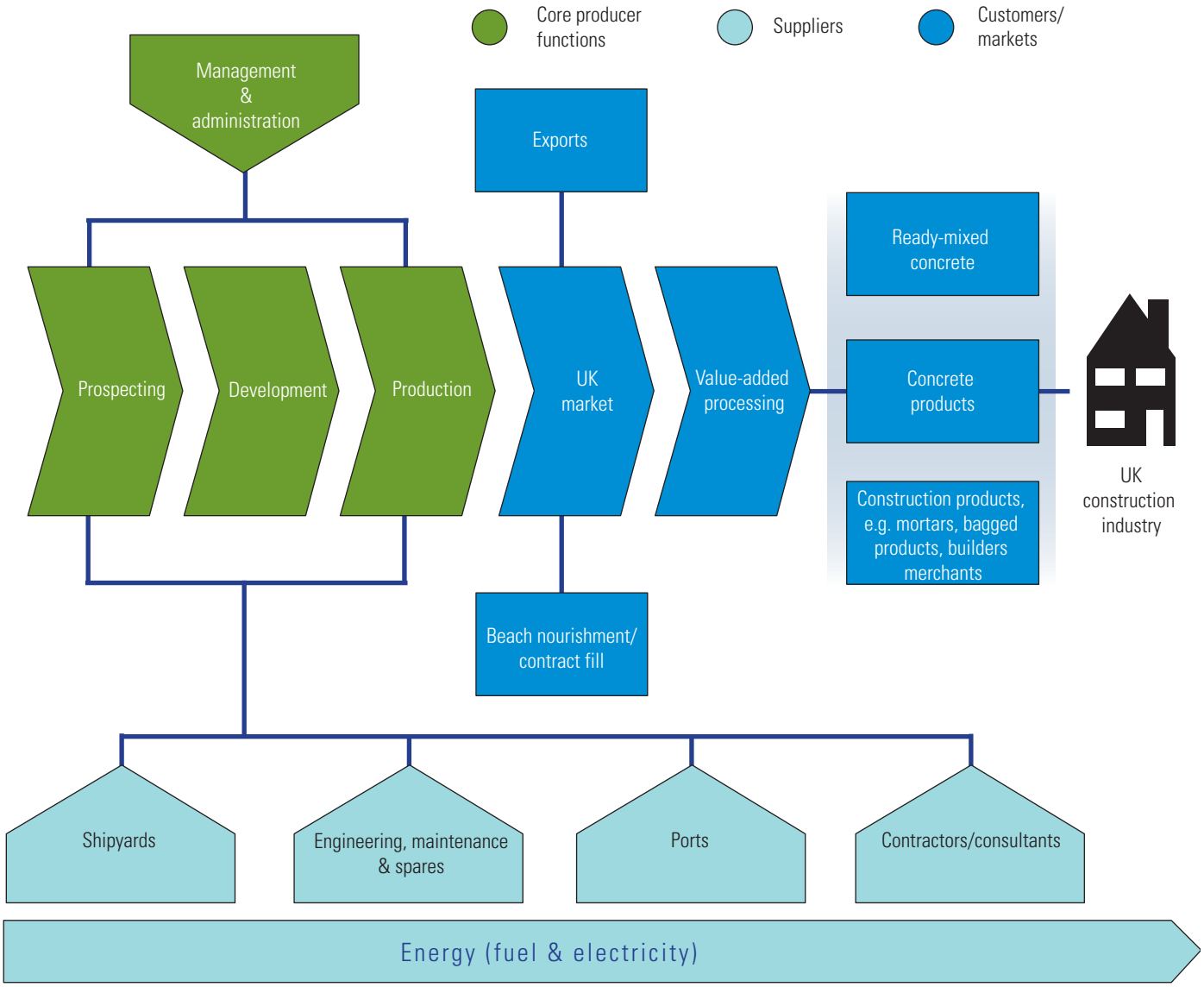


Figure 14 The marine aggregate production value chain.

Major construction projects utilising marine aggregates

Arsenal AFC Emirates Stadium

Queen Alexandra Hospital, Portsmouth

Channel Tunnel Rail Link

Gateshead Millennium Bridge

Jubilee Line Extension

Spinnaker Tower, Portsmouth

Terminal Five, Heathrow

Paradise Project, Liverpool

Millennium Stadium, Cardiff

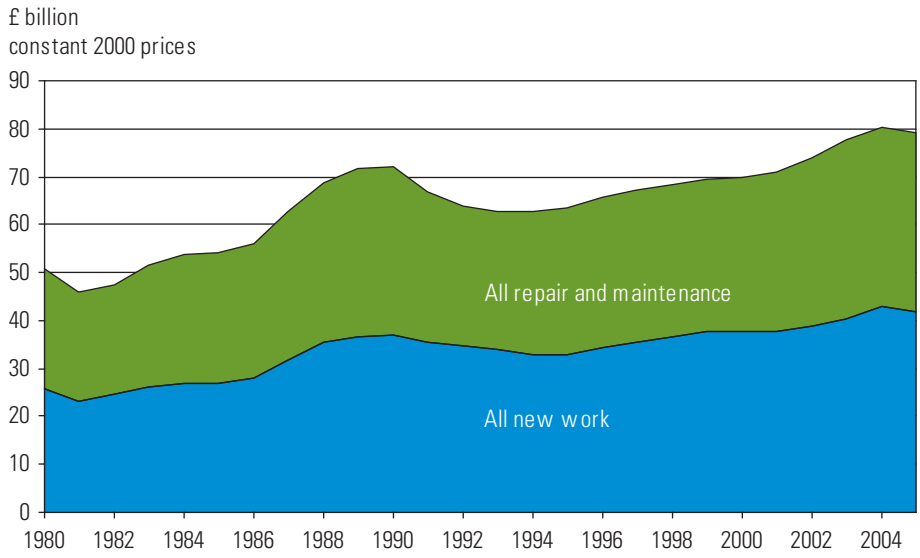


Figure 15 Great Britain: Value of construction output, 1980 – 2005 (in constant 2000 prices).

Source: DTI

Regional importance

London and the South East account for about one-third of UK economic activity as measured by GVA. They also account for a similar proportion of total construction output (see Table 6). Construction activity in these two regions is in support of the dynamic financial and business services sector of the regional economies and the associated demand for homes, offices and infrastructure.

London and the South East have a higher dependency on marine aggregates than elsewhere. About 72 per cent of all marine sand and gravel supply was consumed in these two regions in 2005 and marine aggregates accounted for 41 per cent of total primary aggregates consumption in London and 27 per cent in the South East (AM2005). Marine aggregate underpins a significant proportion of the construction activity that takes place in London and the south-east of England. Any loss of this strategic supply would place increasing pressure on land-based reserves and also on an inadequate transport infrastructure to deliver aggregate from more distant and perhaps more environmentally sensitive locations.

Region	Value of all construction output, 2005 £ million (provisional)	%
South West	9137	10
South East	15740	17
London	14434	15
East of England	10950	11
East Midlands	8008	8
West Midlands	9015	9
North West	11341	12
Yorkshire & the Humber	9160	10
North East	3574	4
England	**91360**	**96**
Wales	**4228**	**4**
England & Wales	**95588**	**100**

Table 6 England and Wales: Value of construction output (current prices) by region, 2005.

Source: Construction Statistics Annual Report, 2006. DTI.

Future issues

Demographic changes are placing increasing pressures on land and will also result in increased construction activity. These changes are being caused by population growth in England, which is projected to rise by about 5 million to 55 million by 2026, and changing household structure due, in part, by the growth in single-occupier households (Barker, 2006). More people will require more homes, infrastructure, workplaces and retail premises. The Government has set a new housing target for 2016 of 240 000 additional homes a year and believes that a total of three million new homes will be required by 2020 (*Homes for the future: more affordable, more sustainable*. CLG, 2007). Demand for construction is likely to be greatest in the new growth areas in London, and southern and eastern England. These include the Thames Gateway, which stretches for over 60 km from London Docklands to Southend-on-Sea in Essex and Sheerness in Kent; it coincides with where the major proportion of marine aggregates is landed. Regeneration in the Gateway includes the creation of 180 000 new jobs and the up 160 000 new homes. In London growth for office space remains strong and will be boosted by projects such as the Olympic Park. There will be a continuing, and increasing, need for construction aggregates to supply these major developments. The marine aggregate industry is ideally located to serve this need.

The challenge of climate change and the need to protect existing coastal assets will create a continuing demand

for marine sand and gravel. Large volumes will be required for coast protection purposes and to contribute to the manufacture of concrete products for improvement of the existing inland drainage infrastructure. The Government is currently considering the future role of nuclear electricity in the UK and the coastal sites of existing and potential new power stations would require continuing and long-term protection from erosion by the sea.

The introduction of the new statutory permitting process on 1 May 2007 has brought marine aggregate extraction more in line with land-based planning control. The change has been welcomed by the marine aggregate industry. It considers it will streamline the permitting process compared with the old Government View arrangements and also allow a better balance to be struck between meeting the needs of all marine resource users and minimising environmental impacts.

The Government is also committed to the use of marine aggregates as a resource and recognises in MPS1 the important contribution that they make to aggregates supply, particularly at regional level. The marine aggregate industry has the potential to increase its contribution and whilst land-based reserves, particularly of sand and gravel, are declining those offshore are increasing as new licences are issued.

The ongoing system of managed aggregates supply has proved effective and despite the concerns expressed in the 'Verney' Report in 1976 (*Aggregates: The way ahead*), infrastructure development has not been constrained through any scarcity of aggregates. Past estimates of aggregate demand have often proved to be too high and the former link between primary aggregate demand and construction output has been broken (Figure 16). The intensity of use of primary aggregates, and particularly sand and gravel per unit of construction output has been declining for many years. This decline cannot continue indefinitely and must stabilise and

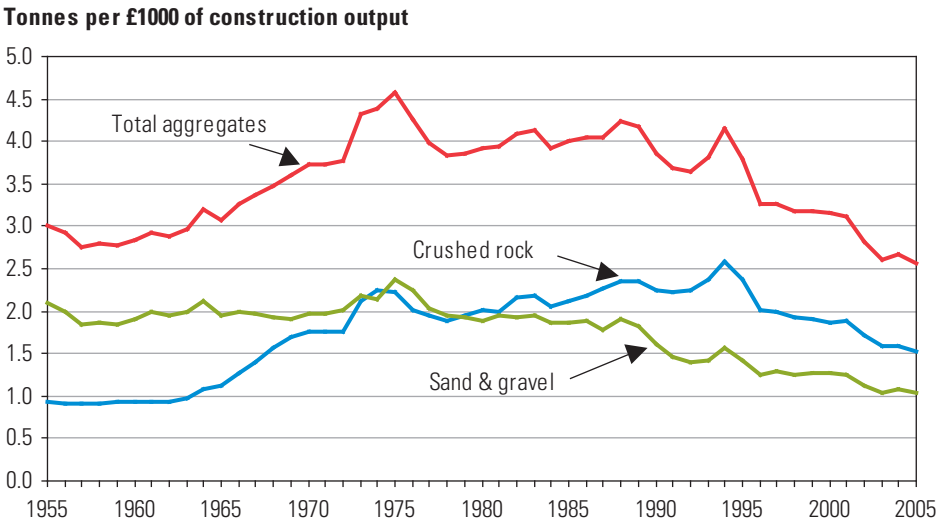


Figure 16 Great Britain: Intensity of use of primary aggregates per unit (£1000) of construction output in constant values, 1955–2005.

Source: United Kingdom Minerals Yearbook, British Geological Survey.

Marine Bill

The UK Government's and devolved administrations' shared vision and strategic goals for the marine environment.

The vision:

Clean, healthy, safe, productive and biologically diverse oceans and seas.

The strategic goals:

- to conserve and enhance the overall quality of our seas, their natural processes and their biodiversity
- to use marine resources in a sustainable and environmentally sensitive manner in order to conserve ecosystems and achieve optimum environmental, social and economic benefit from the marine environment
- to promote and encourage economically and environmentally sustainable use of natural resources to ensure long-term economic benefits and sustainable employment
- to increase our understanding of the marine environment, its natural processes and our cultural marine heritage and the impact that human activities have on them
- to promote public awareness, understanding and appreciation of the value of the marine environment and seek public participation in the development of new policies.

perhaps rise if additional investment is put into transport infrastructure, more homes, coastal and flood protection, and brownfield development.

The new Marine Bill (see text box) will have sustainable management of the marine environment at its core. This will require integrated management and a new system of marine spatial planning will provide the framework for more effective decision-making. It should allow a wider view to be taken about the way individual developments interact, the conflicts between them, and their cumulative impacts, thus integrating society's resource needs with protection of marine wildlife and biodiversity. The key role would be to steer future developments into the appropriate, environmentally acceptable locations. 'Preferred areas' could be identified for different activities or the protection of certain resources. This would be of particular importance for marine aggregates, as they can only be extracted where they occur at workable depth.

Adopting a strategic, plan-led approach to managing marine activities will, as on land, require adequate data to help balance competing interests and objectives. With respect to marine aggregates this will include improving the knowledge base on the extent, thickness and quality of marine aggregate resources and the impacts on the environment of their extraction. Much work has been undertaken over past decades but this will need to continue into the future. BMAPA published its own sustainable development strategy for the marine aggregate sector in 2006 *(Strength from the depths)*. An important element will also be to effectively monitor the strategic role that marine aggregates make to aggregate supply, particularly at regional level. Marine aggregate resources are national assets and it is important to ensure that the capital they represent is managed properly so that the economic benefits they create are in line with the principles of sustainable development.

The 2003 national and regional aggregate guidelines (Table 1) include an assumption for the contribution of marine sand and gravel to national aggregates supply. However, the current system of managed aggregate supply does not extend offshore or indeed include any forecast demand for aggregate use in coastal protection. A key element of marine spatial planning for marine aggregates should be to ensure that the essential contribution they make to Britain's overall aggregate requirements is maintained, perhaps through the adoption of formal guidelines for marine aggregate supply. This will also require close liaison between the various departments with responsibility for land-won and marine supplies. This should, in turn, provide the marine aggregates industry with a greater degree of certainty about the future, enabling it to make the substantial and essential capital investment in ships and wharves to maintain supplies. It would also provide more confidence about future aggregates provision for those MPAs and regions that are heavily reliant on marine aggregates.


Conclusions

Adequate supplies of aggregates are essential for our economic well being and quality of life, and play a crucial role in underpinning the UK construction industry. Whilst the UK is increasingly dependent on imports for many of its mineral raw materials it is self-sufficient in aggregates and, by virtue of marine aggregates, a small net exporter. Land-based aggregate resources are unevenly distributed and many regions are heavily dependent on supplies from other areas, notably London and the South East, which account for over one third of economic and construction activity in the UK.

Marine aggregates are ideally located to fill part of these regional deficits, contributing to diversity of supply and delivering high-quality construction aggregate into the centre of areas of high demand with minimum environmental impact. They accounted for 19 per cent of sand and gravel sales in England and 46 per cent in Wales in 2005 — eight per cent of total primary aggregate sales. The industry is even more important in London and the South East, supplying 32 per cent of primary aggregates consumed in 2005.

Marine aggregates also provide material for restoring eroding beaches and protecting low-lying coastal areas from marine flooding, a use that will become of increasing importance because of climate change. There are large resources of marine sand and gravel, sufficient to last for many decades providing that new permissions are forthcoming.

While the marine aggregate industry is a mature industry sector, it is now entering a new phase. The new permitting process, a new Marine Bill and the establishment of the proposed 'Marine Management Organisation', with its core functions of marine spatial planning and integrated licensing, will enable a more strategic and long-term view of the management of the marine area to be taken. This in turn should provide the industry with greater business certainty to make the £600–900 million capital investment in new ships that will be required to maintain and develop the marine aggregate contribution to overall supply in the medium to long term.


Sources of information

BMAPA website and publications (www.bmapa.org). Including:

- *Aggregates from the sea*
- *Strengths from the depths*

Aggregates: The way ahead. Report of the Advisory Committee on Aggregates. (The Verney Committee). Department of the Environment, Scottish Development Department and the Welsh office. 1976.

Barker Review of Land Use Planning. Final Report – Recommendations, December 2006.

The Crown Estate website and publications (http://www.thecrownestate.co.uk/our_portfolio/marine.htm)

Marine aggregate dredging 2006. The area involved—9th Annual Report. The Crown Estate and the British Marine Aggregates Producers Association. 2007.

Collation of the results of the Aggregate Minerals Survey for England and Wales. British Geological Survey Commissioned report, CR/07/102N 137 pp.

Homes for the future: more affordable, more sustainable. Department for Communities and Local Government, July 2007. Cm 7191.

A Sea Change, a Marine Bill White Paper. Department for Environment, Food and Rural Affairs. March 2007.

Marine Minerals Guidance Note 1: Guidance on the Extraction by Dredging of Sand, Gravel and Other Minerals from the English Sea Bed. Office of the Deputy Prime Minister. July 2002.

Minerals Policy Statement 1: Planning and Minerals. Annex 1: Aggregates. Department for Communities and Local Government. 2006.

National and regional guidelines for aggregates provision in England, 2001 – 2016. Office of the Deputy Prime Minister, 2003.

R C Newell and D J Garner (editors). 2007. *Marine aggregates extraction. Helping to determine good practice.* Marine aggregate levy sustainability fund (ALSF) conference proceedings, September 2006.

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