13 Water resources

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On a rising tide, water will enter the pools through the three sluice structures. This currently only occurs at Copperhouse Pool and Carnsew Tunnels. At high tide the sluice gates will be closed holding back a volume of water in the pools. The volume of water that enters the pools is determined by the hydraulic characteristics of the sluices themselves, and by the magnitude of the tide.

At a predetermined time on the falling tide, the sluice gates will be opened to release the stored water. The timing of the release is intended to maximise the velocity of the discharge flow from the pools, in order to scour sediment out of the harbour.

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13.2 Legislation and planning policy guidance

13.2.1 Water resources

The management of water resources is governed by a range of legislation and guidance set out in international, national and regional policies and plans. This assessment has been prepared taking these plans and policies into account. In addition to its coastal location, Hayle Harbour receives fluvial waters from the Mellanear and Angarrack Streams. It is also in close proximity to the Hayle River. Consideration has been given to legislation covering both fluvial and marine environments.

All three rivers are designated as Main Rivers under the provisions of the Water Resources Act 1991. . Main Rivers are usually larger streams and rivers. However, they do include smaller watercourses of local significance. A Main River is a watercourse marked as such on a Main River map. Main River Maps are administered by the Department for the Environment, Food and Rural Affairs (Defra). The Main River designation also includes any structure or appliance that controls or regulates the flow of water in, into, or out of, the Main River. It does not relate solely to the watercourse itself. The Environment Agency is the responsible authority in relation to Main Rivers, and has permissive powers to carry out flood defence works on such watercourses.

13.2.2 Administrative arrangements

Coordination of policy for inland waterways, coastal and marine environments is managed by Defra. Many quality standards are set at European level, which are then transposed into UK law. Enforcement of water quality standards in England is managed by the Environment Agency.

13.2.3 International policy framework

European Commission Water Framework Directive (2000/60/EC)

The overall objective of the Water Framework Directive (WFD) is to bring about the effective co-ordination of water environment policy and regulation across Europe. The main aims of the legislation are to; ensure all surface water and groundwater reaches 'good' status (in terms of ecological and chemical quality and water quantity as appropriate), promote sustainable water use, reduce pollution and contribute to the mitigation of flood and droughts. The WFD also contains provisions for controlling discharges of dangerous substances to water and includes a 'List of Priority Substances' (see EC Dangerous Substances Directive below). The WFD is implemented in England by the Environment Agency.

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13.2.4 National policy framework

Making Space for Water is a government strategy for flood and coastal erosion risk management in England. Both the consultation document (Defra 2004) and the Government's first response to the consultation exercise (DEFRA 2005) are relevant.

Over the 20 year life time of the strategy the government aims to implement a more holistic approach to managing flood and coastal erosion risk in England. The main aims of the strategy are to reduce the threat to people and their property, and to deliver the greatest environmental, social and economic benefit consistent with the government's sustainable development principles.

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Planning Policy Statement 25 (PPS 25) was published by the UK Government in December 2006 superseding PPG 25. The document sets out how new development should take flood risk into account at all stages in the planning process. PPS25 is underpinned by the Sequential Test, which aims to direct new development to areas of lowest possible flood risk. If, following the Sequential Test, development is considered to be necessary in a higher risk flood zone, and depending on the severity, an Exception Test can be conducted. Through the appraisal of risk and impacts, PPS25 steers appropriate development towards implementation of appropriate flood risk reduction and management measures. This includes the incorporation of Sustainable Urban Drainage Systems (SUDS) where appropriate.

PPS 25 incorporates potential climate change impacts, and the current scientific ambiguity, by incorporating a 'high emissions' extrapolation for sea level rise. Guidelines are also included to take account of increased storminess through increased rainfall, river flow, wind speed and wave heights.

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Certain marine works within Hayle Harbour fall within the scope of the Coast Protection Act 1949. The Act sets out to control activities in, and to protect, the coastal zone. Under the Hayle Harbour Act 1989, the Harbour Authority (Hayle Harbour Company Ltd) has powers to undertake certain works within the harbour. These powers include the ability to carry out dredging within the harbour, and to dispose of the material arising in a prescribed way.

Wildlife and Countryside Act 1981

In England SSSIs are notified by Natural England under the Wildlife and Countryside Act 1981 (amended 1985) to protect those sites which represent the country's best wildlife and geological sites. Natural England has powers to protect SSSIs from damage and to ensure they are managed appropriately. The Countryside and Rights of Way Act 2000 gives increased power to Natural England to prevent damage that is being made through neglect or inappropriate management. In addition, there is a statutory duty on Local Authorities and other public institutions to further the conservation and enhancement of SSSIs whilst carrying out their operations and exercising their decision making functions (this includes making planning decisions).

Environment Agency General Quality Assessments

The Environment Agency (EA) conducts General Quality Assessments of river and estuary quality annually against four key aspects including biology, chemistry, nutrients and aesthetic quality. Based on the General Quality Assessment, rivers and estuaries are classified into the categories Good, Fair, Poor or Bad.

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Environmental Quality Standards (EQSs) have been established for some rivers setting concentrations of specified substances for the relevant waters. EQSs can be statutory or informal. For example, the Dangerous Substances Directive establishes statutory EQSs for listed substances. Informal EQSs have been set by the EA in the form of River Quality Objectives (RQOs).

The EA set RQOs for each stretch of river on the basis of a system known as the 'River Ecosystem (RE) Classification'. The purpose of the RQOs is to help protect and improve the quality of water in rivers in England and Wales. The objectives will generally be expressed in terms of quality grades which reflect the general health of the waters. They are used to plan the maintenance and improvement of river quality and provide a basis for the EA in setting discharge consent standards.

EQSs for estuaries

The EA reports on estuarine water quality every 5 years. The EA conducts an assessment of estuarine water quality in terms biological, chemical and aesthetic quality. Estuaries are then classified into categories Good, Fair, Poor or Bad. The estuary classification scheme is due to be improved in the near future with estuary quality reported to meet the requirements of the EC Water Framework Directive. This will classify the ecological status of estuaries using information on water quality, hydrology, plants, fish populations and benthic fauna.

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Water Resources Act 1991 (WRA 1991)

The Water Resources Act 1991 consolidated previous water legislation in respect of both the quality and quantity of water resources.

Under Section 85 of the WRA 1991 it is an offence to cause or knowingly permit polluting matter to enter into "controlled waters", that is rivers, estuaries, coastal waters or groundwater, without permission. Permission is generally obtained as a discharge consent granted by the EA. The Agency sets conditions which may control volumes and concentrations of particular substances or impose broader controls on the nature of the effluent. Each consent is based on the objective (RQO) set by the Agency for the quality of the stretch of water to which the discharge is made as well as any relevant standards from EC Directives. The EA may also refuse an application for a discharge consent.

13.2.5 Regional policy framework

Regional Planning Guidance for the South West of England (RPG 10)

This regional planning guidance for the South West of England is provided by the Secretary of State for Transport, Local Government and the Regions. It aims to provide a regional spatial strategy within which local authority development plans in the South West should be prepared for the period 2016 and beyond. All parts of this guidance must be taken into account by local planning authorities in preparing their development plans and may be material to decisions on individual planning applications and appeals. Policies in relation to water resources and flooding are set out in Section 9 'Infrastructure and Natural Resources'.

Policy RE 1 of RPG 10 discusses water resources and water quality. The policy encourages local authorities and developers to protect and enhance river and coastal water quality, protect groundwater resources, take water related issues into account at an early stage and co-ordinate the timing of new development with the provision of sustainable water supplies, sewage treatment and discharge systems. It also promotes the adoption of Sustainable Urban Drainage Systems (SUDS).

Policy RE2 of RPG 10 encourages local authorities and developers to direct development away from land liable to flooding, and promote the use of Sustainable Urban Drainage Systems (SUDS). For development in flood plains the policy advises that development plans need to minimise the cumulative adverse impacts and secure enhancement of the floodwater storage and ecological role of flood plains.

13.2.6 Local policy framework

Penwith Local Plan 2004

The Local Plan provides the strategic base for all land use planning in the Penwith area for the period up to 2007. Management of Water Resources is discussed in Section 5 General Development Guidance and in Section 6 Coast and Countryside. .

Policy GD-4 states that proposals for development will not be permitted where they would cause significant harm as a result of inadequate provision for:

- sewerage treatment, surface water drainage and water supply

- the prevention of water pollution or
- the prevention of flooding, on site or elsewhere

Policy CC-7 states that proposals for development which would significantly harm the nature conservation value or geological interest of a Site of Special Scientific Interest will not be permitted.

Policy CC-8 states that development will not be permitted where it would significantly harm the nature conservation or geological interest of areas of great scientific value, county wildlife site, county geological sites, ancient woodland sites and local nature reserves. Where development is permitted any impact on such values must be minimised and conditions will be imposed, or a planning obligation sought, to ensure that mitigating measures are undertaken.

Policy CC-14 states that proposals for development which would have a significant adverse effect on the shoreline or adjacent coastal waters in terms of its landscape character, amenity, nature conservation, archaeological, historic and geological values will not be permitted.

St Ives Bay Coast Protection Order 2003

Under the Coast Protection Act 1949, Penwith District Council has powers to control certain activities within the coastal zone. Under Section 18 of that Act, in 2003, PDC put in place an Order, prohibiting the excavation or removal of materials from the sea shore, except under licence from PDC. The areal extent of the order, known as the Penwith District Council, St Ives Bay Coast Protection Order 2003, includes Hayle Harbour. Notwithstanding the provisions of the Hayle Harbour Act 1989, the Harbour Authority has entered into a licence, under the provisions of the St Ives Bay Coast Protection Order, in relation to the carrying out of dredging within the harbour.

13.3 Methodology and assessment criteria

13.3.1 Scope

Spatial scope

The spatial scope of this assessment encompasses the area within the planning application boundary and any other areas which are affected by the proposed development site, particularly within the harbour and estuary.

Temporal scope

The current baseline for the assessment is 2007. Impacts will be considered during the 9 year construction phase, which is programmed to commence in 2008. Occupational impacts will be assessed from 2017 onwards with an expected design life of 100 years. Climate change has been assessed in accordance with the

PPS25 guidelines allowing for a 30% increase in peak rainfall intensity and appropriate allowances for sea level rise.

Technical scope

The technical scope of this assessment is to:

- Identify the existing baseline conditions
- Identify potential impacts from construction and occupation
- Assess the significance of identified impacts
- Identify the need for specific mitigation measures
- Identify the likely residual impacts

13.3.2 Methodology

Information regarding the site and the current environmental baseline has been gathered through a desk study, baseline studies and contact with the Environment Agency and Penwith District Council.

The Flood Risk Assessment (FRA) has been conducted in accordance with Planning Policy Statement 25 (PPS25) – Development and Flood Risk. This guidance introduces a sequential risk-based approach to flood risk. The Flood Risk Assessment (Annex 13H) provides more detailed information regarding the methods used and how the development will meet the requirements of PPS25.

The methodology for impact prediction and mitigation is based on assessing both the magnitude of the changes expected and the sensitivity of the receptors.

13.3.3 Baseline studies

To guide the development of the proposed scheme and enhance understanding of Hayle Harbour and its environmental context, a wide range of data collection, studies and investigations have been undertaken. Where appropriate previous information has been reviewed, and when necessary new studies undertaken.

Water based surveys undertaken previous to and during this scheme appraisal include:

Date	Type of Survey	Author
May to June 1983	Current velocities and water levels	Sea Sediments
January 1989	Current velocities and water levels	HR Wallingford
March 2003	LiDAR topographic survey	Environment Agency
July 2004	LiDAR topographic survey	ING Real Estate Development
November 2004	LiDAR topographic survey	ING Real Estate Development
June 2005	Bathymetry x-sections + water levels	Merrett Survey Partnership

The following studies presented in Table 13.1 (and as Annexes to this chapter), together with other reference documents, have been utilised in building knowledge of the water environment and associated issues:

Report Title	Author	Date
Harbour Wall Condition Survey (Annex 13A)	Buro Happold	January 2005
Sediment Exchange Monitoring (Annex 13B)	Buro Happold	March 2005
Harbour Wall Schedule of Works (Annex 13C)	Buro Happold	March 2005
Harbour Contamination Report (Annex 14A)	Buro Happold	December 2005
Copperhouse Sluice Gate Condition Inspection (Annex 13D)	Kenneth Grubb Associates	Sept 2006
Pool Level Factual Information (Annex 13E)	Buro Happold	May 2007
Hydraulic Studies Phase 2 (Annex 13F) * * This report has additional references relevant to this Assessment	HR Wallingford	June 2007
Description of Works (Annex 13G)	Buro Happold	July 2007
Hayle Harbour Flood Risk Assessment (Annex 13H)	Buro Happold	August 2007

Table 13— 1: Key studies

13.3.4 Impact significance criteria

The assessment methodology has separately considered the construction phase (short term impacts) and the operation phase (long term impacts). Construction impacts have been considered by breaking the construction elements down. For the operational phase, the whole scheme has been assessed.

The methodology for assessment of impact significance and mitigation is based on assessing both the magnitude of the changes expected and the sensitivity of the receptors which the changes would affect. Table 13.2 and Table 13.3 detail the criteria used to access these factors.

Magnitude of change	Criteria
Large	Water Resources: Wholesale changes to watercourse channel, route or hydrology. Changes to site resulting in an increase in runoff with flood potential, and also significant changes to soil erosion/sedimentation patterns. Major changes to the water chemistry of surface runoff and groundwater.
Medium	Water Resources: Some fundamental changes to the course and hydrology. Changes to site resulting in an increase in runoff within system capacity. Moderate changes to soil erosion/sedimentation patterns. Moderate changes to the water chemistry of surface runoff and groundwater.
Small	Water Resources: Minor changes to the water courses. Changes to site resulting in slight increase in run off well within the drainage system capacity. Minor changes to soil erosion/sedimentation patterns. Minor changes to the water chemistry of surface runoff and groundwater
Negligible	Water Resources: No change to watercourses, run off and soil erosion and sedimentation patterns and water chemistry.

Table 13– 2: Magnitude of change

Receptor sensitivity	Receptor
High	Water Resources: Water body of very good chemical or biological quality. Includes: designated bathing waters, shellfish and salmonid fisheries. A source used for public water supply. SSSI, SPA/SAC, Ramsar site or highly sensitive aquatic ecosystem.
Moderate	Water Resources: Water body of high amenity value including areas of bathing and where water immersion sports are regularly practised. Water body of 'good or fairly good' chemical and biological quality and/or non-public water supply or cyprinid fishery. Water body of nature conservation importance at the regional level or a moderately sensitive aquatic ecosystem e.g. SNCI.
Low	Water Resources: Water body of 'fair' chemical or biological quality. A source in close proximity to a source protection zone or abstraction point. Water body of moderate amenity value, including public parks, boating or where a popular footpath passes adjacent to the watercourse, or where the receiving water course passes through a housing development or town centre. Also non-contact water sports. Water body of particular local social/cultural/educational interest. Water body of low amenity value with only casual access, e.g. along a road.
Negligible	Water Resources: Low sensitivity aquatic ecosystem. Water of 'poor' or 'bad' chemical or biological quality. Water body of no amenity value, seldom used for amenity purposes, in a remote or inaccessible area.

Table 13– 3: Receptor sensitivity

The significance of a potential impact is derived by considering both the sensitivity of the feature and the magnitude of change. The method is shown in Table 13.4.

Receptor sensitivity	Magnitude of change			
	Large	**Medium**	**Small**	**Negligible**
High	Severe	Major	Moderate	Minor
Moderate	Major	Moderate	Minor	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Minor	Negligible	Negligible

Table 13– 4: Impact significance

Impacts to potential receptors can be adverse or beneficial. For example; surface water flows off the site may be reduced by implementing a revised drainage scheme.

The marine regime of Hayle Harbour, and the extent to which it may be affected by the proposed scheme, depends on the performance of a number of elements. These were identified as:

a) Tidal regime of Carnsew Pool, and the influence of the Carnsew tunnels

b) Tidal regime of Copperhouse Pool, and the influence of the Copperhouse Gate

c) The potential for reinstating sluicing. That is, retention of water in the pools following the high tide in order to release the waters when the external harbour waters are lower, with a strategy for instigating a net sediment movement out of the harbour

d) Installation of a floating marina in the harbour

e) Installation of a half tide gate in Penpol Creek

f) Installation of a fisherman's harbour structure off North Quay

The methodology adopted in this assessment for the water resources issues involved the following:

- Review of international, national, regional and local legislation, policy and guidelines
- Review available background information including previously proposed scheme studies
- Establish baseline conditions on and around the site through literature review and existing data obtained from the Environment Agency, British Geological Survey, Ordnance Survey, and site walkover. Baseline conditions have been broken down to ensure a robust examination of baseline conditions

- Identification of sensitive receptors
- Identification of risk from and to the proposed development and hence the likely impacts, magnitude of change and significance of impact during both the construction and operational phases. The impacts have been broken down to ensure a robust examination of risks from the proposed development.
- Develop mitigation strategies through consultation with the design team and Client
- Identification of residual effects

13.4 Baseline conditions

The baseline conditions of the physical water environment are defined through a number of data sources, depending on their context. The baseline conditions have been broken down into water resources, coastal erosion, flood risk, hydraulic regime (further broken down into sediment transport and hydrology) and navigation.

13.4.1 Water resources

There are a number of natural water resources in close proximity to the site:

- Copperhouse Pool (see Figure 13.1)
- Carnsew Pool (see Figure 13.2)
- Angarrack Stream (see Figure 13.1)
- Mellanear Stream (see Figure 13.4)
- Penpol Creek (see Figure 13.4)
- Hayle Harbour (see Figure 13.3)
- Hayle Estuary (see Figure 13.3)
- St Ives Bay (see Figure 13.5)

None of these waters are used commercially in Hayle, or downstream, apart from mooring and associated quayside activities related to commercial (primarily shell fish) vessels. The principal use for the waters is in amenity use and access to commercial fishing grounds.

Water quality is assessed against the River Quality Objectives (RQO). Theses are targets used to assess whether the river is of adequate quality to support a certain type of ecosystem. Each stretch of river is given a target from the River Ecosystem Classification Scheme. These range from very good quality (suitable for all fish species) to poor quality (likely to limit fish species).

A summary of the latest results for the period 2002 to 2004 and 2003 to 2005 is shown in Table 13.5.

Hayle Harbour

Drawing Title Copperhouse Pool

Drawing Number Figure 13.1

scale N.T.S.

date 21/09/2007

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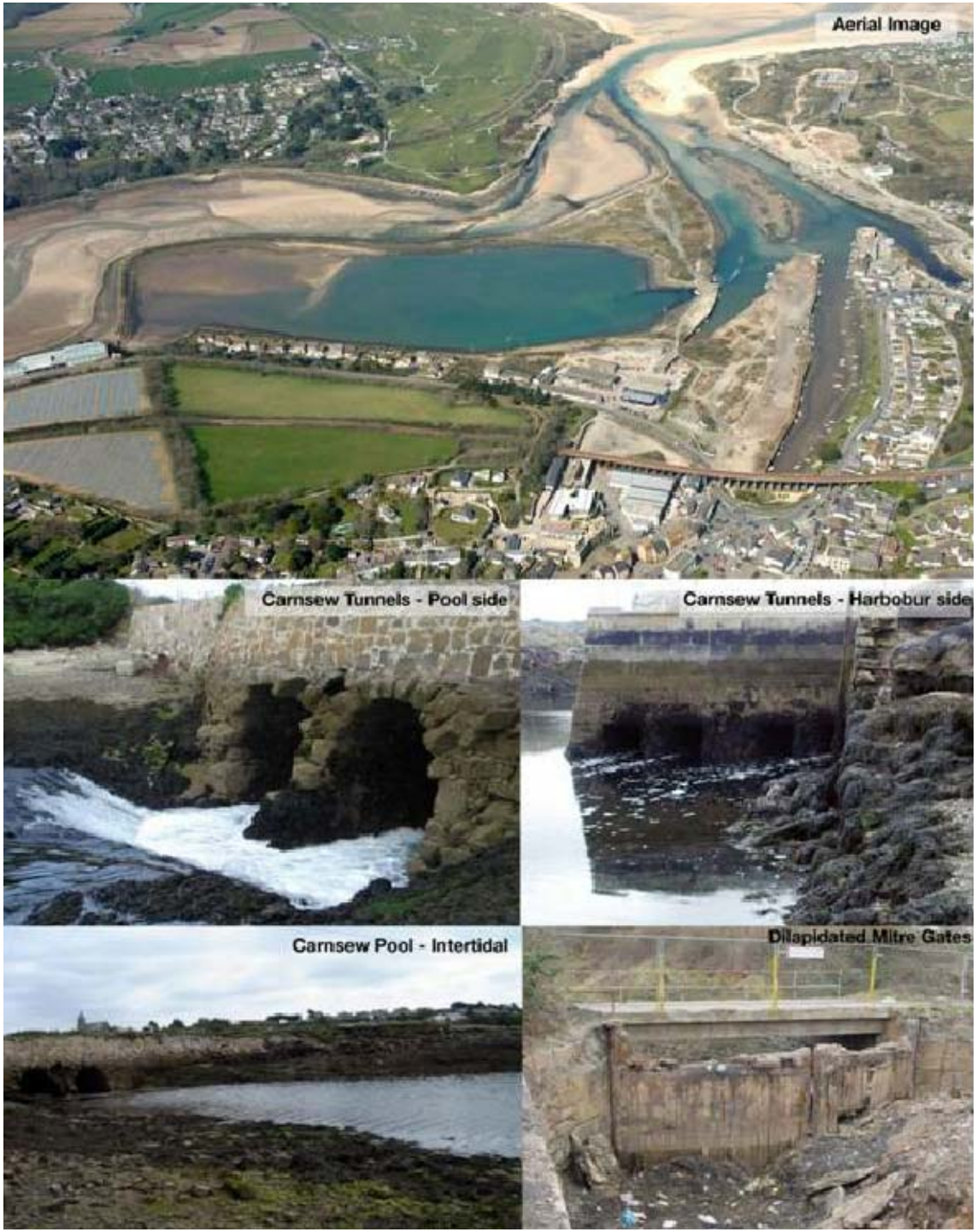

Hayle Harbour

Drawing Title Carnsew Pool

Drawing Number Figure 13.2

scale N.T.S.

date 21/09/2007

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Aerial Image

Harbour from above North Quay

Hayle Harbour

Drawing Title Hayle Harbour

Drawing Number Figure 13.3

scale N.T.S.

date 21/09/2007

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Hayle Harbour

Drawing Title Penpol Creek

Drawing Number Figure 13.4

scale N.T.S.

date 21/09/2007

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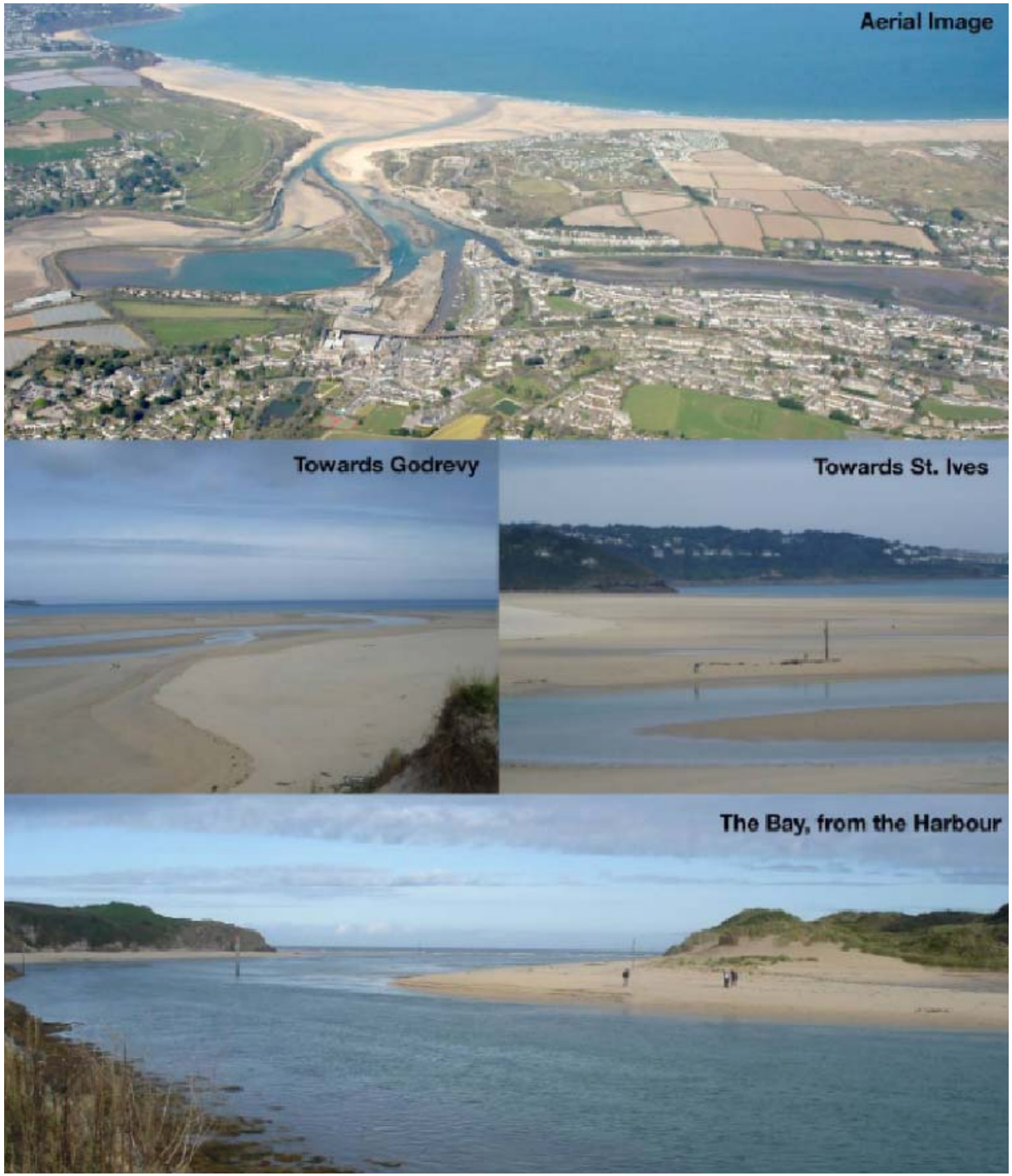

Hayle Harbour

Drawing Title St Ives Bay

Drawing Number Figure 13.5

scale N.T.S.

date 21/09/2007

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River Name	River Stretch	Year	Target	Compliance
Angarrack Stream	Nanpusker-Phillack	2003-2005	1- very good	Marginal
Angarrack Stream	Nanpusker-Phillack	2002-2004	1- very good	Marginal

Table 13– 5 River Ecosystem Classification 2002 to 2004 and 2003 to 2005

13.4.2 Coastal erosion

Appendix F of the Flood Risk Assessment (Annex 13H) contains the Penwith District Council's Draft Pre-Level 2 Strategic Flood Risk Assessment. This makes reference to the Land's End to Hartland Point Shoreline Management Plan (Sections 4.12 to 4.14), and identifies conclusions of the study for the Hayle Estuary.

The morphological processes inherent in an estuary are extremely complex and unpredictable sustaining long periods of accretion followed by long periods of erosion. Currents within the Hayle Estuary are influenced by both tidal flow (spring or high tide and neap or low tides at fortnightly intervals) and fresh water flows from the various streams which empty into the estuary.

The flood tide flows through the main navigational channel at the mouth of the estuary and divides at Middle Weir into two channels. One channel goes to the west into Lelant Water while the other heads to the east into the harbour area. The tidal waters evacuate the estuary along the same channels determined by the rate of the offshore tidal level and the constraints offered by sand bars and sluicing release.

The sediment flow and hydrological processes of the Hayle Estuary is wholly dependent on the coastal processes of St Ives Bay, of which it forms a sub-cell at its southern most extremity. Sediment within St Ives Bay is considered to form a closed sand cell, which constantly circulates sediment around the bay. Very little sediment is believed to enter or leave the system. As a consequence of the St Ives Bay closed sand cell system, littoral topography along the bay and estuary are subject to change. For example, the channel through the estuary is known to have been deeper in the past, allowing passage of ships to travel upstream along the River Hayle as far as St Erth Bridge up until the sixteenth century.

13.4.3 Flood risk

13.4.3.1 Strategic Flood Risk Assessment

Penwith District Council has made available their draft Strategic Flood Risk Assessment (SFRA) which forms part of their Local Development Framework. The Pre-level 2 Assessment is Appendix F of the Hayle Harbour Flood Risk Assessment, which is Annex 13H of this chapter.

The Draft SFRA does not deal with baseline flood risk, but focuses principally on assessing the potential impacts of an earlier version of the current Master Plan for the regeneration of Hayle. This is of limited value, as

there are a number of inaccuracies and misunderstandings within the SFRA. The current version of the Master Plan has not been considered within the draft SFRA.

13.4.3.2 Site specific flood risk assessment

The FRA (included as Annex 13H of this Environmental Statement) contains details of the baseline flood risk relevant to the development site. In summary this concludes that:

- There is no fluvial flood risk to the proposed development site from any of the watercourses in the proximity to the site
- Tidal flood risk is defined by the present day 1 in 200 year still water level of 4.548m ODN. Figure 5 of the FRA indicates that such a level would inundate parts of North Quay in immediate proximity to the harbour, and parts of South Quay. All other parts of the proposed development site would be flood-free
- Significant areas of the existing town within Foundry Square would be inundated in such an event.

13.4.4 Harbour hydraulic regime

Calibrated flow and sand transport models of Hayle Harbour were established by HR Wallingford, using site-specific measurements. Specific attention was given to reproduce the water exchange between the main estuary and the two former sluicing ponds (Carnsew and Copperhouse Pools). Thereafter, spring and neap tide simulations were performed to establish a recent baseline regime against which the effects of the proposed development could be assessed.

Annex 13F contains HR Wallingford's Hydraulic Studies Phase 2 Report.

Sediment transport

The baseline scenarios confirmed that the sediment transport processes within the harbour are dominated by tidal effects. Waves and tides are responsible for the general morphology in the south of St Ives Bay. Whereas the tidal processes are quasi-steady and deterministic, wave energy will vary from season to season and year to year: as a consequence the morphology will also vary and this is consistent with the observed evidence for relatively large scale beach changes at the harbour entrance.

Historically, sluicing was carried out to sweep the harbour clear of sediment. Since sluicing stopped the harbour has accreted, suggesting net import of sediment. Historical evidence indicates that Copperhouse Pool has accreted substantially over the past decades. Conversely, Carnsew Pool has not experienced the same degree of accretion: the northern end of Carnsew still showing a deepened area which was dredged to create a cooling water pool for the power station which ceased operation years previously. This information suggests that Copperhouse Pool has accreted due to sediment import from the Angarrack and Mill Leat streams (there being no stream discharging into Carnsew Pool). That the accreted areas in Copperhouse Pool

include areas of vegetation suggests finer, cohesive sediment which is also more likely to be derived from the Angarrack and Mill Leat Streams rather than from marine sources. However, even with the likely reduced storage volume of Copperhouse Pool (due to accretion) the simulations confirmed that reinstatement of sluicing would be effective in flushing sediment seawards.

Hydrology

The hydraulic features of the four main water bodies within the site are described in the following section.

Copperhouse Pool (Figure 13.1) is characterised as a gated tidal pool. The Pool is fed fluvially by the Angarrack Stream, which runs down a man-made channel to the south of the Pool, with an estimated 1 in 2 year (50% annual probability) discharge of 8m^3/s, and a 1 in 100 year (1% annual probability) discharge of 23 m^3/s. At the down stream end of the Pool, Copperhouse Gate provides flow control and a flood defence function. The gate, owned by the Environment Agency, is primarily designed to act as a flood defence mechanism, with a secondary function to regulate saltwater inundation. Generally the gate is maintained in a position with the lowest edge approximately 600mm above the sill, during special occasions (such as Hayle in Bloom and regattas) the gate is lowered to impound Copperhouse Pool. The pool discharges into Hayle Harbour (Figure 13.3).

Carnsew Pool (Figure 13.2) to the west of the Harbour is fed hydraulically through a series of tunnel culverts which connect the pool to the harbour. These tunnels start in the pool as two arched structures which both split into two, leading to the emergence of four rectilinear tunnels entering into the Harbour (Figure 13.3).

Penpol Creek, located between Penpol Terrace and South Quay (Figure 13.4) all but dries during a low tide. The Mellanear Stream is a culverted watercourse that flows through the town, passing under Foundry Square and discharging through the Southern Quay wall via two culvert outfalls fitted with sluice/flap gates. The stream has an estimated 1 in 2 year (50% annual probability) discharge of 2m^3/s, and a 1 in 100 year (1% annual probability) discharge of 6.6m^3/s.

13.4.5 Navigation

Hayle is a significant fishing centre with 27 vessels registered. In addition, there are some commercial vessels used for diving and pleasure trips. Chapter 15 identifies the socio-economic context of the harbour and user groups. Water based user groups operating out of the Harbour include:

- Commercial fishing
- Recreational fishing
- Water skiing
- Canoeing

- Sailing (limited)

Currently, at low tide the harbour dries out, and moored vessels sit on the sea bed for several hours during the low tide period. Operationally, the vessels tie up against the quay walls, leaning against them as the tide falls below the level that is necessary to keep them afloat. Boats of 1m draft can navigate at Spring Tides for 3 hours either side of high water. This is extremely limiting for a marina. Modern 10m shallow draft yachts require a water depth in excess of 1.4m.

Navigation into Hayle Harbour is also made difficult by a sand bar (Hayle Bar) at the entrance to the approach channel. This sand bar varies in elevation during storm build up and subsequent gradual reduction. The bar has been responsible for a number of incidents over the last couple of decades and presents a safety risk.

All Harbour navigation and water based recreational activities are controlled by the Hayle Harbour Master.

13.4.6 Tide levels

The following tide levels have been obtained from the Admiralty Tide Tables (2006).

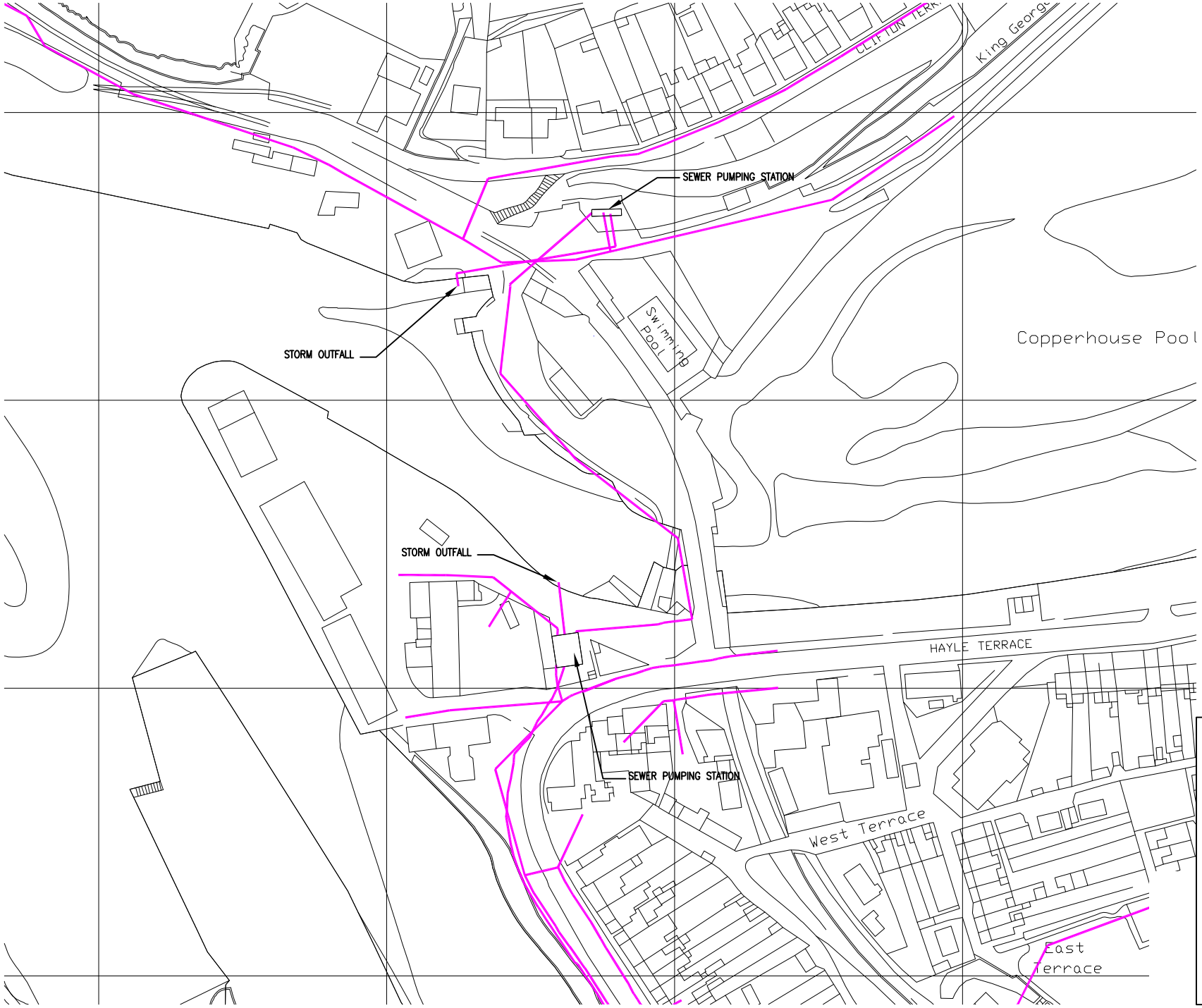
Mean High Water Springs	+6.6m Chart Datum (CD)	+3.2m ODN
Mean High Water Neaps	+4.9m CD	+1.5m ODN
Mean Low Water Neaps	+2.4m CD	-1.0m ODN
Mean Low Water Springs	+0.8m CD	-2.6m ODN

Local Chart Datum at St Ives is 3.4m below ODN.

13.4.7 Surface and foul water drainage

The existing surface and foul water drainage system local to the proposed main development areas consists of a system of combined sewers located within the highway area discharging to the sewage treatment works south of Griggs Quay to the west of Hayle Harbour. This being said, there are significant areas of the site (e.g. South Quay and much of North Quay) that have no formalised surface water drainage systems. There are also a number of ad hoc surface water outfalls to be seen in the existing harbour walls.

The topography for the area shows a natural fall towards the Quays hence the route of the combined sewers follows the main highways local to the pools and creeks. From the asset record information received from South West Water it appears the pumping station on North Quay pumps to the station on East Quay and the combined discharge is pumped from East Quay via Penpol Terrace and Carnsew Road to the sewage treatment works. There are combined storm overflows from the two pumping stations that would permit discharge to the tidal waters between North and East Quays, when the capacity of the pumping installations is exceeded. Figure 13.6 shows the approximate location of combined storm overflows (CSO).



Hayle Harbour

Drawing Title: Combined Storm Overflow Locations

Drawing Number: Figure 13.6

scale 1:2000

date 21/09/2007

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13.4.8 Key receptors

The key water-based receptors are identified with their criteria for assessment in table 13.6.

Receptor	Criteria	Sensitivity
Copperhouse Pool	SSSI, the tidal inundation regime is key to supporting the ecology, refer to Chapter 12. Copperhouse is also used on an occasional basis for regattas.	HIGH
Mellanear Stream	Culverted watercourse immediately upstream of Penpol Creek, and isolated from backflow by sluices/tidal flaps	LOW
Angarrack Stream	Upstream of Copperhouse Pool, and partly within SSSI	LOW
Carnsew Pool	SSSI, the tidal inundation regime is key to supporting the ecology, refer to Chapter 12.	HIGH
Harbour	The water body is of high amenity value, both in recreational and commercial terms.	MODERATE
Penpol Creek	Of lower amenity value than the harbour, however, there is frequent use by a significant number of boat owners	MODERATE
St. Ives Bay	In part a SSSI, in addition to high amenity value	HIGH

Table 13– 6 Key receptors

13.5 Assessment of potential impacts

13.5.1 Key activities resulting in potential impacts

The marine works necessary to support the delivery of the scheme are identified as:

1. Installation of new Carnsew Second Sluice
2. Construction of new fixed pedestrian bridge at Carnsew Second Sluice channel
3. Excavation and renovation of Carnsew Second Sluice channel
4. Refurbishment of tunnels to Carnsew Pool and Carnsew First Sluice
5. Excavation of harbour at Carnsew Quay/Carnsew Wharf

6. Dredging of basin adjacent to Carnsew Wharf tunnel intake
7. Installation of new lifting/swing pedestrian bridge at Penpol Creek
8. Dredging of basin at south end of Penpol Creek
9. Construction of a new Penpol Creek half tide gate and pedestrian crossing
10. Excavation and dredging of Cockle Bank and surrounding area to provide marina basin
11. Installation of a new floating pontoons for marina
12. Construction of a new Fisherman's Quay
13. Excavation and dredging of harbour area to the north-west of Fisherman's Quay
14. Construction of a new fixed vehicular bridge by Copperhouse Gate
15. Construction of a new pedestrian bridge from East Quay to North Quay
16. Maintenance works to Copperhouse Pool sluice gate
17. Remediation and reinstatement of North Quay Wall
18. Remediation and reinstatement of North Quay (Eastern) Wall
19. Remediation and reinstatement of South Quay Wall
20. Remediation and reinstatement of East Quay Wall
21. Remediation and reinstatement of Carnsew Wharf Wall
22. Remediation and reinstatement of Carnsew Quay
23. Slipway and associated land works

Impacts on the water environment have been considered in terms of; water quality, navigation, erosion, and flood risk.

13.5.2 Potential impacts on water quality

13.5.2.1 Assessment of construction impacts on water quality

During construction activities likely to result in impacts include:

- Clearance of land, excavation and backfilling potentially resulting in elevated suspended sediment in site run off draining directly to the harbour and to nearby surface water, and potentially increasing sediment loads
- Demolition of buildings potentially resulting in dust and debris entering the harbour and drainage systems
- Leakage or accidental spillage of fuels or chemicals used on site during construction, including cement material during construction of road infrastructure and buildings and dirty water from the construction site, potentially contaminating the harbour, groundwater and nearby surface water
- On-site mixing of construction materials, potentially resulting in accidental spillage of oils, fuels, cement, sand and gravel – potentially contaminating the harbour, groundwater and nearby surface water

The potential impacts from the construction activities identified above are found in the section below:

1. Increased sediment loads

One of the biggest risks to adjacent surface water bodies during construction is from site runoff containing elevated suspended sediment levels, increasing sediment loads. This can result from land clearance, excavation, movement of materials to and from the site and storage of materials on site. High sediment input can have direct adverse effects on adjacent surface watercourses through increasing turbidity (thus reducing light penetration and reducing plant growth), and by smothering vegetation and bed substrates, thus impacting on invertebrate and fish communities through destruction of feeding areas, refuges and breeding / spawning areas.

Indirect adverse effects can also be associated with suspended sediments that have associated inorganic or organic contaminants (e.g. heavy metals and pesticides, respectively).

The magnitude of any impact from increased sediment loads will depend on the scale and nature of any potential incident and thus is difficult to predict. For a full summary of the impact magnitude see table 13.7.

Hayle Harbour is likely to have some attenuation properties due to tidal flushing thereby minimising potential impacts on the harbour. Where possible any works will be treated as land based construction, isolated from the marine environment. The magnitude of change in terms of sediment loading from the identified construction activities in the harbour is assessed as medium. The resultant significance of the potential impact on Hayle Harbour is therefore deemed to be small adverse with an overall significance of **Moderate Adverse**.

Carnsew Pool is located within the Hayle Estuary and Carrack Gladden SSSI. It has a high sensitivity and may be affected by increased sediment deposition directly from the works or via Hayle Harbour. Where possible any works will be treated as land based construction, isolated from the marine environment. The Harbour is likely to have some attenuation properties due to tidal flushing thereby minimising potential impacts on Carnsew Pool. The magnitude of change to Carnsew Pool in terms of sediment loading is assessed as being medium. Given the sensitivity of the receptor the overall significance of the impact on Carnsew Pool is assessed as being **Major Adverse**.

Hayle Estuary is located within the Hayle Estuary and Carrack Gladden SSSI, has a high sensitivity and may be affected by increased sediment deposition via Hayle Harbour. The Estuary is likely to have some attenuation properties due to tidal flushing thereby minimising potential impacts. The resultant magnitude of the potential change is therefore deemed to be small with an overall impact significance of **Moderate Adverse**.

Penpol Creek is considered to have a low sensitivity to increases in sediment load. The creek lies beyond (in terms of sediment flux) the sediment sink of the dredged basin of the harbour and therefore the impact is considered to be **Minor Adverse**.

Mellanear Stream is considered to have a low sensitivity. The river lies upstream of Hayle Harbour and is isolated from Penpol Creek by sluices/tidal flaps. Therefore the impact of increased sedimentation is considered to be **Negligible.**

Angarrack Stream is considered to have a low sensitivity. The river lies upstream of Hayle Harbour and therefore the impact of increased sedimentation is considered to be **Negligible**.

St Ives Bay is a bathing water beach and is therefore sensitive to any change. However, considering the distance between St Ives Bay and the site, any increased sediment arising from the proposed development would have been dispersed before reaching the bay. The significance of the impact to St Ives Bay is therefore assessed to be **Negligible**.

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
Build new Carnsew Second Sluice	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Medium	Moderate Adverse
Excavation and renovation of Carnsew Second Sluice channel	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Medium	Moderate Adverse
Excavation of harbour at Carnsew Quay/Carnsew Wharf	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Medium	Moderate Adverse
Dredging of basin adjacent to Carnsew Wharf tunnel intake	Hayle Harbour	Medium	Medium	Moderate Adverse
Dredging of basin at south end of Penpol Creek	Penpol Creek	Low	Small	Minor Adverse
	Hayle Harbour	Medium	Medium	Moderate Adverse
	Mellanear Stream	Low	Negligible	Negligible
New Penpol Creek half tide gate and pedestrian crossing	Penpol Creek	Low	Small	Minor Adverse
	Hayle Harbour	Medium	Medium	Moderate Adverse
Excavation and dredging of Cockle Bank and surrounding area to provide marina basin	Hayle Harbour	Medium	Medium	Moderate Adverse
New Fisherman's Quay and Slipway	Hayle Harbour	Medium	Medium	Moderate Adverse
	Hayle Estuary	High	Small	Moderate Adverse

Table 13– 7: Impacts of increased sedimentation from specific work items

2. Dust and debris

Demolition of existing buildings has the potential to release dust and debris that may be blown into adjacent watercourses. Increased dust levels in watercourses may reduce the levels of light reaching aquatic plant and animal species. Debris blown into watercourses can decrease the recreational and aesthetic quality of the resources. For a full summary of the impact magnitude see table 13.8.

Hayle Harbour The magnitude of change to Hayle Harbour from dust and debris is considered to be small, resulting in an impact significance of **Minor Adverse**.

Carnsew Pool is likely to be more affected by debris than dust (due to some attenuation provided by Hayle Harbour), although this is still likely to have little impact on the condition of the SSSI. Due to the proximity of the pool to the site works the magnitude of change is determined to be medium. Therefore the overall significance of the impact is considered to be **Major Adverse**.

Mellanear Stream has a low sensitivity. Due to its proximity to the site works the magnitude of change is considered to be small and the impact significance is considered to be **Negligible**.

Angarrack Stream has a low sensitivity but due to its proximity to the site works the impact is considered to be **Negligible**.

St Ives Bay has a high sensitivity, but due to its distance from the site works it is unlikely to be affected by dust and debris. The impact is therefore considered to be **Negligible**.

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
New fixed pedestrian bridge at Carnsew Second Sluice channel	Hayle Harbour	Medium	Small	Minor Adverse
Refurbishment of tunnels to Carnsew Pool and Sluice	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Medium	Moderate Adverse
New lifting/swing pedestrian bridge at Penpol Creek	Penpol Creek	Low	Small	Minor Adverse
	Mellanear Stream	Low	Negligible	Negligible

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
New fixed vehicular bridge by Copperhouse Gate	Carnsew Pool	High	Medium	Major Adverse
	Angarrack Stream	Low	Negligible	Negligible
New pedestrian bridge from East Quay to North Quay	Hayle Harbour	Medium	Small	Minor Adverse
North Quay Wall remedial and reinstatement works	Hayle Harbour	Medium	Small	Minor Adverse
North Quay (Eastern) Wall remedial works	Hayle Harbour	Medium	Small	Minor Adverse
South Quay Wall remedial works	Hayle Harbour	Medium	Small	Minor Adverse
East Quay Wall remedial works	Hayle Harbour	Medium	Small	Minor Adverse
Carnsew Wharf Wall remedial works	Hayle Harbour	Medium	Small	Minor Adverse
	Carnsew Pool	High	Medium	Major Adverse
Carnsew Quay remedial works	Hayle Harbour	Medium	Small	Minor Adverse
	Carnsew Pool	High	Medium	Major Adverse

Table 13– 8 Impacts of increased dust and debris from individual work items

3. Accidental leaks and spillages of hazardous substances

During construction, there is an elevated risk of potential leaks or accidental spillage of hazardous chemicals used on site infiltrating to groundwater or migrating to nearby surface watercourses and resulting in an adverse

impact. For the most part it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the watercourse, that a significant risk of acute toxicity will arise in the receiving water. This can present a specific risk to certain bottom-dwelling invertebrates and other aquatic invertebrates.

The magnitude of any impact will depend on the scale and nature of any potential incident and thus is difficult to predict. For a full summary of the impact magnitude see table 13.9.

Considering the predicted low water quality of **Hayle Harbour**, the magnitude of any change may be considered to be small adverse, with an overall impact significance of **Minor Adverse**.

Carnsew Pool is an SSSI and therefore has a high sensitivity. Although any leakage or spillage on the site would experience some attenuation and dilution within the Harbour and Hayle Estuary, hazardous substances could result in a medium change to the water body, resulting in an overall impact significance of **Major Adverse**.

Copperhouse Pool is an SSSI and therefore has a high sensitivity. Although any leakage or spillage on the site would experience some attenuation and dilution within the Harbour and Hayle Estuary, hazardous substances could result in a medium change, resulting in an overall impact significance of **Major Adverse**.

Hayle Estuary SSSI has a high sensitivity and is in relative close proximity to the site. Although any leakage or spillage on the site would experience some attenuation and dilution within the harbour and Hayle Estuary, hazardous substances could result in a small change, resulting in an overall impact significance of **Moderate Adverse**.

Penpol Creek is considered to have a low sensitivity. Contaminants which infiltrate groundwater could migrate towards the Penpol Creek, although this is considered unlikely. The impact magnitude is therefore considered to be small, which translates to an overall impact significance of **Minor Adverse**.

Mellanear Stream is considered to have a low sensitivity. Contaminants which infiltrate groundwater could migrate towards the Mellanear Stream, although this is considered unlikely. The impact magnitude is therefore considered to be small, which translates to an overall impact significance of **Minor Adverse**.

Angarrack Stream is considered to have a low sensitivity. Contaminants which infiltrate groundwater could migrate towards the Angarrack Stream, although this is considered unlikely. The impact magnitude is therefore considered to be small, which translates to an overall impact significance of **Minor Adverse**.

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
Build new Carnsew Second Sluice	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
New fixed pedestrian bridge at Carnsew Second Sluice channel	Hayle Harbour	Medium	Small	Minor Adverse
Excavation and renovation of Carnsew Second Sluice channel	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
Refurbishment of tunnels to Carnsew Pool and Carnsew First Sluice	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
Excavation of harbour at Carnsew Quay/Carnsew Wharf	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
Dredging of basin adjacent to Carnsew Wharf tunnel intake	Hayle Harbour	Medium	Small	Minor Adverse
New lifting/swing pedestrian bridge at Penpol Creek	Penpol Creek	Low	Small	Minor Adverse
	Mellanear Stream	Low	Small	Minor Adverse
Dredging of basin at south end of Penpol Creek	Penpol Creek	Low	Small	Minor Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
	Mellanear Stream	Low	Small	Minor Adverse
New Penpol Creek half tide gate and pedestrian crossing	Penpol Creek	Low	Small	Minor Adverse
	Hayle Harbour	Medium	Small	Minor Adverse

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
Excavation and dredging of Cockle Bank and surrounding area to provide marina basin	Hayle Harbour	Medium	Small	Minor Adverse
New floating pontoons for marina	Hayle Harbour	Medium	Small	Minor Adverse
New Fisherman's Quay and Slipway	Hayle Harbour	Medium	Small	Minor Adverse
	Hayle Estuary	High	Small	Moderate Adverse
Excavation and dredging of harbour area to the north-west of Fisherman's Quay	Hayle Harbour	Medium	Small	Minor Adverse
	Hayle Estuary	High	Small	Moderate Adverse
New fixed vehicular bridge by Copperhouse Gate	Copperhouse Pool	High	Medium	Major Adverse
	Angarrack Stream	Low	Small	Minor Adverse
New pedestrian bridge from East Quay to North Quay	Hayle Harbour	Medium	Small	Minor Adverse
Copperhouse Pool sluice gate maintenance works	Copperhouse Pool	High	Medium	Major Adverse
	Angarrack Stream	Low	Small	Minor Adverse
North Quay Wall remedial and reinstatement works	Hayle Harbour	Medium	Small	Minor Adverse
North Quay (Eastern) Wall remedial and reinstatement works	Hayle Harbour	Medium	Small	Minor Adverse
South Quay Wall remedial and reinstatement works	Hayle Harbour	Medium	Small	Minor Adverse
East Quay Wall remedial and reinstatement works	Hayle Harbour	Medium	Small	Minor Adverse
Carnsew Wharf Wall remedial	Hayle Harbour	Medium	Small	Minor Adverse

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
and reinstatement works	Carnsew Pool	High	Medium	Major Adverse
Carnsew Quay remedial and reinstatement works	Hayle Harbour	Medium	Small	Minor Adverse
	Carnsew Pool	High	Medium	Major Adverse

Table 13– 9: Impacts of accidental spillage of hazardous chemicals from individual work items

4. Disturbance of contaminated material

Made ground on site may contain areas of contamination. There is the potential for contaminated land to be disturbed and migrate towards Hayle Harbour and other water features, either by infiltration into the groundwater or overland. For a full summary of the impact magnitude see table 13.10.

The impact magnitude to **Hayle Harbour** is considered to be small, with an overall impact significance of **Minor Adverse**.

Carnsew Pool is an SSSI and therefore has a high sensitivity. Due to the sensitivity of the site and close proximity to site works the impact magnitude is therefore considered to be medium, with an overall impact significance of **Major Adverse**.

Copperhouse Pool is an SSSI and therefore has a high sensitivity. The proximity to the site will allow attenuation and dilution of contaminants within the Harbour. Due to the close proximity to site works the impact magnitude is therefore considered to be medium, with an overall impact significance of **Major Adverse**.

The flushing of the estuary will allow attenuation and dilution of contaminants within the Harbour and Estuary. The magnitude of change to **Hayle Estuary** is therefore considered to be small, with an overall impact significance of **Moderate Adverse**.

Penpol Creek has a low sensitivity, its proximity to the site and low risk of groundwater providing a base flow to the creek gives rise to a small impact magnitude. This translates to an overall impact significance of **Minor Adverse**.

Mellanear Stream has a low sensitivity, its proximity to the site and negligible risk of groundwater providing a base flow to the steam gives rise to a small impact magnitude. This translates to an overall impact significance of **Negligible.**

Angarrack Stream has a low sensitivity, its proximity to the site and negligible risk of groundwater providing a base flow to the stream gives rise to a small impact magnitude. This translates to an overall impact significance of **Negligible**.

St Ives Bay is located sufficiently north of the site, such that any leakage or spillage on the site would experience some attenuation and dilution within the Hayle Estuary. The impact magnitude is therefore considered to be small, with an impact significance of **Moderate Adverse**.

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
Build new Carnsew Second Sluice	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
New fixed pedestrian bridge at Carnsew Second Sluice channel	Hayle Harbour	Medium	Small	Minor Adverse
Excavation and renovation of Carnsew Second Sluice channel	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
Refurbishment of tunnels to Carnsew Pool and Carnsew First Sluice	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Medium	Moderate
Excavation of harbour at Carnsew Quay/Carnsew Wharf	Carnsew Pool	High	Medium	Major Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
Dredging of basin adjacent to Carnsew Wharf tunnel intake	Hayle Harbour	Medium	Small	Minor Adverse
New lifting/swing pedestrian bridge at Penpol Creek	Penpol Creek	Low	Small	Minor Adverse
	Mellanear Stream	Low	Negligible	Negligible
Dredging of basin at south end of Penpol Creek	Penpol Creek	Low	Small	Minor Adverse
	Hayle Harbour	Medium	Small	Minor Adverse

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
	Mellanear Stream	Low	Negligible	Negligible
New Penpol Creek half tide gate and pedestrian crossing	Penpol Creek	Low	Small	Minor Adverse
	Hayle Harbour	Medium	Small	Minor Adverse
Excavation and dredging of Cockle Bank and surrounding area to provide marina basin	Hayle Harbour	Medium	Small	Minor Adverse
New floating pontoons for marina	Hayle Harbour	Medium	Small	Minor Adverse
New Fisherman's Quay and Slipway	Hayle Harbour	Medium	Small	Minor Adverse
	Hayle Estuary	High	Small	Moderate Adverse
Excavation and dredging of harbour area to the north-west of Fisherman's Quay	Hayle Harbour	Medium	Small	Minor Adverse
	Hayle Estuary	High	Small	Moderate Adverse
New fixed vehicular bridge by Copperhouse Gate	Copperhouse Pool	High	Medium	Major Adverse
	Angarrack Stream	Low	Negligible	Negligible
New pedestrian bridge from East Quay to North Quay	Hayle Harbour	Medium	Small	Minor Adverse
Copperhouse Pool sluice gate maintenance works	Copperhouse Pool	High	Medium	Major Adverse
	Angarrack Stream	Low	Negligible	Negligible
North Quay Wall remedial works	Hayle Harbour	Medium	Small	Minor Adverse
North Quay (Eastern) Wall remedial works	Hayle Harbour	Medium	Small	Minor Adverse
South Quay Wall remedial works	Hayle Harbour	Medium	Small	Minor Adverse

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
East Quay Wall works	Hayle Harbour	Medium	Small	Minor Adverse
Carnsew Wharf Wall remedial works	Hayle Harbour	Medium	Small	Minor Adverse
	Carnsew Pool	High	Medium	Major Adverse
Carnsew Quay remedial works	Hayle Harbour	Medium	Small	Minor Adverse
	Carnsew Pool	High	Medium	Major Adverse

Table 13– 10: Impacts of release of contaminated material from individual work items

13.5.2.2 Assessment of operation impacts on water quality

Potential effects on receptors are considered against a whole scheme condition, rather than individual activities, unlike construction phase impacts. Each receptor is considered individually and discussed.

During operation, activities likely to give rise to impacts include:

- Sluicing
- Increased harbour activity
- Retention of impounded water within Penpol Creek upstream of the half tide gate
- Surface and foul water drainage

Sluicing

Operational procedures include the potential for reinstating the use of hydraulic gates to hold back water in Copperhouse and Carnsew Pools after high tide, then releasing it some time after the Harbour levels have dropped (referred to as 'sluicing'). This operation is intended to provide a sediment management function, sweeping sands out of the harbour into St. Ives Bay. Key conditions generated during the sluicing include:

- High water levels retained in Carnsew and Copperhouse Pools for an extended duration
- Increased flow rates in the vicinity of the sluice gates on release of the stored water

The **Angarrack Stream** is a Main River and has a low sensitivity. Running into Copperhouse Pool, it would effectively be impounded for a period during gate closure, and fluvial flow would continue to discharge into the Pool. The watercourse extent, for this assessment, is considered to terminate upon entering Copperhouse Pool, therefore, the impoundment could, if retained for an extended period of time increase stream water levels

upstream of the Pool. The impact magnitude to the Angarrack Stream is considered to be medium, with an overall impact significance of **Minor Adverse**.

Copperhouse Pool is identified as a SSSI, and is therefore an area of high sensitivity. Operating the sluice gates in a sluicing function will retain a high water level for a prolonged period, increasing the length of inundation, and consequently increasing the potential for sedimentation from the Angarrack Stream. The magnitude of change is medium, consequently the significance of impact is **Major Adverse**.

Carnsew Pool is identified as a SSSI, and is therefore an area of high sensitivity. Operating the sluice gates in a sluicing function will retain a high water level for a prolonged period, increasing the length of inundation. The magnitude of change is medium, consequently the significance of impact is **Major Adverse**.

Increased harbour activity

Hayle Harbour (water side) area is the location of significant proposed construction works; excavation of Cockle Bank, provision of a solid quay at the fisherman's harbour and installation of floating pontoons for marina use. The harbour is identified as a low sensitivity. Although there is an active fishing fleet using the harbour, the provision of marina pontoons will bring more vessels into the water space. The potential risk of increased vessel numbers is an increased pollutant potential from poorly maintained engines, poorly controlled sanitary pump-out and other related impacts.

The magnitude of change in the harbour is characterised as large, with an overall impact significance of **Moderate Adverse**.

Impounding Penpol Creek

Under operating conditions, the proposal to install a half tide gate in Penpol Creek will alter the hydrological regime upstream of the gate, which may impact on water quality.

The **Mellanear Stream** is a Main River and has a low sensitivity. Under normal operating conditions, with a retained water level at half tide, the stream will be able to continue to discharge as at present. The impact significance on water quality under these conditions is considered to be **Negligible**. When the impounded level is raised to permit larger vessels to be accommodated within the creek, then the impact significance on water quality is considered to be **Minor Adverse**.

Penpol Creek has a low sensitivity, the provision of a half tide gate will alter the tidal range in the creek. Currently, the creek has a tidal range in the order of 4m, largely drying at low tide. The tidal gate, operating to retain a suitable water level to keep boats afloat at all stages of the tide, will alter the tidal regime. Retention of

the Creek water may impact on water quality due to the reduced rate of water exchange. The impact magnitude is considered to be medium, with an overall impact of significance of **Minor Adverse**.

Surface and foul water drainage

Surface water

The strategy for draining surface water from the proposed development areas will be to construct a separate network of gravity storm drainage. This network will be arranged to follow public areas and to ensure that as much of the system can be vested in South West Water as public sewers under a Section 104 Agreement under the 1991 Water Industry Act. The discharge locations for the surface water will be arranged where possible to be into tidal waters. Discussions with the Environment Agency are ongoing to seek their approval to discharge and agree the necessary consents i.e. land drainage and discharge consents.

New outfalls will be required through the harbour walls at a level likely to be between high and low tidal water levels, the details of these will also require agreement with the Harbour Authority to ensure they do not impact on navigation or mooring.

The piped network will collect flow from roofs and paved areas and convey it to the harbour areas for discharge. Car parking above 50 spaces and other relevant areas which fall under the scope of the EA's PPG3 shall be provided with oil separators of the appropriate class, or other measures will be employed to prevent pollution of the water environment.

With the possible exception of Riviere Fields, attenuation is not proposed to the surface water system given the development areas' proximity to the sea. In relation to Riviere Fields, infiltration systems will be investigated, and if ground conditions permit (specifically, contamination and hydrogeological conditions), SUDS systems will be adopted. If this is not possible, then surface water drainage will be arranged either to Copperhouse Pool attenuated to the Greenfield rate of runoff, or to tidal waters, in which case, attenuation will not be provided.

The proposals will have a number of impacts:

It will reduce the surface water component entering the existing combined sewers – **Negligible**

It will increase the rate of storm discharge to the Harbour – **Negligible**

It will improve the quality of storm water entering the harbour – **Minor Beneficial**

It will reduce the potential for infiltration of rainfall into contaminated ground, and reduce the potential for mobilising contaminants into the Harbour – **Minor Beneficial**

Foul drainage

The strategy for draining foul water from the proposed development areas will be to construct a separate network of gravity foul drainage to connect to the existing South West Water infrastructure. Again this network will be arranged to follow public areas and the system will be designed to be vested in South West Water as public sewers under a Section 104 Agreement under 1991 Water Industry Act. The connection locations for the foul water will be arranged to be as close as possible to the existing pumping stations on North Quay and East Quay. The new development will increase flows both through the pumping stations and their respective rising mains and could potentially impact on the capacity of the sewage treatment works. South West Water has indicated that the infrastructure provision will need to be informed by the carrying out of a network modelling exercise. This would be a combination of flow monitoring and network modelling.

The results of the evaluation will advise what works, if necessary, would be required to upgrade the existing system to cater for the demands of the new development. Consultations with the Environment Agency and South West Water are ongoing to establish what actions will be necessary in this respect. However, it is anticipated that appropriate provision can be made to provide a suitable foul drainage system to serve the development, phased over the 9 year construction period.

The impact magnitude is considered to be small, with an overall impact of significance of **Negligible**.

13.5.3 Potential effects on coastal erosion

13.5.3.1 Assessment of construction impacts on coastal erosion

In littoral terms, the proposed development is located at a process cul-de-sac. Wave and tide action dominate the sediment processes in the vicinity of the harbour mouth, effectively pushing sand around and into the harbour entrance from the beach. However, except for the emerging sand lobe at the Hayle Towans, the Harbour area is virtually isolated from the Bay littoral processes.

During construction a large quantity of material will be excavated, transported and utilised onsite for fill, construction or capping. All of the excavation works will be contained in the Harbour, with some re-shaping of the Hayle Towans sand lobe. The construction phase of the works could release an amount of fine material, which during ebb tides could wash out of the Harbour and accrete on the St. Ives Bay beaches.

The Harbour Contamination Report (Annex 14A) has identified elevated levels of contamination in Cockle Bank, and the dredging/excavation of this area may release contamination into the water body.

The potential impacts of harbour excavation/dredging are considered to be **Moderate Adverse** on the harbour itself and St Ives Bay.

13.5.3.2 Assessment of operation impacts on coastal erosion

Historically, sluicing was carried out to sweep the harbour clear of sediment and maintain a stable and accessible approach channel. Since the cessation of sluicing the Hayle Bar has repeatedly risen, the approach channel has become more constricted and circuitous, and increased quantities of material have moved round the base of the Hayle Towans towards the harbour. The re-introduction of a sluicing regime will slightly alter the sediment regime in the strip of St. Ives Bay between the Harbour and the Hayle Bar. It is anticipated that the level of the bar will be reduced, the approach channel will straighten and the quantity of material entering the harbour will be reduced.

Operational changes will occur within **Hayle Harbour** due to excavation of Cockle Bank, provision of a solid quay at the fisherman's harbour and installation of floating pontoons for marina use.. Currently Cockle Bank directs the ebbing flow from the two pools (Carnsew and Copperhouse). On removal the flows will follow a new path. The altered flow path will impact on erosion and deposition processes as examined in the HR Wallingford report (Annex 13F). The delivery of the fisherman's quay will provide a flow constriction near the entrance of the harbour causing a scour (erosion) and subsequent accretion (deposition) cell. The impact significance of these construction changes on the harbour is considered to be **Minor Adverse**.

Hayle Estuary is designated as a SSSI, and is considered to be of high sensitivity. Altering the hydraulic regime of the harbour and associated pools may have an impact on the hydraulic and sedimentation regime of the Estuary itself. However, the hydraulic modelling undertaken by HR Wallingford demonstrates that regular sluicing from both Copperhouse and Carnsew Pools would tend to drive sediment back out of the estuary as occurred in the past. The magnitude of change is considered to be small, and the reduction of sand ingress into the estuary is considered, through consultation with RSPB to be beneficial to the SSSI, therefore the impact significance of sluicing is **Moderate Beneficial**.

Much **of St Ives Bay**, external to Hayle Harbour, is designated as SSSI and is of high sensitivity. Reinstatement of the sluicing regime at the two pools will increase scour through the approach channel. Although it is not possible to quantify the rate of change or benefit, reinstating sluicing will tend to straighten the approach channel and reduce the level of the bar at the entrance of the channel. The impact significance of sluicing on St Ives Bay is therefore considered to be **Moderate Beneficial**.

In addition, the HR Wallingford report (Annex 13F) indicates that the quantity of sand entering the Hayle Estuary will be reduced. This issue is further discussed in the Ecology Chapter (Chapter 12).

Considering the improvement in sediment management by sluicing through a predicted reduction in Hayle Bar level and the reduction of sand loss from the Bay to the Harbour, the sluicing element of the development is considered to provide an impact significance of **Minor Beneficial**.

13.5.4 Potential impacts on flood risk

The following assessment of potential effects has been based on the Flood Risk Assessment included in Annex 13H. Please refer to this Annex for detailed information.

13.5.4.1 Assessment of construction impacts on flood risk

Only those items of construction work (from Section 13.5) that may have some impact on flood risk, and the development itself are considered below.

Proposed development

The proposed development will be constructed partially within the current Flood Zone 2 (1 in 1000 year flood event) and Flood Zone 3 (1 in 200 year flood event), although a large part of the overall development will be located within Flood Zone 1 (<1 in 1000 year flood event). The construction will be phased. Each phase of development will be constructed in such a way that it is entirely self contained in terms of flood risk management. This includes the setting of minimum finished floor levels and thresholds to undercroft parking at 6.35m OD. This exceeds the recommended standard of protection of 1 in 200 year tidal level, including climate change allowance to the year 2117, and an additional 500mm uncertainty freeboard. It also includes the provision of emergency access routes to all development phases of a minimum level of 5.66m OD. This represents the 1 in 200 year tidal level including climate change allowance to the year 2117. Please refer to the Flood Risk Assessment for full details of this. Therefore the impact significance of the construction of these works on flood risk is considered to be **Negligible.**

Penpol Creek half tide gate

The gate will be constructed so as not to affect tidal exchange within the Creek, and so tidal flood risk to existing development in Hayle will be unchanged. The operational performance of the fluvial discharge from Mellanear Stream into Penpol Creek will be unaffected by these works. Therefore the impact significance of the construction of the half tide gate on flood risk is considered to be **Negligible.**

New fixed vehicular bridge by Copperhouse Gate

The bridge will require temporary works during construction which will over sail, and may be supported from within the waterway immediately upstream of the Copperhouse old railway bridge (the existing bridge crossing). Works may include construction from floating plant, and will involve construction from land based plant. The Land Drainage Consent process for the temporary works, controlled by the EA, will ensure there are no adverse flood risk impacts. Therefore the impact significance of the construction of these works on flood risk is considered to be **Negligible.**

Copperhouse Pool sluice gate maintenance works

These works will require the flood defence gate to be temporarily taken out of commission. This could lead to an increase in flood risk to Copperhouse from two sources. First, if Copperhouse Pool cannot discharge to the harbour, then water levels may build up in the pool and pose a fluvial flood risk to Copperhouse. Second, if the gate is removed for modification, and the sluiceway left open, then the tidal flood risk to Copperhouse will increase. Temporary works arrangements will be agreed with the Environment Agency, and will be controlled through the Land Drainage Consent process to ensure that adverse flood risk impacts are minimised. Therefore the impact significance of construction of these works on flood risk is considered to be **Minor Adverse.**

13.5.4.2 Assessment of operation impacts on flood risk

Proposed development

The proposed development will be constructed in phases. Each phase of development will be constructed in such a way that it is entirely self contained in terms of flood risk management. No part of the development will be occupied, until the full flood protection measures are in place. The flood defence standard adopted for the entire development has been set above the recommended standard (the 1 in 200 year tidal event), and exceeds the 1 in 1000 year tidal event, including climate change and 500mm uncertainty freeboard allowances. Therefore the impact significance of the operation of these works on flood risk for the life of the development is considered to be **Negligible.**

Surface water drainage

Surface water drainage for the new development will be designed, to discharge directly to tidal waters, except in the case of Riviere Fields, where drainage will be either by infiltration, attenuated discharge to Copperhouse Pool, or un-attenuated discharge to tidal waters. Drainage infrastructure will be designed so as not to lead to flooding of buildings for a design event of 1 in 100 years including appropriate allowance for climate change. The design will incorporate measures to direct exceedance flows away from development. Therefore the impact significance of the operation of these works on flood risk for the life of the development is considered to be **Negligible.**

Penpol Creek half tide gate

Once constructed, the new **Penpol Creek Half Tide Gate** will provide an enhanced tidal flood defence to a significant area of Hayle centred on Foundry Square. The impact significance of the operation of these works on flood risk is considered to be **Moderate Beneficial** for the existing development at tidal flood risk in Foundry Square.

The facility to impound Penpol Creek over a large range of levels will provide flexibility to manage fluvial flood risk from the Mellanear Stream when combined with high tidal levels in the harbour. Subject to the agreement of the Environment Agency on the operational arrangements, the impact significance of the operation of these works on flood risk is considered to be **Moderate Beneficial** for the existing development at tidal flood risk in Foundry Square.

Copperhouse Pool sluice gate

The operation of the Environment Agency's Copperhouse Pool Sluice Gate for sluicing will require operational arrangements and procedures to be formally agreed with the Environment Agency, so that its primary function – that of a tidal flood defence gate – is not compromised. Therefore the impact significance of the operation of the gate for sluicing on flood risk is considered to be **Negligible.**

13.5.5 Potential impacts on hydraulic regime

13.5.5.1 Assessment of construction impacts on hydraulic regime

As identified in Section 13.5.1, there are some 23 items of work in the marine environment. This section only identifies those which are considered to have a potential impact on the hydraulic regime during construction. See table 13.11 for details.

Refurbishment of the tunnels to Carnsew *Pool* could have a significant impact on the hydraulic regime of the pool. The refurbishment will require the temporary isolation of the tunnels from the hydraulic process, that is, no flow will pass through them. This will have a significant impact on the inundation regime of the pool and is considered to represent an impact significance of **Severe Adverse**.

New Penpol Creek half tide gate and pedestrian crossing will be constructed within cofferdams and in phases to permit tidal exchange into/out of the creek. Any fluvial outflow from the Mellanear Stream will be unaffected by the construction, and dewatering operations from cofferdams will be pumped into the open harbour area. Considering the low sensitivity of the aquatic ecosystem, the impact significance of these works on Mellanear Stream and Penpol Creek are considered **Minor Adverse**.

Excavation and dredging of Cockle Bank and surrounding area to provide marina basin will remove the existing man-made bank that currently directs the flow from Carnsew and Copperhouse Pools. During the excavation works, the flow will follow an altered route depending on extraction progress. Although there is a marked impact on the hydraulic regime during construction, the inundation regime of the two pools will remain unaltered. Consequently the impact significance on the receptors is considered to be **Negligible**.

In relation to Hayle Harbour, the dredging for the removal of Cockle Bank and the creation of the marina basin will involve the disturbance of sediments due to the dredging process itself. The impact significance on Hayle Harbour is considered to be **Minor Adverse**.,

Construction of the **new Fisherman's Quay** will be undertaken through local exclusion of the tide. These works will not impact on any of the identified receptors. However there is potential risk associated with accidental release of sediments. The location of the Fisherman's Quay, in the vicinity of the highest velocity field found in the harbour, leads to the conclusion that any released sediment will settle in flow reduction areas such as the marina basin, or out in the bay, therefore the sensitive receptors will not be affected, the impact significance is considered to be **Negligible**.

New fixed vehicular bridge in the vicinity of Copperhouse Gate, during the construction works there will be a degree of flow alteration as the three piers are built in the pool. It is unlikely that their construction will have a significant impact on the flow regime into, and out of, the pool. The impact significance is considered **Negligible**.

The new **pedestrian bridge from East Quay to North Quay** will have a single pier towards the centre of the two quay walls, the construction methodology is to form this pier as a single/group of bearing piles, that is locally driven with little in the way of temporary works, or local disruption. The impact significance on Hayle Harbour is considered **Negligible**.

Copperhouse Pool Sluice gate maintenance works will necessitate the removal of the current sluice gate for modification and improvement works. During this period the sluice gate will not operate as a flow regulator or be able to be deployed in a flood defence mode. The flood defence function of this structure is considered of great benefit to third party property, but only in the event of significantly adverse tidal/fluvial conditions. The impact significance on the normal hydraulic regime (filling and emptying) of Copperhouse Pool is considered to be **Moderate Adverse**.

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
Refurbishment of the tunnels to Carnsew Pool	Carnsew Pool	High	Large	Severe Adverse
New Penpol Creek half tide gate and pedestrian crossing	Penpol Creek	Low	Small	Minor Adverse
Excavation and dredging of Cockle Bank	Carnsew Pool	High	Negligible	Minor Adverse
	Copperhouse Pool	High	Negligible	Minor Adverse
	Hayle Harbour	Low	Small	Minor Adverse
Construction of the new Fisherman's Quay	Hayle Harbour	Medium	Negligible	Minor Adverse
	Hayle Estuary	High	Negligible	Minor Adverse
New fixed vehicular bridge	Copperhouse Pool	High	Negligible	Minor Adverse
New pedestrian bridge from East Quay to North Quay	Hayle Harbour	Medium	Negligible	Minor Adverse
Copperhouse Pool Sluice gate maintenance works	Copperhouse Pool	High	Small	Moderate Adverse

Table 13– 11: Effects of construction on Hydraulic Regime

13.5.5.2 Assessment of operation impacts on hydraulic regime

The operation of **Carnsew Pool second sluice** will potentially increase the speed of inundation into Carnsew Pool if both sluice structures are open fully. This will increase the high tide achievable in the pool. The low tide will remain unaltered through the provision of a sill that is at the same elevation as the existing Carnsew Tunnels weir. The impact significance is considered to be **Moderate Adverse**. See table 13.12 for details.

Penpol Creek half tide gate and pedestrian crossing will operationally alter the hydraulic regime of Penpol Creek. Retention of a half tide level will reduce the intertidal area, and increase the subtidal extent. The Mellanear Stream will more often discharge into a half tide marine condition, and on occasions, a higher retained water level condition. Impact significance on the hydraulic regime is considered **Minor Adverse**.

The **Marina basin** will generate an area of velocity reduction, as the flooding tide passes the Fisherman's Quay, and the ebbing tide exits from the two pools. The flow streams from the two sluicing pools will be considered in the design of anchoring the floating pontoons. The impact significance is considered to be **Minor Adverse**.

The Fisherman's Quay will operationally alter the flow paths in its vicinity. The predicted flow pattern and rates are further detailed in the HR Wallingford Report, Annex 13F.

Vehicular bridge in the vicinity of Copperhouse Gate, will have no impact on the operational condition of the hydraulic regime as the piers are designed to avoid the current flow channel from Copperhouse Pool. The impact significance is considered to be **Negligible**.

The new **pedestrian bridge from East Quay to North Quay** will have little effect on the hydraulic regime, as there will only be a single pier support which will be slender and have a **Negligible** impact significance.

Copperhouse Pool Sluice gate will, operationally, have a **Major Adverse** impact on the hydraulic regime of Copperhouse Pool due to the re-instatement of sluicing outlined in Section 13.1.1.1. The high water will be artificially maintained for a period of three hours on every tide.

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
Operation of Carnsew Pool second sluice	Carnsew Pool	High	Small	Moderate Adverse
New Penpol Creek half tide gate and pedestrian crossing	Penpol Creek	Low	Small	Minor Adverse
Construction of the new Fisherman's Quay	Hayle Harbour	Medium	Negligible	Minor Adverse
	Hayle Estuary	High	Negligible	Minor Adverse
New fixed vehicular bridge	Copperhouse Pool	High	Negligible	Minor Adverse
New pedestrian bridge from East Quay to North Quay	Hayle Harbour	Medium	Negligible	Minor Adverse
Copperhouse Pool Sluice gate maintenance works	Copperhouse Pool	High	Small	Major Adverse

Table 13– 12: Effects of operation on hydraulic regime

13.5.6 Potential impacts on navigation

Note: All harbour works associated with the regeneration scheme which may limit navigation in any way will be the subject of a separate Harbour Revision Order.

13.5.6.1 Assessment of construction impacts on navigation

During construction there will be a balance between construction efficiency and the needs of the harbour users. Refer to the Harbour Works Description, Annex 13G, for further information on specific items of work. See table 13.13 for details.

Key work elements that may directly affect navigation are:

Excavation of Cockle Bank and Marina Basin

Initial construction may require the use of a floating dredger, in which case, it is likely to require a quayside mooring and encumber navigation in the vicinity. However, as the dredging operation continues, the dredging activity will be isolated to the historic space of Cockle Bank and will no longer hinder the existing navigation availability.

Potentially, depending on method of construction adopted, there may be the use of a floating pipeline or barge to receive dredged material. In this case, there may be disruption to navigation on the North Quay side of Cockle Bank. The impact severity is considered to be **Minor Adverse**.

Construction of Penpol Creek gate

The most efficient method of construction of the Penpol Gate in Penpol Creek would be to exclude the Creek from the tidal regime during the period of construction. This would exclude vessels from accessing Penpol Creek and represents a significant impact on the navigation of Penpol Creek and is considered as **Moderate Adverse**.

Construction of Fisherman's Quay

The works associated with the construction of the fisherman's quay will be limited approximately to the footprint of the structure itself, without constricting the main flow channel beyond that represented by the harbour arm. The construction phase of the harbour arm will require space on North Quay excluding it temporarily from mooring availability, as other mooring space will be available, the impact significance is considered to be **Minor Adverse**.

Installation of pontoons

The installation of pontoons will be carried out from floating plant, and will not materially affect navigation or mooring berths. The impact significance is considered to be **Negligible**.

New pedestrian bridge from East Quay to North Quay

The construction of the proposed pedestrian bridge will, in the main, be undertaken using land based plant. However the pier is likely to involve marine plant. The duration of works requiring marine based plant will be short (probably less than 6 weeks), but is likely to have an effect on access to a section of East Quay and to the existing harbour slipway during this period. The impact significance is considered to be **Minor Adverse**.

Construction of new slipway and sailing centre

The construction of the proposed slipway and associated sailing centre will be undertaken at the same time as the fisherman quay works, so will not generate additional cumulative impact on navigation during construction. The impact significance is considered **Negligible**.

Quay Wall remedial works

Small sections of wall will be isolated from navigation access during remedial works. The period of isolation will be comparatively short, with other sections of wall available for mooring. The impact significance of these works are considered to be **Negligible**.

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
Excavation of Cockle Bank and Marina Basin	Hayle Harbour	Medium	Small	Minor Adverse
Construction of Penpol Creek Gate	Penpol Creek	Low	Small	Moderate Adverse
Construction of the new Fisherman's Quay	Hayle Harbour	Medium	Negligible	Minor Adverse
	Hayle Estuary	High	Negligible	Minor Adverse
Installation of Pontoons	Hayle Harbour	Medium	Negligible	Minor Adverse
New pedestrian bridge from East Quay to North Quay	Hayle Harbour	Medium	Negligible	Minor Adverse
Construction of new slipway and sailing centre	Hayle Harbour	Medium	Negligible	Minor Adverse
Wall remedial works	Hayle Harbour	Medium	Negligible	Minor Adverse

Table 13– 13: Effects of construction on navigation

13.5.6.2 Assessment of operation impacts on navigation

This section considers the operational activities within the harbour and the potential impacts that each activity may have on navigation.

Sluicing, as a material component of the scheme, will affect navigation in the vicinity of Hayle Harbour. At the point of release (the sluice gates at Copperhouse and Carnsew Pools), there will be a significant increase in local water velocities. These locations, however, are not used as mooring points. Refer to Annex 13F (the HR Wallingford report on flow velocities and extents). The report demonstrates that the flow velocities soon drop to acceptable levels for navigation. Indeed, the navigation window for safe access and egress to and from the harbour is identified as three hours either side of high water. If users adhere to this safe navigation window, they will not be manoeuvring during periods of high sluicing flow. See table 13.14 for details.

The sluicing operation will aid the maintenance of the approach channel in terms of depth. The sluicing process will tend to sweep sediments from the harbour back into St. Ives Bay, it is also considered that the approach channel will straighten and the Hayle Bar, currently a safety risk, will tend to lower. Refer to Annex 13D for more information. The impact of sluicing on navigation in Hayle Harbour is considered **Major Beneficial**.

Marina provision and operation in Hayle Harbour is understood to be contentious due to the safety risks associated with the Hayle Bar. Although there is no statutory requirement for qualification when in ownership, or skippering a vessel in the UK, it is widely understood that navigating the North Devon and Cornwall coast has certain challenges such as large tidal range, tidal races, shoals, Atlantic swell and drying harbours. A marina at Hayle will provide protected floating berths for transiting and resident vessels which are in short supply in the region. Considering the combined findings of the HR Wallingford report, Annex 13F, and local boating awareness, the impact significance is considered **Moderate Beneficial**. However, a safety risk remains to be mitigated, and this is addressed in section 13.6.2.

Other key scheme elements that have a direct impact on navigation are:

Marina basin and floating pontoons

The provision of a marina basin and additional berthing points, with modern facilities and services will be an improvement in the boating amenity value of Hayle, servicing boat users much better than the current provision. The impact significance, in terms of navigation, is **Major Beneficial**.

Penpol Half Tide Gate

When deployed operationally at half tide to retain a fixed water level, navigation will not be possible between the main harbour and Penpol Creek. Navigation will be restricted to water levels above mean tide, that is, a duration of approximately 6 hours, 3 hours either side of high tide. Currently boat owners can access Penpol

Creek over a wider navigation window. However, most require the flow speeds to be low enough through the harbour entrance to navigate. This period occurs concurrently with the revised navigation access regime. The impact significance is considered **Minor Adverse**.

Fisherman's Quay

The fisherman's quay will formalise and increase the facility provision significantly to the local fishing fleet. Better berths, catch handling, storage and operational space will improve their working conditions and safety considerably. The impact significance is **Major Beneficial**.

East Quay to North Quay Bridge

The provision of a bridge between East Quay and North Quay will still permit navigation to the upstream section of East Quay, either beneath the fixed deck portion, or through the moveable section (lifting/swinging). Nonetheless, the ease of navigation will be reduced, and therefore the impact significance is considered to be **Minor Adverse**.

North Quay Slipway and Sailing Centre

Provision of the proposed slipway and sailing centre will increase the facility value of navigation in Hayle. The current slipway is narrow, steep and with poor access. The sailing centre will provide a coordinated, and manageable amenity for recreational sailing and boat use. The impact significance is considered to be **Major Beneficial**.

Item	Receptor	Sensitivity	Magnitude of Impact	Significance of Impact
Sluicing	Hayle Harbour	Medium	Large	Major Beneficial
Marina basin and floating pontoons	Hayle Harbour	Medium	Large	Major Beneficial
Penpol gate	Penpol Creek	Low	Small	Moderate Adverse
Construction of the new Fisherman's Quay	Hayle Harbour	Medium	Large	Major Beneficial
New pedestrian bridge from East Quay to North Quay	Hayle Harbour	Medium	Large	Minor Adverse
Construction of new slipway and sailing centre	Hayle Harbour	Medium	Large	Major Beneficial

Table 13– 14: Effects of operation on navigation

The cumulative impacts of the proposed elements in operation are considered to be **Major Beneficial.**

13.6 Mitigation measures

13.6.1 Mitigation for impacts on water quality during construction

The construction methods discussed below will assist in avoiding, reducing or minimising the potential for contaminants, sediments, dust and debris and pollutants migrating to water features and thus protect water quality and the ecosystems and fisheries they support. The Contractor will be required to prepare a Construction Environmental Management Plan (CEMP), which will include mitigation measures to protect the water environment. This will set out how construction activities will be undertaken in accordance with the pollution prevention guidelines published by the Environment Agency, particularly PPG1 (General guide to the prevention of water pollution), PPG5 (Works in, near or liable to affect watercourses) and PPG6 (Working at construction and demolition sites), and other good construction guidance, such as guidance on silt pollution and how to prevent it.

13.6.1.1 Mitigation for increased sediment loads

The areas of exposed surface will be minimised and the gradient kept as shallow as possible to prevent large amounts of material being washed into the Harbour and Estuary during periods of heavy rainfall. Any areas

which are exposed will either be re-covered/surfaced as soon as practicable, or bunds will be employed to control this element. Tight control of site boundaries will be enforced by the contractor, including minimal land clearance and restrictions on the use of machinery adjacent to Hayle Harbour. Wheel wash facilities will also be provided at all entry and exit points. The residue from the wheel wash facilities will be disposed of outside the site and not discharged into the Harbour.

Run off from site will be captured in perimeter cut-off ditches, settlement lagoons, and/or settlement tanks.

These will allow run-off to be treated prior to discharge. Approval will be required from the Environment Agency for any discharges to controlled waters such as Hayle Harbour. See table 13.15 for details.

Receptor	**Environmental Impact** **Impact Significance**	**Mitigation Measure** **Residual Impact Significance**
Carnsew Pool	Increased sedimentation during excavation Major adverse	Minimise area and gradient of exposed surfaces. Boundary control. Wheel wash facilities. Treatment and interception measures. CEMP. Minor adverse
Hayle Harbour	Increased sedimentation during excavation Moderate adverse	Minimise area and gradient of exposed surfaces. Boundary control. Wheel wash facilities. Treatment and interception measures. CEMP. Minor adverse
Penpol Creek	Increased sedimentation during excavation Minor adverse	Minimise area and gradient of exposed surfaces. Boundary control. Wheel wash facilities. Treatment and interception measures. CEMP. Negligible
Mellanear Stream	Increased sedimentation during excavation Negligible	Minimise area and gradient of exposed surfaces. Boundary control. Wheel wash facilities. Treatment and interception measures. CEMP. Negligible

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Hayle Estuary	Increased sedimentation during excavation Moderate adverse	Minimise area and gradient of exposed surfaces. Boundary control. Wheel wash facilities. Treatment and interception measures. CEMP. Minor adverse

Table 13– 15: Increased sediment loads mitigation

13.6.1.2 Mitigation for dust and debris

Dust management procedures which are typically implemented for air quality management issues (see chapter 11), such as damping down to suppress the creation of dust, could be applied to mitigate impacts from dust on water bodies resulting from demolition and earthworks. Good site practice, perimeter fences and tight control of materials and waste will minimise the risk of debris entering water courses. See table 13.16 for details.

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Carnsew Pool	Dust and debris Major adverse	Dust management procedure e.g. damping. Minor adverse
Hayle Harbour	Dust and debris Minor adverse	Dust management procedure e.g. damping. Negligible
Penpol Creek	Dust and debris Minor adverse	Dust management procedure e.g. damping. Negligible
Mellanear Stream	Dust and debris Negligible	Dust management procedure e.g. damping. Negligible

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Angarrack Stream	Dust and debris Negligible	Dust management procedure e.g. damping. Negligible

Table 13– 16: Dust and debris mitigation

13.6.1.3 Mitigation for accidental leaks and spillages of hazardous substances

The Contractor will be required to prepare a Construction Environmental Management Plan (CEMP), which will include a detailed mitigation strategy to minimise the risk of accidental leaks and spillages of hazardous substances. This will set out how construction activities will be undertaken in accordance with the pollution prevention guidelines published by the Environment Agency, for example **PPG2** (Above ground oil storage tanks).

Storage facilities and tanks will be provided and the re-fuelling of machinery will be conducted within bunded areas. The storage and bunded areas will be constructed of impervious floors and walls with the capacity for the contents of the storage tank and an additional 10% safety margin. Drip trays used for diesel pumps and standing plant will be regularly maintained to prevent leaks. Oil interceptors will also be installed in areas that may be used for temporary oil storage and refuelling. As a remedial measure, spill containment equipment such as absorbent materials will be stored on site.

Any mixing of construction materials, such as concrete, will be conducted in designated areas located away from drainage lines and Quay walls. The mitigation strategies implemented should be reviewed regularly to best suit the practices currently being undertaken on site. See table 13.17 for details.

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Carnsew Pool	Accidental Leaks and Spillages of Hazardous Substances Major adverse	In accordance with EA's Pollution Prevention Guidance. Appropriate storage, interceptors, designated work areas and CEMP. Minor adverse
Hayle Harbour	Accidental Leaks and Spillages of Hazardous Substances Minor adverse	In accordance with EA's Pollution Prevention Guidance. Appropriate storage, interceptors, designated work areas and CEMP. Negligible
Penpol Creek	Accidental Leaks and Spillages of Hazardous Substances Minor adverse	In accordance with EA's Pollution Prevention Guidance. Appropriate storage, interceptors, designated work areas and CEMP. Negligible
Mellanear Stream	Accidental Leaks and Spillages of Hazardous Substances Negligible	In accordance with EA's Pollution Prevention Guidance. Appropriate storage, interceptors, designated work areas and CEMP. Negligible
Angarrack Stream	Accidental Leaks and Spillages of Hazardous Substances Minor adverse	In accordance with EA's Pollution Prevention Guidance. Appropriate storage, interceptors, designated work areas and CEMP. Negligible
Copperhouse Pool	Accidental Leaks and Spillages of Hazardous Substances Major adverse	In accordance with EA's Pollution Prevention Guidance. Appropriate storage, interceptors, designated work areas and CEMP. Minor adverse
Hayle Estuary	Accidental Leaks and Spillages of Hazardous Substances Minor adverse	In accordance with EA's Pollution Prevention Guidance. Appropriate storage, interceptors, designated work areas and CEMP. Negligible

Table 13– 17: Accidental leaks and spillages mitigation

13.6.1.4 Mitigation for disturbance of contaminated materials

Any contaminated land or groundwater discovered on site during construction will be remediated, removed or avoided. See table 13.18 for details.

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Carnsew Pool	Disturbance of contaminated material Major adverse	Remediation or removal of contaminated land prior to construction and CEMP. Minor adverse
Hayle Harbour	Disturbance of contaminated material Moderate adverse	Remediation or removal of contaminated land prior to construction and CEMP. Negligible
Penpol Creek	Disturbance of contaminated material Minor adverse	Remediation or removal of contaminated land prior to construction and CEMP. Negligible
Mellanear Stream	Disturbance of contaminated material Minor adverse	Remediation or removal of contaminated land prior to construction and CEMP. Negligible
Angarrack Stream	Disturbance of contaminated material Minor adverse	Remediation or removal of contaminated land prior to construction and CEMP. Negligible
Copperhouse Pool	Disturbance of contaminated material Major adverse	Remediation or removal of contaminated land prior to construction and CEMP. Minor adverse
Hayle Estuary	Disturbance of contaminated material Minor adverse	Remediation or removal of contaminated land prior to construction and CEMP. Minor adverse

Table 13– 18: Disturbance of contaminated material mitigation

13.6.2 Mitigation for impacts on coastal erosion

13.6.2.1 Mitigation for construction stage

The excavation/dredging of the harbour, including Cockle Bank, will be controlled to limit potential sediment plume formation. Techniques such as dredging screens, and imposing limits to operation within the tidal cycle will reduce the potential impact. Such techniques and operating procedures will be established through the CEMP. These mitigation measures will reduce the impact significance from Moderate Adverse to **Minor Adverse**.

13.6.2.2 Mitigation for operational stage

Operation stage mitigation has been drawn from the previous sub-sections then grouped by function for assessment and identification of residual risk.

During operation of the scheme, coastal erosion, and accretion will be an on going process of maintenance and management. St. Ives Bay is a very active littoral cell. The key processes will remain unchanged by the proposed development that is that wave action at high tide will continue to push sand around the base of Hayle Towans towards the harbour. The transfer of material from St. Ives Bay to the harbour area will be reduced during periods of sluicing. However, this will primarily occur during summer months, rather than during the winter when wave effects are greatest. It is therefore intended to introduce a sediment trap at the seaward end of the fishermen's harbour/marina. This will trap sediments encroaching into the harbour, which sluicing may fail to control. It is proposed that material won from the sediment trap on an operational basis will be redistributed onto the beach of St. Ives Bay in the vicinity of the Towans. See table 13.19 for details.

Receptor	**Environmental Impact** **Impact Significance**	**Mitigation Measure** **Residual Impact Significance**
St Ives Bay	Loss of beach material to the harbour – limited by sluicing regime Minor Beneficial	Management of sediment ingress through sluicing and sediment trap maintenance Major beneficial
Harbour (water side)	Sedimentation in the harbour.	The provision of a sediment trap at the entrance of the harbour will focus accretion at a maintainable location. The marina basin will be excavated towards the Copperhouse Pool, to capture any fine material discharged from the Angarrack Stream.

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
	Moderate Adverse	Minor Adverse
Harbour	Ingress of material from St. Ives Bay Minor Adverse	Management of sediment ingress through sluicing and sediment trap maintenance Negligible

Table 13– 19: Coastal erosion mitigation

13.6.3 Mitigation for water resources impacts

Surface water drainage

Although it is not proposed to provide mitigation for adverse impacts, as these are, at worst, **Negligible**, consideration will be given to re-use of roof water from the larger retail and commercial developments as grey water for toilet flushing and irrigation use.

Foul drainage

There is no mitigation proposed for impacts resulting from the proposed foul drainage strategy.

13.6.4 Mitigation for flood risk impacts

Refer to Annex 13H Hayle Harbour Regeneration Flood Risk Assessment for more information.

The strategy for delivering flood defence to the scheme is through wide spread ground level raising, so that all new development within Flood Zone 3 is set above the appropriate flood level. All development thresholds are to be raised to at least 6.35m AOD, including doorways, parking thresholds, building voids, vents and flood sensitive equipment. Safe access and egress is delivered as identified on Figure 8 of the Flood Risk Assessment. These elements are built in as components of the scheme.

Penpol Creek gate will be constructed to enable functionality as a flood defence asset. Although the activation of Penpol gate will not provide an additional flood defence standard of service for the proposed scheme, it will provide third party flood security to Hayle Town Centre, particularly properties in Foundry Square. See table 13.20 for details.

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Harbour (land side)	Flooding of property and personal safety risk Negligible	No mitigation is proposed as the scheme adequately deals with flood risk for the life of the development including Sea Level Rise, and freeboard. Negligible
Mellanear Stream	Increased flood risk Minor Adverse	There will be an operational regime that will ensure the gate is raised with sufficient notice to provide increased fluvial storage behind the gate to receive storm discharge. Minor Beneficial

Table 13– 20: Flood risk mitigation

13.6.5 Mitigation for impacts on hydraulic regime

Penpol Creek half tide gate

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Penpol Creek	Reduced water quality behind the Gate within the impounded section	The gate will be operated at a half tide configuration, therefore, when the tide rises above this level the creek will receive a full flush from the tide. Maximum retention will be during the neap period, with a maximum residence time of 7 days.
	Minor Adverse	Minor Adverse
	Reduced navigation Minor Adverse	Vessels that require access and egress during times of impoundment may be serviced outside of Penpol Creek Minor Adverse

Table 13– 21: Mitigation for impacts from Penpol half tide gate

Sluicing from both Carnsew and Copperhouse Pools

The scheme proposes that the sluices that were historically located at the entrance to Copperhouse Pool, the Carnsew Tunnels and at the Carnsew 'Second sluice' be replaced with modern equivalents. The sluice gates will be operated in such a way as to aid the sediment management regime operated in the harbour, that is, at high tide the sluice gates will close holding back a significant volume of water in the pools as the tide goes out. At a predetermined time the sluice gates will open to release a large amount of water at an increased velocity. The faster water flow will occur when the channel water levels are lowered by the tide, creating a degree of scour and a net export of material out of the harbour. The results of modelling (Annex 13f) shows in the inner harbour area the sediment flux vectors are reversed suggesting that the sluicing would be effective in flushing sediment out of the harbour. However, principally due to predicted ecological constraints (please refer to Chapter 12 – Ecology for details) this regime cannot be implemented without perceived unacceptable impacts.

The mitigated operational procedure for sluicing is therefore:

a) Sluicing during the period of 15th April to 31st August

b) Sluicing to be undertaken on effective spring tides (not neaps), that is, two high tides a day during a five day period

c) Only one set of Carnsew sluices (either Carnsew Tunnels, or Carnsew Second sluice) will be opened to allow ingress of water. This will replicate the inundation profile that currently exists

d) The waters will be retained for a period not exceeding 3 hours

e) The waters will be released through Copperhouse gate, and a single Carnsew sluice

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Angarrack Stream	Increase stream water levels. Minor Adverse	The duration of retention in Copperhouse Pool (3 hours) will not be sufficient to build levels such as to increase flood risk to Copperhouse. Negligible
Copperhouse Pool	Increased water level retention Major Adverse	Water retention for sluicing will only be undertaken during the most effective tides, that is, the few either side of peak spring tides. Moderate Adverse
Carnsew Pool	Increased water level retention *Major Adverse*	Water retention for sluicing will only be undertaken during the most effective tides, that is, the few either side of peak spring tides. *Moderate Adverse*
Hayle Estuary	Reduced sand ingress into Estuary *Moderate Beneficial*	No mitigation necessary *Moderate Beneficial*
St. Ives Bay	Straightened channel and reduced sand bar. *Moderate Beneficial*	No mitigation necessary *Moderate Beneficial*

Table 13– 22: Mitigation for impacts arising from sluicing

13.6.6 Mitigation for impacts on navigation

Marina basin and floating pontoons

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Harbour (water side)	Increased pollution due to increased vessel numbers Moderate Adverse	A marina pollutant management plan will be operated by the Harbour Authority. Minor Adverse
Copperhouse Pool	Increased pollutant risk on flooding tide Moderate Adverse	Pollution management plan operated by the Harbour Authority Minor Adverse
Carnsew Pool	Increased pollutant risk on flooding tide Moderate Adverse	Pollution management plan operated by the Harbour Authority Minor Adverse
Harbour	Improved recreational boating amenity delivered Major Beneficial	No mitigation necessary Major Beneficial
Boat user safety	Increased boating use, safety risk from Hayle Bar and navigation window Moderate Adverse	Sluicing will straighten the approach channel and reduce the level of the Hayle bar when undertaken. Education of boat users, safe operating practices, notice to mariners etc. Minor Adverse

Table 13– 23: Mitigation for impacts from Marina basin and floating pontoons

Fishermen's Harbour

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Harbour (water side)	Altered sediment regime *Moderate Adverse* Improved commercial user amenity and facility Major Beneficial	Provision of a sediment trap will interrupt incoming material prior to reaching the marina pontoon space for ease of maintenance. *Minor Adverse* No mitigation necessary Major Beneficial

Table 13– 24: Mitigation for impacts from Fishermen's harbour

East Quay to North Quay bridge

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
East Quay	Restricted access Major Adverse	The bridge design will incorporate an opening section, either lifting or swing. Negligible

Table 13– 25 Mitigation for impacts from East Quay to North Quay Bridge

Heritage Footbridge (Penpol Creek)

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Penpol Creek	Restricted access Major Adverse	The bridge design will incorporate an opening section, either lifting or swing. Negligible

Table 13– 26 Mitigation for impacts from Heritage Footbridge

North Quay Slipway and Sailing Centre

Receptor	Environmental Impact Impact Significance	Mitigation Measure Residual Impact Significance
Boat users	Increased facility and amenity value to users Major Beneficial	No mitigation necessary Major Beneficial

Table 13– 27 Mitigation for impacts from North Quay Slipway and Sailing Centre

13.7 Residual impacts

Residual risks from flooding will remain for events greater than 1 in 1000 year event, including climate change. This potential risk is considered **Negligible**.

The absence of a positive drainage network during the construction phase complicates the methods in which contaminants are contained and treated, primarily hydro-carbons and oils. However, mitigation measures will minimise these impacts, and considering that the impacts will be short term only, the residual impacts will generally be **Minor Adverse**.

Mitigation measures have been proposed to treat and contain contaminated soils or pollutants from crude sewage entering the groundwater and/or being washed into Hayle Harbour. Good site practice will also reduce the likelihood of accidental spillages of chemicals and fuels from entering the groundwater or site surface water run off.

Good site practice will reduce the likelihood of excess sedimentation in site surface water run off. There are still residual risks remaining, but the probability is low and the risks are short term only, therefore adverse residual impacts will be Minor. Mitigation measures proposed for the operational phase of the development are intended to avoid adverse impacts, rather than minimise. Residual impacts will therefore be **Negligible**.

13.7.1 Construction stage residual impacts

A Construction Environmental Management Plan (CEMP) will be prepared and implemented to manage the environmental impacts of the construction process. All construction and installation activities including those carried out by subcontractors and suppliers would be supervised, or regularly checked through the completion of site inspections by the Contractors Environmental Manager, to ensure that requirements identified in risk assessments or method statements have been implemented. The frequency and extent of this supervision would vary according to the degree of competence displayed by the workforce and the level of risk to the

environment. Construction phase operations would be carried out in accordance with guidance contained within the Environment Agency Pollution Prevention Guidelines. Notwithstanding this, residual impacts remain, and these are considered below.

13.7.1.1 Increased sediment loads

Receptor	Environmental Impact	Residual Impact Significance	Management
Carnsew Pool	Increased sedimentation during excavation	*Minor adverse*	Stormwater will be diverted around and away from stockpiles using diversion channels and bunds. Implementation of a CEMP.
Hayle Harbour	Increased sedimentation during excavation	*Minor adverse*	Stormwater will be diverted around and away from stockpiles using diversion channels and bunds. Implementation of a CEMP.
Hayle Estuary	Increased sedimentation during excavation	*Minor adverse*	Stormwater will be diverted around and away from stockpiles using diversion channels and bunds. Implementation of a CEMP.

Table 13– 28 Residual Impact of increased sediment loads

13.7.1.2 Dust and debris

Receptor	Environmental Impact	Residual Impact Significance	Management
Carnsew Pool	Dust and Debris	*Minor adverse*	Barriers put in place to prevent debris entering Carnsew Pool during construction. Implementation of a CEMP.

Table 13– 29 Residual Impacts of dust and debris

13.7.1.3 Accidental leaks and spillages of hazardous substances

Receptor	Environmental Impact	Residual Impact Significance	Management
Carnsew Pool	Accidental Leaks and Spillages of Hazardous Substances	*Minor adverse*	No such materials will be kept within the 1 in 200 year flood extents. Waste will be stored within a bunded area and disposed of appropriately by a regulated waste contractor. Implementation of a CEMP.
Copperhouse Pool	Accidental Leaks and Spillages of Hazardous Substances	*Minor adverse*	No such materials will be kept within the 1 in 200 year flood extents. Waste will be stored within a bunded area and disposed of appropriately by a regulated waste contractor. Implementation of a CEMP.
Hayle Estuary	Accidental Leaks and Spillages of Hazardous Substances	*Minor adverse*	No such materials will be kept within the 1 in 200 year flood extents. Waste will be stored within a bunded area and disposed of appropriately by a regulated waste contractor. Implementation of a CEMP.

Table 13– 30 Residual Impacts of accidental leaks and spillages

13.7.2 Operational stage residual impacts

Appointed environmental representatives will carry out regular inspections of their respective areas, to verify that management, maintenance and supporting controls are being implemented effectively. These inspections will utilise the site environmental standards as the minimum standards that should be achieved, with necessary actions being recorded and raised at progress meetings. Subsequent inspections would commence with a review of all outstanding actions from previous reports to verify that they have been completed.

13.7.2.1 Hydraulic regime

Receptor	Environmental Impact	Residual Impact Significance	Management
Penpol Creek	Reduced Water Quality behind the Gate and Reduced Navigation	*Minor Adverse*	Implementation of a CEMP.

Table 13– 31 Residual Impacts of hydraulic regime

13.7.2.2 Sluicing from both Copperhouse and Carnsew Pools

Receptor	Environmental Impact	Residual Impact Significance	Management
Harbour (water side)	Sedimentation in the harbour.	Minor Adverse	Implementation of a CEMP.
Copperhouse Pool	Increased water level retention	Moderate Adverse	Implementation of a CEMP.
Carnsew Pool	Increased water level retention	Moderate Adverse	Implementation of a CEMP.

Table 13– 32: Residual Impacts of sluicing

13.7.2.3 Fisherman's Harbour

Receptor	Environmental Impact	Residual Impact Significance	Management
Harbour (water side)	Altered sediment regime	Minor Adverse	Implementation of a CEMP

Table 13– 33: Residual Impacts of new fisherman's harbour

13.8 Monitoring

It is essential to monitor sedimentation, pollution and other negative impacts throughout the whole project cycle, from the design of the scheme, through to the construction and operation phases. The residual impacts identified in section 13.7 will be monitored and mitigation adjusted as necessary.

13.8.1 Monitoring during construction stage

Monthly water monitoring is advised during the construction period, to ensure proposed mitigation measures are being effective in maintaining the existing surface water quality. A water quality monitoring programme should be implemented to confirm the water quality impact before the full-scale implementation of construction. Providing correct working procedures are adopted and care is taken to avoid pollution of the watercourses, no significant residual effects are predicted for the construction phase of the development.

13.8.1.1 Increased sediment loads

Receptor	Environmental Impact	Residual Impact Significance	Monitoring
Carnsew Pool	Increased sedimentation during excavation	Minor adverse	Monitoring of water quality and sediment testing throughout the construction stage
Hayle Harbour	Increased sedimentation during excavation	Minor adverse	Monitoring of water quality and sediment testing throughout the construction stage
Hayle Estuary	Increased sedimentation during excavation	Minor adverse	Monitoring of water quality and sediment testing throughout the construction stage

Table 13– 34 Monitoring of increased sediment loads

13.8.1.2 Dust and debris

Receptor	Environmental Impact	Residual Impact Significance	Monitoring
Carnsew Pool	Dust and Debris	Minor adverse	Monitoring of the dust /debris produced and water quality during the construction stage

Table 13– 35 Monitoring of dust and debris

13.8.1.3 Accidental leaks and spillages of hazardous substances

Receptor	Environmental Impact	Residual Impact Significance	Monitoring
Carnsew Pool	Accidental Leaks and Spillages of Hazardous Substances	Minor adverse	Water quality monitoring will take place throughout the construction stage
Copperhouse Pool	Accidental Leaks and Spillages of Hazardous Substances	Minor adverse	Water quality monitoring will take place throughout the construction stage
Hayle Estuary	Accidental Leaks and Spillages of Hazardous Substances	Minor adverse	Water quality monitoring will take place throughout the construction stage

Table 13– 36 Monitoring of accidental leaks and spillages

13.8.1.4 Effects on coastal erosion

Receptor	Environmental Impact	Residual Impact Significance	Monitoring
Hayle Estuary	Sediment plumes and mobilisation of contaminants due to dredging	Minor adverse	Water quality monitoring will take place throughout the construction stage
St Ives Bay	Sediment plumes and mobilisation of contaminants due to dredging	Minor adverse	Water quality monitoring will take place throughout the construction stage

Table 13– 37 Effects on Coastal Erosion

13.8.2 Monitoring during operational stage

13.8.2.1 Hydraulic regime

Receptor	Environmental Impact	Residual Impact Significance	Monitoring
Penpol Creek	Reduced Water Quality behind the Gate and Reduced Navigation	Minor Adverse	Water quality monitoring will take place at regular intervals

Table 13– 38 Monitoring of the hydraulic regime

13.8.2.2 Sluicing from both Copperhouse and Carnsew Pools

Receptor	Environmental Impact	Residual Impact Significance	Monitoring
Harbour (water side)	Sedimentation in the harbour.	Minor Adverse	Monitoring of sedimentation and water quality at regular intervals
Copperhouse Pool	Increased water level retention	Moderate Adverse	Monitoring of sedimentation and water quality at regular intervals
Carnsew Pool	Increased water level retention	Moderate Adverse	Monitoring of sedimentation and water quality at regular intervals

Table 13– 39 Monitoring of sluicing

13.8.2.3 Fisherman's Harbour

Receptor	Environmental Impact	Residual Impact Significance	Monitoring
Harbour (water side)	Altered sediment regime	Minor Adverse	Monitoring of sediment regime at regular intervals

Table 13– 40 Monitoring of the fisherman's harbour

13.9 Bibliography

Aldersgate Developments Ltd 1988. Hayle Harbour Development. Engineering Appraisal. Sir Alexander Gibb & Partners

Aquatic Environmental Consultants 1998. Impact of proposed engineering works on the intertidal invertebrates of Copperhouse Pool, Hayle

Babtie Group 2002. Hayle Harbour. Hydrodynamic Modelling Report. Final Report R02

Buro Happold 2005a. Hayle Harbour Redevelopment. Progress Report. Cockle Bank Re-use Assessment Job 007838

Buro Happold January 2005 Hayle Harbour Redevelopment. Harbour Wall Condition Survey

Buro Happold 2005b. Sediment Exchange monitoring Job 007838 February

Buro Happold February 2005 Hayle Harbour Redevelopment. Harbour Wall schedule of Works

Buro Happold December 2005 Hayle Harbour Redevelopment. Harbour Contamination Report

Buro Happold May 2007 Hayle Harbour Redevelopment. Pool Level Factual Information

Buro Happold July 2007 Hayle Harbour Redevelopment. Description of Works

Buro Happold August 2007 Hayle Harbour. Flood Risk Assessment

Field Studies Council Research Centre, August 1989. Surveys of Harbours, Rias and Estuaries in Southern Britain. Hayle Estuary. Volume 1. A report to the Nature Conservancy Council from the, Fort Popton, Pembroke, Dyfed, C Gill

Garrett, C and Cummins, P 2004, J. Waterway, Port, Coastal, and Ocean Engineering, **130**, 3

Gill C 1989. Surveys of Harbours, Rias and Estuaries in Southern Britain. Hayle Estuary. Volume 1. A report to the Nature Conservancy Council from the Field Studies. Fort Popton, Pembroke, Dyfed

Kenneth Grubb Associates September 2006. Copperhouse Sluice Gate Condition Inspection

Hayle Harbour Development 1998. Sediment and water quality analysis. WSP Environmental, February

HR Wallingford, June 1976. The Port of Hayle. Aspects to be considered in relation to future requirements

HR Wallingford, October 1988. Hayle Harbour. Preliminary hydraulic appraisal of proposed development works on entrance channel siltation. EX1814

HR Wallingford, April 1989. Hayle Harbour. Hydraulic and siltation studies. Report EX1911

HR Wallingford, April 2005. Hayle Harbour Development. Hydraulic Studies Phase 1. Report EX5120

Sea Sediments 1983. An investigation of sediment dynamics in the Hayle Estuary, Cornwall, September

Smith P, October 1988. Report on macroinvertebrates and sediment chemistry of Copperhouse Pool, Hayle.

Smith P, November 1988. Report on Arsenic, Copper and Zinc in Copperhouse Pool and other sites in Hayle, Cornwall

WSP Environmental, February 1998. Hayle Harbour Development. Sediment and water quality analysis