SCOPAC Coastal Landfills Study: Coastal Flooding, Erosion and Funding Assessment

Date: April 2019

Version: 2.1

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Document Information

Project	SCOPAC Coastal Landfills Study: Coastal Flooding, Erosion and Funding Assessment
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Environment Agency Project Ref.	SOC501E/000A/031A

Document History

Date	Version	Prepared	Checked	Approved
17.04.19	2.1 Final	MW	SC	SCOPAC RSG

EXECUTIVE SUMMARY

There are a number of historic coastal landfill sites across the SCOPAC region that have previously been protected from the sea but are now eroding due to deterioration of the original protection. Vast quantities of waste are theoretically at risk of being released (into the sea and onto nearby land) which will pollute the marine environment and pose hazards to the public and wildlife. The nature of the problem is long-term as erosion will increase with sea level rise and it is likely that the landfill sites contain some of the early plastics. Given that these can take hundreds of years to biodegrade, it will be necessary to continue to contain the sites for the foreseeable future, as removal is unlikely to be a feasible option.

This desk-based study builds upon previous work by the Eastern Solent Coastal Partnership (ESCP) which identified landfill sites at risk of erosion and flooding and started an initial assessment of possible funding sources. This investigation has been extended across the SCOPAC region (Lyme Regis, Dorset to Shoreham-by-Sea, West Sussex) where it appears there are many landfill sites with an unclear understanding of impacts, liability, or costs involved in resolving future problems. There are 144 historic coastal landfill sites across the 18 SCOPAC Local Authorities, the majority of which are on publicly owned land and lack information about their contents. Liability for historic coastal landfill sites is highly uncertain, both in theory and more so in practice.

There is a need for a long-term plan that is technically feasible and affordable. The Shoreline Management Plans form the basis of this plan, however at present, as far as protection of landfill is concerned, they are aspirational as there is no appropriate funding mechanism. Many landfill sites are undeveloped and hence do not qualify for Flood and Coastal Erosion Risk Management Grant in Aid funding (FCERM GiA), resulting in coastal defences being 'patched up' rather than undergoing major capital works. Furthermore, the sums of money required for capital works are high: £100s of millions for coastal protection across the SCOPAC region, and more to remove and/or treat waste.

This study undertook a more thorough review of possible funding sources which concluded that under the current arrangements there is no obvious funding stream to manage the risks from eroding landfills, unless the sites qualify for FCERM GiA, or where an area can attract substantial private investment. The study also investigated 7 case studies in more detail from across the SCOPAC region to better understand flood and coastal erosion risk and whether the SMP2 policy could be delivered under the current funding arrangements. The information from the study was then condensed into an infographic which has been used to raise the profile of the issue to politicians and other decision makers at a regional and national level.

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ACKNOWLEDGEMENTS

We thank the following for helping to fund this work:

- SCOPAC (Standing Conference on Problems associated with the Coast)
- The Southern and Wessex RFCC (Regional Flood and Coastal Committees), and
- The Local Government Association Coastal Special Interest Group (LGA SiG).

We also thank the University of Southampton for sharing information from a NERC funded study (Dr Anne Stringfellow, Dr Richard Beaven and Professor Robert Nicholls).

1. INTRODUCTION

1.1 Background

Globally there are 100,000s of landfills (Brand, 2017) and an estimated 20,000 historic landfill sites in the UK that were filled with waste prior to modern regulations (Independent, 2016; Shrubsole, 2016). An estimated 1,200 historic landfills lie within the Environment Agency's Coastal Flood Plain or Coastal Erosion Zones (Cooper et al, 2012; Brand, 2017). Waste from these sites can enter the marine environment by land erosion, leachate or flood waters – and risks will worsen with climate change, particularly due to sea level rise (SLR).

Following successive failures and difficulty accessing funding to repair a revetment protecting historic landfill at Broadmarsh in Havant, a project was initiated by the Eastern Solent Coastal Partnership (ESCP). Following this and due to concern over other landfills, SCOPAC (*Standing Conference on Problems Association with the Coastline* – *www.scopac.org.uk*) commissioned this research. This research has been funded by SCOPAC, two Regional Flood and Coastal Committees (RFCCs) (Southern and Wessex) and the Local Government Association Coastal Special Interest Group (LGA SiG).

1.2 Aims and objectives

The aim is to raise the profile of the coastal landfill issue, supported by an assessment across the SCOPAC region. The objectives are to:

1. Examine key funding sources for coastal engineering and management to protect landfills at risk of flooding and/or coastal erosion.
2. Produce a SCOPAC wide regional database, including high level statistics (number of sites, Shoreline Management Plan (SMP) policy, land-use, area, defence length, schemes profiled in the Environment Agency's programme of investment).
3. Select case studies to highlight and provide further insight to landfills across the SCOPAC region particularly the funding situation.
4. Deliver presentations at appropriate meetings and publish user-friendly information to raise awareness of this issue.
5. Interact with other projects on landfills (University of Southampton NERC/ERIIP project, CIRIA Guidance).

1.3 Report Structure

This report is structured as follows:

- Chapter 2 is a desktop review of historic landfill history, risks and liabilities;
- Chapter 3 is an assessment of funding mechanisms (e.g. for defence);
- Chapter 4 presents findings from the SCOPAC wide database;
- Chapter 5 provides case studies;
- Chapter 6 summarises where this project aimed to raise the profile of the coastal landfill issue and collaborated with other work;
- Chapter 7 is the conclusions and recommendations.

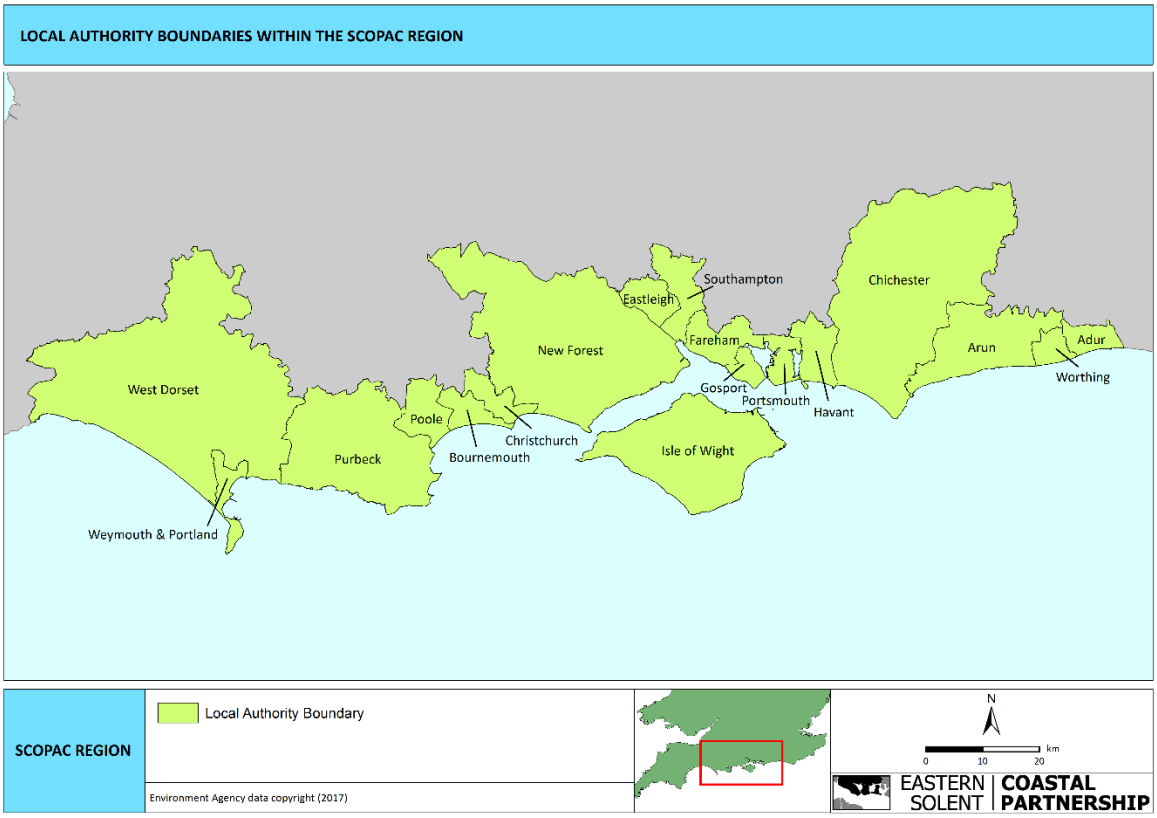


Figure 1.1 Map showing the location of the SCOPAC region and the coastal Local Authorities

2. HISTORY, RISKS AND LIABILITIES

2.1 Background to the landfill problem

Disposal of waste through landfilling became common practice in Europe and the US toward the end of the 19th century. It is often claimed that the UK is the birthplace of the industrial revolution – the legacy of this history is socio-economic development but also environmental impacts, and explains the scale of the issue, as well as some of the risks and uncertainties. Before the 1st World War, most domestic waste was either recycled or burnt at home, however in the 1920s "Controlled Tipping" as landfill was then known was introduced which was then seen as the way forward. However, this depends how 'controlled' is defined – this was at the time filling holes (e.g. created by extraction of minerals) with largely uncontrolled mixed waste. Contrary to perceptions today, saltmarsh was considered waste land, or harbouring disease, and so needed "improvement" by tipping waste with a thin layer of topsoil to provide public open space. During the 2nd World War rubble from bomb damage was disposed of in the same manner, and understandably in the circumstances, this was uncontrolled, and records are vague.

The amount of waste generated was once considered small enough to be diluted in the environment, and many older sites (generally pre-1980s) were "Dilute and Disperse" systems. These relied on groundwater to dilute leachate and disperse it in the underlying/surrounding strata (no physical barrier was constructed between the waste and the surrounding soil). This was commonly accompanied by the practice of co-disposal (e.g. industrial waste was mixed with domestic waste). Legislation had begun at various stages in the 20th century to recognise the need to protect human health and to a lesser extent the environment; for example, the Public Health Act 1936 made provision to mitigate the impacts from old landfills (e.g. Nathanail, 2011). Meanwhile the Clean Air Act (1956) which came into place to alleviate London's deadly smog events, caused landfilling to become more commonplace (as burning waste became forbidden). It is widely considered that prior to the 1970s there were few controls on waste disposal activities, and subsequently the Control of Pollution Act (COPA, 1974) was introduced to improve the control and regulation of waste disposal sites.

However, population growth and increasing consumerism caused progressively greater use of landfill. This provided the first waste disposal licensing regime from which others have stemmed. There had been a series of legislation (The Deposit of Poisonous Wastes Act 1972, The 1974 Local Government Act) which made Local Authorities and the Water Authorities responsible for waste management. Modern landfill sites are subject to strict controls derived from sources such as the 1999 EU Landfill Directive (which became UK law in 2002). They are constructed with impervious cells that include systems to capture and remove leachate, which is processed and managed. Systems often operate with landfill gas collection which is used to produce electricity.

The Environmental Protection Act (EPA, 1990) is the fundamental structure and authority for waste management and control of emissions into the environment. Much of the Act is of a framework nature, with the detail being provided in secondary legislation. In May 1994 Part I of the COPA 1974 was replaced by Part 2 of the EPA. The EPA built on COPA, with stricter licensing controls and provisions aimed at the environment. Part 2 covers waste on land and provides the statutory framework for the collection and disposal of waste. Part 2A deals with the identification and remediation of contaminated land and came into force on 1 April 2000 and established a

legal regime for the identification and remediation of land where contamination is causing unacceptable risks.

Prior to May 1996, when the EPA 1990 was enabled, waste operators could surrender a waste disposal licence without restriction, meaning that any future liabilities (remediation or clean-up) would effectively fall on the landowner and therefore public purse. The result of this history is that Local Authorities have inherited an unknown future liability to manage sites, that may be adjacent to sensitive, and designated environmental areas.

2.2 The Legacy

Regarding coastal landfill, CIRIA's C718 guidance (Cooper et al, 2012) found there to be 1,290 historic landfills in England and Wales with unique Historic Landfill Database Reference numbers and which fall at least partially in areas with a 0.5% annual probability of tidal flooding. Meanwhile Brand (2017) approximated 5,000 historic landfills in areas at risk of flooding and coastal erosion, of which 1,500 are in the 1 in 200-year coastal flood zone around England and Wales, and a further 184 are still authorised to accept waste (Wilkinson, 2009; Cooper et al., 2012; Brand, 2017). Brand (2017) comments that discrepancy between these numbers is likely to be due to a combination of revisions to flood zones and consolidation of duplicated landfill records. Most estimates obtained are likely to be underestimates as records are believed to be incomplete (Cooper et al., 2012).

In most cases the risk of pollution from these landfills will decrease by natural flushing and dilution. At many of these sites there will still be pollution concerns arising from the escape of solid waste, leachate and landfill gas (e.g. explosion, carcinogens, asphyxiation) and persistent contaminants such as heavy metals. Pathways for contaminants are difficult to define for historic landfills, especially if impacted by rainwater and saltwater. However, an issue with erosion in the marine environment includes the release of plastics, which has recently received attention for its prevalence and long-term unknown impacts on the oceans. Plastic debris released from an eroding coastal landfill will end up in seawater and may, for example, be consumed by fish, having also absorbed toxic pollutants in the landfill and sea, with a wide range of potential chronic effects. Plastic/polymer production began in the 1820s (e.g. vulcanised Rubber, Parkesine, Cellulose) and early synthetic plastics were developed in the early 1900s. Some of these items are persistent and perhaps harmful to the marine environment, and present in most landfills. However, plastic production significantly increased after the 1950s, with over 330 million tonnes of plastic now produced annually. This indicates that a substantial proportion of coastal landfills which have operated since the 1970s likely contain (and hence are at risk of releasing) plastics.

Sea level rise is slowly making the sites more vulnerable to both flooding and erosion. In many cases in the SCOPAC region the sites are in sheltered locations, however the fronting saltmarshes in the Solent have eroded by up to 86% since the 1940s (SDCP, 2008), thereby reducing the standard of protection. In these "low-energy" environments erosion is not a consistent process but occurs erratically when significant coastal events (surges/storms) take place. These could cause sudden failure of the protection and then wash polluting material into the tidal waters. Additionally, there are risks when lesser amounts of waste wash out from damaged or un-maintained defences. Although presenting apparently a lower risk of significant pollution, these types of events are seen by the public as harmful and hence can cause a significant workload for the Local Authority irrespective of their liability.

2.3 Shoreline Management Plans

In 1994 the Coastal Groups and Local Authorities of England & Wales were encouraged by Government to adopt the concept of Shoreline Management Plans (SMPs), which are the first stage in achieving Defra's strategic flood and coastal erosion risk management remit. SMPs are a high-level, non-statutory policy document that provides a large-scale assessment of the risks associated with coastal processes and the consequences of climate change. SMP advice helps to generate a vision for short (0-20 years), medium (20-50 years) and longer (50-100 years) term coastal management. This is seen as a 'route map' for a more strategic and sustainable approach to coastal defence. The first round of SMPs (SMP1) were completed in the late 1990s, and the second round (SMP2) in 2011. The policy options that can be allocated to sections of shoreline within an SMP are summarised in Table 2.1. Following SMPs, localised flood and coastal erosion management 'strategies' are sometimes produced to assess the management options for smaller stretches of coast in more detail than SMPs. These may also look at how defences will be funded, whilst SMP policies can be changed because of these strategies.

Table 2.1 Shoreline Management Plan policy definitions

Policy	Description
Hold the Line (HTL)	An aspiration to build or maintain artificial defences so that the position of the shoreline remains. Sometimes, the type or method of defence may change to achieve this result.
Advance the Line (ATL)	New defences are built on the seaward side.
Managed Realignment (MR)	Allowing the shoreline to move naturally but managing the process to direct it in certain areas. This is usually done in low-lying areas but may occasionally apply to cliffs.
No Active Intervention (NAI)	There is no planned investment in defending against flooding or erosion, whether or not an artificial defence exists.

Source: http://apps.environment-agency.gov.uk/wiyby/134834.aspx

The SMP policy recommendation for most coastal landfills is 'Hold the Line' (HTL). The Environment Agency (EA) define the HTL policy as "*An aspiration to build or maintain artificial defences so that the position of the shoreline remains. Sometimes, the type or method of defence may change to achieve this result*."

This project arose because in most cases of coastal landfill there is some basic protection between the landfill and the sea (e.g. in the form of either blockwork or rubble revetment), which achieves HTL. This was provided when the landfill was finished and converted to public open space. These are now often deteriorating with age, and costly to replace.

This study has found the HTL policy for coastal landfills to be aspirational given the cost of protection or remediation is very high and the sites generally do not qualify for Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA) (the main source of central government funding for coastal flood protection works) – as explained further in Chapter 3 where funding mechanisms are explained and reviewed in more detail.

Table 2.2 The five Shoreline Management Plans* within the SCOPAC Region (from west to east).

SMP Area ref. (most recent)	Name	Lead	Length (km)	SMP2 approval	Link
SMP 16	Durlston Head to Rame Head	Teignbridge District Council	308	2010	http://southwest.coastalmonitoring.org/resources/smp/sdadcag-smp2/
SMP 15	Hurst Spit to Durlston Head (Poole & Christchurch Bays)	Bournemouth Borough Council	190	2011	https://www.twobays.net/
SMP 14	Isle of Wight	Isle of Wight Council	113	2011	http://www.coastalwight.gov.uk/smp/
SMP 13	Selsey Bill to Hurst Spit (North Solent)	New Forest District Council	386	2010	http://www.northsolentsmp.co.uk/
SMP 12	Beachy Head to Selsey Bill	Arun District Council	105	2006	https://www.se-coastalgroup.org.uk/wp-content/uploads/2013/10/Beachy-Head-to-Selsey-Bill-SMP-FINAL.pdf

**Note this this refers to SMP2 (SMP1 had different) boundaries.*

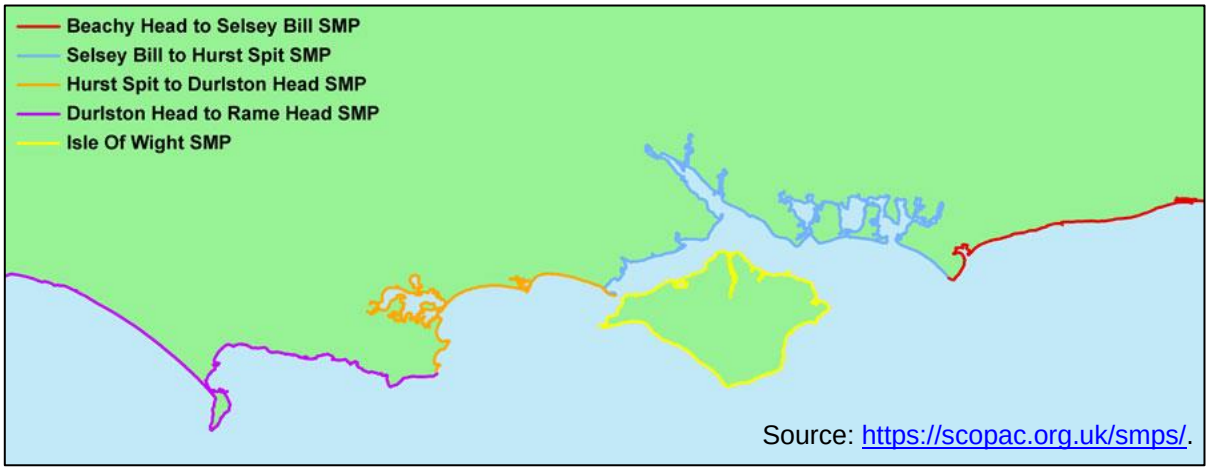


Figure 2.1 The SCOPAC region and the location of the Shoreline Management Plans

2.4 Potential liability

The sequence of questions and actions relating to legislative responsibilities is explained in the CIRIA 718 Guidance (Cooper et al, 2012). Liability for historic landfills can occur via EPA 1990 Part 2A whereby each Local Authority has a statutory duty to inspect its area for the purposes of identifying contaminated land and where such land is identified, to secure its remediation. This asserts that the authority first looks for persons who caused or knowingly permitted each significant contaminant linkage ("Class A causers or knowing permitters"). If no Class A persons can be found, then the landowner or occupier is liable as a Class B person. The EPA can work alongside other rules (e.g. Water Resources Act 1991; Environmental Permitting Regulations 2010) which all contain offences relating to contamination and give regulators (e.g. EA, LAs) wide-ranging powers to address problem sites. However, in practice (for coastal landfills) action is rarely enforced unless there is substantial evidence of environmental harm or health risks.

This project does not go into detail over liability and legality, as it would involve a detailed legal study, and there are few examples of coastal landfills that have been defended or remediated because of legal orders, and hence there are many "grey areas" in the interpretation of theory to practice. Where permits and licences for landfilling continue to exist, then liability (e.g. for harm to humans and/or environment) typically attaches to those. However, most sites are historic,

hence any permits have often been surrendered. This occurred on a broad scale in the mid-1990s where many waste operators surrendered licences to Local Authorities.

If harm has been suffered, personal injury or negligence claims are a possibility, but this must be proven to be linked with something caused by the historic landfill site, and there is a need to demonstrate that those who operated the site owed a duty of care (e.g. because the risk of harm to others should have been foreseen). It is regarded by the legal profession that bringing nuisance or negligence claims in relation to something that has its origins many years ago can be very difficult to establish and there have been intervening acts and events that can complicate establishing a causal link (e.g. Colvin, 2018). For example, waste may be mixed and from various sources and/or operators, who themselves may no longer be in existence. Some licences issued under the Control of Pollution Act 1974 were time limited and expired on the date specified in the licence, and records may in some instances be lost.

It should also be noted that where the pollution risk may affect European Designated sites (Special Areas of Conservation – SACs, and Special Protection Area – SPAs) that the landowner may be liable to prosecution by Natural England (NE). Also, under the Water Framework Directive, River Basin Management Plans (RBMPs) which cover both inland and coastal waters have been produced. The relevant one for this area is the South East RBMP which was produced in 2009 and updated in 2016. This sets out the current state of the water environment and measures to achieve the environmental objectives in The South-East river basin district which extends from Hampshire in the west to Kent in the east.

A site in Powys, Wales (2017) is a recent high-profile non-coastal example of where a Local Authority was not considered liable even though its statutory predecessors operated the (domestic and commercial waste) landfill, tipped the waste and were evidently the polluters. Powys County Council assumed it had taken over its predecessor's liability for a site and carried out landfill monitoring which led to concerns over leachate pollution of two rivers which had been designated as Site(s) of Special Scientific Interest (SSSI). On 27 July 2017 The Court of Appeal held that liability had not been transferred to Powys County Council, and instead the landowner was liable. This judgment may increase the liability risks for landowners and occupiers near operational and historic council landfill sites, and perhaps exposed as a misconception that landfill or contaminated land liabilities are based upon the "polluter pays" principle. Since the predecessor bodies had been abolished by statute, they could not be found as "appropriate persons". There is a financial hardship test under Part 2A that can potentially exclude landowners and occupiers with minimal funds, but this is not guaranteed to work. Some of the legal profession consider that landowners, trustees and estate companies in agricultural areas with substantial assets are at greater risk (Davison, 2017).

There are not any known examples of a coastal historic landfill being required to be remediated because of legal proceedings. An eroding landfill at Trow Quarry in northeast England underwent two rounds of ground investigation in 2003 and 2005, prompted by the council's Contaminated Land Strategy which identified the area as an "Area for Further Investigation". This determined the land should not be classified as "Contaminated Land" under Part 2A (EPA, 1990), although works were funded to prevent waste escaping (refer to Section 3.1 of this report)

Local Authorities are often in a complex situation as they may be both the landowner and the enforcement authority. **The conclusion so far is that liability for the many UK historic coastal landfill sites is highly uncertain, both in theory and more so in practice.**

2.5 Risk management options and actions

The CIRIA 718 guidelines on the management of contaminated and landfill sites on eroding or low-lying coastlines appraises suitable management options for short-term and long-term strategic coastal management planning (some of this is summarised in Table 2.3).

Table 2.3 Summary of historic landfill coastal management options.

Option	Description	Cost	Comments
Do nothing.	-	-	Currently there are not clear costs associated with the negative impacts from historic coastal landfills.
Inspection and surveillance.	Characterise risk/hazard (e.g. borehole investigation, soil & sea water sampling)	Variable (e.g. waste sampling & risk assessment of the Lyme Regis Spittles Lane site (Dorset – refer to Section 5.1) cost £30,000.	For most historic landfills there is not a specified baseline to determine pollution outliers for contaminants. CIRIA (2013) highlight requirements of the Health & Safety at Work Act 1974; Control of Substances Hazardous to Health (COSHH) 2002 & the Construction Design & Management (CDM) Regulations; & specific health & safety guidance (BS ISO 10381-3:2001). Consultation with operators, landowners & regulators usually required.
Leave waste in situ, reactively remove from foreshore	Collection and suitable disposal of waste materials identified as posing a risk	West Dorset DC set aside a contingency budget of £100k to intermittently clear up waste released from the Lyme Regis site (see above).	Usually requires site-specific risk assessment as a precursor. This does not fully prevent waste reaching the sea or posing a hazard especially on exposed foreshores where the sea can rapidly wash waste away.
Remove the source of the risk.	Treat the waste	>£25+ per m^3.	Inland examples average £30 per m^3; the cost could escalate for hazardous contents & depending on type of treatment required.
	Excavate/remove	>£100m^3	Excavation costs around £5 per m^3 + **Landfill Tax (to dispose at other sites)** is £84.40 per tonne, transport costs are unknown.
Break the pathway between the source and the receptor.	Cliff stabilisation	£22,000 per m	Based on recent Lyme Regis, Dorset works
	Sea defence maintenance /upgrade/crest raising	£1,000-£2,000 per m	Lower costs apply to maintenance and refurbishment; high-quality sea wall schemes in harbours, estuaries are typically > £4,000-£5,000 per m; greater costs for open coast.
	Harbour or estuary revetment (capital scheme)	£5,000 per m	These approximate costs are based on examples from recent high specification schemes in Portsmouth, e.g. North Portsea Island (harbour) and Southsea (open coast, at detailed design stage).
	Open coast concrete sea wall (capital scheme)	£15,000 per m	
Remove the receptor to the risk.	Move people or properties away from the landfill	N/A	Theoretically possible for residents of floodplains etc, but not the sea.

Solutions for dealing with landfill vary greatly in cost although are generally very expensive. Fundamentally the risk to receptors (e.g. people, marine life) can be reduced by controlling the source (treatment or removal of the landfill contents) and pathways (pollutants escaping into the ground or sea). To 'remediate' generally refers to reversing or stopping environmental damage, and is the term applied as a solution to historic landfills classified as 'contaminated land' when subject to Part 2A liability. In this context it means the landfill can be protected and/or treated (or even removed). Determining costs of remediation generally requires a knowledge of waste volume and landfill contents – for which there is limited information (e.g. Brand and Spencer, 2018). Operational Practices for many landfills, based upon dispersing liquid wastes equally within the waste mass meant filling was often to between 1m to 3m depth (Leachater, 2012) which concurs with examples where waste depths were found in the case studies (Chapter 5).

2.5.1 Coastal protection

Local Authorities, under the Coast Protection Act 1949, have powers, but not duties, to protect land from erosion. Similarly, the Environment Agency has powers under the Water Resources Act 1991 (and other acts) to protect land from flooding. The Flood and Water Management Act 2010 places a duty on all flood risk management authorities to co-operate with each other and provides Lead Local Flood Authorities and the Environment Agency with a power to request information required about their flood risk management functions. In general, both Local Authorities and the Environment Agency will only exercise these powers for major works when funding is available (mostly FCERM GiA), or are in the public interest, and would normally attract national funding. However as discussed in the following chapter, securing funding is challenging, and based on a scoring system (e.g. properties at risk of flooding) which often needs partnership contributions to be available, as explained in the overview of funding mechanisms in Chapter 3 and illustrated by case studies in Chapter 5.

In the context of SMP2 HTL policy recommendations, remediation may be suitable for sites where it is beneficial for the coast to be dynamic and erode and/or the contents are highly toxic; whereas front face protection may be more suitable where the shoreline is complementary to the protection of other receptors (e.g. flood risk to properties).

2.5.2 Waste treatment or removal

For some shorelines, No Active Intervention (NAI) or Managed Realignment (MR) may be appropriate from a coastal process perspective, although not appropriate without first mitigating for the landfill related hazards. Ideally, high risk coastal landfills on dynamic coasts would be treated and/or relocated inland so that their contents never escape into the sea, and to allow for sustainable shoreline evolution. However, this is extremely expensive and invokes a tax liability since this is counted as “new” landfill (Table 2.3). In cases where moving landfill is not feasible, the only solution is to defend them from the sea.

Each site has its own risks and appropriate potential management options that need to be assessed, whether involving coastal protection or other forms of remediation. There could be hybrid options to manage costs – for example part of the landfill nearest the sea could be remediated and sheet piled to form a barrier, saving cost on full scale remediation or removal. Despite significant challenges, reuse of old landfills is achievable via a range of regeneration technologies (e.g. Bouazza and Kavazanjian, 2001; DfIT, 2015). Because land reuse is essential in a densely populated country such as the UK, it could be advantageous if, in appropriate circumstances, development pressure incentivised the treatment of landfills. However, although the revised National Planning Policy Framework states support for the reuse of brownfield land, greenfield (e.g. greenbelt) development is rapidly taking place. Under the Town and Country Planning (General Development Procedure) Order 1995 Local Planning Authorities must consult with the Environment Agency (or Natural Resources Wales), about all applications they receive to develop land within 250 metres of landfill sites, including any land that has been used as a landfill site within the past 30 years or is likely to be used as one in the near future.

Every coastal landfill site is different and will require a comprehensive appraisal to determine the preferred solution. The following chapter assesses potential funding mechanisms for landowners and shoreline operators.

3. REVIEW OF FUNDING

Given that there is increasing pressure and potential liability to reduce risks arising from coastal landfills, this section focuses upon funding – mainly relating to maintenance, improvements and capital works. Coastal protection is not assumed as the only solution, and the previous Chapter acknowledges other methods (Table 2.3) that could also be used to remediate coastal landfills and contaminated land.

We have identified possible funding mechanisms for the management of eroding or flood-prone landfill sites as follows:

- FCERM GiA
- Environment Agency – Contaminated Land Capital
- Local Authority – Waste Management Capital
- Parish/Town - community
- Land-fill Tax
- Coastal Access & footpaths
- Flood and Coastal “Local Levy”
- Funding from Lead Local Flood Authorities
- Water Framework Directive– Grant in aid (WFD GiA now WEIF).
- Costs of Infraction Proceedings
- Unlocking the land fund
- Insurance provisions

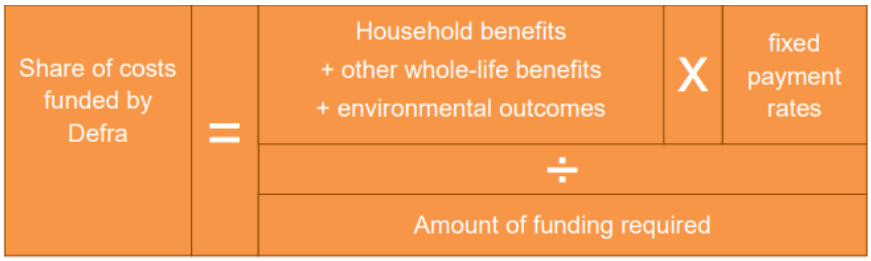
The following sections present a brief explanation of where each funding mechanism is appropriate.

3.1 Flood and Coastal Erosion Management Grant in Aid (FCERM GiA)

FCERM GiA is the primary source of capital money for major flood and coastal erosion projects. There is quite a complicated mechanism for application, but since the primary objective is to prevent flooding and erosion that affects housing, the primary driver is a set of “outcome measures” (OMs) which represent the number of the houses protected by flooding (OM2) or erosion (OM3). OM4 represents environmental gains (water dependent and intertidal habitats, and protected rivers) measured by area and/or length; whilst OM1s can represent a range of wider benefits (of a scheme) for example to amenity value (Table 3.1).

The steps to apply for FCERM GiA are as follows:

1. Calculate Outcome Measures achieved for scheme.
2. Calculate a “raw” Partnership Funding (PF) Score – using a PF calculator spreadsheet provided by the EA. The formulae and weightings show that the OM2s and OM3s dominate this calculation, compared to OM1 – this determines the proportion of funding from Defra:



3. The PF score must exceed 100% for FCERM GiA to be available – so it is necessary to obtain contributions from other sources if the raw score is below 100%. As highlighted in Chapter 5, many landfills achieve such a low raw PF score that it is difficult to attain sufficient contributions to release any FCERM GiA.
4. Schemes are prioritised nationally according to PF score.

Unfortunately, due to the emphasis on OM2 and OM3 scores, this means that it is unlikely that under the current criteria that this will be a major source of finance for schemes that only protect landfill sites and not houses. However, this mechanism may be helpful, particularly where houses are indirectly at risk from the impacts of floods.

Table 3.1 Summary of Outcome Measures and payment rates

OUTCOME MEASURE	DESCRIPTION	PAYMENT RATE (VALUE PER £POUND)
OM1	"Net Present Value of whole life benefits" – i.e. economic Benefits which are the average benefit cost ratio across the capital programme based upon the present value whole life costs and benefits.	5.56p
OM2	Households moved from the "very significant" or "significant category" of flood risk to the "moderate" or "low" category.	20p – 45p (payment rates are linked to levels of deprivation whereby higher levels of deprivation are allocated more)
OM3	Households better protected from coastal erosion.	
OM4	Statutory environmental obligations fully met [OM4a – hectares of net water-dependent habitat created; OM4b – hectares of net intertidal habitat created; OM4c – km of protected river improved].	100p

**These rates are those in the FCRM Partnership Funding Calculator – Version 8 January 2014.*

In England, FCERM expenditure is driven by both planned expenditure via an agreed 6-year profile and responses to extreme weather events. Spending fluctuates year on year with peaks in total expenditure in 2010/11 (£746.7 million in 2017/18 prices), 2014/15 (£837.7 million in 2017/18 prices), and 2016/17 (£807.8 million in 2017/18 prices).

Trow Quarry near South Shields is a rare (possibly unique) example of where, between 2005-2008 a £1.8 million coastal defence project was undertaken for a landfill, fully funded by FCERM GIA. Erosion had exposed waste (landfilled between the 1960s and 1980s) that was intermittently washed onto the foreshore and into the sea. The Environment Agency in partnership with the South Tyneside Council and the National Trust built a rock revetment to limit infill material being washed out, whilst the slopes were regraded and stabilised (hence some of the waste was removed). The site was planted with local marine species to aid stability, followed by programme of monitoring, inspection and investigation. A project appraisal technical report (EA/Defra, 2010)

states [of this project] the *"unusual nature of this site and the consequences of erosion led to difficulties relating to evidence base and methodologies – it was difficult to justify damages consequential to exposing the waste"*. CIRIA (2013) cite that this scheme demonstrated nearly £16 million in economic benefits over its 50-year design life. However, the business case did not include flood or erosion risk to residential property, instead predominantly values assigned to loss of life via exposure to hazardous material, as well as loss of amenity value and land (the landfill is on "Trow Point" which is essentially a control structure for Sandhaven Beach to the north). The nearest houses are over 400m inland from the inland boundary of the site and not in the flood zone). Inputting the economic benefits and design life to the current Partnership Funding Calculator indicates that this scheme could achieve a score of around 60%, requiring over £600,000 external contributions to access FCERM GiA under the current system. Furthermore, it is unlikely that the hazard related benefits could now qualify, because they do not relate to flooding.

Partnership Funding is currently under review and it is recognised that there are problems with funding for schemes where the main benefits are not related to residential property (e.g. environmental) risks (Stratton and Wadey, 2017). It is possible that additional funding from FCERM GiA, in combination with other sources will become more accessible in the future. This project recommends that future revisions to the Partnership Funding system should consider ways to incorporate benefits from damage avoided by schemes that protect or remediate landfills. (e.g. based upon human health, ecology, marine litter etc). In Chapter 5 a series of case studies in the SCOPAC Region outline some of the issues in accessing FCERM GiA funding for protection of coastal landfill.

3.2 Environment Agency – Contaminated Land Capital

There has been a fund for Capital Expenditure on Contaminated land sites in the past and although there was £1.5 million allocated by Defra in 2013/14, there were bids for £5.7 million and so the criteria were very strict.

The funding has now effectively ceased for all but on-going projects and so at present there seems little point in pursuing this. However, it does seem an appropriate mechanism for protecting old landfill sites and so it should be considered should an allocation become available from Defra in future, and maybe representation should be made to re-instate this source of funding.

3.3 Local Authority – Waste Management Capital

The prime responsibility for management of old landfill sites seems to rest with the Local Authority either as Landowner or as enforcing authority, or both. However, funding is difficult for all local services at present; it therefore seems appropriate that some funding, both revenue and capital in the future, is allocated but this is seen as part of a partnership arrangement.

The long-term nature of the problem reinforces the need for a strategic approach for both the engineering and the funding as an appropriate amount of maintenance and capital funding in the early years may save the need for large amounts of emergency funding in the future.

3.4 Parish/Town – community funding

In several cases former landfill sites form an important and popular public open space that is valued by the local community. The community may be able to assist by directly assisting to fund "improvements", particularly to access and amenities on the land.

This is very unlikely to provide significant sums compared with the capital costs involved, however community involvement and providing a stake in projects can greatly assist in public acceptance of any scheme. It will also in some cases assist with access to other funds.

3.5 Land-fill Tax and other environment grants

There are schemes that enable grants to environmental projects, from bodies that receive money from Landfill Tax. In general, these are for relatively small projects and are aimed at communities rather than public bodies, in most cases, but not all, Local Authorities are not allowed to apply for these grants.

Since there are many different schemes with different criteria it does not seem productive to research them but more productive to find an appropriate scheme when a pilot project has been selected. This study has raised an anomaly with the land-fill tax system, it is understood that if landfill is removed from an existing site and replaced in another, that landfill tax will be liable on the quantity of landfill moved. This makes moving the landfill to a safer location uneconomical mainly due to the tax rather than the actual cost of the operation and surely was not the intention of the system.

3.6 Funding for Coastal Access & footpaths

Under the Marine and Coastal Access Act 2009, Natural England is establishing a coastal path around the whole of England. The aim is to establish the whole of the England Coastal Path by 2020. Natural England has announced the programme for the South of England. Full details of the programme are available on this link: https://www.gov.uk/government/publications/england-coast-path-in-the-south-of-england.

Although Natural England's funding is limited, and it is mainly for negotiating agreements with landowners, the timescale may provide a one-off opportunity to work with Natural England to ensure that risks due to the landfill sites along the route are managed and minimised.

3.7 Flood and Coastal "Local Levy"

The local levy is an additional, locally raised, source of income for flood and coastal erosion risk management projects to supplement national FCERM GiA funding. The Regional Flood and Coastal Committees (RFCCs) have responsibility to manage Flood Defence and Coastal Erosion works within their area. In this case, it is the Southern and Wessex RFCCs. Most of their finance is provided by Defra to the Environment Agency and managed under the FCERM GiA rules. However, a relatively small amount, about £1.2 million, is available effectively at the discretion of the committee.

Currently most of this funding is directed towards investigations and planning of schemes that will receive more substantial funding through the FCERM GiA system in the future. This study was fortunate enough to be funded by Local Levy, given the outputs are regionally, and at the time of writing, nationally significant. Whilst it is hoped this Local Levy funded project may contribute to future opportunities to access larger sources of funding, Local Levy itself is too small for managing coastal landfills on the scale identified here.

3.8 Funding from Lead Local Flood Authorities

Upper tier authorities, County and Unitary authorities, receive a relatively small allocation from Government (e.g. Hampshire County Council £208,000 Portsmouth City Council £129,000 for 2015-16) to act as Lead Local Flood Authorities. This allocation is not ring-fenced and may be appropriate as "seed-corn" funding where landfill sites are at risk of flooding or coastal erosion. **However, the sums involved mean that it will not be useful for major works.**

3.9 Water Framework Directive Grant in Aid (WFD GiA)

The Water framework directive aims to move all ground and surface waters in the EU to "good status". The details and timescales are complicated and subject to negotiation between the UK and the EU. However, to meet these targets Defra used to provide some funding through WFD GIA. This funding was prioritised on a National basis and priority is also given to projects where there are other "matched" sources of funding amounting to 50% of the project cost. Funding for Flood and Coastal Erosion (FCERM GiA) does count as matched although also coming from Defra.

This scheme has now been superseded by the Water Environment Improvement Fund (WEIF) which is administered by the Environment Agency on behalf of Defra – and will provide £9 million each year (2018-21) to "restore local eco-systems and deliver substantial benefits to people and the environment". The bidding process is quite complex, but initial bids go to the Environment Agency Area and are then prioritised nationally.

Bids are expected to be in partnerships, although this could come from other sources such as FCERM GiA. The priority system is based on the size of the environmental improvement and the population that it affects.

3.10 Costs of Infraction Proceedings

If the UK fails to meet any obligation under EU law, the EU Commission may commence "Infraction" proceedings against the UK. Should the UK government be found to be in breach of the legislation, the commission can impose fines which are large (£10 million minimum) and can continue on a daily basis until the breach is rectified.

Under the Localism Act 2011 there is a provision for Central government to pass on EU fines to Local Government if they have caused breach in the legislation.

Such procedures are very rare; however, infraction proceedings were started in February 2014 for a breach of the air pollution regulations (the European Commission initiated an infringement

case against the UK for its failure to cut 'excessive' levels of Nitrogen Dioxide (NO_2). The Government does not appear to have an estimate of how large a financial penalty could be imposed by the Court of Justice of the European Union as it is unclear how many air quality zone breaches would be considered (Parliament, 2018). The proceedings are currently on-going.

Although there is no specific funding for avoidance of Infraction proceedings, the possibility of high fines, and legal bills means there are good economic reasons for avoidance. The government takes the view that there is no additional cost, but that Local Authorities should prioritise spending to avoid these risks.

So, although this does not produce any additional funding, it does help justify funding from other sources although the situation is likely to change following Brexit.

3.11 Unlocking the land fund

The Department of communities and Local Government, through the Homes and Communities Agency had recently (March 2016) announced a £1.2 billion Starter Home land fund (DCLG, 2016).

The fund is to assist Local Authorities, and other government agencies, in making land available for starter homes. The fund is available, among other things, for remediation and de-risking of contaminated brownfield sites, but is specifically aimed at providing starter homes by 2020.

CIRIA have commenced a project "A Guide to Developments on Small Contaminated Sites" which is aimed at small developers. This will no doubt help in the future and it would be useful to be involved with this project, but the timescales mean that it is unlikely to be helpful to get grants from this fund.

The Homes and Communities Agency were asking for expressions of interest from Local Authorities by 13th May 2016. The requirement for an expression of interest was quite onerous, requiring a clear "pipeline" to deliver a substantial (300-600) number of starter homes by 2020/21. It also seems that the sites should already be included for housing in the local plan.

The fund is aimed at provision of substantial numbers of starter homes, so unless other land is available and landfill sites could be added to provide additional houses, it is unlikely to be a useful fund at present.

3.12 Insurance

The possibility of insurance covering the liability that Local Authorities face has been raised and can broadly be divided into two sub-categories, historic and future:

Historic Insurance: Most Local Authorities would have carried public liability insurance in the past, and the wording of many past policies probably included future liabilities from the council. So, particularly if the Local Authority owned and ran a land-fill site, the long-term consequence may be covered by the insurance in place at the time.

This would require "archaeological" investigation both of the history of the landfill (ownership etc when active) and the wording of insurance policy held by the Local Authority at the time. This

may require a considerable investment in time and maybe legal fees – there are insurance agents who will undertake this type of work, but they would obviously charge in some way.

Although this is an unlikely source of finance, if an appropriate policy were found to be in existence the sums of money would be significant. It may be appropriate to investigate further for a pilot site.

Future Insurance: It is possible to take out insurance to cover environmental consequences occurring in the future. For instance, both private companies and Local Authorities have insured landfill sites against leachate leakage. Discussions suggest that insurers may be willing to insure coastal landfill sites, either against breach, or against a breach causing environmental damage to a designated site. This would probably be the first time this has been done in the UK and so would require careful legal input to ensure that the provisions were clearly understood on both sides. These types of insurance are priced on an individual basis and would require full disclosure of the known risks and the insurer may wish to make further investigations before taking on the risk. Generally, insurers would prefer short-term policies (say 3 years) but may take on risks for up to 10 years. Since the principle of insurance is to spread risks, insurers may be more interested (and hence give a more competitive price) for a portfolio of sites, say across the whole of the Southern Coastal Group (SCG) area. **In future, this could provide mitigation to individual authorities in event of a problem in their area. As with the historic insurance above, the best way to take this further would be a specific enquiry for a pilot site to establish whether it is possible and the likely costs etc.**

3.13 Summary

Under the current funding arrangements there is no obvious funding stream to manage the risks from eroding landfill sites. During this study a number of possible funding mechanisms have been found, however again there is nothing that is ideally suited or large enough for the scale of the issue. This was verified following a letter to the Environment Agency from the Southern Coastal Group as part of this study (during 2017, refer to Table 6.1).

The possibility of insurance, both historic and future, deserves further investigation, probably through a pilot project. Although this may not provide additional money, it may provide a mechanism for spreading costs both geographically and in time. This is likely to take a considerable time – the problem is a result of policies about 50 years ago and so it is not surprising that there is no “quick-fix” solution. Still, a pilot project may help to move things forward.

4. SCOPAC REGIONAL STUDY

This chapter assesses shoreline management policy, land use, and flood and erosion risk for historic coastal landfill sites in the SCOPAC region across the 18 Local Authorities.

The Environment Agency's Flood Zone 3 mapping and SMP2 NAI erosion rates were intersected with the EA historic landfill shapefile dataset (and 12 sites from the Authorised Landfill dataset, believed to no longer be active but without a record of licence surrender). This selected 200 landfill polygons, although when overlapping data, duplicates and adjoining polygons were organised into 'Landfill Areas', this reduced to 144 areas of historic coastal landfill across the SCOPAC region.

4.1 Shoreline Management Plan (SMP) Policy

The SMP2 recommends protecting most landfill, with a HTL policy for the coast in front of 76% of SCOPAC's coastal landfill sites, with a slight shift towards NAI and MR later in the century. This implies that the reasoning behind the SMPs assumes that in later years sites will have to be protected and/or remediated. However as highlighted in the previous chapter, HTL is aspirational given the lack of funding available to implement new defences or to treat the waste.

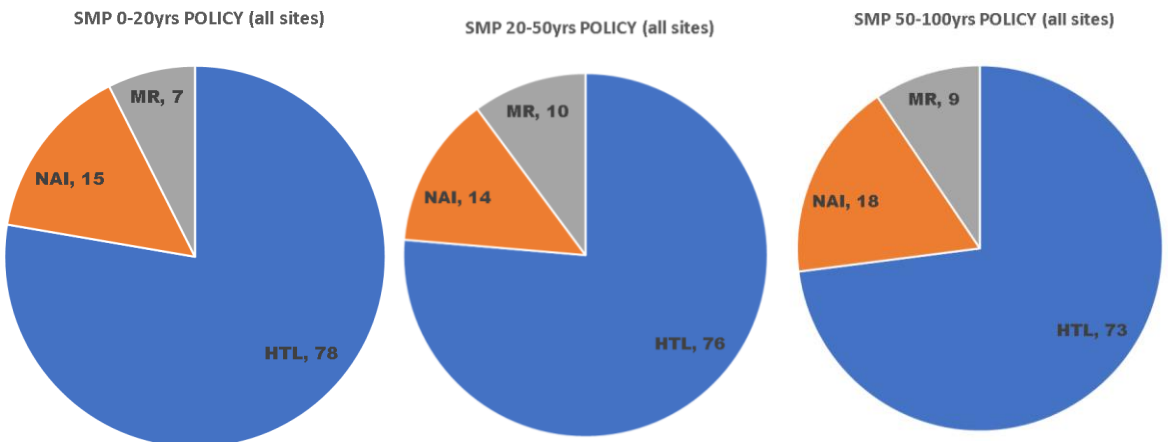


Figure 4.1 SMP policy for the SCOPAC landfill sites

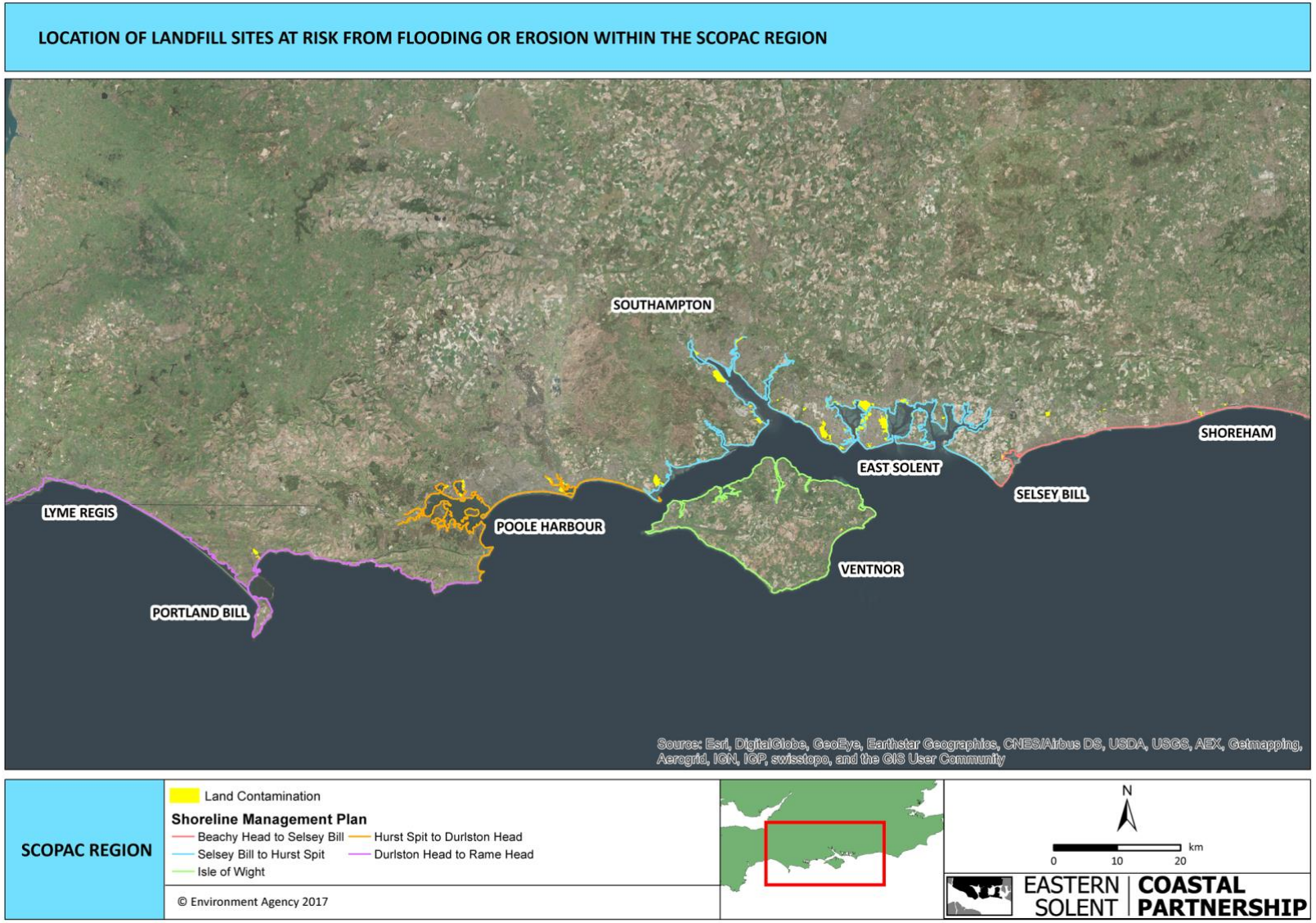


Figure 4.2 The SCOPAC Region, with landfill and SMP2 areas

4.2 Coastal environment and land-use

Most of the SCOPAC coastal landfills are in relatively low energy sites, mainly harbours, with less than a quarter of the region's landfill on the "open coast" (i.e. not located behind a river or harbour shoreline and hence exposed to larger waves) (Figure 4.3).

The predominant land-use for these sites is recreation and open space, such as playing fields, and many sites are on land that is now used for commercial and/or industrial activity (Figure 4.4).

Around a quarter of the historic landfills share land with residential development. From another perspective around 6,500 residential properties are located on areas of historic landfill, although 4,400 of these are in the city of Portsmouth which is mostly well-defended (or with schemes planned to defend) against coastal erosion and flooding.

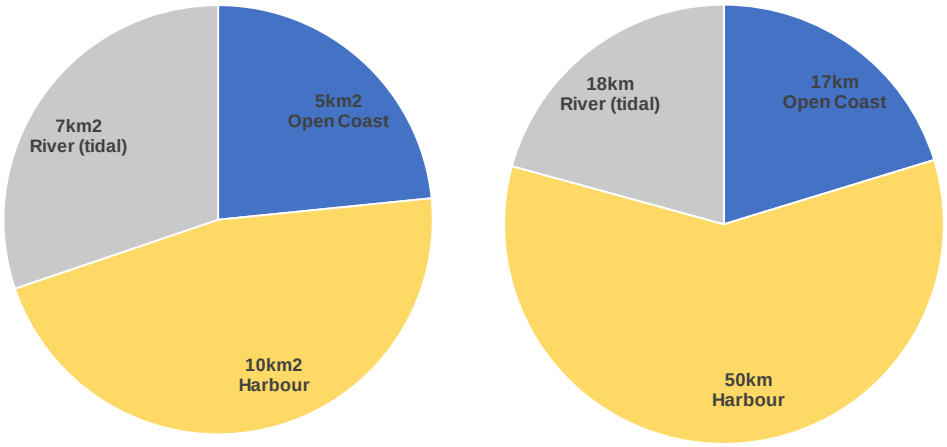


Figure 4.3 Coastal environment type for SCOPAC historic coastal landfills quantified by area (left) and shoreline length (right)

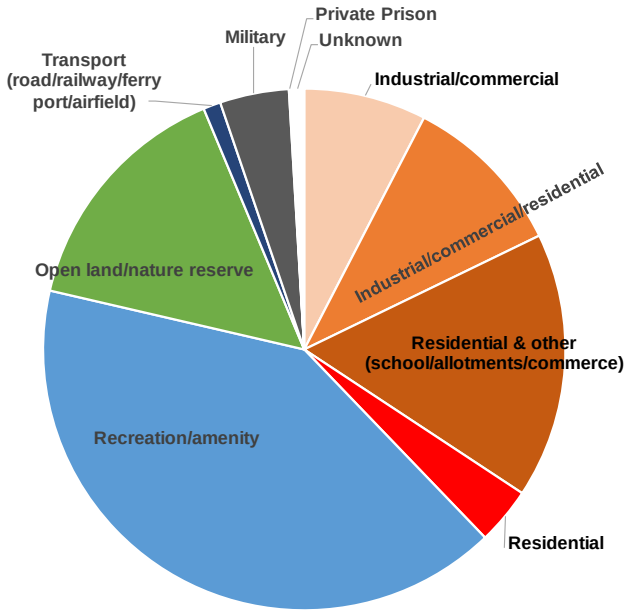


Figure 4.4 Land-use for historic landfill counted by area

4.3 Site Contents

The EA Historic Landfills database provides a generalised waste classification for each site record: inert, commercial, industrial, household, liquid sludge, special and waste unknown. The count of these waste classifications associated with each site record is shown in Table 4.1 (note each landfill often contains multiple waste types as summarised in Figure 4.5).

In addition to the 5 sites where waste is stated as “unknown” (far right column of Table 4.1) there are a further 30 sites in the historic database where there is no entry; therefore for 9% of the total SCOPAC coastal landfill area the contents are unknown (Figure 4.5).

Table 4.1 Waste classification entries in the EA Historic Landfill database for (SCOPAC coastal region)

	INERT	INDUSTRIAL	COMMERCIAL	HOUSEHOLD	SPECIAL	LIQSLUDGE	WASTE UNKNOWN
COUNT	82	56	51	91	5	13	5

A further 12 sites from the EA “Authorised” Landfill Database were added, which for this study includes sites that recently closed or are no longer accepting waste (but still have a licence associated with the site). This database has a slightly different form of waste classification, summarised in Table 4.2:

Table 4.2 Waste classification entries in the EA Authorised Landfill database (in this study)

Descriptor	COUNT
A04: Household, Commercial & Industrial Waste Landfill	4
L05: Inert LF	1
A05: Landfill taking Non-Biodegradable Wastes	2
A01: Co-Disposal Landfill Site	3
A07: Industrial Waste Landfill (Factory curtilage)	1
A06: Landfill taking other wastes	1
TOTAL	12

Most SCOPAC coastal landfill sites contain a mixture of waste types, which is summarised in terms of land area in Figure 4.5.

In some locations there have been intrusive investigations which provide more insight to contents, contaminant levels, and waste depth. Workshops held with members of the four Local Authority environment teams across the ESCP region showed how such data could supplement the database, whilst some of the case studies reveal more detail about landfill extent and contents (than available in the EA Historic Landfills shapefile).

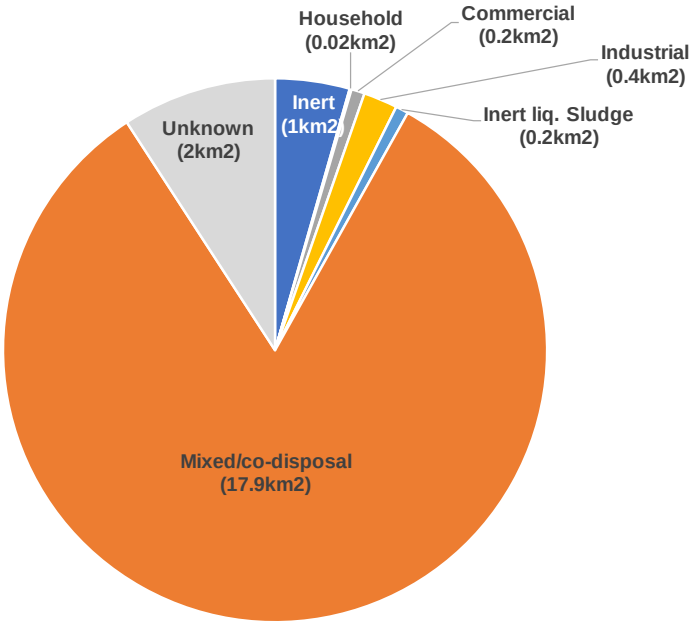


Figure 4.5 Contents of landfill as stated in the EA Database for the SCOPAC region (calculated by area)

Figure 4.5 can be compared to the national perspective, where Brand and Spencer (2018) note that just 37% of historic coastal landfill sites contain only a single waste type, 45% of the sites contain a mixture of waste types in unknown proportions, and 18% of the sites have no record of the waste received.

Where data is available regarding time periods of waste input, the earliest landfilling in the SCOPAC region was around the start of the 20th century (Table 4.3) although most historic sites appear to have started accepting waste in the mid-1960s, and many closed during or before the mid-1970s. Because 90% of these landfills are reported to have been closed after 1955, many are likely to contain plastics.

Table 4.3 Waste input dates (SCOPAC Region)

Date Type	Number of sites (where information is available)	Earliest	Latest	Average
First input	78	01/01/1900* (next earliest is 1912)	01/08/1993	28/09/1966
Last input	61	31/12/1929	31/12/1994	10/12/1975
Licence issue	83	01/04/1974	21/05/1999	31/12/1982
Licence surrender	39	09/04/1977	18/02/2016	04/09/1989

**The 1900 date may be erroneous, the 1912 earliest first input is more likely.*

4.4 Land Ownership

Where known, the largest proportion of landfills in the SCOPAC region are on land owned by Local Authorities (Figure 4.6). A substantial number are also owned privately.

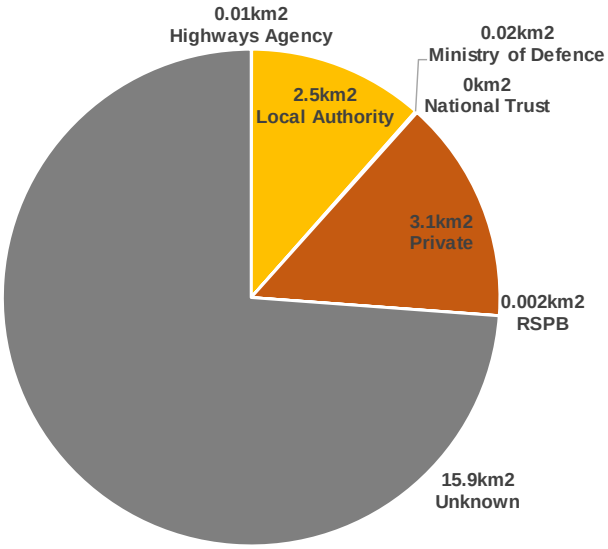


Figure 4.6 Land ownership for historic landfill sites in the SCOPAC region

4.5 Shoreline maintainer

Most of the SCOPAC shoreline that is in front of historic coastal landfills is maintained by Local Authorities, as well a considerable length managed by the Environment Agency and the Ministry of Defence (Figure 4.7).

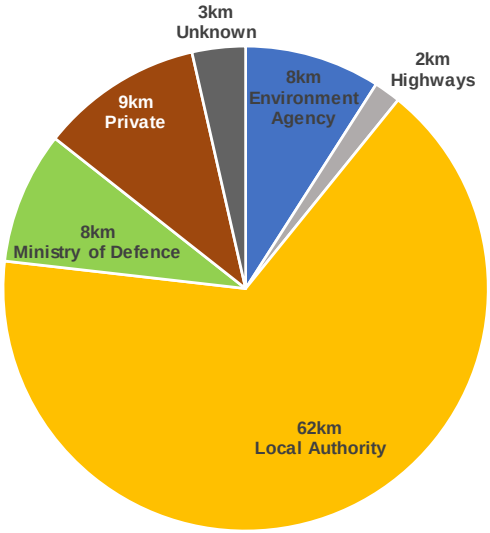


Figure 4.7 Shoreline maintainer in front of landfill areas in the SCOPAC region

4.6 Number of landfills at risk of flooding and coastal erosion

This section summarises landfills at risk of flooding and/or erosion in the SCOPAC region (Table 4.4). Some of the original polygons in the EA database were simplified to generate landfill 'areas' to avoid double counting and provide statistics to assess risk, which indicates that 144 areas of landfill covering 22km^2 are at risk of coastal flooding or erosion, with 86km of shoreline in front of these areas. Of these landfills, 89 are at the coastal margin, and for most a layer of land, foreshore or defence protects them from erosion.

Table 4.4 Landfill at risk of flooding and/or erosion

Risk	No. of landfills	Area of landfill (km^2)	Length of shoreline in front of these landfills (km)
Flooding or erosion	144	22	86
Erosion only (over the next century)	108	19	68
Erosion only – high risk (at the coast now)	89	14	64
Tidal flooding only	136	22	85
Both erosion & flooding	106	19	77
Both erosion (high risk) & flooding	86	14	64

An overview of schemes in the 6-year FCERM investment program indicates that 28 out of the 144 'at risk' SCOPAC landfill areas have a scheme profiled but not all are guaranteed full funding whilst it is not known if all schemes will fully protect the landfill (as they are based upon property cost: benefit). A review of the investment programme alongside aerial photos of the region overlain with the landfill data indicates that around 80 areas landfill could be considered high priority for further risk assessment.

To illustrate the scale of potential costs involved, removal of all the 144 coastal landfills in the SCOPAC region (i.e. to areas not at risk of erosion, flooding and sea level rise) would cost at least £4.3 Billion (if their volume is based on their total area and an assumed 2m depth). This cost is based only on Landfill Tax and in reality, it would be much higher when considering excavation and transport.

To defend the 80 'higher priority' sites which look to be fronted by weaker defences and do not have a scheme planned would cost in the order of £150 million, which is much less than the £1.3 billion estimate to remove them inland. Treating the waste so it is less toxic, or hybrid schemes would cost somewhere in between.

The regional and national scale of the historic coastal landfill problem indicates that there would not be sufficient funds to fulfil remediation or protection – because as explained in the previous chapter there is no clear funding mechanism.

5. SCOPAC CASE STUDIES

A selection of 7 landfill case studies are provided to accompany the SCOPAC regional analysis by illustrating key historic coastal landfill issues. These were chosen to represent a spatial spread with different coastal environments and were agreed with the SCOPAC Research Sub-Group. Furthermore, three of these (Lyme Regis, Pennington and Wicor Cams) were studied within a recent University of Southampton project funded by NERC's Environmental Risks to Infrastructure Innovation Programme (ERIIP). These case studies highlight the location of landfills in relation to flood and erosion risk, along with SMP2 policy and current funding status. Information was obtained from existing public literature and resources.

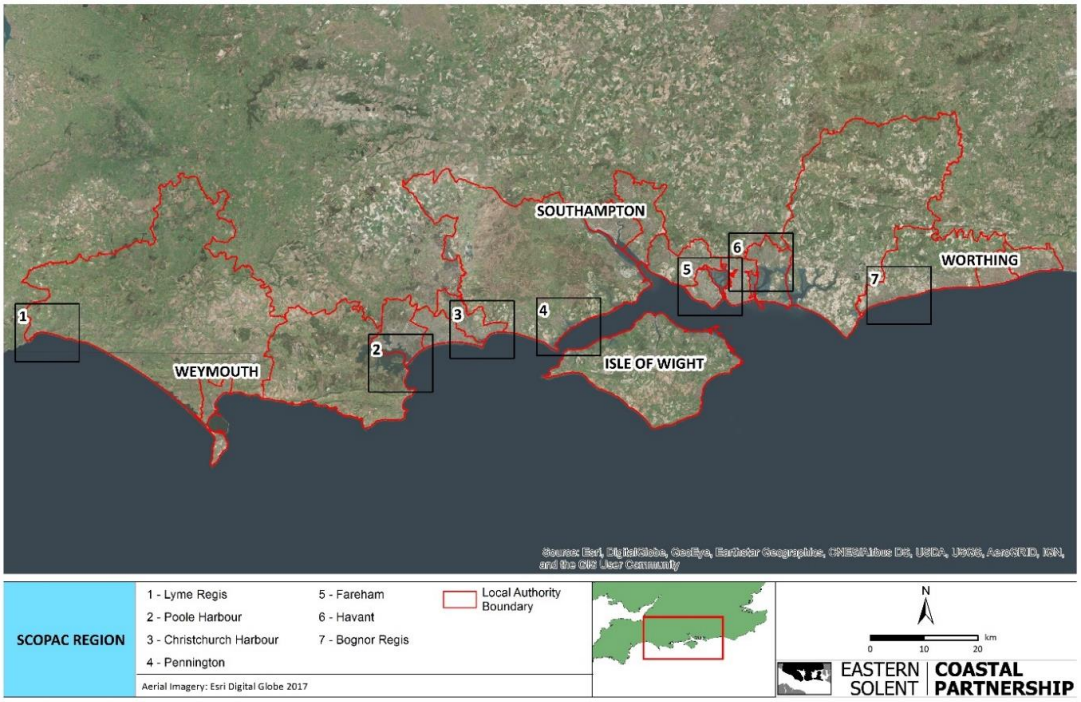


Figure 5.1 Location of the landfill case studies

Calculating the FCERM GiA Partnership Funding Score

Where no known FCERM GiA scheme is forthcoming within the case studies, we have provided an indicative coastal protection cost for each site to illustrate the low Partnership Funding Score (Table 5.3). These are simplistic and based on assumptions but illustrate the scale of funding that should be considered. Defence costs are based upon the length of landfill at the coastline that would need some form of barrier constructed to prevent waste release into the sea. Costs are based upon previous project experience and vary between £2,000 and £3,000 per metre run of sea wall defence.

5.1 Lyme Regis, Dorset (Case Study 1)

There are two historic landfill sites located within the Lyme Regis study area (Figure 5.2). The coast at both sites is within a landslip zone exposed to open coast wave conditions. This study demonstrates a situation where adjacent landfills are both subject to rapid cliff retreat but have contrasting SMP2 policies. Both sites are recorded in the EA database to contain inert, industrial, commercial, and household waste.

Former Gas Holder Site:

This site has a HTL status in the SMP2 for all epochs. The area is now developed with houses and nearby playing field and has undergone a recent scheme to protect 480 properties at risk of erosion (OM3s) and other infrastructure from coastal erosion and landslips for the up to 100 years. These new defences were completed in June 2015 and included major land stabilisation, 390m of seawall walkway, stabilising piles, soil nailing and drainage systems, and a Beach Management Plan.

This scheme had raw Partnership Funding (PF) score of 77% (adjusted PF 111%) hence was funded mainly by FCERM GiA (Table 5.2).

Refuse Tip East of Spittles Lane:

Tipping at this site took place from the early 20th century and continued until the late 1970s. This site has a NAI status in the SMP2 for all epochs. The landfill is experiencing coastal cliff erosion, including a major landslip in May 2008, which exposed old waste materials and spread them over the cliff face and the beaches below. Predicted erosion rates indicate that this site will be eroded into the sea within the coming decades. The NERC ERIPP (UoS, 2018) research project suggested that the most likely outcome is that waste will be cleared on an ad-hoc basis as it erodes. This raises concern over landfill pollution escaping into the sea and potential local environmental risks to ecosystems and shellfish.

There is no prospect for scheme funding via the current FCERM GiA route, as there are zero properties currently in the predicted erosion zones.

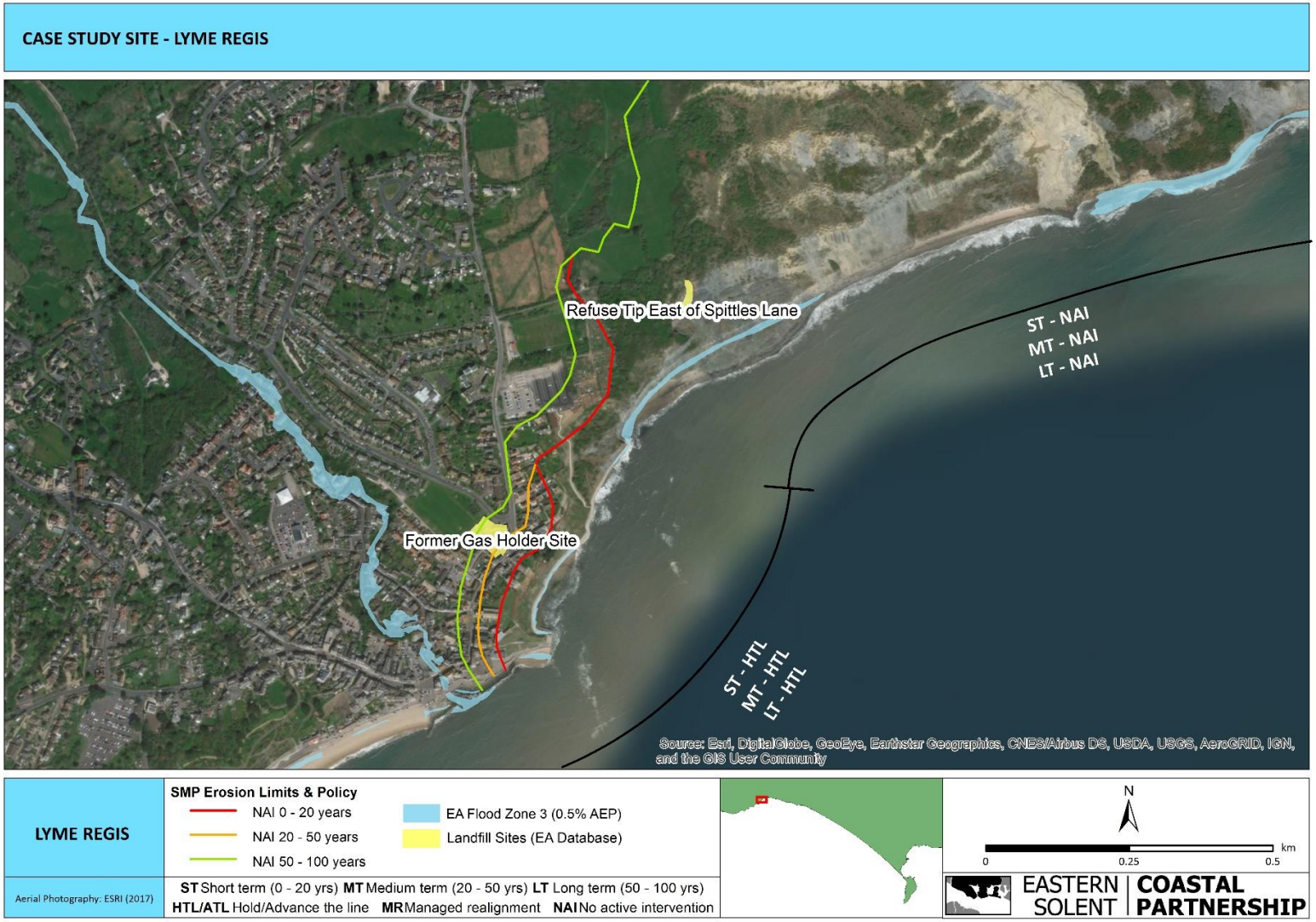


Figure 5.2 Map of the Lyme Regis landfills, along with SMP2 erosion prediction, flood zone 3, and SMP2 policy recommendations

5.2 Poole Harbour, Dorset (Case Study 2)

Three sites are case studied in Poole: Foreland Road (Turlin Moor), Holes Bay Road, and Whitecliff/Baiter (Figure 5.3). Ground investigation data, background information and history was provided to this study by the Borough of Poole (BoP) (reference: PBC, 2004), giving insight to depth of fill, contents, and geochemical data. Furthermore Whitecliff/Baiter was not in the EA Historic Landfills database (the location was provided by BoP).

Foreland Road, Turlin Moor

A stand out feature of this site is that the first epoch (0-20 years) of SMP2 recommendation is MR (rather than HTL), followed by HTL for the remaining epochs. The SMP2 states that *"It is proposed that some realignment takes place during epoch one to set back the defensive line to a more sustainable position, followed by a hold the line policy during epochs two and three".* The "Poole Bay, Poole Harbour and Wareham Flood and Coastal Erosion Risk Management – Final Strategy" (EA, 2014) agrees with the SMP2 policy recommendations here.

The area is school playing fields and comprises a natural shoreline with no defence scheme planned to protect the landfill. The sites here originally contained pulverised fuel ash (PFA) from coal burning, and when the local power station changed to burning oil (mid-1950s) the reclamation was continued by dumping of rubbish (household tip between 1984 and 1990). The BoP ground investigation report indicates that the made ground overlays clays and peats (to a depth of 3m-5m). Leachate and gas was identified as present from domestic waste, with some metals in the deeper PFA area.

Figure 5.3. (a) Recreation ground and (b) natural shoreline at the Foreland Road site.

Under the current Partnership Funding system and properties at risk of flooding, a scheme is unlikely to obtain funding, with a Raw Partnership Funding score of around 5%. However, the number of properties at risk of flooding is predicted to grow from 12 to 400 over the next 100 years which would push the score to over 100%, hence more likely to be funded[1]. However, waste (including plastics) is likely to be released into Poole Harbour before this time, and the contents may require some remediation before any further

[1] This was estimated on the assumption of building a £10 million sea wall scheme over a 900m section of shoreline.

groundworks take place. Borough of Poole (2017) states: *"landfill, contamination and soil stability issues need to be assessed fully before any scheme can be progressed, as the outcome will have a significant effect on viability"*.

Whitecliff/Baiter

With a HTL policy across all SMP2 epochs this is now a recreation ground with football/cricket pitches and children's playgrounds. The shoreline is defended by sheet pile wall and rock armour, although there are gradually eroding sections of natural shoreline and minor flooding during storms. The SMP1 and SMP2 identified that here there may be scope for some realignment at the Whitecliff Harbourside Park, but also raised concerns that landfill in this area would make this difficult. However, the SMP2 does note that *"subject to further investigation and with respect to potential habitat loss throughout the area, this* [managed realignment] *needs to be highlighted as an option for consideration in the future".*

The site was reclaimed in the 1960s and filled with builder's rubble and domestic refuse. An investigation in 2003 concluded that it was suitable for use as public open space. The site was found to be generally covered with topsoil up to 0.8m thick (although as thin as 0.1m in some places) over various fill materials ranging between 0.6m and 3.4m, comprising sand and clays of differing fractions. Several boreholes in the BoP data contained domestic refuse (e.g. plastic, metal, fabric, wire, glass) over wet silty sands and sandy silts and clays. Contaminants include elevated levels of Polycyclic Aromatic Hydrocarbons (PAHs)[2].

A basic scheme to improve flood protection and protect the shoreline for the entire site achieves a low Raw PF score of around 5% (Table 5.3). The site received £175,000 funds (FCERM GiA) from the EA for emergency repairs following the 2013/14 storms; although **beyond this the prospects for a scheme to improve protection of the waste is low.**

Figure 5.4 (a) Beach and (b) rock defences at Baiter/Whitecliff, Poole Harbour

[2] PAHs are carcinogenic. This assessment was determined however by an assessment that was undertaken using Soil Guideline Values that have since been withdrawn and replaced (the PAH levels in relation to recent guidelines is not known).

Holes Bay Road

This area has a HTL SMP2 policy across all epochs and comprises two sites recorded to contain inert, industrial, commercial and household waste, dumped between the late 1970s and mid-1980s. The surrounding area has been developed as housing and as an industrial park. The main A350 road runs along the edge of the reclamation. Behind the road runs a railway line and Poole Railway Station. A walkway and cycle path run along the revetment between Poole and Upton Country Park. Because of the various business developments across this site there have been numerous safety investigations, gas control measures (e.g. actively vented open subfloors) in the building units and monitoring of carbon dioxide and methane.

Investigations within the BoP data reveal variable fill material across the site, predominantly building rubble and granular fill with pockets of domestic waste. Surface strata layers included 1m to 2.5m of tarmac/sub-base over coarse gravel and silty sand which contains traces of brick, ash and organic matter. This typically was found to overlay 2m to 3.5m of domestic refuse, described as containing plastic and paper with some metal, ceramic and glass. This landfill is already protected over its full length by rock revetment and saltmarsh. The defence is currently in good condition, although loss of the standard of protection due to saltmarsh decline and SLR should be considered for future protection of the landfill.

Based on the current system there are only a few residential properties at risk of flooding, and hence low likelihood of FCERM GiA funding without substantial contributions.

Figure 5.5 (a) Reclamation for road building at Holes Bay; and right (b) the road as it is today.

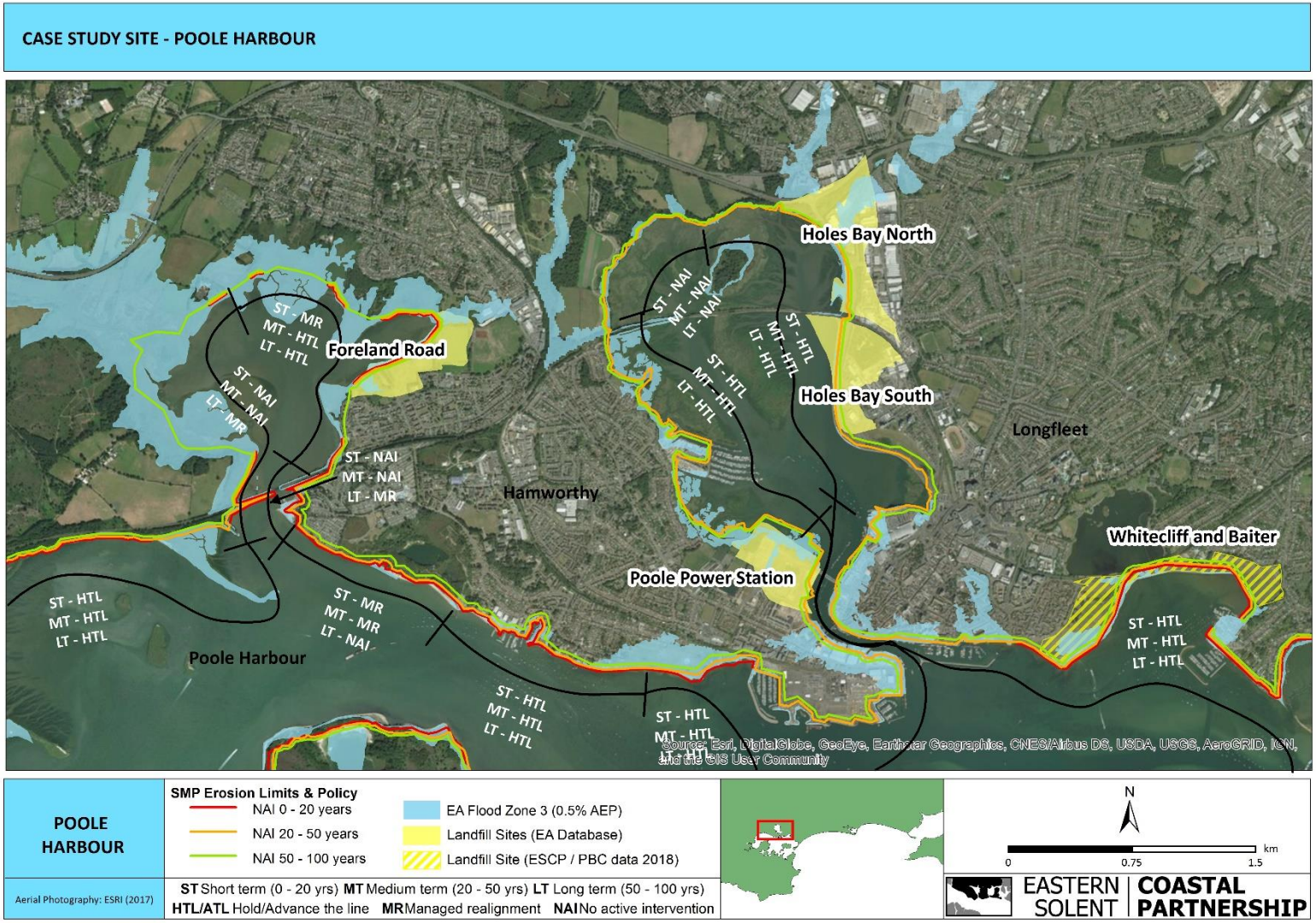


Figure 5.6 Map of the Poole Harbour landfills along with SMP2 erosion prediction, flood zone 3, and SMP2 policy recommendations.

5.3 Christchurch Harbour, Dorset (Case Study 3)

Christchurch Harbour contains several former landfill sites. Within the Harbour, the Shoreline Management Plan (SMP2) (RHDHV, 2011) policy across the epoch periods varies, with MR and NAI recommendations in place for most of the harbour. A HTL policy recommendation is in place for the short term across the large historic landfill at Stanpit – followed by MR for the remaining epochs. The SMP review states the advice for this area is to: *"Maintain opportunity for roll back of marshes with Sea level rise subject to investigation of landfill"* and comments that *"principal opportunities for such adaptation are in the areas of Stanpit marshes, constrained by the anticipated need to defend former landfill areas".*

Stanpit Marsh is one of the UK's foremost nature reserves and illustrates how in the past tipping often occurred directly onto coastal and estuarine mudflats or marshland. Inert, industrial, commercial and household waste was infilled between the 1930s and 1980s. The landfilling here is understood to have involved minimal or no site engineering to contain or manage leachate and landfill gases; and the westerly Stanpit landfill is between 2m-5m depth whereas the easterly area is 1m-3m deep (these depths are provided in the FCERM Study by Christchurch BC, 2015).

The SMP2 and Christchurch Bay FCERM Study identified the Stanpit Marsh coastal landfill site as an area of concern regarding climate change and sea level rise (SLR); this site would present a danger of contamination if it became intertidal (Halcrow, 2004). A major threat from future flooding and/or coastal erosion was considered not likely to affect the landfill for over 50 years. The natural marshes presently provide some protection to the landfill. However the fringes of the landfill are already potentially exposed to flooding from extreme sea levels (Figure 5.8). To allow lead time for building future defences as sea level rises, 'Trigger' and 'Warning' levels were advised for the next review of the Christchurch Bay FCERM Study alongside recommendations for improved monitoring of the site during and after flood events, to assess whether pollutants are being released (Christchurch BC, 2015).

Figure 5.7 (a) the marsh area in front of the landfill at Stanpit; (b) aerial view (from the report by Christchurch BC, 2015) – Stanpit is in the north of Christchurch Harbour, which is the marsh in the lower left of this photo.

There is presently no actual plan or any known funding mechanisms to achieve this. In the case of coastal defence, if the 1,500m of shoreline in front of the landfills were to be defended by a concrete sheet piled revetment, costing approximately £5 million, the Raw Partnership Funding (PF) score would by 5% (Table 5.3). **This would mean no chance of FCERM GiA funding without substantial contributions.**

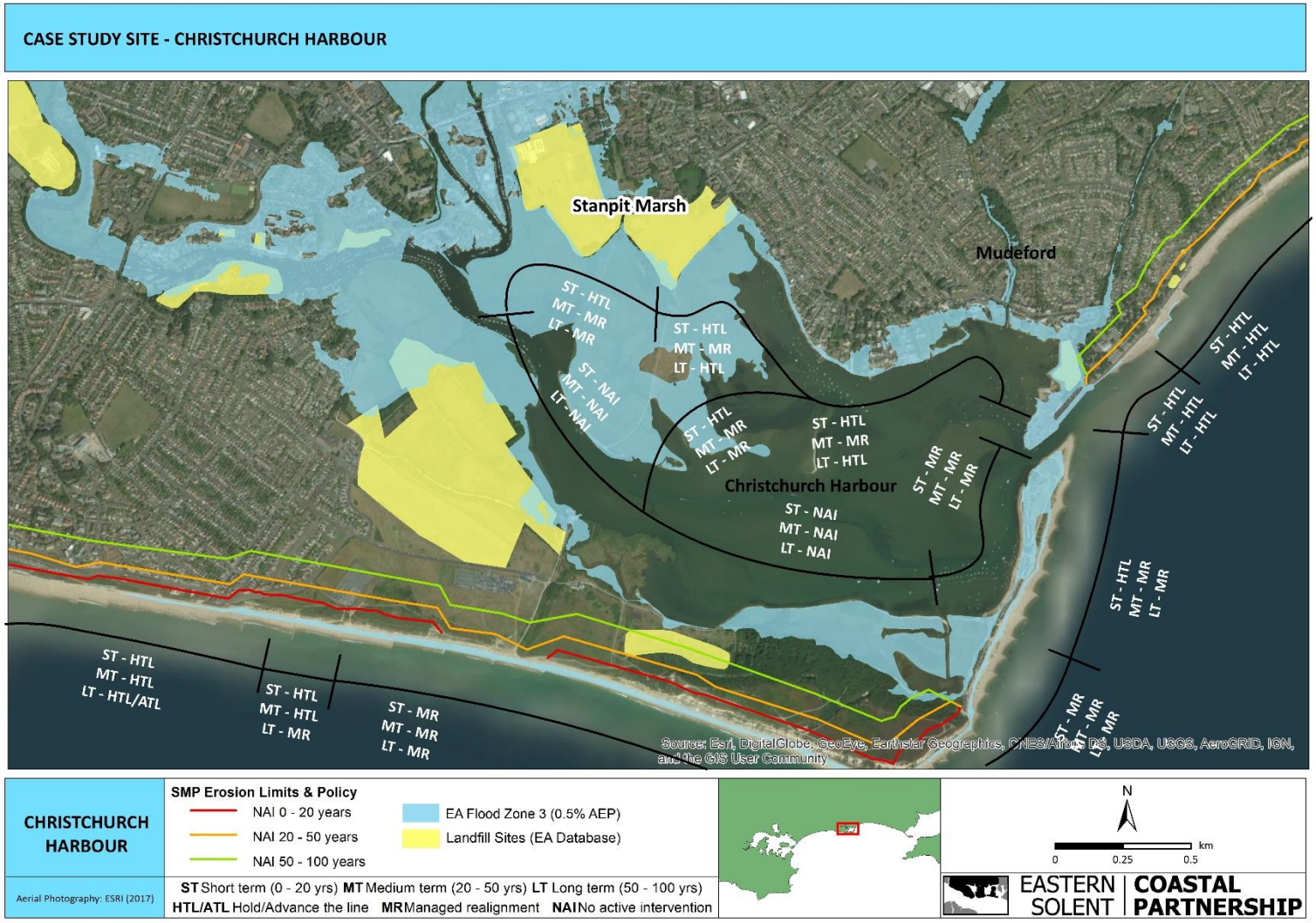


Figure 5.8 Map of Christchurch Harbour showing location of the Stanpit landfills, along with SMP2 erosion prediction, flood zone 3, and SMP2 policy recommendations.

5.4 Pennington, New Forest, Hampshire (Case Study 4)

This coastline between Hurst Spit and Lymington comprises low-lying land with mudflats and saltmarsh. Historic landfill here is located on low lying rural land (grassland/coastal grazing marshes and brackish lagoons) positioned behind the Pennington embankment sea wall (Figure 5.9). The site is of historic and nature conservation importance (including SSSI, SPA, SAC, and Ramsar designations). The coastal floodplain contains a closed landfill owned and managed by Hampshire County Council (HCC). Landfilling took place between 1962 and 1969, with a mixture of inert, industrial, commercial, and household waste. Further inland is a mix of historic and present-day authorised landfills.

The SMP2 policy for the coastal stretch fronting the landfills is HTL for all the three epochs (Figure 5.9). The 8.1 km sea wall from Keyhaven to Lymington is in moderate condition and subject to overtopping during storms, and its replacement or upgrade is likely to be considered within the coming years. The saltmarsh offers some protection to the sea wall although is eroding, whilst a relatively sheltered wave climate is afforded by the presence of the managed shingle barrier, Hurst Spit.

A significant pathway for release of waste could be breach of the wall and erosion. During a period of heavy storms, on 17th December 1989 waves over-washed and tidally breached Hurst Spit. Subsequently sections of the Pennington embankment collapsed, which flooded several properties in the marsh area, and over 50 properties in nearby Lymington (NRA, 1990; Wadey et al, 2012). Soon after these floods the sea wall was rebuilt, and the crest raised by 0.4m-0.5m, although the UoS (2018) research project highlights erosion and flood risks associated with loss of the saltmarsh and subsequent a decrease in standard of sea wall protection (Beaven et al, 2017). At present the large size of the floodplain and consequent risk of pollutants being dispersed across this area in a flood or erosion scenario, HTL and protection of the entire site is a default management option. However, a detailed appraisal of options in the long term would be appropriate (e.g. to monitor or remove the landfill).

Depending on the type of future coastal defence option and benefits assessment, the Raw Partnership funding score for a scheme to repair or rebuild the Pennington wall along the entirety of its length is likely to be between 20-40%. Hence substantial financial contributions would be needed.

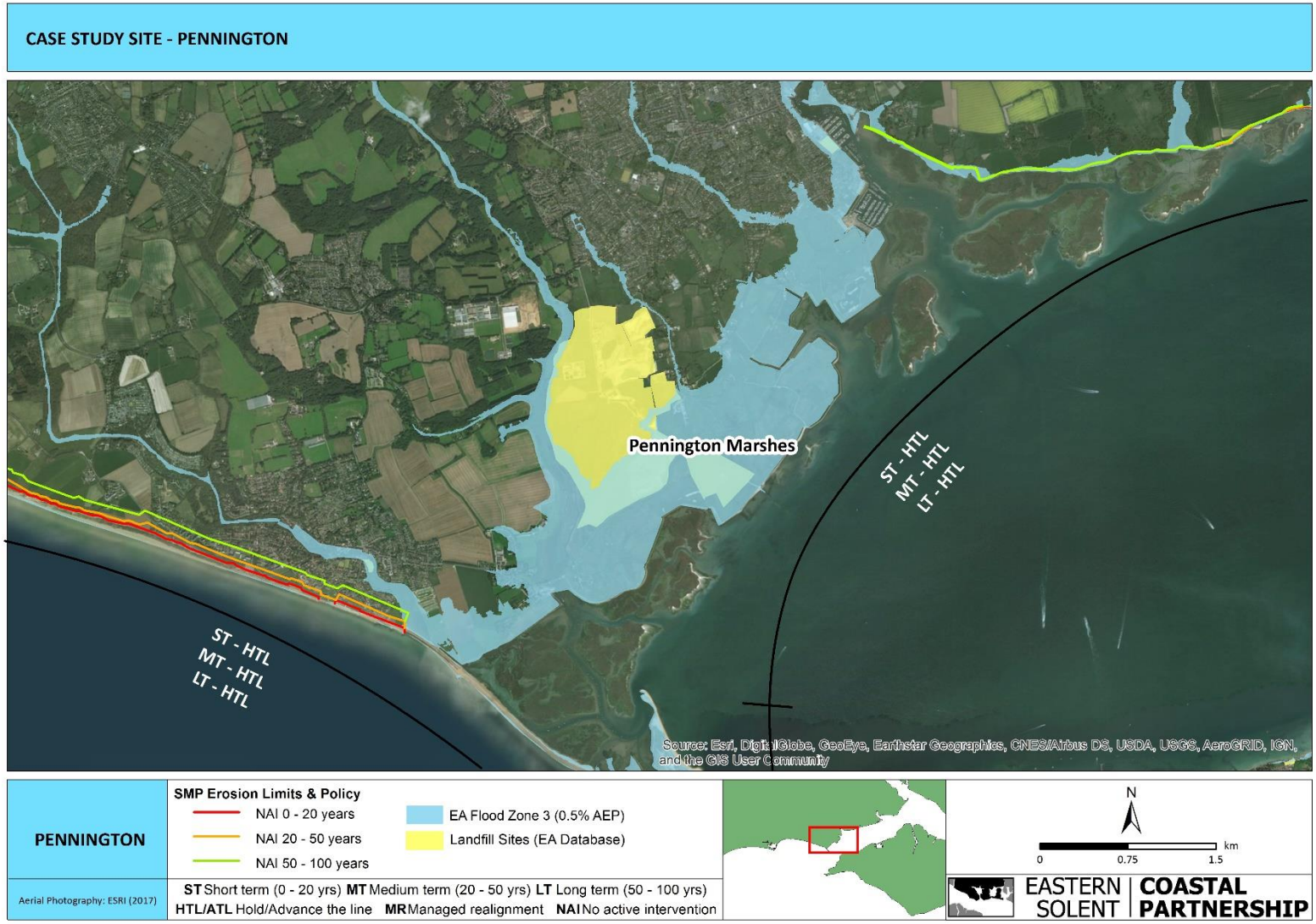


Figure 5.9 Map of the Pennington landfills along with SMP2 erosion prediction, flood zone 3, and SMP2 policy recommendations.

5.5 Fareham, Hampshire (Case Study 5)

Two of the landfill areas in the north of Portsmouth Harbour are case studied here. They include the sites at Wicor Cams, and the land south of Hamilton Road in Portchester (Figure 5.11). The two case study sites illustrate contrasting outcomes of FCERM GiA funded defences: Wicor Cams has a low Partnership Funding score and no present funding allocated for future defences whereas Portchester Quay has new defences planned and potential access to FCERM GiA.

Wicor Cams

This area consists of the historic landfill sites of Cams Bay Tip and Birdwood Grove Tip, which are now open land used for recreational activities. These sites received commercial and household waste, mainly during the 1970s. Site investigations including boreholes carried out in 2013 identified concrete, glass, red brick, wood, cloth, metal, plastic, and clinker in a gravelly clay mix. The quality of the landfill leachate at this site is generally poor with concentrations of metals and organics present. There is current evidence of waste release (e.g. household items including plastic-based debris) onto the foreshore (Figure 5.10b). The SMP2 recommended a HTL policy across all epochs, although no schemes are in place

Figure 5.10 (a) defences at Wicor Cams and (b) erosion of waste

Generally, the site is undefended, although there are some areas with informal defences in place, such as kerb stones, dumped rubble revetment and concrete sandbags. The defences that are visible have been in poor condition for some time (FBC, 2006) and are at the end of their life. **Potential options to manage the erosion and flood risk here were investigated in The River Hamble to Portchester Coastal Strategy (RHPS). This has formed the basis for the example costs and Partnership Funding score in Table 5.5 which only equates to 1% given the relatively long length of defence required and lack of Outcome Measures.**

Portchester Quay

This site is located approximately 2km east of the Wicor Cams sites, in Paulsgrove Lake within the north of Portsmouth Harbour (Figure 5.11). The SMP2 recommended HTL across all epochs.

The EA Historic Landfills Database does not state the dates of fill or the type of contents for this site.

At this site there is a plan to install a new scheme, including a sheet pile wall in front of the landfill, as part of defences to reduce the risk of coastal flooding and designed to a 1 in 200-year standard of protection. The Portchester to Paulsgrove Coastal Flood and Erosion Risk Management Scheme attained a Partnership Funding score of 64% because the floodplain (which contains the landfill) has within it almost 400 residential properties at risk of coastal flooding – there are also over 100 commercial properties at risk. This is expected to increase with the effects of climate change to 662 residential and 141 commercial properties at risk by the year 2115 (ESCP, 2018).

However even the notable amount of property risk does not guarantee funding, hence it is planned that the scheme will be funded by a combination of FCERM GiA and Private contributions (the developer Quadrant who own the industrial development Trafalgar Wharf), and Local Levy. The scheme is currently in the outline design phase. A business case for funding to undertake the detailed design and construction of the scheme was submitted to the Environment Agency in August 2017 and has since received approval, although is subject to a further significant external contribution to the scheme. If the contribution can be secured, it will enable the scheme to move into the pre-construction phase and protect the landfills. The scheme is likely to be constructed over a two-year period, with the earliest start date on-site being April 2020 (depending on funding).

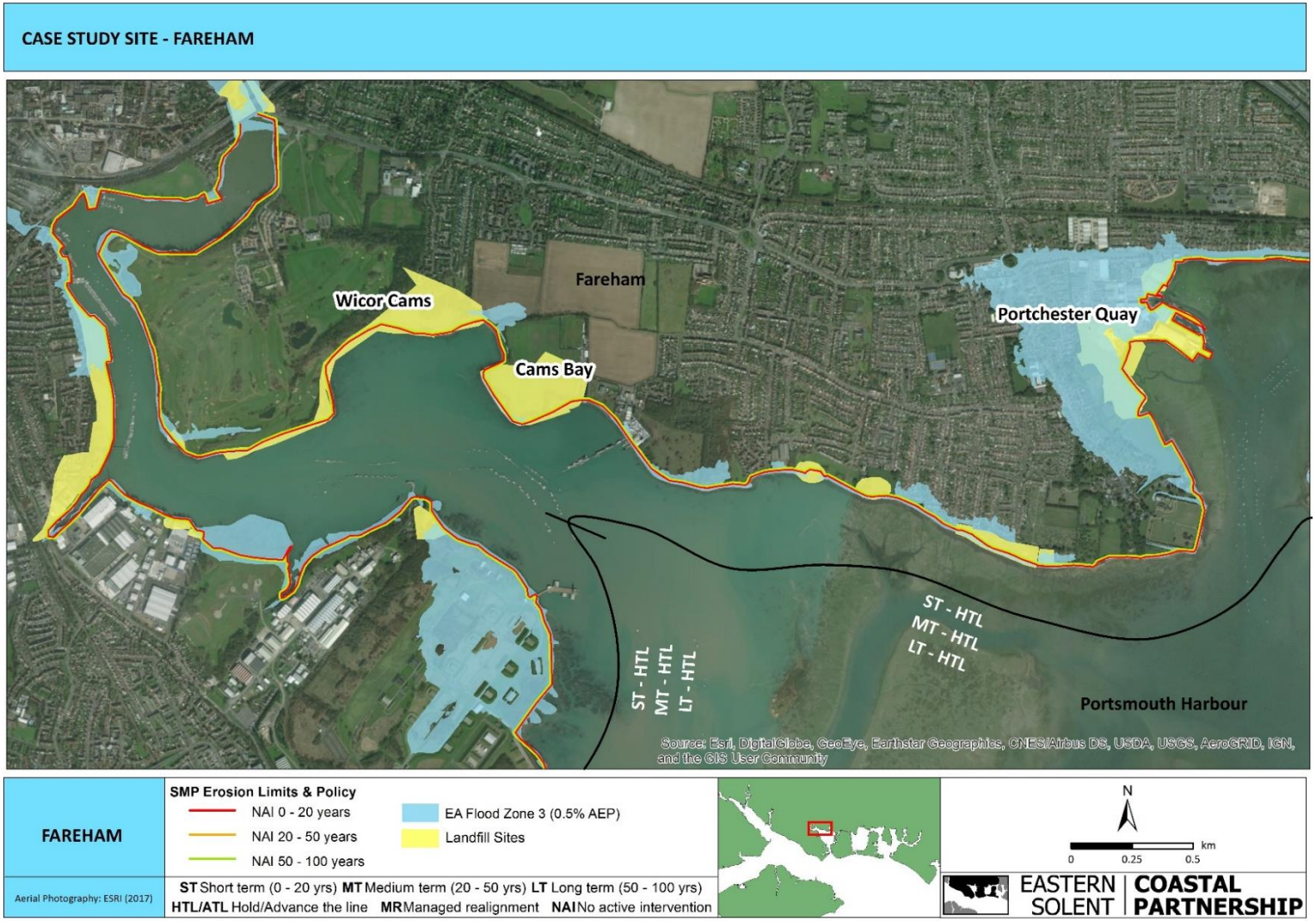


Figure 5.11 Map of the Fareham (Wicor Cams and Portchester Quay) landfills along with SMP2 erosion prediction, flood zone 3, and SMP2 policy recommendations.

5.6 Havant, Hampshire (Case Study 6)

This case study constitutes two adjacent main areas on mainland Havant in Langstone Harbour, to the west of the entrance to Hayling Island (Figure 5.11). This is now amenity land with a HTL policy recommendation in the North Solent SMP2, one where repairs rely on Local Authority maintenance budget, the other which is unprotected:

(1) Broadmarsh ("Harts Farm Way"): adjacent to Harts Farm Way, this reclaimed landform is situated to the west of the Brockhampton stream. The EA Historic Landfills database indicates a licence was awarded during November 1978 to dispose of household waste. This site is protected by 1km of sloped revetment of approx. 1:2 gradient, primarily clad in Armourloc concrete blocks first constructed in the early 1990s.

(2) Brockhampton ("Land South of Budds Farm Sewage Works"): this site is to the east of Broadmarsh and contains household waste (dates not recorded) and is not protected by hard defences. At Brockhampton, a wire fence runs behind the beach and waste is visible. Some of the Brockhampton site is at risk of coastal flooding (Figure 5.11).

Failures at Broadmarsh have occurred due to the flow of water through the revetment causing material beneath to slump, thus pushing blocks seaward, whilst local wind-waves also load the defence. The revetment's overall condition is deteriorating whereby each repair is the minimal amount that is required to prevent landfill escaping. At Broadmarsh as much as £500,000 has been spent refurbishing the revetment over the past 25 years.

Following damage during the storms of 2013/14 the EA part-funded (via additional storm response FCERM GiA) Broadmarsh emergency repairs during 2015/16 (£120,000, with £50,000 contributed by Havant Borough Council) (ESCP, 2014). The EA advised further funding would not be forthcoming, due to rules stating that Local Authorities were responsible for protecting areas contaminated by previous landfill.

The Portchester Castle to Emsworth FCERM Strategy (EA, 2012) identified a preferred option to sustain defences here to a 1 in 100-year standard of protection. The strategy states: *"At Broadmarsh capital maintenance is anticipated from 2016-2021. It is proposed that moderation will apply to comply with the legal requirements, and funding would therefore be provided with FDGiA* [now FCERM GiA] *support".*

A scheme for a Brockhampton Quay and Broadmarsh Landfill revetment features has been assessed by ESCP. These profiled works for the year 2022/23 and 2023/24 have a total scheme cost of £6,012,000, of which £4,173,000 would be FCERM GiA requiring £1,839,000 contributions (Table 5.3).

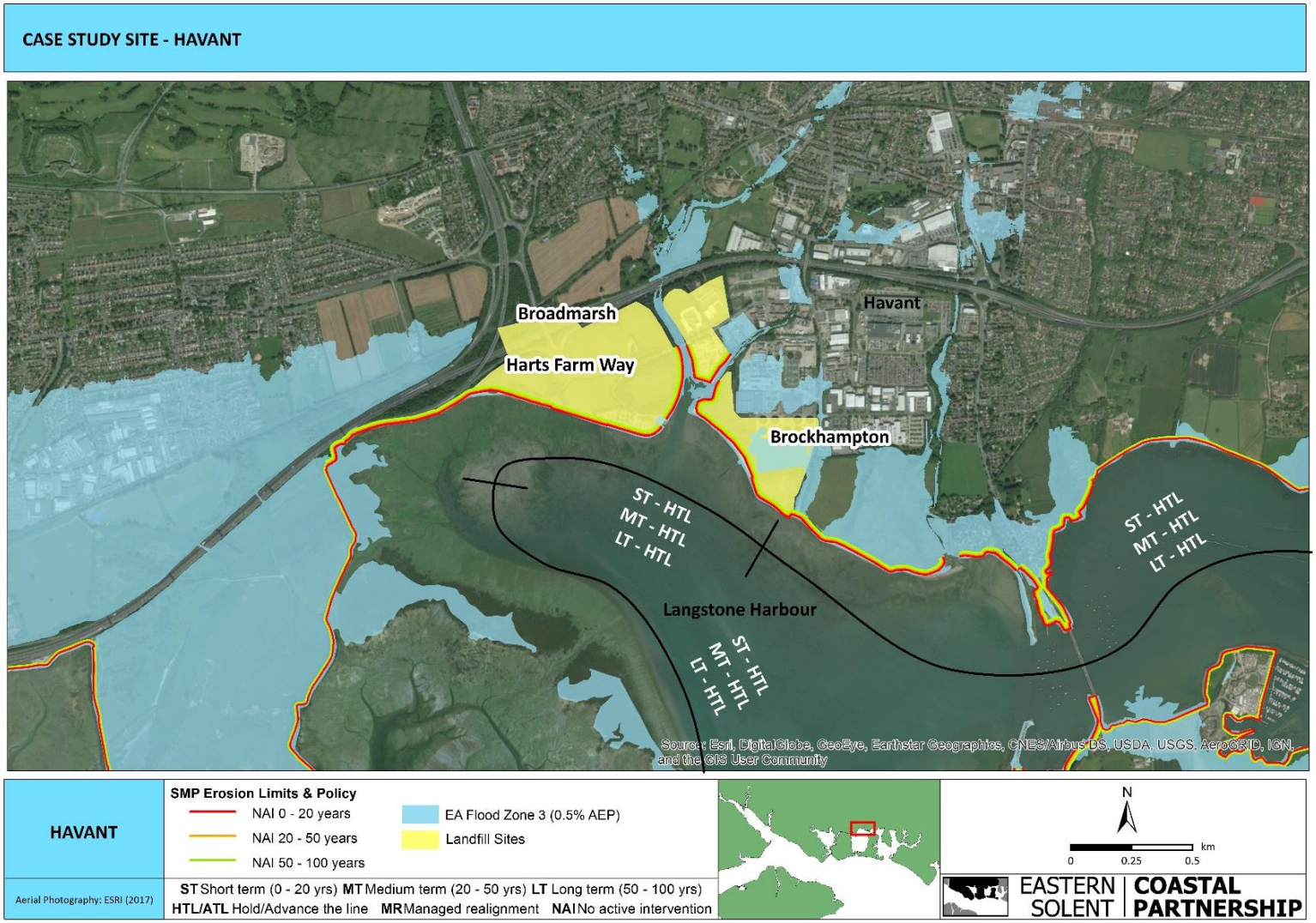


Figure 5.12 Map of the Havant (Broadmarsh and Brockhampton) landfills along with SMP2 erosion prediction, flood zone 3, and SMP2 policy recommendations.

5.7 Bognor Regis/Felpham, West Sussex (Case Study 7)

This site within the Arun District received inert waste for around a year between 1982 and 1983 and with an area of less than 2.5 ha is one of the smaller sites in the region (Figure 5.13). This area is now amenity land with a HTL policy recommendation within the Beachy Head to Selsey Bill SMP2. The length of coast immediately in front of the landfill is around 200m, and adjacent open coast defences front a wider floodplain affected by from compound sources (including when rainwater flooding becoming tide-locked, such as occurred in 2012 when 43 properties flooded in Felpham – West Sussex CC, 2012). Historically this area has been affected by erosion and wave overtopping during periods of low beach levels and in 1999 the seawall and groynes were renewed and the beach re-nourished (Arun DC, 2008).

This frontage is managed by the Environment Agency with a substantial concrete seawall, timber/rock groynes and a shingle beach. A proposed scheme that will protect this area is the "Arun to Pagham Beach Management Plan" (Table 5.2), which aims to conduct a series of beach management options (e.g. recharge, extended sea wall toe protection and groyne replacement). Funding for the entirety of the scheme is not yet secured.

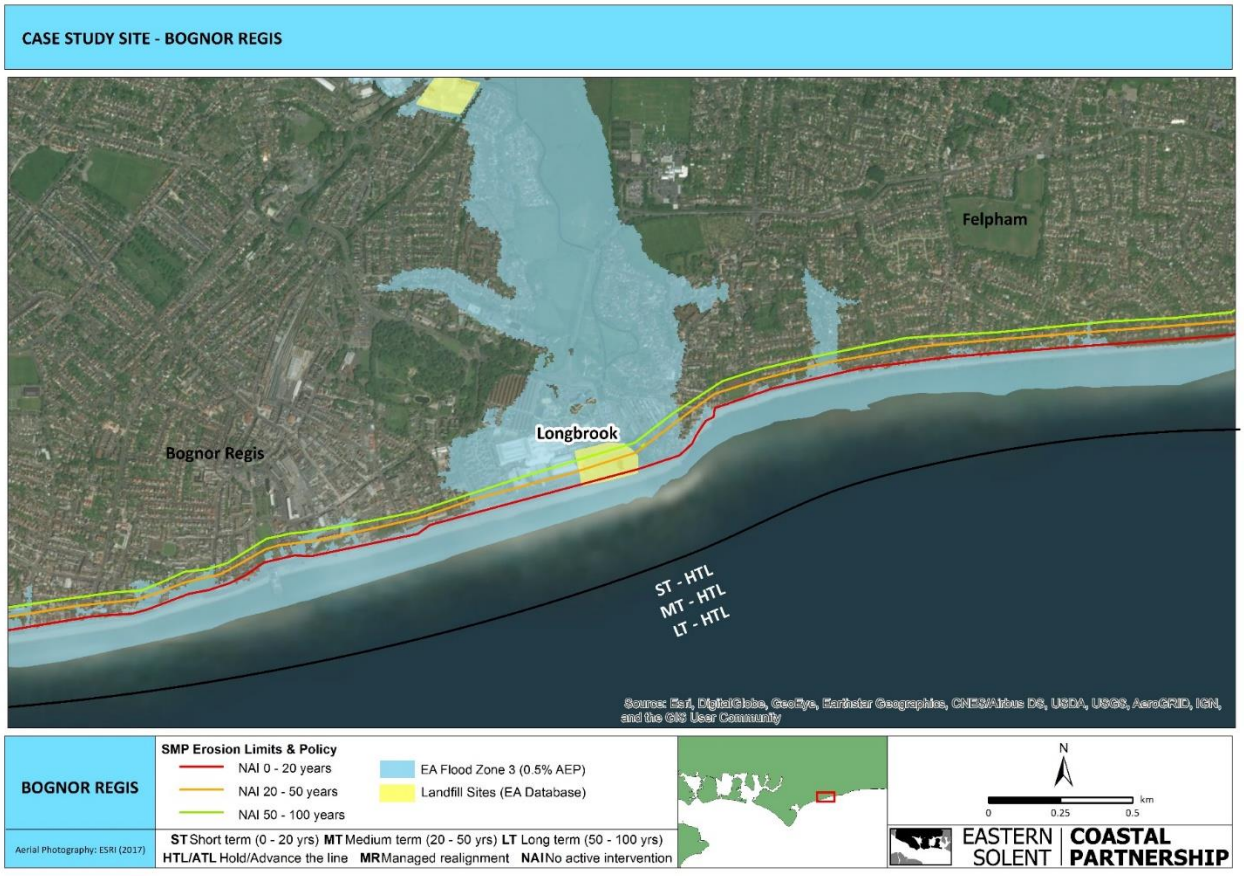


Figure 5.13. Map of the Felpham landfills along with SMP2 erosion prediction, flood zone 3, and SMP2 policy recommendations.

5.8 Summary

The case studies feature 13 landfill site areas, across 7 Local Authorities in the SCOPAC region. Some key facts about these case studies are summarised in Table 5.1.

- **The SMP2 policy recommendation for most of the shoreline in the case studies is HTL.** Exceptions exist, including NAI across all epochs at the eastern Lyme Regis site, MR for the 0-20 years epoch at Turlin Moor in Poole Harbour, and MR for part of the shoreline fronting a considerable proportion of the Stanpit site in Christchurch Harbour (Figure 5.8).
- **More detailed information (compared to waste classification within the EA Historic Landfills database) is available about some the sites** from documents that describe sampling of contents via boreholes. This can highlight important landfill features (e.g. contents and volume).
- **Most of these sites are now some form of open space rather than residential area, hence prospects for FCERM GiA are low under the current system**. This is the case even where substantial amenity and other benefits (OM1s) are included in the PF calculation. Broadmarsh (Havant), which triggered this study has a benefit: cost ratio of more than 12:1 yet cannot get a high enough Partnership Funding score to be protected, despite the problem here being regarded serious enough to secure emergency FCERM GiA funding after the 2014 storms.
- **Several sites are visibly releasing waste** (Lyme Regis east, Poole Turlin Moor, and Wicor Cams), whilst two others have historically experienced some flooding (Pennington and Whitecliff Baiter). Two sites that are protected by natural defences alone (e.g. marsh in Christchurch Harbour, and narrow beach in front of the site at Brockhampton which is otherwise exposed) are at risk of releasing waste this century.
- **The Hold-the-Line policy is being enacted at several sites primarily through maintenance activities via Local Authority funds** (Whitecliff-Baiter, Pennington, Broadmarsh) although this is likely to become an increasing struggle as structures at these sites (and foreshore) deteriorate.
- **Protection of one historic landfill has been fully secured based upon property Outcome Measures that have accessed FCERM GiA** (Lyme Regis – Former Gas Holder), whilst two others are currently quite well protected and await to secure further FCERM GiA funding (Portchester and Longbrook/Felpham).

Table 5.1. Summary of the landfill site case studies and key facts where known

Coastal segment ref.	Area	Site name & location	Period active	Waste type	Size (Ha)	Current land use	Shoreline length in front of site (km)	SMP2 Policy			Defended?	Recent scheme or likely to be funded under current system?
								0-20	20-50	50-100		
1	Lyme Regis, Dorset	Refuse Tip East of Spittles Lane	1974-1990	Inert, Industrial, Commercial, Household	0.1	Amenity	0.098	NAI	NAI	NAI	N	N
2		Former Gas Holder Site	1993-1994	Inert, Industrial, Commercial, Household	0.3	Residential	0.073	HTL	HTL	HTL	Y.	Y
3	Poole, Dorset	Foreland Road, Turlin Moor, Eastern Lytchett Bay	1984-1990	Inert, Industrial	17.8	School, recreational	0.8	MR	HTL	HTL	N	N
4		Holes Bay North	1977-1985	Inert, Commercial, Household	45.4	Industrial/ Commercial. Road, cycleway	2.1	HTL	HTL	HTL	Y	N
		Holes Bay South	1982-1984	Inert								
5		Whitecliff-Baiter	1984-1990	Building rubble, domestic refuse	24.3	Recreational areas, playpark, cycleway	1.8	HTL	HTL	HTL	Y/N	N
6	Christchurch, Dorset	Stanpit Marsh	1938-1981	Inert, Industrial, Commercial, Household	19.0	Amenity – open land & sports centre	1.4	HTL	MR	MR/HTL	N	N
7	Pennington, Hampshire	HCC Pennington Marshes Site A	-	Inert, Industrial, Commercial, Household	17.9	Grazing marsh/habitat – Efford adjoins active landfill.	8.1	HTL	HTL	HTL	Y	N
		Efford	1962-1969		147.2							
		Manor Farm	1989-?									
		Manor Farm Eastern Extension	-									
8	Fareham, Hampshire	Wicor-Cams I: Cams Bay Tip - Birdwood Grove	1969	Commercial, Household	20.3	Recreation	2.5	HTL	HTL	HTL	N	N
		Wicor-Cams II: Birdwood Grove Tip	1984	Inert, Industrial								
		Wicor-Cams III: Land near Wicor.Hard Cranleigh Road	-	Household								
9		Portchester Quay, Land South of Hamilton Road	-	N/A	11.7	Amenity, Trading estate		HTL	HTL	HTL	Y	Y?
10	Havant	Harts Farm Way 'Broadmarsh'	-	Household	36.2	Amenity	1.1	HTL	HTL	HTL	Y	N
11		Brockhampton	-	Household	12.2		0.7	HTL	HTL	HTL	N	N
12	Felpham, Sussex	Longbrook	1982-1983	Inert	2.5	Private Leisure	0.2	HTL	HTL	HTL	Y	Y?

Table 5.2. Programme of flood and coastal erosion risk management schemes/investment for the SCOPAC case study areas where schemes have been completed or are profiled

Project Name	Lead Risk Management Authority Name	Project Stage	Grant In-Aid 2018/19 (£k)	Grant In-Aid (Indicative) 2019/20 - 2020/21 (£k)	Partnership Funding 2018/19 - 2020/21 (£k)	Forecast Construction Start	Forecast Construction Completion	OM2	OM3	Notes
Lyme Regis Environmental Improvements Phase 4	West Dorset District Council	**Completed scheme**: Lyme Regis Coast Protection Works Phase IV was rated to have £86,373,000 PV whole life benefits over 100 years, costing £18,000,000 (funded by £13,800,00 FCERM GiA). The Lyme Regis Coast Protection Works Beach Management Plan (BMP Works) was also completed as a separate project delivering 55 OM3s.						N/A	480	**Raw PF score 77% (adjusted: 111%)**
Lyme Regis Coast Protection Works Beach Management Plan (BMP & Works) 2017/18 onwards		In Construction	66	132	0	Pre 2018	Post 2021	112	141	-
Arun to Pagham Beach Management Plan	Arun District Council	In Construction	50	100	30	Pre 2018	2018-2021	136	136	-
Portchester Castle to Paulsgrove Tidal Defence	Fareham Borough Council	Early Assessment	29	2,998	5,314	2018-2021	2018-2021	361	361	Raw Partnership Funding score of 64%

Source: https://www.gov.uk/government/publications/programme-of-flood-and-coastal-erosion-risk-management-schemes (where known, partnership funding scores have been added to the notes column from 2017/18 Medium Term Plan entries).

Table 5.3 Assessment of theoretical FCERM GiA score for a selection of case studies.

Site	Example Defence Option	PV Costs (£k)	OM2s	PV Benefits (£k)	PF score (indicative)
Wicor Cams	New frontline wall to protect against erosion of the landfill and flooding	2,807	0	409	1%
Foreland Road, Turlin Moor	New concrete sea wall to protect against flooding along the entire frontage	10,007	12	500	5%
Whitecliff/Baiter	Raise crest level; fill in areas without sheet piling; geotextile to protect landfill in lee of defences	1,020	0	1,000	5%
Holes Bay Road	Upgraded concrete revetment and crest raising	4,900	20	2,000	6%
Stanpit	New revetment sea wall to protect against flooding and erosion along the entire frontage	5,000	0	2,000	5%
Pennington Marshes	Repairs to revetment sea wall or rebuild	5,000+	100-200	1,000	20%
Broadmarsh	Major sea wall refurb, capital maintenance	6,012	1	75,117	69%

Based on approximated benefits over a 50-year duration. The Wicor Cams example was assessed in the River Hamble to Portchester Strategy as the preferred option and includes environmental benefits from preventing erosion but does not include an assessment of wider WFD benefits. The Broadmarsh entry is from the ESCP 2018/19 Project Application and Funding Service (PAFS) submission to the EA (costs and Outcome Measures where stated are project totals).

6 COLLABORATION & RAISING AWARENESS

The key aim of this project has been to raise the profile of the issue. This has taken place gradually throughout the project and has included a range of actions within the SCOPAC area, and at Regional and National events. These are summarised in Table 6.1. It is hoped that these will ultimately contribute to other projects increasing knowledge and awareness of coastal landfill risks and hazards.

An 'infographic' was developed to summarise the key messages from this project and is shown in Figure 6.1. This has been disseminated to members of the LGA SiG and SCOPAC and has been posted on the SCOPAC website.

Table 6.1 List of activities where this project has disseminated our findings, interacted with other projects and/or supported coastal landfills related research.

Date	Who to	Location	Format	Theme/ description	Outcome
31st Jan 2017	NERC ERIIP Coastal Landfills and Shoreline Management Project	Boldrewood, University of Southampton	Workshop/ consultation	Stakeholder meeting – discuss case studies.	Ongoing collaboration / sharing of project findings.
23rd March 2017		Highfield, University of Southampton	Meeting	Discuss collaboration.	
May 2017	University of Brighton	-	Research bid – support	Landfill erosion monitoring	Bid not successful
9th June 2017	Southern Coastal Group Meeting	Havant	Presentation	Presented funding from the ESCP area funding & risk assessment.	Members approved letter outlining themes in the talk, to be sent to EA Regional Directions.
20th June 2017	CIWEM Spring Conference: Outcome Measures for Flood and Coastal Risk Management - Fit for the Future?	Belgrave Square, London	Presentation & paper	ESCP presented a paper *"Outcome Measures – A help and a hindrance to our Flood & Coastal Erosion Risk Management partnership projects"*	Paper available which highlighted FCERM funding focuses on property protection (and not wider issues such as landfill).
5th July 2017	EA Regional Director – Wessex	-	Letter	Letter from SCG requesting confirmation of lack of funding for landfill protection (e.g. via FCERM GiA does not give Risk Management Authorities access to specific funds to protect assets).	Reply (Wessex, 18th Aug; SSD 8th Aug). Acknowledged issue & confirmed our findings (email)
	EA Regional Director – Solent & South Downs	-			Raised issue at national EA meeting of Area Flood & Coastal Risk Managers (see below).
September 2017	*Landfills issue raised at Environment Agency Area Flood & Coastal Risk Managers meeting*				
14th Nov 2017	EA Coastal Chairs Meeting	Westminster, London	Presentation	"Landfill risk at the coast" - Neil Watson (EA/SCOPAC) delivered an overview of issues around funding to protect historic landfill sites	NW took the issue forward to collate views of other Coastal Group Chairs
The 5th Mar 2018	CIWEM Event	Central London	Abstract (submitted)	"Diffuse Pollution: Evidence, Effective Practice and Lessons	Presentation not allocated.

					for Policy, Practice and Investment"	
9th Mar 2018	Coastal (Student) Seminar	Highfield, University of Southampton	Presentation	Presented SCOPAC landfills project to Engineering (BSc & MSc) students	-	
21st Mar 2018	Flood & Coast Conference	Telford	Presentation	Talk *"A toxic legacy? Coastal landfill – erosion, flooding, legality and funding"*	Presentation delivered & available on conference website.	
14th May 2018	NERC Highlight topic - Kate Spencer (QMW)	-	Research bid – support	Contributed comments to proposal that was circulated to CIRIA attendees.	Announced 30th Nov that NERC will be funding research on 'impact of legacy waste in the coastal zone'.	
11th June 2018	Landfill legal issues paper	-	Collaboration / telecon	CIRIA & NERC ERIIP team "Legal issues" paper produced by Richard Beaven (University of Southampton) to support engagement	Pending.	
5th July 2018	CIRIA landfills guidance update	Barbican, London	Workshop/ consultation	Funding overview presentation.	ESCP co-reviewed updated CIRIA guidance.	
25th Sept 2018	LGASiG meeting, Lewes	Lewes, Sussex	Presentation	Follow-up: shared links to national landfill locations. SiG members contacted confirming instances of where location matched local knowledge.	-	
7th Dec 2018	LGASiG meeting, London	Westminster, London	Presentation & infographic	Presented the findings of this project & distributed copies of the infographic to Local Authority councillors & officers	-	
18th Jan 2018	SCOPAC	Public Service Plaza, Havant	Presentation & infographic	Councillors and officers from Local Authorities across the region attend this meeting.	-	
22nd Jan 2018	RFCCs	-	Email circulated to Coastal Chairs	Correspondence raising awareness of issues highlighted in this report to Southern RFCC which was circulated to all Coastal Chairs	-	
12th Feb 2019	Contaminated Land Liaison Group (CLLG)	Winchester City Council City Offices	Presentation	Raise issue profile to this working group who report to the Hampshire & Isle of Wight Environmental Health Managers Group.	-	
N/A	EA Flood & Coastal Erosion Risk Management, Directorate; Defra/Cabinet	-	Letter	Highlight scale of the landfill issue & lack of funding – clarify next steps at national level (e.g. outcome of SMP Refresh?).	-	

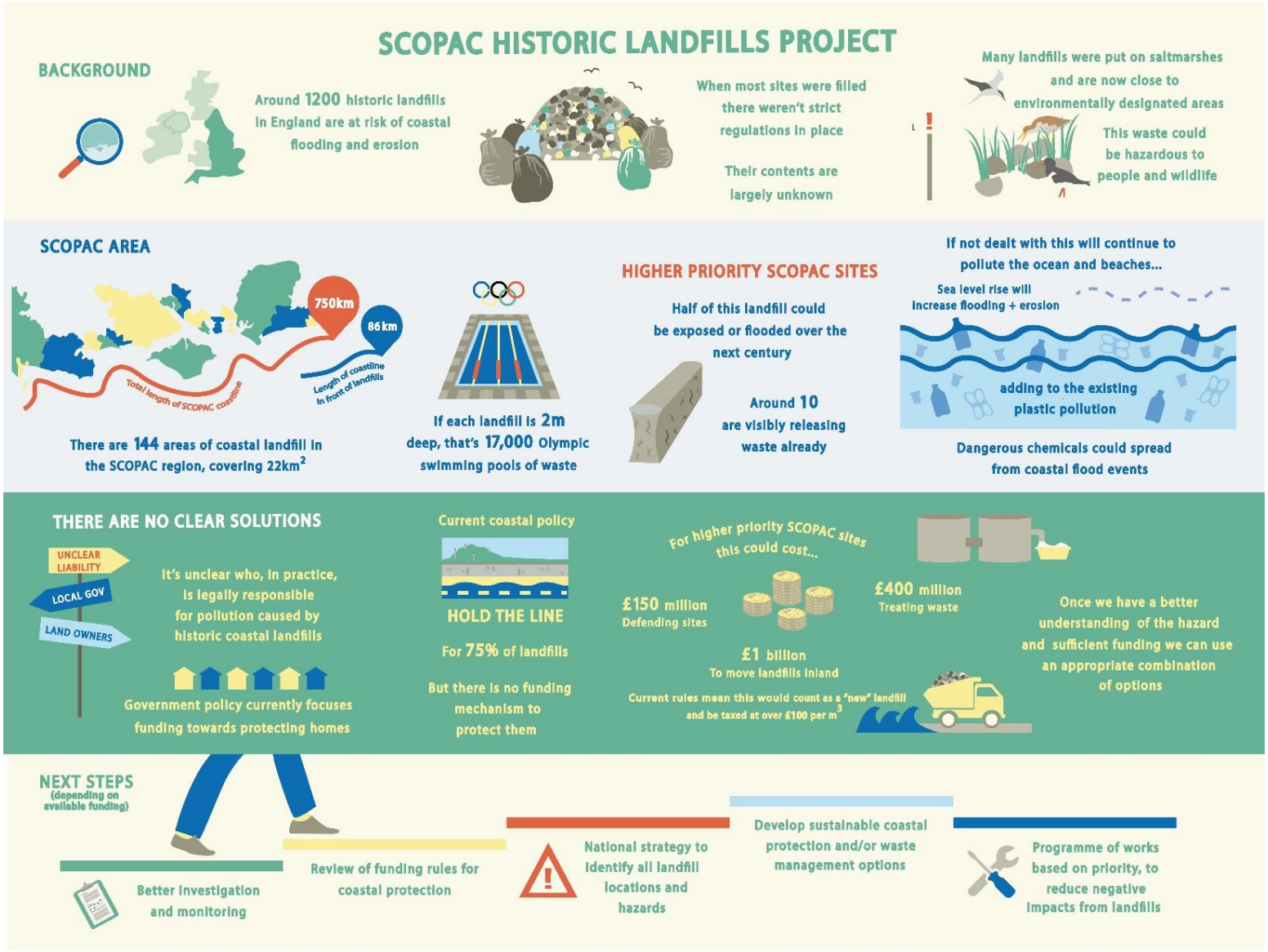


Figure 6.1. Landfill full infographic

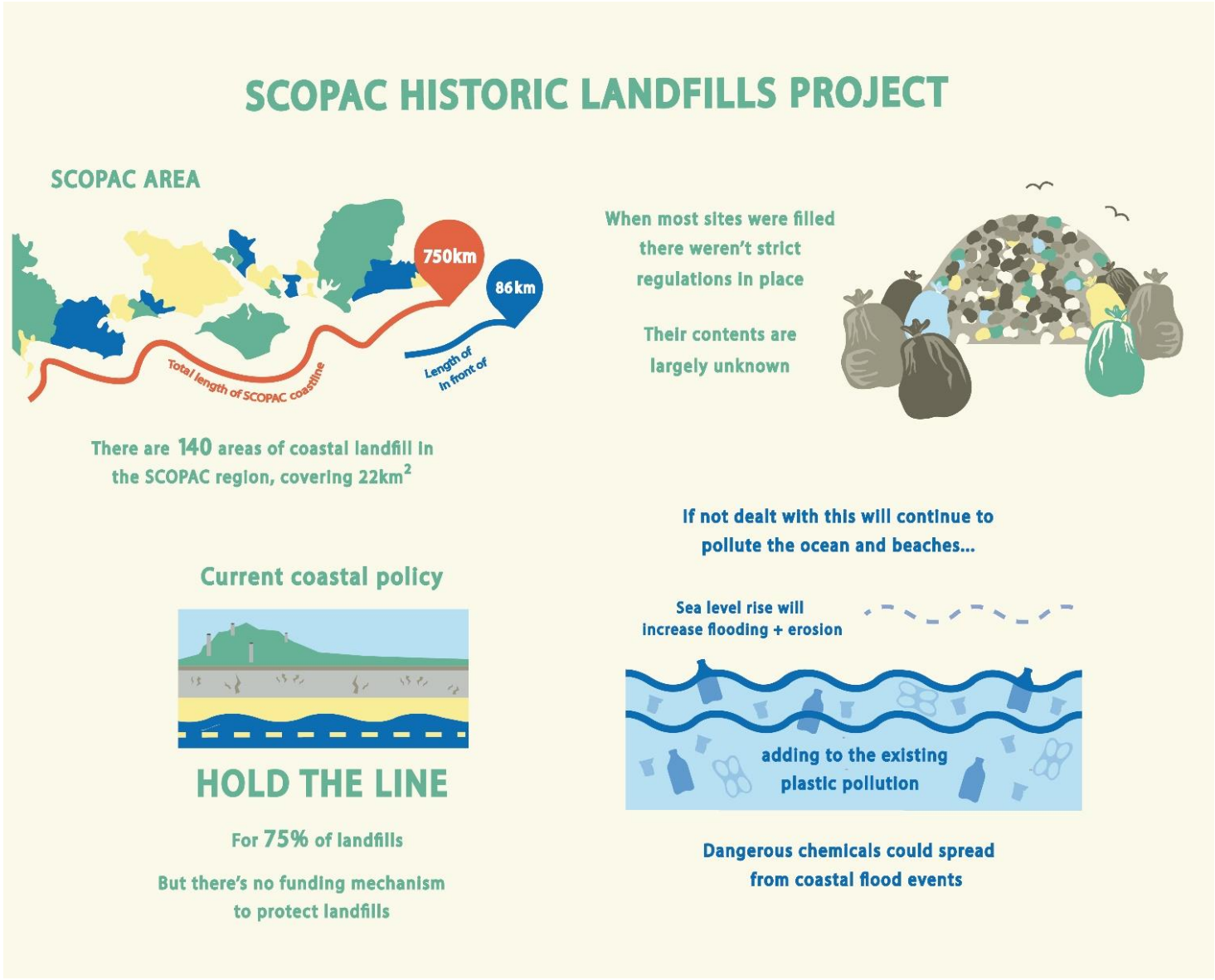


Figure 6.2. Landfill summary infographic

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary

This project highlights the legacy of historic landfills that are at risk of flooding and/or erosion. The work was undertaken for the SCOPAC region although the findings are applicable across the UK. In the SCOPAC region we identified 144 areas (22km^2) of SCOPAC landfill at risk of coastal erosion and flooding, using SMP2 erosion zones (up to 100 years) and the EA flood zone 3, not considering sea level rise. Around half of these sites are higher priority due to their proximity to the coast and with defences unlikely to protect them over the next century and no imminent replacement scheme planned. Most of these areas are on land and/or behind defences that are Local Authority owned, so public investment is required.

Much of this landfill legacy is due to waste disposal onto coastal land once considered low value (such as saltmarsh) but is now often of environmental importance. Some sites are releasing waste now, and there is a growing evidence base and public interest into this issue, including the links to human health and ocean plastics. In some cases, the risks of erosion and flooding exist because of the deterioration of defences that are at the end of their serviceable life, and in other locations landfill simply exists near a natural shoreline with no defences, and sea level rise (and resultant increased flooding and erosion) threatens to exacerbate the issue.

There is a lack of practical advice or evidence to clarify liability, and there remains uncertainty for landowners and Local Authorities affected by historic coastal landfill; especially given that the historic polluters may no longer exist, or predecessor bodies may have been abolished or changed in statute. Furthermore, there is minimal scientific evidence regarding impacts of historic coastal landfill on designated water bodies, or pathways of contamination to hazardous human health impacts.

The second-generation Shoreline Management Plans (SMP2s) advised upon most of these sites being defended. We assessed 12 potential funding mechanisms (inclusive of infraction proceedings and insurance provisions) which indicate that only a few sites out of the 144 identified have any prospect of being protected under current FCERM GiA rules. However, FCERM GiA can only provide funding when there is sufficiently high cost: benefit ratio, for which benefit scoring is heavily weighted towards residential property ‘outcome measures’ (OM2 and OM3) that would be protected by any new scheme. The other funding mechanisms are either too small, unfeasible or unknown.

The best method of risk management of coastal landfill risks is site specific, and may involve rebuilding and maintaining sea defences, reducing the pollution effects or even removing the contents of the landfill (this is generally a very expensive option and exposes an anomaly of Landfill Tax which makes this option prohibitive).

The profile of the issue, including the funding assessment, was successfully raised via a series of actions throughout the course of the study, summarised in Table 6.1. It is hoped that this can lead to actions to decrease the negative impact of the landfill legacy.

7.2 Recommendations

The problem will be an expensive one to solve and existing funds are not sufficient. A way forward if FCERM GiA can be accessed for landfill protection is that benefits can be derived from hazards avoided (to people and environment), and longer-term benefits relating to coastal evolution and protection. However as indicated in Chapter 3, FCERM GiA is not available to solve this problem in its current Partnership Funding / Outcome Measure form.

To move forward the following could be considered:

- The Environment Agency's historic landfill shapefile data set provides a good starting point for identifying the location of these sites.
- The list of historic landfill sites needs to be prioritised using a combination of urgency and potential environmental risk.
- The "rules" for a number of the funding mechanisms need to be challenged and maybe changed to ensure that they are able to be used where appropriate public investment will save public money in the future – for example the administration of Landfill Tax when re-locating historic coastal landfill.
- There needs to be provision for routine maintenance, a contingency for emergencies and allowance for future major (capital) expenditure.
- It would be beneficial to have a routine monitoring system to identify whether any pollution is occurring.
- Understanding of pathways of causes of harm from coastal landfill is an area of high research importance to support statements about landfills impacting human health.
- With finite land resources and pressure to build homes, the planning system is potentially a major route for dealing with land contamination if there can be a forward-thinking approach, although unfortunately this has not yet been prioritised.
- Ideally, a method would be developed to assign benefit criteria to preventing the release of this waste or pollutants from landfills, for example in a form that could form a new Outcome Measure for a FCERM GiA Partnership Funding type assessment and that would support the business case for protecting the public and environment from coastal landfills. This could for example, be combined with calculations of how much landfill will erode using the Historic Landfill Sites dataset and GIS mapping.
- Recent global attention over plastics in the ocean is likely to raise the profile of this issue and may assist with benefits assessment and attract other funding streams if they become available. It is advised that this movement is monitored closely for landfills at the coast.

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