BEACH RECHARGE IN SUSSEX & EAST KENT: A PRELIMINARY INVENTORY & OVERVIEW

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1 Introduction

Sand and shingle are being lost from many beaches in Sussex and Kent as a result of natural coastal processes as well as ill-designed sea defence and coastal protection schemes. To counteract falling beach levels, the Environment Agency and local authorities are increasingly resorting to "topping-up" the beaches with additional sand and shingle. Several terms are currently employed to refer to the artificial provision of extra beach material, but there is disagreement about their precise definition. For the purpose of this report, *beach nourishment* (or *beach replenishment*) is defined as the supply of material that has been dredged from the seabed or extracted from inland sand and gravel pits. *Beach recycling* is defined as the removal of material from an accreting beach and its return to a beach from which it has been transported by longshore drift. The term *beach bypassing* will be used to refer to the "borrowing" of sand and shingle from beaches updrift, which under natural conditions could be expected to supply the material through longshore drift. The terms *beach recharge* and *beach feeding*, often regarded as synonyms for beach nourishment, are used in this report as overall terms for beach nourishment, bypassing and beach recycling.

Beach reprofiling is the artificial reshaping of beaches using existing beach materials. Storms tend to flatten and lower beaches, causing the beach crests to retreat landward. Often the beaches become steeper again during periods of calmer weather, but artificial beach reprofiling is sometimes undertaken to speed up the process and prepare the beaches for the onslaught of further storms. The Environment Agency regularly undertakes beach reprofiling at a number of sites on the coast of South East England, for example at Medmerry on the Selsey Peninsula in West Sussex. Although beach reprofiling is becoming an important management tool, it falls outside the scope of the present report.

Beach nourishment is often presented, perhaps too kindly, as "working with nature", whereas beach recycling can be seen as a deliberate intervention to reverse the natural process of longshore drift. Beach nourishment tends to be undertaken as a "one-off" operation, and charged against capital funds, whereas beach recycling (and bypassing) is often carried out once or twice a year, and is viewed as a maintenance cost. Nevertheless, no rigid temporal distinction can be drawn between beach nourishment and beach recycling, and both techniques are sometimes combined in the same project.

Beach recycling can be criticised because it reduces the natural supply of sand and shingle to beaches downdrift of the point of extraction. This interference with the natural replenishment of the beaches can, if carried to excess, lead to shoreline retreat and flooding problems. Recycling is, however, is about ⅓ cheaper than beach nourishment using sand and gravel dredged from the seabed (Eastbourne Borough Council and the Environment Agency, 2003).

According to the review undertaken by Hanson *et al*. (2002), beach nourishment and beach recycling were first employed as forms of coastal defence in the UK in the 1950s.[1] It would indeed be true to say that coastal engineers in the first half of the twentieth century were heavily engaged in constructing seawalls and vast groyne fields. Nevertheless, there were several pioneer beach recharge schemes in South East England and perhaps elsewhere (see below for details). Recycling was carried out at Seaford on the Sussex coast as early as 1900. Further recycling took place in the late 1930s, and in addition it is reported that some shingle was brought in from Dungeness to top-up the beach. At Pett Level, sand and shingle dug from a pit just inland from the coast was dumped on the beach in the 1930s.

It is often said that the sole purpose of beach recharging in the early years was to provide coastal protection, and that no attention was paid to enhancing the recreational value of beaches. This again is an oversimplification. In 1938, for example, the authorities at Ramsgate decided to improve the narrow beach on the western (southern) edge of the town by transporting 14,000 tons of sand (~7,700 m^3) from the wide eastern beach at a cost of £7000 (Dimond, 2002). The experiment was a success and the West Beach (or Artificial Beach, as it was known to locals) was very popular with holidaymakers both before and after the war.

Dredging offshore for sand and gravel underwent rapid expansion in the UK during the 1970s because of technological advances. Beach nourishment using marine sand and shingle began in 1972 and soon took on an important role in coastal defence (Hanson *et al*., 2002). Provided care is taken to select an appropriate grade of material, dredgings can make excellent beach fill. Large volumes can be quickly added to beaches with minimum inconvenience to the public, avoiding the need to use vast convoys of heavy lorries. One lorry can carry at most about 20 tonnes of sand or shingle; this same amount can be pumped ashore from a dredger in less than half a minute! Another advantage of marine sand and gravel is that it is readily available and can be purchased at very competitive rates. Posford Duvivier (1987) have calculated that recharging beaches with dredged shingle costs only ½ or ⅔ as much as bringing the shingle by lorry from a gravel pit 50 miles inland, though the sand content, which may be unwanted, is likely to be higher.

Because of its many advantages, beach nourishment has become the preferred option in South East England for managing "beaches at risk". Public support for traditional "hard" defences, such as seawalls, has steadily declined, but beach nourishment has won

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[1] What may be termed "accidental" beach nourishment has, of course, a much longer history. In 1850, for example, the chalk cliff at Seaford was dynamited in order to create a cliff fall that would act as a giant groyne and restrict the loss of shingle from Seaford Beach. 380,000 tons of chalk were dislodged, setting the cliff line back by 30 m (100 feet). The debris covered a 110 m wide stretch of beach to a depth of up to 15 m and extended 120 m from the new cliff base in a seawards direction (see The Illustrated London News, September 28, 1850). To everyone's disappointment, the chalk was so broken up that it was quickly removed by the waves, and only briefly checked the longshore drift. However, it undoubtedly contributed significant quantities of flint to the beach. In 1931-35 the seawall and promenade known as the Undercliff Walk was constructed at the foot of the chalk cliffs between Brighton and Saltdean, the cliffs were trimmed back by unemployed Welsh miners, and the spoil, including numerous flints, was dumped on the beach. Just as at Seaford, the chalk debris was quickly washed away by the sea, but the flints provided useful beach nourishment. On the Durham coast, vast quantities of colliery waste were dumped on the beaches between 1919 and 1993 (Humphries, 1996).

increasing acceptance as an environmentally sensitive "soft engineering" alternative, which can greatly enhance the amenity value of a beach.

Offshore dredging is carried out under licence from the Crown Estate, and is allowed only after detailed assessment of its potential impact on the environment, especially fish stocks. Dredging is permitted only in relatively deep water several kilometres offshore where it cannot have any adverse effects on shorelines and beaches. It is the responsibility of the dredging companies to apply for licences, which currently take about 5 to 10 years to obtain (Bellamy, undated).

Marine shingle is generally smaller in diameter and more angular than the shingle on Channel beaches, and is often mixed with sand. In many areas the shingle forms a thin "lag-gravel" overlying sand (Harrison, 1996). Only the thicker deposits of shingle are of value for recharging shingle beaches.

On the Sussex coast, many beach nourishment schemes have used shingle dredged from the Owers Bank, 9 km south of Littlehampton. The seabed immediately east of the Isle of Wight is sandier and has somewhat finer shingle than the Owers Bank, and so far has been less targeted for beach recharge material. The Hastings Bank, 13 km south of Hastings and 20 km east of Beachy Head, is another valuable source of shingle for beach nourishment, but dredging is allowed only within a very limited area (an application has been made to enlarge the area) and only at certain times of the year in order to conserve fish stocks. For ecological reasons, boats are not permitted to screen dredged shingle at sea to reduce its sand content. Exploitation of the Owers Bank is subject to less strict environmental controls, and screening can be carried out during dredging. Unfortunately, shingle stocks have dwindled because of the amount of dredging, and the Owers is in danger of being "worked out" (Stuart Meakins, personal communication). According to Posford Duvivier (1997, p. 22), the Hastings Bank yields slightly coarser shingle on average than the Owers Bank, which could make it more desirable as a source of beach nourishment material. However, the Owers Bank material is very variable, and much depends on where precisely the dredging vessels operate (Mark Russell, personal communication). Similarly, on the Hasting Bank, only some shingle is coarse, and the remainder is of relatively small size (Steve McFarland, personal communication).

Only a small proportion of the sand and gravel that is dredged from the seabed each year off England and Wales is used for beach nourishment. In 2003 about 22.1 million tonnes (~12.3 million m^3) of marine sand and gravel were brought ashore, mostly for concrete production and construction infill (Crown Estate and BMAPA, 2003). Some 6.1 million tonnes (27.6% of the total) were exported to The Netherlands, Belgium and France. Only 1.5 million tonnes (6.9% of the total) were used for beach nourishment in England and Wales. Demand for marine sand and gravel in the UK rose impressively during the 1970s and 1980s, but for the last 10 years has been fairly static. In 1999 about 23.7 million tonnes were dredged from the seabed off England and Wales (Marine Habitat Committee, 2000) and in 1994 about 22 million (Harrison, 1996).

Since 1972 nearly all the sand and gravel used in UK beach nourishment has been dredged from the seabed. Very little has come from inland pits. Hanson *et al.* (2002) estimate that an average of 125,000 m^3 of sand and 170,000 m^3 of shingle were added annually to UK beaches between 1970 and 1994. These estimates disguise the fact that the annual totals rose very greatly over this period. According to Bellamy (undated), the use of dredged sand and gravel for UK beach nourishment peaked in 1996 at 6.2 million tonnes (~3.4 million m^3). Since then the annual demand in England and Wales has averaged less than 2 million m^3, contrary to the forecast of Humphreys *et al.* (1996) that demand would remain steady for many years at 3 to 6.5 million m^3 (5.5 to 11.5 million tonnes).

The largest beach nourishment scheme in the UK was begun in August 1994 to defend a 24 km stretch of the Lincolnshire coast, between Mablethorpe and Skegness Beach (Zwiers *et al.*, 1996). Four years later, some 7.8 million m^3 of sand had been dredged from the seabed 20 km offshore and pumped onto the beach at a cost of £45 million (Hanson *et al.*, 2002). Further recharging has taken place and by about 2007 the total volume of sand pumped onto the beach is expected to have risen to 9.4 million m^3. By comparison, beach nourishment schemes on the coast of South East England have been quite modest in scale. The largest, at Seaford in 1986-7, saw the deployment of 1.67 million m^3 of shingle, and the next largest, at Hythe in 1996, about 1 million m^3. What the Kent and Sussex schemes lack in size, however, they more than make up in number, and judged on the total volume of recharge, South East England probably accounts for a full third of all the beach nourishment in the UK.

Hanson *et al*. (2002) have mapped the location of 34 UK “documented” beach nourishment schemes. No less than 16 are located on the Channel coast, with 9 falling in the BAR area. The map in this report gives a useful impression of the relative frequency of schemes at a regional scale, but is seriously misleading in detail. As shown later, many more schemes have been completed in Sussex and Kent, or are under way, than appear on the map.

One reason why Hanson *et al*. (2002) may have overlooked so many schemes is that they are often poorly documented. Drawing up the present inventory has been surprisingly time-consuming. Much valuable information is “buried” in consultant’s reports and local authority files, which can prove surprisingly elusive, and, even when found, frustratingly incomplete. Many schemes are well documented in the early planning stages, but details of what was finally agreed and actually implemented can be much harder to find. Work programmes are sometimes abruptly modified leaving almost no paper trail. Quite frequently recharge work is carried out at short notice at the end of a financial year in order to eliminate a budgetary surplus. The appropriate paperwork is not always completed.

The present catalogue is essentially a progress report. Some beach recharge schemes have doubtless been missed, perhaps as many as 20% of the total, and, for some of the schemes listed, details are scanty. Any reader who can supply additional information is invited to get in touch with the author.

2 Inventory of beach recharge schemes

TABLE 1: DOCUMENTED BEACH RECHARGE SCHEMES IN WEST SUSSEX. Beach recycling and bypass schemes are listed in italics. N/A = not available.

BEACH	**DATE**	**LENGTH OF FRONTAGE**	**VOLUME OF RECHARGE**	**SOURCE OF RECHARGE**	**COST**
WEST SUSSEX					
MEDMERRY	1988-89	200 m	5550 m^3	N/A	N/A
CHURCH NORTON	*Early 1990s onwards*	*200 m*	*15,000 m^3 of shingle*	*Pagham Harbour entrance*	*N/A*
BOGNOR	Late 1970s	N/A	N/A	N/A	N/A
FELPHAM	1999	N/A	40,200 m^3	“Dredged from the seabed”	N/A
ELMER	1992-3 (main phase)	1.5 – 2 km	200,000 m^3	N/A	£6 million including 8 detached rock breakwaters
CLIMPING to ATHERINGTON	*1994 onwards*	*250 m (?)*	*24,000 m^3 per year (average)*	*Climping Beach*	*N/A*
LITTLEHAMPTON to CLIMPING	*Since 1993*	*N/A*	*~23,000 m^3 per year (average)*	*Beach just west of Arun mouth*	*N/A*
LITTLEHAMPTON East Beach	*1994*	*N/A*	*Harbour dredgings in 1994 & later recycling*	*Arun mouth*	*N/A*
FERRING RIFE	2003	N/A	~30,000 m^3 of sand and shingle	East of the Isle of Wight.	N/A
WORTHING	Early 1990s & 1998 onwards	N/A	“small” amounts of recharge	N/A	N/A
BROOKLANDS	*1995*	*N/A*	*30,000 m^3 of shingle*	*Eastern end of Shoreham Beach*	*N/A*
SHOREHAM & LANCING, phase 1	1996-99	3.3 km	35,172 m^3	East Wight	£10 million including rock groynes (Phases 1 & 2)
SHOREHAM & LANCING, phase 2	2002-3	3.3 km	200,000 m^3	The Nab	
SHOREHAM & LANCING, phase 3	2005-	3.3 km	100,000 m^3 planned	N/A	N/A
SHOREHAM HARBOUR	*1992 onwards*	*N/A*	*10,000 m^3 per year (average)*	*Beach west of the western harbour arm*	*N/A*

TABLE 2: DOCUMENTED BEACH RECHARGE SCHEMES IN EAST SUSSEX. Beach recycling schemes are listed in italics. N/A = not available.

BEACH	DATE	LENGTH OF FRONTAGE	VOLUME OF RECHARGE	SOURCE OF RECHARGE	COST
ROTTINGDEAN	1994-95	N/A	102,000 m^3	Owers Bank	N/A
SALTDEAN	1996-97	N/A	94,000 m^3	Owers Bank	N/A
OVINGDEAN	*c. 1995*	*N/A*	*N/A*	*Rottingdean*	*N/A*
SEAFORD	*1900*	*c.1 km*	*41,000 m^3*	*Beach east of East Pier, Newhaven*	*£66,000*
SEAFORD	*1936-40*	*c. 1 km*	*26,000 m^3*	*Beach east of East Pier, Newhaven* & Dungeness	*N/A*
SEAFORD	*1963*	*c. 1.2 km*	*N/A*	*Beach east of East Pier, Newhaven*	*£140,000 including additional groynes*
SEAFORD	1986-87	1450 m	1.67 million m^3	Owers Bank	£9 million including a new terminal groyne and other defence works
SEAFORD	*Annually*	*1450 m*	*100,000 m^3 per year*	*SE end of frontage*	*N/A*
CUCKMERE HAVEN	*Annually*	*250 m*	*7000m^3 in 2004 and 2005*	*Mouth of the River Cuckmere*	*N/A*
EASTBOURNE	1983-89	N/A	41,000 m^3	N/A	N/A
EASTBOURNE (Holywell to Langney Point sewage outfall)	1997-98	Over 6 km	780,500 m^3	Outer Owers Bank	£11,984 million = £15/m^3 excluding overheads
PEVENSEY BAY	1990s	c. 1 km	N/A	Inland gravel pits and seabed	N/A
PEVENSEY BAY	2001	N/A	16,000 m^3	N/A	N/A
PEVENSEY BAY	2002	8 km	200,000 m^3	Hastings Bank	N/A
PEVENSEY BAY	Annually since 2002	9 km	20,000 m^3	Mainly Hastings Bank, a little from the Owers Bank	N/A
BEXHILL	c. 1978	N/A	N/A	N/A	N/A
BULVERHYTHE & GLYNE GAP	2005-	N/A	20,000 m^3	N/A	N/A
WEST HASTINGS	Late 1980s-early 1990s	N/A	N/A	N/A	N/A
EAST HASTINGS	1993	N/A	N/A	N/A	N/A
WINCHELSEA BEACH & PETT LEVEL	1933-36	6.5 km	N/A	Gravel pit at Rye Harbour	N/A
PETT LEVEL & RYE HARBOUR	*From the 1950s onwards. Now annual*	*6.5 km*	*30-40,000 m^3 per year*	*Next to Rye Harbour breakwater*	*N/A*

TABLE 3: DOCUMENTED BEACH RECHARGE SCHEMES IN SOUTH AND EAST KENT. Beach recycling and bypass schemes are listed in italics. N/A = not available.

BEACH	DATE	LENGTH OF FRONTAGE	VOLUME OF RECHARGE	SOURCE OF RECHARGE	COST
BROOMHILL & JURY'S GAP	*c. 1957 onwards, mostly annual*	*N/A*	*c. 30,000m^3 per year*	*North-east side of Dungeness Point*	*N/A*
DUNGENESS POWER STATION	*Annually from 1966*	*N/A*	*c. 30,000 m^3 per year*	*North-east side of Dungeness Point*	*N/A*
LITTLESTONE & St MARY'S BAY	*Annually from 1979*	*N/A*	*c. 5000 m^3 per year*	*North-east side of Dungeness Point*	
HYTHE MILITARY RANGES	1989 Present	3.1 km	50,000 m^3 N/A	N/A N/A	N/A N/A
HYTHE, Fisherman's Beach	1990-91	360 m	N/A	N/A	£16,909 including some rock protection works.
HYTHE to SANDGATE	1996	4.6 km	1 million m^3 (k)	Mostly from the Owers Bank, some additional material from the Hastings Bank	£12 million (estimated), excluding 8% overheads
HYTHE to SANDGATE	*1997-2004*	*4 km*	*c. 34,000 m^3 was recycled annually from areas of surplus to areas of deficit.*	*N/A*	*N/A*
FOLKESTONE	1979-80	N/A	N/A	N/A	£22,000
HYTHE to FOLKESTONE	2004	7 km	350-360,000 m^3 of shingle	Hastings Bank	£13 million
ABBOTS CLIFF & SAMPHIRE HOE	1992	0.5 km	N/A	N/A	N/A
ST MARGARET'S BAY	At intervals from 1957 to 1982.	500 m	N/A	N/A	N/A
OLDSTAIRS BAY, KINGSDOWN	2003	N/A	N/A	N/A	N/A
KINGSDOWN, north to Deal Castle	1995	N/A	58,000 m^3 of shingle	N/A	N/A
KINGSDOWN, north to Deal Castle	1998	N/A	80,000 m^3 of shingle	N/A	N/A
KINGSDOWN	2003-4	N/A	47,000 m^3 of shingle	N/A	N/A

TABLE 3: Continued

BEACH	DATE	LENGTH OF FRONTAGE	VOLUME OF RECHARGE	SOURCE OF RECHARGE	COST
DEAL CASTLE to SANDOWN CASTLE	*1960*	*Deal frontage.*	*22,000 m^3 of beach material*	*Beach at Walmer*	*N/A*
DEAL CASTLE to SANDOWN CASTLE	*1974*	*N/A*	*9,000 m^3 of beach material*	*Beach at Walmer*	*N/A*
DEAL CASTLE to SANDOWN CASTLE	*1982*	*N/A*	*N/A*	*N/A*	*N/A*
SANDOWN CASTLE	*At mostly annual intervals, 1961-1979*	*c. 100 m*	*65,710 m^3 of shingle*	*Walmer beach*	*N/A*
SANDOWN CASTLE	*1983, and at intervals since*	*c. 100 m*	*N/A*	*N/A*	*N/A*
RAMSGATE, West Beach	*1938*	*c. 200 m*	*7,700 m^{3}of sand*	*East Beach*	*£7,000*
RECULVER to MINNIS BAY	Since c. 1990 and continuing	4.5 km	At least 400,000 m^3 of sand & shingle	N/A	N/A
HERNE BAY	1974-91	600 m	>40-50,000 m^3	Mostly from inland pits	N/A
HERNE BAY	1991-2	600 m	67,330 m^3 of sand & shingle	The Sunk, off Harwich	£5 million, including a rock breakwater
HERNE BAY	*Post 1992*	*N/A*	*N/A*	*N/A*	*N/A*
TANKERTON	1974-1998	3 km	“50,000 cu m of beach recharge and recycling”	N/A	N/A
TANKERTON western & central part of bay	1998-1999	2.3 km	130,000 m^3 of shingle	Hastings Bank	£4.2 million including new groynes (40 m spacing).
TANKERTON eastern end of bay	2004	0.7 km	50,199 m^3 (47,974 m^3 actual nourishment and 2195 m^3 recycled)	Hastings Bank & Owers in 2:1 ratio	£2.2 million including 15 new timber groynes.

3 Notes and sources

Medmerry beach nourishment. Medmerry on the west side of Selsey Bill has long been a trouble spot. In the winter of 1998/9 high tides and heavy seas were particularly menacing and the Environment Agency hurriedly transported 10,000 tons of shingle (~ 5550 m^3) in 200 lorry loads from Shoreham Harbour quayside to Medmerry to replenish the beach (The Argus, January 5, 1999). In addition, recycling and reprofiling is carried out each winter.

Church Norton beach recycling. Since the early 1990s, recycling has taken place on an annual basis to clear the Pagham Harbour entrance and rebuild the south spit (South Downs Coastal Defence Group, 2005). About 15,000 m^3 of shingle is moved annually.

Bognor Regis beach nourishment. See The Argus (October 29, 1998), which stated that Bognor beach was recharged with shingle to prevent flooding "two decades ago".

Felpham beach nourishment. The 1999 sea defences project at Felpham (near Bognor Regis) was undertaken jointly by the Environment Agency and Arun District Council. Some 72,367 tonnes (~40,200 m^3) of marine sand and shingle were added to the beach between Outram Road and Limon Lane (Marine Habitat Committee, 2000), groynes were rebuilt, some rock armour was installed and a sea wall constructed for a total cost of £3.4 million (see The Argus, May 12 and September 23, 1999).

Elmer beach nourishment. About 20,000 m^3 of "marine aggregate" was added to the beach in 1989 (South Downs Coastal Defence Group, 2005). The later Elmer sea defence scheme was a joint project between Adur District Council and the National Rivers Authority, now the Environment Agency. In addition to c. 200,000 m^3 of beach recharge, 8 island breakwaters were constructed, using 100,000 m^3 of rock (Robert West and Partners, 1991 and 1992; Cooper *et al.*, 1996; Sistermans and Nieuwenhuis, 2001).

Climping to Atherington beach recycling. About 24,000 m^3 of sand and shingle is removed annually from Climping beach and taken to Atherington beach to compensate for beach starvation downdrift of the Pool Place Terminal Groyne at the east end of Elmer (South Downs Coastal Defence Group, 2005).

Littlehampton to Climping beach recycling. Information from Roger Spencer, Senior Engineer (coastal), Arun District Council. The Environment Agency are responsible for the recycling; the amounts vary considerably from year to year:

YEAR	Months	Amount in m^3
1993	17 May – 20 June	12,300
1994	8 June – 24 June	15,250
1994-5	12 December – 18 January	12,235
1995a	20 March – 7 April	7850
1995b	12 October – 29 December	25,475
1996a	12 February – 29 March	20,346
1996b	14 October – 20 December	33,615
1997	24 November – 24 December	12,596

1998a	2 March – 31 March	12,189
1998b	19 October – 11 December	26,271
1999-00	15 December – 18 February	13,312
2000-01	Autumn – Spring	Not available
2001-02	Autumn – Spring	25,555
2002-03	Autumn – Spring	18,888
2003-04	Autumn – Spring	19,444

The recorded total for the 12 years, 1993 to 2004, is 255,326 m^3 (with one missing year of data), which averages to 23,211m^3 per year. The shingle is taken from a 150 m stretch of beach immediately west of the Arun mouth, where it accumulates because of longshore drift.

Littlehampton Harbour mouth. Dredged shingle from the Harbour Entrance was placed on the beach east of the Entrance in 1994. The South Downs Coastal Defence Group (2005) also report that this same beach is subject to annual recycling.

Ferring Rife beach nourishment. Information from Stuart Meakin, Environment Agency. The recharge came from Area 351 directly east of the Isle of Wight. Recycling is also carried out between Littlehampton and Worthing (South Downs Coastal Defence Group, 2005).

Worthing. A small amount of recharge was carried out at Worthing in the early 1990s, and since 1998 there have been annual recharges (? Recycling) at East Worthing (South Downs Coastal Defence Group, 2005).

Brooklands recycling. Brooklands lies between South Lancing and east Worthing. Emergency works were started in Autumn 1995 and completed in advance of the winter storms. Three rock groynes were built and 30,000 m^3 of shingle were provided "to raise and extend the beach crest" (Holmes and Beverstock, 1996). The shingle was taken from the east end of Shoreham Beach (Stuart Meakin, personal communication). More barge-loads of limestone were delivered to build additional groynes in 2005 (The Argus, March 8, 2005). The total cost of the defences, which are designed to protect 1340 residential and commercial properties, is £5.7 million.

Shoreham and Lancing beach nourishment, phases 1 & 2 (1996-2003). This Environmental Agency scheme was designed to protect 1300 homes and 90 commercial properties worth £94 million (Holmes and Beverstock, 1996; Sistermans and Nieuwenhuis, 2001. Falling beach levels were leading to frequent overtopping, and the existing wooden groynes were considered to be inadequate. Following a strategy study by Scott Wilson Kirkpatrick, the Environment Agency decided to recharge the beach and construct rock groynes over a 3.3 km frontage. Phase 1 of the scheme saw the emplacement of c. 80,000 m^3 of shingle and sand from East Wight (St Catherine's) and Phase 2 c. 110,000 m^3 from The Nabs (Stuart Meakin, personal communication). Phase 1 concentrated on protecting the 1.2 km long King's Walk frontage, immediately east of Widewater lagoon. During the summer of 1999, 20,000 m^3 of imported larvikite boulders (weighing 8-12 tonnes each) were delivered by barge and used to construct 4 rock groynes. Later, 35,000 m^3 of shingle were brought in, again by ship, to nourish the beach at the eastern end of the frontage near the Church of the Good Shepherd (The Argus, June 18, 1999). According to the South Downs Coastal Defence Group (2005) 11 groynes were built between 1996 and 1999.

Phase 2 saw the construction of further rock groynes and shingle recharge in the central part of the King's Walk frontage. Phase 3 comprises beach recharge and the construction of additional groynes at the western end.

Shoreham Harbour bypassing. Shingle moving eastwards under longshore drift accumulates next to the western breakwater at the entrance to Shoreham Harbour. Under the Shoreham Harbour Act, Shoreham Port Authority is required to remove shingle trapped in this way and deposit it on Southwick Beach, east of the harbour entrance, in order to enable the longshore drift to bypass the harbour. At present about 10,000 m^3 of shingle is removed annually (in two sessions) from port-owned land adjacent to the western breakwater and taken by lorry to Southwick (Halcrow Group Ltd., 2000). However, some 16,000 m^3 of shingle is thought to be accumulating annually against the western breakwater because of longshore drift (Scott Wilson Kirkpatrick, 2000; Halcrow Group Ltd., 2000).[2] The Port Authority are unwilling to take more shingle from their land because they consider that it would undermine the breakwater. In theory, additional shingle could be extracted from areas of Shoreham Beach not owned by the port, but residents and conservation groups would almost certainly raise strenuous objection. See also Holmes and Beverstock (1996).

Rottingdean beach nourishment. Information from Martin Eade at Brighton & Hove City Council (January 2005). The figure of 102,000 m^3 includes 9000 m^3 of "demolition material, which went down first". The shingle came from the Owers Bank off Littlehampton (The Argus, 9 September 1994; South Downs Coastal Defence Group, 2005).

The Council carry out periodic beach re-profiling to counter the effect of winter storms. Posford Duvivier (1997) recommended future beach nourishment at Ovingdean and the Marina (pp. 25 & 32) and estimated that the annual rate of longshore drift immediately west of the Marina (before its construction) was about 15,000 m^3 (p.31).

Saltdean beach nourishment. E-mail from Martin Eade at Brighton & Hove City Council (January 2005). See also Posford Duvivier (1997), p. 24.

Ovingdean recycling. As part of the 1994-95 beach renourishment scheme, some extra shingle was moved from Rottingdean to Ovingdean in the expectation that it would drift back again (E-mail from Martin Eade at Brighton & Hove City Council, January 2005).

Seaford recycling (1900). Following recommendations in a report by Ellice-Clarke (1897), the Newhaven and Seaford Sea Defence Commissioners (appointed in 1898) built new groynes at Seaford and recharged the beach with 75,000 tons (~41,000 m^3) of shingle taken from the accreting beach on the east side of Newhaven East Pier (Sir William Halcrow and Partners, 1961). The total cost of the operation was £66,000.

In the southern part of Seaford Bay the direction of longshore drift is south-eastwards, but near Newhaven Harbour East Pier the direction is westerly. Because the shingle was transferred mostly in an updrift direction, the operation is best described as beach recycling rather than beach nourishment.

Seaford recycling and possible nourishment (1936-1940). Falling beach levels at Seaford in the 1920s and 30s caused increasing concern, and in the autumn of 1935 a severe gale

[2] The South Downs Coastal Defence Group (2005) give conflicting figures for the annual bypass operation (e.g. [a] an annual transfer of 8500 m^3 a year between 1993 and 2000, [b] 72,000 m^3 during 1992 and 2000, [c] 21-22,000 m^3 between 1992 and 2000, and [d] 20,000 tonnes annually). In some years no shingle has been moved, and in other years extra has been taken, so amounts are very variable.

caused great damage to the sea defences. In response, the Commissioners in 1936 embarked on a four-year programme of beach recycling. By 1940 they had transported 34,000 cubic yards (~26,000 m^3) of shingle from the beach in the lee of Newhaven's East Pier, dumping the material at the more badly eroded sections of the Seaford frontage (Sir William Halcrow and Partners, 1961).

In addition, Ove Arup and Partners (1973) record that shingle "was brought from Dungeness" to Seaford "before the last war". There is no mention of this in the Halcrow report and no other details seem to be available.

Seaford recycling (1963). See Anon (1962a) and Joliffe (1964). Once again, the Newhaven and Seaford Sea Defence Commissioners took shingle away by lorry from a borrow pit on the beach immediately east of the East Pier and used it to recharge Seaford beach, from the Buckle Inn to the Eversley Hotel.

Seaford beach nourishment (1986-87). This appears to be the largest shingle nourishment scheme yet carried out in the UK. The Zanden Dredging and Contracting Co. Ltd. (of Newbury) state in their publicity documentation ("Seaford Project 1987") that 3 million tons of shingle were added to the beach, which equates to about 1.67 million m^3. Note, however, that Brampton and Millard (1996) estimate that only 1.45 million m^3 were added to the beach, and Coates *et al*. (2001) quote a figure of 1.5 million m^3. At the other extreme, Hanson *et al*. (2002) give the volume of recharge as 2.5 million m^3. The Zanden Dredging and Contracting Co. Ltd. were awarded a contract of £6 million, which implies that each cubic metre of recharge (assuming a total of 1.67 million m^3) cost £3.6, including management charges. The total cost of the project was £9 million (Seaford Gazette, October 1987).

Sistermans and Nieuwenhuis (2001) state that the shingle used to replenish Seaford, Eastbourne and Pevensey beaches has a smaller D50 than the original shingle.

Seaford beach recycling (1987-present). Originally, it was planned to recycle 30,000 m^3 of shingle a year, at an annual cost of £60,000 (Seaford Gazette, October 1987), but this plan had to be revised upwards. Brampton and Millard (1996) estimated that 75,000 m^3 would need to be recycled annually to keep the beach in equilibrium. According to Stuart Meakin (personal communication), the annual total is now around 100,000 m^3.

Cuckmere Haven beach recycling. Very variable amounts of shingle are removed each year from the "delta" at the Cuckmere Mouth and heaped up on the eroding west beach to help stabilise the river mouth and protect the former coastguard cottages. Recycling volumes in January 2004 and 2005 have been calculated from BAR surveys at 7000m^3.

Eastbourne (1983-89) beach nourishment. Mentioned by Waters (2002, p. 6), but only briefly.

Eastbourne (1998) beach nourishment. This £30.6 million scheme was initiated to counteract falling beach levels and repeated damage to the seawalls following the 1987 Great Storm (Posford Duvivier, 2001; Waters, 2002). The recharge was in two phases, the first in 1997, was for 355,000 m^3 of shingle, the second for 425,000 m^3 was completed in 1998. It was initially expected that the shingle would cost £12 per cubic metre, but the actual cost for the phase 1 shingle was £4.8 million (excluding overheads), pricing each cubic metre at £13. The shingle in phase 2 cost £7.2 million, making each cubic metre worth £15. In addition to the shingle recharge, the seawalls were refaced and numerous replacement timber groynes (and some more massive rock groynes) were constructed to slow the longshore drift.

Pevensey Bay (1990s). According to Ian Thomas, Project Manager of Pevensey Coastal Defence Ltd., the Beachlands frontage was artificially nourished on several occasions during the 1990s by the National Rivers Authority and its successor, the Environment Agency, which was formed on the 1st of April 1996. The shingle was mostly brought in by lorries, presumably from inland gravel pits, but a barge was used at least once, presumably to dump dredgings. The recharge operations seem to have been carried out on a rather ad hoc basis, probably at the end of financial years in order to mop up small, unplanned budget surpluses.

The Marine Habitat Committee (2000) record that 17,094 tonnes (~9497 m^3) of marine aggregate were placed on the beach at Pevensey Bay in 1999.

Pevensey Bay (2001 and continuing). Pevensey Coastal Defence Ltd. (formerly Pentium Coastal Defence Ltd.) manages the sea defences at Pevensey on behalf of the Environment Agency, under a PFI (Private Finance Initiative) contract signed in June 2000, which runs for 25 years at a total cost of £30 million. Originally, the contract applied to 8 km of shoreline, but the 1 km long Sovereign Harbour frontage was added in May 2003. The Pevensey project protects 2000 properties, 2 major roads, a railway and internationally important wetland habitats, including a nature reserve.

Recharge began in 2001 when the beach was topped up by 16,000 m^3 of marine shingle. A further 200,000 m^3 were added in 2002, providing 1 in 200 year flooding protection. Recharge continues on an annual maintenance basis. PCDL take small volumes of shingle (5-7000 m^3) on an annual basis from the beach south of Sovereign Harbour to nourish the Pevensey frontage (thus bypassing the Harbour). Under their contract, they are required to allow 16,000 m^3 to leave the frontage annually and drift east to Cooden. Information from Ian Thomas, Project Manager.

Bexhill. Thorburn (1977, p. 8), reporting on a survey of beach levels in Sussex from 1973 to 1975, referred to impending beach recharge work at Bexhill:

> "The Beach Monitoring Survey shows losses of 30,000 to 35,000 cubic metres from 200 metre long sections at Normans Bay and Bexhill. These are the highest losses recorded by the survey for the East Sussex coast.
> Storm damage and the associated losses of beach material have, of course, brought about the need for the expensive remedial operation at Beaulieu Road, Bexhill. The defence works needed are to be supplemented by the importation of granular material to artificially nourish the beach…"

I have as yet been unable to obtain confirmation that this beach nourishment was carried out.

Bulverhythe and Glyne Gap. The shingle beach along this stretch of coast has suffered long-continued erosion, exacerbated in the late nineteenth century by the removal of shingle for industrial purposes (Shoreline Management Plan, Appendix C, 2005). The Environment Agency is engaged in constructing rock groynes and a rock revetment, and is also intending to recharge the beach (Information from Stuart Meakin, Environment Agency). Ian Thomas (personal communication) believes that a recharge was carried out in the 1990s, but I cannot find any documentary evidence.

West Hastings. Beach recharge was carried out in the late 1980s or early 1990s when the groyne field was reconstructed (Shoreline Management Plan, Appendix C, 2005).

East Hastings. Recharge was carried out in 1993 when the seawall was rebuilt just east of the pier (Shoreline Management Plan, Appendix C, 2005).

Winchelsea Beach and Pett Level beach recharge(1930s). See Robinson (1988). Between 1933 and 1936, timber sea defences were erected along the shore of Pett Level. Shingle transported from a gravel pit at Rye Harbour along a specially constructed narrow gauge tramway was dumped on the beach to increase its height and protect the defences.

Pett Level and Rye Harbour, beach recycling (c. 1950). Between 1947 and 1952 the Kent River Board built a new sea wall from Pett to Winchelsea Beach, at a cost of £700,000. To protect the wall, beach recycling was undertaken, and is now an annual event. The recycling began in the 1950s (Taylor, 1958; Russell, 1960), not the 1960s as suggested by Eddison (1983). The shingle accumulates against the western breakwater at the mouth of the River Rother and is periodically removed by lorry and taken varying distances (up to 8 km) south-westwards along the coast before being dumped back on the beach. Eddison (1983 and 1998) gives the following data:

YEAR/WINTER	ANNUAL TOTAL/AVERAGE (m^3)
1979	29,301
1986/87, 1987/88, 1988/89, 1989/90	30,416
1990/91	40,431

Surveys on the west side of the western breakwater in June 1959 and June 1960 showed that the beach increased in volume by 14,550 m^3 (Russell, 1960). During the same period the quantity of shingle removed for recycling was 26,760 m^3, so the total annual accretion was 14550+26760=41,310 m^3 or 74,000 tons. The Shoreline Management Plan (1995, p. 2.28) suggests that, in the absence of recycling, shingle accumulation at Rye Harbour would be around 60,000 tonnes per year.

Broomhill and Jury's Gap. Longshore drift along the coast east of Camber is to the east, towards Dungeness. To combat erosion of the coast and seawall, the Kent River Board began beach recycling in the mid to late 1950s (Taylor, 1958; Eddison, 1983). Initially, the Board planned to transport about 65,000 tons (36,000 m^3) of shingle back from Dungeness by lorry each year (Taylor, 1958). Annual costs were stated to be £30,000, with an additional £145,000 for start-up (The Times, January 8, 1958). The Southern Water Authority, successors to the Kent River Board, continued the recycling operations. In 1979, 16,719 m^3 were brought in by lorry and dumped at Jury's Gap at the east end of Broomhill Wall (Eddison, 1983). An average of 27,320 m^3 was supplied by lorry over the four winters 1986/87 to 1989/90, rising to 44,075 m^3 in the stormy winter of 1990/91 (Eddison, 1998). Tooley (1995, p. 3) stated that on average 36,000 m^3 were dumped each year at Broomhill. The shingle is taken by lorry from a 300 m stretch of beach just north of Dungeness Point (Shoreline Management Plan, Appendix C, 2005). At present c. 60,000 m^3 are removed each year and shared between Broomhill/Jury's Gap and Dungeness Power Station (see below). Another 5000 m^3 is taken to Littlestone (see below).

Dungeness Power Station. Shingle has been fed onto the beach at the south-west corner of the nuclear power station at Dungeness Point from 1966 onwards (Eddison, 1983). In 1979 some 26,697 m^3 were brought in by lorry (Eddison, 1983). Tooley (1995) records that approximately 30,000 m^3 is dumped each year at the power station (47,000 in the winter of 1990/91). See also Clarke (2004).

Littlestone and St Marys Bay. Littlestone Wall was built in 1930 from the southern end of Dymchurch Wall to just south of Littlestone (Eddison, 1983). The beach in front of the wall has been recharged since 1978, when a January storm overtopped the wall (Eddison, 1983). In 1979, 37,834 m^3 were fed to the beach. Tooley (1995) states that 4000 m^3 of shingle is supplied to the beach in a normal winter, rising to 5000 m^3 in a stormy winter (e.g. 1990/91). See also Clarke (2004). The current rate of annual recharge is said to be 5000 m^3 (Shoreline Management Plan, Appendix C, 2005).

Hythe Military Ranges beach nourishment. The 1989 recharge is discussed by Posford Duvivier (1994). According to the Shoreline Management Plan (Appendix C, 2005), beach recharge is again being undertaken.

Hythe, Fishermans Beach nourishment. See Posford Duvivier (1994).

Hythe to Sandgate beach nourishment (1996). Information from Posford Duvivier (1994) and Simon Brooks, Shepway District Council (E-mail December 13, 2003).

Hythe to Sandgate beach recycling (1997-2004). Information from Simon Brooks, Shepway District Council (E-mail December 13, 2003).

Folkestone beach nourishment. An unspecified amount of shingle was placed on the beach below Leas Cliff Hall (Posford Duvivier, 1994).

Hythe to Folkestone beach nourishment. Data from Simon Hetherington, Shepway District Council. Most of the recharge material was placed on the beach below Folkestone's Coastal Park. A large rock headland and three other rock structures have been constructed (South East Coastal Group, 2004).

Abbots Cliff and Samphire Hoe. When Samphire Hoe was constructed in 1992 to accommodate the chalk waste from the Channel Tunnel, the opportunity was taken to recharge the beach to the south-west with shingle (Shoreline Management Plan, Appendix C, 2005). No other details have come to light.

St Margaret's Bay beach nourishment. Information is scanty. Lewis & Duvivier (1987, p. 3) state, "beach nourishment has been necessary at intervals over the years and was last carried out in 1982. Since then the beach has been satisfactory despite some seasonal fluctuations". The same consultants in 1948 discussed the need for improved sea defences but made no mention of beach nourishment. Most of the seawall was built in 1950. The very large concrete structure ("Groyne no. 2") at the north-east end of the bay is designed to act as a terminal groyne.

Kingsdown (Oldstairs Bay) beach nourishment. Dover District Council constructed a rock revetment and timber groynes at Oldstairs in 2001 (Anon, c. 2003). Longmire (2004) notes that a beach feed was carried out in December 2003, but gives no details of the amount or the source of the material.

Kingsdown to Deal Castle beach nourishment (1995-8). Data mainly from Anon (c. 2003). Under the heading "Kingsdown", this report states, "a major beach nourishment scheme was carried out in the summer of 1995 involving the importation of 58,000 m^3 of shingle. Further works were carried out in 1997 to install scour protection at the southern end of the sea wall, and in 1998 further beach nourishment was carried out involving the importation by sea of some 80,000 m^3 of shingle". Under the heading "Kingsdown to Deal Castle", the report adds, "the beach was renourished "in 1995 and 1998 as part of the works at Kingsdown". This would seem to imply that much of the shingle recharge took place at Kingsdown, but some was assigned to the beaches as far north as Deal Castle. The 1995 recharge of 58,000 m^3 is mentioned by W.S. Atkins Consultants Ltd. (1997), who also state that emergency works at Kingsdown in 1997 included 36,000 m^3 of shingle recharge. They advised adding 90,000 m^3 of beach material in 1990 and a further 64,000 m^3 in 2000, but this appears not to have been implemented. In 2003-4, however, an additional 47,000 m^3 of shingle was brought in by sea to raise beach levels at Kingsdown.

Deal Castle to Sandown Castle beach nourishment (1960 and 1974). According to Anon (1962b), 29,750 cubic yards of shingle were deposited during 1960 to fill up the new groyne compartments at Deal. Anon (c. 2003) records that "the beach has been nourished on several occasions including the importing of 22,000 m^3 in 1960 and a further 9000 m^3 in 1974."

Deal Castle to Sandown Castle beach nourishment (1982). Published information is scanty. Lewis and Duvivier (1987) state that, following the rebuilding of the groynes at Deal (completed in 1982), the beach received "artificial nourishment", but do not record the volume of material.

Walmer to Sandown Castle, beach bypass. See Southern Water Authority (1980, Table A8) and Lewis and Duvivier (1987). The recharge material was taken from the beach at Walmer and dumped on the beach just north of Sandown Castle, because it was feared that the groynes installed in 1960-63 between the Royal Hotel and Sandown Castle (by Sir William Halcrow and Partners on behalf of Deal Borough Council) would greatly restrict the longshore drift, thus starving the beaches north of the Castle. The groynes, however, proved inefficient at trapping shingle and were rebuilt in the early 1980s (the work was completed in 1982). Lewis and Duvivier in 1987 made the point that it was "illogical to move beach material deliberately in the direction of natural drift", and argued that any surplus on Walmer beach would be better re-circulated against the drift and taken to Kingsdown. According to Lewis and Duvivier, the practice of removing shingle from Walmer and dumping it north of Sandown Castle began in 1966, but the SWA report of 1980 gives 1961 as the start date. Excluded from the present table is an additional 9300 m^3, which was deposited in 1978-79 "on the beach around sections 18 to 20", which I am unable at present to locate (see SWA, 1980, Table A8).

Sandown Castle, beach nourishment or recycling (1983 and later). The rock armour revetment north of Sandown Castle was built by the Southern Water Authority in 1980-81 (Lewis and Duvivier, 1987). The same consultants noted that the SWA in 1983 they "imported more beach material to fill a scour hole which had again formed on the north side of the castle. Since then they have continued to nourish the beach with imported material." The practice seems to have stopped, as it is not mentioned in recent reports.

Ramsgate, West Beach. As mentioned in the introduction, the authorities at Ramsgate decided in 1938 to improve the recreational value of the town's all too narrow West Beach by feeding it with 14,000 tons of sand (~7,700 m^3), taken from the well-endowed East Beach (Dimond, 2002). So successful was the experiment, that locals named it the Artificial Beach. The beach was still well endowed with sand in the 1950s.

Reculver to Minnis Bay beach nourishment. Initially, shingle was brought in by lorry and dumped on the beach each winter. In 1995 rock groynes were built and the beach was nourished with "half a million tonnes of shingle", brought in by dredger and sprayed on to the beach, mostly close to Reculver. The concrete sea walls were repaired in 1999 and protected by massive boulders. Beach nourishment continues on an annual basis (www.users.globalnet.co.uk/~draynet/coastman.htm).

Herne Bay beach nourishment (1974-91). A seawall was built to protect the central part of the Herne Bay frontage in the late 1920s or early 1930s, and another wall added behind in 1960 (Anon, 2003a). Neither wall could be relied upon to withstand severe storms, and so Canterbury City Council decided to top up the beach to reduce wave attack. Dr Steve McFarland, Principal Engineer, Sea Defence and Land Drainage, Canterbury City Council, writes, "between 1974 and the 91/92 scheme there were 9 recharges totalling around 40-50,000 cubic metres in the central area, and more updrift which would have benefited the area. Most of this would have been from land quarries" (E-mail, 19 January 2005).

Herne Bay beach nourishment (1991-2). In 1991-2 the coastal defences in the central area of Herne Bay were rebuilt (Anon, 2003a). A 400 m long breakwater was constructed using 80,000 tonnes of granite rip-rap from a quarry at Creetown in Scotland. This lies offshore, at a distance of 80-200 m from the seawall. A new beach containing 20,000 m^3 of dredged sand was built to connect the breakwater to the shore. In addition, the beach in front of the promenade was recharged, and to the west a berm of granite riprap was constructed, with a concrete wave wall on top, in order to trap longshore drift.

According to Steve McFarland, the amount of sand and shingle needed to complete the project was 67,330 m^3, but Anon (2003a) refers variously to 150,000 tonnes (~83,000 m^3) and 70,000 m^3 of beach material being bought in by boat.

Herne Bay's sea defences are discussed by Roberts and van Overeem (1991) and de Vroeg *et al.* (1992).

Herne Bay beach nourishment and recycling (1992-present). There have been a large number of small recharges and a few recycling operations since 1992 (Steve McFarland, e-mail, 19 January 2005).

Tankerton beach nourishment and recycling (1974-1998). Between 1974 and the major beach renourishment scheme of 1998-99, "more than 50,000 cu m of beach recharge and recycling" was carried out at Tankerton (Anon, 2003b).

Tankerton beach nourishment, Phases 1 & 2 (1998-99), western and central sections of the bay. Information from Steve McFarland, 17 January 2005 and Anon (2003b). The Marine Habitat Committee (2000) reported that the Tankerton frontage received 250,587 tonnes of recharge, which equates to about 139,215 m^3.

Tankerton beach nourishment, Phase 3 (2004), eastern end of the bay. Information from Anon (2003b) and Stephen McFarland.

4 Conclusion

Until the 1970s beach recharge schemes played only a small part in the UK's sea defence and coastal protection strategies. In the 1970s the first large-scale schemes were introduced, but not without teething troubles. In 1974-5, for example, an £850,000 beach recharging scheme was carried out at Bournemouth, using 655,000 m^3 of sand dredged from the seabed 8 km south of Boscombe. The Council was well pleased with the results, but one of the two contractors (Taywood Dredging Ltd.) expressed major reservations:

> “Though this beach nourishment scheme technique is comparatively new in this country, Taywood does not see a bright future for it. The capital-intensive, uncertain nature of the exercise and the relatively low rewards add up to commercial non-viability. According to contracts manager Mr C Strachan, Taywood would not seek further contracts of this type” (Anon, 1975).

The operational methods used at Bournemouth to bring the sand ashore were badly flawed and much sand was wasted. Since then there have been major improvements. The dredging companies now have considerable expertise in handling recharge operations, and can be relied upon to deliver sand and shingle quickly and efficiently. Since 1970 over 5 million m^3 of extra shingle have been placed on beaches in Sussex and East Kent (Table 4), and in addition there has been considerable beach recycling. Most of the low-lying urbanised coast in South East England is now being protected by beach nourishment and recycling schemes.

TABLE 4: BEACH NOURISHMENT IN SOUTH EAST ENGLAND BY 5 YEAR INTERVALS (RECYCLING SCHEMES EXCLUDED)

YEARS	NUMBER OF SCHEMES (of known and unknown volume, by end year)	KNOWN VOLUME (in m^3, proportioned as necessary by 5-year interval)
1970-74	3?	c. 15,000
1974-79	6?	c. 19,000
1980-84	3	c. 40,000
1985-89	6	c. 1.78 million
1990-94	8	c. 532,000
1995-99	11	c. 1.70 million
2000-04	9	c. 956,000

Costs of beach nourishment in South East England have risen substantially over the years. As already noted, the shingle recharge at Seaford in 1986-7 cost less than £4 per m^3. The first phase of the Eastbourne scheme cost around £13 per m^3 but the second phase was more expensive with the shingle costing £15 per m^3 (Waters, 2002). In 1997, W.S. Atkins Consultants Ltd. estimated the cost of shingle recharge in Kent at £20 per m^3. The same figure is currently quoted as the cost on the Sussex coast (Eastbourne Borough Council and the Environment Agency, 2003). Despite the considerable increase in costs, beach recharge remains a very competitive and environmentally sustainable method of providing coast protection. The present investment in beach nourishment in South East England can be valued at around £100 million.

Several issues continue to be debated. The first concerns the provision of groynes.
On relatively sheltered beaches where longshore drift is modest, such as at Pevensey, few if any groynes are needed, provided beach recycling is carried out regularly. On more exposed beaches, such as at Shoreham and Lancing, groynes are a necessity. Wooden groynes require pile driving, creating noise disturbance for nearby residents, and the timber sourcing can be contentious. The Eastbourne scheme was significantly delayed because of opposition to the use of tropical hardwood from Guyana (Waters, 2002). Another disadvantage of timber groynes is that they are often quickly worn away by shingle scour, and require regular maintenance. Rock groynes are less subject to abrasion damage (provided suitably hard rocks are selected) and can be placed directly on beaches without the need for pile driving. They also produce more complex wave reflections than wooden groynes and so may reduce beach scour. It is claimed, however, that they create a greater obstacle to people walking along the beaches, and there have been instances of children becoming trapped between the rocks, requiring rescue by the emergency services.

Another issue, of particular relevance to the BAR project, concerns the optimal size of the beach recharge material. Sandy beaches that are extensively used for recreation obviously need to be recharged with sand, but this can prove very expensive because of the volumes involved. Shingle beaches have steeper gradients than sand beaches (often > 1:10 as against ~1:40), and therefore require less recharging. Some contractors have tried to match the size of the recharge shingle to the size of the original beach material, but an alternative strategy is to choose coarse shingle regardless of what is present naturally. Coarse shingle is less mobile than fine shingle and less susceptible to “draw-down” during storms. It is possible to create a steeper beach than with fine shingle, and thus minimise the volume of recharge. Unfortunately, really coarse shingle is in short supply. Many contractors have therefore recharged depleted beaches with relatively fine shingle or shingle-sand mixes. The long-term effectiveness of these materials needs to be carefully evaluated. Tests by BAR researchers suggest that fine shingle and shingle-sand mixes may be subject to less rapid abrasion than coarse shingle, and thus provide unanticipated, extra value for money.

Also causing concern are the future prospects for beach recharge schemes. In the short-term, both beach nourishment and beach recycling are likely to remain effective options for protecting the South East England coast from erosion and flooding. Reserves of offshore sand and gravel are considerable, and more than sufficient to meet demand for a great many years (Bellamy, undated). The long-term outlook is much less rosy, however. Increases of sea-level due to global warming are widely predicted to be about 60 cm in 100 years (DEFRA guidance), and to raise the crest line of many beaches by this amount would require prohibitively expensive quantities of beach material, since increasing the height would necessitate a very large increase in width. It is only too clear that the existing Shoreline Management Plans will need to be drastically reformulated if the forecast rise starts to materialise.

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