



An Daingean Small Craft Harbour
Supporting Information for Screening for Appropriate
Assessment and Natura Impact Statement
Volume 2 – Appendices

Produced by
AQUAFAC International Services Ltd

On behalf of
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Appendix 1

SACs and SPAs

SITE SYNOPSIS

SITE NAME: BLASKET ISLANDS SPA

SITE CODE: 004008

The Blasket Islands are situated at the end of the Dingle peninsula in Co. Kerry. The site comprises all of the main islands in the group, as well as the various islets and rocks, and also the seas which surround the islands to a distance of 500 m. There are six main islands, plus some smaller islands, islets and sea stacks. The largest island, Great Blasket, is separated from the mainland by the Blasket Sound, a distance of some 2 km. The smallest island, Beginish, lies close to Great Blasket, while the other islands (Inishtooskert, Inishnabro, Inishvickillane, Tearaght Island) are between about 7 km and 12 km from the mainland. The bedrock is principally Old Red Sandstone, with some outcrops of volcanic and Silurian rocks on Inishvickillane and Beginish. Apart from the low-lying Beginish near the mainland, all of the main islands rise to substantial heights, as follows: Great Blasket 292 m, Inishtooskert 162 m, Inishnabro 175 m, Inishvickillane 138 m and Tearaght 184 m. There are no permanent habitations, though Great Blasket was inhabited until 1953.

Sea cliffs, mostly precipitous, are the dominant habitat and, indeed, much of the vegetation on the islands consists of species typical of cliffs or cliff-tops. Typical species of the more rocky cliffs include Rock Samphire (*Crithmum maritimum*), Tree Mallow (*Lavatera arborea*) and Rock Sea-spurry (*Spergularia rupicola*). On the higher slopes where a maritime turf is found, swards of Thrift (*Armeria maritima*), Sea Campion (*Silene maritima*), Sea Plantain (*Plantago maritima*) and Buck's-horn Plantain (*Plantago coronopus*) are dominant, along with such species as Kidney Vetch (*Anthyllis vulneraria*), Bird's-foot Trefoil (*Lotus corniculatus*) and Common Scurvy-grass (*Cochlearia officinalis*). The seas surrounding the islands have well-developed reef communities.

The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Fulmar, Manx Shearwater, Storm Petrel, Shag, Lesser Black-backed Gull, Herring Gull, Kittiwake, Arctic Tern, Razorbill, Puffin and Chough. The site is also of special conservation interest for holding an assemblage of over 20,000 breeding seabirds.

The Blasket Islands SPA is one of the most important seabird colonies in the country, with at least 11 species of seabird breeding regularly. It is the most important site in the country for Storm Petrel and Manx Shearwater, with internationally important populations of both (c. 52,141 and 19,534 pairs respectively in the 2000/2001 survey). A survey of some of the Blasket Islands conducted in 1988 recorded the following nationally important populations: Fulmar (2,179 pairs), Lesser Black-backed Gull (at least 333 pairs), Herring Gull (131 pairs), Kittiwake (773 pairs) and Puffin (4,924 pairs). An incomplete survey in 1999/2000 recorded a nationally important population of Shag (60 pairs). Guillemot also breeds though in relatively low

numbers (316 pairs in 2001). A nationally important population of Arctic Tern also breeds within the site with at least 200 pairs in 1988 and 102 pairs in 2001.

The islands are traditional sites for Peregrine (1-2 pairs) and Chough (9 pairs in 2002). Further breeding species typical of western islands include Oystercatcher, Rock Dove, Wheatear, Raven and possibly Twite.

The Blasket Islands SPA is one of the most important seabird sites in the country, with two species having internationally important populations and at least a further eight having nationally important populations. A nationally important population of breeding Chough also occur on the islands. Of note is the regularly occurrence of four species listed on Annex I of the E.U. Birds Directive - Storm Petrel, Arctic Tern, Peregrine and Chough. Tearaght Island is a Statutory Nature Reserve.



Site Name: Mount Brandon SAC

Site Code: 000375

This site comprises the central and north-western parts of the Dingle Peninsula. It is a mountainous area that encompasses several peaks including Mount Brandon (952 m), which is the highest peak outside of the Macgillycuddy's Reeks, Brandon Peak (840 m), and the Stradbally range which includes Beenoskee (826 m). The site includes the high sea cliffs of Brandon Head, as well as low-lying areas such as the Owenmore River/Cloghane River valley. Glaciation has played a large part in shaping the landscape into a series of ridges and valleys, with corrie lakes and steep cliffs. The underlying geology features Old Red Sandstone and Dingle Beds (the oldest Devonian rocks in Ireland). Conglomerates are also present.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

- [1230] Vegetated Sea Cliffs
- [3110] Oligotrophic Waters containing very few minerals
- [3130] Oligotrophic to Mesotrophic Standing Waters
- [4010] Wet Heath
- [4030] Dry Heath
- [4060] Alpine and Subalpine Heaths
- [6230] Species-rich *Nardus* Grassland*
- [7130] Blanket Bogs (Active)*
- [8110] Siliceous Scree
- [8210] Calcareous Rocky Slopes
- [8220] Siliceous Rocky Slopes
- [1029] Freshwater Pearl Mussel (*Margaritifera margaritifera*)
- [1421] Killarney Fern (*Trichomanes speciosum*)

Arctic and arctic-alpine species, including important bryophyte and lichen assemblages, are found on the dramatic north- to east-facing inland cliffs and on the alpine heath of the highest ridges (above 750 m). Species present include Dwarf Willow (*Salix herbacea*), Alpine Bistort (*Polygonum viviparum*), Alpine Saw-wort (*Saussurea alpina*), Mountain Sorrel (*Oxyria digyna*), Alpine Lady's-mantle (*Alchemilla alpina*), Alpine Hair-grass (*Deschampsia alpina*), Alpine Meadow-grass (*Poa alpina*), Roseroot (*Rhodiola rosea*), saxifrages (*Saxifraga stellaris* and *S. rosacea*), and ferns such as Holly Fern (*Polystichum lonchitis*), Green Spleenwort (*Asplenium viride*), Wilson's Filmy-fern (*Hymenophyllum wilsonii*) and Brittle Bladder-fern (*Cystopteris fragilis*).

These inland cliffs correspond to the habitats Calcareous Rocky Slopes, Siliceous Rocky Slopes and Siliceous Scree, and are particularly important for their range of rare oceanic bryophyte species, including *Adelanthus lindenbergianus*, *Scapania nimbosa*, *S. ornithopodioides*, *Lejeunea* spp. and many more.

The most common habitats within the site are heath, upland grassland and blanket bog. The heath occurs in areas of shallow peat and on the mineral soils of the mountain sides. It varies in nature from dry to wet. The dry heath is dominated by Heather (*Calluna vulgaris*) and Western Gorse (*Ulex gallii*), while the wet contains Cross-leaved Heath (*Erica tetralix*), Purple Moor-grass (*Molinia caerulea*), Carnation Sedge (*Carex panicea*) and bog mosses (*Sphagnum* spp.). The dry heath often grades into upland grassland which supports a range of characteristic grasses: Mat-grass (*Nardus stricta*), Common Bent (*Agrostis capillaris*) and Viviparous Fescue (*Festuca vivipara*).

Areas of blanket bog occur on level or gently sloping ground. There are three main areas of particular interest: two upland bogs and a lowland, valley bog. Coumanare Bog is an impressive tract of mountain bog dominated by Purple Moor-grass and Deergrass (*Scirpus cespitosus*). It features a large and particularly well-developed scraw (i.e. area of floating vegetation), associated with a series of springs along the Scorid River, where bog mosses dominate (e.g. *Sphagnum cuspidatum*, *S. auriculatum* var. *auriculatum*, *S. papillosum* and *S. subnitens*). Another upland blanket bog, located on the south-facing slopes of Beenator and Coumbaun Mountains, is heavily grazed and dominated by Deergrass, Heather and Common Cottongrass (*Eriophorum angustifolium*). Some of the lowland bog in the Owenmore River/Cloghane River valley is intact and is dominated by Deergrass, with Black Bog-rush (*Schoenus nigricans*), Purple Moor-grass, Great Sundew (*Drosera anglica*) and bog mosses also occurring.

Oligotrophic corrie lakes are a feature of the site, including a string of Paternoster lakes below the Brandon range. Characteristic plant species found include Shoreweed (*Littorella uniflora*), Quillwort (*Isoetes lacustris*) and Six-stamened Waterwort (*Elatine hexandra*).

Vegetated sea cliffs, which stretch for some 12 km along the north-western edge of the site, are amongst the highest in Ireland (over 400 m above sea level). The cliffs support a good variety of plant species typical of the habitat, including Thrift (*Armeria maritima*), Sea Campion (*Silene vulgaris* subsp. *maritima*), Sea Spleenwort (*Asplenium marinum*) and Rock Sea-spurrey (*Spergularia rupicola*). Populations of a number of relatively scarce plants, including Roseroot, Irish Saxifrage (*Saxifraga rosacea*) and Mountain Sorrel also occur. The cliff tops support heath or coastal grassland, and here such species as Creeping Willow (*Salix repens*), Crowberry (*Empetrum nigrum*) and Allseed (*Radiola linoides*) are found. The scarce Small Adder's-tongue (*Ophioglossum azoricum*) has been recorded from cliff tops in the site.

A suite of rare Red Data Book plant species have been recorded, associated with the inland cliffs and alpine heath: Alpine Bistort, Alpine Meadow-grass, Alpine Saw-

wort, Alpine Lady's-mantle and Holly Fern. Mount Brandon is one of the most southern locations in Britain and Ireland for Alpine Bistort, a species which is protected under the Flora (Protection) Order, 2015. Cornish Moneywort (*Sibthorpia europaea*), also a Red Data Book species, occurs at several locations within the site. In Ireland this species is found only on the Dingle Peninsula. Killarney Fern (*Trichomanes speciosum*), protected under the E.U. Habitats Directive and the Flora (Protection) Order, 2015, occurs within the site.

A population of Freshwater Pearl Mussel (*Margaritifera margaritifera*) occurs within the site. This is an endangered species that is listed on Annex II of the E.U. Habitats Directive. Other fauna of interest recorded from the site includes Large Heath (*Coenonympha tullia*), a vulnerable butterfly, and Arctic Char (*Salvelinus alpinus*), a Red Data Book fish species found recently in Anascaul Lough.

The Dingle Peninsula supports some of the highest densities in Ireland of breeding Chough, a Red Data Book species that is listed on Annex I of the E.U. Birds Directive. The abundance of Chough on the peninsula was first noted in the 1800s and has been demonstrated in recent surveys. In the site the birds are particularly to be found close to the Brandon Head sea cliffs, but also as large roosting flocks in several inland upland areas, as at Ballybrack, Lough Doon, Anascaul Lough and Arraglen. Peregrine, also an E.U. Birds Directive Annex I species, uses the site, as well as a variety of seabird species that breed on the sea cliffs.

The main land use within the site is sheep grazing. The serious effects of over-grazing are widespread and are exacerbated by the upland, exposed nature of the site. Other threats come from turbarry and afforestation. Part of the site is state-owned, the Mount Brandon Nature Reserve.

The site is of high conservation value due to the presence of good quality examples of 11 habitats that are listed on Annex I of the E.U. Habitats Directive, as well as populations of two species that are listed on Annex II of this Directive. The presence of the E.U. Birds Directive Annex I species, Chough and Peregrine, as well as of populations of a suite of rare Red Data Book plant species, adds considerably to the significance of the site.

Site Name: Tralee Bay and Magharees Peninsula, West to Cloghane SAC

Site Code: 002070

This large site in Co. Kerry stretches from Tralee town westwards to Fenit Harbour and Cloghane, encompassing Tralee Bay, Brandon Bay and the Magharees Peninsula. It includes extensive mudflats at the eastern end, the beaches of Derrymore Island, the sand dunes and lagoons of the Magharees Peninsula, as well as the rocky headlands at its end. The site includes two Statutory Nature Reserves, Tralee Bay and Derrymore Island, and much of the estuarine part of the site has been designated a Special Protection Area (SPA) for birds and their habitats.

The site is mostly underlain by limestone, but significant parts of this are covered with glacial drift or windblown sand. The main exposures occur at Fenit port, Oyster Hall, Blennerville and at Rough Point and Fahamore, but there are some other low outcrops on the beaches west to Castlegregory. Elsewhere the sandstones and slates of the Dingle Beds appear.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

- [1130] Estuaries
- [1140] Tidal Mudflats and Sandflats
- [1150] Coastal Lagoons*
- [1160] Large Shallow Inlets and Bays
- [1170] Reefs
- [1210] Annual Vegetation of Drift Lines
- [1220] Perennial Vegetation of Stony Banks
- [1310] *Salicornia* Mud
- [1330] Atlantic Salt Meadows
- [1410] Mediterranean Salt Meadows
- [2120] Marram Dunes (White Dunes)
- [2130] Fixed Dunes (Grey Dunes)*
- [2170] Dunes with Creeping Willow
- [2190] Humid Dune Slacks
- [6410] *Molinia* Meadows
- [91E0] Alluvial Forests*
- [1355] Otter (*Lutra lutra*)
- [1395] Petalwort (*Petalophyllum ralfsii*)

Both the Tralee and Brandon (Owenmore) estuaries feature wide expanses of sheltered intertidal flats, often fringed with saltmarsh vegetation. Plant species are typically scarce on the flats, although there are some eelgrass (*Zostera* spp.) beds and patches of green algae (e.g. *Ulva* spp. and *Enteromorpha* spp.). The eelgrass beds at Derrymore Island include *Zostera noltii*, a species which has a limited distribution in Ireland. A variety of polychaetes (worms) and bivalve molluscs are also present in the intertidal sections.

The majority of Tralee Bay is shallow and composed of sublittoral sediments. In the more sheltered areas of the bay, there is a variety of important sublittoral sediment communities in which a number of rare species occur. Seagrass beds in sandy substrates are characterized by oysters and the rare anemone *Calliactis parasitica* which lives on shells inhabited by the hermit crab *Pagurus bernhardus*. The little known hydroid, *Laomedea angulata*, is also found on the fronds of the seagrass. The native oyster, *Ostrea edulis*, occurs in sediment communities throughout the bay. Maerl beds, composed of the free-living coralline algae *Lithothamnion corallioides* and *Phymatolithon calcareum*, and characterized by anemones (*Anthopleura balli*) and oysters, occur in the middle of the bay. The rare anemone *Halcampa chrysanthellum* has been recorded here.

The intertidal reefs of Tralee Bay and the Magharees peninsula range from being exposed to sheltered from wave action, and the communities present are good examples of the communities typically found on these types of shores. The barnacle/limpet community with the lichen *Lichina pygmaea* is an uncommon community and is found in the upper-mid shore at Rough Point. The low shore at Rough Point, which is moderately exposed to wave action, and the shore at Coosanea, which is sheltered from wave action, are both very species-rich. Rocky outcrops on the shore half way round the bay near Camp are known to support a community of the uncommon honeycomb worm *Sabellaria alveolata*. The sublittoral reefs support communities characterised by a variety of red foliose algae, as well as the brown algae *Dictyota dichotoma*, and are typical of communities that are subjected to sand scour as indicated by the presence of the red algae *Furcellaria lumbricalis* and *Polyides rotundus*.

In the transition zone between the intertidal flats and saltmarsh, specialised colonisers of mud predominate - swards of Common Cord-grass (*Spartina anglica*) are extensive on the leeward side of Derrymore Island, while swards of Glasswort (*Salicornia europaea* agg.) also occur in parts of the site.

Saltmarsh vegetation frequently fringes the mudflats, with the most extensive areas being found at Blennerville, Derrymore Island and Formoyle in Brandon Bay. The dominant type of saltmarsh present is Atlantic salt meadow. Characteristic species occurring include Common Saltmarsh-grass (*Puccinellia maritima*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Sea-milkwort (*Glaux maritima*), Sea Plantain (*Plantago maritima*), Red Fescue (*Festuca rubra*), Creeping Bent (*Agrostis stolonifera*), Saltmarsh Rush (*Juncus gerardi*), Long-bracted Sedge (*Carex extensa*), Lesser Sea-spurrey (*Spergularia marina*) and Sea Arrowgrass (*Triglochin maritima*). Areas of

Mediterranean salt meadows, characterised by clumps of Sea Rush (*Juncus maritimus*), occur occasionally.

Sandy beaches backed by strips of 'white' dunes are common along the southern shore of the site. The vegetation of these 'white' dunes is dominated by Marram (*Ammophila arenaria*). However, the main dune area on this southern shore occurs on the Magherees Peninsula - a tombolo which joins a number of the Magherees Islands with the mainland. Here there are extensive areas of fixed 'grey' dunes, which feature a number of damp hollows or dune slacks. The fixed dunes are species-rich, with characteristic species such as White Clover (*Trifolium repens*), Lesser Hawkbit (*Leontodon taraxacoides*), Common Centaury (*Centaureum erythraea*), Lady's Bedstraw (*Galium verum*) and grasses (e.g. *Festuca rubra*, *Poa trivialis* and *Avenula pubescens*).

Relatively scarce plants found on the dunes include the following: Fringed Rock-cress (*Arabis brownii*), Fragrant Orchid (*Gymnadenia conopsea*), Squinancywort (*Asperula cynanchica*), Autumn Lady's-tresses (*Spiranthes spiralis*) and Dodder (*Cuscuta epithymum*). Dune slack species include Strawberry Clover (*Trifolium fragiferum*), Chaffweed (*Anagallis minima*) and the fungus *Inocybe halophila*.

Lough Gill, a natural sedimentary lagoon, is located at the base of the Magherees Peninsula. The lagoon is only slightly brackish and therefore contains freshwater species along with lagoon specialists. Submerged flora present includes Beaked Tasselweed (*Ruppia maritima*) and Horned Pondweed (*Zannichellia palustris*), while species fringing the lagoon include Common Reed (*Phragmites australis*), Sea Club-rush (*Scirpus maritimus*) and Grey Club-rush (*S. lacustris* subsp. *tabernaemontani*).

Other coastal habitats that occur within the site include shingle beaches, rocky shores and vegetated sea-cliffs. The site also contains fragments of terrestrial habitats such as deciduous woodland, scrub, heath, dry limestone grassland, wet grassland and freshwater marshes.

There is some good limestone flora on the hill at Oyster Hall, with Burnet Rose (*Rosa pimpinellifolia*), Southern Polypody (*Polypodium australe*) and Hairy Rock-cress (*Arabis hirsuta*) occurring. There is an old record for the Red Data Book species, Sea-kale (*Crambe maritima*). At Fahamore and Rough Point it is the intertidal communities that are particularly rich, benefiting from a multitude of microhabitats in the eroded limestone. Red algae are frequent, including the agar seaweeds *Gelidium* and *Pterocladia*.

A small area of *Molinia* meadow is found in the site, with species such as Purple Moor-grass (*Molinia caerulea*), Devil's-bit Scabious (*Succisa pratensis*), Sharp-flowered Rush (*Juncus acutiflorus*) being common, and species such as Greater Tussock-sedge (*Carex paniculata*), Tormentil (*Potentilla erecta*), Marsh Cinquefoil (*Potentilla palustris*), Wild Angelica (*Angelica sylvestris*) and Common Valerian (*Valeriana officinalis*) also frequent.

Beach features dominate the northern coast of the Dingle Peninsula with an excellent series of shingle ridges forming Derrymore Island and the tombolo which links

former Magheree Islands (Rough Point, etc.) to the mainland. Here there is a large area of well developed sand dunes with an exceptionally rich flora and great topographic variation. The flora includes Fringed Rock-cress, Squinancywort, Dodder, Autumn Lady's-tresses and Chaffweed - all plants with a restricted distribution in the west of Ireland. These occur in a vegetation with abundant Red Fescue, scattered Marram, and herbs such as Lady's Bedstraw, Wild Thyme (*Thymus praecox*), Common Bird's-foot-trefoil (*Lotus corniculatus*) and Kidney Vetch (*Anthyllis vulneraria*). Yellow-rattle (*Rhinanthus minor*), eyebrights (*Euphrasia* spp.), Pyramidal Orchid (*Anacamptis pyramidalis*) and Heath Spotted-orchid (*Dactylorhiza maculata*) are four sensitive species which also occur here.

At the seaward edge drift line vegetation is often present. The more stable areas of shingle support Sea Beet (*Beta vulgaris* subsp. *maritima*), Sea Mayweed (*Matricaria maritima*), Sea Campion (*Silene vulgaris* subsp. *maritima*), Curled Dock (*Rumex crispus*), oraches (*Atriplex* spp.), Sea Sandwort (*Honkenya peploides*) and Silverweed (*Potentilla anserina*).

Between the dunes where erosion has removed the sand down to the water table there are temporary ponds or dune slacks with many additional species. Marsh Pennywort (*Hydrocotyle vulgaris*), Silverweed, various sedges (*Carex panicea* and *C. nigra*) and, in places, Strawberry Clover, Adder's-tongue (*Ophioglossum vulgatum*), Knotted Pearlwort (*Sagina nodosa*) and the orchids *Dactylorhiza majalis* and *D. incarnata* all occur. Some parts of the dune slacks feature a vegetation community characterised by the presence of Creeping Willow (*Salix repens*).

Woodland is rare on the Dingle Peninsula so the three stands included in this site are locally important. A deserted river valley at Killelton, the steep valley of the Finglas River at Camp and the west-facing slopes of Drom Hill opposite Cloghane all have features of significant interest. The last site has many species of lower plant (liverworts and lichens) that form distinctive elements of the westernmost natural woods in Ireland. At Garrahies Wood, adjacent to the Finglas River, there is an example of wet woodland on base-rich soils subject to flooding. The woodland type falls into the ash-alder alluvial forest category. The most common tree species are Alder (*Alnus glutinosa*), Downy Birch (*Betula pubescens*) and willows (*Salix* spp.). Bluebell (*Hyacinthoides non-scripta*), grasses and Bramble (*Rubus fruticosus* agg.) are the most common species in the ground layer.

The dune complex on the Magharees Peninsula supports the largest Irish breeding population of Natterjack Toads. Indeed, the population may be the largest breeding population in Britain and Ireland. The Natterjack Toad is listed as vulnerable in the Red Data Book and is protected under both European and national legislation. The toads require shallow warm water to spawn in and sandy habitats for over-wintering. Their tadpoles are vulnerable to predation in permanent lakes but despite this they have some success in Lough Gill which is a shallow lake with flat shores of sand, wet grassland or marsh. Natterjack Toads also breed within the site at Fermoy, to the west. Also recorded from Fermoy is the rare whorl snail *Vertigo angustior*, a species listed on Annex II of the E.U. Habitats Directive. Two species of

hover fly - *Platycheris perpilladus* and *Sphaerophoria loewi* - have their only Irish records from the Magharees Peninsula dune system and a water beetle, *Cercyon sternalis*, was first recorded in Ireland in 1997 in Lough Gill.

The site supports populations of several rare plant species which have not been mentioned already. The bryophyte Petalwort (*Petalophyllum ralfsii*), which is listed on Annex II of the E.U. Habitats Directive, is known from the dune slacks on the Magharees Peninsula and Smooth Brome (*Bromus racemosus*), a Red Data Book grass, has been recorded from two wet meadows within the site. Several aquatic plants of interest grow in Lough Gill, the rarest being the Red Data Book stonewort *Chara canescens*. The Slender-leaved Pondweed (*Potamogeton filiformis*) occurs far to the south of its distribution elsewhere in Ireland and Britain, while there are also old records for Spiral Tasselweed (*Ruppia spiralis*). The marshes along the southern shore in the past support a rich variety of vegetation including several species rare in Kerry such as Water Dock (*Rumex hydrolapathum*) and Greater Spearwort (*Ranunculus lingua*), as well as sedges (*Carex dioica*, *C. limosa* and *C. diandra*) on patches of peat. Despite local reclamation it is likely that most of these still survive.

Otters regularly feed within this extensive site though it is not known if they breed. Otter is listed on Annex II of the E.U. Habitats Directive.

Tralee Bay, including Lough Gill, is an internationally important wetland for wintering waders and wildfowl. Species present which are listed on Annex I of the E.U. Birds Directive include Whooper Swans (24, mid-1980s), Golden Plover (3,053, 1994-95) and Bar-tailed Godwit (903, 1995-96). The dunes also provide an important feeding ground for Chough, a resident Annex I species.

Other wintering waders and wildfowl present include: Pale-bellied Brent Goose (944, mid-1980s), Shelduck (218, 1995-96), Gadwall (14, 1994-95), Teal (860, 1994-95), Pintail (56, 1995-96), Shoveler (144, mid-1980s), Scaup (1560, 1994-95), Scoter (620, 1994-95), Red-breasted Merganser (46, 1994-95), Ringed Plover (332, 1994-95), Grey Plover (674, 1995-96), Lapwing (5700, 1994-95), Knot (320, 1994-95), Sanderling (270, 1994-95), Purple Sandpiper (103, mid-1980s), Dunlin (4122, 1995-96), Black-tailed Godwit (508, 1994-95), Curlew (826, 1994-95), Redshank (352, 1995-96), Greenshank (21, 1994-95) and Turnstone (477, mid-1980s). Most of these species are present in nationally important numbers.

The dunes at this site face pressures from intensive farming practises and recreational use by visitors. The most threatening activities include fertilisation of the species-rich dune grasslands, over-grazing, and trampling of areas of dunes adjacent to tourist facilities (e.g. caravan parks). These activities may lead to severe erosion and eutrophication of the dune grasslands and dune slacks. Parts of the dune system are also vulnerable to invasion by Sea Buckthorn (*Hippophae rhamnoides*).

Agricultural run-off from areas of fertilised dune grasslands in the vicinity of Lough Gill pose a continued threat to the nutrient status of the lagoon; algal blooms and fish

kills have occurred in the past. Removal of sand has also occurred and poses a threat to the integrity of the system.

Generally, the intertidal areas are relatively robust, although certain communities are vulnerable. For example, *Spartina* has spread widely, and may oust less vigorous colonisers of mud and may also reduce the area of mudflat available to feeding birds. Other activities, such as land reclamation and aquaculture, pose potential threats in terms of damage to habitats and potential disturbance to wintering birds.

Domestic and industrial wastes are discharged into inner Tralee Bay, but water quality is generally satisfactory - except in the inner bay, reflecting the sewage load from Tralee Town. Further industrial development along the bay in the vicinity of Tralee Town and Fenit and water polluting operations are potential threats.

This site is of considerable ecological and conservation significance for the excellent diversity of habitats it contains, many of which are listed on Annex I of the E.U. Habitats Directive. The occurrence of a species listed on Annex II of the E.U. Habitats Directive adds further importance to the site. The presence of a number of Red Data Book species, including the largest population of Natterjack Toads in Ireland, is also notable, as is the occurrence of several species listed on Annex I of the E.U. Birds Directive.

Site Name: Blasket Islands SAC

Site Code: 002172

The Blasket Islands are situated at the end of the Dingle peninsula in Co. Kerry. The site includes all of the islands in the group as well as a substantial area of the surrounding seas. There are six main islands, plus some rocky islets and sea stacks. Great Blasket Island, separated from the mainland by the Blasket Sound, is by far the largest of the islands (459 ha) and rises to 292 m above sea level. Inishtooskert (99 ha, 162 m), Inishnabro (51 ha, 175 m), Inishvickillane (81 ha, 138 m) and Tearaght Island (27 ha, 184 m) are located between approximately 7 km and 12 km from the mainland and, like Great Blasket, rise steeply from the sea. In contrast, Beginish is a small, low lying island (15 ha, 14 m) and lies within 2 km of the mainland. The bedrock is principally Old Red Sandstone, with some outcrops of volcanic and Silurian rocks on Inishvickillane and Beginish. The islands have a very maritime climate, being exposed to the prevailing Atlantic wind and swells. There are no permanent habitations, though Great Blasket was inhabited until 1953.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

[1170] Reefs
[1230] Vegetated Sea Cliffs
[4030] Dry Heath
[8330] Sea Caves
[1351] Harbour Porpoise (<i>Phocoena phocoena</i>)
[1364] Grey Seal (<i>Halichoerus grypus</i>)

The vegetation of the islands is typical of exposed western islands. Sea cliffs are the dominant habitat and, aside from the cliffs themselves, much of the vegetation of the islands consists of species typical of cliffs or cliff-tops. Typical species of the more rocky cliffs include Rock Samphire (*Crithmum maritimum*), Tree-mallow (*Lavatera arborea*) and Rock Sea-spurrey (*Spergularia rupicola*). On the higher slopes where a maritime turf exists, swards of Thrift (*Armeria maritima*), Sea Campion (*Silene vulgaris* subsp. *maritima*), Sea Plantain (*Plantago maritima*) and Buck's-horn Plantain (*Plantago coronopus*) are all abundant, along with such species as Kidney Vetch (*Anthyllis vulneraria*), Common Bird's-foot-trefoil (*Lotus corniculatus*) and Common Scurvygrass (*Cochlearia officinalis*). Sea caves occur at the base of the cliffs on several of the islands.

The cliff vegetation merges into dry grassland dominated by Red Fescue (*Festuca rubra*) on several of the islands. Also occurring are areas dominated by Bracken

(*Pteridium aquilinum*). Several of the islands have small areas of dry heath. Heather (*Calluna vulgaris*) is the main species and often occurs in a stunted form due to exposure. Other characteristic heath species include Heath Bedstraw (*Galium saxatile*) and Tormentil (*Potentilla erecta*).

The seas surrounding the islands have well-developed reef communities. In particular, there are good examples of exposed and tide swept shallow water kelp communities, deeper water sponge dominated communities and a hydroid dominated community. The kelp forest community, composed of *Laminaria hyperborea*, with *Laminaria saccharina* and/or *Saccorhiza polyschides*, extends to 18 m below sea level. There is an understorey of diverse foliose red algae, including the rare red alga *Schizymenia dubyi*. On vertical surfaces, jewel anemones (*Corynactis viridis*), massive sponges (*Pachymatisma johnstonia*) and encrusting sponges (*Esperiopsis fucorum*) are characteristic. There are patches of vertical cliff face in very exposed areas that are characterized by plumose anemones (*Metridium senile*) and dense bryozoans (*Chartella papyracea*) where the rare nudibranch *Crimora papillata* is found. Species richness in these marine communities can be high. At depths greater than 20 m animal dominated communities are found. The communities present may be characterised by Deadman's Fingers (*Alcyonium digitatum*), massive sponges such as *Clinoa clelata*, and species of *Nemartesia* hydroid, indicating that there is moderate tidal stream. Other areas have a mixture of cushion sponges, hydroids and the rose 'coral' *Pentapora foliacea*. The brown alga *Carpomitra costata*, an uncommon species, is found in this community and is considered a good indicator of clean oceanic waters.

The site has a large Grey Seal population (648-833 breeding in 2005; one-off moult count of 989 seals in 2007). This is one of the largest populations in the country and represents about one-third of the Irish population. The seals breed on boulder beaches and caves on several of the islands. The seals on these islands are sometimes perceived as competitors for local fish stocks. This occasionally leads to threats to their welfare; the most recent occurred in November 2004 when a large number of adults and pups were shot and clubbed.

The site is also of importance for Harbour Porpoise, a species which has a regular presence in Blasket Sound. A population estimate in 2008 gave a figure of 267-477 individuals. Other cetaceans (whales and dolphins) regularly observed in the site include Common Dolphin, Bottle-nosed Dolphin, Risso's Dolphin, Killer Whale and Minke Whale. Few other mammal species occur on the islands, though Inishvickillane has an introduced population of native Red Deer.

The site supports one of the most important seabird colonies in the country, with at least 11 species of seabird breeding regularly. It is the most important site in the world for Storm Petrel, and in the country for Manx Shearwater, the populations of both being of international importance (approx. 51,000 and 20,534 pairs respectively in 2000/01). Nine other seabird species occur regularly in nationally important numbers, the populations of three being of particular importance, i.e. Fulmar (approx. 3,000 pairs), Lesser Black-backed Gull (421 pairs) and Puffin (approx. 5,000 individuals). Other species present in nationally important numbers are Shag (350+

pairs), Herring Gull (100+ pairs), Great Black-backed Gull (approx. 400 pairs), Kittiwake (750+ pairs), Razorbill (500+ individuals) and Black Guillemot (44+ individuals). Guillemot also breeds though in relatively low numbers (470+ individuals). Arctic Tern breeds in some years, with at least 200 pairs in 1988 and 102 pairs in 2001. The Blaskets is one of the few known sites in the country where Leach's Petrel has bred and may still breed.

The islands are traditional sites for Peregrine (1-2 pairs) and Chough (11 pairs in 2002). Both of these species are listed under the E.U. Birds Directive. Additional breeding species typical of western islands that occur include Oystercatcher, Rock Dove, Wheatear, Raven and possibly Twite. The Blaskets formerly had wintering populations of Greenland White-fronted Goose and Barnacle Goose. The islands have a long history of seabird recording, with a major survey being undertaken in 1988 and partly updated during the Seabird 2000 survey.

This extreme south-western maritime site has high conservation value owing to the occurrence of good examples of several habitats that are listed on Annex I of the E.U. Habitats Directive, i.e. vegetated sea cliffs, dry heath, marine caves and reefs, as well as populations of Grey Seal and Harbour Porpoise, both species that are listed on Annex II of this Directive. The site is also one of the most important seabird sites in the country, with the populations of two species present being of international importance and at least a further nine being of national importance. Of especial significance is that it is the most important site in the world for Storm Petrel. The occurrence of important populations of Storm Petrel and Arctic Tern is of particular note as these are listed on Annex I of the E.U. Birds Directive; also listed are Leach's Petrel, Peregrine and Chough. The islands are also noted for their cultural, and in particular, literary importance.

Site Name: Castlemaine Harbour SAC

Site Code: 000343

This is a large site located on the south-east corner of the Dingle Peninsula, Co. Kerry. It consists of the whole inner section of Dingle Bay, i.e. Castlemaine Harbour, the spits of Inch and White Strand/Rosbehy and a little of the coastline to the west. The River Maine, almost to Castlemaine, and much of the River Laune catchment, including the Gaddagh, Gweestion, Glanooragh, Cottoner's River and the River Loe, are also included within the site.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

- [1130] Estuaries
- [1140] Tidal Mudflats and Sandflats
- [1210] Annual Vegetation of Drift Lines
- [1220] Perennial Vegetation of Stony Banks
- [1230] Vegetated sea cliffs of the Atlantic and Baltic coasts
- [1310] *Salicornia* Mud
- [1330] Atlantic Salt Meadows
- [1410] Mediterranean Salt Meadows
- [2110] Embryonic Shifting Dunes
- [2120] Marram Dunes (White Dunes)
- [2130] Fixed Dunes (Grey Dunes)*
- [2170] Dunes with Creeping Willow
- [2190] Humid Dune Slacks
- [91E0] Alluvial Forests*

- [1095] Sea Lamprey (*Petromyzon marinus*)
- [1099] River Lamprey (*Lampetra fluviatilis*)
- [1106] Atlantic Salmon (*Salmo salar*)
- [1355] Otter (*Lutra lutra*)
- [1395] Petalwort (*Petalophyllum ralfsii*)

Inch Spit holds a fine sand dune system. It is one of the largest and best remaining dune systems in the country. Fore dunes are found on the western side of Rosbehy and Inch. In these younger, mobile dunes, Marram (*Ammophila arenaria*) is common, with Groundsel (*Senecio vulgaris*), Sea Rocket (*Cakile maritima*) and Dandelion

(*Taraxacum* agg.) also present. Other characteristic species include Sand Couch (*Elymus farctus*), Lyme-grass (*Leymus arenarius*) and Sea Spurge (*Euphorbia paralias*). Fixed dune, a priority habitat under the E.U. Habitats Directive, is well-represented at the site, and in particular towards the tip of Inch Spit. Such areas support species such as Lady's Bedstraw (*Galium verum*), Common Bird's-foot-trefoil (*Lotus corniculatus*), Wild Thyme (*Thymus praecox*), Kidney Vetch (*Anthyllis vulneraria*), Wild Pansy (*Viola tricolor*), Biting Stonecrop (*Sedum acre*), Common Centaury (*Centaureum erythraea*), Thyme-leaved Sandwort (*Arenaria serpyllifolia*) and Common Whitlowgrass (*Erophila verna*), among others. There is also a rich lichen and bryophyte flora. The slightly damper conditions which prevail in dune slacks support Creeping Bent (*Agrostis stolonifera*), Crested Dog's-tail (*Cynosurus cristatus*), Glaucous Sedge (*Carex flacca*), Creeping Willow (*Salix repens*) and Jointed Rush (*Juncus articulatus*). The rare bryophyte Petalwort (*Petalophyllum ralfsii*), which is listed on Annex II of the E.U. Habitats Directive, has been recorded in this system. A smaller spit, with a similar diversity of dune types, occurs at Rosbehy on the southern shore, from where Yellow Centaury (*Cicendia filiformis*) and Knotted Pearlwort (*Sagina nodosa*) have been recorded from a dune slack along with other, more common, species.

The sand spits, and also the Coomore peninsula, are underlain by shingle and in places the shingle is exposed and supports a characteristic flora. Species present include Lyme-grass and Sea Sandwort (*Honkenya peploides*). Strandline communities are well-developed along Inch spit, with the exception of the north-western end where recreational pressure is high. Typical species of the strandline include Prickly Saltwort (*Salsola kali*), Sea Rocket, oraches (*Atriplex* spp.) and Sea Sandwort. Two Red Data Book plants, Sea Pea (*Lathyrus japonicus* subsp. *maritimus*) and Sea-kale (*Crambe maritima*), are found associated with the shingle and strandline communities.

The coastline is fringed in many places by saltmarsh. The vegetation here includes Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Aster (*Aster tripolium*), Sea Rush (*Juncus maritimus*) and Sea Plantain (*Plantago maritima*). Upper saltmarsh communities extend inland, along estuarine channels, where they are mixed with freshwater communities. Sea Club-rush (*Scirpus maritimus*) and Common Reed (*Phragmites australis*) occur at these locations. Common Cord-grass (*Spartina anglica*) has colonised the lower part of the saltmarsh at Inch and extends out onto the open mudflat. Glassworts (*Salicornia* spp.) occur in association with saltmarsh.

West of Inch, cliffs of glacial drift occur, which support such plants as Ivy (*Hedera helix*), Red Fescue (*Festuca rubra*), Heather (*Calluna vulgaris*), Thrift, Sea Plantain, Sea Mayweed (*Matricaria maritima*), Kidney Vetch and Honeysuckle (*Lonicera periclymenum*). Along the cliff-tops there is coastal grassland with species such as Sweet Vernal-grass (*Anthoxanthum odoratum*), Cock's-foot (*Dactylis glomerata*) and Wood Sage (*Teucrium scorodonia*).

Much of the site consists of intertidal sand and mudflats, supporting a number of soft sediment communities, including beds of eelgrass (mostly *Zostera noltii*) in some

places. A subtidal mixed sediment community complex is also present in the channel between Rossbehy Point and Inch Point.

The rivers and their associated habitats also make up a considerable portion of the site. These associated habitats include wet grassland, woodland, scrub and bog/heath. In the valley up-river of Killorglin, is an interesting area of alluvial wet woodland, dominated by Alder (*Alnus glutinosa*) and willows (*Salix* spp.). The vegetation is quite diverse, and there are spectacular tussocks of Greater Tussock-sedge (*Carex paniculata*). Other species which occur include Ash (*Fraxinus excelsior*), Wild Angelica (*Angelica sylvestris*), Cuckooflower (*Cardamine pratensis*), Meadowsweet (*Filipendula ulmaria*), Common Nettle (*Urtica dioica*), Remote Sedge (*Carex remota*) and a range of bryophytes. While small in area, this is one of the few examples in Ireland of woodland on riverine alluvium dominated by native tree species.

Five plants listed in the Irish Red Data Book have been recorded at this site: Sea-kale, Corn Cockle (*Agrostemma githago*), Sea Pea, Pennyroyal (*Mentha pulegium*) and Irish Lady's-tresses (*Spiranthes romanzoffiana*). The three last-named are legally protected under the Flora (Protection) Order, 1999, as is the rare bryophyte, Petalwort. Other scarce species which occur here are Yellow Bartsia (*Parentucellia viscosa*), Lax-flowered Sea-lavender (*Limonium humile*) and Blue-eyed-grass (*Sisyrinchium bermudiana*).

The vicinity of Castlemaine Harbour is also important as one of few areas in Ireland (all of which are in Co. Kerry) where the Natterjack Toad naturally occurs. This amphibian is listed in the Irish Red Data Book and on Annex IV of the E.U. Habitats Directive.

The site also supports a small colony of Common Seal, while two Lamprey species have been recorded in the Laune river catchment. The Laune catchment is used by Otter and is also an important Salmon system with nurseries, riffles pools and glides.

Castlemaine Harbour is a very important site for passage and wintering waterfowl. The following figures are derived from counts between 1994/5 and 1996/7. One species occurs here in internationally important numbers - Brent Goose (734) - with 16 species having populations of national importance: Cormorant (215), Shelduck (129), Pintail (167), Scaup (138), Wigeon (3,513), Red-breasted Merganser (51), Oystercatcher (1,539), Ringed Plover (330), Golden Plover (1,940), Grey Plover (122), Knot (347), Sanderling (207), Dunlin (1,360), Redshank (299), Greenshank (26) and Turnstone (296).

Castlemaine Harbour is of major ecological importance. It contains a range of coastal habitats of excellent quality, including many that are listed on Annex I of the E.U. Habitats Directive, and two which are listed with priority status (fixed dunes and alluvial forests). It also includes long stretches of river and stream which are excellent habitats for Salmon, Lamprey and Otter. Inch dunes are recognised as among the finest in the country, with particularly well-developed dune slacks. The

site supports internationally important waterfowl populations, rare plant species, the rare Natterjack Toad, as well as populations of several animal species that are listed on Annex II of the E.U. Habitats Directive. Part of the site is designated a Special Protection Area (SPA) and is listed as a site under the Ramsar Convention. Part of Castlemaine Harbour is a Statutory Nature Reserve, while Inch and Rosbehy are Wildfowl Sanctuaries.

SITE SYNOPSIS

SITE NAME: DINGLE PENINSULA SPA

SITE CODE: 004153

The Dingle Peninsula SPA is a large site situated on the west coast of Co. Kerry. It encompasses the high coast and sea cliff sections of the peninsula from just south of Brandon Point in the north, around to the end of the peninsula at Slea Head, and as far east as Inch in the south. The site includes the sea cliffs, the land adjacent to the cliff edge, areas of sand dune on the Magharees Peninsula and near Murreagh, and also several upland areas further inland of the coast about Ballybrack, Lough Doon, Anscaul Lough, Arraglen and Ballynane. The high water mark forms the seaward boundary. The site is underlain by a variety of sedimentary rock types of various ages, predominantly Devonian and Devonian/Silurian sandstones, conglomerates and siltstones, but also Ordovician mudstones, siltstones and breccias, and Silurian siltstones. An area of volcanic rocks of Silurian age is found about Clogher Head/Dunquin.

The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Chough, Peregrine and Fulmar.

The site supports some of the highest densities in Ireland of breeding Chough, a Red Data Book species that is listed on Annex I of the E.U. Birds Directive. The abundance of Chough on the Dingle Peninsula was first noted in the 1800s. When the first modern survey of Chough was undertaken in 1982 the species was seen to be still abundant there. Since then the high importance of the site for Chough has been demonstrated by surveys in 1992 and 2002/03 when 107 and 105 breeding pairs respectively were recorded within the SPA.

The topography of the Dingle Peninsula, with its mosaic of grazed semi-improved and improved pastures, extensive well-drained uplands, and sand dune systems in close proximity to breeding cliffs, favours Chough. Particularly high densities of Chough occur at Reenbeg in the south of the site, The Three Sisters in the north-west and Ballydavid Head in the north. Large post-breeding flocks gather, particularly in the autumn, at the dune systems at Castlegregory and Inch (which is included in an adjacent SPA). Marked individuals have provided evidence that young birds converge in these flocks from throughout the peninsula and it is possible that Chough gather in the dunes here from even further afield. Known roost sites within the SPA include a site on the Magharees Peninsula and a number of inland locations such as the cliffs at Anscaul Lough, Arraglen and Lough Doon. Flocks of up to 80 birds form in the mountains during the summer months. Studies have shown that Chough forage mainly within 300 m inland of the cliff tops used for breeding and these areas have been included in the site.

The site also supports nationally important populations of Peregrine (5 pairs in 2002) and Fulmar (1,016 pairs), as well as smaller populations of other breeding seabirds: Razorbill (3 pairs), Herring Gull (33 pairs), Lesser Black-backed Gull (2 pairs), Shag

(23 pairs) and Great Black-backed Gull (1 pair) – all seabird data from 1999-2000. The site also holds a population of Black Guillemot.

The Dingle Peninsula SPA is of ornithological importance as it supports an internationally important population of Chough. It also supports nationally important populations of Fulmar and Peregrine. The presence of Chough and Peregrine, both species that are listed on Annex I of the E.U. Birds Directive, is of particular significance. Part of the Dingle Peninsula SPA is a Statutory Nature Reserve.

Appendix 2
Dredging Studies Report



AN DAINGEAN DREDGING DREDGING STUDIES REPORT

Department of Agriculture, Fisheries & Food

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Client	Department of Agriculture, Fisheries and Food					
Project Title	An Daingean Dredging					
Document Title	Dredging Studies Report					
Document No.	IBE0137/R01/Nov 08					
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BIBLIOGRAPHY

1.0 INTRODUCTION

RPS Consulting Engineers were commissioned by the Department of Agriculture, Fisheries and Food (Formerly the Department of Communication, Marine and Natural Resources) to prepare a report on various aspects of a proposal to dredge the entrance to An Daingean (Dingle) Harbour, Co Kerry.

The purpose of the study is to examine the effects of the proposed dredging and subsequent dumping at sea in terms of:

1. Impact on hydrodynamics within the harbour and at the dump site
2. Impact to benthic flora and fauna at the dump site
3. Chemical analysis of dredge sediments
4. Radiological analysis of dredge sediments
5. Potential impacts of dredging operation on Dingle Bay's resident dolphin, Funghi

This report will examine the potential impact of the proposed dredging operation in the context of these criteria and, where relevant, appropriate mitigation measures have been suggested.

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2.0 CONSULTATIONS

Due to the sensitivity of An Daingean Harbour and Dingle Bay, consultations were held with the main local stakeholders to ensure that any potential issues were brought to light early in the environmental assessment.

2.1 CONSULTATION MEETINGS

Consultation meetings were held in November and December 2007 with a number of local stakeholders:

- Brian Farrell (Dingle Harbour Master)
- Kevin Flannery (Sea Fishery Protection Authority)
- Eamon Scanlon (Senior Executive Engineer, Kerry County Council)
- Jimmy Flannery (Kerry Co-op Chairman)
- Pascal Dower (National Parks and Wildlife Service Local Ranger)
- David Lyons (Marine Ecologist, National Parks and Wildlife Service Local Ranger)

Issues highlighted during the consultation period included concern over how the proposed dredging work might affect the daily business of the Port; access for larger boats into the harbour during the two hours spanning high tide being very important.

In terms of commercial activity within the harbour itself and the recovery of the sea bed communities at the dump site, it is preferred that the dredging works should be undertaken outside the peak tourism and fishing periods of mid-May to mid-September. If dredging can be completed within a short number of weeks it may be possible to facilitate a short-term closure of the harbour. If dredging activities are expected to last for months, plans must be made to retain access to the port for working vessels throughout the works.

Consultations with the Local Authority also revealed the presence of outfall structures within or close to the proposed dredging route. These will require to be avoided or mitigated against.

Concerns were raised over any potential to dispose of the dredged spoil on land. There are currently no plans to dispose of any of the dredged spoil on land. Consultation has been held with the Marine Institute who have reviewed the contamination testing undertaken on sediments taken from several sites along the dredging route, and have confirmed that it is likely to be suitable for disposal at sea. Sediment samples were also subjected to radiological testing after consultation with the RPII and have been declared as safe for disposal at sea.

Concern was also raised about possible effects to water quality in terms of increased turbidity in the harbour as there is an intake in the harbour for sea-water to the aquarium in Dingle.

3.0 HYDRODYNAMIC MODELLING

3.1 DATA SOURCES

Data for the hydraulic studies have been extracted from the following reports supplied by DAFF:

- Copy of Site investigation drawing and hydrographic survey 2004 xyz data
- Site investigation report – IGSL Ltd 2005
- July 2001 survey of harbour area by Irish Hydrodata
- July 2001 report on Dingle Harbour Breakwater study by Malachy Walsh

Other sea bed hydrographic data from C-Map of Norway was collected by RPS for use in the models. Offshore wave data was extracted from RPS' offshore wave database with additional data received from the European Centre for Medium range Weather Forecasts, (ECMWF).

3.2 FIELD SURVEYS

Aqua-Fact International Services Ltd undertook current metering and sediment sampling for the study. Their report of these surveys is contained in Appendix A.

The tidal velocity measurements were taken at two locations, one in the centre of the entrance channel and one at the centre of the proposed dump site. The ADCP measurements taken at the centre of the dumpsite showed highly variable velocities and directions both in the time domain and in the vertical profile. This was due to the fact that the current velocities are extremely weak at this site and hence no sensible depth averaged flow regime can be extracted from this data. An excel sheet of the various 2m depth measurement bins is available on request.

The flow regime at the entrance to the harbour is measurable and hence the velocity results from the ADCP measurements at this site showed a consistent and logical flow regime.

An additional bathymetric survey in An Daingean harbour was completed in late November 2007 by Aqua-Fact International. This bathymetric data was found to be of good quality and was consistent with the channel survey undertaken on behalf of the DCMNR in 2004.

3.3 HYDRAULIC MODELS

The hydraulic models used for this study were based on the MIKE21/LITPACK coastal process modelling software developed by the Danish Hydraulics Institute. These models included 2D flow models for the simulation of the dredging on the tidal regime, nearshore spectral wind-wave models to examine the wave climate effects at the proposed dump site and 3/2D particle tracking models to simulated the sedimentation and water quality plumes related to the dredging and disposal for the material from the deepened entrance channel.

3.4 TIDAL MODELLING

The various tidal models were set up and run for the period 27 October to 30 November 2007. The base model of the whole of Dingle Bay and its approaches was set up using a 135m grid rectangular mesh model. The boundary data for this model was extracted from RPS's flexible mesh Irish Coastal model.

The 135m grid model was used to provide the boundaries for the nested system of 45m, 15m and 5m models of Dingle Bay. The plan area of the 135m grid model and the nested 45m, 15m and 5m model is shown in Figure 3.1 and 3.2 below.

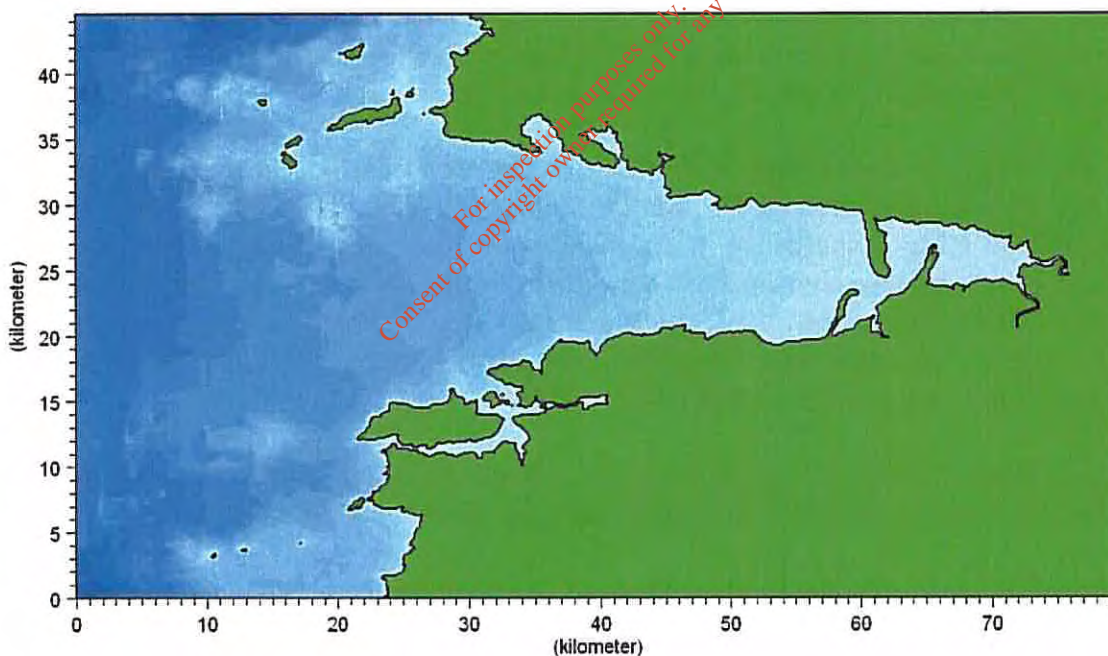


Figure 3.1 Extent of 135m grid flow model of Dingle Bay

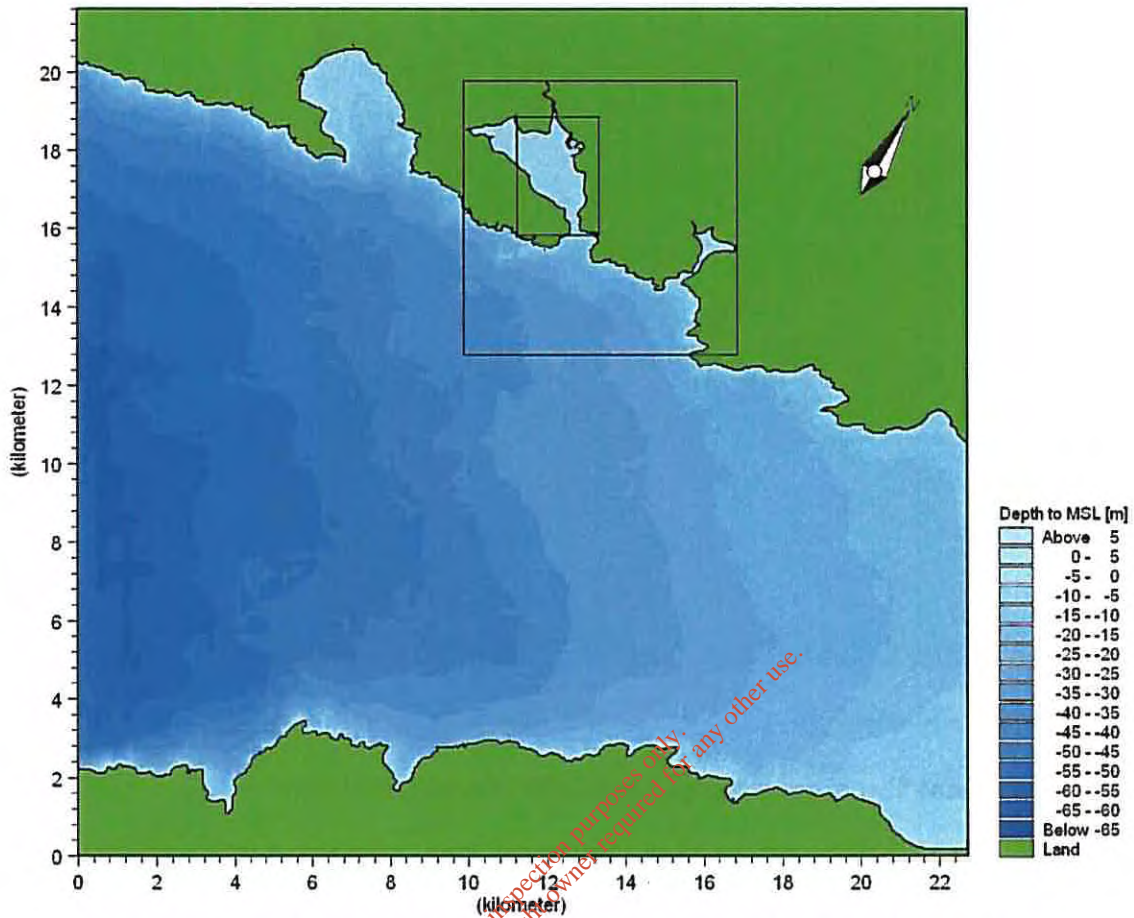


Figure 3.2 45m-15m-5m grid nested flow model for An Daingean Harbour

The peak spring flood and ebb tide flow patterns are shown in Figures 3.3a and 3.3b and in 3.4a and 3.4b for the 15m and 5m grid nests respectively. It will be seen that while there is a moderately strong tidal flow velocity through the entrance to An Daingean Harbour the tidal flow velocities in the dumpsite area are very weak.

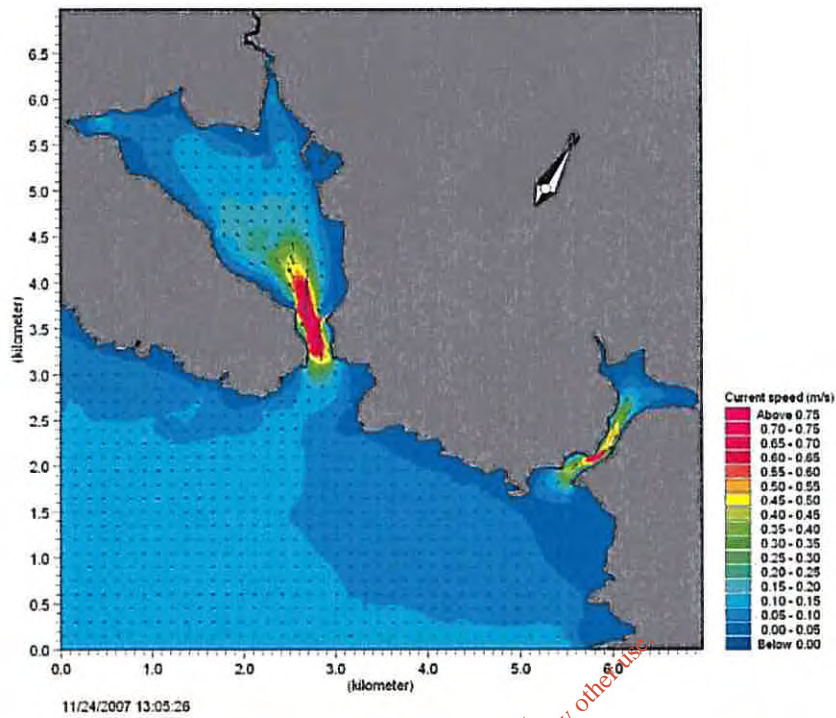


Figure 3.3a Tidal flow around An Daingean - Mid flood spring tide

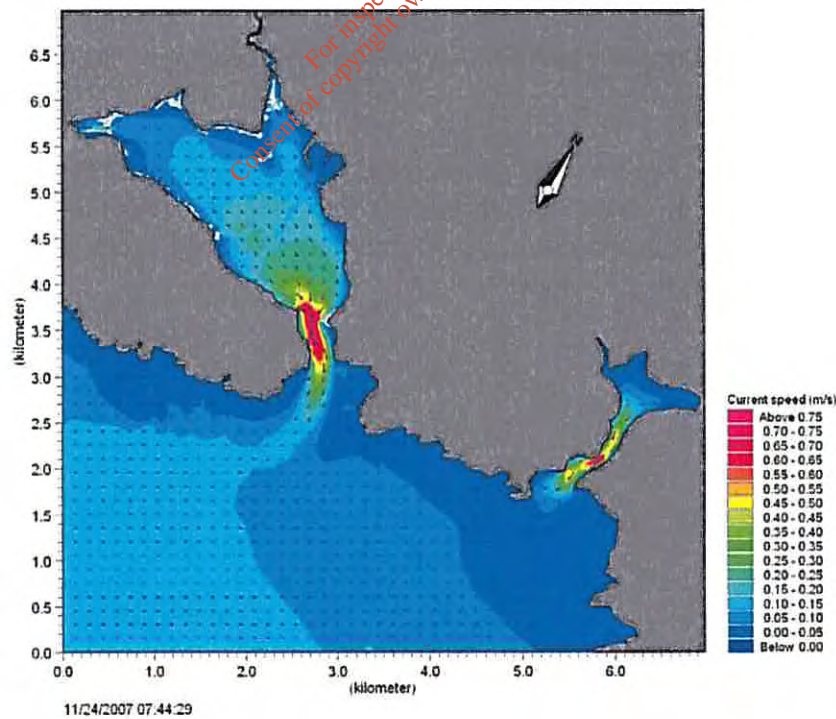


Figure 3.3b Tidal flow around An Daingean - Mid ebb spring tide

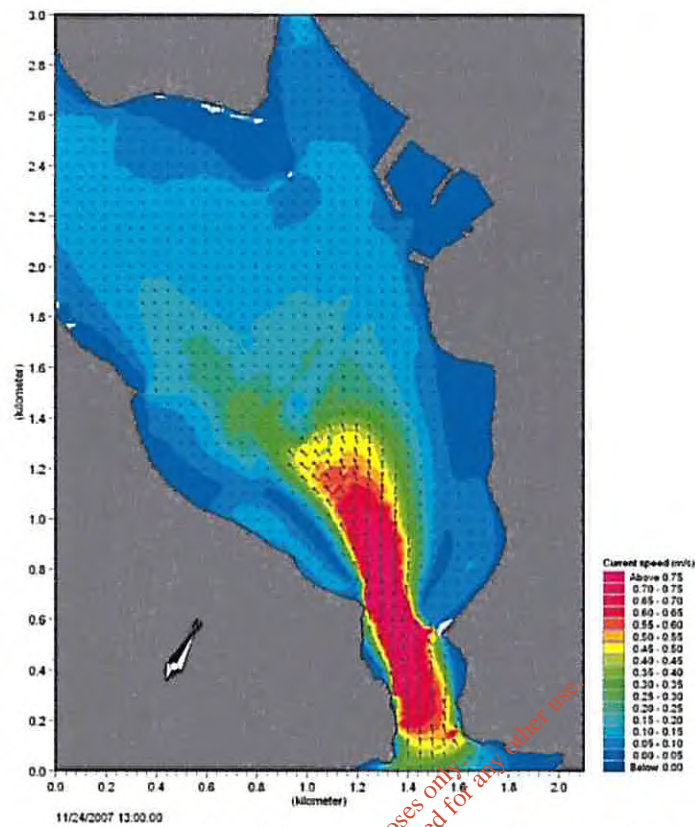


Figure 3.4a Tidal flow around An Daingean Harbour - Mid flood spring tide

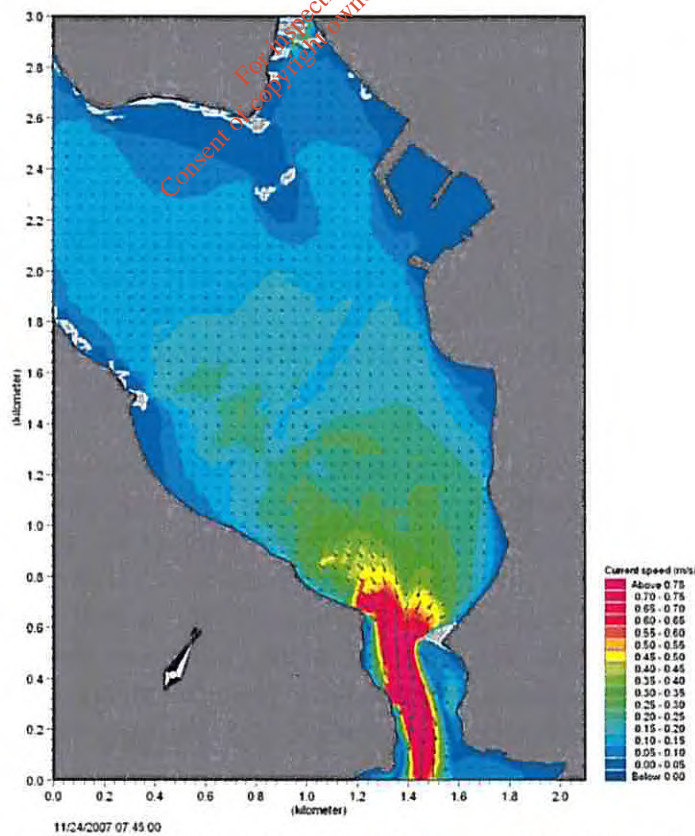


Figure 3.4b Tidal flow around An Daingean Harbour - Mid ebb spring tide

Figure 3.5 shows the residual tidal velocities around the area averaged over the lunar month of tides. It will be noted that there is a net clockwise circulation to the south west of Bull's Head.

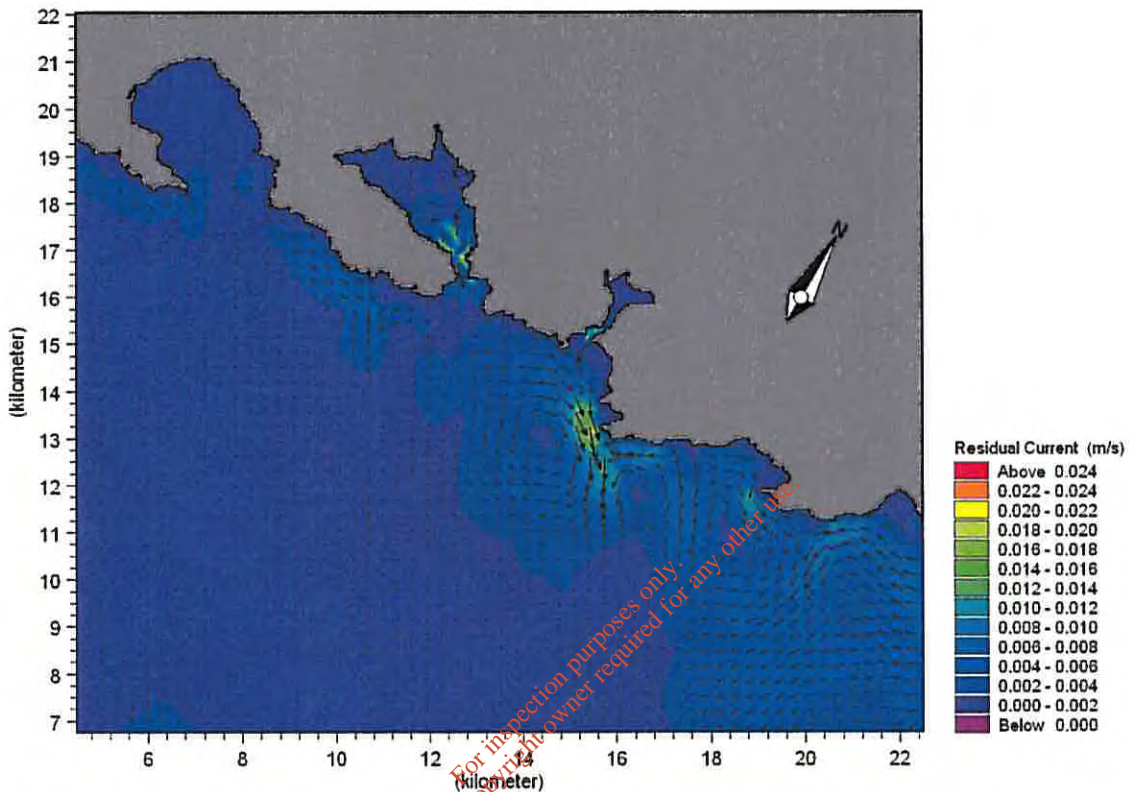


Figure 3.5 Lunar month residual tidal flow around An Daingean

The model tidal velocities have been compared with the current meter field measurements. The tidal velocities in the centre of the dump site are very weak with peak spring tidal velocities of about 0.075 m/s. As noted in section 3.2 above the ADCP field measurements at the dump site show an almost random scatter of velocity and direction due to the very low tidal velocities in this area.

Unlike the dump site area, the flow velocities in the entrance to An Daingean harbour are significant thus the ADCP results are more consistent. The results of the tidal velocity measurement at the entrance to An Daingean Harbour together with the model simulations are shown in Figure 3.6 and 3.7 for the spring and neap tide. It will be seen that there is good correlation in the tidal phasing with a slight variation in the tidal elevations due to the impact of surges (both positive and negative) in the field measurements which are not represented in the model simulations. The tidal velocities in the model accord well with those measured at the entrance to the harbour with speeds of 0.7m/s at springs and 0.4 to 0.5 m/s at neaps.

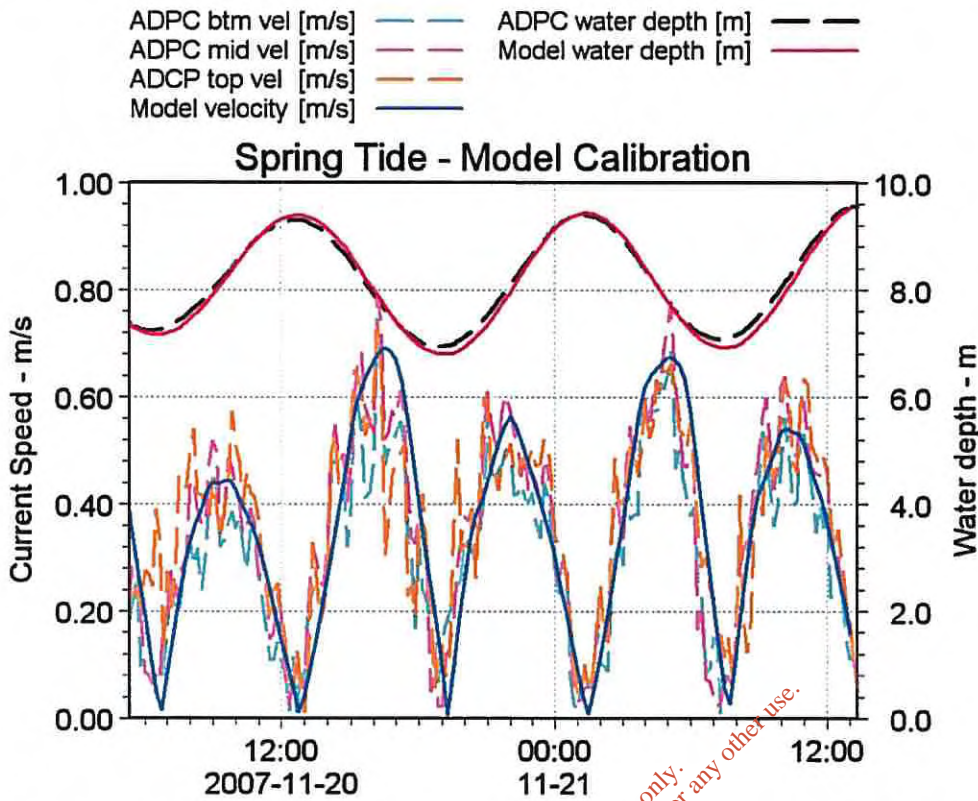


Figure 3.6 Spring tide model and ADCP data at entrance to An Daingean Harbour

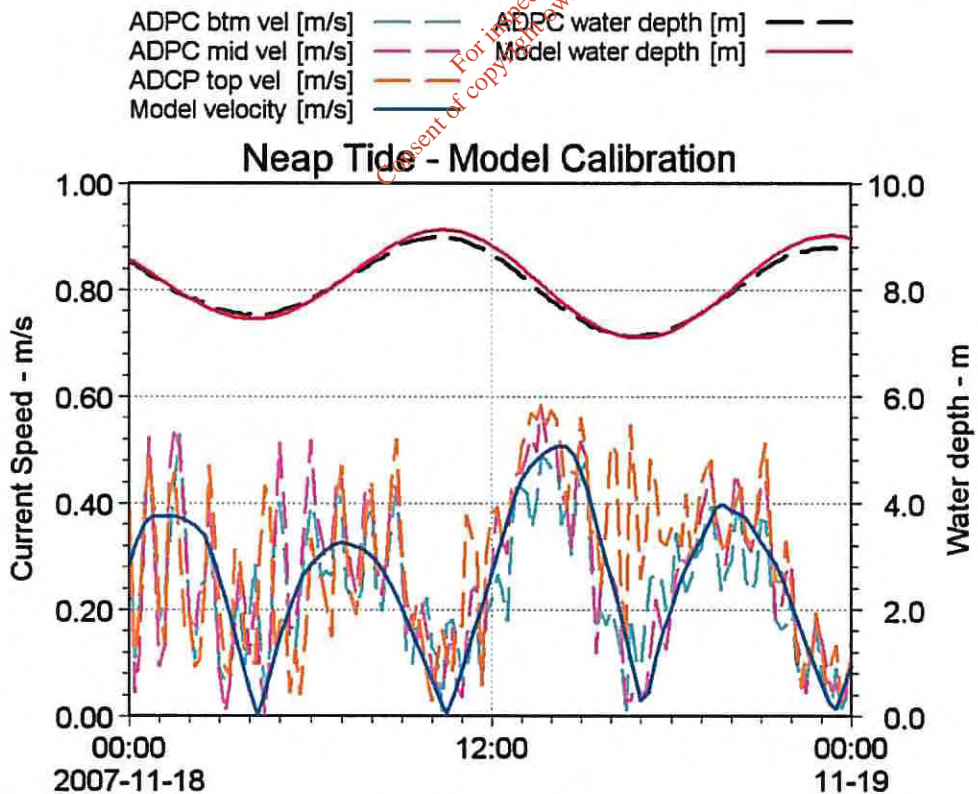


Figure 3.7 Neap tide model and ADCP data at entrance to An Daingean Harbour

3.5 DREDGED CHANNEL MODELLING

3.5.1 Impact of dredged channel on tidal flow

The flow models have been run for the same period 27 October to 30 November 2007 for the harbour with the channel dredged to -7.7m OD Malin. Figures 3.8 and 3.9 show the mid flood and ebb tidal flow patterns with the channel dredged to the increased depth.

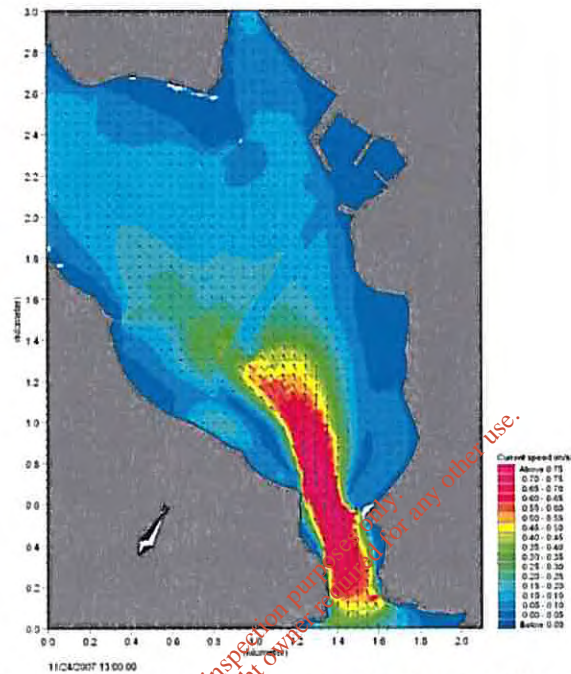


Figure 3.8 Tidal flow - dredged An Daingean Harbour - Mid flood spring tide

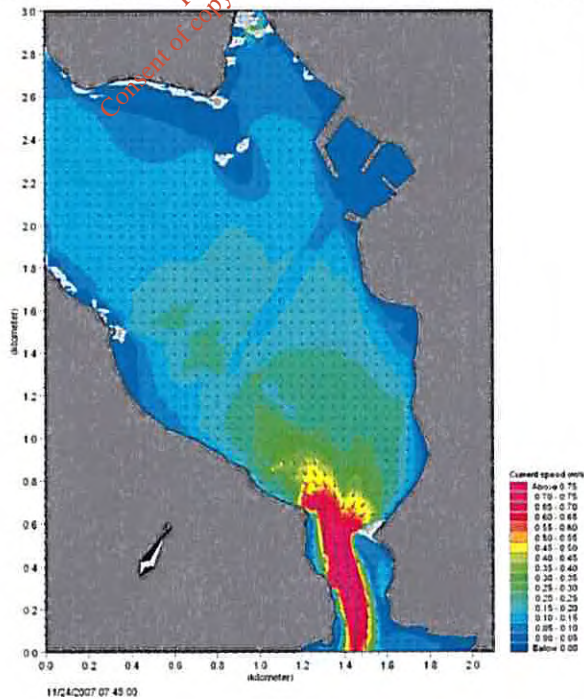


Figure 3.9 Tidal flow - dredged An Daingean Harbour - Mid ebb spring tide

Figure 3.10 shows a comparison of the tidal elevations at An Daingean. It will be seen that the proposed dredging of the channel will have virtually no effect on the tidal heights at the harbour.

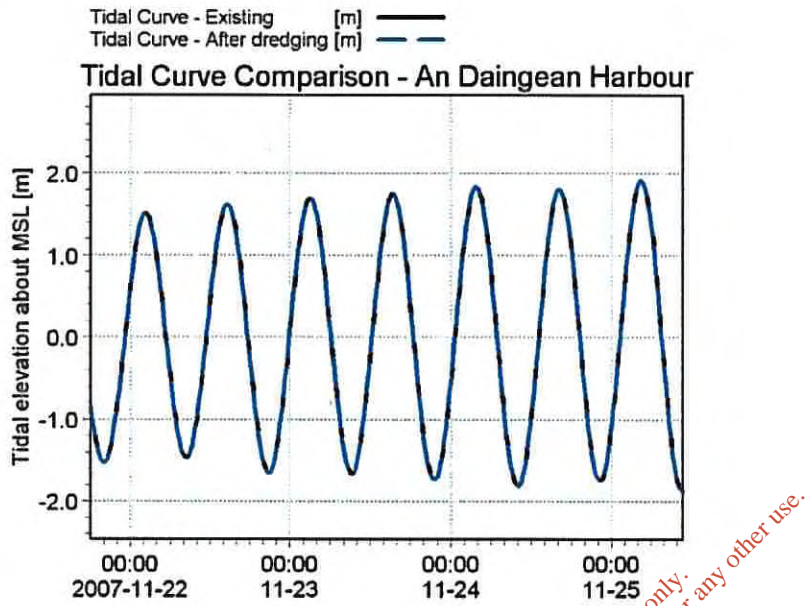


Figure 3.10 Comparison of tidal curves at An Daingean with and without dredging

The changes in the tidal flow regime induced by the extra channel depth are most easily seen by difference plots, i.e. the tidal velocity for with the deeper channel minus the tidal velocity with for the current bathymetry. Figures 3.11 and 3.12 show the differences in the peak and mean flood and ebb spring flow velocities in the harbour due to the proposed dredging. It will be seen that the changes in velocity are generally less than about 0.1m/s.

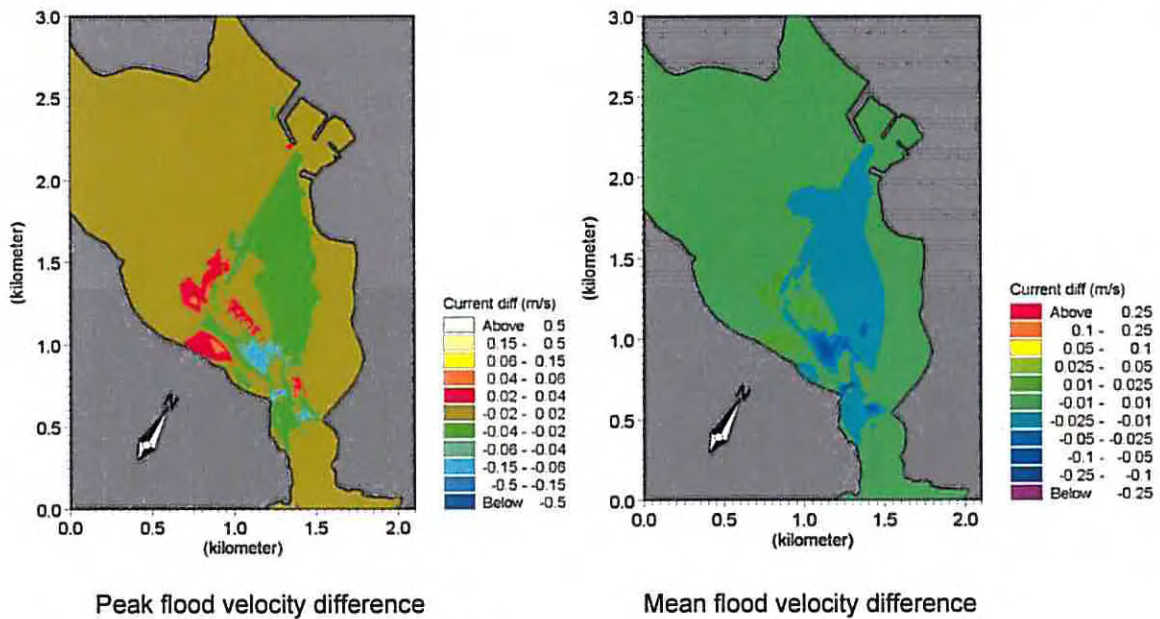


Figure 3.11 Difference in peak and mean flood spring tidal velocity Harbour with dredged channel minus harbour with existing channel

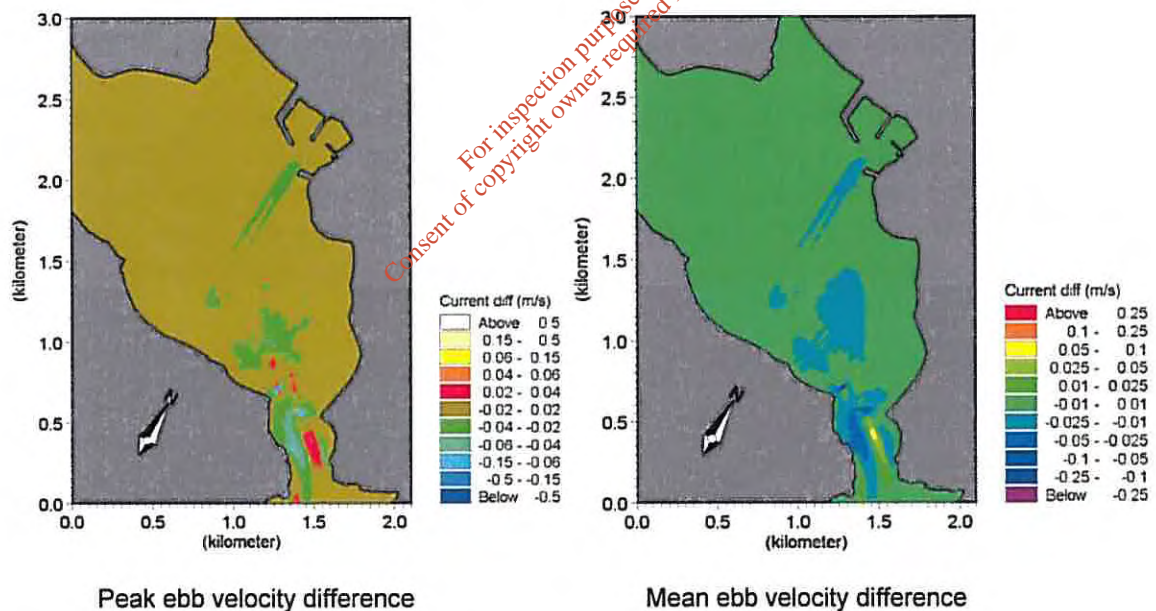


Figure 3.12 Difference in peak and mean ebb spring tidal velocity Harbour with dredged channel minus harbour with existing channel

Analysis of the peak flood and ebb velocity differences for the area outside the harbour show that the proposed deeper channel will have no impact on the tidal flow regime outside the harbour.

3.5.2 Impact of the dredging on sedimentation and water quality

The modelling of the impact of the dredging operation on sedimentation and suspended sediment loads in An Daingean Harbour was simulated using the MIKE321 npa particle tracking model.

In the analysis it was assumed that the dredging would take about 6 months with an average dredging rate of 1,600 m³ per 24 hour day. Due to the nature of the bed material the simulation of the dredging operation was split into two sections i.e. the outer leg, which runs from the entrance to the right angle turn in the channel, and the inner north-south running leg. In the simulations the dredger was assumed to dig its way in from the entrance to the quays. The simulations included both excavation time and disposal time on the basis of 3 hours of dredging and 3 hours of disposal, i.e. a 6 hour cycle.

The losses from the dredger were assumed to be 4% of the dredged volume, 2% at the cutting head taken at 1 metre above the bed and 2% at the surface due to the overspill from the hopper. For the outer leg of the channel the grading of the material lost from the cutter head was as follows:

<i>% of total losses</i>	<i>Mean grain diameter</i>
20	10mm
20	2.0mm
30	0.6mm
25	0.25mm
5	0.063mm

The losses from the overspill of the hopper during the dredging will mainly be the finer fractions of the dredged material and for the outer part of the channel were taken as:

<i>% of total losses</i>	<i>Mean grain diameter</i>
30	0.6mm
50	0.25mm
20	0.063mm

The material to be dredged from the inner north-south orientated section of the channel has a higher percentage of fines. The grading of the material lost from the cutter head and the overspill to the surface for the dredging of the inner channel section was taken to be

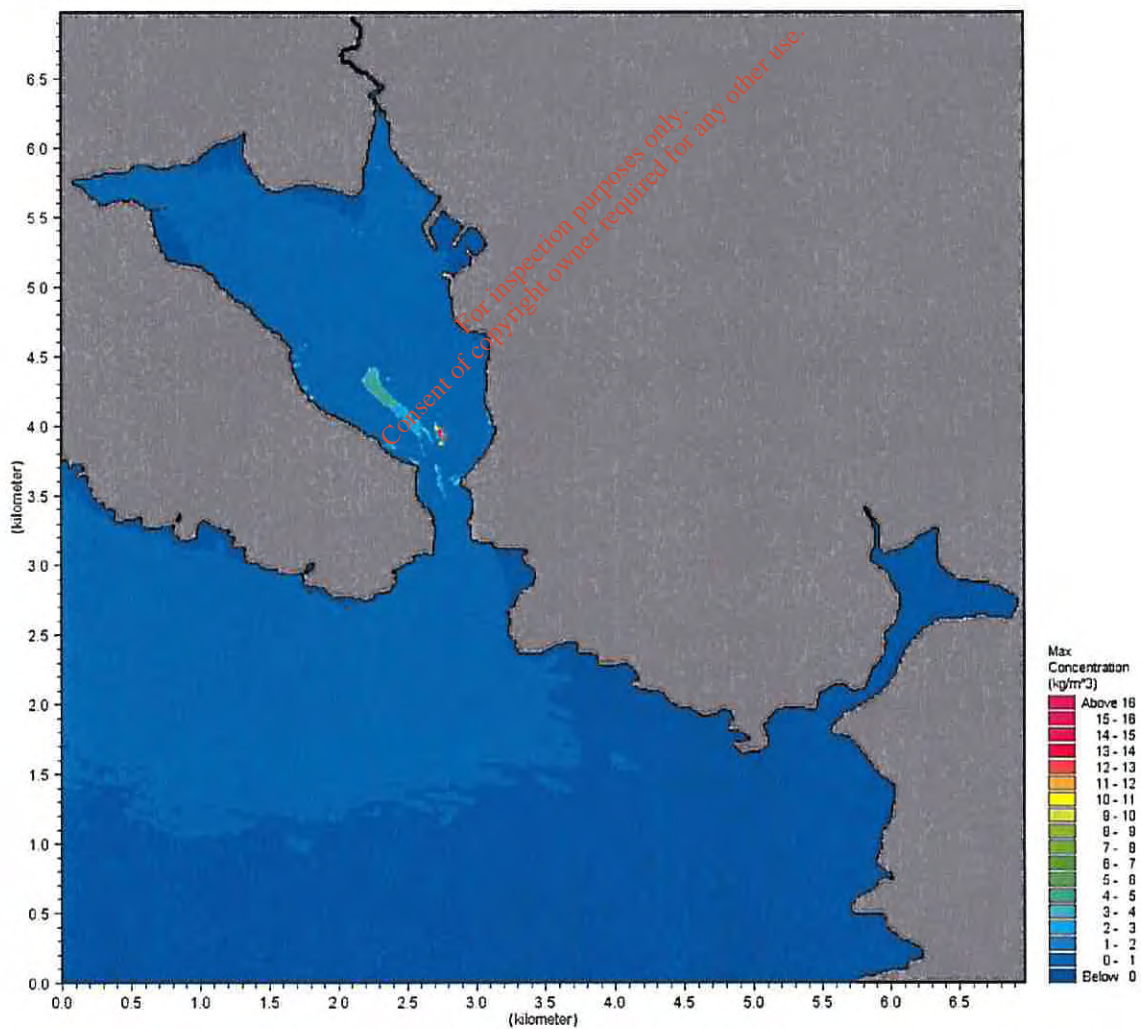
<i>% of total losses</i>	<i>Mean grain diameter</i>
10	10mm
20	2.5mm
20	0.75mm
20	0.20mm
20	0.063mm
10	0.020mm

for the cutter head losses, and

<i>% of total losses</i>	<i>Mean grain diameter</i>
10	0.6mm
20	0.25mm
40	0.063mm
30	0.020mm

for the overspill losses.

The maximum suspended sediment concentration in the water column during the dredging operation for the outer and inner parts of the channel is shown in Figures 3.13 and 3.14. These values are the maximum that occur at any time during the dredging operation even if it is only for a very short period of time. The mean value of the suspended sediment concentration in the water column over the dredging period is shown in Figures 3.15 and 3.16. It will be seen from the diagrams that the suspended sediment values away for the dredging operation in the channel are low.



**Figure 3.13 Maximum suspended sediment concentration in the water column
 Dredging of outer leg of channel**

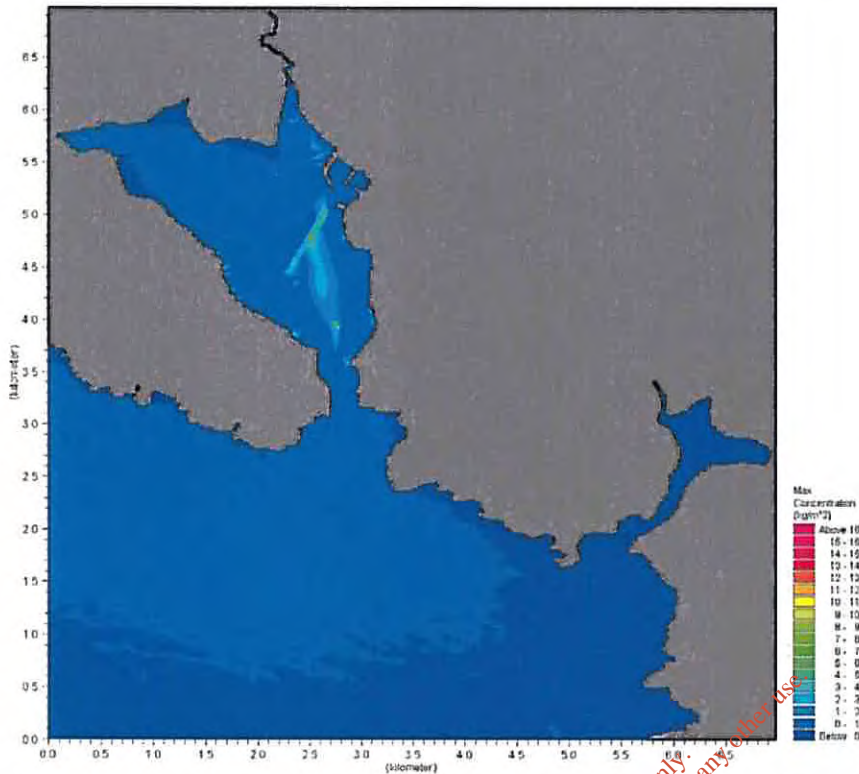


Figure 3.14 Maximum suspended sediment concentration in the water column
Dredging of inner leg of channel

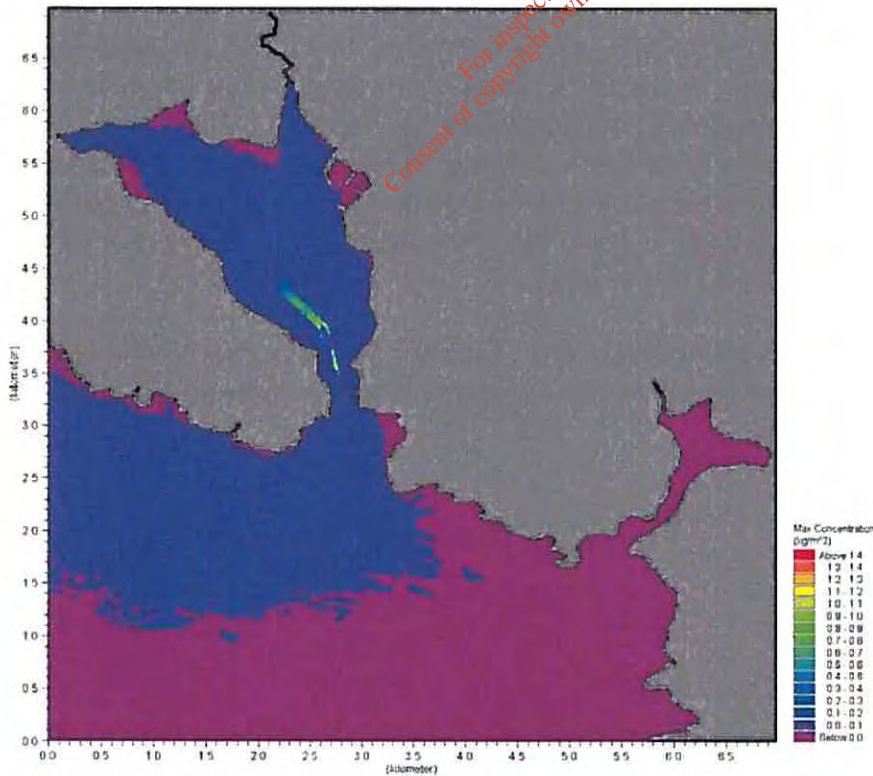
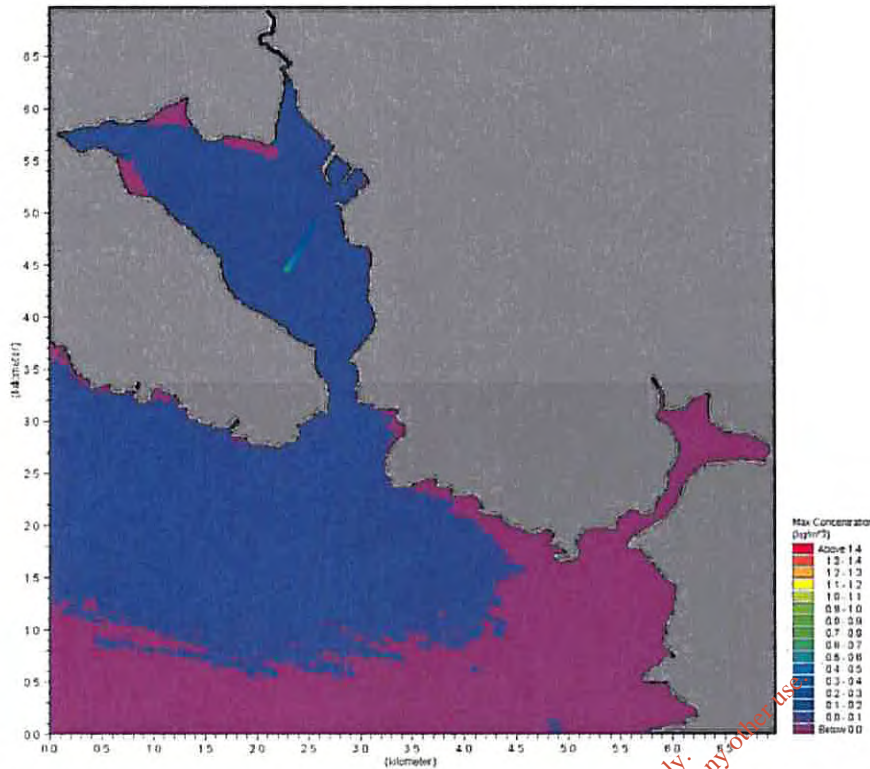


Figure 3.15 Mean suspended sediment concentration in the water column
Dredging of outer leg of channel



**Figure 3.16 Mean suspended sediment concentration in the water column
 Dredging of inner leg of channel**

The deposition of sediment from the dredging plume on the sea bed around the harbour at the end of the dredging operations is shown in Figure 3.17 below. It will be noted that sediment is deposited in the shallower areas outside the harbour entrance. This is due to the fact that the simulations are undertaken in calm conditions. Wave action outside the harbour will re-suspend this sediment and the material will be dispersed so that the final deposition depths will be as shown in Figure 3.18. In this diagram the deposition depths in millimetres can be assessed by multiplying the Kg/m^3 values by 0.6.

It can be seen from the suspended sediment and deposition diagrams that the proposed dredging will not have a significant impact on bed sediments or water quality in An Daingean Harbour.

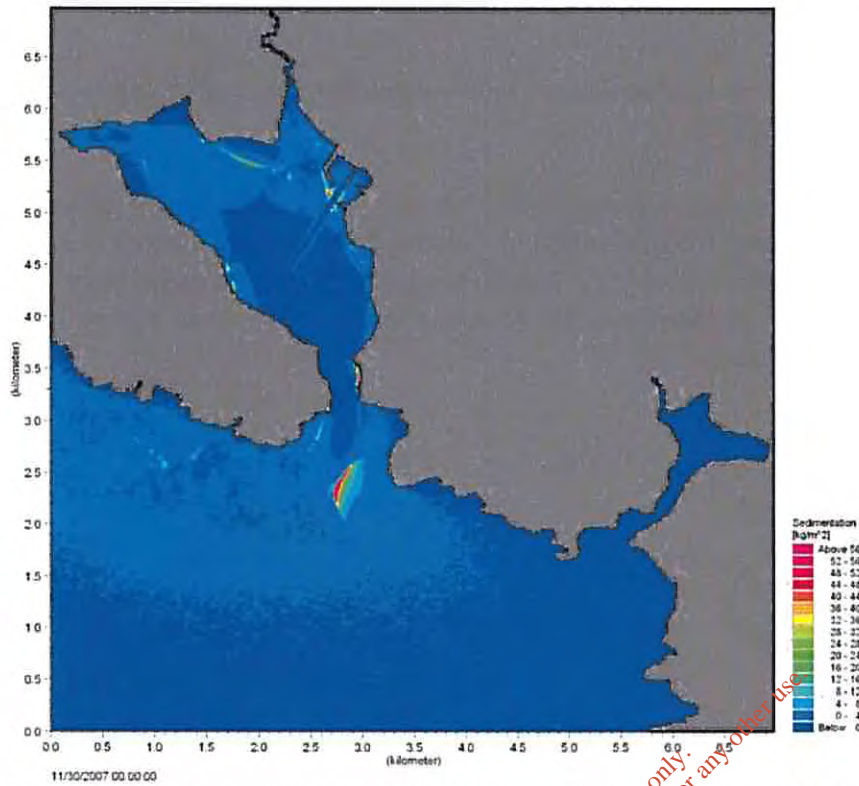


Figure 3.17 Deposition of sediment at end of dredging operations (Calm conditions)

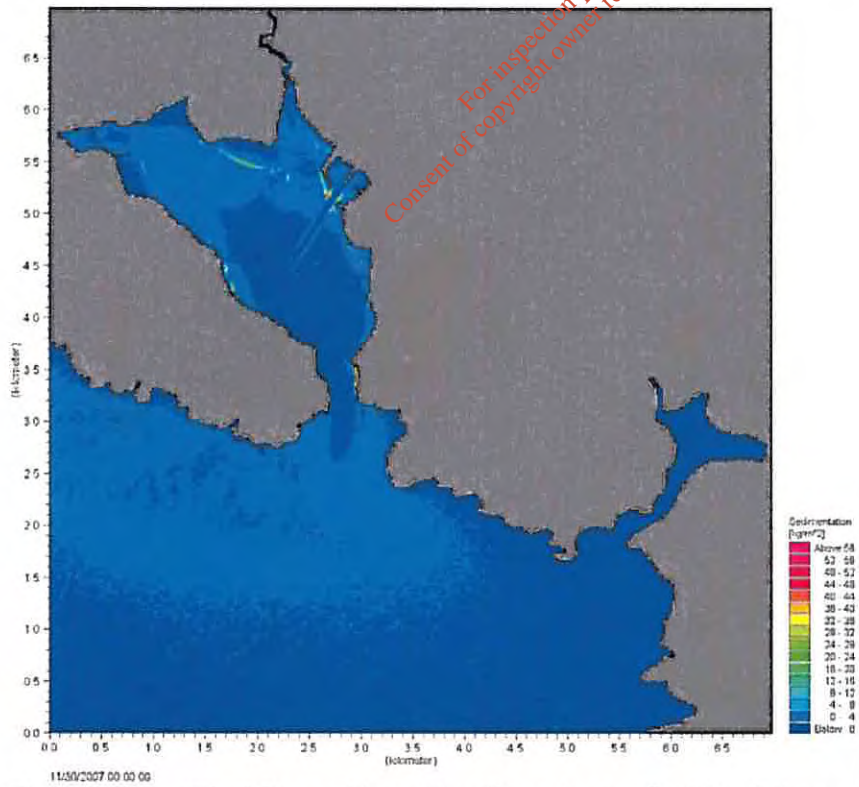


Figure 3.18 Final Deposition of sediment at end of dredging operations

3.6 WAVE MODELLING

The offshore wave climate was established using 3 hourly wave data for the 10 year period 1996 to 2005 for a point at 11° W, 51.5° N.

The wave rose for each year was examined against the 10 year average wave rose so as to identify the year which would most closely represent the long term average with a view to transforming this typical year to the inshore site. It was found that 2004 was a good fit for the 10 year average as can be seen by comparing the 10 year average wave roses, Figure 3.19 with the 2004 year wave roses, Figure 3.20

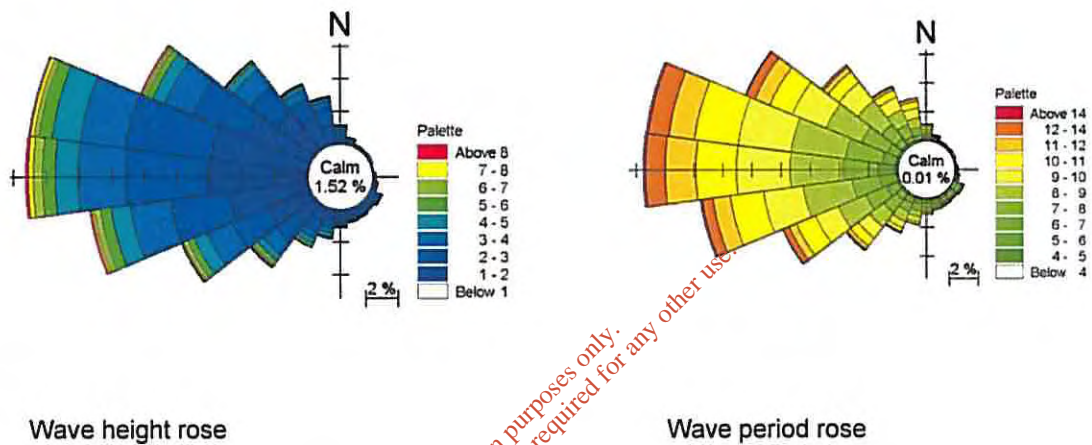


Figure 3.19 10 year average offshore wave roses

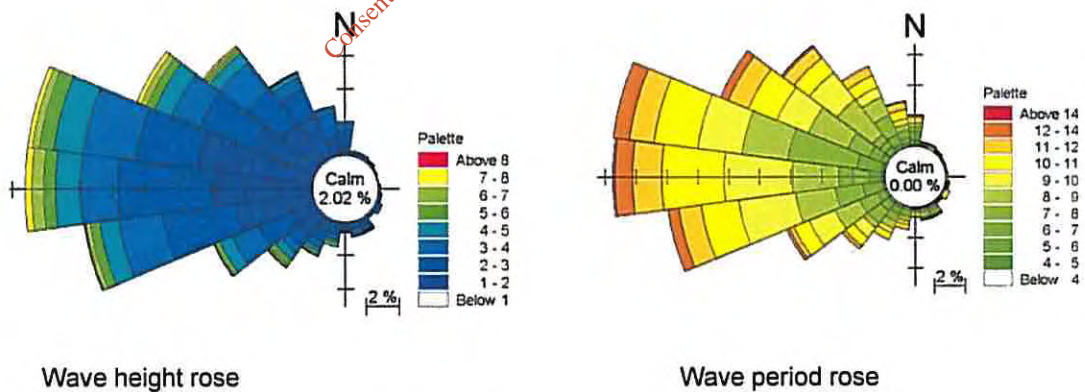


Figure 3.20 Year 2004 offshore wave roses

The 3 hourly offshore wave time series for 2004 was transformed to the proposed disposal site area using the Mike21 Nearshore Spectral Wave model. The results of the wave transformation resulted in the inshore wave rose at the centre of the proposed spoil disposal site as shown in Figure 3.21.

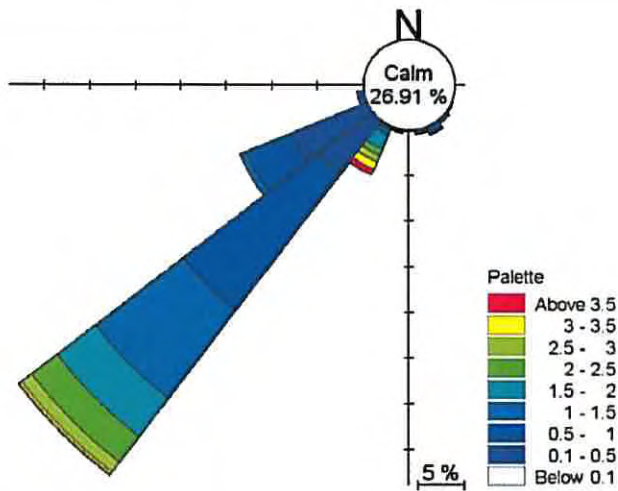


Figure 3.21 Inshore annual wave rose at centre of proposed disposal site

The wave characteristics derived from the inshore time series for the larger waves that could potentially mobilise bed sediments were found to be as follows:

Wave height H_{m0}	Typical wave period	Mean direction	% time in year
4.0 – 4.5m	11.52s	215.6°	0.205
3.5 – 4.0m	10.92s	215.9°	0.478
3.0 – 3.5m	10.34s	216.9°	1.230
2.5 – 3.0m	9.74s	218.4°	2.152
2.0 – 2.5m	9.37s	220.3°	4.167
1.5 – 2.0m	9.77s	221.0°	7.206
1.0 – 1.5m	8.82s	222.8°	13.969

3.7 DISPOSAL SITE DISPERSION

The dispersion characteristics of the proposed disposal site were assessed by undertaking a modelling exercise which simulated the disposal of about 288,000 m³ of material over the area of the disposal site over the 6 month period. The material was given a grading as follows which approximates to the average grading of the material to be dredged from the channel.

<i>% of total</i>	<i>Mean grain diameter</i>
20	10mm
20	2.5mm
20	0.75mm
20	0.20mm
20	0.063mm

A preliminary dispersion study was initially undertaken which showed that due to the low current velocity at the site the material deposited on the seabed would not be moved by tidal currents alone.

Dredged spoil deposited on the sea bed at the proposed disposal site will be subjected to wave action during gales and storms. The wave orbital velocities close to the seabed may lift some of the material into suspension and allow the currents to move the material away from the site. The rate of sediment transport across the disposal site under the combined action waves and currents was calculated for each grains size and storm wave group listed in section 3.6 above using the DHI LITRACK coastal process software.

The results of the analysis were as follows:

Grain size	Wave Hm0, Tm	Peak rate of transport	% time
0.063mm	1.25m, 8.82s	0.00029879 m ³ /s	13.969
0.063mm	1.75m, 9.17s	0.00091852 m ³ /s	7.206
0.063mm	2.25m, 9.37s	0.00404640 m ³ /s	4.167
0.063mm	2.75m, 9.74s	0.01112970 m ³ /s	2.152
0.063mm	3.25m, 10.34s	0.02869400 m ³ /s	1.230
0.063mm	3.75m, 10.92s	0.06554320 m ³ /s	0.478
0.063mm	4.25m, 11.52s	0.11341200 m ³ /s	0.205
0.20mm	1.25m, 8.82s	0.00000216 m ³ /s	13.969
0.20mm	1.75m, 9.17s	0.00005871 m ³ /s	7.206
0.20mm	2.25m, 9.37s	0.00013222 m ³ /s	4.167
0.20mm	2.75m, 9.74s	0.00025826 m ³ /s	2.152
0.20mm	3.25m, 10.34s	0.00044622 m ³ /s	1.230
0.20mm	3.75m, 10.92s	0.00568520 m ³ /s	0.478
0.20mm	4.25m, 11.52s	0.00584840 m ³ /s	0.205

0.75mm	1.25m, 8.82s	0.00000000 m ³ /s	13.969
0.75mm	1.75m, 9.17s	0.00000000 m ³ /s	7.206
0.75mm	2.25m, 9.37s	0.00003270 m ³ /s	4.167
0.75mm	2.75m, 9.74s	0.00011352 m ³ /s	2.152
0.75mm	3.25m, 10.34s	0.00018531 m ³ /s	1.230
0.75mm	3.75m, 10.92s	0.00022516 m ³ /s	0.478
0.75mm	4.25m, 11.52s	0.00083507 m ³ /s	0.205
2.50mm	2.75m, 9.74s	0.00000000 m ³ /s	2.152
2.50mm	3.25m, 10.34s	0.00003127 m ³ /s	1.230
2.50mm	3.75m, 10.92s	0.00029694 m ³ /s	0.478
2.50mm	4.25m, 11.52s	0.00045208 m ³ /s	0.205
10.0mm	4.25m, 11.52s	0.00000000 m ³ /s	0.205

It will be seen from the above that only the silt and fine to medium sand will be moved by wave action. Even then only the finer fractions will be moved a significant distance from the site. Figure 3.22 below shows the way the finer fractions will be gradually transported towards the centre of the bay. Although the diagram shows the movement over a month of tides, it will take much longer for the actual sediment to be moved this distance as the sediment is only suspended during the higher wave events which only last a relatively small percentage of time in a year.

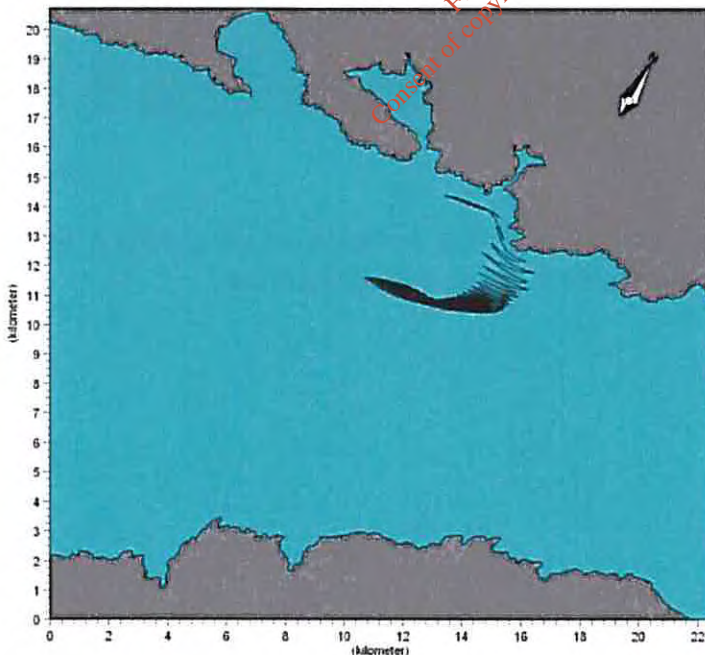


Figure 3.22 Track of suspended sediment over a month of tides

The deposition of the dredged spoil at the disposal site was simulated by modelling the dispersion of the spoil as the dredger dumped its loads at the site. The dredger was assumed to traverse backwards and forward over the disposal site as it dumped each load over a 60 minute period once in every 6 hours. The simulations were run for a full month of tides for six months. Initially the simulation were run for calm weather only and as can be seen from Figure 3.23 the deposited material remains mainly within the confines of the site. The maximum and mean suspended sediment plumes in the water column during the dumping period are shown in Figures 3.24 and 3.25.

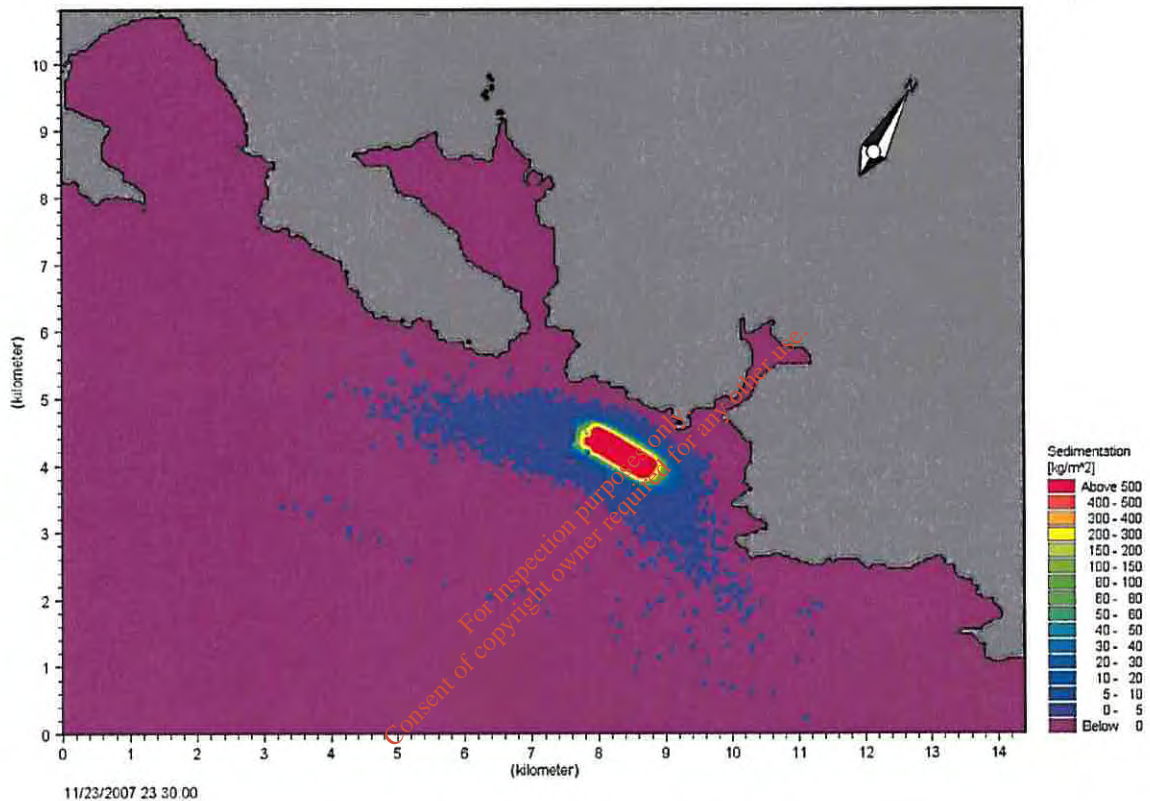


Figure 3.23 Deposition depths at completion of the dumping of the dredged spoil with calm conditions during the 6 month dumping period

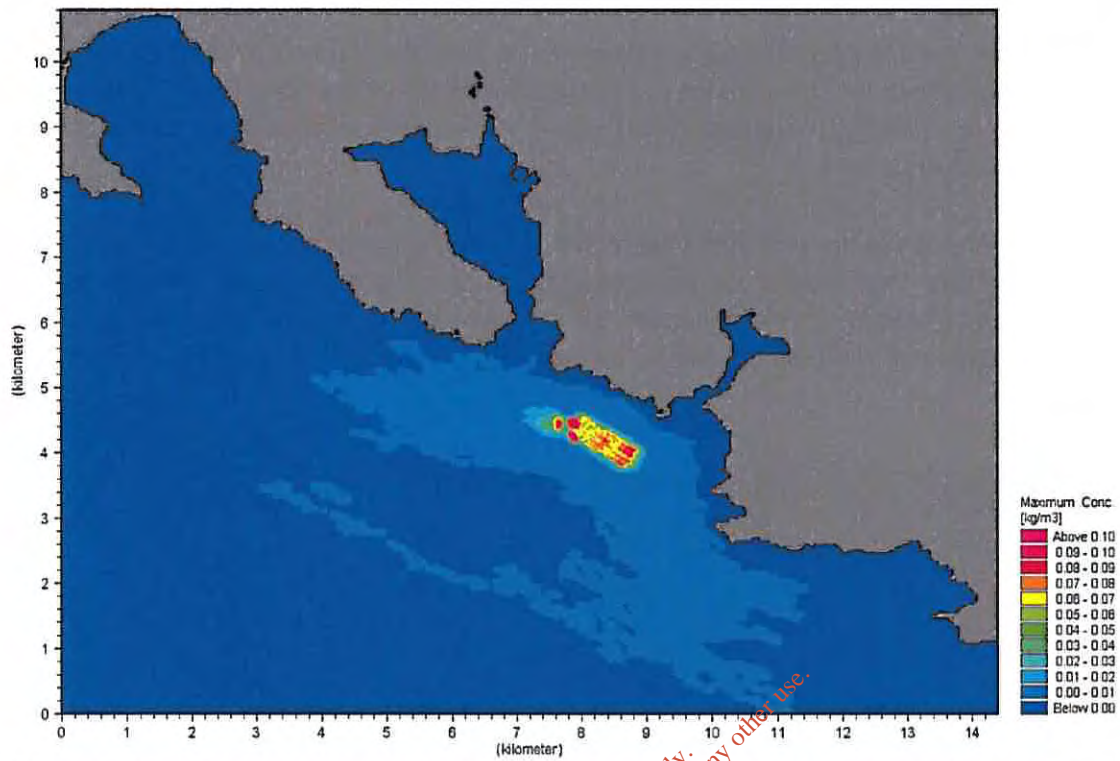


Figure 3.24 Maximum suspended sediment concentration in water column during the 6 month dumping operations

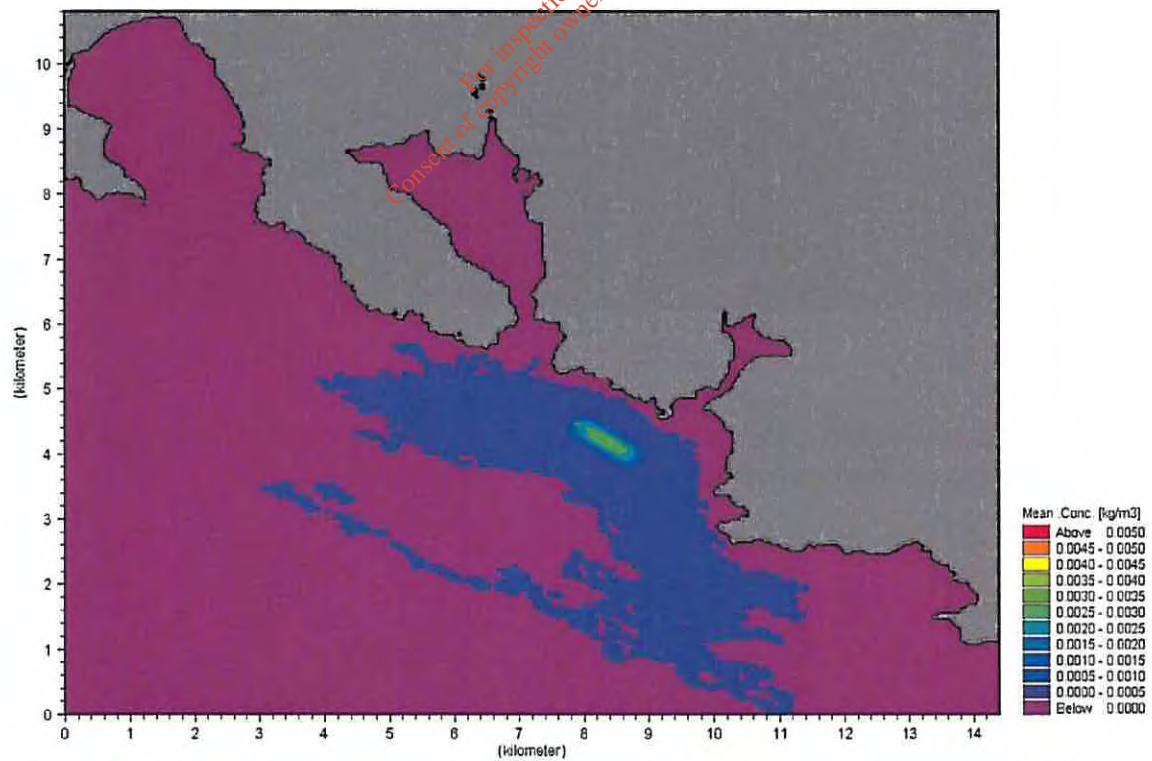


Figure 3.25 Average suspended sediment concentration in water column during the 6 month dumping operations

It is unlikely that there will be no waves during the whole of the 6 month dumping period so the critical shear stress for re-suspension was adjusted in the model separately for three of the six months to allow for the impact of waves on the dispersion process as noted in the wave climate analysis above.

The deposition depths at the end of the six month dredging programme are shown in Figure 3.26. It will be seen that most of the material remains close to the disposal site with some material migrating towards the east under the influence of waves and tidal action. The depths of deposition in millimetres may be obtained by multiplying the kg/m^3 values by 0.6.

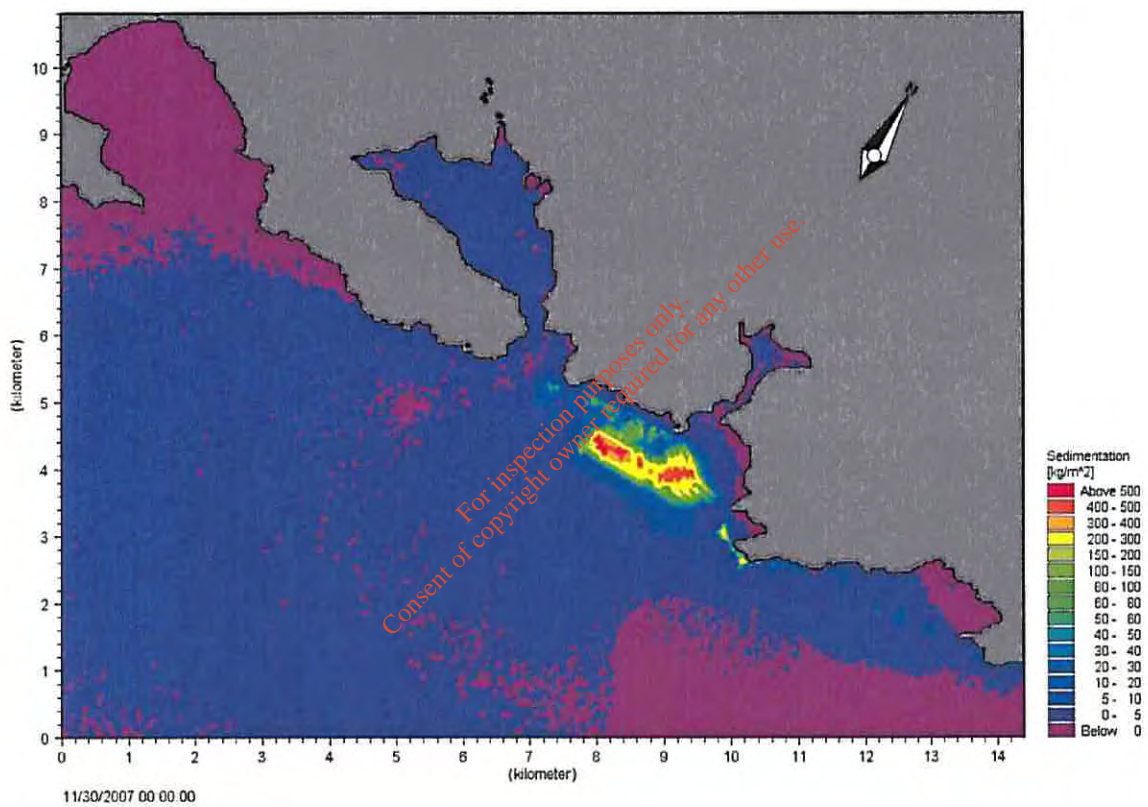


Figure 3.26 Deposition depths at completion of the dumping of the dredged spoil including wave action during the 6 month dumping period

4.0 BENTHIC STUDIES

A Benthic Survey was commissioned at the proposed dump site to determine what impact, if any, disposing of the dredged spoil from Dingle Harbour would have on the benthic communities present in and around the site in Dingle Bay (Figure 4.1).

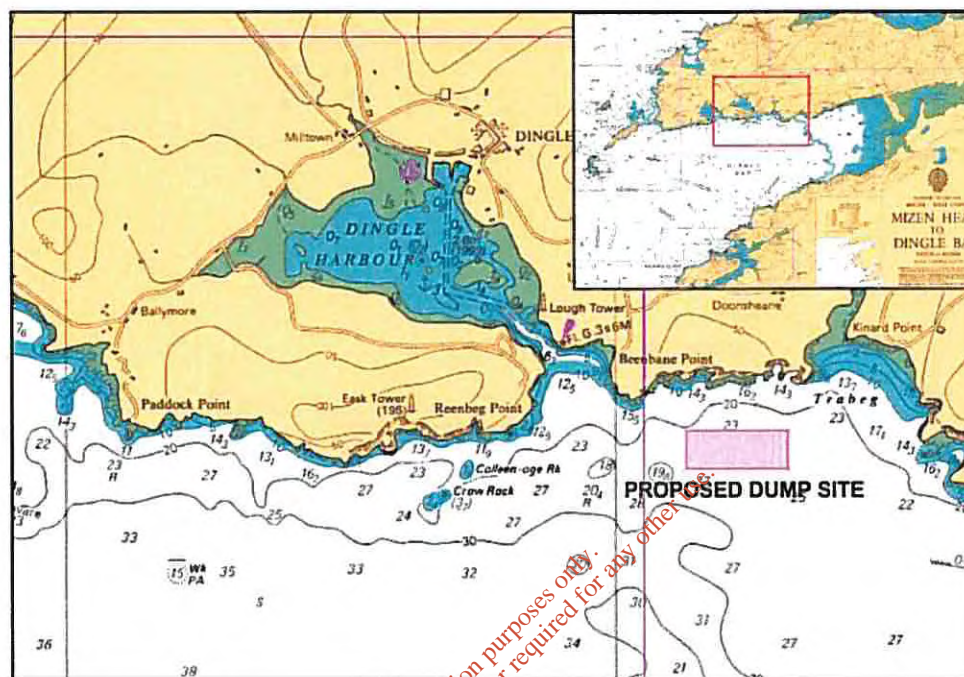


Figure 4.1 Proposed Dump Site

4.1 METHODOLOGY

4.1.1 Field Sampling

Fieldwork for this survey was undertaken during two separate field campaigns. The first field campaign involved a detailed video assessment of the area to the immediate south of the proposed dumpsite. This was undertaken on November 11th 2007. The second field survey involved a detailed video assessment within the area of the proposed disposal site and areas to the east, north and west of the dumpsite. In addition, a detailed benthos survey was undertaken during this field campaign within soft-sediment areas present in the vicinity. This was undertaken from 20th - 21st November 2007.

Positions were taken using the vessel's navigation system, although problems arose during the first field campaign with sampling positions because of technical difficulties using the vessel's on-board differential GPS system. These technical difficulties were addressed prior to the second field campaign, with positions cross-checked with a sub-meter differential-GPS system during the second campaign.

A full list of video and benthic sampling positions are represented graphically in Figures 4.2-4.4 and presented in Table 4.1.

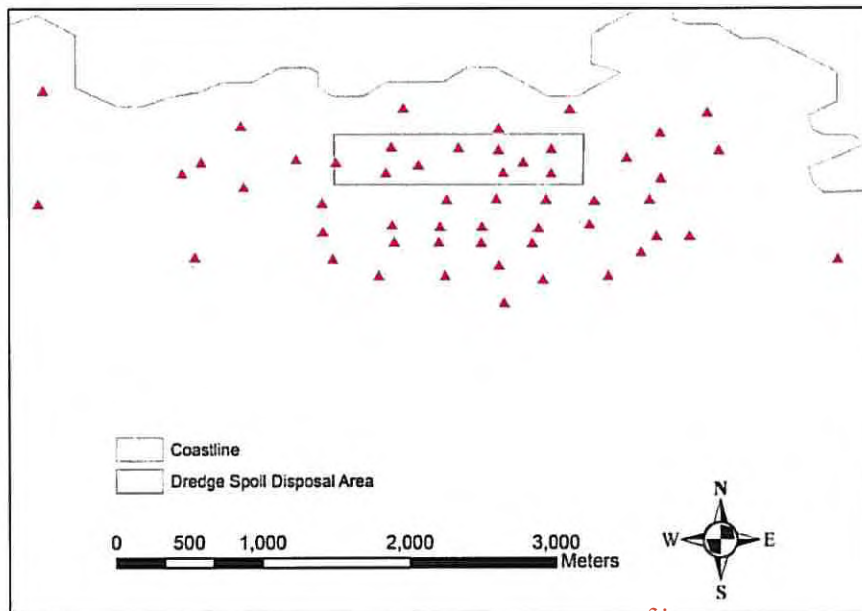


Figure 4.2 Positions of Video Drop Locations Throughout the Course of the Survey.

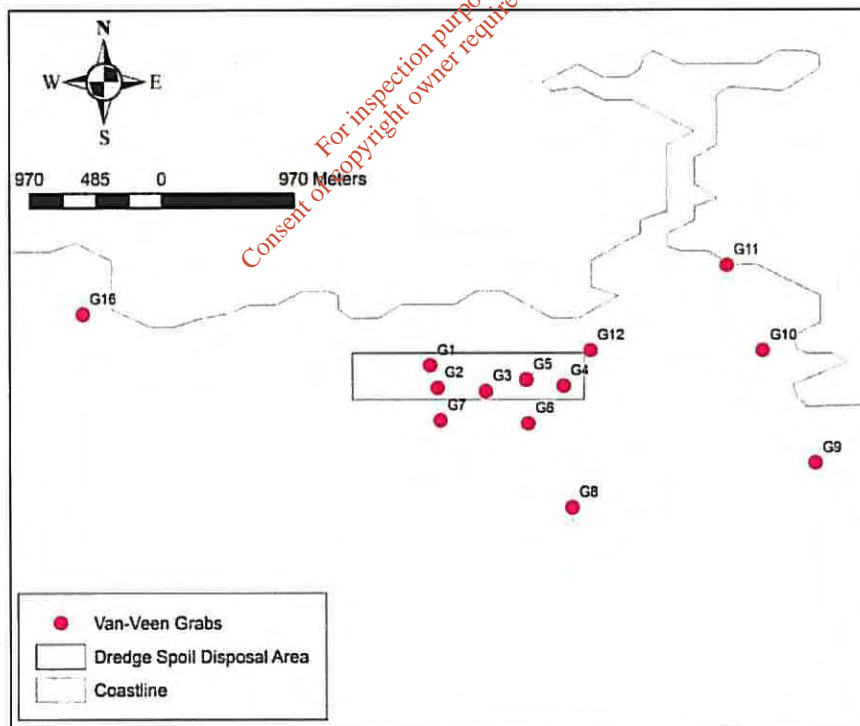


Figure 4.3 Positions of Benthic Grab Samples Throughout the Course of the Survey.

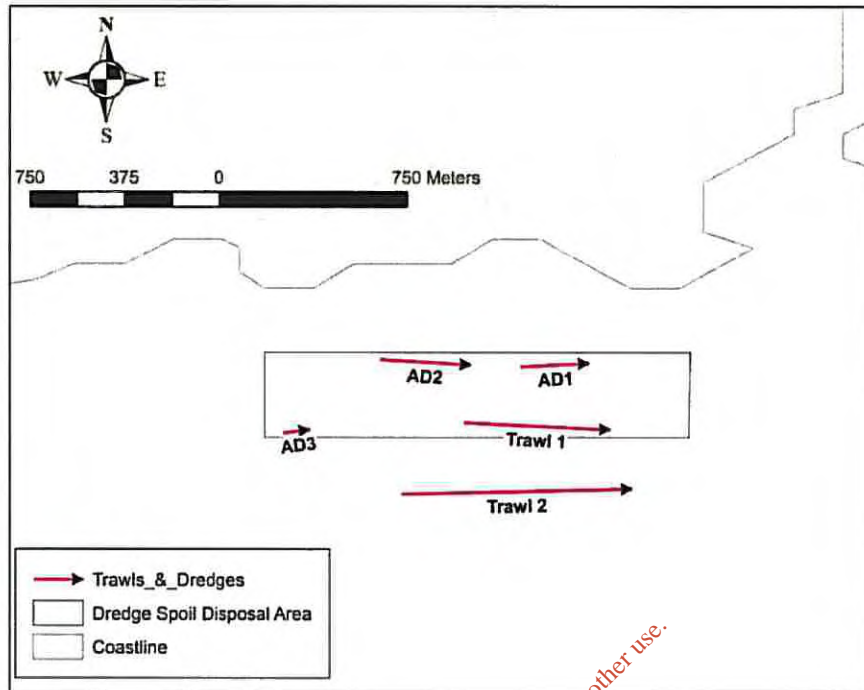


Figure 4.4 Positions of Benthic Trawl and Dredge Samples Throughout the Course of the Survey.

Table 4.1 Positions of Benthic Sampling and Video Survey Positions at the Dredge Spoil Disposal Site

Video Stations	Latitude	Longitude		Latitude	Longitude
Box 1	52° 6.682' N	10° 14.292' W	D18	52° 6.864' N	10° 12.928' W
Box 2	52° 6.644' N	10° 14.109' W	D19	52° 6.808' N	10° 13.693' W
Box 3	52° 6.641' N	10° 14.857' W	D20	52° 6.544' N	10° 13.341' W
Box 4	52° 6.645' N	10° 13.677' W	D21	52° 6.548' N	10° 13.519' W
Box 5	52° 6.683' N	10° 13.603' W	D22	52° 6.549' N	10° 13.703' W
Box 6	52° 6.643' N	10° 13.500' W	D23	52° 6.548' N	10° 13.886' W
Box 7	52° 6.739' N	10° 14.089' W	D24	52° 6.534' N	10° 14.343' W
Box 8	52° 6.736' N	10° 13.841' W	D25	52° 6.429' N	10° 14.339' W
Box 9	52° 6.728' N	10° 13.694' W	D26	52° 6.329' N	10° 14.304' W
Box 10	52° 6.733' N	10° 13.499' W	D27	52° 6.269' N	10° 14.136' W
D1	52° 6.454' N	10° 14.086' W	D28	52° 6.269' N	10° 13.893' W
D2	52° 6.393' N	10° 14.079' W	D29	52° 6.256' N	10° 13.531' W
D3	52° 6.449' N	10° 13.911' W	D30	52° 6.269' N	10° 13.291' W
D4	52° 6.393' N	10° 13.916' W	D31	52° 6.171' N	10° 13.674' W

D5	52° 6.449' N	10° 13.756' W	D32	52° 6.336' N	10° 14.811' W
D6	52° 6.391' N	10° 13.758' W	D33	52° 6.683' N	10° 14.788' W
D7	52° 6.444' N	10° 13.548' W	D34	52° 6.946' N	10° 15.371' W
D8	52° 6.389' N	10° 13.571' W	D35	52° 6.700' N	10° 13.222' W
D9	52° 6.458' N	10° 13.359' W	D36	52° 6.791' N	10° 13.100' W
D10	52° 6.458' N	10° 13.359' W	D37	52° 6.727' N	10° 12.887' W
D11	52° 6.308' N	10° 13.693' W	D38	52° 6.878' N	10° 13.431' W
D12	52° 6.329' N	10° 12.451' W	D39	52° 6.881' N	10° 14.045' W
D13	52° 6.414' N	10° 12.994' W	D40	52° 6.673' N	10° 13.989' W
D14	52° 6.414' N	10° 13.114' W	D41	52° 6.693' N	10° 14.438' W
D15	52° 6.356' N	10° 13.171' W	D42	52° 6.816' N	10° 14.641' W
D16	52° 6.548' N	10° 13.139' W	D43	52° 6.592' N	10° 14.631' W
D17	52° 6.624' N	10° 13.098' W	D44	52° 6.532' N	10° 15.389' W
Grab Stations					
Grab Stations	Latitude	Longitude	Latitude	Longitude	
G1	52° 6.735' N	10° 13.993' W	G7	52° 6.517' N	10° 13.952' W
G2	52° 6.646' N	10° 13.963' W	G8	52° 6.171' N	10° 13.430' W
G3	52° 6.633' N	10° 13.771' W	G9	52° 6.347' N	10° 12.472' W
G4	52° 6.654' N	10° 13.464' W	G10	52° 6.793' N	10° 12.678' W
G5	52° 6.678' N	10° 13.611' W	G11	52° 7.131' N	10° 12.820' W
G6	52° 6.505' N	10° 13.603' W	G12	52° 6.794' N	10° 13.357' W
Anchor Dredges					
Anchor Dredges	Latitude In	Longitude In	Latitude Out	Longitude Out	
AD1	52° 6.753' N	10° 13.743' W		52° 6.762' N	10° 13.599' W
AD2	52° 6.767' N	10° 14.052' W		52° 6.755' N	10° 13.851' W
AD3	52° 6.607' N	10° 14.261' W		52° 6.607' N	10° 14.261' W
Beam Trawls					
Beam Trawls	Latitude In	Longitude In	Latitude Out	Longitude Out	
Trawl 1	52° 6.632' N	10° 13.872' W		52° 6.617' N	10° 13.553' W
Trawl 2	52° 6.475' N	10° 14.005' W		52° 6.488' N	10° 13.508' W

4.1.2 Video Surveys

Video surveys were undertaken using a Video Pro-Ray 3 Remotely Operated Vehicle. The vessel was anchored and the ROV was deployed over the side of the boat. The ROV descended to the sea-bed and video images were captured in MPEG-3 format directly to a Laptop. The video data which was obtained during the present survey is available on request.

All video imagery captured during the course of this survey was analysed and assessments were made on the nature of the benthos and the communities present. This information was used to broadly classify the different habitat types which are present in the survey area. Due to the variable quality of the video imagery it was not always possible to identify animals

observed to species level. Where this was not possible, animals were identified to lowest possible taxonomic level.

4.1.3 Benthic Faunal Sampling

Grab Survey

Benthic grab samples were taken by means of a 0.1m² Stainless Steel Van-Veen Grab. A total of 13 sites were sampled using the Van-Veen grab.

At each station:

- 1x 0.1m² Van Veen grabs were deployed for benthic faunal analysis. Samples were transferred to separate, labelled 10 litre sample containers (13 samples).
- 1 x 0.1 m² Van Veen grab from which approximately 100g of well-mixed sediment was transferred to a sealed, labelled plastic container for sediment grainsize and organic carbon analysis.

Anchor Dredge Sampling

In areas where no benthic sampling was possible using the Van Veen grab, sampling was undertaken using a modified anchor dredge. A total of three anchor dredge samples were taken. In places where samples were required for further analysis, samples were transferred to labelled 20 litre sample containers.

Beam Trawl Sampling

Beam trawl samples were taken at only two locations due to the varied nature of the benthos (benthic sediment ranged from sands to bedrock/cobble). Surveys were undertaken using a 2m beam trawl equipped with a chain matrix and a 4mm square mesh cod-end. Tows were carried out into the current at a speed of 2 knots. Tows were 10-15 minutes in duration, with a warp length of a minimum 2½ times the water depth.

Organisms from the beam trawl were identified in-situ where possible. Commercial fish species, where present, were identified onboard the vessel and returned. Where material required further identification, samples were transferred to labeled containers and fixed using 10% buffered formalin.

Fauna Sample Processing

All soft sediment fauna samples (Grabs and Dredges) were sieved through a 1 mm mesh sieve and fixed using 4% buffered formalin. Samples were washed and sorted by eye. Taxonomic identification of the samples was undertaken with macrofauna identified to species level, where possible.

Fauna from the beam trawl survey which were not identified in-situ were fixed using 4% buffered formalin and returned to the laboratory where specimens were identified using standard keys for western European fauna.

4.1.4 Sediment Analysis

Granulometry

Granulometric analysis was carried out on oven dried sediment samples from each station. A known weight of each sample was passes through a series of nested brass test sieves with the aid of a mechanical shaker. The brass sieves chosen were 4mm, 2mm, 1mm, 500 μ m, 250 μ m, 125 μ m and 63 μ m. The sediments were then divided into three fractions: % Gravel (>2mm), % Sand (<2mm >63 μ m) and % Mud (<63 μ m). Further analysis of the sediment data was undertaken using the Gradistat package (Blott & Pye, 2001).

Organic Matter

Organic matter was estimated using the Loss on Ignition (LOI) method. One gram of dried sediment was ashed at 450C for 6 hours and organic matter was calculated as % sediment weight loss.

4.1.5 Habitat Assessment

Biotores were identified using the JNCC Marine Habitat Classification for Britain and Ireland (Conner et al, 2004)

4.2 RESULTS

4.2.1 Physical Environment

General sediment distribution (Video)

Results from the video survey (Figure 4.5 and Table 4.2) indicate the heterogeneous nature of the benthos in the area of the proposed disposal site. Immediately within the proposed dredge disposal site, the benthos consists primarily of sands and muddy sands along most of the area. Along the western margin of the proposed dredge spoil disposal site is an area of hard benthos characterised by the presence of cobble, boulders and bedrock.

The area to the south of the proposed site is dominated by sands and gravely sands. In addition, sandy areas are present close to shore to the east of the proposed disposal area. There are areas of hard and mixed benthos present throughout the survey area.

The presence of extensive hard substrate within the survey area made faunal sampling difficult in these areas.

Table 4.2 Notes on sediment distribution throughout the survey from video images obtained from the ROV survey

Video ID	Date	Time	Depth	Description	Video ID	Date	Time	Depth	Description
Box 1	20/11/2007	13:43	34	Rocky Ground moving to Gravel on eastern drift	D18	09/11/2007	14:04	28	Sandy Gravel
Box 2	20/11/2007	13:54	34	Sand - drifted (east) onto cobble	D19	09/11/2007	14:15	32	Sandy Gravel
Box 3	20/11/2007	14:03	34	Sand, starfish and active burrows	D20	09/11/2007	14:26	32	Sand
Box 4	20/11/2007	14:15	34	Sand, starfish and active burrows	D21	09/11/2007	14:35	34	Sand
Box 5	20/11/2007	14:23	34	Sand, starfish and active burrows	D22	09/11/2007	14:45	34	Sand
Box 6	20/11/2007	14:32	34	Sand, starfish and active burrows	D23	09/11/2007	14:55	34	Sand
Box 7	20/11/2007	15:14	34	Sand, Irregular pattern	D24	09/11/2007	15:07	36	Sand
Box 8	20/11/2007	15:23	34	Gravely Sand with waves	D25	09/11/2007	15:10	36	Sand
Box 9	20/11/2007	15:32	32	Gravely Sand with waves	D26	09/11/2007	15:15	36	Sand
Box 10	20/11/2007	15:43	32	Gravely Sand with waves	D27	09/11/2007	15:25	36	Sand
D1	09/11/2007	10:45	32	Sand	D28	09/11/2007	15:35	36	Sand
D2	09/11/2007	12:15	34	Sand	D29	09/11/2007	15:45	34	Sand
D3	09/11/2007	10:55	32	Sand	D30	09/11/2007	15:50	37	Rock with sand patches
D4	09/11/2007	12:05	34	Sand	D31	09/11/2007	15:57	37	Rough ground
D5	09/11/2007	11:10	32	Sand	D32	09/11/2007	16:15	36	Sand
D6	09/11/2007	12:00	32	Sand	D33	09/11/2007	16:20	32	Gravely Sand/Rock
D7	09/11/2007	11:15	32	Sand	D34	09/11/2007	16:30	33	Sand
D8	09/11/2007	11:45	32	Sand	D35	20/11/2007	16:00	32	Bedrock
D9	09/11/2007	11:25	32	Sand	D36	20/11/2007	16:12	28	Bedrock
D10	09/11/2007	11:35	32	Sand - Some rocky ground/gravel	D37	20/11/2007	16:24	24	Gravely Sand with waves
D11	09/11/2007	13:00	34	Sandy cobble	D38	20/11/2007	16:37	30	Bedrock
D12	09/11/2007	13:10	32	Sand	D39	20/11/2007	16:54	28	Bedrock
D13	09/11/2007	13:25	32	Sand	D40	20/11/2007	17:06	32	Bedrock
D14	09/11/2007	13:32	32	Rock	D41	20/11/2007	17:26	28	Cobble/Boulder
D15	09/11/2007	13:40	32	Rock	D42	20/11/2007	17:37	28	Sand [no video recorded]
D16	09/11/2007	13:45	32	Rough Ground	D43	20/11/2007	17:59	30	Bedrock
D17	09/11/2007	13:55	32	Mixed Gravel	D44	20/11/2007	18:13	30	Gravel with boulders and bedrock

Sediment Grainsize Analysis

Results from the sediment grainsize analysis indicate the presence of extensive muddy sand beds within the proposed disposal site (Table 4.3 & Figures 4.5 & 4.6). Results from sediment grainsize analysis from benthic grab and dredge sites indicate that the area within the proposed dredge site is dominated by sands and muddy sands with low LOI results.

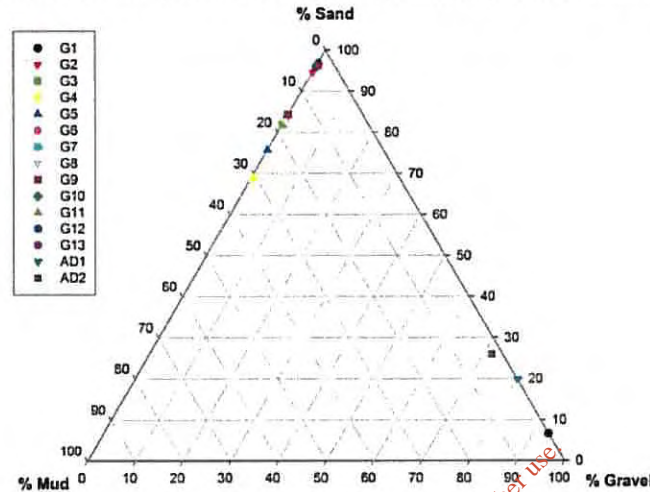


Figure 4.5 Ternary plot of Granulometric Analysis at each Subtidal Grab/Dredge Site.

Table 4.3 Sediment Characteristics for Sub-Tidal Grab and Dredge Samples.

	% Gravel	% Sand	% Mud	% LOI	Textural Group	Sorting
Grab 1	93.28	6.60	0.12	n/r	Gravel [G]	Moderately Well Sorted
Grab 2	0.00	94.56	5.44	0.90	Sand [S]	Moderately Sorted
Grab 3	0.00	81.94	18.06	1.21	Muddy Sand [mS]	Poorly Sorted
Grab 4	0.53	68.71	30.76	3.17	Slightly Gravelly Muddy Sand [(g)mS]	Poorly Sorted
Grab 5	0.00	75.72	24.28	2.23	Muddy Sand [mS]	Poorly Sorted
Grab 6	0.00	83.80	16.20	1.14	Muddy Sand [mS]	Moderately Sorted
Grab 7	0.00	83.64	16.36	1.40	Muddy Sand [mS]	Moderately Sorted
Grab 8	0.00	82.89	17.11	0.92	Muddy Sand [mS]	Poorly Sorted
Grab 9	0.00	84.36	15.64	1.69	Muddy Sand [mS]	Poorly Sorted
Grab 10	0.00	96.81	3.19	0.61	Sand [S]	Well Sorted
Grab 11	0.00	95.96	4.04	0.64	Sand [S]	Moderately Well Sorted
Grab 12	0.00	95.85	4.15	0.70	Sand [S]	Moderately Well Sorted
Grab 13	0.32	96.20	3.48	0.65	Slightly Gravelly Sand [(g)S]	Moderately Well Sorted
AD 1	80.14	19.83	0.02	1.07	Gravel [G]	Moderately Sorted
AD 2	71.69	25.95	2.36	2.69	Sandy Gravel [sG]	Poorly Sorted

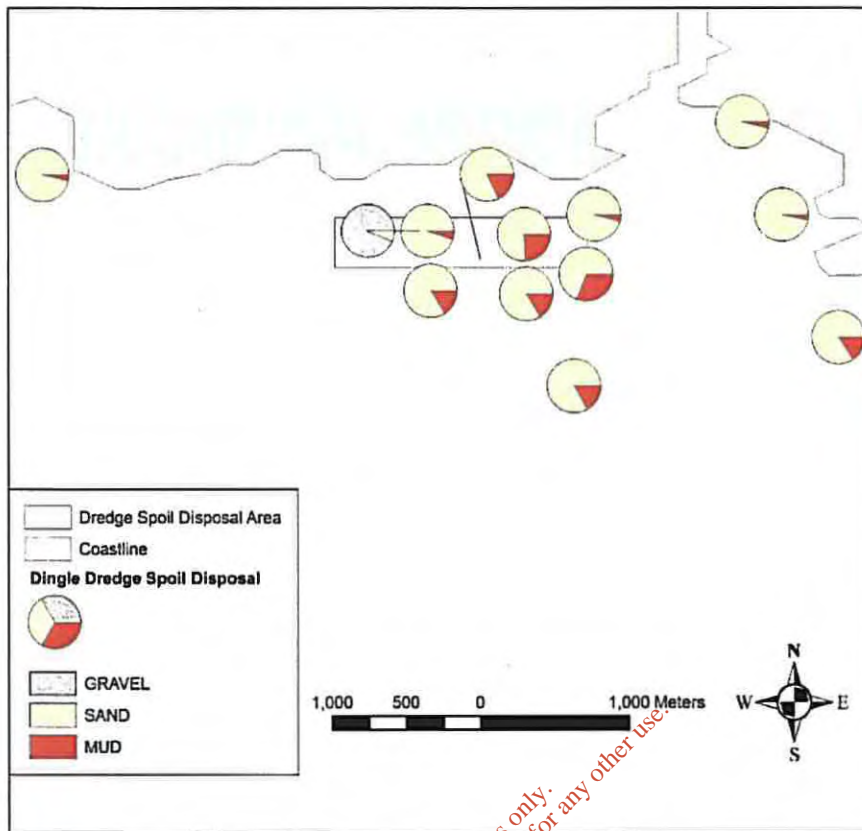


Figure 4.6 Distribution of Sediment Types Across the Survey Area from Benthic Grab/Dredge Samples.

4.2.2 Biological Environment

Anchor Dredge Samples

A total of three anchor dredges were taken during the course of this survey. No sediment was returned in 1 Anchor Dredge (AD 3). Only a small amount of sediment was returned in AD2 which was retained for sediment analysis as no fauna was evident in this sample. A third anchor dredge sample returned a relatively large amount of gravel. No fauna was returned in this sample.

Grab Samples

A total of 38 taxa were encountered in the benthic grab samples (Table 4.4). All species identified are of widespread occurrence in Irish coastal waters. The most abundant species present in the current survey is the brittlestar *Amphiura filiformis*, although several other species across throughout the area in significant numbers including the polychaetes *Lagis koreni*, *Magelona alleni* and *Nephtys hombergii* and the bivalve mollusc *Thyasira flexuosa*. In addition, the cumacean *Diastyllis rugosa* was present in 12 of the 13 sampling locations. The species identified in the present survey are typical of muddy sand communities.

Table 4.4 Faunal abundances from Van-Veen Grab Sampling Programme

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G16
<i>Abra alba</i>	-	-	-	5	5	-	2	-	1	-	-	-	-
<i>Abra prismatica</i>	-	1	-	-	-	-	-	-	-	1	-	-	-
<i>Actaeon tornalis</i>	-	-	-	-	1	-	-	-	-	-	-	-	-
<i>Ampelisca</i> sp.	-	1	-	-	1	-	-	3	-	-	-	-	-
<i>Amphiura filiformis</i>	-	4	4	17	7	9	1	6	9	-	-	4	-
<i>Bathyporeia guilliamsoniana</i>	-	-	-	-	-	-	-	-	-	1	14	-	3
<i>Chaetozone setosa</i>	-	8	-	-	-	-	-	3	2	5	-	2	-
<i>Clausinella fasciata</i>	-	1	-	-	-	1	-	1	-	-	-	-	-
<i>Cultellus pellucidus</i>	-	-	1	1	1	2	1	1	3	-	-	-	-
<i>Cumopsis goodsiri</i>	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Diastylis rugosa</i>	3	3	1	8	-	1	3	5	3	1	1	2	1
<i>Diplocirrus glaucus</i>	-	-	11	-	2	3	1	7	8	-	-	-	-
<i>Echinocardium cordatum</i>	-	-	-	1	3	1	-	-	-	-	8	-	-
<i>Eteone longa</i>	-	-	-	7	4	-	-	2	1	-	-	-	-
<i>Eurydice spinigera</i>	-	-	-	-	-	-	-	-	-	-	-	-	2
<i>Gastrosaccus spinifer</i>	-	-	-	-	-	-	1	-	-	-	-	-	-
<i>Glycera cf lapidum</i>	2	3	-	2	-	-	2	-	6	6	2	1	-
<i>Hyalinoecia tubicola</i>	2	-	-	-	-	-	-	-	-	-	-	-	-
<i>Iphinoe trispinosa</i>	-	2	-	-	-	-	-	2	-	-	-	-	1
<i>Lagis koreni</i>	4	2	-	5	4	5	-	11	16	-	-	-	-
<i>Lanice conchilega</i>	-	-	-	-	-	-	2	-	1	-	-	-	-
<i>Lumbrineris</i> sp.	-	-	-	-	-	-	-	3	-	-	-	-	-
<i>Mactra stultorum</i>	-	1	2	-	-	1	-	-	-	-	-	1	-
<i>Magelona alleni</i>	3	2	-	1	10	-	-	-	5	8	-	5	2
<i>Microprotopus maculatus</i>	2	-	-	-	-	-	-	-	-	-	-	-	-
<i>Montacuta ferruginea</i>	-	-	-	-	-	1	-	-	-	-	-	-	-
<i>Natica catena</i>	-	-	-	-	-	-	-	1	-	-	1	-	-
<i>Nemertean indet</i>	-	-	1	2	1	3	1	-	-	-	-	-	-
<i>Nephtys hombergii</i>	-	-	3	-	11	2	3	6	5	-	5	2	2
<i>Nucula nucleus</i>	-	-	-	-	1	-	-	-	-	-	-	-	-
<i>Philine</i> sp.	-	2	-	-	-	-	1	-	-	-	-	-	-
<i>Phyllodoce</i> sp.	-	-	-	-	-	-	-	-	1	-	-	-	-
<i>Pygospio elegans</i>	-	-	-	-	-	-	3	-	-	1	-	-	-
<i>Sigalion mathildae</i>	-	1	1	-	2	1	-	1	-	-	-	-	-
<i>Synchelidium maculatum</i>	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Tellina fabula</i>	-	1	-	-	-	-	-	1	-	10	-	-	-
<i>Thyasira flexuosa</i>	-	-	-	29	3	-	1	-	2	-	-	-	-
<i>Travisia forbesii</i>	-	-	-	1	-	-	-	-	-	-	-	-	-

Data Analysis

A group average sorting dendrogram on all grab samples indicated the presence of 3 distinct clusters (Figure 4.7).

Group I (Average Similarity of 51.48%) and all other groups separated at ~31% similarity. **Group II** (Average Similarity of 53.41%) and **Group III** (Average Similarity of 50.41%) separated at ~39% similarity.

The distribution of these groups is also preserved in the MDS ordination (Figure 8). The stress value of the MDS ordination is 0.14, which indicates a useful representation of distribution.

Results from SIMPER analysis which determines the species that account for the greatest similarity within each of the faunal groups is presented in Table 6. Information from this analysis is then used to determine the communities which are present within the survey area.

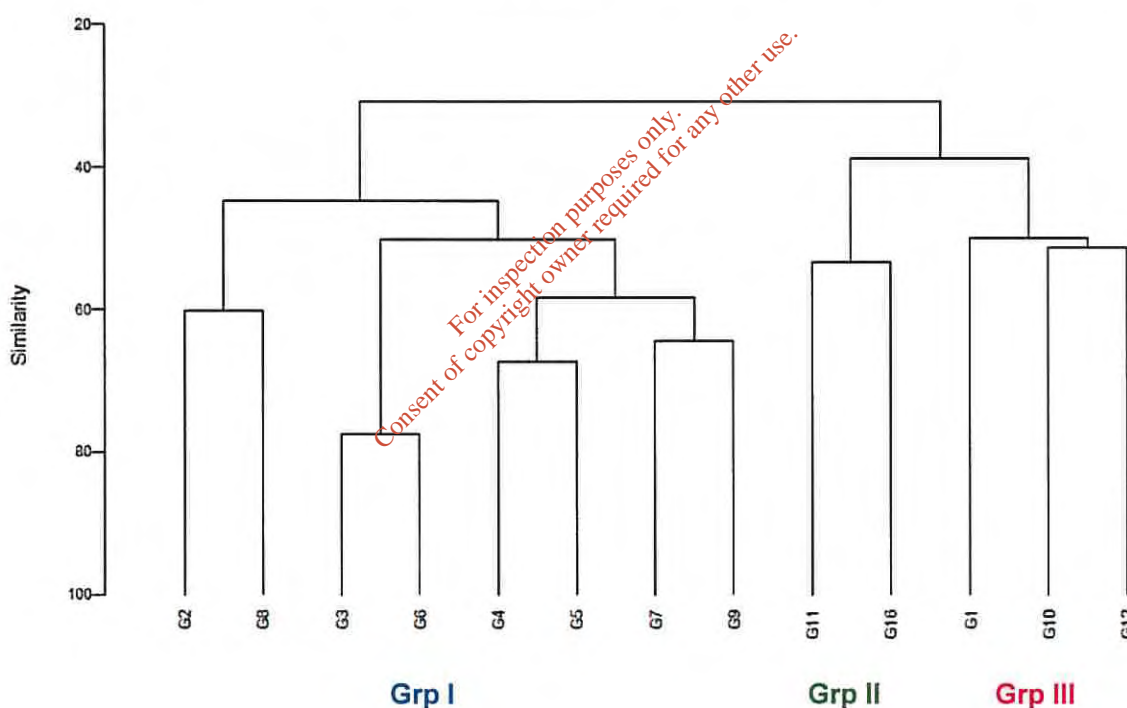


Figure 4.7 Cluster diagram from Faunal Grab Samples

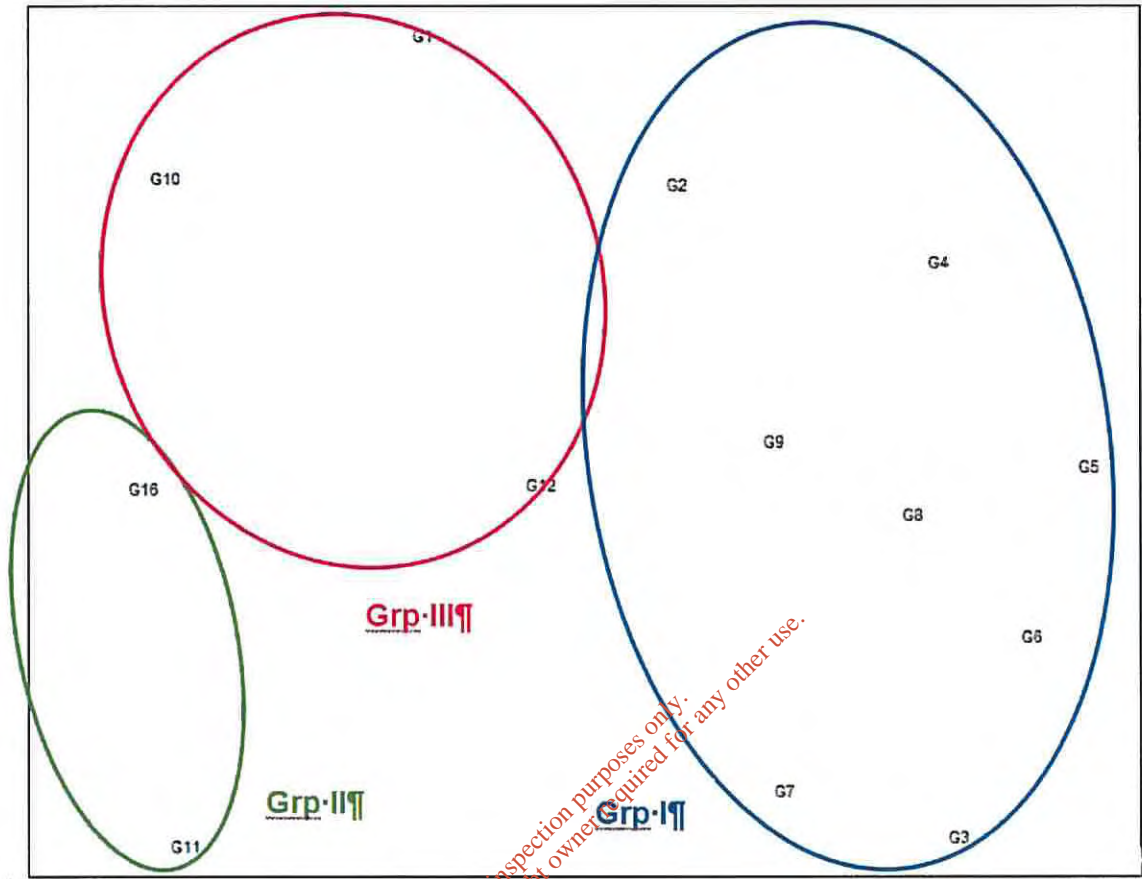


Figure 4.8 Non metric Multi Dimensional Scaling (MDS) of faunal grabs taken [stress = 0.14].

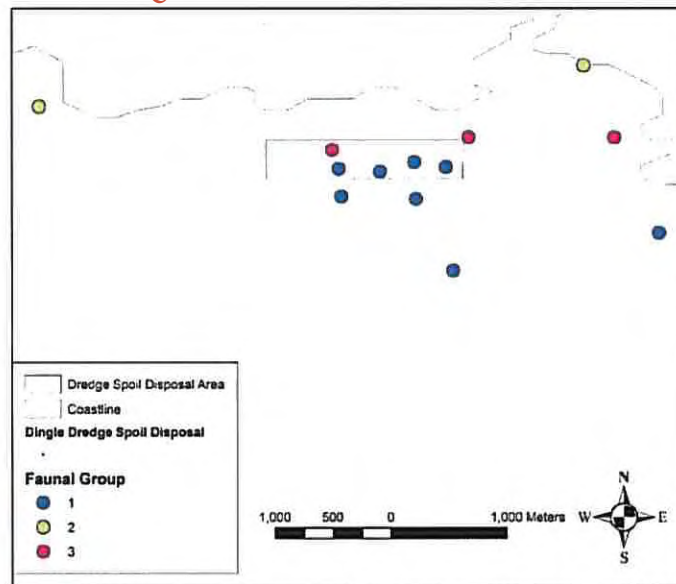


Figure 4.9 Graphical Representation of the Geographical Spread of Faunal Groups Within and in the Immediate Vicinity of the Disposal Area at Dingle.

Table 4.5 Table summarising the top 10 species (where applicable) that contribute to the similarity within each of the groups identified in Dingle. The % contribution of each species to the similarity of the group is given.

Top 10 Species	Average Abundances	% Contribution	Cumulative %
Group I Average Similarity: 51.48%			
<i>Amphiura filiformis</i>	7.13	18.52	18.52
<i>Diastylis rugosa</i>	3.00	11.70	30.22
<i>Nephtys hombergii</i>	3.75	9.60	38.82
<i>Cultellus pellucidus</i>	1.25	9.59	48.41
<i>Lagis koreni</i>	5.38	8.91	58.32
<i>Diplocirrus glaucus</i>	4.00	8.83	67.14
<i>Nemertea indet</i>	1.00	5.01	72.15
<i>Sigalion mathildae</i>	0.75	4.71	76.86
<i>Glycera cf lapidum</i>	1.63	3.16	80.02
<i>Thyasira flexuosa</i>	4.38	3.04	83.06
Group II Average Similarity: 53.41%			
<i>Bathyporeia guilliamsoniana</i>	8.50	41.81	41.81
<i>Nephtys hombergii</i>	3.50	34.87	76.68
<i>Diastylis rugosa</i>	1.00	23.32	100.00
Group III Average Similarity: 50.41%			
<i>Magelona alleni</i>	5.33	37.11	37.11
<i>Glycera cf lapidum</i>	3.00	28.66	65.77
<i>Diastylis rugosa</i>	2.00	25.19	90.96
<i>Caetozone setosa</i>	2.33	9.04	100.00

Table 4.7 Summary of natural and derived indices for Dingle Dredge Survey Sites

Group	Sample Number	Number of Species	Number of Individuals	Shannon-Wiener Diversity	Pielou's Evenness	Simpson's Dominance
I	G2	14	32	2.39	0.907	0.117
	G3	8	24	1.65	0.795	0.267
	G4	12	79	1.90	0.765	0.209
	G5	15	56	2.39	0.883	0.114
	G6	12	30	2.16	0.870	0.153
	G7	13	22	2.45	0.956	0.095
	G8	15	53	2.42	0.893	0.109
	G9	14	63	2.29	0.866	0.130
	mean		12.88	44.88	2.21	0.867
II	G11	7	32	1.50	0.769	0.285
	G16	7	12	1.86	0.958	0.167
	mean		7.00	22.00	1.68	0.864

III	G1	6	16	1.75	0.979	0.180
	G10	8	33	1.73	0.830	0.210
	G12	7	17	1.79	0.919	0.190
mean		7.00	22.00	1.76	0.909	0.193

Trawl Samples

Only two trawls were taken during the present survey as a result of the heterogeneous nature of the benthos in the area (areas of sand intermixed with extensive areas of boulder and bedrock). These trawls returned a total of 10 taxa (Table 8).

Table 4.7 Faunal Abundances of all Species Returned in Beam Trawls

	Trawl 1	Trawl 2
<i>Adamsia cariniopados</i>	-	1
<i>Astropecten inequalis</i>	2	-
<i>Liocarcinus holsatus</i>	-	1
<i>Macropodia</i> sp.	-	1
<i>Ophiura ophiura</i>	4	34
<i>Pagurus prideauxi</i>	-	1
<i>Sepiolo atlantica</i>	2	-
<i>Asterias rubens</i>	17	164
<i>Solea solea</i>	2	-
<i>Sygnathus rostellatus</i>	1	-

A total of 6 taxa with 28 individuals were returned in Trawl 1. The starfish *Asterias rubens* was the dominant species identified in this trawl with 17 individuals identified. In addition, two sole (*Solea solea*) and a single pipefish (*Sygnathus rostellatus*) were collected in this trawl. Trawl 2 also returned 6 taxa but had 202 individuals. The dominant faunal species here was also the starfish (*A. rubens*) which accounted for 164 individuals, but 34 brittlestar (*Ophiura ophiura*) were also returned in this trawl. No fish species were collected in Trawl 2.

4.2.3 Video Survey

To assist with the interpretation of the video imagery obtained in the current survey the video data was analysed according to geographic location within the dredge spoil area and in its immediate vicinity. This resulted in 5 areas:

- Disposal Site – The area within the proposed dredge spoil disposal area
- Northern Sector
- Eastern Sector
- Southern Sector
- Western Sector

Disposal Site

A total of 10 video dives were performed inside the disposal area. This areas surveyed within the disposal site are displayed in Figure 4.10.

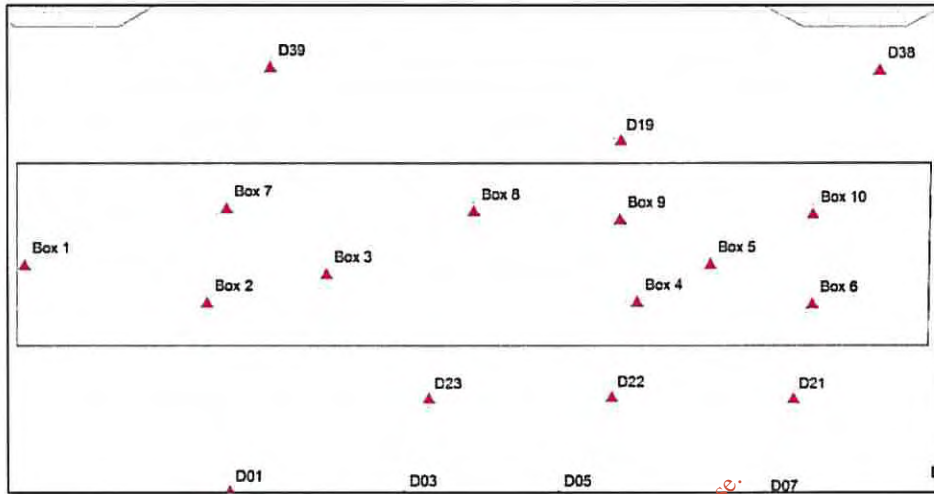


Figure 4.10 Map of disposal site with Video Dive positions Indicated

Within the disposal site three main types of habitat were recorded. Table 4.8 displays the fauna identified at each site from the video footage.

Table 4.8 Fauna Present at Each Site from the Disposal Site Video Footage.

	Box 1	Box 2	Box 3	Box 4	Box 5	Box 6	Box 7	Box 8	Box 9	Box 10
<i>Asterias rubens</i> (Common starfish)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Active burrows	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
<i>Pomatoceros sp.</i> (Keel worm)	Yes							Yes	Yes	Yes
Bryozoan/Hydroid Turf	Yes									
<i>Lanice conchilega</i> (Sand mason worm)							Yes			
<i>Pagurus bernhardus</i> (Hermit crab)					Yes					
<i>Eutrigula gurnardus</i> (Grey gurnard)							Yes		Yes	
<i>Trisopterus luscus</i> (Bib)	Yes						Yes			
<i>Labrus mixtus</i> (Cuckoo wrasse)	Yes									

Habitat 1

This habitat is characterised by sandy communities typified by the presence of small sand waves with little visible epifauna except for the common starfish (*Asterias rubens*) and the presence of active burrows on the sediment surface and occasional crab species indicating faunal activity. The sand mason (*Lanice conchilega*) is also present but was only encountered along video dive Box 7. Fish species were absent from the sandy ground in the disposal area with the exception of a single grey gurnard (*Eutrigula gurnardus*) which was buried in the sand along video dive Box 7. Fish are that remain buried in the sand are difficult to see and remain in hiding under the sand unless disturbed by the video camera. As a result bottom sand dwelling fish species are probably under recorded for the all of the video survey. This type of habitat predominates in the disposal area with 6 video dives recording this type of habitat (Dives labelled Box 2-7). Sandy ground is found in the inner regions on the disposal area and accounts for about approximately 60-70 percent of the area. [Figs 4.11 – 4.14] This habitat type may be classified under the JNCC classification system as SS.SSa (Sublittoral sands and muddy sands).

Habitat 2

This habitat is characterised by coarser sands and gravels and mixtures of these sediment types. These areas are characterised by little in the way of visible fauna with the exception of starfish and occasional keel worms (*Pomatoceros* sp.) on the larger cobble or rocks. There are small patches of bryozoans on some of the smaller rocks. This type of habitat is found in 3 of the video dives (Box 8-10). These dives are located in the north-eastern portion of the disposal area. [Figs 4.15-4.17] This habitat type may be classified under the JNCC classification system as SS.SMx.CMx (Circalittoral mixed sediment).

Habitat 3

This habitat is composed of rocky ground comprising of either flat bedrock or bedrock with relief in the form of cobble and rocks. This habitat type is only recorded in one video dive (Box 1). These rocky areas are characterised by more diverse collection of epifauna than the sandy areas. The rock surfaces are covered by a faunal crust of bryozoans and hydroids. It is difficult to identify these animals from video footage. Keel worms and starfish are present on the bedrock. Two species of fish, bib (*Trisopterus luscus*) and poor cod (*Trisopterus minutus*) are recorded from the area. These fish are observed swimming around the rocky outcrops on the seafloor. [Fig 4.18] This habitat type may be classified under the JNCC classification system as SS.SCS.CCS.PomB (Pomatoceros triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles).



Figure 4.11 Sandy ground with common starfish (*Asterias rubens*) along Box 4.

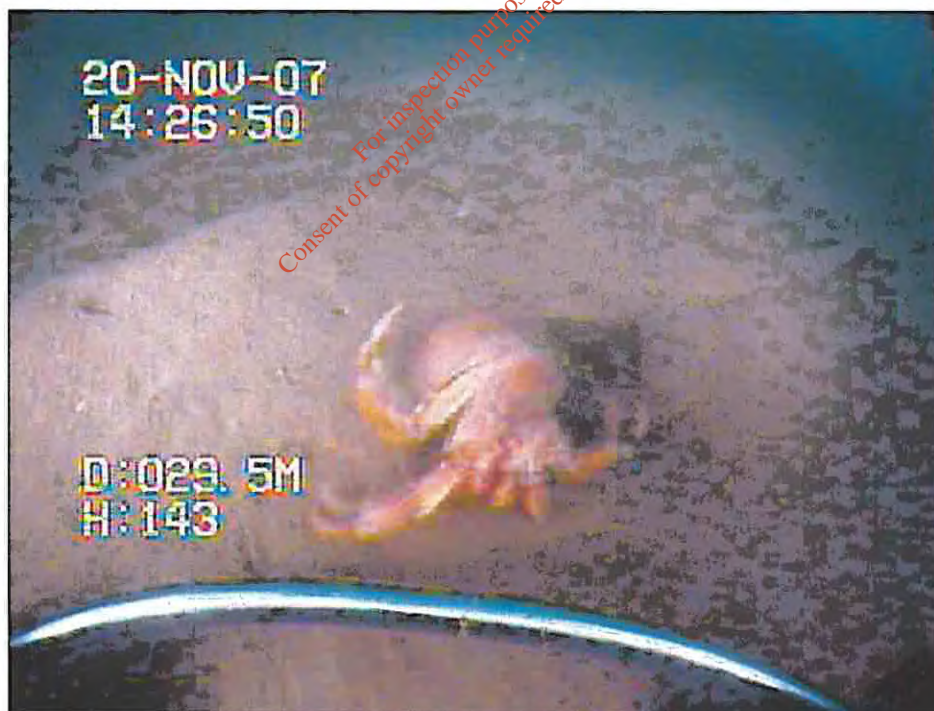


Figure 4.12 Sandy ground with hermit crab (*Pagurus bernhardus*) along Box 5.



Figure 4.13 Sandy ground with sand mason tube (*Lanice conchilega*) along Box 7.



Figure 4.14 Sandy ground with grey gurnard (*Eutrigula gurnardus*) concealed in the sand along Box 7.



Figure 4.15 Sandy gravels with keel worm (*Pomatoceros sp.*) on small rocks along Box 8.



Figure 4.16 Sandy gravels with starfish (*Asterias rubens*) along Box 9.



Figure 4.17 Sandy gravels with bivalve shell along Box 10.

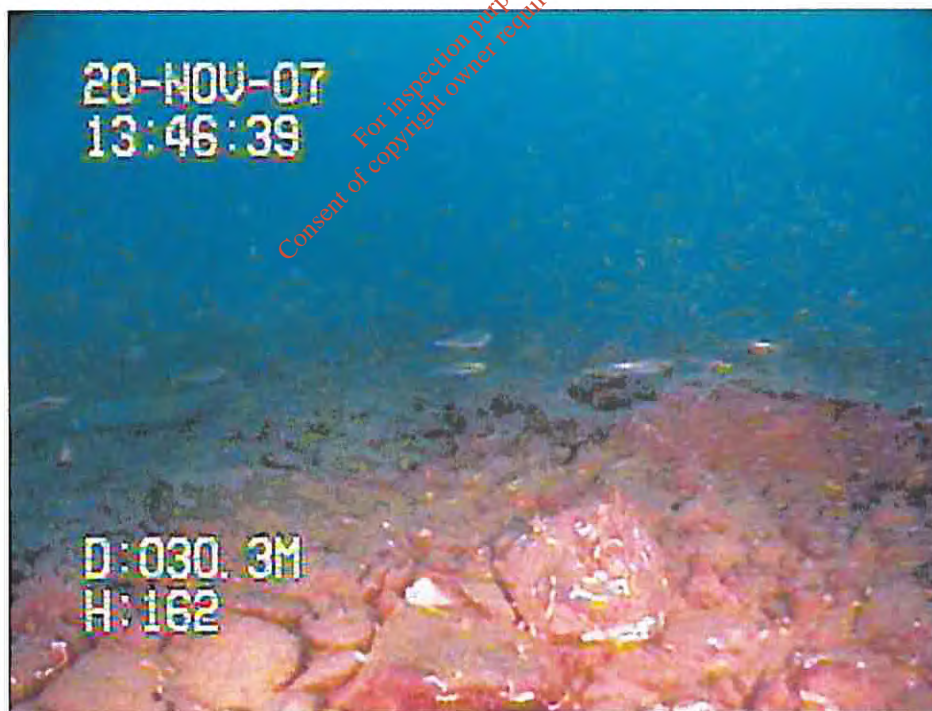


Figure 4.18 Rocky ground along Box 1 with poor cod (*Trisopterus minutus*) in the background. Keel worm is also present on the rocks and boulders.

Northern Sector

A total of 3 video dives were performed immediately to the north of the disposal area. This area is displayed in Figure 4.19.

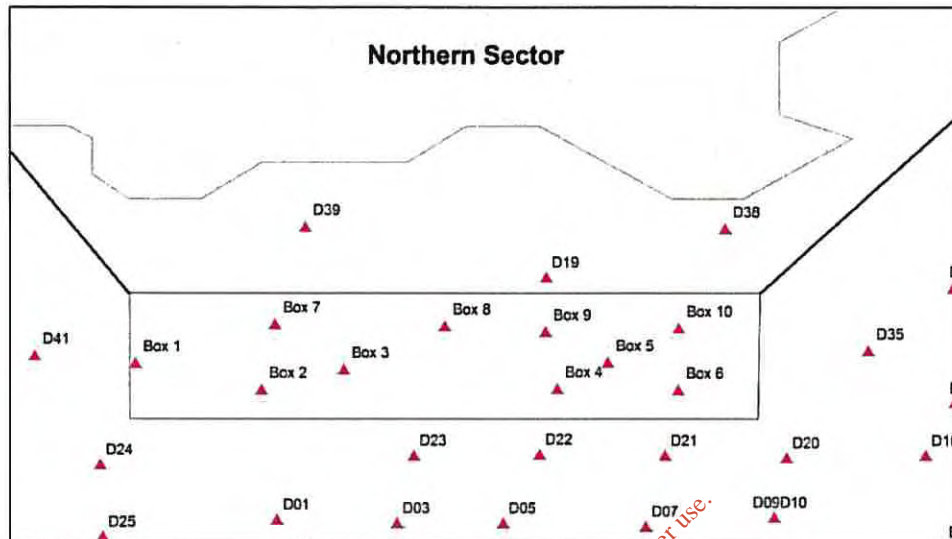


Figure 4.19 Map of Northern sector with dive positions indicated

The northern sector of the study area comprises of mostly hard ground although 2 types of habitat are identified from the video data. Table 4.9 displays the fauna identified at each site from the video footage.

Table 4.9 Fauna present at each Site from the Northern Sector Video Footage.

	Dive 19	Dive 38	Dive 39		Div e 19	Dive 38	Div e 39
<i>Asterias rubens</i> (Common starfish)	Yes	Yes	Yes	<i>Alcyonium digitatum</i> (Dead mans fingers)	Yes		
<i>Pomatoceros sp.</i> (Keel worm)	Yes	Yes	Yes	<i>Sagartia sp.</i> (Anemones indet)			Yes
<i>Filograna implexia</i> (Spaghetti worm).			Yes	<i>Urticina felina</i> (Dahlia anemone)		Yes	
Bryozoan/Hydroid Turf		Yes	Yes	<i>Trivia sp</i> (Cowry shell)		Yes	
<i>Corallinaceae</i> indeterminate crusts	Yes	Yes	Yes	<i>Trisopterus minutus</i> (Poor cod)	Yes	Yes	Yes
<i>Suberites sp</i> (Orange ball sponge).		Yes		<i>Trisopterus luscus</i> (Bib)		Yes	
<i>Cliona celata</i> (Boring sponge)		Yes		<i>Labrus mixtus</i> (Cuckoo wrasse)		Yes	
<i>Carophyllia smithii</i> (Devonshire cup coral)	Yes						

Habitat 1

This area is characterised by the presence of bedrock which is covered with a thin layer of sands and gravels. The seabed is relatively flat and there is little in the way of relief with the exception of occasional low lying rocky outcrops. There is little evidence of visible fauna with the exception of keel worms (*Pomatoceros* sp.) on the larger cobble or rocks. On some areas where larger rocks occur, Devonshire cup coral (*Carophyllia smithii*) and dead mans fingers (*Alcyonium digitatum*) are observed. This type of habitat is found in video dive 19. [Figure 4.20] This habitat type may be classified under the JNCC classification system as SS.SCS.CCS.PomB (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles).

Habitat 2

The remaining two video dives (Dive 38 and 39) revealed a rocky environment with bedrock and large boulders. The rock surfaces are covered by a faunal crust of bryozoans, hydroids and sponges. These are difficult to identify to species level from the video footage. Sheets of encrusting red coralline algae are also interspersed on the rock surfaces. Keel worms and starfish are again common in the area. Where there is more relief in the form of rocky outcrops and boulders larger more conspicuous fauna like boring sponges (*Cliona celata*), anemones (*Anthozoa* sp), Devonshire cup corals (*Carophyllia smithii*) and tunicates (*Ascidiacea*) are also present. Fish species such as bib (*Trisopterus luscus*), poor cod (*Trisopterus minutus*) and wrasse (*Labridae*) are also present on the rougher ground and are associated with these boulder communities. [Figs 4.21 – 4.22] This habitat type may be classified under the JNCC classification system as CR.MCR.EcCr (Echinoderms and crustose communities).



Figure 4.20 Mixed ground with sand, gravel, and small rocks along Dive 19. Keel worm are also present on the rocks

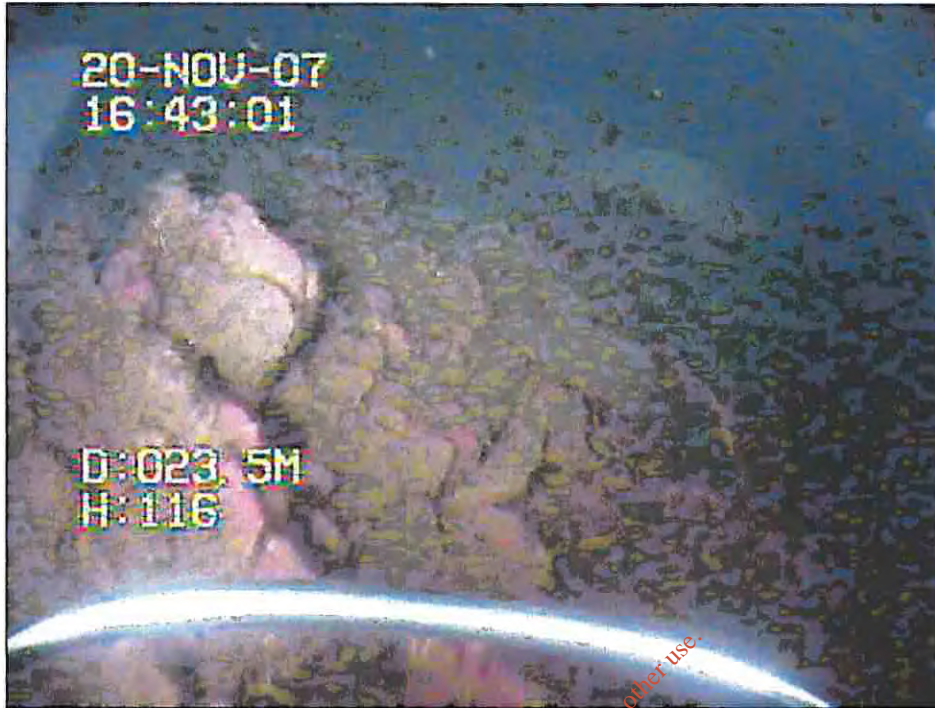


Figure 4.21 Rocky ground along Dive 38 with encrusting coralline algae and keel worm on the rocks.

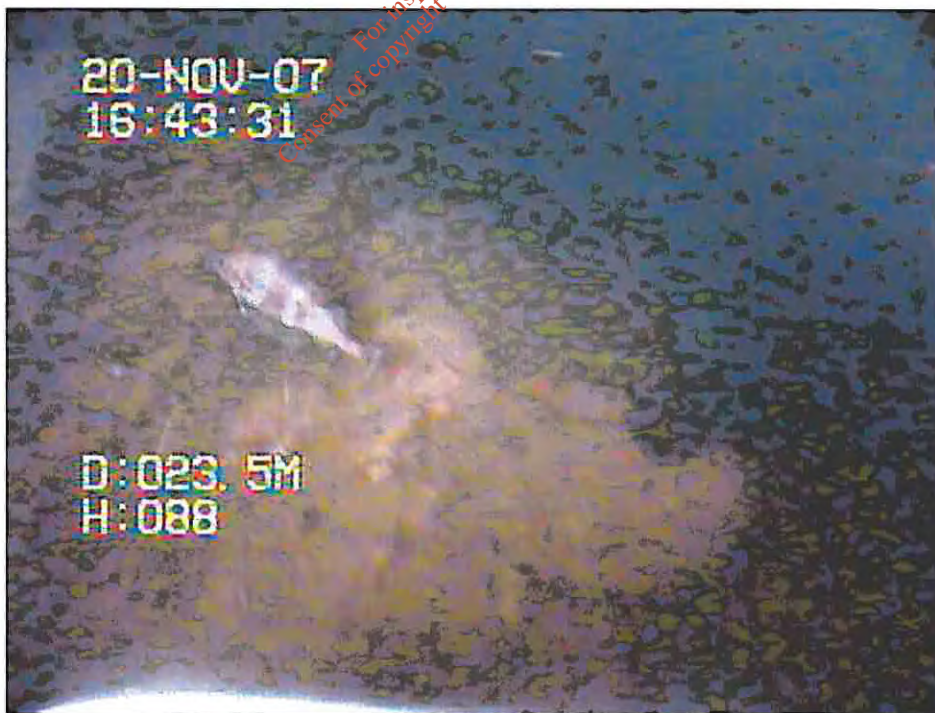


Figure 4.22 Rocky ground along Dive 38 with Bib (*Trisopterus luscus*) in the foreground.

Eastern Sector

A total of 9 video dives were performed to the eastern side of the disposal area (Figure 23).

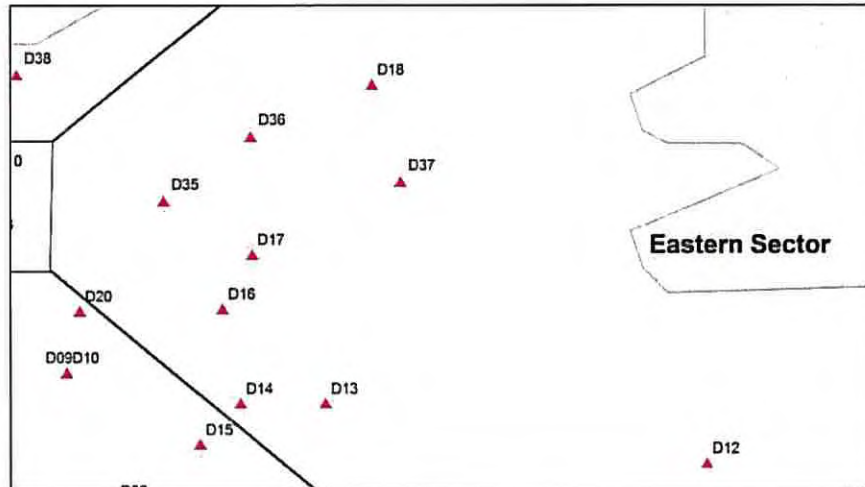


Figure 4.23 Map of Eastern sector with Dive Positions Indicated

The eastern sector comprises of a mixture of hard grounds in one area and sandy grounds in the remaining area. There are 2 main types of habitat identified from the video data. Table 11 displays the fauna identified at each site from the video footage.

Habitat 1

Moving east from the edge of the disposal area for a distance of approximately 600 meters the area is characterised by rocky ground with bedrock and rocky outcrops. This type of habitat is predominant and is found at Dives 14, 16, 35, and 36. The visible fauna is diverse and the rocky environment supports a large number of sessile organisms on the rock faces such as keel worms, a faunal mat of bryozoa, hydroids, sponges, anemones, cup corals, and dead mans fingers. There are also a number of fish species present in the video surveys with poor cod, bib and cuckoo wrasse being the most prevalent around boulders. Other small unidentified fish were also present along some of the video dives (Dive 35 and 36). [Figs 4.24 – 4.28] This habitat type may be classified under the JNCC classification system as CR.MCR.EcCr (Echinoderms and crustose communities).

Habitat 2

The remaining video dives further east in the sector (Dive 12, 13, and 37) revealed a sandy environment which supported a limited number fauna similar to the sandy sites described in the disposal area, with starfish and active burrows on the seafloor being the most common feature. A hermit crab (*Pagurus bernhardus*) and a grey gurnard (*Eutrigla gurnardus*) are recorded along Dive 37. [Fig 29] This habitat type may be classified under the JNCC classification system as SS.SSa (Sublittoral sands and muddy sands).

Habitat 3

Dives 17 and 18 has a slightly coarser sandy gravel substrate with cobble and occasional rocks. Along these dives no active burrows are observed and keel worm are present on the larger rocks. [Fig 4.30] This habitat type may be classified under the JNCC classification system as SS.SCS.CCS.PomB (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles).

Table 4.10 Fauna present at each site from the Eastern sector video footage.

	Dive 12	Dive 13	Dive 14	Dive 16	Dive 17	Dive 18	Dive 35	Dive 36	Dive 37
<i>Asterias rubens</i> (Common starfish)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Active Burrows	Yes	Yes							
<i>Pomatoceros lamarcki</i> (Keel worm)			Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Filograna implexia</i> (Spaghetti worm).							Yes		
Bryozoan/Hydroid Turf			Yes		Yes		Yes	Yes	
<i>Corallinaceae</i> indeterminate crusts							Yes		
<i>Suberites sp</i> (Orange ball sponge).					Yes		Yes		
<i>Cliona celata</i> (Boring sponge)								Yes	
<i>Esperiopsis fucorum</i> Shredded carrot sponge								Yes	
<i>Carophyllia smithii</i> (Devonshire cup coral)							Yes	Yes	
<i>Alcyonium digitatum</i> (Dead mans fingers)								Yes	
<i>Sagartia sp.</i> (Anemones indet)							Yes	Yes	
<i>Pagarus bernhardus</i> (Hermit Crab)									Yes
<i>Eutrigla gurnardus</i> (Grey gurnard)									Yes
<i>Trisopterus minutus</i> (Poor cod)			Yes	Yes			Yes	Yes	
<i>Trisopterus luscus</i> (Bib)							Yes		
<i>Labrus mixtus</i> (Cuckoo wrasse)								Yes	
Small unidentified fish					Yes		Yes	Yes	



Figure 4.24 Rocky ground with larger boulders and bib in the foreground along Dive 14.

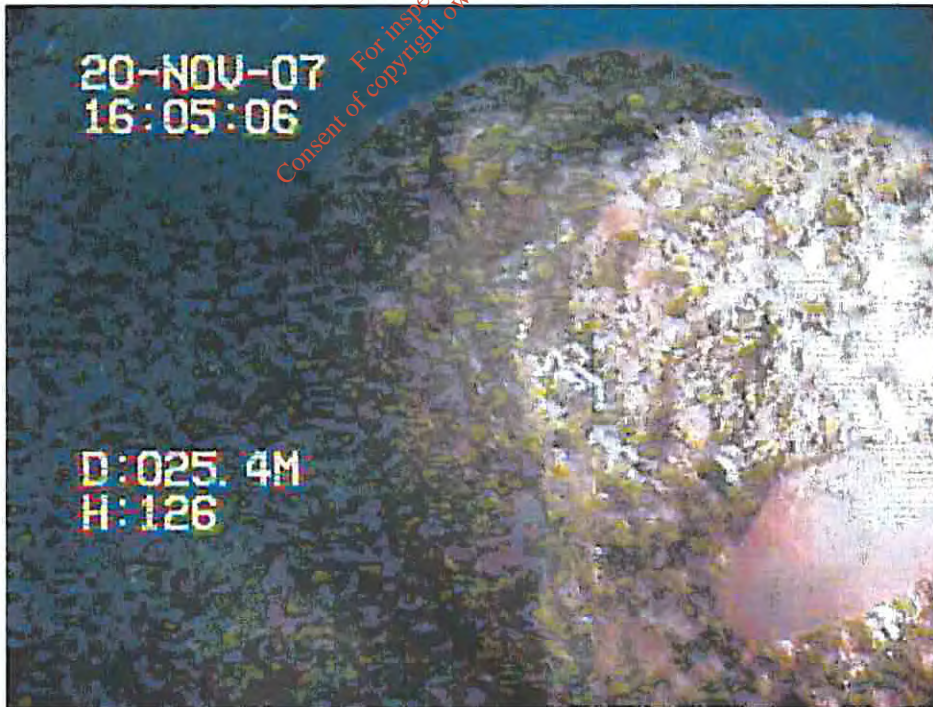


Figure 4.25 Rocky ground along Dive 35 with pink seasquirt (*Ascidia mentula*) and keel worm present on boulder face.

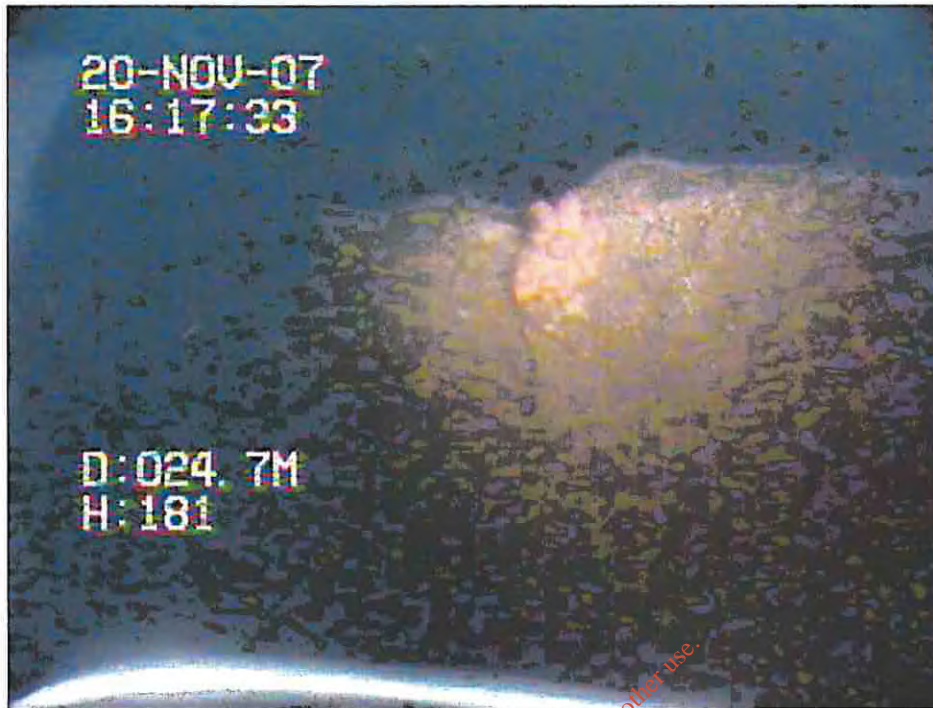


Figure 4.26 Rocky ground along Dive 36 with dead mans fingers (*Alcyonium digitatum*) on boulder face.



Figure 4.27 Rocky ground along Dive 36 with boring sponge (*Cliona celata*) and encrusting pink coralline crusts (*Corallinaceae*) on boulder face.



Figure 4.28 Rocky ground in evidence along Dive 36 with cuckoo wrasse (*Labrus mixtus*) in the background.

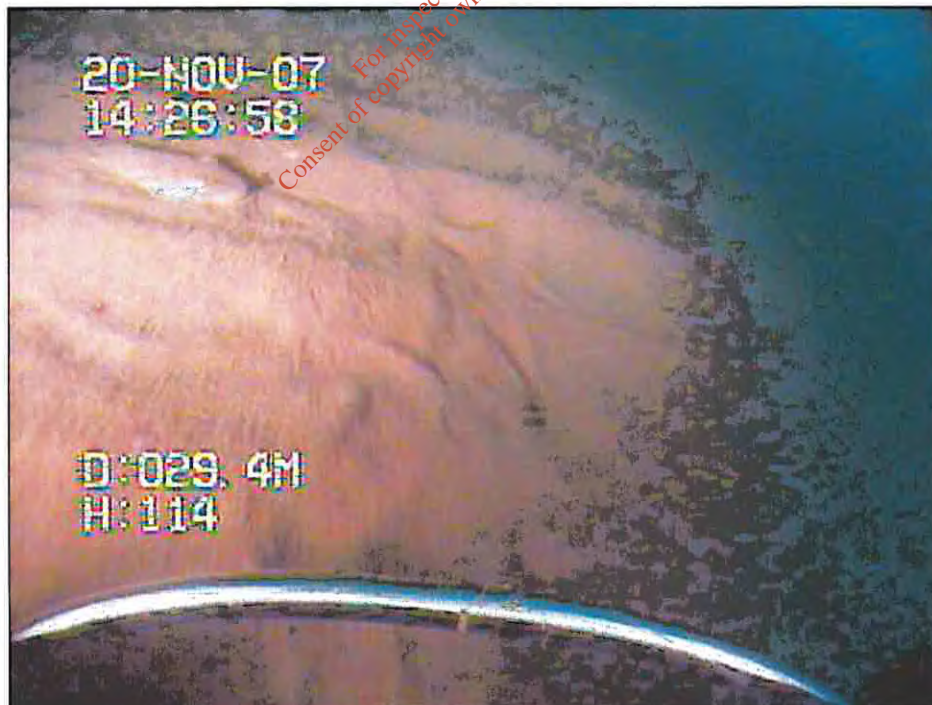


Figure 4.29 Rippled sand with grey gurnard (*Eutrigla gurnardus*) buried in the sand along dive 37.



Figure 4.30 Sand, cobble and small rocks along Dive 17.

Southern Sector

A total of 23 video dives were performed to the south of the disposal area. Three main habitat types were encountered in this sector. The positions for these video dives in the southern sector are displayed in Figure 31.

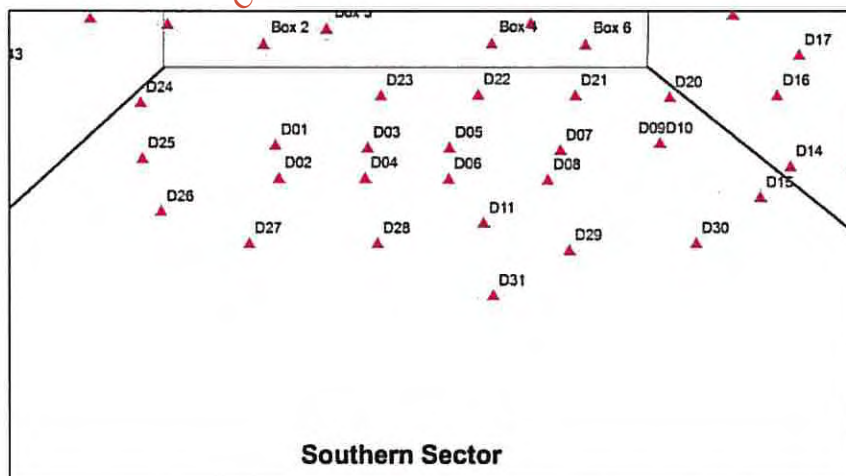


Figure 4.31 Map of Southern sector with dive positions indicated

Three main habitat types were encountered in this sector namely sandy ground, mixed sediment and rocky ground. A complete species list is presented in Table 4.11.

Table 4.11 Fauna present at each site from the Southern sector video footage.

	Dive 1	Dive 2	Dive 3	Dive 4	Dive 5	Dive 6	Dive 7	Dive 8	Dive 9	Dive 10	Dive 11	Dive 15
<i>Asterias rubens</i> (Common starfish)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Active Burrows	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
<i>Lanice conchilega</i> Sand mason										Yes		
<i>Pomatoceros</i> sp. (Keel worm)											Yes	Yes
Bryozoan/Hydroid Turf										Yes		Yes
Corallinaceae indeterminate crusts												Yes
<i>Carophyllia smithii</i> (Devonshire cup coral)										Yes		
Ascidians Unident. seasquirt												Yes
<i>Trisopterus minutus</i> (Poor cod)												Yes
<i>Alcyonium digitatum</i> (Deadmans fingers)										Yes		
	Dive 21	Dive 22	Dive 23	Dive 24	Dive 25	Dive 26	Dive 27	Dive 28	Dive 29	Dive 30	Dive 31	
<i>Asterias rubens</i> (Common starfish)	Yes	Yes		Yes		Yes				Yes		
Active Burrows	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
<i>Lanice conchilega</i> Sand mason	Yes			Yes								
<i>Pomatoceros lamarcki</i> (Keel worm)										Yes		
<i>Pleuronectidae</i> (Unident. Flatfish)		Yes										
<i>Pollachius pollachius</i> (Pollack)										Yes		
<i>Trisopterus luscus</i> (Bib)										Yes		
Small unidentified fish											Yes	

Habitat 1

For 20 of the sites surveyed, the video footage recorded a sandy substrate (Dives 1-11, and Dives 20-28). The sandy area covers the majority of the southern sector and extends from the disposal site to about 1500 meters south of it. The sandy areas are fairly homogenous and provide little in the way of visible fauna with the exception of starfish and active burrows. [Figs 4.32 and 4.33] This habitat type may be classified under the JNCC classification system as SS.SSa (Sublittoral sands and muddy sands).

Habitat 2

The seafloor along Dives 10 and 11 is a mixture of coarse sands with gravel and occasional small rocks. Where the rocks do occur they are sometimes covered with encrusting keel worm and a bryozoan/hydroid faunal mat. [Fig 4.34] This habitat type may be classified under the JNCC classification system as SS.SMx.CMx (Circalittoral mixed sediment).

Habitat 3

Rocky seafloor was only encountered on the 4 furthest points southeast from the disposal area, Dives 15 and Dives 29-31. The visible fauna on the rocks is not as diverse as similar habitats described in the Eastern sector. Keel worm is commonly present on the rock surfaces with cup corals also present on some of the rocky faces and overhangs. Fish species such as bib, poor cod and pollack are recorded during the video dives. [Figs 4.35 and 4.36] This habitat type may be classified under the JNCC classification system as CR.MCR.EcCr (Echinoderms and crustose communities).



Figure 4.32 Small sand waves with starfish along Dive 1; this habitat type is typical for Dives 1-11.



Figure 4.33 Sandy ground with Sandmason Worms (*Lanice conchilega*) Present in Lower Right Corner of Image Along Dive 28.



Figure 4.34 Mixed sediment with sands, gravel and cobble along Dive 11.



Figure 4.35 Rocky ground along Dive 15 with poor cod (*Trisopterus minutus*) shoaling over the sea floor.



Figure 4.36 Rocky ground along Dive 30 with Pollack (*Pollachius pollachius*).

Western Sector

A total of 8 video dives were performed to the west of the disposal area. Two main habitat types were encountered in this sector. The positions for these video dives in the southern sector are displayed in Figure 4.37.

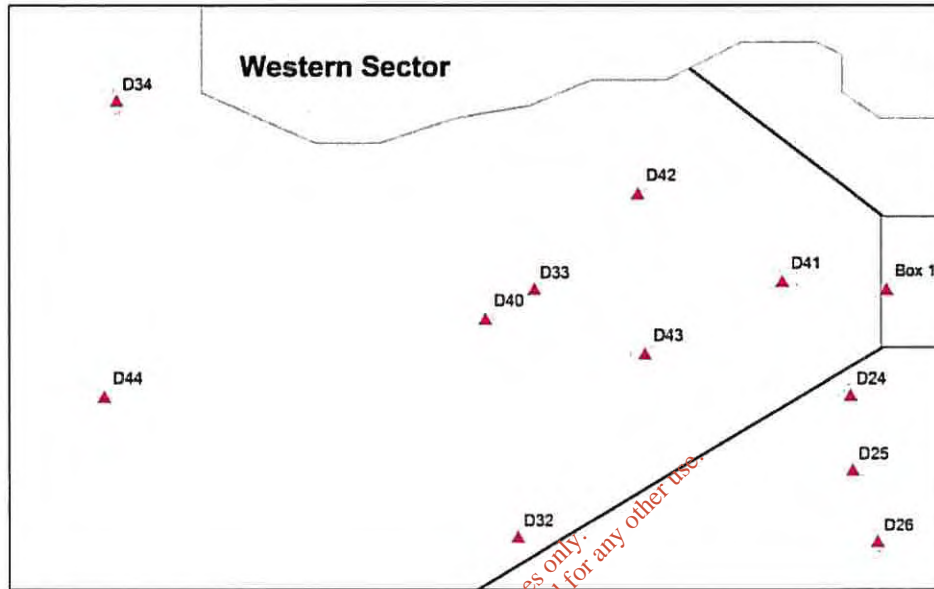


Figure 4.37 Map of Western sector with dive positions indicated

Two main habitat types were encountered in this sector namely sandy ground and rocky ground. A complete species list for all video dives is presented in Table 4.12.

Table 4.13 Fauna present at each site from the western sector video footage.

	Dive 32	Dive 34	Dive 33	Dive 40	Dive 41	Dive 43	Dive 44
<i>Asterias rubens</i> (Common starfish)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Active Burrows	Yes	Yes	Yes				
<i>Pomatoceros lamarcki</i> (Keel worm)				Yes	Yes	Yes	Yes
Bryozoan/Hydroid Turf				Yes	Yes	Yes	
Corallinaceae indeterminate crusts					Yes		
<i>Halichondria panicea</i> (Breadcrumb sponge).						Yes	
<i>Cliona celata</i> (Boring sponge)						Yes	
<i>Esperiopsis fucorum</i> Shredded carrot sponge						Yes	Yes
<i>Carophyllia smithii</i> (Devonshire cup coral)				Yes		Yes	
<i>Alcyonium digitatum</i> (Dead mans fingers)			Yes			Yes	Yes
<i>Metridium senile</i>							Yes

	Dive 32	Dive 34	Dive 33	Dive 40	Dive 41	Dive 43	Dive 44
(Plumose anemone)							
<i>Urticina felina</i> (Dahlia anemone)						Yes	
<i>Pagurus bernhardus</i> (Hermit Crab)				Yes			
<i>Ascidia mentula</i> Pink seasquirt						Yes	
<i>Trisopterus minutus</i> (Poor cod)						Yes	
<i>Trisopterus luscus</i> (Bib)				Yes			

Habitat 1

Sandy ground was encountered along the northern regions of this sector at Dives 42, and at Dive 34 in the harbour mouth. Sandy ground was also encountered along Dive 32 in the southern region of the sector. The sandy habitats supported little in the way of visible fauna with the exception of starfish and active burrows as described for previous sites. No fish species were encountered in the area. [Fig 38] This habitat type may be classified under the JNCC classification system as SS.SSa (Sublittoral sands and muddy sands).

Habitat 2

Rocky habitats were encountered at the remaining 5 dive sites namely Dives 33, 40, 41, 43, and 44. The rocky habitats varied from very rough ground with big boulders observed along Dive 40 to boulders to bedrock interspersed with gravelly sand observed along Dive 44. The rocky habitats supported a wide range of visible fauna from sessile organisms such as cup corals, dead mans fingers, anemones, tunicates and sponges. Keel worm and starfish were also common throughout the area. Fish species such as poor cod and bib were also observed in the rocky areas. [Figs 39-42] This habitat type may be classified under the JNCC classification system as CR.MCR.EcCr (Echinoderms and crustose communities).



Figure 38 Sandy ground with common starfish (*Asterias rubens*) present in lower left corner of image along Dive 32.

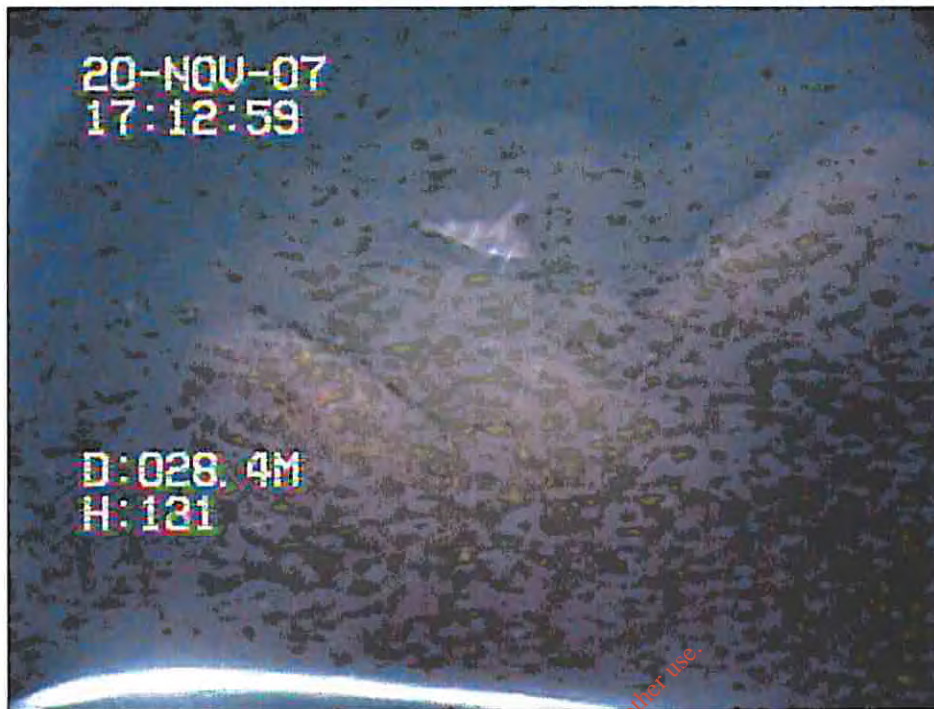


Figure 4.39 Rocky ground along Dive 40 with fish (*Trisopterus luscus*) over bedrock.

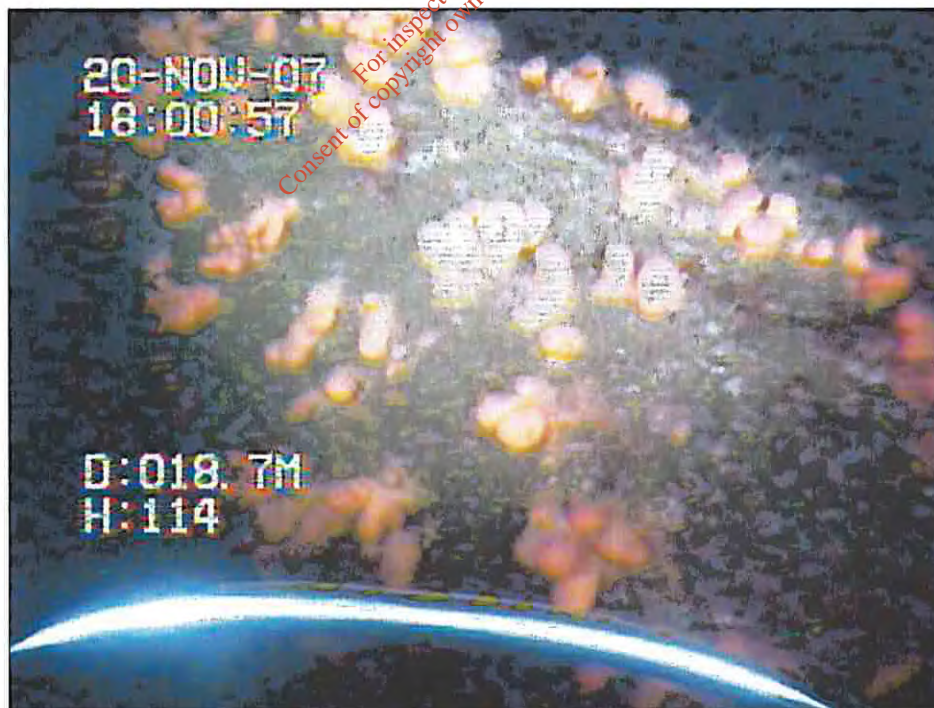


Figure 4.40 Deadmans fingers (*Alcyonium digitatum*) covering a boulder along Dive 43



Figure 4.41 Dahlia anemone (*Urticina felina*) on boulder with a coralline and byrzoan/hyroid crust covering the boulder along Dive 43.



Figure 4.42 Red seaquirts (*Ascidia mentula*) on boulder face with epifauna along Dive 43.

4.2.4 Biotope Classification

Biotope classification was undertaken on the benthic grabs, trawls and video data using the JNCC habitat classification system for Britain and Ireland (Connor *et al*, 2004). In areas where only video imagery was possible over sandy ground, classification using infauna was based on the closest benthic grabs to those video sites.

Analysis of the benthic grab and trawl samples indicates the presence of three distinct community types based on infaunal results. There is a distinct distribution of fauna based on sediment grain size across the survey area. The largest infaunal grouping present in the survey area is the SS.SMu.CSaMu (Circalittoral Sandy Mud). This grouping is dominated by the brittlestar *Amphiura filiformis*. Further classification is made difficult due the absence of other significant identifier species, although this species is characteristic of this biotope type. This biotope is typical of areas with a moderately strong to weak tidal flow, which is identified in the hydrodynamic modelling report for the area, and is reflected in the fact that this biotope contains the sites with the highest mud content in the survey area. This area also contains both trawl sites, which contain species of fish and epifauna, which would be characteristic of this type of community.

The other two faunal groupings are classified as SS.SSa.CFiSa (Circalittoral fine sands). This biotope identification is based solely on the sediment grainsize data as the lack of obvious faunal species makes further identification difficult. Analysis of the faunal data indicates the presence of two faunal groupings within this biotope. However, it is not possible to further identify these groups based on the lack of obvious key species.

Analysis of the video data identified four distinct habitat types. The most common habitat identified in the survey area based on the video data using the JNCC classification system is SS.SSa (Sublittoral sand and muddy sands). In the survey area this habitat consists of low rippled sand with little in the way of visible fauna with the exception of active burrows and starfish. This habitat is present along 6 of the video dives in the actual disposal area, 3 dives in the eastern sector, 18 dives in the southern sector, and 2 dives in the western sector.

A second sandy habitat type identified from the video data is characterized by coarser sands and gravels and mixtures of these sediment types. For the survey area, these areas are characterised by little in the way of visible fauna with the exception of starfish and occasional keel worms (*Pomatoceros sp.*) on the larger cobble or rocks. There may also be small patches of bryozoans on some of the smaller rocks. This habitat type can be described as SS.SMx.CMx (Circalittoral mixed sediment) under the JNCC habitat classification system. This habitat is present along 3 dives in the disposal site and along two dives in the southern sector.

Over rocky ground two distinct habitat types were encountered in the survey area. The most common rocky habitat encountered during the current survey ranges from low-lying bedrock with occasional boulders to bedrock with relief in the form of large boulders. This type of habitat has previously been described by the JNCC as CR.MCR.EcCr (Echinoderms and crustose communities on moderately exposed circalittoral rock). The fauna encountered in

this habitat type is sparse with echinoderms and low profile faunal and algal crusts dominating this habitat. The fauna is also tolerant to the wave-exposed conditions experienced during storm events (Conner *et al*, 2004). At the Dingle site, this habitat type occurs frequently and keel worm, encrusting coralline algae (*Corallinaceae*), and bryozoans and hydroids are common on the rock surfaces. On and around the boulders dead mans fingers (*Alcyonium digitatum*), cup corals (*Carophyllia smithii*) and the echinoderm (*Asterias rubens*) occur frequently. The boulder areas have a more diverse fauna than the areas with low-lying bedrock. This is likely a result of additional niches available for animals to colonise such as the vertical faces of boulders, overhangs, and possibly different exposure conditions. This habitat type occurs along 2 video dives in the northern sector, along 4 dives in the eastern sector and southern sector, and along 5 dives in the western sector. This habitat type was not encountered within the proposed disposal area.

The second rocky habitat type identified over rocky ground occurs in the mixed pebble/cobble ground in the survey area. The JNCC classification for the cobble pebble habitats in moderately exposed circalittoral cobbles and pebbles is SS.SCS.CCS.PomB (Pomatoceros triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles). In the Dingle survey area these cobble pebble areas support little in the way of visible fauna with the exception of keel worm, starfish and bryozoan and algal crusts. This type of habitat is rare in the survey area occurring at only one location within the disposal area, a single location within each of the northern and southern sectors and in two locations along the eastern sector.

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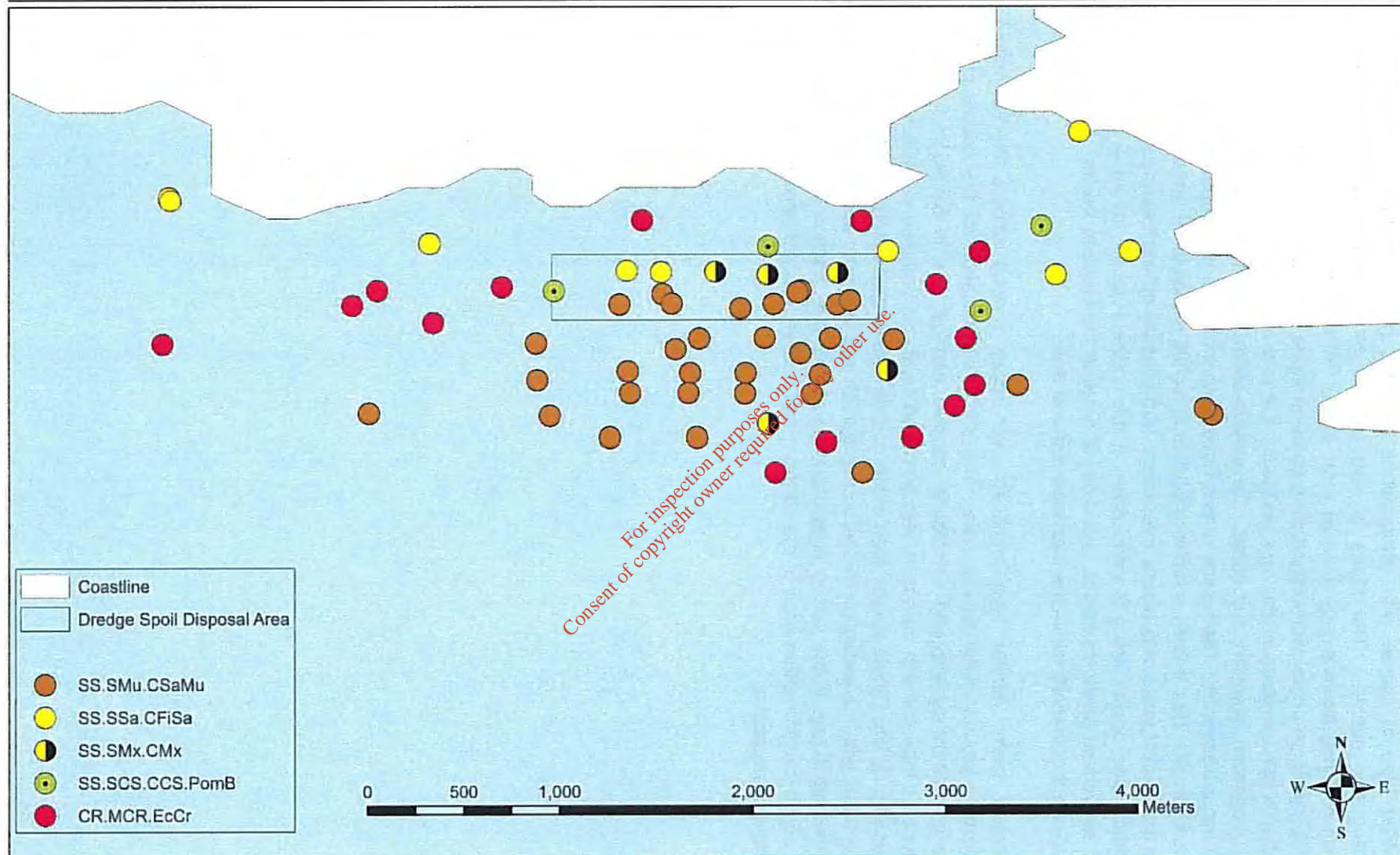


Figure 4.43 Location of Biotope Types within the Dingle disposal site survey area.

4.3 DISCUSSION

4.3.1 Benthic Impact Hypothesis

The current proposal is to dredge circa 300,000m³ of sediment from the channel within Dingle Harbour. It is proposed to dump this dredge spoil at the proposed dumpsite located 2 kilometres from the mouth of Dingle Harbour.

Results from the present survey indicate the presence of 4 distinct faunal communities ranging from fine sands and muddy sands to bedrock communities within the proposed disposal site and its immediate vicinity.

Dumping of dredge spoil on the seabed can have several effects on benthic communities which include:

- smothering from dredge spoil deposited on the seabed
- habitat loss if the dredge spoil differs physically from the existing sediment type
- impacts from disposal plumes on benthos outside the area of the proposed disposal site
- toxicity from contaminants within the dredge spoil

Smothering

The current hydrodynamic model indicates that the proposed site is classified as a low energy site with very little dispersion qualities. As a result, the current hydrodynamic model indicates a deposition of over 1½ meters of sediment (based on an approximate sediment density of 1800 kg/m³). The sediment which will be deposited in the dredge spoil disposal area consists of coarser sediment (dredged sediment consists of 40% Gravels, 40% Sands, 20% Muds compared to the present mean values on site of 0.1% Gravel, 80% Sands, 21% Muds). The model indicates that the site is as low energy site, and predicts little movement of sediment from the disposal area, except during storm events.

The most common biotope within the disposal area is the sandy mud community (Circalittoral Sandy Mud). This extends across the central and southern parts of the disposal area and is dominated by the brittlestar *Amphiura filiformis* and fauna typical of a sandy mud/muddy sand matrix. In addition, the starfish *Asterias rubens* is common in the area (both in the trawls and the video surveys). This biotope type also extends to the south of the disposal area and is the most dominant habitat type identified in the survey area.

Although there is a significant body of literature indicating that benthic infauna have the capability to survive episodic sediment burial, this is limited to <0.5m of similar sediment (Essink, 1999). Therefore, while the organisms present within the disposal area are adapted to moving through the sediment in case of burial, the expected deposition of >1m will exceed their burrowing capacity resulting in smothering. It should be noted, however, that the area affected is relatively small (36.75ha) and that a similar habitat type is present within the immediate vicinity, providing new recruits to colonise the deposited spoil (Fig. 4.43).

Previous studies undertaken at dredge spoil disposal grounds have indicated a recovery rate of between ½ - 2 years (Smith & Rule, 2001; Simonini *et al*, 2005; Angonesi *et al*, 2006;

Powilleit *et al*, 2006). At each of these study sites, the deposited dredge spoil showed negligible levels of contamination and contained a similar sediment structure to the sediment within the disposal area. Although the dredge spoil to be disposed of at the Dingle site is free of contamination, there is expected to be a significant change in the sediment composition at the site. There will be a significant shift from fine sediments to coarser mixed sediments and its associated communities are likely to resemble (in time) more those identified along the north-eastern section of the disposal area, where the sediment composition is also coarser in nature. Thus, it is expected that the communities present in the immediate disposal area will change from SCS.SSa.CFiSa (Circalittoral fine sands) and SS.SMu.CSaMu (Circalittoral muddy sands) to SCS.SMx.CMx (Circalittoral mixed sediments) following disposal.

This type of community is characterised by a greater numbers of epifaunal species such as *Pomatoceros triqueter* and various hydroids. In addition, given the mixed nature of the sediment which will be deposited, this will give rise to mosaics of cobble, gravel and pebbles which will overlay the existing muddy sand/sandy mud deposits at the site. This will give rise to a more diverse infaunal community than at present. It is expected that the species in question will immigrate into the area from similar habitats in the surrounding area. These faunal elements would be similar to those currently at the site, but species relative abundances are likely to vary.

The time it will take for the re-development of a stable infaunal community at the disposal site is uncertain. However, significant development should have occurred after 3 years.

Changes in Sediment Matrix

Particle size analysis of the dredge spoil indicates that the sediment to be deposited in the disposal area is different (mean dredge spoil sediment matrix – 40% Gravels, 40% Sands, 20% Muds) to that which is already present in the area (mean disposal area sediment matrix – 0.1% Gravel, 80% Sands, 21% Muds). A change to coarser sediment is expected to occur. This will result in a change from muddy sands, which currently dominate the site to muddy gravely sands. Because of the low energy nature of the site, this is expected to remain stable over the course of a number of years.

Impacts Outside the Proposed Disposal Site

Benthic infauna which are subjected to stress events, such as those exposed to irregular storm events, are resilient to changes in sediment levels in the water column. As such, the communities identified are well adapted to short term increases in suspended sediment levels in the water column and it is not expected that there will be any significant impact from associated suspended levels in the water column following dredge spoil disposal at the site.

However, there are several areas immediately to the east of the proposed dredge spoil disposal area which are characterised by the presence of sessile epifaunal communities on boulders and bedrock. These communities are dominated by the cnidaria Dead man's fingers (*Alcyonium digitatum*), sponges (*Cliona celata*), keelworms (*Pomatoceros* sp.) and other epifauna. These communities would be expected to be exposed to increased levels of suspended sediment during dumping of the dredge spoil. The location of these communities

to the east of the proposed disposal site indicates that these are subjected to residual sedimentation from the storm events which frequent the area, and as such these communities would be acclimated to such increases in suspended sediment and associated turbidity.

Toxicity from Contaminants

The levels of contaminants in the dredge spoil are classified as negligible and are not expected to pose any significant threat to the benthos within the proposed disposal area.

4.3.2 Residual Impact

Results from the current survey indicates the community present within the dredge spoil disposal area will be removed as a result of direct smothering of the disposed sediment. However, due to the low energy nature of the site, it is expected that this impact, although locally severe, will remain restricted to the disposal area. Because of the coarser nature of the dredge spoil, a change in communities is expected to occur within the footprint of the disposal site. The community type, which is expected to occur, would contain species more adapted to coarser sediments, similar to those found in the mixed sediment communities present in the region.

4.3.3 Mitigation

As it is not possible to mitigate against the effects of smothering in such a small area, it is recommended to carry out the dredging and disposal of the dredge spoil at a time which would facilitate the rapid recolonisation of the disposed sediment. As such, it is recommended to carry this out in early Spring/late Winter to facilitate the rapid recolonisation by means of larval migration.

4.3.4 Recommendations

It is recommended that a follow up survey be undertaken in the area 24-36 months post cessation of disposal to assess the recovery of the site.

5.0 FISHERIES

5.1 COMMERCIAL FISHERIES

The outlined dump site sees very little fishing activity. Rarely, up to 3-4 boats may pot for crabs (July-September) but this is far from good crabbing ground. Chartered boats (up to 6 licensed in the area) do not visit the site for angling but do fish about 0.5-0.75 miles to the south west of the site in an area known as 'the Hole', mainly for pollack (white and black).

There are 8-9 inshore lobster boats fishing the general area but the site is rarely, if ever, used for lobster fishing as the ground is not hard enough, aside from one small area. Most lobster fishing is along the shore inshore from the dump site. V-notching is undertaken in the Dingle area for lobster conservation.

The nearest herring fishing area is out at Slea Head or out toward Caherciveen; there is no herring spawning in the area of the dump site. To the south of the dump site trawlers might make 2 to 3 passes per year but not in the dump site area itself.

The area is subject to high swells and water movement from the SW during storms.

5.2 WILD FISHERIES

The sites is probably used as a feeding area for demersal species such as plaice, dab, flounder, lemon sole, whiting, dragonet, rays and gobies, and the bean trawls revealed sole (*Solea solea*). In addition, the small areas of hard ground may in addition have wrasse, pollack and the video survey showed *Trisopterus* spp. While some of the smaller bottom-dwelling species may be directly impacted by the dumping, the main impact is likely to be a reduction in the local feeding in the dumping footprint for one or two seasons, after which, with the return of infaunal and epifaunal diversity and biomass, the site should again regain much of its fisheries carrying capacity. In the context of the wider Dingle Bay, this impact can be considered temporary and very localised.

6.0 MARINE MAMMALS

6.1 INTRODUCTION

This section of the report details the potential risks to marine mammals and recommendations for mitigation measures related to the proposed dredging and blasting works in the development of Dingle Harbour, Án Daingean, Co. Kerry according to the proposed construction plan provided. This report is based on a site visit including three marine mammal surveys in the area, information from published and unpublished literature and communication with local relevant authorities and expert knowledge.

Dingle Harbour is a shallow, enclosed bay consisting of a sandy and rocky intertidal area and a shallow sublittoral basin with a dredged channel for vessel access to the inner harbour and marina. For the purposes of this report the Harbour can be considered to be comprised of three areas, the inner harbour including all waters within the entrance channel, the narrow entrance channel marked by the lighthouse, and the outer harbour including waters outside of the narrow channel and lighthouse but within the area between Beenbane Point and Reenbeg Point.

Sounds generated by blasting and dredging activities will likely be mainly confined to the waters within the harbour itself and the waters immediately adjacent to the harbour mouth with a minimal risk of sound and disturbance to animals in waters in Dingle Bay. However, any marine mammal within the Harbour and at the mouth of the harbour will be exposed to acute and chronic effects of the development works. The exclusion zone referred to in this report includes the entire harbour area the entrance to the harbour and the outer harbour as far as a line between Beenbane Point and Reenbeg Point.

6.2 LEGISLATION PERTAINING TO MARINE MAMMALS IN IRISH WATERS

Marine mammals are protected by national legislation and by a number of international regulations which the Republic of Ireland is signatory to. The main legislation that affords protection to marine mammals in Irish waters is the Wildlife Act (1976) amendment Act (2000), which prohibits willful interference to wild mammals and disturbance of resting and breeding sites.

All cetacean (whales, dolphins and porpoises) species occurring in European waters are now protected under the EU Habitats Directive. All cetaceans are included in Annex IV of the Directive as species 'in need of strict protection'. Additionally harbour porpoises (*Phocoena phocoena*) and bottlenose dolphins (*Tursiops truncatus*) are listed in Annex II of the Directive as species requiring the designation of Special Areas of Conservation). Ireland's two pinniped (true seals) species harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) are also designated Annex II species under the EC Habitats Directive. The Republic of Ireland is also signatory to conservation agreements under the Bonn Convention on Migratory Species (1983), the OSPAR Convention for the Protection of the Marine Environment of the northeast Atlantic (1992) and the Berne Convention on Conservation of European Wildlife and Natural Habitats (1979).

In light of the legislation and conservation status of marine mammals, careful consideration must be given during all anthropogenic activity with potential effect on marine mammal species and their habitats.

6.3 POTENTIAL EFFECTS ON MARINE MAMMALS

6.3.1 Blasting

Noise associated with the planned works represents a source of acute acoustic disturbance in the marine environment with associated noise disturbance throughout the entire blasting period. Blasting operations and shipping traffic produce sounds with combined low and high frequency components (Goold, 1996), which may potentially affect both the low frequency-sensitive baleen whales and pinnipeds and high frequency-sensitive toothed cetaceans (odontocetes). Noises caused by blasting likely include; vessel activity, drilling of the charge sites, rock breaking activities and removal of displaced rock material in addition to the actual detonation of the charges.

Documentation of biological damage from high-level sound may be categorized as either direct injuries (lethal, sub-lethal or non-lethal) or indirect effects (changes in behavioural or distribution patterns). Explosions produce shock waves, which at short range can cause severe physical injury or death. Effects are likely to be most severe in near-surface waters where cavitation caused by the reflected shock wave creates a region of negative pressure. Organs most susceptible to damage are those with a boundary of different tissue densities in particular within the auditory system (Ketten *et al.*, 1993). The physiological effect of exposure to loud underwater noise can include temporary or permanent shifts in hearing thresholds, which degrade an animal's ability to forage and carry out other activities that depend on auditory acuity such as communication, navigation and mating. Playback experiments of drilling sounds in the presence of cetaceans have shown avoidance reactions and reduction of calling rates by various baleen whale species (Richardson *et al.*, 1995).

Studies on the responses of marine mammals to anthropogenic noise have identified the following factors as influencing the degree of response given by animals: (i) source intensity levels, (ii) degree of background noise, (iii) distance to source, (iv) species involved, (v) behavioural state, season, time of day (vi) prior degree of exposure and (vii) age and sex of the individual (Anguilar *et al.*, 2004). The peak pressure, duration and the frequency spectrum of anthropogenic sound are important factors relating to potential biological impacts. Several studies have examined the direct and indirect impacts of blasting activities on marine mammals and in general have indicated that source levels of 180-200dB P-P re 1 μ Pa are sufficient to induce behavioural effects on marine mammals within a few kilometres of the sound source (Gausland, 2000). Phocid seals are more sensitive than small odontocetes to noise of low frequency and are therefore potentially more susceptible to disturbance from low frequency anthropogenic noise (Thompson *et al.*, 1998). The National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA) in the US has established criteria for determining non-lethal injury (Level A harassment) and non-injurious harassment (Level B harassment) from underwater

explosions. For non-lethal injury from explosives the criteria are established as the peak pressure that will result in (i) the onset of slight lung hemorrhage, or (ii) a 50-percent probability level for a rupture of the tympanic membrane. These are injuries from which animals would be expected to recover on their own. The maximum horizontal extent for mortality/lethal injury and non-lethal injury, estimated based on a total charge weight of 37lb (16.8kg) would be less than 1875 ft (571 m) and 3750 ft (1143 m) respectively (Payne, 2005). These distances are based on an open-water charge calculation however, and other factors such as water depth, topography and confined (stemmed) blasts result in a significant change in the strength of the pressure wave released as compared to an open water blast. Furthermore, the topography of the surrounding area will have an effect on the transmission of the energy from the blast site and this must be considered on a site specific basis when planning blasting in a confined harbour such as Dingle. Any marine mammal within the locality of blasting will be exposed to potential damage or disturbance effects. In addition the length of period that blasting occurs will have an effect on the risk of displacement of local marine mammals. Any mitigation to blasting activities must ensure that marine mammals within a predefined exclusion zone are not exposed to blasting sounds. This may well be problematic for operators and may conflict with health and safety constraints of laying and exploding the charges. Specifically planned blasts must be able to be aborted in the event of marine mammals entering the exclusion zone after the charges are laid.

In summary potential effects of blasting/drilling on marine mammals include:

- Physical injury or death of individuals resulting from close range exposure.
- Chronic hearing damage from short/medium range exposure.
- Temporary or permanent displacement as a result of noise disturbance caused by the drilling and blasting activities.
- Long term effects resulting from habitat degradation such as prey species depletion.
- Short term effects on foraging and navigation abilities from sediment disturbance.

6.3.2 Dredging

Benthic dredging activity can result in significant short-term and long-term damage to the biological environment. Dredging will alter characteristics of benthic habitats with subsequent effects on prey distribution and abundance and impact on marine predators. However, the severity of impact on marine mammals will be determined by the extent and duration of dredging activity. In addition to the physical act of sediment removal, dredging activities will result in potential disturbance to marine mammals through increases in vessel activity and increases in local ambient marine noise levels. Furthermore, the suspension of disturbed particles in the water column will affect water quality and turbidity and the health and status of the aquatic community of organisms living within the impacted area.

In summary potential effects of dredging on marine mammals include:

- Physical injury or death of individuals resulting from collisions with operator vessels.
- Chronic hearing damage or disturbance/displacement as a result of noise.

- Consumption of contaminated prey items resulting from contaminants entering the food chain (where contaminated substrates are disturbed).
- Displacement resulting from effects on available prey.
- Displacement caused by disturbance from noise and proximity of dredging activities

6.4 MARINE MAMMALS IN THE AREA

It is necessary to determine which species of marine mammals use the immediate and adjacent areas and the abundance of animals and the time spent in the area and surrounding waters in order to estimate the likely significance of any impacts resulting from the proposed development.

6.4.1 Cetaceans

There are 24 species of cetacean recorded in Irish waters (Berrow and Rogan, 1997, Berrow *et al.*, 2002) It is possible that any of these species may enter the waters of Dingle Bay adjacent to Dingle Harbour. However, based on species' ecology and sighting records, cetacean species most likely to use waters adjacent to Dingle Harbour in Dingle Bay include minke whales (*Balaenoptera acutorostrata*), fin whales (*Balaenoptera physalus*), humpback whales (*Megaptera novaeangliae*), harbour porpoises (*Phocoena phocoena*), bottlenose dolphins (*Tursiops truncatus*), Risso's dolphins (*Grampus griseus*) killer whales (*Orcinus orca*) and common dolphins (*Delphinus delphis*) (Evans, 1992, Berrow *et al.*, 2001; Ingram, 2000; Ingram *et al.*, 2001 and 2003; Rogan *et al.*, 2001; Ó Cadhla *et al.*, 2004).

Minke Whale

The most common species of baleen whale found around Irish coasts, the minke whale is frequently recorded around all parts of the west coast (Pollock *et al.*, 1997, Berrow *et al.*, 2002; O'Cadhla *et al.*, 2004; Berrow *et al.*, 2002). Research conducted in UK waters suggest that the species moves southwards to inshore Atlantic Margin waters in spring and summer remaining until late autumn following which numbers decline (Pollack *et al.*, 2000; Northridge *et al.*, 1995). Minke whales have been sighted in near inshore waters in southwest Ireland (Roycroft *et al.*, 2007; P. Dower, NPWS *pers. comm.*) and is the most frequently reported coastal baleen whale species in Irish waters. This coastal distribution, potentially exposes minke whales to anthropogenic noise resulting from coastal developments such as the proposed harbour works more than other species of large whale. It is unlikely however that there is a direct threat of physical injuries to individuals from the blasting and dredging proposed as there are no records of this species within Dingle Harbour. Minke whales have been reported within Dingle Bay particularly off Sleah Head (pers obs.; www.iwdg.ie) and sound transmission to waters outside the harbour from blasting may cause behavioural changes such as avoidance or displacement. However as the work is short-term and the area does not support significant numbers of minke whales it is unlikely that the proposed work will impact on this species.

Fin and humpback whales

Fin whales and humpback whales are large species of baleen whale considered to be relatively common in the north east Atlantic. The continental shelf may form an important

migration guide for these species as they move between high latitude summer feeding grounds and low latitude wintering grounds (Evans, 1987). Fin whales and humpback whales although generally distributed offshore have been reported closer to shore in Ireland by the Irish Whale and Dolphin Group (www.iwdg.ie) in particular along the south coast during summer and early winter months. There are 2 records of humpback whales within Dingle Bay (www.iwdg.ie) and no records of either species within Dingle Harbour. It is highly unlikely that the proposed works will impact on these species.

Harbour Porpoise

Europe's smallest cetacean species, the harbour porpoise is likely the most abundant cetacean species in Irish waters. Sightings reports are relatively common off southern, western and southwestern coasts of Ireland and in the Irish Sea (Northridge *et al.*, 1995; Hammond *et al.*, 1995; Pollack *et al.*, 1997; O' Cadhla *et al.*, 2004; Berrow *et al.*, 2001; Roycroft *et al.*, 2007). The species is listed as qualifying interest for the nearby Blasket Islands Special Area of Conservation (SAC) and recent studies suggest densities of up to 1.33 per km² and up to 760 porpoises using the area during September (Berrow *et al.*, 2007). Densities of harbour porpoise are thought to be greater off the southwest coast compared to other parts of Ireland (Rogan & Berrow, 1996; Reid *et al.* 2003). The small size of harbour porpoises and their erratic surfacing behaviour make them difficult to detect but it is likely that they occasionally use the waters within Dingle Harbour and are therefore potentially vulnerable to the proposed works.

Bottlenose Dolphin

A coastal species of cetacean commonly sighted in western Irish waters (Evans, 1992, Pollock *et al.*, 1997) bottlenose dolphins are numerous in the southwestern coastal waters of Ireland (Ingram and Rogan, 2002; Ingram and Rogan, 2003; Ingram *et al.*, 2003). Bottlenose dolphins are a wide-ranging species and individuals commonly travel between coastal regions especially during the summer months (Ingram *et al.*, 2003). The Shannon Estuary in its entirety is Ireland's only designated SAC for bottlenose dolphins and represents a critical habitat of international importance for the species (Ingram and Rogan 2002). Approximately 140 dolphins have been estimated to use the SAC (Englund *et al.*, 2007) and the Shannon does not represent the geographic ranging limits of these protected animals. It is likely that members of the Shannon Estuary population and other coastal bottlenose dolphins frequent Dingle Bay and enter Dingle Harbour, indeed bottlenose dolphins are the most commonly reported species within Dingle Bay with 4 sightings (other than Fungi) reported within the actual Harbour by the IWDG since 1990 (www.iwdg.ie). In addition, bottlenose dolphins are attracted to vessel activity, making them potentially vulnerable to physical harm from boat based industrial activities.

6.4.2 The resident bottlenose dolphin, 'Fungi'

Of particular concern is the resident bottlenose dolphin 'Fungi' that remains in Dingle Harbour and adjacent waters year-round. Fungi has been present in the area since the mid 1980's (Fitzgibbon, 1988) and a considerable local dolphin tourist infrastructure has developed, including dolphin watching boat trips, diving equipment hire and a dolphin

exhibition. In the mid 1990s Fungi was attracting up to 75,000 visitors each year and was estimated to be worth an €4 million to the local economy (Hoyt, 1995). Notwithstanding the significant economic benefits and environmental awareness that Fungi has brought to the area in the last two decades, Fungi is protected under national and international conservation legislation as outlined in *Section 2* and as potential detrimental effects from the proposed works include lethal or non-lethal physical injuries and/or behavioural responses outlined in *Section 6.3.1.* Fungi should be considered as extremely vulnerable to potential detrimental disturbance from industrial activities associated with the proposed harbour development and these activities should not be conducted whilst Fungi is present within the Harbour or at the harbour mouth. The limited ranging behaviour of Fungi within Dingle Bay make it likely he will be within hearing range of all sound sources resulting from the development works. In addition to acute disturbance from acoustic activity, Fungi will be vulnerable to potential long term chronic habitat degradation resulting from disturbance of the benthic environment through dredging and benthic disturbance. Bottlenose dolphins feed on a wide range of species in the wild however Fungi relies on prey available within the harbour and degradation of the community of aquatic species supporting these prey species and direct effects on the prey themselves will have an indirect negative effect on his health and survival probability. Fungi is highly habituated to people and vessels and is unlikely to respond to disturbing activities as would other free ranging wild bottlenose dolphins. As a result of this habituation Fungi may not leave the harbour or may approach the works site when potentially dangerous levels of sound are produced thus exposing him to potential harmful levels of noise.

Fungi hasn't lived outside the Harbour for the majority of his adult life and it is impossible to know whether he is capable of living permanently outside the harbour, thus if he is permanently displaced from the harbour due to the development activities his survival may be under a continued threat.

Fungi is an extremely high profile animal and a major public attraction. As a consequence, concerns regarding his welfare will be of a high priority amongst local and non-local people. There is a high risk of a strong public reaction and high profile media coverage relating to potentially disturbing activities and a danger that subsequent deleterious effects, death or permanent displacement of the resident dolphin may be perceived to have resulted from or to have been associated with this development.

Common Dolphin

Although a mainly oceanic species, common dolphins have been frequently observed in large schools around the coasts of Ireland (Pollock *et al.*, 1997; Gordon *et al.*, 1999) and it is the most commonly stranded cetacean around the Irish coast (Berrow & Rogan, 1997, Murphy, 2004). Mobile schools of common dolphins seen in coastal waters tend to be foraging for shoaling fish species and sightings are frequent in southwest Ireland (P. Dower, NPWS *pers. comm.*; Ingram *et al.*, 2005 Roycroft *et al.*, 2007). Common dolphins are attracted to vessels and are easily sighted and identified and have frequently been reported by the IWDG within Dingle Bay (www.iwdg.ie). It is unlikely that the proposed works will impact upon common dolphins in the area as they do not frequent the harbour area, however mitigation measures outlined in *Section 6.6* will minimise potential impacts of the proposed

works in the event of their entering the Harbour immediately prior to or during blasting and dredging activities.

Risso's Dolphin

In Ireland, Risso's dolphins have generally been recorded close to the coast with highest numbers of sightings between August and February (Pollack *et al.*, 1997; 2000). A large and robust species, readily recognised by their distinctive scarring patterns and large size Risso's dolphins are slow moving and often seen in small schools around the west coast (Berrow *et al.*, 2002). Risso's dolphins will not usually approach vessels and tend to be evasive. Although there have been no reports of Risso's dolphins in Dingle Harbour, it is possible given their coastal distribution, that they may occasionally enter the area. It is unlikely that the proposed works will impact upon this species but in the event of Risso's dolphins entering the Harbour during operations, mitigation measures outlined in Section 6.6 will minimise potential impacts of the proposed works.

6.4.3 Pinnipeds

Harbour seal

Harbour seals (also known as "common seals") have established themselves at inter-tidal, terrestrial colonies (or haul-outs) along all coastlines of Ireland, which they leave when foraging or moving between areas, for example, and to which they return in order to rest, suckle young, and engage in social activity. These haul-out groups of harbour seals have tended historically to be found among inshore bays and islands, coves and estuaries (Lockley, 1966; Summers *et al.*, 1980), particularly around the hours of lowest tide. The southwest of Ireland is of national importance to harbour seals where over one-third of the estimated national population use haul-out sites and the surrounding waters (Cronin *et al.*, 2007). The majority of haul-out sites are located south of Dingle Bay, within Kenmare River, Bantry Bay, Dunmanus Bay and Roaringwater Bay and Dingle Bay does not contain any haul-out groups of significant size. A national aerial census of harbour seals in Ireland during 2003 identified haul-out sites in inner Dingle Bay where a group of 9 harbour seals were counted, approximately 20km from the proposed works. No harbour seals were recorded within Dingle Harbour during that survey (Cronin *et al.*, 2007).

Harbour seals are most vulnerable at their terrestrial haul-out sites during breeding and moulting periods. These events occur between June and September in Ireland. The surrounding waters are also likely to be critical habitat for harbour seals, for feeding and/or for navigation between haul out sites and foraging areas. A recent study (Cronin, 2007) on the haul-out behaviour of harbour seals in southwest Ireland found that harbour seals spend up to 80% of their time at sea. Similar behaviour patterns have been seen in studies of harbour seals in Scotland (Thompson & Miller, 1990). Unlike grey seals harbour seal adults continue to forage during the breeding season (Bonnes *et al.*, 1994). In addition the mating strategy is based on males diving and calling at aquatic display sites (Van Parijs *et al.*, 1997, 2000, Hayes *et al.*, 2004). Disturbance from anthropogenic noise during this period could potentially affect mating success. Despite the fact that there are no significant haul-outs for harbour seals in the vicinity of the proposed work, considering the relatively large population

of harbour seals using waters in southwest Ireland there is the potential for harbour seal use of the waters of Dingle harbour and thereby to be potentially affected by blasting and dredging.

Grey seal

Grey seals are distributed throughout Irish coastal waters and commonly seen hauled out on more exposed shores than the harbour seal (Kiely, 1998). The grey seal colony on the nearby Blasket Islands is of national importance with between 650-850 seals using the islands during the breeding season (Cronin *et al.*, 2007b; O Cadhla *et al.*, 2005) and up to 1000 during the moult (O Cadhla *et al.*, 2007). Grey seals also use the islands outside of these periods. A total of 31 grey seals were counted on Inishvickillaun during the national harbour seal census conducted during August 2003 (Cronin *et al.*, 2003).

Grey seals are also most vulnerable at their terrestrial haul-out sites during breeding and moulting periods, between September and March in Ireland, but the Blasket Islands colony are located at least 10km from Dingle harbour and therefore will be disturbed at their terrestrial sites by the proposed work during these periods. In addition to the identified terrestrial sites, the surrounding waters are also likely to be a critical habitat for grey seals, for feeding and/or for navigation to more offshore foraging areas. Grey seals have a wider offshore foraging distribution than harbour seals and as a result seals from the Blasket Islands colony and other large breeding colonies on the west coast (e.g. Inishkea Islands) may potentially use the waters surrounding Dingle harbour for foraging and/or navigation and thereby to be potentially affected by blasting and dredging.

6.4.4 Site visits

Three surveys of Dingle Harbour and adjacent coastal areas were made on November 4th 2007 and February 10th and 11th 2008.

Methods:

Dingle harbour and adjacent seas in Dingle Bay were surveyed for marine mammals by land-based visual observations from a fixed vantage point on a cliff-top at Beenbane Point southeast of the harbour entrance (Figure 6.1). Scans were conducted using 10 x 50 Leica binoculars for four to five hours between 10.30 to 14.30 on November 4th 2007; 11.00 to 16.00 on February 10th 2008 and 08.00 to 12.00 on February 11th 2008. Survey periods were planned within two hours either side of high tide on November 4th two hours either side of low tide on February 10th and between high and low water on February 11th

The shoreline of Dingle harbour was also surveyed using a telescope (equipped with a 30x eyepiece) and 10 x 50 Leica binoculars for all marine mammals at sea or ashore during the low water period on February 11th. The low water period was surveyed in order to maximise the likelihood of observing seals hauled out on rocks and identify potential seal haul-out sites within the harbour.

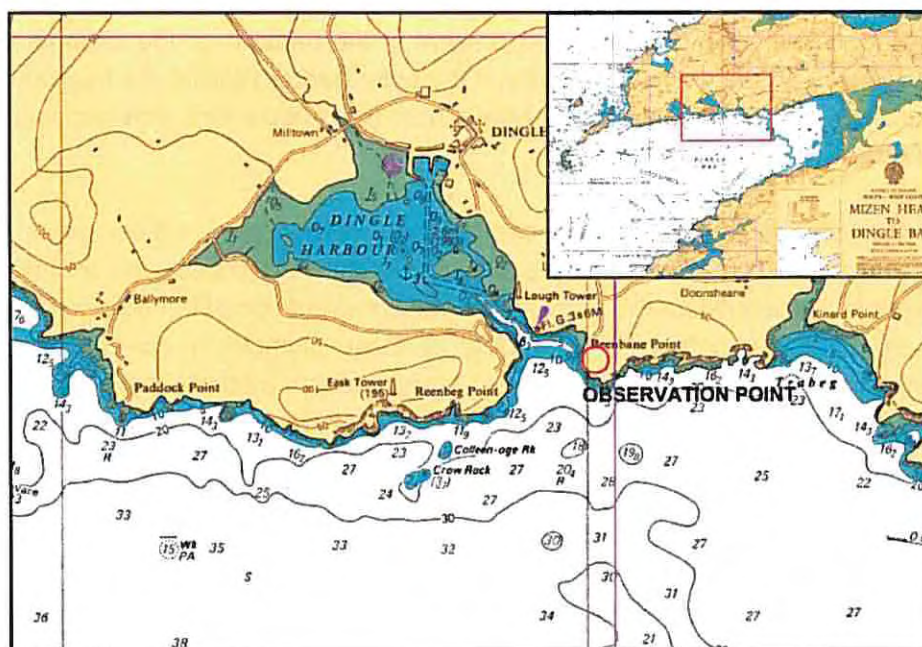


Figure 6.1 Marine Mammal Field Survey Observation Point

Observations of marine mammals at sea are affected by prevailing sea conditions with a decline in sighting probability in Beaufort sea-states of three or higher. The conditions on all survey days were favourable for visual surveillance, sunny with a Beaufort sea-state of one to two and a light variable breeze.

Results:

November 4th 2007

The resident bottlenose dolphin Fungi was present in the harbour and in the channel between the inner and outer harbour during the four hour survey period. No other marine mammals were sighted during the survey.

February 10th 2008

The resident bottlenose dolphin Fungi was present in the harbour, in the channel between the inner and outer harbour and in the outer harbour during the four hour survey period. He travelled to the outer harbour twice following a RIB and fishing vessel but returned to harbour shortly after.

A juvenile grey seal was sighted on numerous occasions during the survey period in the outer harbour southeast of the harbour entrance. The seal was observed feeding and possibly herding fish towards the surface where seabirds (including kittiwakes, fulmars, shags, gannets, lesser black-back gulls) fed on the shoaling fish.

February 11th 2008

The resident bottlenose dolphin Fungi was present in the harbour, in the channel between the inner and outer harbour and occasionally in the outer harbour during the four hour survey period. An adult grey seal was observed 'bottling' near the harbour entrance mid way through the survey period.

The results of these watches confirm the use of the inner and outer harbour areas by seals and the bottlenose dolphin 'Fungi'. These areas are within the considered exclusion zone outlined in section 1 and indicate the need for careful consideration of the issues presented in this report regarding the potential vulnerability of these animals to the proposed works. These findings indicate the need for further and more in depth field research in the Harbour prior to approving or planning any such activities (see section 6.6).

6.5 MITIGATION MEASURES

Taking into account the two elements in the planned works that may potentially impact upon marine mammals in the area, namely blasting and dredging, it is considered that the potential negative impacts of blasting on marine mammals are significantly greater than those that may result from dredging (Section 6.3). The simplest method to protect marine mammals from underwater explosions is to avoid periods when they are within a predefined exclusion zone surrounding the blast site. Depending on location, there may be time periods when marine mammals are not in the area due to their life history characteristics (e.g. breeding cycle, migration patterns, diurnal activities etc). Using accurate information on these natural variations in animal presence near the proposed blast site blasting can be planned during time periods of low marine mammal abundance. In addition, measures can be implemented to further reduce the risk of exposure of marine mammals to dangerous or disturbing sound. Surveillance procedures can report when marine mammals are observed moving into the exclusion area prior to or during blasting, and activities can be ceased until they move out of the pre-determined exclusion zone. Additionally, efforts can be made to plan and manage the blasting in order to reduce the level of sound transmitted into the environment. Finally, it is possible to use active disturbance methods such as active sound deterrents and vessel activities to attempt to drive animals away from and out of the exclusion zone prior to blasting. These approaches are addressed separately in this section and additional mitigation measures to minimize the impact of the proposed works on marine mammals are considered.

(i) Planning the timing of the blasting during periods of low marine mammal abundance to minimize the impacts on marine mammals

As there are no significant haul-outs for either seal species in the immediate vicinity of the harbour it is considered that there will be no disturbance caused at terrestrial sites so the timing of sensitive periods during breeding and moulting is inconsequential. The aforementioned cetacean species that have been sighted in waters in the vicinity of Dingle Harbour will have seasonal and daily behavioural patterns that will vary between species. The number of sightings generally increase during summer months (P. Dower, NPWS, pers

comm.; www.iwdg.ie) but this could be observer effort and/or weather related. There is not enough data available to identify a period of low abundance of all marine mammal species potentially using the area. However as the works will be carried out in the confines of the harbour, the species most likely to be impacted upon by the proposed works is bottlenose dolphins which have been reported within the harbour and in the waters of Dingle Bay frequently over recent years. Specifically the largest risk is to the resident bottlenose dolphin 'Fungi'. There is no published data from dedicated studies or observations on the behaviour and daily and seasonal activity patterns of Fungi, therefore no information exists to assist in planning the timing of the blasting to coincide with periods of low use of the harbour by the animal.

Therefore a thorough study should be undertaken to examine the movements and residency of Fungi before any blasting activity is approved and planned;

- It is recommended that a dedicated observational study by a trained marine mammal observer be conducted at least 6 months prior to the start of the proposed works to determine daily activity patterns of Fungi, his ranging behaviour and time budget in order to investigate whether the proposed activities, particularly blasting, can be timed while he is absent from the Harbour area. This study should use passive acoustics to provide diurnal movement patterns and theodolite tracking techniques to map his movements in detail. Observations should be made from shore using telescopes and binoculars to avoid observer effects caused by a study vessel. These watches will also collect data on the frequency and duration of visits by other marine mammals and otters (otters are not covered by this report) in the waters within and adjacent to Dingle Harbour.
- In addition, researchers should gather and review any non-published anecdotal information (from e.g. fishermen, dolphin watching vessel operators and local community and interest groups) to gather all existing data on the animal's behaviour and activity patterns. Together with the data from the dedicated study all information will be analysed to assess the potential for conducting harbour development operations during periods when marine mammals and otters (not covered by this report) are not present within the Harbour.

(ii) Ensuring no marine mammals are present in a pre-determined blast zone prior to and during blasting and dredging operations.

In the case that activities are deemed acceptable and are approved for times during which no marine mammals are using Dingle harbour the following procedures should be followed.

- A cliff top and vessel based observational marine mammal surveillance programme should be implemented prior to, during and after any blasting and dredging activities. This procedure will inform operators of any marine mammals entering the harbour during or prior to blasting, drilling or dredging activities and any other activity judged to present a potential risk to marine mammals. Observers should conduct a marine mammal watch with no less than two qualified observers from a small water craft and an elevated land based vantage point, at least 90 minutes before and continuing for 90 minutes after each detonation to ensure that there are no marine mammals in the area at the time of

- detonation. The vessel-based observer programme will take place in a circular area at least three times the radius of the above described caution zone (called the watch zone).
- Passive acoustic surveillance should be incorporated to provide streamed, live data on the presence of marine mammals in the area. This information will augment observer data. Acoustic surveillance should use an array of moored hydrophones which can be monitored constantly by a trained scientist approved by the NPWS during the 90minutes before and after blasting occurs.
 - Detonation of charges must not occur if a marine mammal is sighted or detected acoustically within the harbour exclusion zone and will be delayed or aborted until the animal(s) move(s) out of the safety zone on its own volition.

As a result of the small impact zones, the relatively shallow waters for blasting, and the nature of bottlenose dolphins to remain in surface waters, the cliff and boat based monitoring program and the acoustic surveillance is expected to be effective in locating all marine mammals prior to them entering an area where injury or mortality might result and thereby preventing injury or mortality.

(iii) Measures to minimize the impact of the explosive device on marine mammals:

Studies (e.g., Nedwell and Thandavamoorthy, 1992) have shown that stemmed/confined blasts (i.e. placed in a hole drilled in rock and tamped with rock) have a greater than 90 percent decrease in the strength of the pressure wave released as compared to an open water blast.

- Confining the explosives in a hole with drill patterns restricted to a minimum of 8 ft (2.44 m) separation from any other loaded hole
- Capping the hole containing explosives with rock in order to reduce the outward potential of the blast, thereby reducing the chance of injuring animals.
- Matching, to the extent possible, the energy needed in the "work effort" of the borehole to the rock mass to minimize excess energy vented into the water column
- Staggering the detonation for each explosive hole in order to spread the explosive's total overpressure over time, which in turn will reduce the radius of the caution zone
- Restricting the hours of detonation from 2 hours after sunrise to 1 hour before sunset to ensure adequate observation of marine mammals in the safety zone
- Restricting operations to periods of good visibility and calm sea states (<Beaufort 2) to maximise the probability of observing animals within the exclusion zone prior to, during and after blasting.
- Planning a procedure to enable effective abortion of planned explosions once charges have been deployed to prevent forced blasting regardless of the presence of marine mammals under human health and safety grounds.

(iv) Measures to actively deter or exclude 'Fungi' the resident bottlenose dolphin from the blasting zone during periods of blasting

There is a potential for proposals to arise which may plan to attempt to deter or exclude Fungi from the harbour prior to or during the blasting period.

- These methods may include the following;
- To physically catch and remove Fungi from the Harbour for relocation for the entire works period, with subsequent rehabilitation. *illegal*
- Corraling by vessels to lead or force fungi out of the harbour
- Use of acoustic deterrents to drive fungi and other marine mammals from the harbour *risk of displacement*

Remove and rehabilitation would be illegal under national law and present a real and severe risk to Fungi's physical health and survival. This must not be considered as a viable option. Because of Fungi's habituation to human contact, attempts to safely deter him from the Harbour prior and during dredging and blasting activities will pose a direct risk of permanent displacement or fail to entice him to move from his home range. Attempts using vessels will almost certainly fail to remove or exclude him from the harbour area and will expose him to unnecessary and willful disturbance.

'Pingers' or acoustic deterrent devices produce ultrasound signals of low intensity (source level <150 dB re luPa at 1 m) in mid-high frequencies (2.5-10kHz) with higher harmonic frequencies (160-180kHz). They were designed to prevent by-catch of small cetaceans (Reeves et al 2001) and keep dolphins away from fishing nets. Trials in the Shannon Estuary to test the effects of continuous and responsive pingers on bottlenose dolphin behaviour showed avoidance by dolphins, whereby they immediately left the area in a highly directional manner at speed, frequently leaping (Leeney et al., 2007). However there are some significant concerns surrounding this approach. There is no specific information available regarding any potential negative effect that using such deterrents may have on 'Fungi' e.g. hearing damage and/or long-term displacement. A possible side effect of using pingers in the area is long term displacement and exclusion of dolphins from their habitat or important parts of it (Goodson et al., 1997; Laake et al., 1998; ACCOBAMS, 2002). This is a great risk especially in river mouths and/or harbours as there are few possibilities to avoid the pingers.

Short-term exclusion of Fungi from the harbour area using directed and intentional disturbance prior to blasting would be unacceptable, and would constitute willful disturbance under the Wildlife Act amendment Act (2000). Using disturbance to exclude Fungi from the Harbour during blasting and dredging may cause long term displacement from the area and would be a hugely unsatisfactory with a significant negative impact on the local economy and on 'Fungi's survival probability. Another serious concern is potential hearing damage from the pinger which can occur if the dolphin comes within 2-3 metres of an active pinger (Gordon & Northridge, 2002). Dolphins can also become potentially habituated to pingers when they are used over extended periods of time (Philpott, pers. comm.). Another concern would be that the pingers could potentially act as an attractant to other marine mammal species such as seals, as there is large inter-species variation on the effects of pingers, thereby leading to the opposite to the intended desired effect, attracting marine mammals

into the blasting zone and increasing the risks of physical harm. Moreover, there may be issues regarding the use of pingers in shallow water, e.g. in the U.S. NOAA recommend pingers can only be used in water depths >600ft (Franse, 2005)

Considering all of the aforementioned points it is not recommended that the short-term disturbance and displacement methods including the use of ADDs (pingers), vessel corralling, bubble nets or other such methods are used within Dingle Harbour in order to deter Fungi from entering or remaining within the Harbour during blasting periods.

6.6 CONCLUSIONS AND RECOMMENDATIONS

6.6.1 Blasting

Because of the severe potential threats posed by the use of explosive charges on the resident bottlenose dolphin 'Fungi' it is recommended that a lengthy and thorough investigation of 'Fungi's movements is conducted to ascertain whether periods exist when he is routinely and predictably absent from the Harbour and adjacent area to enable blasting. If it appears that Fungi is routinely using the Harbour and his periods outside of the Harbour are short and unpredictable, blasting is not recommended and in this case any attempt to blast within the Harbour will have an unpredictable effect and will potentially cause death, permanent injury or displacement of him from Dingle Harbour.

In the event that findings show that 'Fungi' is unlikely to be using the harbour during a prolonged and predictable period and blasting is authorised, measures must be taken to protect other marine mammal species and individuals. It is unlikely that blasting will have a population level effect on any marine mammals and mitigation measures should focus on reducing potential risks to individuals (see *Section 6*). Specifically the following precautionary measures are strongly advised:

- Blasting operations should be restricted to days with calm seas and good visibility.
- Charge sizes and blasting periods are kept to a minimum.
- Charges are contained within drilled and capped holes
- A detailed surveillance procedure is adopted including boat-based and land-based visual observations and simultaneous passive acoustic monitoring.
- Qualified and experienced visual observers, approved by the National Parks and Wildlife Service, should maintain watches of the blast area for a period of 90minutes before, during and one hour after each blasting operation.
- Blasting should only be made when no marine mammals have been sighted within the Harbour exclusion zone (see section 1) during the preceding 90minute watch.
- Blasting should cease or be aborted if marine mammals are sighted during or immediately prior to planned detonation. Issues with health and safety regarding the use of explosives must be resolved to prevent charges being detonated under these auspices despite marine mammals remaining within the exclusion area.
- The presence of marine mammals within Harbour during these watch periods are reported to the National Parks and Wildlife Service and all visual and acoustic data recorded and compiled into a report detailing the entire period of development activities.

6.6.2 Pre-Blasting Risk Assessment

It is recommended that upon appointment of a Contractor to undertake the works, the Contractor should submit a detailed plan for blasting activity to be submitted for a desktop risk assessment.

This must include the exact/approximate amounts of explosives and the number of blasts planned for the entire operation. The plans must also include contingency for unplanned explosive discharge as occasionally once explosive charges are laid the operators can insist on blasting before nightfall due to human risks. In this case a decision from the Gardae will over-rule any animal welfare issues. This is not acceptable in the case of Dingle where it is extremely likely that this action will result in uncontrolled expose of Fungi to blasting.

The desktop study should be undertaken by an experienced underwater acoustics consultant and should include the following:

Review the available literature to find the safe levels of blast

- Review the proposed blasting and estimate the likely source level associated with the blasting
- Calculate the critical ranges within which there will be
 - Behavioural response
 - Auditory damage
 - Physical injury
 - Death

A summary report should be prepared, detailing these findings. The results should be presented not only as "raw" data metrics such as unweighted RMS Sound Pressure Levels, Sound Exposure Levels and RMS pressure levels, but also in the dBht format for Fungi's species of cetacean, or a surrogate species of cetacean if an audiogram is not available for Fungi's species of cetacean specifically.

6.6.3 Monitoring

Even though a desk study based risk assessment will estimate the safe distances to exclude Fungi from the blasting, if there is a possibility that objections may be raised then we would strongly recommend that the sound level is monitored during the blasting. Ideally measurements will be taken adjacent to Fungi when the blasting occurs to record the actual level of sound Fungi has been exposed to. A summary report should then be provided documenting the subsea noise associated with the blasting.

6.6.4 Dredging and Dumping

It is considered that the proposed dredging and dumping of dredged material will have little likelihood of impacting on marine mammals in the area at a population level. The greatest risk is to the resident dolphin 'Fungi' as summarised in Section 6.3.2. The main risks to Fungi include, death or injury through vessel collision (unlikely), permanent injury through acoustic disturbance (possible) and temporary disturbance or displacement during activities (likely) or permanent displacement due to disturbance and habitat degradation (likelihood unknown). It is recommended that a detailed report be presented detailing exactly the area to be dredged and the volume of material to be moved and the duration of dredging activities before specific recommendations are made. In the event that permission to dredge is granted it is recommended that a predefined protocol is adopted to minimise potential impacts.

It is recommended that vigilance should be maintained for any marine mammal approaching the area throughout dredging operations as there will be potential effects of acoustic disturbance resulting from noise associated with construction and increased boat activity associated with dredging. The following precautionary measures are advised:

- A shore based observer approved by the NPWS maintains watches during dredging activities and informs the operators of any approach or a marine mammal within 50m.
- Passive acoustic surveillance is used to record the levels of sound produced by the dredging activity and the results of these recordings are used to refine or change the mitigation measures during operation.
- Operations should cease temporarily if a seal or cetacean is observed swimming in close proximity (<50 m) to the area of industrial activity and work can be resumed once the animal(s) have moved away. This recommendation should be flexible to change in the light of acoustic data reported by passive acoustic surveillance (see above).
- Any approach by marine mammals into the immediate (<50 m) works area should be reported to the National Parks and Wildlife Service. A full report detailing marine mammal observations is presented to NPWS at the end of the operation.

7.0 SEDIMENT CHEMICAL AND RADIOLOGICAL ANALYSIS

Sediment samples were taken at the locations outlined in Figure 7.1 and Table 7.2 by means of a 0.025 m² VanVeen grab. Grabs were taken at 11 of the stations for contaminant analysis; while a further grab was taken at 2 of the granulometric stations for radiological analysis (see Figure 7.1). When samples were returned from each station, notes were logged on sediment type, amount, colour, smell and any other information that was considered relevant. A sample of surface sediment was taken from the centre of the grab and placed in a suitable cleaned container. The contaminant samples were split into a glass and a plastic container, the sample being transferred by a metal or plastic spoon where applicable. All sampling jars were marked externally with date, station number, sample number and survey reference number and placed in a cooler box.

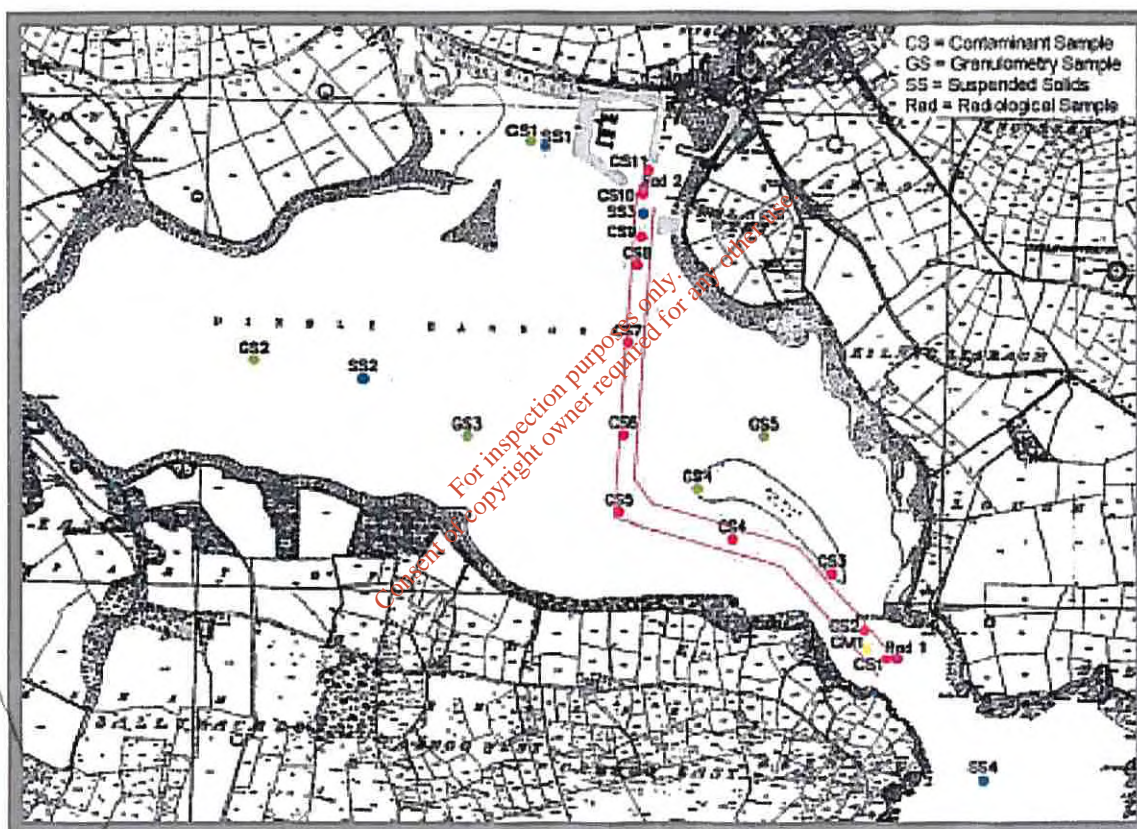


Figure 7.1 Sediment Sampling Locations

On return to the laboratory, the samples for contaminant samples were sent to the UK Environment Agencies National Laboratory Service facility at Llanelli for the following analysis:

- a). total organic carbon
- b). carbonate
- c). mercury, arsenic, cadmium, copper, lead, zinc, chromium, nickel, iron, manganese.

- d). organochlorines including γ -HCH (Lindane), and PCBs (to be reported as the individual CB congeners: 28, 52, 101, 118, 138, 153, 180).
- e). total extractable hydrocarbons.
- f). tributyltin (TBT) and dibutyltin (DBT)
- g). Polycyclic aromatic hydrocarbons (PAH) - Anthracene, Fluoranthene, Phenanthrene, Benz-[A]-anthracene, Benzo-[A]-pyrene, Benzo-[ghi]-perylene, Chrysene, Benzo(k) fluoranthene, Naphthalene, Indeno-[1,2,3-cd]-pyrene, Benzo-(B)-fluoranthene, Pyrene

The methodologies for each of the analysis are included in the results report sent by NLS and included as Appendix B. Appropriate marine CRMs were analysed with the samples and the results presented with the sample results.

Table 7.1 Locations of the sediment sampling stations in Dingle Harbour November 2007

Station	Easting	Northing
CS1	45080	99117
CS2	44972	99208
CS3	44866	99393
CS4	44536	99507
CS5	44160	99595
CS6	44174	99849
CS7	44189	100153
CS8	44220	100406
CS9	44233	100502
CS10	44237	100643
CS11	44255	100719
GS1	43865	100814
GS2	42962	100091
GS3	43658	99843
GS4	44420	99672
GS5	44638	99845
RAD1	45080	99117
RAD2	44241	100665

(CS = contaminant sample, GS = granulometry sample, RAD = radiological sample)

The two radiological samples were sent to Radiological Protection Institute of Ireland for analysis. The samples were prepared for high-resolution gamma spectrometry by placing an aliquot of sample in a well –defined counting geometry. The samples were measured on a high-resolution gamma spectrometer. Appropriate density corrections were applied to the

resultant spectra to take account of the difference in sample density. Dry to wet weight ratio was determined for the samples and the results quoted on a dry weight basis.

7.1 CONTAMINANT ANALYSIS

The full results of the contaminant analysis carried out on the 11 sediment samples (see Figure 7.1) are included as Appendix B. Table 7.2 overleaf presents a summary of these results.

The results of the contamination testing were passed on to the Marine Institute for comment. The Marine Institute have indicated that there is a general degradation in the quality of sediment of samples 7-11, nearest the harbour basin itself. The affected samples are above the lower threshold level for sediment quality but do not exceed the upper threshold. It is therefore likely that the material will be suitable for disposal at sea; however some conditions may be attached, such as a form of capping with the clean coarse sediments dumped last.

The Marine Institute are unable to give conclusive comment on the suitability of the sediments for dumping at sea until a dumping at sea licence application has been submitted.

7.2 RADIOLOGICAL ANALYSIS

The results of the radiological analysis are presented in Table 7.3 and the report from the Radiological Protection Institute of Ireland included as Appendix C.

Table 7.3 Results of Radiological Analysis, November 2007

Reference	Nuclide	Activity Concentration (Bq/kg,dry) ¹
RAD 1	K-40	249±27
	I-131	<2
	Cs-134	<1
	Cs-137	<1
	Ra-226	<75
	U-235	<6
	U-238	37±6
RAD 2	K-40	662±70
	I-131	<4
	Cs-134	<1
	Cs-137	6.7±0.5
	Ra-226	<168
	U-235	<9
	U-238	62±6

The results indicate that the sediments do not pose a radiological hazard.

Table 7.2 Summary of Sediment Contamination Analysis Results

	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10	CS11	CRM
Carbon (%)	3.44	5.28	4.8	1.61	3.02	2.07	3.38	3.04	3.49	3.69	4.4	*
Carbon, Organic (%)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	*
Mercury (mg/kg)	0.006	0.0085	0.01	0.007	0.0081	0.0051	0.022	0.0348	0.0323	0.0423	0.0391	0.0957
Aluminium (mg/kg)	*	*	*	4760	*	*	*	*	*	*	*	*
Iron (mg/kg)	10100	10200	15700	15400	12800	13200	21900	26400	26900	25500	28800	39600
Arsenic (mg/kg)	4.45	4.57	4.65	3.66	3.63	3.53	5.66	7.7	7.34	6.83	9.19	18.2
Cadmium (mg/kg)	0.033	0.033	0.034	0.038	0.0412	0.043	0.162	0.213	0.221	0.22	0.276	1.9
Chromium (mg/kg)	9.2	9.07	15.8	13.5	13.3	13.2	26.4	31.8	29.5	31.6	33	64
Copper (mg/kg)	1.9	2.19	2.21	2.85	2.65	2.51	11.4	16.2	18.5	16.2	22.9	26.2
Lead (mg/kg)	3.35	2.99	4.05	4.99	3.83	2.95	12.2	15.3	16.2	15.2	18.6	19.5
Lithium (mg/kg)	*	*	*	18.4	*	*	*	*	*	*	*	*
Manganese (mg/kg)	477	415	473	338	358	319	435	494	507	492	512	317
Nickel (mg/kg)	7.69	7.81	72.9	11.4	12.1	11.9	20.9	24.3	24.7	24	26.9	39.1
Vanadium (mg/kg)	*	*	*	18.1	*	*	*	*	*	*	*	*
Zinc (mg/kg)	18.7	17.1	23.7	22.9	22.7	22.1	54.9	69.8	78.3	73.2	87.9	137
HCH-gamma (µg/kg)	<1	<1	<1	<1	<1	<1	<1	2.78	<1	<1	<1	572
Anthracene (µg/kg)	<10	<10	<10	<10	<10	<10	11.3	47.8	18.3	13.6	34.5	1190
B(a)anthracene (µg/kg)	<2	<2	9.68	<2	12.8	<2	36	112	73.2	51.3	149	4950
B(a)pyrene (µg/kg)	<2	<2	10.7	<2	12.7	<2	34.5	100	95.7	56	127	3620
B(b)fluoranthene (µg/kg)	<10	<10	<10	<10	18.2	<10	49.3	92.1	96.8	<73.6	135	3320
B(ghi)perylene (µg/kg)	<10	<10	<10	<10	12.3	<10	30.8	68	79.7	49.1	93.4	2910
B(k)fluoranthene (µg/kg)	<10	<10	<10	<10	<10	<10	21.6	45.3	50.8	39.1	53.6	1970
Chrysene (µg/kg)	3.98	<2	8.97	<2	15.4	<2	41.7	114	92.7	78.7	158	6310
Fluoranthene (µg/kg)	6.54	<2	6.66	2.51	14.5	2.16	76.2	223	132	149	261	8560
Indeno123cdPyrene (µg/kg)	<10	<10	<10	<10	11.5	<10	38	80.4	90	58.3	97	2730
Naphthalene (µg/kg)	32	34.5	31.5	30.8	42.5	44.7	32.4	83.9	70.4	123	206	2100
Phenanthrene (µg/kg)	<10	<10	<10	<10	<10	<10	42.5	182	180	105	100	862
Pyrene (µg/kg)	6.43	<2	6.62	2.86	15.7	2.12	66.6	194	129	127	259	9920

Table 7.2 (contd)

	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10	CS11	CRM
PCB28 (µg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	72.5
PCB25 (µg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	80.3
PCB101 (µg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	72.3
PCB118 (µg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	56.9
PCB138 (µg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	55.6
PCB153 (µg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	69.8
PCB180 (µg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	45.7
Dibutyl Tin (mg/kg)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.68
Tributyl Tin (mg/kg)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.005	0.01	0.01	0.08	0.02	0.5
Eq.C No>10-12 Al (µg/kg)	597	566	421	<300	542	517	1100	742	824	1120	731	*
Eq.C No>10-12 Ar (µg/kg)	385	328	401	393	503	530	571	882	559	418	533	*
Eq.C No>12-16 Al (µg/kg)	2850	2540	3310	2080	2920	4170	3930	4670	3320	8390	6410	*
Eq.C No>12-16 Ar (µg/kg)	1450	2860	1470	2310	3650	2300	4170	5170	3880	2820	5220	*
Eq.C No>16-21 Al (µg/kg)	7840	3660	11500	2010	5500	14400	16900	6920	2770	2900	17700	*
Eq.C No>16-21 Ar (µg/kg)	5090	2300	3780	2490	6040	5190	11300	9270	9680	13200	12400	*
Eq.C No>21-35 Al (µg/kg)	74100	31500	55000	25300	34300	60100	70000	50200	69400	12300	97000	*
Eq.C No>21-35 Ar (µg/kg)	27900	34400	2700	35600	32500	20200	36000	59400	56300	33100	94600	*
Eq.C No>35-40 Al (µg/kg)	4930	3200	5860	3100	4490	4660	8290	5510	6220	7990	6120	*
Eq.C No>35-40 Ar (µg/kg)	<3000	3750	3110	3650	3360	<3000	5460	600	5040	5900	6830	*
Hydrocarbons, Al. (µg/kg)	90300	41500	76200	2700	47700	83800	100000	68000	52600	170000	1280000	*
Hydrocarbons, Ar. (µg/kg)	36300	43700	35800	44400	46000	29800	57400	80800	75500	55400	120000	*
Hydrocarbons, total. (µg/kg)	127000	85100	112000	77100	93700	114000	158000	149000	128000	225000	247000	*
Dry Solids (%)	75.3	71.5	74.8	82.7	75.5	76.4	53.4	49.8	51	47.8	40.3	*

8.0 SUMMARY AND CONCLUSIONS

The results of each of the individual studies to assess the potential impact of the proposed dredging of the navigation channel at An Daingean (Dingle) harbour are summarised below:

8.1 IMPACT ON HYDRODYNAMICS

8.1.1 Tidal Modelling

While there is a moderately strong tidal flow velocity through the entrance to An Daingean Harbour the tidal flow velocities in the dumpsite area are very weak.

It will be seen that the proposed dredging of the channel will have virtually no effect on the tidal heights at the harbour, changes in velocity are generally less than about 0.1m/s. Outside the harbour there will be no impact on the tidal flow regime.

8.1.2 Sedimentation and Water Quality

It can be seen from the suspended sediment and deposition diagrams that the proposed dredging will not have a significant impact on bed sediments or water quality within An Daingean Harbour. All impacts will be short term.

A modelling exercise was undertaken which simulated the disposal of about 288,000 m³ of material over the area of the disposal site over the proposed 6 month dredging period. Preliminary dispersion studies showed that due to the low current velocity at the site the material deposited on the seabed would not be moved by tidal currents alone, however dredged spoil deposited on the sea bed at the proposed disposal site will be subjected to wave action during gales and storms, which may lift some of the material into suspension and move it away from the site.. It is unlikely that there will be no waves during the whole of the 6 month dumping period so the critical shear stress for re-suspension was adjusted in the model separately for three of the six months to allow for the impact of waves on the dispersion process.

Even allowing for wave action, deposition of sediment is largely confined to within the dump site itself and there will be no impact to the nearby beaches.

8.2 IMPACT ON BENTHIC FLORA AND FAUNA

8.2.1 Benthic Habitats

Video surveys, benthic grabs and beam trawls were taken within and around the dump site. It was found that immediately within the proposed dredge disposal site, the sea bed consists primarily of sands and muddy sands. Along the western margin of the dump site is an area of hard benthos characterised by the presence of cobble, boulders and bedrock.

The area to the south of the proposed dumpsite is dominated by sands and gravelly sands. In addition, sandy areas are present close to shore to the east of the proposed disposal area.

8.2.2 Benthic Species Predicted Impact

Results from the benthic survey indicate the presence of 4 distinct faunal communities ranging from fine sands and muddy sands to bedrock communities within the proposed disposal site and its immediate vicinity.

The hydrodynamic model indicates that the proposed site is classified as a low energy site with very little dispersion qualities. The sediment which will be deposited in the dredge spoil disposal area consists of coarser material than is currently present (dredged sediment consists of 40% Gravels, 40% Sands, 20% Muds compared to the present mean values on site of 0.1% Gravel, 80% Sands, 21% Muds).

Although there is a significant body of literature indicating that benthic infauna have the capability to survive episodic sediment burial, this is limited to <0.5m of similar sediment. Therefore, while the organisms present within the disposal area are adapted to moving through the sediment in case of burial, the expected deposition of >1m will exceed their burrowing capacity resulting in smothering. It should be noted, however, that the area affected is relatively small (36.75ha) and that a similar habitat type is present within the immediate vicinity, providing new recruits to colonise the deposited spoil. Previous studies undertaken at dredge spoil disposal grounds have indicated a recovery rate of between ½ - 2 years

8.2.3 Mitigation

As it is not possible to mitigate against the effects of smothering in such a small area, it is recommended to carry out the dredging and disposal of the dredge spoil at a time which would facilitate the rapid recolonisation of the disposed sediment. As such, it is recommended to carry this out in early Spring/late Winter to facilitate the rapid recolonisation by means of larval migration.

It is recommended that a follow up survey be undertaken in the area 24-36 months post cessation of disposal to assess the recovery of the site.

8.3 IMPACT ON FISHERIES

Commercial Fisheries

In terms of commercial activity within the harbour itself and the recovery of the sea bed communities at the dump site, it is preferred that the dredging works should be undertaken outside the peak tourism and fishing periods of mid-May to mid-September. If dredging can be completed within a short number of weeks it may be possible to facilitate a short-term closure of the harbour. If dredging activities are expected to last for months, plans must be made to retain access to the port for working vessels throughout the works. The dump site itself sees very little commercial fishing activity, therefore there are not anticipated to be any direct impacts on commercial fisheries arising from using the proposed dumpsite.

Wild Fisheries

While some of the smaller bottom-dwelling species may be directly impacted by the dumping, the main impact is likely to be a reduction in the local feeding in the dumping footprint for one or two seasons, after which, with the return of infaunal and epifaunal diversity and biomass, the site should again regain much of its fisheries carrying capacity. In the context of the wider Dingle Bay, this impact can be considered temporary and very localised.

8.4 IMPACT ON MARINE MAMMALS

Noise associated with the planned works represents a source of acute acoustic disturbance in the marine environment with associated noise disturbance throughout the entire blasting period.

8.4.1 Potential impacts of blasting/drilling on marine mammals

- Physical injury or death of individuals resulting from close range exposure.
- Chronic hearing damage from short/medium range exposure.
- Temporary or permanent displacement as a result of noise disturbance caused by the drilling and blasting activities.
- Long term effects resulting from habitat degradation such as prey species depletion.
- Short term effects on foraging and navigation abilities from sediment disturbance.

8.4.2 Potential impacts of dredging on marine mammals

- Physical injury or death of individuals resulting from collisions with operator vessels.
- Chronic hearing damage or disturbance/displacement as a result of noise.
- Consumption of contaminated prey items resulting from contaminants entering the food chain (where contaminated substrates are disturbed).
- Displacement resulting from effects on available prey.
- Displacement caused by disturbance from noise and proximity of dredging activities

Of particular concern is the resident bottlenose dolphin 'Fungi' that remains in Dingle Harbour and adjacent waters year-round. Fungi has been present in the area since the mid 1980s and a considerable local dolphin tourist infrastructure has developed, including dolphin watching boat trips, diving equipment hire and a dolphin exhibition. In the mid 1990s Fungi was attracting up to 75,000 visitors each year and was estimated to be worth an €4 million to the local economy. Notwithstanding the significant economic benefits and environmental awareness that Fungi has brought to the area in the last two decades, Fungi is protected under national and international conservation legislation.

8.4.3 Suggested Mitigation Measures

Mitigation of impacts to marine mammals, particularly Fungi, are discussed in detail in Section 6.5, these are summarised as follows:

- Planning the timing of the blasting during periods of low marine mammal abundance to minimize the impacts on marine mammal
- Ensuring no marine mammals are present in a pre-determined blast zone prior to and during blasting and dredging operations.
- Implementing physical measures to minimize the impact of the explosive device on marine mammals through careful design of explosive requirements
- Actively deterring or excluding 'Fungi' the resident bottlenose dolphin from the blasting zone during periods of blasting

In addition to these general mitigation measures, it is recommended that upon appointment of a Contractor to undertake the works, the Contractor should submit a detailed plan for blasting activity to be submitted for a desktop risk assessment.

The desktop study should be undertaken by an experienced underwater acoustics consultant and should include the following:

Review the available literature to find the safe levels of blast

- Review the proposed blasting and estimate the likely source level associated with the blasting
- Calculate the critical ranges within which there will be
 - Behavioural response
 - Auditory damage
 - Physical injury
 - Death

Even though a desk study based risk assessment will estimate the safe distances to exclude Fungi from the blasting, if there is a possibility that objections may be raised then we would strongly recommend that the sound level is monitored during the blasting. Ideally measurements will be taken adjacent to Fungi when the blasting occurs to record the actual level of sound Fungi has been exposed to.

8.5 SEDIMENT CONTAMINATION TESTING

8.5.1 Chemical Testing

In terms of impact to benthic species, the benthic sub-consultant has determined that the levels of contaminants in the dredge spoil are not expected to pose any significant threat to the benthos within the proposed disposal area.

Suitability for disposal of dredged material at sea is overseen by the Marine Licence Vetting Committee (MLVC) and therefore the results of the contamination testing were passed on to the Marine Institute for comment. The Marine Institute indicated that there is a general degradation in the quality of sediment of samples 7-11, nearest the harbour basin itself. The affected samples are above the lower threshold level for sediment quality but do not exceed the upper threshold.

It is therefore likely that the material will be suitable for disposal at sea; however some conditions may be attached, such as a form of capping with the clean coarse sediments dumped last.

8.5.2 Radiological Testing

The results of the radiological analysis indicate that the sediments do not pose a radiological hazard.

8.6 CONCLUSIONS

This report concludes that the proposed dredging at An Daingean (Dingle) harbour should not have any significant impact on the local tidal currents or sediment transport regime. There will be a short-term localised impact to the benthic species at the dump site, however full recovery is expected to be achieved within 2 years.

There are no anticipated impacts arising from contamination of the dredged spoil; however some mitigation measures may be imposed by the MLVC to eliminate any potential.

There is a potential for impact on marine mammals arising from the dredging and particularly from blasting. With appropriate mitigation, these impacts can be eliminated.

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APPENDIX A

**CURRENT METERING AND SUSPENDED SEDIMENT
MEASUREMENT**

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APPENDIX A

.1 INTRODUCTION

A current meter survey, together with suspended solids and sediment sampling surveys were required in connection with a sedimentation study being undertaken for proposed dredging of the entrance channel at Dingle (An Daingean) Harbour, Co Kerry (see Figure 1.1). Aqua-Fact International Services Ltd. was commissioned by RPS Consulting Engineers to carry out these works.

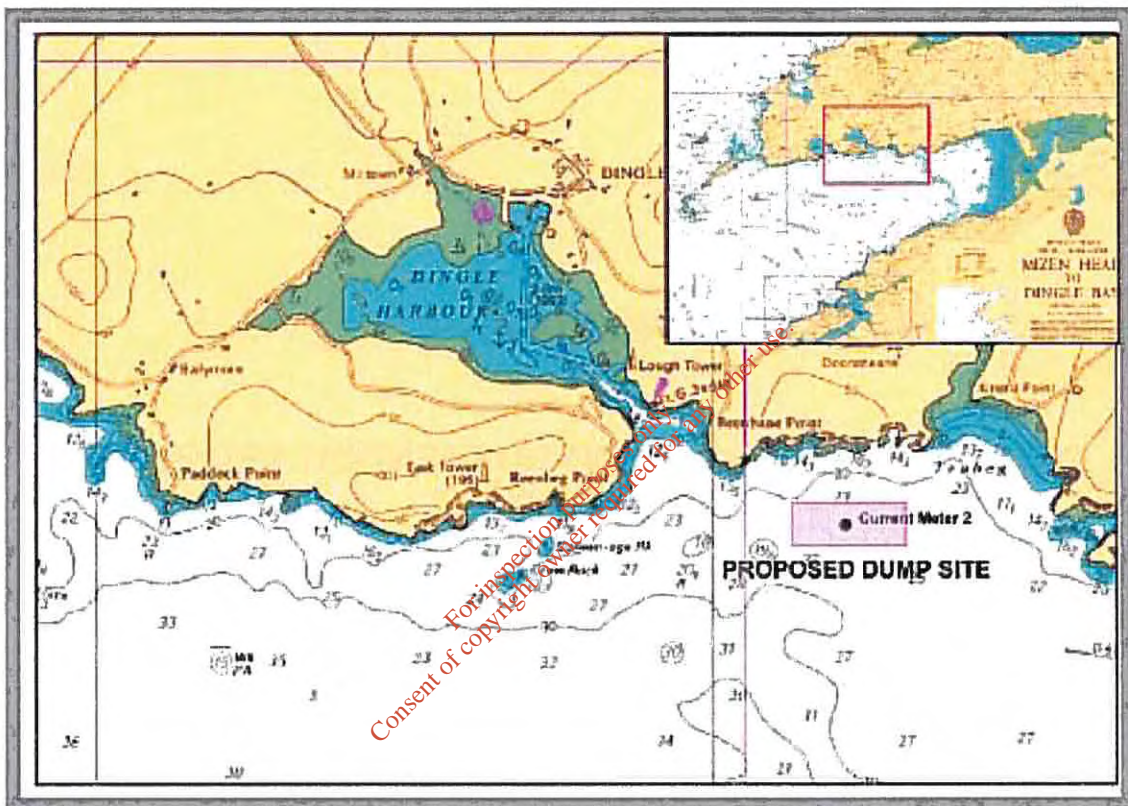


Figure A1.1 Location of Current Meters

The survey at Dingle Harbour was conducted from Aqua-Fact's 6.9m rigid inflatable boat (RIB), which is fully equipped with DGPS, VHF and Sounder systems. Sediment and water samples were taken on 12th and 13th November 2007 and water samples again on 19th November with current and tidal data recorded from the 12th to 21st November 2007. Positions of sampled stations and meter deployments were recorded by DGPS. Weather conditions on both sampling occasions were good with light north easterly winds.

.2 CURRENT AND TIDE RECORDING

Nortek current profilers were deployed at two locations, at the mouth of the harbour and centre of the dump site, to automatically record current velocities and direction for a spring and neap tide period. The positions and depth of water in which the meters were placed are given in Table A1.1 and shown in Figure A1.1.

The profilers were bottom mounted on dedicated frames and programmed to record current velocity and direction through the water column every 10 minutes from the 12th to 21st November 2007. Tidal amplitude was also recorded by a pressure sensor located in the transducer head of both meters

Table A1.1 Current Profiler Locations

Location	Easting	Northing	Water Depth
Dump Site	46991.609	98012.542	27 m
Harbour Mouth	44981.568	99145.752	9 m

.3 SUSPENDED SEDIMENTS

Water samples were taken every hour over a spring (13.11.07) and neap tide (19.11.07) at the four water sampling stations (Figure 2.1) to determine the suspended sediment load in the water column. Where water depth was sufficient (> 4m), samples were taken at three depths (sub-surface, mid-water and off-bottom) by means of a water sampling bottle and messenger system and transferred to clean sample jars. When water depth was below 4 m only midwater samples were taken. In addition, a secchi disc was deployed to determine water transparency.

Each sample was filtered through a standard GFF glass fiber filter, and the residue retained on the filter was dried to constant weight at 103-105°C. Results are expressed in mg/l. Additional samples were taken at each station to determine the particle size distribution of the suspended solid material. Samples were passed through a Malvern laser diffraction instrument.

.4 RESULTS

The full tidal and current data recorded by the two automatic current meters are available on request.

Tide Recording

Tidal amplitude recorded at the meter at the mouth of the harbour is presented in Figure A1.2. A maximum tidal range of 2.682 m occurred during the spring ebb tide on 13th November while a range of 1.418 m was recorded during the neap ebb tide on 16th November. There were no significant differences between timing and range recorded at the meter at the dump site compared to the presented data.

Current Meter Data

Data recorded by the Nortek current profiler located in the mouth of Dingle Harbour are presented in Figure A1.3. Each graph represents a scatter plot of the east and north vectors recorded every 10 minutes over the survey period.

Data recorded by the Nortek current profiler located at the dump site are presented in Figure A1.4. Each graph represents a scatter plot of the east and north vectors recorded every 10 minutes over the survey period.

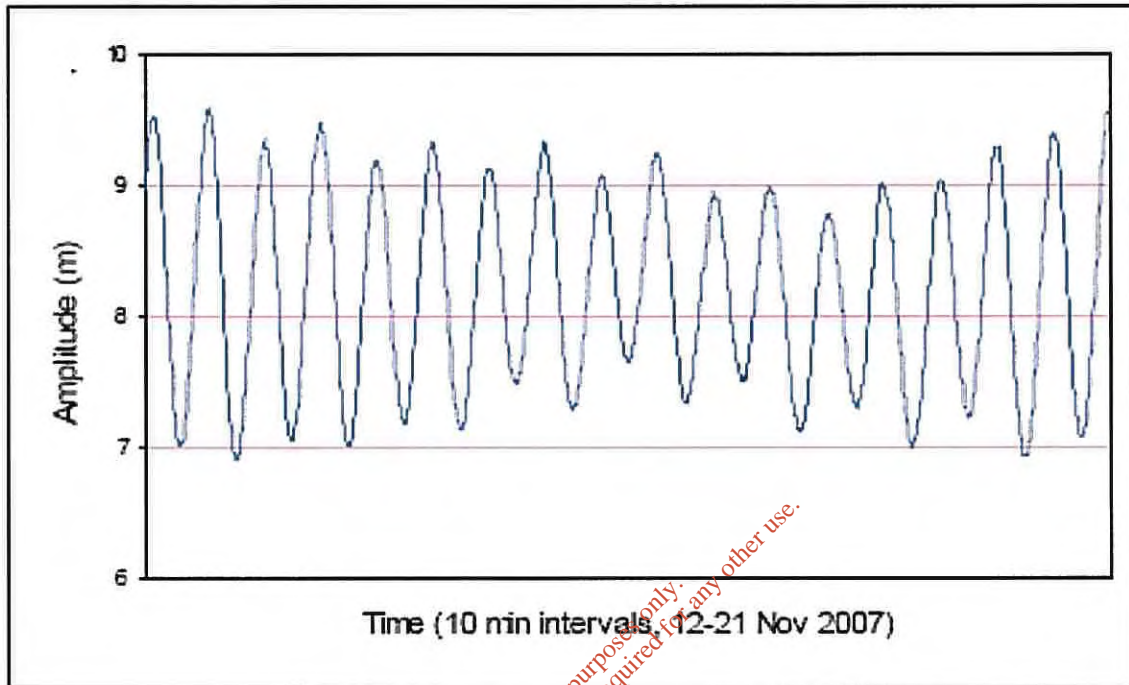


Figure A1.2 Tidal amplitude recorded in Dingle Harbour, 12th to 21st November 2007

Results of the secchi disc and suspended solid analysis indicate that the water in Dingle Harbour was clear on both sampling occasions. Discussion with the harbour master and local fishermen indicate that this is normally the case at this location. As a result, the Malvern laser diffraction instrument could not determine particle size distributions from the samples as there was not enough material to analysis, even when concentrating the samples by filtering out the water.

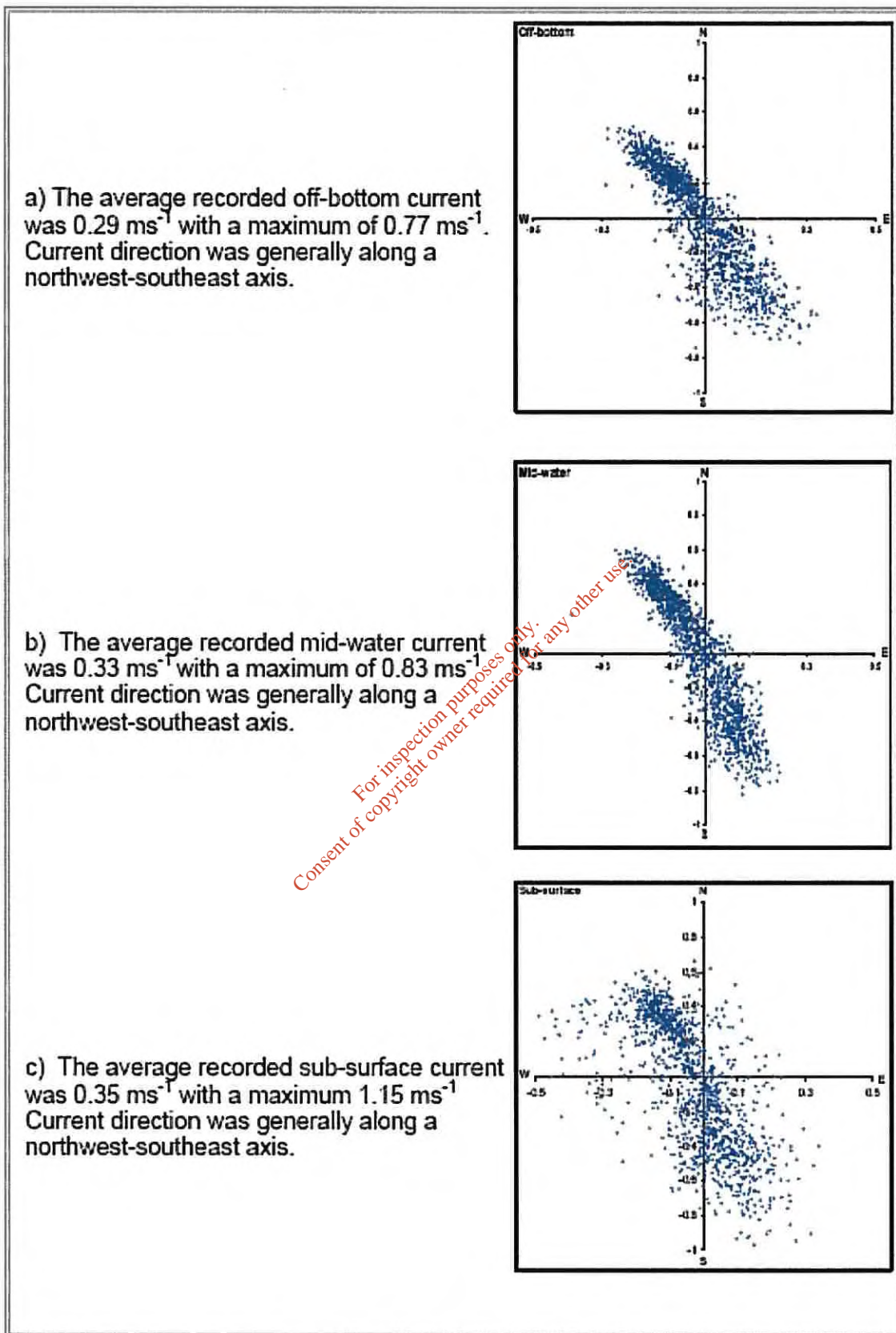


Figure A1.3 Current Data recorded at Dingle Harbour entrance 12th to 21st Nov 2007

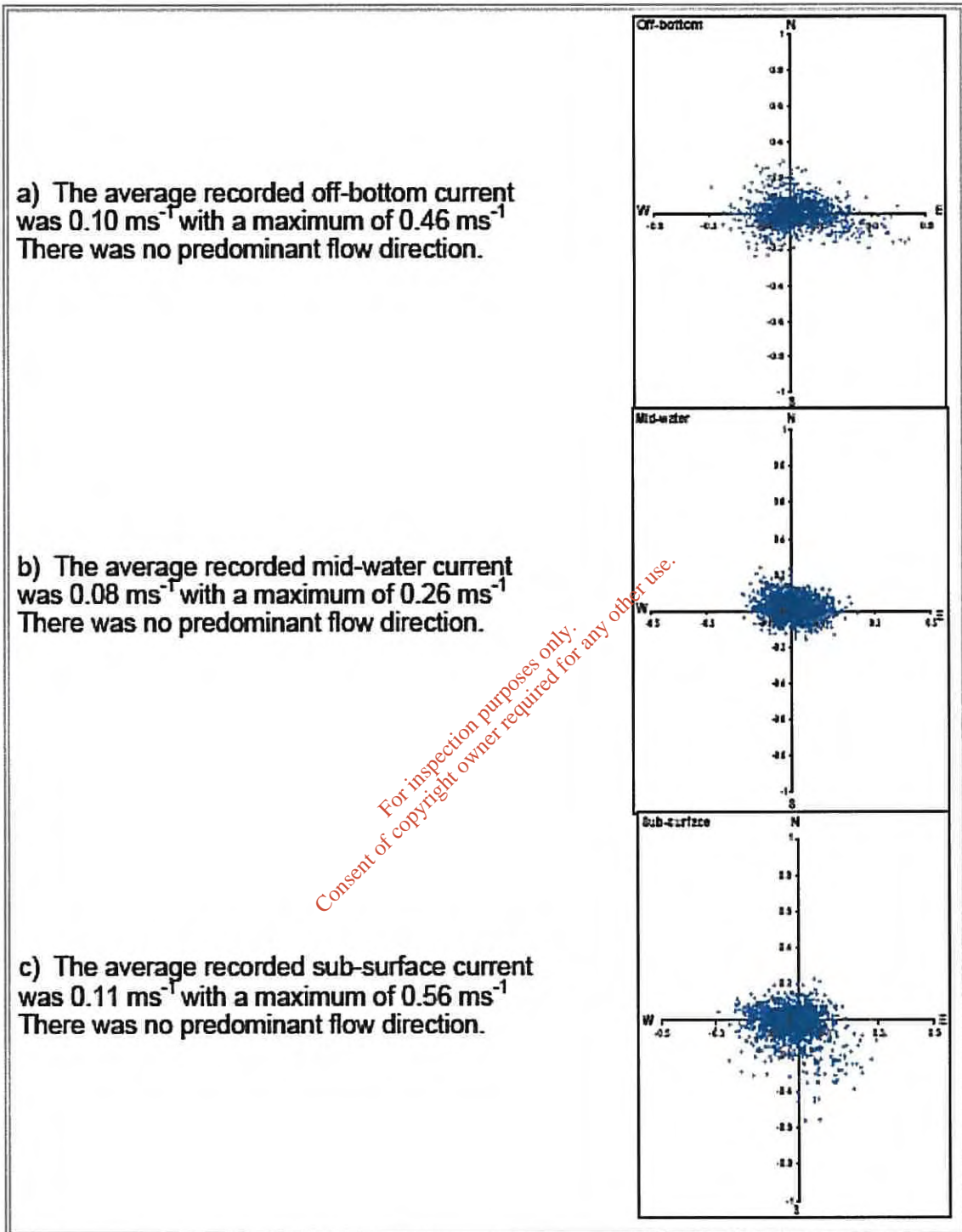


Figure A1.4 Current Data recorded at the proposed dump site 12th to 21st Nov 2007

.5 SUSPENDED SOLIDS

Results of the suspended solid analysis of the water samples collected from the four stations in Dingle Harbour during spring and neap tidal periods are presented in Tables A1.2 and A1.3 respectively. Results from the secchi disc revealed that water transparency was greater than water depth on all sampling occasions e.g. the secchi disc reached the seafloor before it became lost from view.

Table A1.2 Suspended solid results from water samples taken in Dingle Harbour 13.11.07

Station SS1			Station SS2			Station SS3			Station SS4		
Time	Depth	SS	Time	Depth	SS	Time	Depth	SS	Time	Depth	SS
		(mg/l)			(mg/l)			(mg/l)			(mg/l)
08:26	mid	0.2	08:35	mid	0	08:41	surf	0.2	08:47	surf	0.2
09:30	mid	0.1	09:36	mid	0.1		mid	0.2		mid	0.2
10:32	mid	0.1	10:36	mid	0.1		bottom	0.3		bottom	0.1
11:29	mid	0.4	11:36	mid	0.3	09:43	surf	0.2	09:50	surf	0.3
12:31	mid	0.6	12:35	mid	0.1		mid	0.4		mid	0.1
13:30	mid	0.5	13:34	mid	0.2		bottom	0.2		bottom	0.2
14:25	mid	0.3	14:32	mid	0.4	10:41	surf	0.3	10:46	surf	0.4
15:30	mid	0.2	15:35	mid	0.2		mid	0.3		mid	0.3
16:27	mid	<0.1	16:33	mid	0.2		bottom	0.3		bottom	0.1
17:30	mid	<0.1	17:34	mid	0.1	11:42	surf	0.1	11:47	surf	0.2
							mid	0.4		mid	0.7
							bottom	0.6		bottom	0.8
						12:42	surf	0.5	12:51	surf	0.4
							mid	0.5		mid	0.4
							bottom	0.8		bottom	0.9
						13:41	surf	0.2	13:48	surf	0.2
							mid	0.6		mid	0.3
							bottom	0.5		bottom	0.1
						14:37	surf	0.2	14:45	surf	0.3
							mid	0.1		mid	0.2
							bottom	0.3		bottom	0.1
						15:39	surf	0.2	15:44	surf	0.1
							mid	0.1		mid	0.1
							bottom	0.2		bottom	0.1
						16:39	surf	0.5	16:46	surf	0.2
							mid	0.4		mid	0.1
							bottom	0.3		bottom	0.1
						17:40	surf	0.2	17:53	surf	0.2
							mid	0.2		mid	0.2
							bottom	0.9		bottom	0.2

**Table A1.3 Suspended solid results from water samples taken in Dingle Harbour
19.11.07**

Station SS1			Station SS2			Station SS3			Station SS4		
Time	Depth	SS (mg/l)	Time	Depth	SS (mg/l)	Time	Depth	SS (mg/l)	Time	Depth	SS (mg/l)
08:05	mid	0.2	08:10	mid	0.1	08:14	surf	0.3	08:19	surf	0.1
09:00	mid	0.4	09:03	mid	0.1		mid	0.3		mid	0.1
10:02	mid	0.2	10:06	mid	0.1		bottom	0.4		bottom	0.1
11:00	mid	0.2	11:05	mid	0.2	09:08	surf	0.4	09:14	surf	0.2
11:58	mid	0.3	12:03	mid	0.1		mid	0.4		mid	0.1
13:02	mid	0.3	13:06	mid	0.1		bottom	0.5		bottom	0.2
14:00	mid	0.2	14:05	mid	0.2	10:11	surf	0.3	10:21	surf	0.1
15:05	mid	0.5	15:11	mid	0.1		mid	0.2		mid	0.1
16:00	mid	0.4	16:04	mid	0.2		bottom	0.3		bottom	0.1
17:01	mid	0.4	17:05	mid	0.2	11:11	surf	0.6	11:16	surf	0.3
							mid	0.8		mid	0.5
							bottom	0.8		bottom	0.3
						12:08	surf	0.5	12:13	surf	0.4
							mid	0.4		mid	0.1
							bottom	0.5		bottom	0.3
						13:11	surf	0.5	13:18	surf	0.2
							mid	0.5		mid	0.2
							bottom	0.7		bottom	0.4
						14:11	surf	0.2	14:20	surf	0.6
							mid	0.2		mid	0.5
							bottom	0.3		bottom	0.6
						15:14	surf	0.6	15:20	surf	0.7
							mid	0.2		mid	0.4
							bottom	0.8		bottom	0.2
						16:09	surf	0.6	16:15	surf	0.8
							mid	0.6		mid	0.6
							bottom	0.7		bottom	0.6
						17:10	surf	0.6	17:15	surf	0.7
							mid	0.5		mid	0.7
							bottom	0.8		bottom	0.9

APPENDIX B

SEDIMENT CHEMICAL TESTING RESULTS

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Mark Costello
Aqua Fact International Services Ltd
12 Kilkerrin Park
Liosbaun
Galway
Ireland

Dear Mark

Please find attached the results for the batch of samples described below.

Samples taken on: 14-Nov-2007
Samples Registered on: 20-Nov-2007

Results for Batch Number 20004924

You will be invoiced shortly by our accounts department.

If we can be of further assistance then please do not hesitate to contact us.

Yours sincerely

William Fardon
Customer Services Team Leader
Tel: (0113) 231 2177
nls@environment-agency.gov.uk

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Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation. Details of analytical procedures and performance data are available on request. The date of sample analysis is available on request.

The Environment Agency carries out analytical work to high standards and within the scope of its UKAS accreditation, but has no knowledge of whether the circumstances or the validity of the procedures used to obtain the samples provided to the laboratory were representative of the need for which the information was required.

The Environment Agency and/or its staff does not therefore accept any liability for the consequences of any acts or omissions made on the basis of the analysis or advice or interpretation provided.





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513454 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 1

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	3.440	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.00600	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	10100.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	4.450	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.0330	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	9.2000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	1.900	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	3.350	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	477.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	7.690	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	18.700	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	< 2.00	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	< 2.00	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
Chrysene DW	3.98	ug/kg	2	UKAS	LI 680
Fluoranthene DW	6.54	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	< 10.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	32.0	ug/kg	10	UKAS	LI 680
Phenanthrene DW	< 10.0	ug/kg	10	UKAS	LI 680
Pyrene DW	6.43	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	597.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	385.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	2850.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	1450.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	7840.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	5090.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	74100.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	27900.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	4930.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	< 3000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	90300.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	36300.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt {EPH}	127000.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	75.30	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513454

The sample was received in a small plastic pot weighing approx.429g in total.

The sample appeared to be medium brown sand with white specks of shell present.

88.31g of the sample was taken for drying at <30degC which gave 70.03g of dried sample.

The sample was sieved to <10mm and then crushed using a pestle and mortar.

No waste was discarded after sieving at 10mm.

The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513455 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 2

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	5.280	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.00850	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	10200.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	4.570	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.0330	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	9.0700	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	2.190	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	2.990	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	415.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	7.810	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	17.100	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	< 2.00	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	< 2.00	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
Chrysene DW	< 2.00	ug/kg	2	UKAS	LI 680
Fluoranthene DW	< 2.00	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	< 10.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	34.5	ug/kg	10	UKAS	LI 680
Phenanthrene DW	< 10.0	ug/kg	10	UKAS	LI 680
Pyrene DW	< 2.00	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Equiv.Carbon No >10-12 Aliphatic fraction : Dry Wt	566.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >10-12 Aromatic fraction : Dry Wt	328.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >12-16 Aliphatic fraction : Dry Wt	2540.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >12-16 Aromatic fraction : Dry Wt	2860.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >16-21 Aliphatic fraction : Dry Wt	3660.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >16-21 Aromatic fraction : Dry Wt	2300.	ug/kg	400	UKAS	Le	920
Equiv.Carbon No >21-35 Aliphatic fraction : Dry Wt	31500.	ug/kg	3000	UKAS	Le	920
Equiv.Carbon No >21-35 Aromatic fraction : Dry Wt	34400.	ug/kg	3000	UKAS	Le	920
Equiv.Carbon No >35-40 Aliphatic fraction : Dry Wt	3200.	ug/kg	900	UKAS	Le	920
Equiv.Carbon No >35-40 Aromatic fraction : Dry Wt	3750.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	41500.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	43700.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt (EPH)	85100.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	71.50	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513455

The sample was received in a small plastic pot weighing approx.910g in total.

The sample appeared to be grey wet sand with stones, shell, sticks and worms present.

118.17g of the sample was taken for drying at <30degC which gave 88.55g of dried sample.

The sample was sieved to <10mm and then crushed using a pestle and mortar.

No waste was discarded after sieving at 10mm.

The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513456 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 3

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	4.800	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.01000	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	15700.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	4.650	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.0340	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	15.8000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	2.210	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	4.050	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	473.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	72.900	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	23.700	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	9.68	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	10.70	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
Chrysene DW	8.97	ug/kg	2	UKAS	LI 680
Fluoranthene DW	6.66	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	< 10.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	31.5	ug/kg	10	UKAS	LI 680
Phenanthrene DW	< 10.0	ug/kg	10	UKAS	LI 680
Pyrene DW	6.62	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	421.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	401.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	3310.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	1470.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	11500.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	3780.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	55000.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	27000.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	5860.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	3110.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	76200.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	35800.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt (EPH)	112000.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	74.80	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513456

The sample was received in a small plastic pot weighing approx.388g in total.
The sample appeared to be grey sand with crushed shell and sticks present.

82.19g of the sample was taken for drying at <30degC which gave 65.04g of dried sample.
The sample was sieved to <10mm and then crushed using a pestle and mortar.
No waste was discarded after sieving at 10mm.
The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513457 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 4

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	1.610	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.00700	mg/kg	0.001	UKAS	LI 1042
Aluminium : Dry Wt	4760.000	mg/kg	0.40	UKAS	LI 1043
Iron : Dry Wt	15400.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	3.660	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.0380	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	13.5000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	2.850	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	4.990	mg/kg	0.20	UKAS	LI 1041
Lithium : Dry Wt	18.400	mg/kg	0.10	UKAS	LI 1041
Manganese : Dry Wt	338.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	11.400	mg/kg	0.30	UKAS	LI 1041
Vanadium : Dry Wt	18.10	mg/kg	1	UKAS	LI 1041
Zinc : Dry Wt	22.900	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	< 2.00	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	< 2.00	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
Chrysene DW	< 2.00	ug/kg	2	UKAS	LI 680
Fluoranthene DW	2.51	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	< 10.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	30.8	ug/kg	10	UKAS	LI 680
Phenanthrene DW	< 10.0	ug/kg	10	UKAS	LI 680
Pyrene DW	2.86	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI	685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI	685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI	685
Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	< 300.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	393.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	2080.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	2310.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	2010.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	2490.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	25300.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	35600.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	3100.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	3650.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	32700.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	44400.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt {EPH}	77100.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	82.70	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513457

The sample was received in a small plastic pot weighing approx.834g in total.

The sample appeared to be dark grey non-soil sample with small amount of sandy sediment, plant, stones and shells present.

157.80g of the sample was taken for drying at <30degC which gave 132.92g of dried sample.

The sample was sieved to <10mm and then crushed using a pestle and mortar.

No waste was discarded after sieving at 10mm.

The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513458 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 5

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	3.020	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.00810	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	12800.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	3.630	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.0420	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	13.3000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	2.650	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	3.830	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	358.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	12.100	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	24.000	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	12.80	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	12.70	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	18.2	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	12.3	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
Chrysene DW	15.40	ug/kg	2	UKAS	LI 680
Fluoranthene DW	14.50	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	11.50	ug/kg	2	UKAS	LI 680
Naphthalene DW	42.5	ug/kg	10	UKAS	LI 680
Perylene DW	< 10.0	ug/kg	10	UKAS	LI 680
Pyrene DW	15.70	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Equiv.Carbon No >10-12 Aliphatic fraction : Dry Wt	542.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >10-12 Aromatic fraction : Dry Wt	503.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >12-16 Aliphatic fraction : Dry Wt	2920.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >12-16 Aromatic fraction : Dry Wt	3650.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >16-21 Aliphatic fraction : Dry Wt	5500.	ug/kg	300	UKAS	Le	920
Equiv.Carbon No >16-21 Aromatic fraction : Dry Wt	6040.	ug/kg	400	UKAS	Le	920
Equiv.Carbon No >21-35 Aliphatic fraction : Dry Wt	34300.	ug/kg	3000	UKAS	Le	920
Equiv.Carbon No >21-35 Aromatic fraction : Dry Wt	32500.	ug/kg	3000	UKAS	Le	920
Equiv.Carbon No >35-40 Aliphatic fraction : Dry Wt	4490.	ug/kg	900	UKAS	Le	920
Equiv.Carbon No >35-40 Aromatic fraction : Dry Wt	3360.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	47700.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	46000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt (EPH)	93700.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	75.50	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513458

The sample was received in a small plastic pot weighing approx.454g in total.

The sample appeared to be grey sand with crushed shell, stones and seaweed present.

127.57g of the sample was taken for drying at <30degC which gave 99.85g of dried sample.

The sample was sieved to <10mm and then crushed using a pestle and mortar.

No waste was discarded after sieving at 10mm.

The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513459 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 6

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	2.070	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.00510	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	13200.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	3.530	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.0430	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	13.2000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	2.510	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	2.950	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	319.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	11.900	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	22.100	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	< 2.00	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	< 2.00	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	< 10.0	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	< 10.0	ug/kg	10	UKAS	LI 680
Chrysene DW	< 2.00	ug/kg	2	UKAS	LI 680
Fluoranthene DW	2.16	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	< 10.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	44.7	ug/kg	10	UKAS	LI 680
Perylene DW	< 10.0	ug/kg	10	UKAS	LI 680
Pyrene DW	2.12	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	517.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	530.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	4170.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	2300.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	14400.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	5190.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	60100.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	20200.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	4660.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	< 3000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	83800.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	29800.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt (EPH)	114000.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	76.40	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513459

The sample was received in a small plastic pot weighing approx.430g in total.
The sample appeared to be dark grey clay/sand with little shells present.

103.45g of the sample was taken for drying at <30degC which gave 82.35g of dried sample.
The sample was sieved to <10mm and then crushed using a pestle and mortar.
No waste was discarded after sieving at 10mm.
The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513460 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 7

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	3.380	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.02200	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	21900.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	5.660	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.1620	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	26.4000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	11.400	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	12.200	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	435.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	20.900	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	54.900	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	11.3	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	36.00	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	34.50	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	49.3	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	30.8	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	21.6	ug/kg	10	UKAS	LI 680
Chrysene DW	41.70	ug/kg	2	UKAS	LI 680
Fluoranthene DW	76.20	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	38.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	32.4	ug/kg	10	UKAS	LI 680
Perylene DW	42.5	ug/kg	10	UKAS	LI 680
Pyrene DW	66.60	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	0.00500	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	1100.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	571.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	3930.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	4170.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	16900.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	11300.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	70000.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	36000.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	8290.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	5460.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	100000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	57400.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt {EPH}	158000.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	53.40	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513460

The sample was received in a small plastic pot weighing approx.378g in total.

The sample appeared to be black non-soil sample with sediment, worms and a sulphur odour present.

95.17g of the sample was taken for drying at <30degC which gave 57.48g of dried sample.

The sample was sieved to <10mm and then crushed using a pestle and mortar.

No waste was discarded after sieving at 10mm.

The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC



Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513461 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 8

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	3.040	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.03480	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	26400.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	7.700	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.2130	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	31.8000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	16.200	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	15.300	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	494.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	24.300	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	69.800	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	2.78	ug/kg	1	UKAS	LI 672
Anthracene DW	47.8	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	112.00	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	100.00	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	92.1	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	68.0	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	45.3	ug/kg	10	UKAS	LI 680
Chrysene DW	114.00	ug/kg	2	UKAS	LI 680
Fluoranthene DW	223.00	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	80.40	ug/kg	2	UKAS	LI 680
Naphthalene DW	83.9	ug/kg	10	UKAS	LI 680
Perylene DW	182.0	ug/kg	10	UKAS	LI 680
Pyrene DW	194.00	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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NG2 3HN

NLS Starcross
Staplake Mount
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EX6 8PE



**ENVIRONMENT
AGENCY**



Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	0.01000	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	742.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	882.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	4670.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	5170.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	6920.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	9270.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	50200.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	59400.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	5510.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	6000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	68000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	80800.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt (EPH)	149000.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	49.80	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513461

The sample was received in a small plastic pot weighing approx. 883g in total.

The sample appeared to be black non-soil sample with sediment, worms and a sulphur odour present.

112.52g of the sample was taken for drying at <30degC which gave 63.23g of dried sample.

The sample was sieved to <10mm and then crushed using a pestle and mortar.

No waste was discarded after sieving at 10mm.

The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513462 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 9

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	3.490	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.03230	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	26900.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	7.340	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.2210	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	29.5000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	18.500	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	16.200	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	507.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	24.700	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	78.300	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	18.3	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	73.20	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	95.70	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	96.8	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	79.7	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	50.8	ug/kg	10	UKAS	LI 680
Chrysene DW	92.70	ug/kg	2	UKAS	LI 680
Fluoranthene DW	132.00	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	90.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	70.4	ug/kg	10	UKAS	LI 680
Perylene DW	180.0	ug/kg	10	UKAS	LI 680
Pyrene DW	129.00	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	0.01000	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	824.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	559.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	3320.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	3880.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	2770.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	9680.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	39400.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	56300.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	6220.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	5040.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	52600.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	75500.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt (EPH)	128000.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	51.00	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513462

The sample was received in a small plastic pot weighing approx. 741g in total.

The sample appeared to be black wet non-soil sample with sediment and a sulphur odour present.

112.26g of the sample was taken for drying at <30degC which gave 64.19g of dried sample.

The sample was sieved to <10mm and then crushed using a pestle and mortar.

No waste was discarded after sieving at 10mm.

The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513463 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 10

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	3.690	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.04230	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	25500.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	6.830	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.2200	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	31.6000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	16.200	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	15.200	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	492.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	24.000	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	73.200	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	13.6	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	51.30	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	56.00	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	< 73.6	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	49.1	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	39.1	ug/kg	10	UKAS	LI 680
Chrysene DW	78.70	ug/kg	2	UKAS	LI 680
Fluoranthene DW	149.00	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	58.30	ug/kg	2	UKAS	LI 680
Naphthalene DW	123.0	ug/kg	10	UKAS	LI 680
Perylene DW	105.0	ug/kg	10	UKAS	LI 680
Pyrene DW	127.00	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Nottingham
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NLS Starcross
Staplake Mount
Starcross
Exeter
EX6 8PE



ENVIRONMENT
AGENCY



Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	0.08000	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	1120.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	418.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	8390.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	2820.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	29000.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	13200.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	123000.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	33100.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	7990.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	5900.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	170000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	55400.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt (EPH)	225000.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	47.80	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513463

The sample was received in a small plastic pot weighing approx.300 in total.
The sample appeared to be black non-soil sample with sediment present.

78.55g of the sample was taken for drying at <30degC which gave 44.99g of dried sample.
The sample was sieved to <10mm and then crushed using a pestle and mortar.
No waste was discarded after sieving at 10mm.
The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513464 Sampled on: 14-Nov-07 @ 00:00
Comments: Station 11

	Result	Units	MRV	Accred	Lab / TestCode
Carbon : Dry Wt	4.400	%	0.4	UKAS	LI 404
Carbon, Organic : Dry Wt as C	< 0.400	%	0.4	None	LI 404
Mercury : Dry Wt	0.03910	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	28800.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	9.190	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	0.2760	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	33.0000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	22.900	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	18.600	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	512.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	26.900	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	87.900	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	< 1.00	ug/kg	1	UKAS	LI 672
Anthracene DW	34.5	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	149.00	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	127.00	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	135.0	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	93.4	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	53.6	ug/kg	10	UKAS	LI 680
Chrysene DW	158.00	ug/kg	2	UKAS	LI 680
Fluoranthene DW	261.00	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	97.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	206.0	ug/kg	10	UKAS	LI 680
Perylene DW	100.0	ug/kg	10	UKAS	LI 680
Pyrene DW	259.00	ug/kg	2	UKAS	LI 680
PCB 028 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	< 0.100	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	< 0.100	ug/kg	0.1	UKAS	LI 685

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Dibutyl Tin : Dry Wt as cation	< 0.00300	mg/kg	0.003	MCertS	Le	897
Tributyl Tin : Dry Wt as cation	0.02000	mg/kg	0.003	MCertS	Le	897
Equiv. Carbon No >10-12 Aliphatic fraction : Dry Wt	731.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >10-12 Aromatic fraction : Dry Wt	533.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aliphatic fraction : Dry Wt	6410.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >12-16 Aromatic fraction : Dry Wt	5220.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aliphatic fraction : Dry Wt	17700.	ug/kg	300	UKAS	Le	920
Equiv. Carbon No >16-21 Aromatic fraction : Dry Wt	12400.	ug/kg	400	UKAS	Le	920
Equiv. Carbon No >21-35 Aliphatic fraction : Dry Wt	97000.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >21-35 Aromatic fraction : Dry Wt	94600.	ug/kg	3000	UKAS	Le	920
Equiv. Carbon No >35-40 Aliphatic fraction : Dry Wt	6120.	ug/kg	900	UKAS	Le	920
Equiv. Carbon No >35-40 Aromatic fraction : Dry Wt	6830.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aliphatic extractable C10 - C40 : Dry Wt	128000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Aromatic extractable C10 - C40 : Dry Wt	120000.	ug/kg	3000	UKAS	Le	920
Hydrocarbons, Total extractable C10 - C40 : Dry Wt (EPH)	247000.	ug/kg	4000	MCertS	Le	920
Dry Solids @ 30°C	40.30	%	1	None	Le	924
Sample Preparation	1	Text		None	Le	924

Folder Number: 513464

The sample was received in a small plastic pot weighing approx.824g in total.

The sample appeared to be black non-soil sample with wet sediment and a sulphur odour present.

106.72g of the sample was taken for drying at <30degC which gave 51.55g of dried sample.

The sample was sieved to <10mm and then crushed using a pestle and mortar.

No waste was discarded after sieving at 10mm.

The sample was received unpreserved.

All parameters are determined on the air-dried (<30degC) portion except those requiring a wet sample fraction where as received (wet) sample was used.

Dry Weight (DW) results are reported as determined at <30degC





Client: Aqua Fact International Services Ltd Project: Marine Sediments
Folder No: 000513465 Sampled on: 14-Nov-07 @ 00:00
Comments: CRM

	Result	Units	MRV	Accred	Lab / TestCode
Mercury : Dry Wt	0.09570	mg/kg	0.001	UKAS	LI 1042
Iron : Dry Wt	39600.000	mg/kg	0.30	UKAS	LI 1043
Arsenic : Dry Wt	18.200	mg/kg	0.10	UKAS	LI 1041
Cadmium : Dry Wt	1.9000	mg/kg	0.01	UKAS	LI 1041
Chromium : Dry Wt	64.0000	mg/kg	0.05	UKAS	LI 1041
Copper : Dry Wt	26.200	mg/kg	0.10	UKAS	LI 1041
Lead : Dry Wt	19.500	mg/kg	0.20	UKAS	LI 1041
Manganese : Dry Wt	317.000	mg/kg	0.20	UKAS	LI 1041
Nickel : Dry Wt	39.100	mg/kg	0.30	UKAS	LI 1041
Zinc : Dry Wt	137.000	mg/kg	0.20	UKAS	LI 1041
HCH -gamma DW	572.00	ug/kg	1	UKAS	LI 672
Anthracene DW	1790.0	ug/kg	10	UKAS	LI 680
B(a)anthracene DW	4950.00	ug/kg	2	UKAS	LI 680
B(a)pyrene DW	3620.00	ug/kg	2	UKAS	LI 680
B(b)fluoranthene DW	3320.0	ug/kg	10	UKAS	LI 680
B(ghi)perylene DW	2910.0	ug/kg	10	UKAS	LI 680
B(k)fluoranthene DW	1970.0	ug/kg	10	UKAS	LI 680
Chrysene DW	6310.00	ug/kg	2	UKAS	LI 680
Fluoranthene DW	8560.00	ug/kg	2	UKAS	LI 680
Indeno123cdPyrene DW	2730.00	ug/kg	2	UKAS	LI 680
Naphthalene DW	2100.0	ug/kg	10	UKAS	LI 680
Perylene DW	862.0	ug/kg	10	UKAS	LI 680
Pyrene DW	9920.00	ug/kg	2	UKAS	LI 680
PCB 028 DW	72.500	ug/kg	0.1	UKAS	LI 685
PCB 052 DW	80.300	ug/kg	0.1	UKAS	LI 685
PCB 101 DW	72.300	ug/kg	0.1	UKAS	LI 685
PCB 118 DW	56.900	ug/kg	0.1	UKAS	LI 685
PCB 138 DW	55.600	ug/kg	0.1	UKAS	LI 685
PCB 153 DW	69.800	ug/kg	0.1	UKAS	LI 685
PCB 180 DW	45.700	ug/kg	0.1	UKAS	LI 685
Dibutyl Tin : Dry Wt as cation	0.68000	mg/kg	0.003	MCertS	Le 897
Tributyl Tin : Dry Wt as cation	0.50000	mg/kg	0.003	MCertS	Le 897

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Key to Accreditation: UKAS = Methodology accredited to ISO/IEC 17025:2005, MCertS = Methodology accredited to MCertS Performance Standard for testing of soils, none = Methodology not accredited

Key to Lab Code: Le = Leeds, Ll = Llanelli, No = Nottingham, Sx = Starcross, SC = Sub-Contracted outside NLS

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National Research
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de recherches Canada

HISS-1, MESS-3, PACS-2

Marine Sediment Reference Materials for Trace Metals and other Constituents

The following tables show those constituents for which certified and information values have been established. Certified values are based on the results of determinations by at least two independent methods of analysis. The uncertainties represent 95% confidence limits for an individual sub-sample of 250 mg or greater.

Trace Metals (milligrams per kilogram)

	HISS-1	MESS-3	PACS-2
Antimony	(0.13)*	1.02 ± 0.09	11.3 ± 2.6
Arsenic	0.801 ± 0.099	21.2 ± 1.1	26.2 ± 1.5
Beryllium	0.129 ± 0.023	2.30 ± 0.12	1.0 ± 0.2
Cadmium	0.024 ± 0.009	0.24 ± 0.01	2.11 ± 0.15
Chromium	30.0 ± 3.8†	135 ± 4	90.7 ± 4.6
Cobalt	(0.65)*	14.4 ± 2.0	11.5 ± 0.3
Copper	2.29 ± 0.37	33.9 ± 1.6	310 ± 12
Lead	3.13 ± 0.40	21.1 ± 0.7	183 ± 3
Lithium	2.83 ± 0.54	73.6 ± 5.2	32.2 ± 2.0
Manganese	36.1 ± 4.2	324 ± 12	440 ± 19
Mercury	(0.01)*	0.091 ± 0.009	3.04 ± 0.20
Molybdenum	(0.13)*	2.78 ± 0.07	5.43 ± 0.28
Nickel	2.16 ± 0.29	46.9 ± 2.2	39.5 ± 2.3
Selenium	0.050 ± 0.007	0.72 ± 0.05	0.92 ± 0.22
Silver	0.016 ± 0.002	0.18 ± 0.02	1.22 ± 0.14
Strontium	93.9 ± 11.2	129 ± 11	276 ± 30
Thallium	(0.06)*	0.90 ± 0.06	(0.6)*
Tin	(0.11)*	2.50 ± 0.52	19.8 ± 2.5
Uranium	(0.26)*	(4)*	(3.)*
Vanadium	6.60 ± 0.78	243 ± 10	133 ± 5
Zinc	4.94 ± 0.79	159 ± 8	364 ± 28
Tributyltin (as Sn)	—	—	0.98 ± 0.13
Dibutyltin "	—	—	1.09 ± 0.15
Monobutyltin "	—	—	0.45 ± 0.05

*information value only

† see page 3

NRC - CNRC

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APPENDIX C

SEDIMENT RADIOLOGICAL TESTING RESULTS

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Radiological Protection Institute of Ireland

An Institiúid Éireannach um Chosaint Raideolaíoch

Laboratory Test Report

Report Date: 14th December 2007

Samples Tested on Behalf of: Mr M Costelloe
Aqua-Fact International Services Ltd
12 Kilkerrin Park
Liosbaun
Galway

Laboratory Analysis: High Resolution Gamma Spectrometry with appropriate density correction

Sample Type: Marine Sediment ex An Daingean Co Kerry

Date of Receipt: 16th November 2007

Date of Analysis: 16th November - 14th December 2007

Results:

RPII Reference	Client Reference	Coordinates	Nuclide	Activity Concentration (Bq/kg, dry) ¹
CT0703084	St Rad 1	52° 07.432 10 15.840	K-40	249 ± 27
			I-131	Less than 2
			Cs-134	Less than 1
			Cs-137	Less than 1
			Ra-226	Less than 75
			U-235	Less than 6
			U-238	37 ± 6
CT0703085	St Rad 2	52° 08.135 10 16.531	K-40	662 ± 70
			I-131	Less than 4
			Cs-134	Less than 1
			Cs-137	6.7 ± 0.5
			Ra-226	Less than 168
			U-235	Less than 9
U-238	82 ± 8			

Note:

(1) Quoted uncertainties are ±1 SD counting statistics

The Radiological Protection Institute of Ireland received two samples of sediment, from Aqua-fact Ltd. The samples were taken from the An Daingean Harbour development area on behalf of RPS Consulting Engineers in support of an application for a Permit for Maintenance Dredging. The samples were prepared for high-resolution gamma spectrometry by placing an aliquot of sample in a well-defined counting geometry. The samples were measured on a high-resolution gamma spectrometer. Appropriate density corrections were applied to the resultant spectra to take account of the differences in sample density. Dry to wet weight ratio was determined for the sample. Results are quoted on a dry weight basis.



Stephanie Long
Laboratory Manager

Notes:

- This report relates only to the samples tested.
- This report shall not be reproduced except in full, without the approval of the Institute
- The following scientific officers may sign test reports on behalf of the lab manager: Mr David Pollard, Ms Mary Fegan, Mr Kevin Kelleher, Ms Alison Dowdall
- Where applicable, the number following the symbol \pm is the combined standard uncertainty and not a confidence interval.

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Appendix 3
Outline CEMP

**Outline Construction Environmental
Management Plan (CEMP)
An Daingean FHC Small Craft Harbour, Co. Kerry**



ISSUE FORM	
Project number	21579
Document number	6050
Document revision	C
Document title	Outline Construction and Environmental Management Plan
Document status	Preliminary
Document prepared by	EL (MWP 2022-06-27)
Document checked by	PP (MWP 2020-06-27)

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1. INTRODUCTION

This outline Construction and Environmental Management Plan (CEMP) for the proposed An Daingean FHC Small Craft Harbour, has been prepared by MWP. It has been developed specifically for this project and outlines construction practices and environmental management and mitigation measures which will be implemented during the construction phase, in order to ensure that the project is constructed in accordance with best practice, with the minimum impact on the surrounding environment.

Prior to construction, the Appointed Main Contractor will prepare a detailed CEMP taking into account methods/requirements outlined in this report. This outline CEMP will form the basis of the construction management approach on site, while the works are being completed; ensuring environmental management measures are in place, which will be implemented during the construction phase, in order to ensure that the project is constructed in accordance with best practice, with the minimum impact on the surrounding environment.

1.1 CEMP PURPOSE AND OBJECTIVES

The purpose of a Construction Environmental Management Plan is to outline how the Appointed Contractor(s) will implement a Site Construction Management System to meet the specified requirements which include Contractual, Regulatory and Statutory Requirements, Environmental Mitigation Measures and Planning Conditions.

The principal objective of this outline CEMP is to avoid, minimise and control potential environmental impacts associated with all aspects of the construction of the proposed development. In essence, this Outline CEMP is intended to provide the Appointed Contractors with a practical guide to ensure compliance by all parties with any Planning and Environmental requirements.

The Outline CEMP achieves this by providing the environmental management framework to be adhered to during the construction phase of the proposal. It outlines the work practices, construction management procedures, management responsibilities, mitigation measures and monitoring proposals that are required to be adhered to, in order to complete the proposed development, in an appropriate environmental manner.

All site personnel will be required to be familiar with the plan's requirements as related to their role on site.

There is a requirement on the Appointed Contractor(s) that details of this Project outline CEMP are updated with progress, including the roles and responsibilities of those appointed on the site for the construction of the project, if their respective roles change during the project.

While this version of the outline CEMP provides a benchmark for good practice, where avoidance or further minimisation of risks to the environment can be demonstrated through use of alternative methods or improvements to current practices, the Contractor will implement these wherever possible.

2. PROJECT OVERVIEW

The Department of Agriculture, Food and the Marine (DAFM) proposes the construction and operation of a Small Craft Harbour (SCH) at An Daingean, Co. Kerry.

The Proposed Development is located at An Daingean Fishery Harbour Centre (FHC) and consists of an approximately 150 berth small craft harbour just south of the west breakwater at Dingle inner harbour. The project consists of dredging of an area of seabed, installation of anchoring piles, installation of floating breakwaters, small craft type pontoons, walkways and fingers, a sloped gangway from the west breakwater to the small craft area, trolley bays, toilet facilities, power and water kiosks and other ancillary furniture. The project also includes operations required for the disposal of dredge material to sea in an area east of the mouth of Dingle Harbour.

The overall above-water area of the SCH is approximately 120 m x 220 m (26,400 m²). The layout plan for the SCH is presented in Figure 4. A detailed description of the Proposed Development is presented in Section 4.

3. PROJECT LOCATION

The Proposed Development is located at An Daingean Fishery Harbour Centre (FHC). The project also includes operations required for the disposal of dredge material to sea in an area east of the mouth of Dingle Harbour.



Figure 1: Location of the Proposed Development south of the west breakwater at Dingle inner harbour shown in blue.



Figure 1: Location of the Proposed Development and Proposed Dredge Spoil Disposal Area.

4. CONSTRUCTION WORKS

4.1 INTRODUCTION

The Proposed Development at Dingle FHC comprises two works areas. The first area is located in Dingle Harbour where a new small craft harbour (SCH) comprising approximately 150 berths will be constructed just south of the west breakwater at Dingle inner harbour. The second works area is a dredge spoil site located to the east of the mouth of Dingle Harbour. The locations of the works areas are shown in Figure 1 and Figure 2. The project consists of dredging of an area of seabed, installation of anchoring piles, installation of floating breakwaters, small craft type pontoons, walkways and fingers, a sloped gangway from the west breakwater to the small craft area, trolley bays, toilet facilities, power and water kiosks and other ancillary furniture. The overall above-water area of the SCH is approximately 120 by 220m (26,400 m²). The SCH will be constructed within the confines of Dingle inner harbour. Disposal of dredge material will take place outside the harbour.

The works comprise in summary:

- Dredging
- Piling
- Breakwaters, pontoons and fingers
- Ancillary items

The following sub-sections go provide greater detail on the above.

4.2 DREDGING

The total seabed footprint of the works is approximately 3.2 ha. This includes a dredge area of 2.7 ha dredged to -3.1 m Chart Datum (CD), plus the area of the side slopes around the perimeter of the -3.1 m CD area which will be at 5 horizontals to 1 vertical. The project requires the dredging of some 100,000 m³ of material from within the proposed SCH area and of side slopes around the perimeter of the area. The material to be dredged is a mix of cohesive and non-cohesive sediments overlying rock. Ground investigations comprising 15 boreholes indicate rock levels to be 2 m or more below the planned dredge level. Of the material to be dredged 41.6% is in the silt/clay fraction, 51.3% is in the sand fraction and 7.1% is in the gravel fraction. A contingency of 1,000 m³ for any rock outcrops is included. It is proposed to dispose of the dredge material to sea in Dingle Bay in an area east of the mouth of Dingle Harbour. The location of the proposed dredge spoil disposal area is shown in Figure 2. Dredging will be undertaken using a backhoe or grab from a floating platform which fills a dredge spoil barge beside the floating platform. When full the dredge spoil barge will carry the material to the disposal site and deposit the material there. Dredging will take approximately 2.5 months, based on c. 1,600 m³ per day. There will be approximately 350 trips to the disposal site, based on 300 m³ capacity of disposal barge. If a larger barge is used there will be fewer trips.



Figure 3: Looking south toward the proposed extension area (red) for the existing Dingle port and marina, Dingle Harbour (February 2021)

4.3 BREAKWATERS, PONTOONS, AND FINGERS

The small craft area is to be protected from wave action by means of a floating breakwater installed around the perimeter of the area. The floating breakwater will consist of concrete breakwater units some 4-5 m wide and with a draft of 1-1.5 m depending on their location around the perimeter. The overall length of the floating breakwater will be approximately 470 m. Breakwater units will be approximately 20 m each and the southern leg of the breakwater will have a low (0.75 m) wave wall on top.

It is proposed that there will be two lines of marina type walkways with fingers for berthing of craft from smaller than 9 m length up to 16 m length. There will be a line of berths that can accommodate up to 16 m length craft and lines for up to 9 m and 12 m craft. In all it is anticipated that the harbour will have a capacity for approximately 150 craft.

The installation of the pontoons/breakwater units would be as follows:

- Breakwater, walkway and finger units will be manufactured off site and brought to site via road. They and other items will be stored as required within a site compound on the breakwater adjacent to the proposed area. The breakwater units may, depending on their size and road constraints, be brought to site via sea.
- The units will be lifted into the water from the shore using a large mobile crane. The units will then be floated into position and connected to each other and the support piles.
- A mobile crane will also lift the access gangway (25 x 2.5 m) into position. The gangway will be fixed to a concrete bank seat constructed on the west breakwater and allowed to move on the pontoon as the tide rises and falls.
- Works will be required to provide ducting, pipes and cabling to connect services to the berths via the gangway. Services will be lighting, water supply, toilets and electricity supply.
- Ancillary items will include the installation of trolley bays on the pontoons, toilet facilities on the pontoons/breakwaters, small craft harbour furniture such as power and water outlets, lights and ducting for same, lifebuoys and fire extinguishers, emergency ladders and cleats and bollards for tying up to. These will be installed on the pontoon and breakwater units when these units are in

position. Breakwaters, walkway pontoons, fingers, etc. will be manufactured off site and installed once the piles are in place. There can be some overlap between these operations and the piling, perhaps one month. The ancillary items will take 2 to 3 months to install.

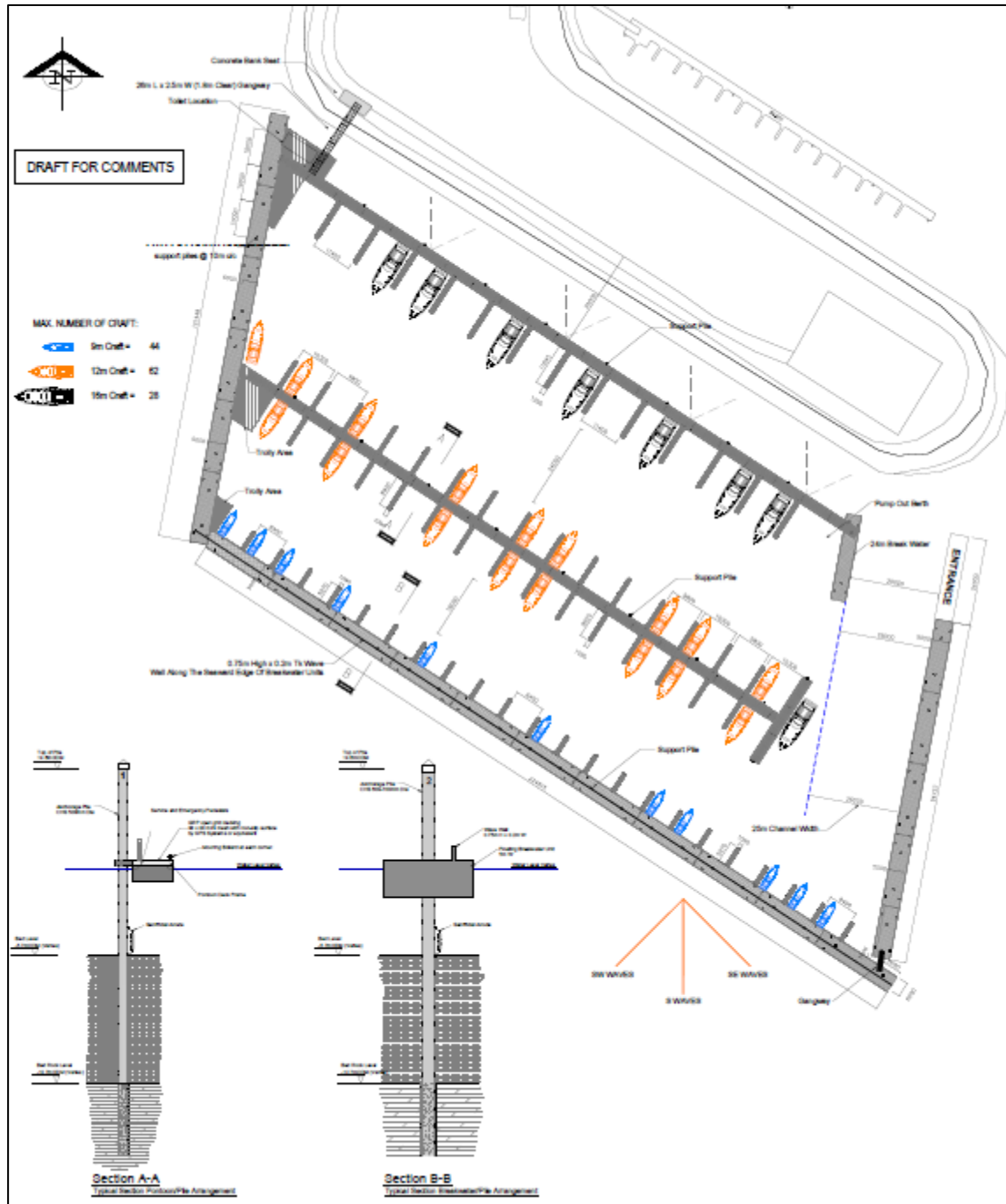


Figure 4: SCH Layout Plan

4.4 PILING

The breakwaters and walkways will be held in position using approximately 70 No. CHS 508-610 mm diameter steel piles. These piles will be driven through the seabed overburden and socketed into the rock underneath the overburden. Socketing involves the drilling of a vertical cylindrical hole in the rock, the placing of concrete in the hole and the installation of the pile in the concrete and the holding of the pile in position for perhaps 24 hours until the concrete goes off (cures). The holes will be approximately 800 mm in

diameter and will extend up to 4 m into the rock. In places where the rock levels are low no socketing will occur; it is likely however that all piles will require to be socketed.

The installation of the piles would be as follows:

A jack-up barge with drilling rig and crane would be towed into position and moved when required. Piles would have been transported to site and placed on the barge from the quayside within the fishing harbour. The piles will be transported to site via road. For each pile a temporary pile casing would be lifted into position using the crane and driven through overburden to refusal. The rock socket would be drilled through the temporary pile casing (typical socket depth c. 4 m). It is likely that the means of drilling will be rotary percussion. Concrete will be tremmied¹ into the hole using a hopper and pipe to supply the concrete to the bottom of the hole. As the hole is filled, the pipe will be raised to allow the flow of concrete. The pipe is to remain within the concrete however, during the pour. The tubular steel piles CHS508Ø will be lifted into the concrete within the rock-socket and secured. The temporary pile casing will be removed over the pile head. Piling works will be undertaken following completion of the dredging. There may be some element of overlap between the two operations. Piling will take some 5-6 months to complete, based on 70 piles at one pile every 1-2 days.

4.5 EQUIPMENT AND RESOURCES REQUIRED

- Barges
- Dredgers
- Piling rigs
- Cranes
- Work boats
- Piles
- Pontoon units
- Welfare facilities, potable water, power source.
- A site compound will be required for the successful contractor to undertake the works.

4.6 WORKING HOURS

Likely Construction hours:-

8.00am – 06.00pm* (Monday – Friday inclusive)

08.00am – 1.00pm* (Saturday)

* Works will be carried out during daylight hours only.

¹ A tremie is a pipe that will be used to pour concrete underwater in a way that avoids washout of cement from the mix due to water contact.

5. CONSTRUCTION METHODOLOGY

5.1 METHOD STATEMENTS/ENVIRONMENTAL MANAGEMENT PLANS

Method statements/EMPs have been prepared for various stages of construction and are provided in Appendix 1, below. They are prepared for activities identified in the specification and risk assessments and are issued to all personnel responsible for and involved with the activity concerned. They define the proposed method of working for an element or section of work taking into account the particular requirements of the project including site conditions, safety hazards, the contract drawings, specification or code of practice. They define the proposed use of plant, labour and materials, any hold points or permits and may be supplemented by drawings, sketches and produce data as necessary.

5.2 SITE PREPARATION AND PRE-CONSTRUCTION ACTIVITIES

Before construction commences, a number of preparatory activities will be carried out. A construction phase management plan will be prepared and implemented. The following key works will be undertaken as part of the site preparation and pre-construction activities:

5.3 PROTECTION OF HABITATS

To describe the measures for the management and protection of habitats on the site, the following measures will be put in place to minimise any disturbance or impact.

5.3.1 Prevention of Release Sediment, Chemical or Other Waste Material

Measures will include standard construction best practice used to manage the risk of potential for loss of concrete or hydrocarbons such as diesel and hydraulic fluids during the construction phase. Careful supervision of concrete handling, curing times and general construction practice will reduce the risk from concrete-related impacts so that the likelihood of impacts is best described as low. In-situ concrete works are related only to the grouting of the steel piles and the construction of shoreside bank seats for the gangway. Just like cement, the implementation of general construction practice will ensure that the likelihood of pollution in a well-equipped, maintained and managed construction site is low. Some key measures required are presented below.

- All machinery fuel on site will be stored in appropriate bunded container during the works
- No on-site concrete batching will be permitted at the proposed works areas. Concrete will instead be transported to the site within a concrete truck. Quick setting concrete mixes will be used to reduce the risk of wash-out. Concrete trucks will be washed down to a mortar bin/skip which has been examined in advance for any defects. The wash down area will not be located within 50 m of any waterbody or drainage
- Oil spill accident response equipment will be held on the jack-up barge, floating platform and dredge spoil barge. At a minimum the response equipment will include the following: absorbent mats, waste bags, oil splash goggles, gloves and vinyl or rubber shoe covers to protect the user from the harmful effects of the spilled material
- A Construction Waste Management Plan (as part of the overall CEMP) which will provide for the segregation of all wastes into recyclable, biodegradable and residual wastes. All operations at the site will be managed and programmed in such a manner to minimise waste production and maximise recycling in order to prevent potential ground pollution. Wastes sent off site for recovery or disposal will only be conveyed by an authorised waste contractor and transported from the proposed development site to an authorised site of recovery/disposal in a manner which will not affect the environment

- Where necessary bunds for the storage of chemicals will be lined or constructed of materials resistant to damage by the materials stored therein. Additionally, the capacity of such bunds will be a minimum of 110% of the volume of the largest container stored therein. Bunds will be designed in accordance with Environmental Protection Agency guidance in relation to the storage of potentially polluting liquids (“IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities”, 2004)
- Where refuelling is to take place, it will where possible be within a designated impermeable, bunded area, away from all drains. Where machinery require refuelling outside of this area, fuel will be transported in a mobile double skinned tank. An adequate supply of spill kits and hydrocarbon adsorbent packs will be stored in this area. All relevant personnel will be fully trained in the use of this equipment
- Drip trays will be used where hydrocarbons are being used for machinery maintenance/refuelling
- Portable chemical toilets will be provided for the duration of the works and all waste material will be removed from site and disposed of to an appropriately licensed facility.
- Two water turbidity monitors will be used at the dredge site. One, within the harbour adjacent to the aquarium water inlet point and one 150m to the southeast of the loading operations. They will be alarmed and will have a live link to the environmental manager and DAFM representatives.
- The environmental manager will also undertake visual monitoring of the dredge plume as the operations are ongoing.
- Four turbidity monitors will be deployed within a 200m buffer zone of the dredge dump location. These will be alarmed and will have live links to the environmental manager and DAFM representatives.
- When the dredge vessel is travelling to the dump location the environmental manager will attend on board to monitor the plume visually and to also monitor the turbidity monitors.

5.3.2 Noise Mitigation Measures

To mitigate any potential impact to marine mammal species DAFM and the appointed Contractor will implement relevant impact mitigation and monitoring measures in relation to marine mammals as outlined in DAHG Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014) and the MMRA.

The DAHG (2014) guidance on measures required to manage the risk of man-made sound to marine mammals relates to the following human activities that can introduce sound into the marine environments at levels that may harm and/or disturb species that are legally protected:

- Geophysical acoustic surveys
- Dredging
- Drilling activities
- Pile driving
- Blasting activities

The appointed Contractors will adhere to DAHG (2014) guidance on mitigation measures and monitoring to be implemented for dredging and pile driving. This includes the use of MMOs and operational protocols. The implementation of the relevant mitigation measures outlined for dredging and piling will mitigate the risk of potential impacts of noise to marine mammals from the proposed project. In summary, dredging and piling operations shall not commence until after the successful completion of pre-start visual monitoring, undertaken by MMOs as per DAHG guidance, with no marine mammals observed over the required

monitoring period in the monitored zone. Once pre-start monitoring requirements have been achieved, operation can be commenced.

5.3.3 Storage of Materials

The storage of materials, containers, and waste, however temporary, should follow best practice at all times and be stored at designated areas. Storage will be located as follows:

- Away from drains and any watercourses or drains.
- Fuel oils etc. should be stored on a sheltered dry elevated site well removed from aquatic zones.
- On an impermeable base.
- Well away from moving plant, machinery and vehicles.
- On land not required until later in the development.
- Hazardous material storage areas will be identified, labelled, and properly marked and fitted with spill containment systems.
- The scale of potential impacts on water quality will be reduced by only storing the required volume of oils for the works taking place at the time.
- Access to oil stores will be controlled by only storing oils within a secure steel container located in the site compound.
- Collision with oil stores will be prevented by storing oils within a steel container in a designated area of the site compound away from vehicle movements.
- Leakages of oil from oil stores will be prevented by storing these oils in secure bunded areas which have a capacity of 110% of the total volume of the stored oil. Ancillary equipment such as hoses and pipes will be contained within the bunded storage container. Taps, nozzles or valves will be fitted with a lock system.
- Major leakages will be prevented through monitoring oil storage tanks/drums for leaks and signs of damage.
- Long term storage of waste oils will not be allowed on site. These waste oils will be collected in leak-proof containers and removed from the site for disposal or re-cycling by an approved service provider; and
- All containers will be stored upright and clearly labelled. Sufficient storage should be supplied near to all working areas.

5.3.4 Hydrocarbon Control

- Fuels/oils etc will be stored within a bunded area in the enclosed compound along with tools, materials etc. All plant is to be refuelled in this compound and a drip tray fitted to any stationary plant working in proximity to surface waters.
- All equipment will be in good condition to avoid spillage or discharge of oil, smoke and excessive noise.
- An appropriate waste container will be placed at a suitable location at the harbour to collect waste before disposal by an authorised company.
- Refuelling will be carried out by competent and trained people away from any environmentally sensitive areas; and dredger to be moored up securely
- Excavators and other equipment will be checked for any fuel/oil leaks on a regular basis by the crew.
- Any spills will be reported immediately to the site agent/authorities
- Use absorbent materials from the spill kit to mop up the spill (sand or absorbent materials will be used rather than detergents).

- Place boom around any affected water as a precaution.
- Do not wash spillage. Washing will only make the situation worse and disperse the pollutant
- Shovel contaminated sand/earth/absorbent granules into sacks or skips and
- A specialist oil removal company or contaminated soil company will remove pooled oil and/or soils contaminated oil.

5.3.5 Waste Management

To contain and manage construction phase waste, two types of skip will be provided at the site compound; one for recyclable waste and others for various construction wastes. These skips will be emptied when required by a licensed waste management company.

Any waste lubricants/oils will be collected and stored in drums in the site compound within a prefabricated bunded storage unit and will be removed and disposed of by a licensed waste management company without delay.

There will be no discharge of effluent or waste water on site. Waste water tank and sewage will be emptied as required and removed from site to a licensed facility. These staff facilities will be removed at the end of the construction phase.

5.3.6 Emergency Response Plan

This mitigation section describes measures for the prevention of an environmental accident or incident and the response required to minimise the impact of such an event.

All site personnel will be inducted in the provisions of the Emergency Response Plan. In the event of an environmental emergency, all personnel will react quickly and adhere to this procedure. The following outlines some of the information, on the types of emergency, which must be communicated to site staff:

- Release of hazardous substance - fuel or oil spill;
- Environmental buffers and exclusion zones breach;
- Housekeeping of materials and waste storage areas breach;
- Stop works order; due to environmental issue or concern (threat to archaeological or ecological feature) and
- Fire on site (cross-reference site Safety Emergency Plan as appropriate).

If any of the above situations occur; the Emergency Response Plan is activated. The Project/Environmental Manager will most likely be responsible for overseeing the Emergency Response Plan (to be confirmed upon appointment of Contractor) and will be prepared and ready to implement the plan at all times. The Project/Environmental Manager will be immediately informed and report to the scene. He/she must be aware of the

- Nature of the situation – brief description of what has happened;
- Location of the incident;
- Whether any spill has been released; and
- Whether the situation is under control.

The Emergency Response Plan must be completed by the appointed Contractor.

5.3.7 Contacts

As an Environmental Control Measure, the Environmental Manager will append the relevant contact details to the Emergency Response Plan document. Examples of such contact details include:

- Environmental Manager;
- Specialist oil removal Company;
- Kerry County Council;
- Inland Fisheries Ireland; and
- National Parks and Wildlife Service.

5.3.8 Location of Emergency Spill Kits

- A map indicating the location of all emergency spill kits will be attached to the Emergency Response Plan document; and
- Emergency oil spill kits will also be carried in all site vehicles and machinery and in the site office.

5.3.9 Responsibility

- The Environmental Manager will prepare and finalise an Emergency Response Plan to be ready to respond to any incident;
- All site personnel will report any spillages of oil or chemicals to the Environmental Manager and Construction Manager immediately; and
- As appropriate, the Environmental Manager will report the spillage to the western RBD of IFI, local authority and any other relevant authority.

5.4 METHOD STATEMENTS

The appointed Contractor will provide method statements to carry out the works and risk assessments based on the outline method of works, procedures and the environmental requirements set out in this outline CEMP.

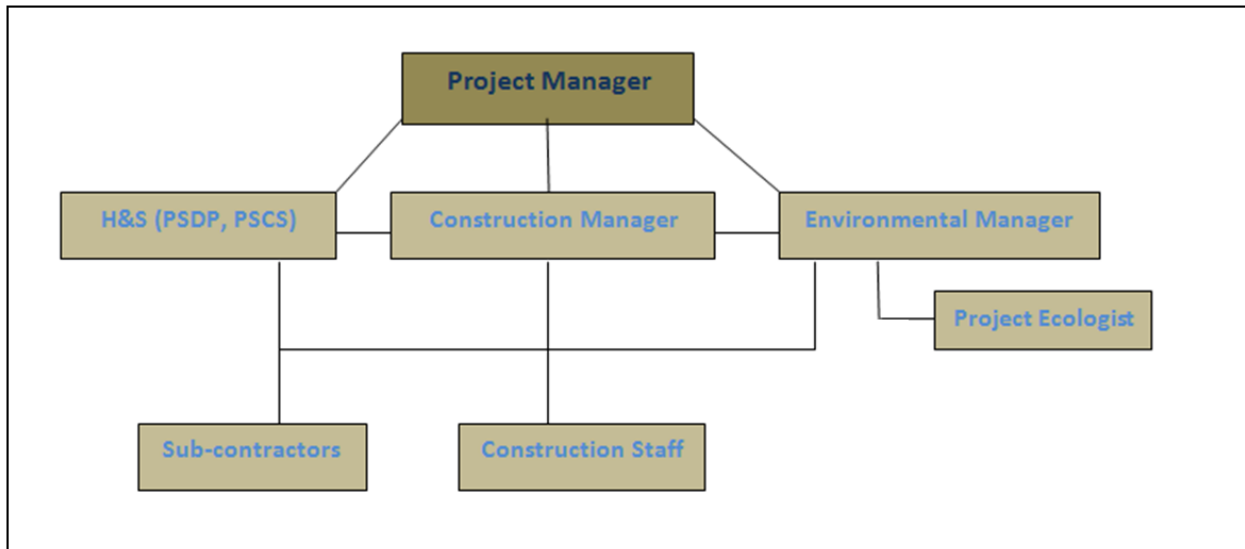
The following will be considered during the detailed planning of the works phase:

- Good practice guidelines on the control of water pollution from construction sites developed by the Construction Industry Research and Information Association (CIRIA) in particular.
- Method statement for management of surface water to prevent run-off of silt or any other pollutant from the site to watercourses.
- C532 Control of water pollution from construction sites: guidance for consultants and contractors (Masters-Williams et al, 2001).
- SP156 Control of water pollution from construction sites – guide to good practice (Murnane et al, 2002).
- Proper storage and bunding of any oils/ hydrocarbons.
- Noise management measures.

6. ORGANISATIONAL STRUCTURE, DUTIES AND RESPONSIBILITIES

6.1 ON SITE ORGANISATIONAL STRUCTURE AND RESPONSIBILITY

The Organisational Structure for the appointed Contractor's Project Team is included below. This structure will be defined by the Contractor and will include the names of the assigned personnel with the appropriate responsibility and reporting structure reflected.



6.2 DUTIES AND RESPONSIBILITIES

The general role of key people on site implementing the CEMP will be;

- The Project Manager - liaises with the Project Team in assigning duties and responsibilities in relation to the CEMP to individual members of the main contractor's project team.
- The Construction Manager - liaises with the Environmental Manager when preparing site works where there is a risk of environmental damage and manages the construction personnel and general works.
- The Design Engineer - undertakes and certifies the Design and supervises the standard of works, including geotechnical aspects.
- The Environmental Manager - ensures that the CEMP is developed, implemented and maintained. The Environmental Manager's tasks at the construction site are described below at **Section 5.2.4.1**.

Other roles are outlined as follows;

- Health and Safety (PSDP and PSCS).
- Project Ecologist (as required by the Environmental Manager)
- Resident Engineer (as required by Design Engineer).

The roles and responsibilities outlined below are indicative and will be updated on the appointment of the main contractor (Contractor). Details of the personnel and their responsibilities must be added to the finalised CEMP. An outline of potential roles is provided below but will require revision.

6.2.1 Project Manager

(To be updated upon appointment of Contractor/finalisation of CEMP)

Name: _____

A Project Manager is to be appointed on behalf of the main Contractor to manage and oversee the entire project. The Project Manager is responsible for:

- Implementing of the Construction and Environmental Management Plan (CEMP).
- Implementing the Health and Safety Plan.
- Management of the construction project.
- Liaison with the client/developer.
- Liaison with the Project Team.
- Assigning duties and responsibilities in relation to the CEMP.
- Production of construction schedule.
- Materials procurement.
- Maintaining a site project diary.

6.2.2 Construction Manager

(To be updated upon appointment of Contractor/finalisation of CEMP)

Name: _____

The Construction Manager manages all the works to construct the Wind Farm, on behalf of the main contractor. The Construction Manager reports to the Project Manager. In relation to the CEMP, the Construction Manager is responsible for:

6.2.2.1 Site-Specific Method Statements

- Liaising with the Environmental Manager in preparing site-specific Method Statements for all Works activities where there is a risk of environmental damage, by incorporating relevant Environmental Control Measures and referring to relevant Environmental Control Measure Sheets.
- Liaising with the Environmental Manager in reviewing and updating site-specific Method Statements for all Works activities where Environmental Control Measure and Environmental Control Sheets have been altered.
- Liaising with the Environmental Manager where third party agreement is required in relation to site-specific Method Statements, Environmental Control Measures and/or Environmental Control Measure Sheets.

6.2.2.2 General

- Being aware of all project Environmental Commitments and Requirements.
- Ensuring that all relevant information on project programming, timing, construction methodology, etc., is communicated from the Project Manager, to the Environmental Manager in a timely and efficient manner in order to allow pre-emptive actions relating to the environment to be taken where required.
- Programming and planning of excavation works and communicating this schedule to the Environmental Manager.

- Ensuring that adequate resources are provided to design and install any environmental interventions.

Liaising with the Design Engineer and providing information on environmental management to the Design Engineer during the course of the construction phase.

- Liaising with the Project Team in assigning duties and responsibilities in relation to the CEMP to individual members of the main contractor's project staff.
- Ensuring that the Environmental Manager performs regular and frequent environmental site inspections.

6.2.3 Design Engineer

The Design Engineer appointed by DAFM is MWP.

The Design Engineer reports to the Project Manager and is responsible for:

- Design of the Works.
- Review and approval of relevant elements of the method statements – assist the Construction Manager with the overall review.
- Oversee geotechnical aspects of the Works (a geotechnical engineer may be used where required).
- Participating in Third Party Consultations.
- Liaising with Third Parties through the Environmental Manager.

6.2.4 Environmental Manager

(To be updated upon appointment of Contractor/finalisation of CEMP)

Name: _____

The Environmental Manager is appointed by the Contractor and reports to the Project Manager.

The Environmental Manager is responsible for:

6.2.4.1 General

- Being familiar with the project environmental commitments and requirements.
- Being familiar with baseline data gathered for the Environmental Impact Assessment and during pre-construction surveys.
- Assisting the Construction Manager in liaising with the Design Engineer and the provision of the information on environmental management to the Design Engineer during the course of the construction phase.
- Liaising with the Project Team in assigning duties and responsibilities in relation to the CEMP to individual members of the main contractor's project staff.
- Implementing the environmental procedures of the CEMP.
- Liaising with the Construction Manager to ensure that the control measures set out in the Schedule of Environmental Mitigation are implemented.
- Liaising with the client/developer in relation to environmental issues.
- Auditing the construction works from an environmental viewpoint.

6.2.4.2 Site-Specific Method Statements

- Liaising with the Construction Manager in preparing site-specific Method Statements for all Works activities where there is a risk of environmental damage. These site-specific Method statements should incorporate relevant Environmental Control Measures and take account of relevant Environmental Control Measure Sheets.
- Liaising with the Construction Manager in reviewing and updating site-specific Method Statements for all Works activities where Environmental Control Measures and Environmental Control Sheets have been altered.
- Liaising with the Construction Manager where third party agreement is required in relation to site-specific Method Statements, Environmental Control Measures and/or Environmental Control Measure Sheets.

6.2.4.3 Third Party Consultations

- Overseeing, ensuring coordination and playing a lead role in third party consultations required statutorily, contractually and in order to fulfil best practice requirements.
- Ensuring that the minutes of meetings, action lists, formal communications, etc., are well documented and that the consultation certificates are issued to the Design Engineer as required;
- Liaising with all prescribed bodies during site visits, inspections and consultations.
- Where new Environmental Control Measures are agreed as a result of third party consultation, ensuring that the CEMP is amended accordingly.
- Where new Environmental Control Measures are agreed as a result of third party consultation, the Environmental Manager should liaise with the Construction Manager in updating relevant site-specific Method Statements.
- Where required, liaising with the Construction Manager in agreeing site-specific Method Statements with third parties.

6.2.4.4 Licensing

- Ensuring that all relevant works have (and are being carried out in accordance with) the required permits, licences, certificates, planning permissions, etc.
- Liaising with the designated licence holders with respect to licences granted pursuant to the Wildlife Act, 1976, as amended.
- Bringing to the attention of the Project, Design and Construction Team any timing and legal constraints that may be imposed on the carrying out of certain tasks.

6.2.4.5 Waste Management Documentation

- Holding copies of all permits and licences provided by waste contractors.
- Ensuring that any operations or activities that require certificates of registration, waste collection permits, waste permits, waste licences, etc., have appropriate authorisation.
- Gathering and holding documentation with the respect to waste disposal.

6.2.4.6 Legislation

- Keeping up to date with changes in environmental legislation that may affect environmental management during the construction phase.
- Advising the Construction Manager of these changes.
- Reviewing and amending the CEMP in light of these changes and bringing the changes to the attention of the main contractor's senior management and subcontractors.

6.2.4.7 Specialist Environmental Contractors

- Identifying requirements for specialist environmental contractors (including ecologists, waste contractors and spill clean-up specialists) before commencement of the project.
- Procuring the services of specialist environmental contractors and liaising with them with respect to site access and report production.
- Ensuring that the specialist environmental contractors are competent and have sufficient expertise to co-ordinate and manage environmental issues.
- Co-ordinating the activities of all specialist environmental contractors on environmental matters arising out of the contract.

6.2.4.8 Environmental Induction Training and Environmental Tool Box Talks

- Ensuring that Environmental Induction Training is carried out for all the main contractor's site personnel. The induction training may be carried out in conjunction with Safety Induction Training.
- Providing toolbox talks on Environmental Control Measures associated with Site-specific Method Statements to those who will undertake the work.

6.2.4.9 Environmental Incidents/Spillages

- Prepare and be in readiness to implement at all times an Emergency Response Plan.
- Notifying the relevant statutory authority of environmental incidents.
- Carrying out an investigation and producing a report regarding environmental incidents. The report of the incident and details of remedial actions taken should be made available to the relevant authority, the Design Engineer and the Construction Manager.

6.2.4.10 Site Environmental Inspections

- Carrying out regular documented inspections of the site to ensure that work is being carried out in accordance with the Environmental Control Measures and relevant site-specific Method Statements, etc.
- Carrying out a daily inspection of the bunded areas and site drainage system.
- Appending copies of the inspection reports to the CEMP.
- Liaising with the Construction Manager to organise any repairs or maintenance required following the daily inspection of the site.

6.2.5 Other Roles

6.2.5.1 Health and Safety Personnel

(To be updated upon appointment of Contractor/finalisation of CEMP)

The Health and Safety personnel for the construction project are appointed by the Contractor in line with the Construction Regulations:

- Carrying out duty of Project Supervisor Construction Stage.
- Responsible for safety induction of all staff and personnel on site.
- Implementing the Health and Safety Plan.
- Auditing and updating the Health & Safety Plan.
- All other required legal duties.

6.2.5.2 Project Ecologist /MMO / Archaeologist

(To be updated upon appointment of Contractor/finalisation of CEMP)

The Project Ecologist /MMO / Archaeologist Ecologist, may be appointed by the Contractor or DAFM and is responsible for:

- Ensuring implementation of ecological mitigation measures.
- Induct all construction members via weekly 'tool box talks' making them aware of the method statement and the sensitivities of the site before they are allowed to access the site.
- Check that relevant staff are familiar with emergency response procedures and trained in the use of spill kits.
- Have the authority to suspend works if works are not being carried out in line with the agreed method statement or daily monitoring indicates that the proposed measures are not functioning adequately to minimise the potential impact to local environment.
 - Project Ecologist: to ensure implementation of environmental monitoring and mitigation.
 - Project Archaeologist: to ensure implementation of archaeological monitoring and mitigation.
 - Project MMO: to ensure implementation of MMRA mitigation.

6.2.5.3 All site personnel

The site personnel appointed by the Contractor are responsible for:

- Adhering to the relevant Environmental Control Measures and relevant site-specific Method Statements.
- Adhering to the Health and Safety Plan.
- Reporting immediately to the Environmental Manager and Construction Manager any incidents where there has been a breach of agreed procedures including:
 - A spillage of a potentially environmentally harmful substance;
 - An unauthorised discharge to ground, water or air, damage to a protected habitat, etc.

6.3 CONTACTS

6.3.1 Main Safety Contacts

Position Title:	Name:	Phone:	Email:
The Client (Project Developer will be the client)	DAFM		
Project Supervisor Design Stage (PSDP)	MWP		
Project Supervisor Construction Stage (PSCS)			

6.3.2 Main Contractor Contacts

Position Title:	Name:	Phone:	Email:
Project Manager			
Construction Manager*			
Environmental Manager*			
Safety (PSCS)*			
Safety Officers*			
Site Emergency Number*			
Project Ecologist			
Overall Project PSDP			
Project Liaison Officer			

6.3.3 Third Party Contacts

Organisation:	Position:	Name:	Phone:	Email Address:
Inland Fisheries Ireland	Senior Environmental Officer			@fisheriesireland.ie
National Parks and Wildlife Service	District Conservation Officer			@ahg.gov.ie
Environmental Protection Agency		EPA Headquarters	053 916 0600	
Local Authority		Kerry County Council		
Department of Arts, Heritage and the Government	District Conservation Officer			
Health and Safety Authority		Office	1890 289 389	wcu@hsa.ie
Emergency Services			999	
Other, as appropriate.				

7. ENVIRONMENTAL CONSIDERATIONS AND POTENTIAL EFFECTS

The key potential environmental impacts associated with the proposed development preparation and construction works are set out in the NIS. Relevant potential sensitive receptors to the works are identified. These potential sensitive receptors, the environmental considerations and potential impacts are to be considered as the basis for a future detailed CEMP.

8. ENVIRONMENTAL COMMITMENTS

8.1 SCHEDULE OF ENVIRONMENTAL REQUIREMENTS (MITIGATION MEASURES)

A number of Environmental Commitments, in the form of mitigation measures, were identified in the project NIS.

The Appointed Project Manager and/or Environmental Manager will be required to update the Schedule of Environmental Mitigation if any modifications or additional requirements arise.

8.2 ENVIRONMENTAL MANAGEMENT PLANS (EMP)

A number of environmental management plans (EMP) have been prepared for managing the impacts of Construction Activities associated with the development. See **Table 1** below and refer to **Appendix 1**. These plans are to be implemented by the Project Manager and/or Project Contractor as relevant.

Table 1: Plans for Managing Impacts of Construction Activities

Ref:	Procedure:
EMP-1	Management of Dredging
EMP-2	Management of Piling
EMP-3	Management of Pontoon Installation
EMP-4	Fuels and Oils Management
EMP-5	Wheel Wash Management
EMP-6	Waste Management
EMP-7	Construction Noise
EMP-8	Emergency Response Plan
EMP-9	Site Environmental Training and Awareness
EMP-10	Monitoring and Auditing
EMP-11	Environmental Accidents, Incidents and Corrective Actions
EMP-12	Environmental Complaints

9. AUDITING, MONITORING AND RESPONSE

9.1 ENVIRONMENTAL MONITORING SCHEDULE

The environmental Monitoring Schedule will take cognisance of all mitigation measures outlined in the EIAR and relevant planning conditions outlined in the grant of planning permission. The Monitoring Schedule for construction will also provide for the checking of equipment, materials storage and transfer areas and specific environmental controls.

A Preliminary Monitoring Schedule is provided below (**Table 2**) and will be finalised pending appointment of the Contractor. The Contractor's developed daily Site Checklists must have the following information included at a minimum:

Table 2: Preliminary Monitoring Schedule

Aspect	Monitoring Required	Frequency	Note	Responsibility
Water	Fuel & Oil Storage inspection	Daily	Refer to Table 3 below	Environmental Manager
Ecology	Material and Waste Storage	Daily	Refer to Table 3 below	Environmental Manager
Water	Water quality monitoring	Ongoing	Minimum parameters: pH, Suspended Solids, metals, nitrates, phosphates	Environmental Manager

The Contractor will assign an on-site Environmental Manager to monitor the construction activities on a day to day basis. The duties will include completing the required checklists (sample checklist included below) and coordinating with the relevant personnel (e.g. Project Ecologist, and the Design Engineer as required) ensuring all environmental monitoring is carried out.

The Contractor-developed daily Site Checklists will have the following information included at a minimum:

Table 3: Site Checklist

Area of Inspection	Environmental Hazards
Silt filters	Missing filters Blocked filters - build up of sediment
Post and wire boundary fence	Signs of movement (i.e. not in a straight line) Damaged or fallen sections of fence
The land adjacent to the development	Presence of waste Presence of construction equipment Presence of invasive species identified during the preconstruction survey
Site roads	Unacceptable level of sediment/silt on the road surface Presence of waste
Site compound – storage area	Damage Untidiness
Site compound – waste collection area	Damage Untidiness Full skips
Site compound – oil storage area	Damage to containers or ancillary equipment Leakages

	Unlocked storage container
Dry wheel wash	Build up of sediment
Waste water facilities	Holding tank requiring emptying
Site Entrance	Unacceptable level of sediment/silt on the road surface Presence of waste

9.2 ENVIRONMENTAL PERFORMANCE INDICATORS

The Appointed Project Contractor will outline the key performance indicators for the site in gauging successful site management in the prevention of pollution and the protection of the environment.

Environmental performance indicators will at a minimum include:

- Number of environmental accidents logged.
- Breach of procedure and corrective actions.
- Number of environmental complaints received.
- Results of site audits.

The performance indicators will be finalised by the Appointed Contractor and communicated to all relevant personnel and sub-contractors. The review periods for analysing site performance indicators must also be specified.

9.3 RESPONSE PROCEDURE

In the event of an environmental incident, or breach of procedure, or where a complaint is received, the contributing factors are to be investigated and remedial action taken as necessary. The Contractor will ensure that the following respond actions will take place:

- 1) the Project Manager, PSDP and Client must be informed of any incident, breach of procedure and/or complaint received and details must be recorded in the incident/complaint register.
- 2) the Project Manager is to conduct/co-ordinate an investigation to determine the potential influence that could have led to the non-compliance.
- 3) the Project Manager is to notify and liaise with the appropriate site personnel where required, e.g. Site Environmental Manager, Project Ecologist.
- 4) If necessary, the Project Manager will inform the appropriate regulatory authority. The appropriate regulatory authority will depend on the nature of the incident.
- 5) The details of the incident will be recorded on an Incident / Complaints Form which is to record information such as the cause, extent, actions and remedial measures used following the incident/complaint. The form will also include any recommendations made to avoid reoccurrence of the incident.
- 6) The Project Manager will be responsible for any corrective actions required as a result of the incident e.g. an investigative report, formulation of alternative construction methods or environmental sampling, and will advise the Main Contractor as appropriate.
- 7) the Site Project Manager is to ensure that the relevant environmental management plans/procedures are revised and updated as necessary.

9.4 CORRECTIVE AND PREVENTATIVE ACTION

Corrective Action Requests will be issued to ensure that prompt action is agreed and committed to, with a view to the effective resolution of any deviations from the CEMP requirements or any environmental issues.

10. SUMMARY

This outline CEMP provides the information which will be contained in the final Contractor-developed Plan at the construction stage of the project. The requirement on the Contractor to update these details has been explained, and there is a particular requirement for an update to the roles and responsibilities of those appointed on the site for the construction of the project. The CEMP is a live document and will be improved upon as the project progresses as appropriate.

APPENDIX 1:

EMP 1: MANAGEMENT OF DREDGING

Purpose

To describe measures for the management of all excavations on the site

Procedure

General

- Dredging machinery will not operate outside of demarcated areas.
- Dredging craft movements will be restricted to the footprint of the permitted development and along access channels into the inner harbour and to the disposal site.
- Dredging will be carried out with environmental buckets.
- Material will be placed directly into the disposal hoppers.
- Two water turbidity monitors will be used at the dredge site. One, within the harbour adjacent to the aquarium water inlet point and one 150m to the southeast of the loading operations. They will be alarmed and will have a live link to the environmental manager and DAFM representatives.
- The environmental manager will also undertake visual monitoring of the dredge plume as the operations are ongoing.
- Two turbidity monitors will be deployed within a 200m buffer zone of the dredge dump location. These will be alarmed and will have live links to the environmental manager and DAFM representatives.
- When the dredge vessel is travelling to the dump location the environmental manager will attend on board to monitor the plume visually and to also monitor the turbidity monitors.
- Disposal of material will be carried out only within the disposal site. Material will be evenly distributed.

Responsibility

- The Environmental Manager will monitor water quality.
- The Construction Manager will monitor vehicle, dredger and barge movements throughout the construction phase.
- The Project Manager will oversee the phasing of the dredging and machinery movement over water and accessing the site.
- Construction personnel will be informed of the measures to prevent pollution of water courses,
- The Design Engineer and Sub-contractors will have responsibilities as appropriate.
- All responsibilities will be finalised by the Appointed Contractor.

EMP 2: MANAGEMENT OF PILING

Purpose

To describe measures for the management of all piling works on the site

Procedure

General

- Piling machinery will not operate outside of demarcated areas.
- Piling will be carried out from floating barge equipment.
- To mitigate any potential impact to marine mammal species the implementation of relevant impact mitigation and monitoring measures in relation to marine mammals as outlined in DAHG Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014) and the MMRA are to be carried out.
 - These will include the use of a MMO to ensure the site is clear of marine mammals before piling commences and start measures once they do commence.
- Waste material from pile hole boring will be removed off-site for disposal.
- Steel piles will be set into the rock cores and cast in with a non-shrink grout/concrete.
- No on-site concrete batching will be permitted at the proposed works areas. Concrete will instead be transported to the site within a concrete truck. An additive is to be used to reduce the risk of wash-out. Concrete trucks will be washed down to a mortar bin/skip which has been examined in advance for any defects.

Responsibility

- The Environmental Manager will monitor noise and water quality.
- The Construction Manager will monitor vehicle, piling and barge movements throughout the construction phase.
- The Project Manager will oversee the phasing of the piling and machinery movement over water and accessing the site.
- Construction personnel will be informed of the measures to prevent pollution of water courses.
- The Design Engineer and Sub-contractors will have responsibilities as appropriate.
- All responsibilities will be finalised by the Appointed Contractor.

EMP 3: MANAGEMENT OF PONTOON INSTALLATION

Purpose

To describe measures for the management of all works related to the installation of the pontoon system.

Procedure

General

- Pontoon units and deck furniture will be fabricated off-site and transported to site by road.
- They will be stockpiled in a location agreed with the FHC.
- A mobile crane will lift the units into the water for installation.
- A work boat will be used to tow the units into position.
- Units will be fixed around the support piles using bolt fixings.
- Units will be fixed together using bolt fixings.
- The pontoon units will have service ducting pre-fabricated.
- Cable and pipes will be run through the ducting and connected from the shore to the service units, lights etc.
- Waste material will be collected and disposed off-site.

Responsibility

- The Environmental Manager will monitor waste management.
- The Construction Manager will monitor vehicle movements throughout the construction phase.
- The Project Manager will oversee the phasing of the works over water and accessing the site.
- Construction personnel will be informed of the measures to prevent pollution of water courses.
- The Design Engineer and Sub-contractors will have responsibilities as appropriate.
- All responsibilities will be finalised by the Appointed Contractor.

EMP 4: FUEL AND OILS MANAGEMENT

Purpose

To describe measures for the management of all fuel and oils on site for the protection of habitats from any spills.

Procedure

Construction Machinery, Vehicles and dredging craft

- The potential for hydrocarbons getting into the existing drains and local watercourses will be mitigated by only refuelling construction machinery and vehicles in designated refuelling areas using a prescribed re-fuelling procedure.
- Refuelling will be carried out using 110% capacity double bunded mobile bowzers. The refuelling bowser will be operated by trained personnel. The bowser will have spill containment equipment which the operators will be fully trained in using.
- To reduce the potential for oil leaks, only vehicles and machinery will be allowed onto the site that are mechanically sound. An up to date service record will be required from the main contractor.
- Potential leaks from delivery vehicles will be reduced by visually inspecting all delivery vehicles for major leaks. Contractors supplying concrete and crushed stone to the site will be contractually required to supply their products using roadworthy vehicles.
- Potential leaks from the cranes used for turbine erection will be mitigated by contractually requiring the crane supplier to supply cranes to site that are in good working order, up to date in servicing and free of leaks.
- Should there be an oil leak or spill, the leak or spill will be contained immediately using oil spill kits; the nearby dirty water drain outlet will be blocked with an oil absorbent boom until the fuel/oil spill has been cleaned up and all oil and any contaminated material removed from the area. This contaminated material will be properly disposed of in a licensed facility.
- The Environmental Manager will be immediately informed of the oil leak/spill, and will assess the cause and the management of the clean-up of the leak or spill. They will inspect nearby drains for the presence of oil, and initiate the clean-up if necessary.
- Immediate action will be facilitated by easy access to oil spill kits. An oil spill kit that includes absorbing pads and socks will be kept at the site compound and also in site vehicles and machinery.
- Correct action in the event of a leak or spill will be facilitated by training all vehicle/machinery operators in the use of the spill kits and the correct containment and cleaning up of oil spills or leaks. This training will be provided by the Environmental Manager at site induction.
- In the event of a major oil spill, a company who provide a rapid response emergency service for major fuel spills will be immediately called for assistance, their contact details will be kept in the site office and in the spill kits kept in site vehicles and machinery.

Responsibilities

The Construction Manager and Environmental Manager are responsible for ensuring Fuel and Oils are managed in line with this procedure. The Appointed Contractor, in updating the CEMP, must designate personnel to the tasks relating to Fuels and Oil, as outlined.

Reference: Best Practice Guidelines BPGCS005 – Oil Storage Guidelines (Enterprise Ireland).

EMP 5: WHEEL WASH MANAGEMENT PROCEDURE

Purpose

To describe Measures for the protection of Watercourses and the Public Roads from dirty water from vehicles.

Procedure

The Appointed Contractors will reduce the potential for the roads being dirtied by heavy vehicle traffic, by including the following:

- A Wet/dry Wheel Wash facility will be provided at the Site Entrance
- Wheel washes will be cleaned as required

Responsibility

Construction Project Manager

EMP 6: CONSTRUCTION WASTE MANAGEMENT

Purpose

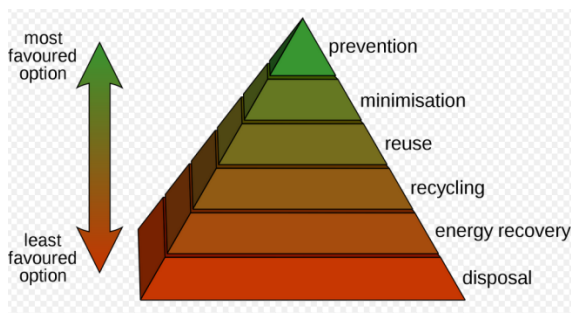
To describe measures for the management of all wastes associated with the construction of the wind farm.

Procedure

Waste Management Plan

A Waste Management Plan should be prepared by the Appointed Project Contractor for the construction phase. This Plan will form part of the CEMP:

- Regard should be had to the Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects (DoEHLG, July 2006) in preparing and maintaining this plan.
- The Waste Management Hierarchy (illustrated below) should be assessed and applied in the preparation and maintenance of the Construction Phase Waste Management Plan.
- The Construction Phase Waste Management Plan should address the following aspects of the Project:
- Analysis of the waste arising/material surpluses.
 - Specific waste management objectives for the project.
 - Methods proposed for prevention, reuse and recycling of wastes.
 - Material handling procedures.



Any material deemed unsuitable for re-use in the works will be transported off site in trucks and disposed of under license from Clare Council. This will prevent any contaminated run-off to drains adjacent to access tracks during heavy rainfall.

The Waste Management Plan should contain individual headings describing the following:

- Description of the Project.
- Wastes arising including proposals for minimisation/reuse/recycling.
- Estimated cost of waste management.
- Record keeping procedures.

As part of the record keeping procedures, the Environmental Manager should keep records provided by waste contractors of all waste being removed from site. The Environmental Manager should record waste removed from site on a quarterly basis. This information should be recorded in a standard format.

A construction phase waste management plan should be developed to control all site generated construction waste and the storage and disposal of same.

Any introduced semi-natural (road building materials) or artificial materials must be taken off site at the end of the construction phase. Any accidental spillage of solid state introduced materials must be removed from the site by the appropriate means.

General Waste

- Access to materials will be controlled. A dedicated storage area will be provided in the site compound for building materials such as Terram, geotextile matting, tools and equipment, fence posts and wire, booms, etc.
- Access to stored materials will be restricted; the site compound will be securely fenced from the outset and will be locked when there are no site personnel present.
- To contain and manage construction phase waste, multiple skips will be provided at the storage compound; one for recyclable waste and others for various construction waste. These skips will be emptied when required by a licensed waste management company. Waste oil and waste oil drums will be collected and stored in containers and on a bunded tray within the storage container.
- The works will be carried out in phases. At the end of each phase, the completed works areas will be tidied of any unused material or waste; this material will be brought to the site compound for storage and reuse or placed in the appropriate skip for disposal.

Waste water

- Any waste water will be removed from site to a licensed facility.

Responsibility

- The Environmental Manager will be responsible for creating and updating the Waste Management Plan.
- The Environmental Manager will be responsible for identifying a waste contractor to remove waste that can be recycled or reused. He/she will obtain records for all waste leaving the site for this purpose.
- It is the Construction Managers responsibility to organise the removal of skips from his/her area when they are full.

Reference

Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects (DoEHLG, July 2006).

Details of Site Waste Management to be finalised by Appointed Contractor.

EMP 7: CONSTRUCTION NOISE MANAGEMENT

Purpose

To describe measures for the management of impacts from construction noise

Procedure

Control of Noise at Source

- Plant will be properly and regularly maintained.
- Compressors, if needed, will be 'sound related' models fitted with properly lined and sealed acoustic covers which will be kept closed whenever machines are in use.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers.

Best practice in the form of BS5228 –1&2:2009 + A1 2014, *Code of Practice for the Control of Noise and Vibration on Construction and Open Sites* will be adopted during the construction phase in order to minimise the noise generated by construction activities and nuisance to neighbours.

All plant and equipment for use will comply with the Construction Plant and Equipment Permissible Noise Levels Regulations 1996 (SI 359/1996) and other relevant legislation.

Responsibility

- The Construction Manager will be familiar with the noise sensitive receptors and alert the Environmental Manager in good time prior to work commencing in the areas closest to any noise sensitive receptors.
- The Environmental Manager will review any relevant planning conditions in updating this plan.

References

BS5228 –1&2:2009, *Code of Practice for the Control of Noise and Vibration on Construction and Open Sites*

IOA GPG Supplementary Guidance Note 5: *Post Completion Measurements* (July 2014).

Details of management of noise on the site to be finalised by Appointed Contractor

EMP 8: EMERGENCY RESPONSE PLAN

Purpose

To describe measures for the prevention of an environmental accident or incident and the response required to minimise the impact of such an event.

Procedure

In the event of an environmental emergency, all personnel will react quickly and adhere to this procedure. All site personnel will be inducted in the provisions of the **Emergency Response Plan**. The following outlines some of the information, on the types of emergency, which must be communicated to site staff:

- Release of hazardous substance - Fuel or oil spill
- Concrete spill or release of concrete
- Flood event – extreme rainfall event
- Environmental buffers and exclusion zones breach
- Housekeeping of materials and waste storage areas breach
- Stop works order due to environmental issue or concern (threat to archaeological or ecological feature)
- Fire on site (cross-reference site Safety Emergency Plan as appropriate)

If any of the above situations occur; the Emergency Response Plan is activated. The Environmental Manager will most likely be responsible for overseeing the Emergency Response Plan (to be confirmed upon appointment of Contractor) and will be prepared and ready to implement the plan at all times. The Environmental Manager will be immediately informed and report to the scene. He/she must be aware of the;

- Nature of the situation – brief description of what has happened.
- Location of the incident.
- Whether any spill has been released.
- Whether the situation is under control.

The Emergency Response Plan must be completed by the appointed Contractor.

Oil Spillages

The following list outlines issues likely to be appropriate for inclusion in such a plan:

- Site staff will report the spillage immediately to the Environmental Manager or Construction Manager.
- Where relevant, the Environmental Manager will report the spillage to Inland Fisheries Ireland and Clare County Council.
- Where possible, the source of pollution will be identified.
- Switch off all sources of ignition.
- Stop the spillage spreading.
- Use absorbent materials from the spill kit to mop up the spill (sand or absorbent materials should be used rather than detergents).
- Place boom across watercourse or in nearby downstream existing drains as a precaution.

- Do not wash spillage into drainage system. Washing will only make the situation worse and extend the pollution to other water bodies/drainage systems.
- If the spill has already reached drains, block the inlet of the dirty water cross pipes in the nearby drainage outflow points on the roadside drains with oil absorbent booms, which will prevent oils flowing into the existing drains.
- Shovel contaminated sand/earth/absorbent granules into sacks or skips.
- A specialist oil removal company should remove pooled oil.

Contacts

As an Environmental Control Measure, the Environmental Manager will append the relevant contact details to the Emergency Response Plan document. Examples of such contact details include:

- Environmental Manager.
- Specialist oil removal Company.
- Clare County Council.
- Inland Fisheries Ireland.
- National Parks and Wildlife Service.

Location of Emergency Spill Kits

- A map indicating the location of all emergency spill kits will be attached to the Emergency Response Plan document.
- Emergency oil spill kits will also be carried in all site vehicles and machinery and in the site office.

Responsibility

- The appointed Contractor/Environmental Manager will prepare and finalise an Emergency Response Plan to be ready to respond to any incident.
- All site personnel will report any spillages of oil or chemicals to the Environmental Manager and Construction Manager immediately.
- As appropriate, the Environmental Manager will report the spillage to the Regional Fisheries Board, local authority and any other relevant authority.

Details of Emergency Response Plans to be finalised by Appointed Contractor

EMP 9: SITE ENVIRONMENTAL TRAINING AND AWARENESS

Purpose

To describe measures for the training of all site personnel in the protection of the environment and the relevant controls.

Scope

All site personnel and construction teams which may influence environmental impacts.

Procedure

An initial site environmental induction and ongoing training will be provided to communicate the main provisions of the CEMP to all site personnel. Two-way communication will be encouraged to promote a culture of environmental protection. The following outlines some of the information which will be communicated to site staff:

- Environmental procedures of the CEMP.
- Environmental buffers and exclusion zones.
- Housekeeping of materials and waste storage areas.
- Environmental Emergency Response Plan.

Housekeeping and Storage of hazardous materials

- Hazardous materials marked with the following symbols will only be stored in the secure storage container in the site compound.



- Subcontractors will provide a copy of the Material Safety Data Sheets for all hazardous substances brought on site.

All finalised CEMP policies will be adhered to, in the management of fuels and oils, concrete, and installation of sediment and erosion controls and drainage features. All finalised details will be communicated with site personnel. Environmental Training including spill kit training, installation of silt fence training is to be provided by the Appointed Contractor. Environmental training records will be retained in the site office.

Responsibility

- Environmental Manager
- Construction Manager
- All site personnel

Details of Induction and Training to be finalised by Appointed Contractor

EMP 10: MONITORING AND AUDITING PROCEDURE

Purpose

To describe measures for environmental monitoring during the construction works and audit of control measures to ensure environmental protection.

Procedure

All mitigation measures, any planning conditions and relevant construction methods will be monitored on site. The Appointed Contractor will nominate an Environmental Manager for the works. The Environmental Manager will provide Audit Checklists to ensure regular checks of the site's control measures for the ongoing protection of the environment.

At a minimum monitoring will be carried to ensure adherence with the following;

Ref:	Procedure:
EMP-1	Management of Dredging
EMP-2	Management of Piling
EMP-3	Management of Pontoon Installation
EMP-4	Fuels and Oils Management
EMP-5	Wheel Wash Management
EMP-6	Waste Management
EMP-7	Construction Noise
EMP-8	Emergency Response Plan
EMP-9	Site Environmental Training and Awareness
EMP-10	Monitoring and Auditing
EMP-11	Environmental Accidents, Incidents and Corrective Actions
EMP-12	Environmental Complaints

Checklists for daily, weekly or monthly site audits will be finalised by the Environmental Manager and the relevant personnel informed of their duties. Checklists will include (but are not limited to) confirmation that fuel is stored appropriately, waste management rules are adhered to, all environmental buffers are maintained, sediment and erosion control measures of the Sediment & Erosion/Storm Water Control Plan are in place and functioning, and concrete chute wash-out procedure is being followed. Checklists will be finalised with the Final Contractor's CEMP.

All environmental records, including completed checklists, will be retained at the site office.

Responsibility

- Project Manager
- Environmental Manager
- Construction Manager
- Project Ecologist
- Project Archaeologist

Details of Monitoring Procedure and Checklists to be finalised by Appointed Contractor's Environmental Manager

EMP 11: ENVIRONMENTAL ACCIDENTS, INCIDENTS AND CORRECTIVE ACTIONS

Purpose

To describe measures for the recording, investigating and close-out of any environmental accidents or incidents on the site

Procedure

- The Environmental Manager or Construction Manager will be contacted as soon as possible where there is any incident that carries the possibility of negative environmental consequences (e.g. minor oil leakage or blockage of drainage pipe).
- The Emergency Response Plan and standard emergency procedures will be applied to get the incident under control and prevent injury or loss of life in the first instance.
- Work in the area will be halted and the Environmental Manager will be called to the scene to assess the situation and to decide on initial responses and remedial measures.
- Once the situation is under control, the environmental accident or incident will be recorded and the cause investigated.
- Any remedial action required will be taken to mitigate any damage and prevent a reoccurrence.
- Corrective actions will be communicated to personnel and sub-contractors where relevant – particularly where it results to a change in procedure.

Example list of environmental accidents & incidents

- Accidents involving large spill of fuel or concrete from delivery truck (emergency response required).
- Spills of fuel and oil (minor).
- Waste or rubbish left around the site (not in dedicated waste areas).
- Breach of any buffers (ecological, archaeological, watercourse).
- Failure of any control measures (silt fences collapsed in a storm).
- Concrete chute wash out in a non-dedicated area.
- Unplanned vehicle movement off the access tracks.
- Unplanned vehicle movement within a buffer zone.

Responsibility

- Site staff will contact the Environmental Manager or Construction Manager as soon as possible where there is any incident that carries the possibility of negative environmental consequences.
- The Environmental Manager is responsible for alerting the relevant authorities.

Details of Environmental Accidents, Incidents and Corrective Actions Procedure, including a chain of responsibility, to be finalised by Appointed Contractor and communicated to all personnel and sub-contractors

EMP 12: ENVIRONMENTAL COMPLAINTS

Purpose

To describe measures for the recording and resolving complaints by third parties, including local residents or members of the public

Procedure

Any environmental complaints received, whether internal or external, will be recorded and investigated. It is recommended that immediate action is taken as relevant to resolve environmental complaints to avoid any nuisance to the local community or any environmental damage.

This procedure includes:

- Recording of any complaints to a Site Log.
- Follow up by the relevant site representative – Environmental Manager.
- Remedial measures where required.
- Ongoing communication with complainant to confirm resolution.
- Any required training or communication with site personnel and sub-contractors as a result.

Responsibility

- Project Manager
- Environmental Manager
- Construction Manager

Details of Environmental Complaints Procedure to be finalised by Appointed Contractor

Appendix 4

MaREI UCC Numerical Modelling

An Daingean Small Craft Harbour

Numerical Modelling of Tidal Currents, Dredge and Disposal Plumes, and Waves - Output

MaREI, University College Cork

Rev B

20th May 22

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1.0 An Daingean Small Craft Harbour Modelling Output

1.1 General

Numerical modelling of tidal currents, dredging and disposal plumes and waves at the proposed small craft harbour site was undertaken by MaREI of UCC. This appendix contains the output from the model runs.

Runs were undertaken to

- Estimate tidal currents at both the proposed dredge and disposal sites. The output given is for a spring tide when the currents would be larger and the extent of the spread of any plumes from the dredge or disposal site would be greater.
- Plumes at the dredge and disposal site were modelled and the output given relates to the concentrations of suspended sediments towards the end of the dredging campaign for the disposal site and on a flood and ebb tide for the inner harbour during the dredging campaign.
- Estimate the depth of sediment in the disposal area at the end of the dredging campaign.
- Estimate 50 year wave conditions within the inner harbour area for waves from approximately the south east that would be generated in part in Dingle Bay and propagate into the inner harbour.
- Estimate 50 year wave conditions generated within the inner harbour from a range of directions.

The total volume of material to be dredged is approximately 100,000m³ and the dredging is estimated to take 70 days to complete. The material consists of a mix of sand / silt and clay fractions with some gravel. The full breakdown is given in the preliminary report. The model details use settling velocities instead of grain size and are given below with the plume output.

The models were calibrated using wave and tidal current measurements taken at the proposed dredge site during March 21.

2.0 Disposal Site Modelling

2.1 Dispersion of Sediment at Disposal Site

The existing licensed dumpsite coordinates are given in Figure 1.

A dispersed modelling of the dumpsites was used to give an accurate picture of the dumpsite operations, as shown in Figure 2 and Figure 3.

	WGS84/ETR89		ITM	
	LAT	LONG	E	N
(a)	52° 6.9'N	10°14.5'W	446478.8	598272.1
(b)	52° 6.9'N	10°13.5'W	447620.1	598237
(c)	52° 6.65'N	10°14.5'W	446464.5	597808.7
(d)	52° 6.65'N	10°13.5'W	447605.9	597773.5

Figure 1 Definition of dumpsite area

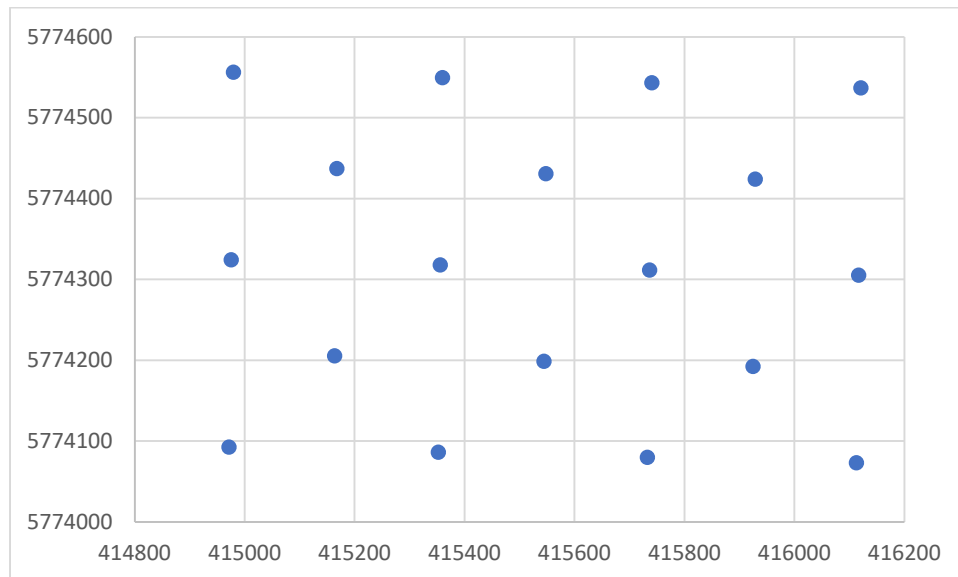


Figure 2 Dispersion of the Dumpsites within the rectangular area

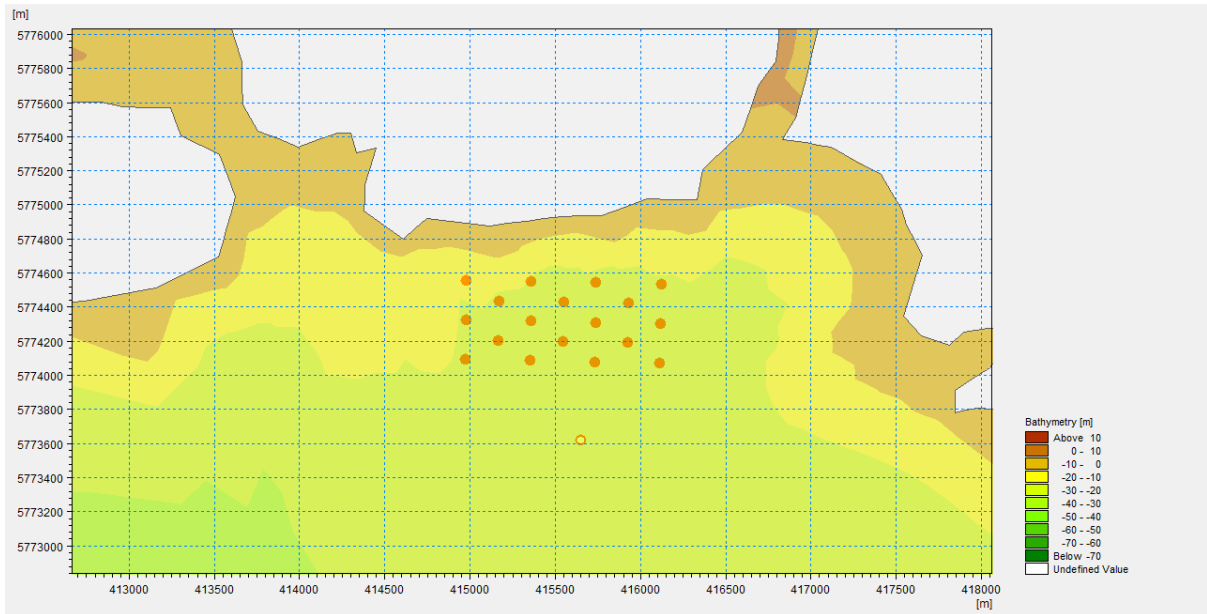


Figure 3 Mike 21 view of dumpsite locations

2.2 Model Details

The dumpsite model was run with two fractions, sand with fall velocity of 0.005m/s and silt/clay with a fall velocity of 0.00005m/s.

The deposition of the dredging material was distributed evenly throughout the 18 dispersed dumpsites. A load was dumped at one of the dumpsites every 6 hours. The dumping rate was 0.6m³/second continuously for a period of 10 minutes, over a 70-day dredging/dumping campaign.

The modelling of tidal currents and dispersion at the disposal site was undertaken using predicted astronomic tides. The current speed profile for the dumpsite point with greatest bed thickness change is shown in Figure 4.

Snapshots of tidal currents were taken on a spring tide mid-flood and mid-ebb states of the tide – when the tidal currents would be expected to be at their maximum. These snapshots of current speed are shown in Figure 5 and Figure 6.

2.3 Tidal Currents

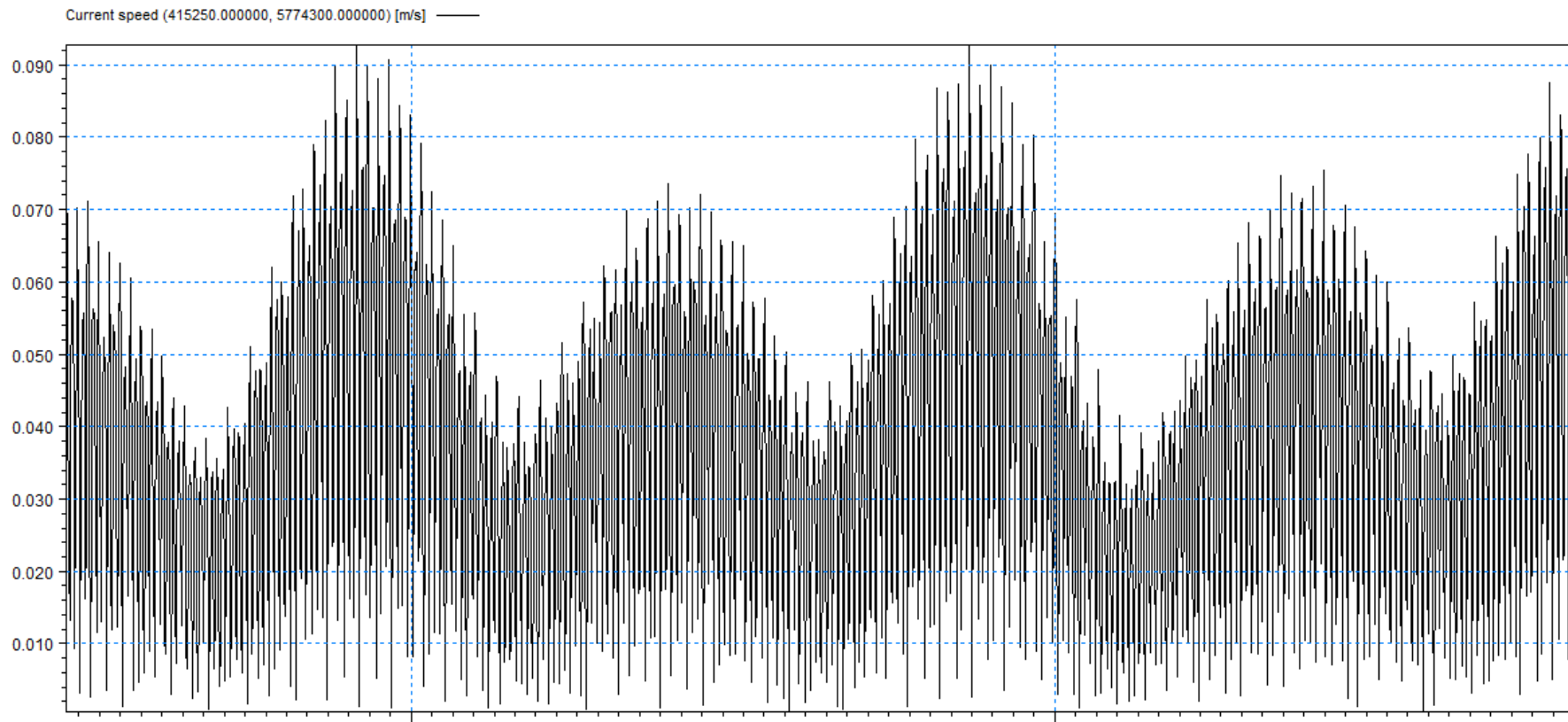


Figure 4 Profile of current speed at key dumpsite location (location of greatest bed thickness increase)

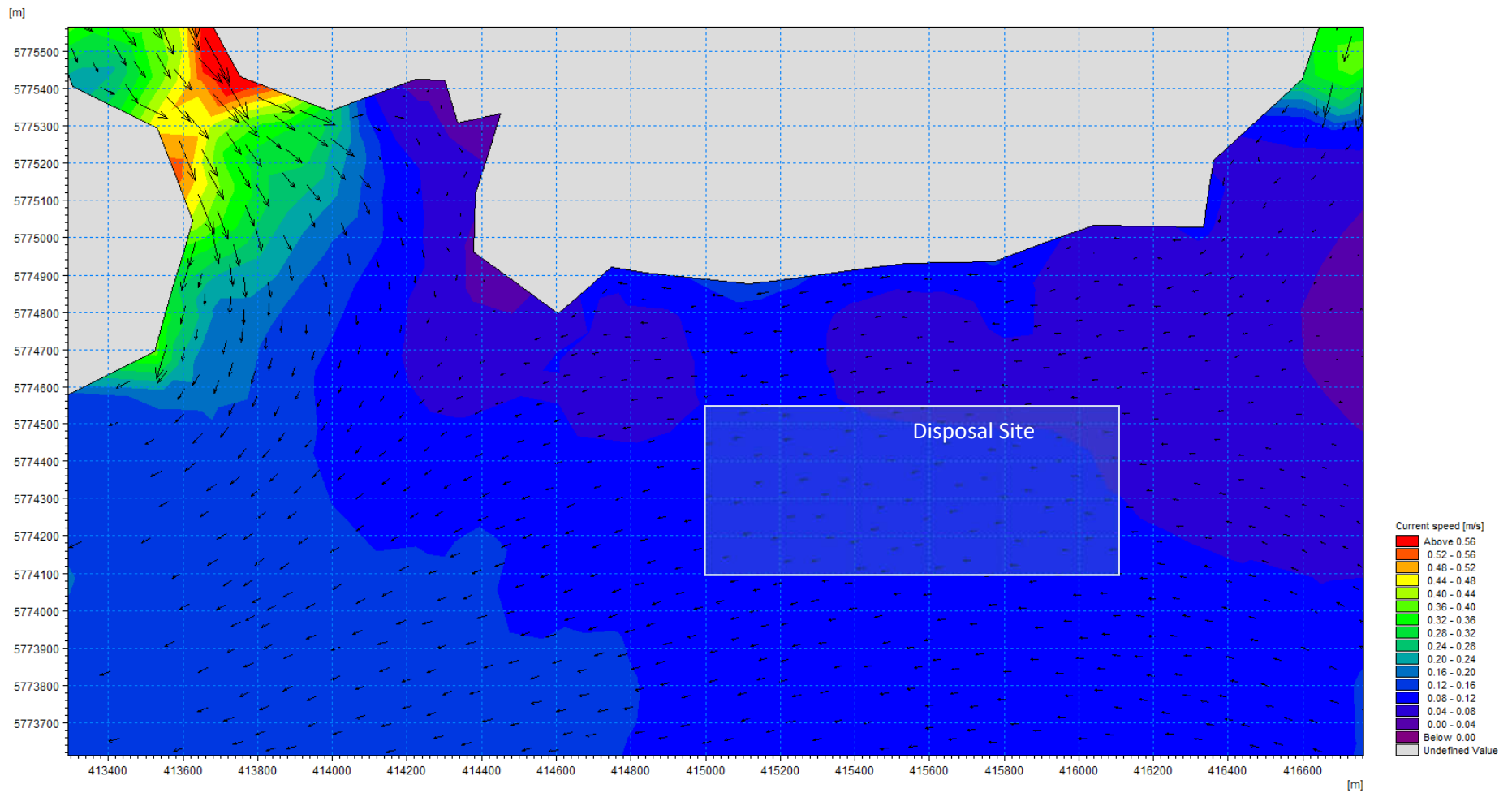


Figure 5 Spring Tide Mid-Ebb Tidal Currents – Harbour Mouth and Disposal Site

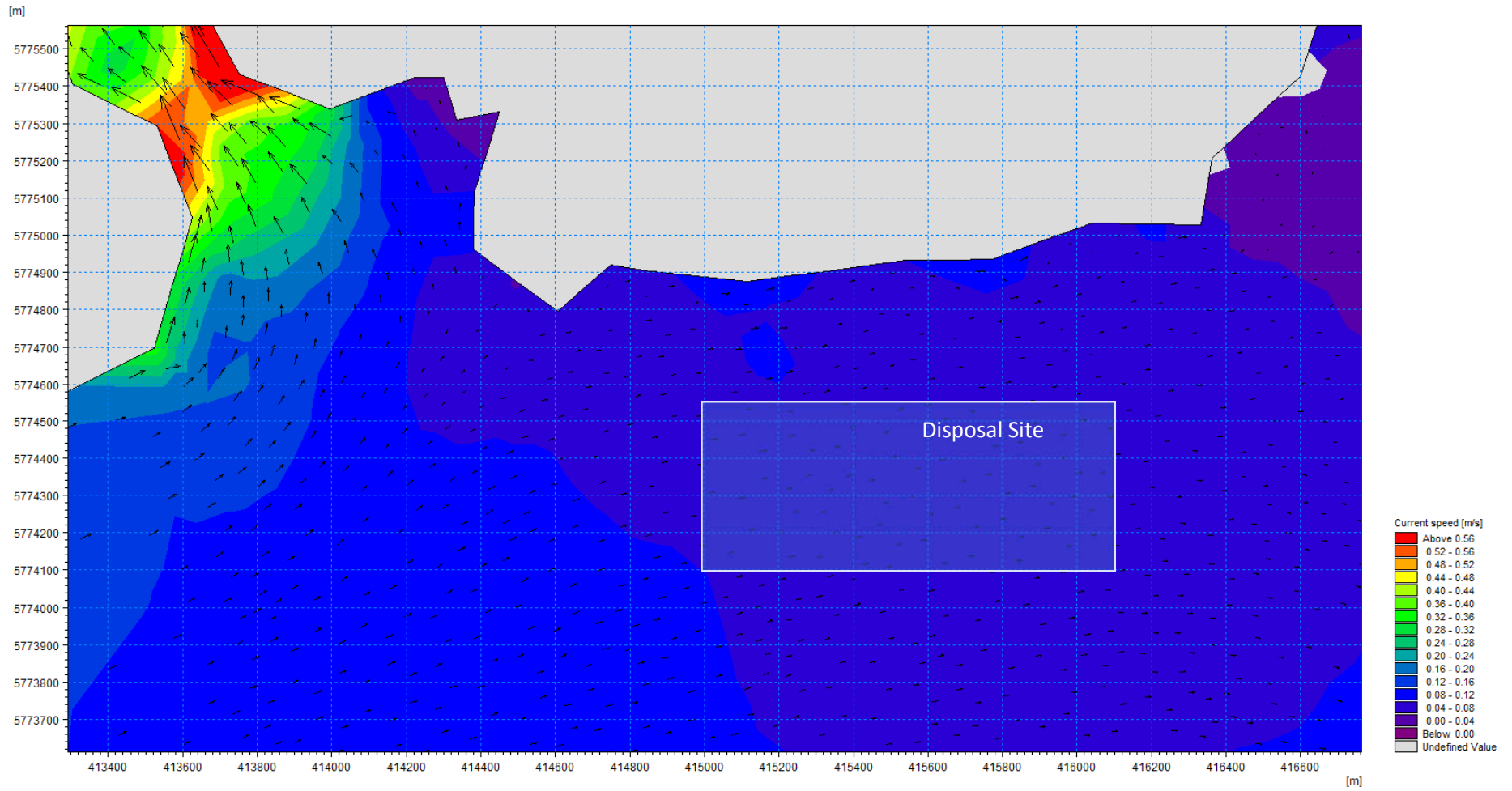


Figure 6 Spring Tide Mid-Flood Tidal Currents – Harbour Mouth and Disposal Site

3.0 Disposal Site Model Output

3.1 Suspended Sediment Concentration (SSC)

The increase in SSC only occurs in the immediate vicinity of the disposal site and does not persist beyond the cessation of disposal (see Figure 7 which shows geographic localisation of SSC increase at the end of the 70-day dumping operation).

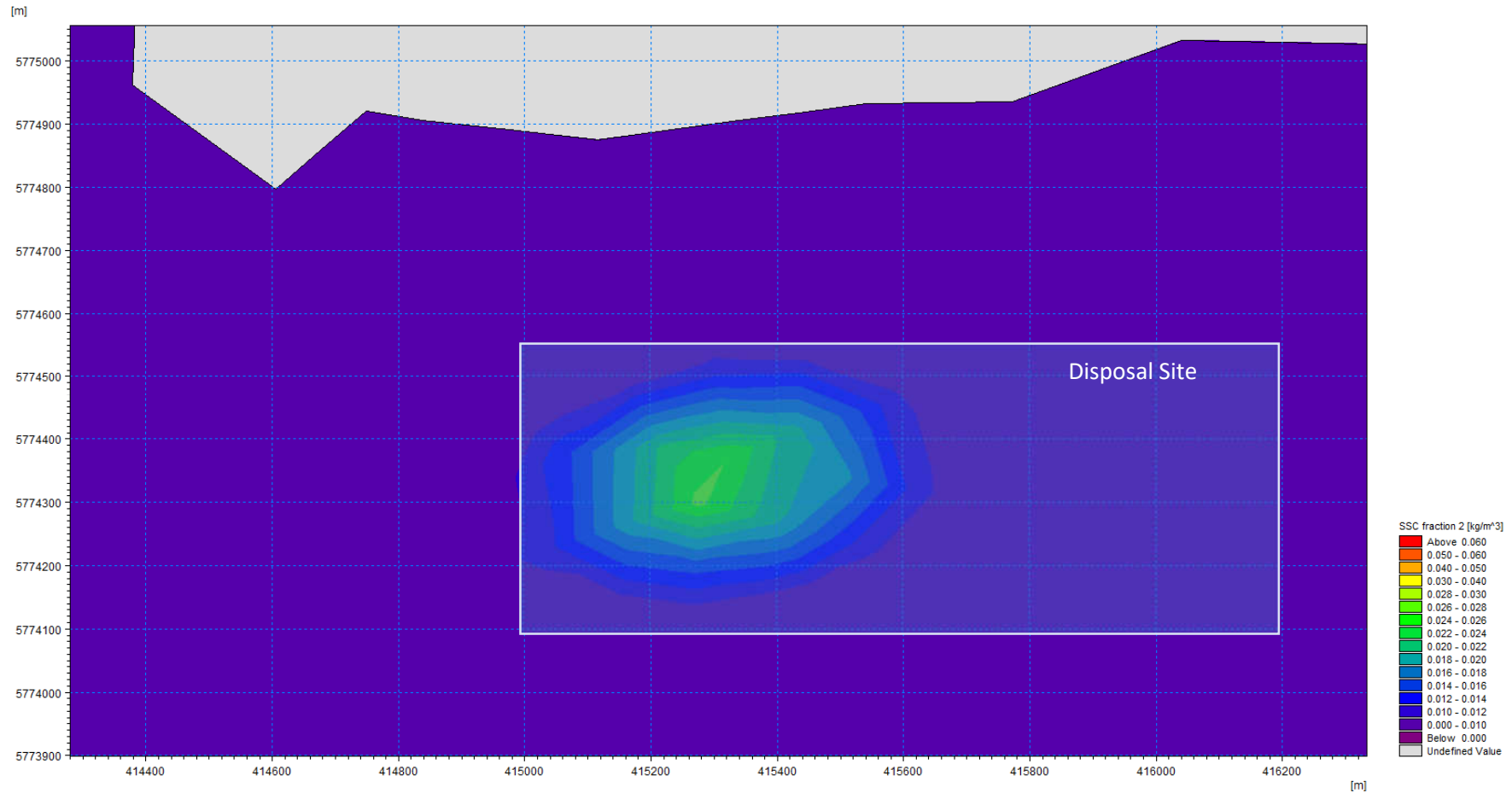


Figure 7 Dumpsite: SSC concentration localised at end of dumping operations (three hours after last dumping operation)

3.2 Bed Thickness Change

The build-up of bed thickness at the end of the dumping operations is shown in Figure 8.

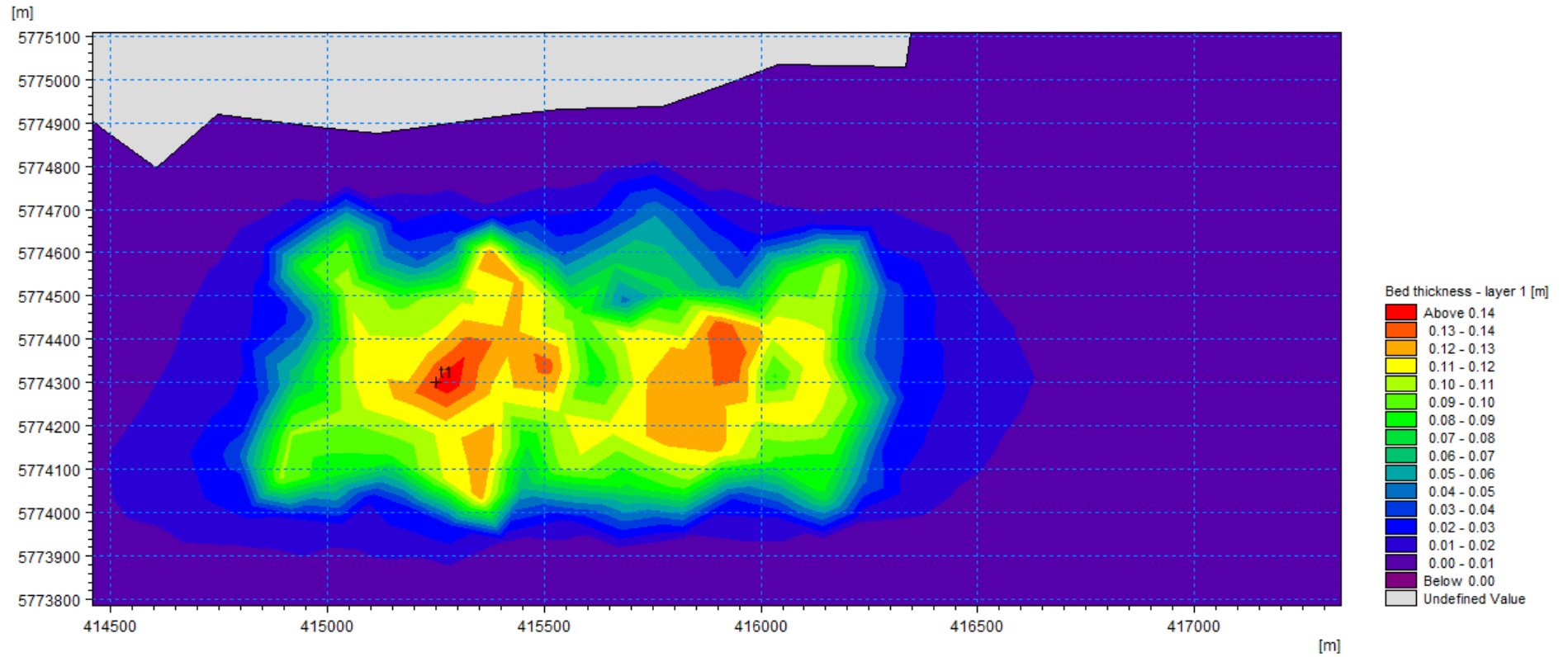


Figure 8 Dumpsite: Bed Thickness Change at end of dumping operations (day 70)

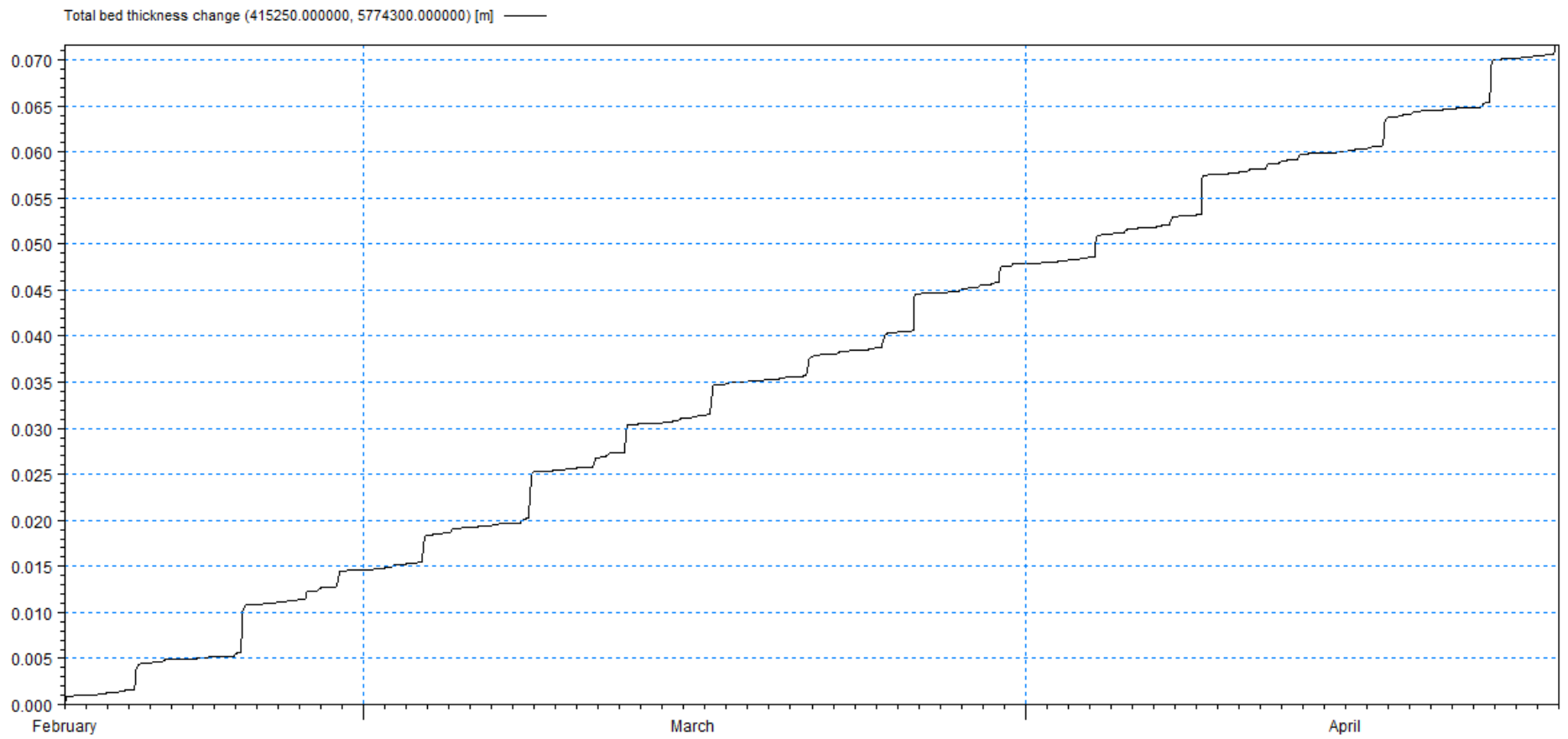


Figure 9 Total Bed Thickness at point of maximum build-up at dumpsite (location shown by t1 marker in Figure 8)

Dredge Site Model

4.1 Bathymetry and Surface Elevation

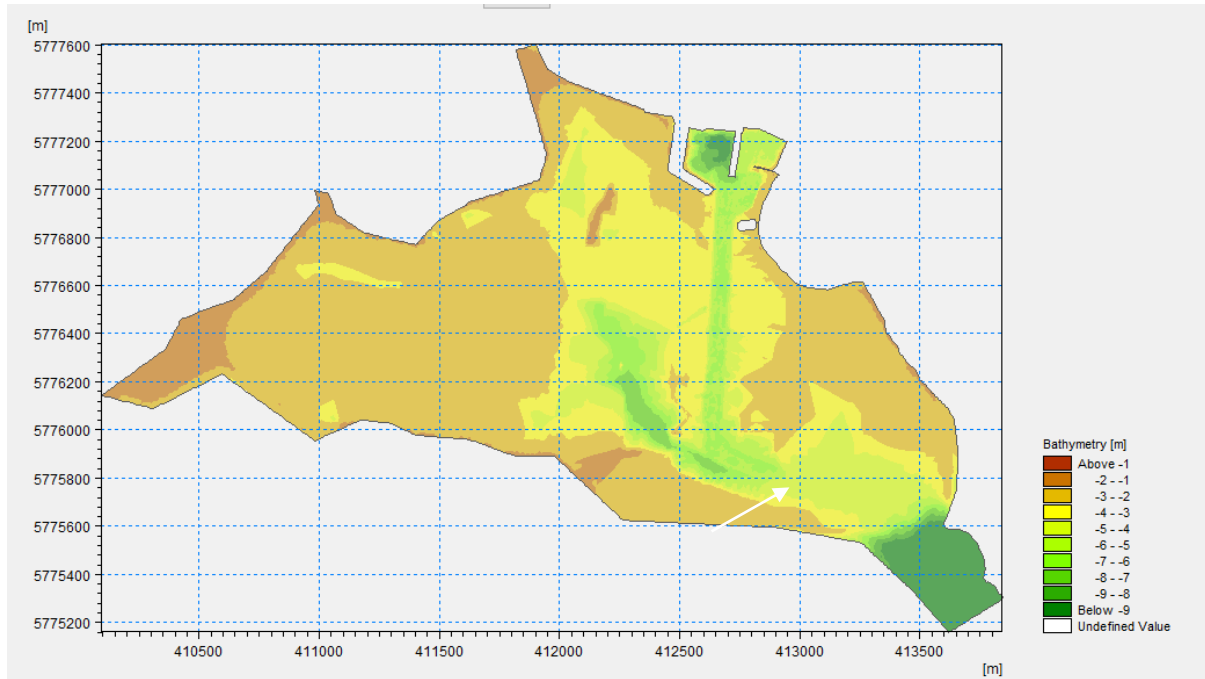


Figure 10 Bathymetry of Dingle Inner Harbour

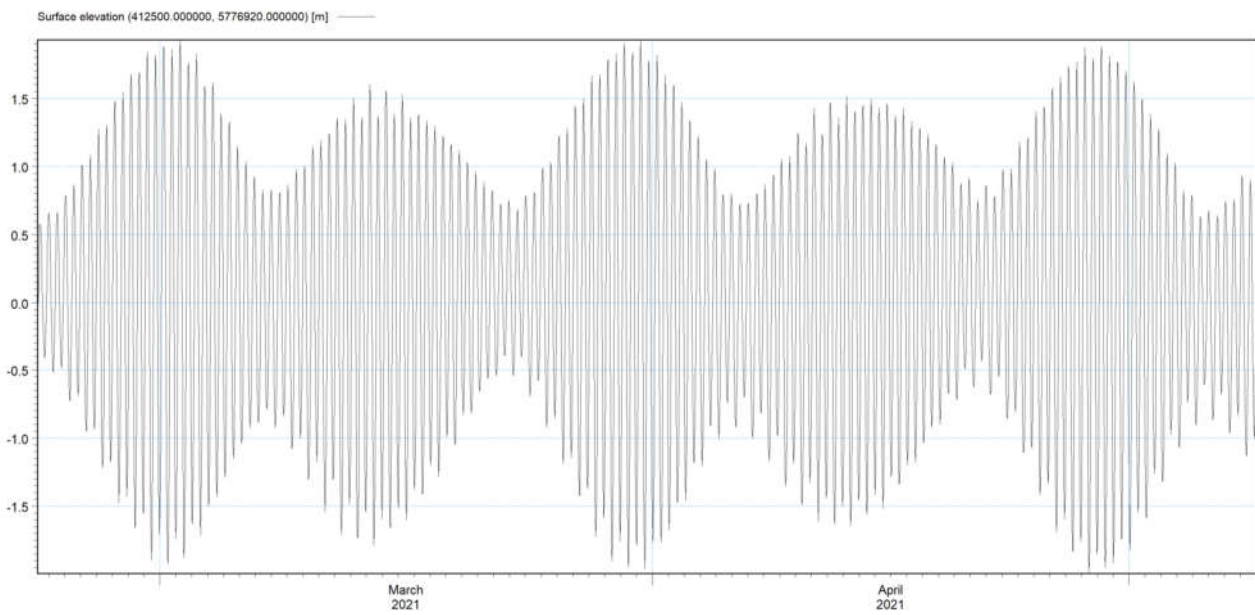


Figure 11 Surface Elevation at dredge site

4.2 Tidal Currents

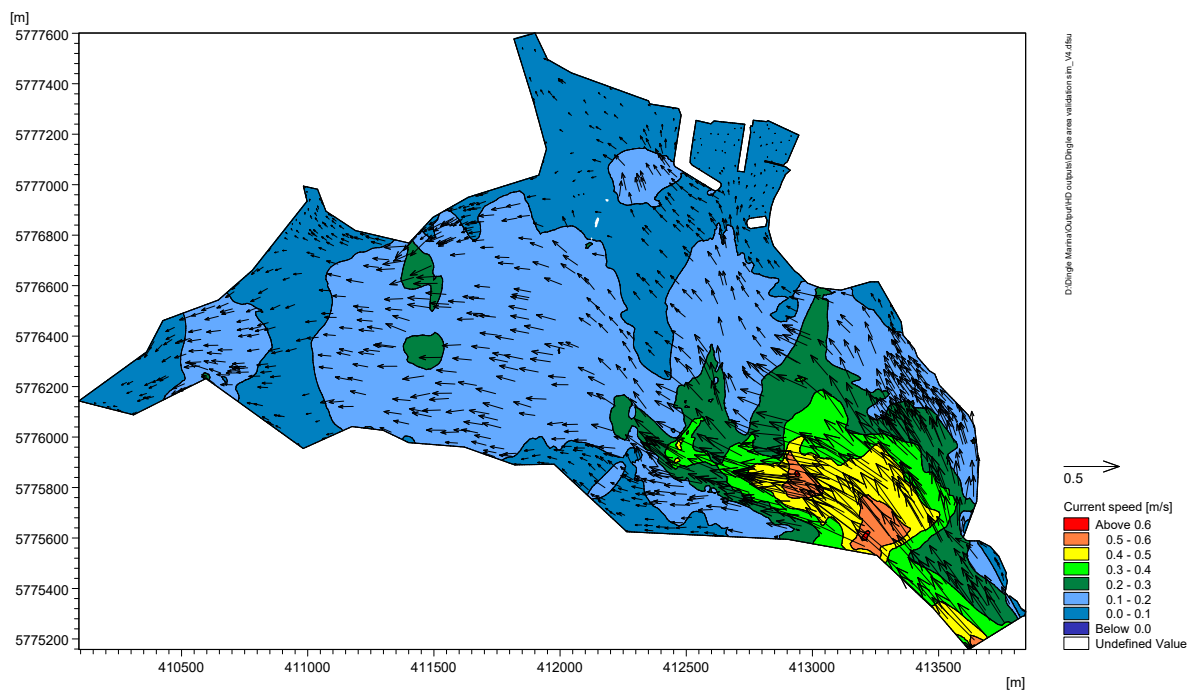
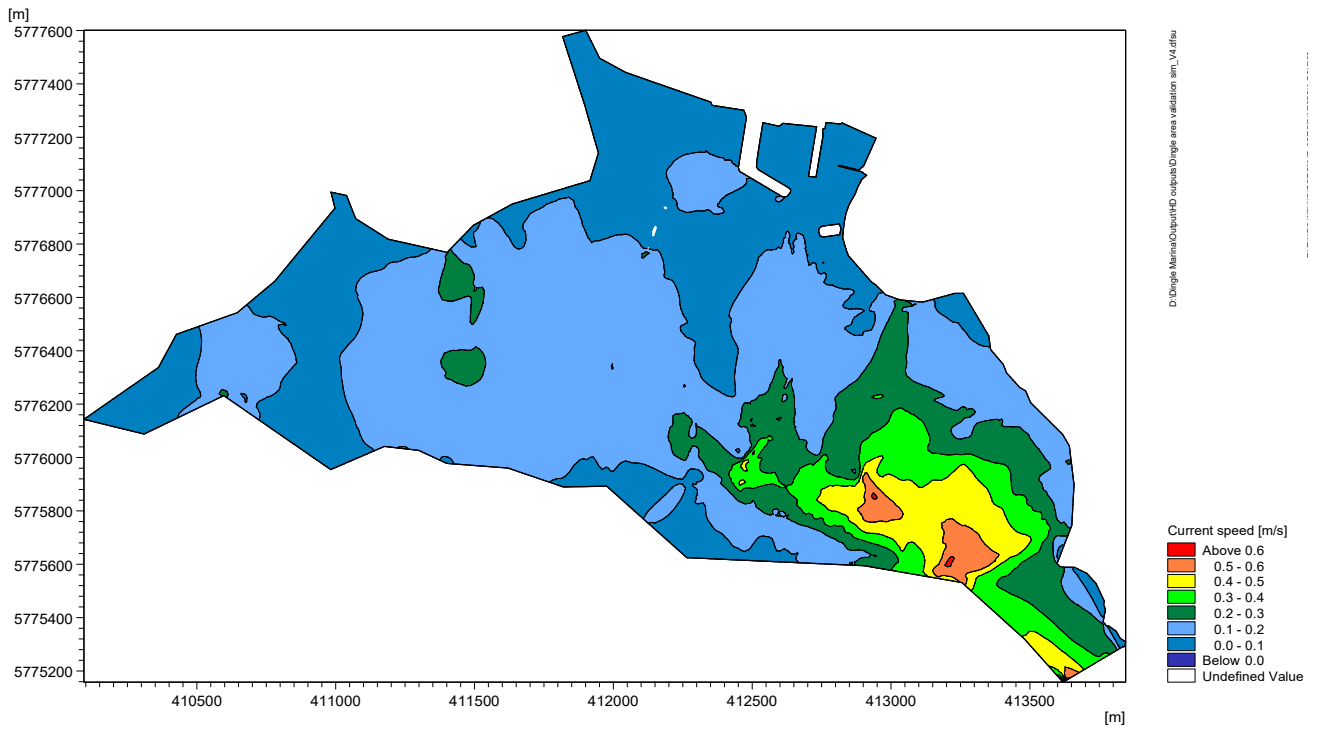


Figure 12 Inner Harbour: Spring Tide Mid Flood Tidal Currents

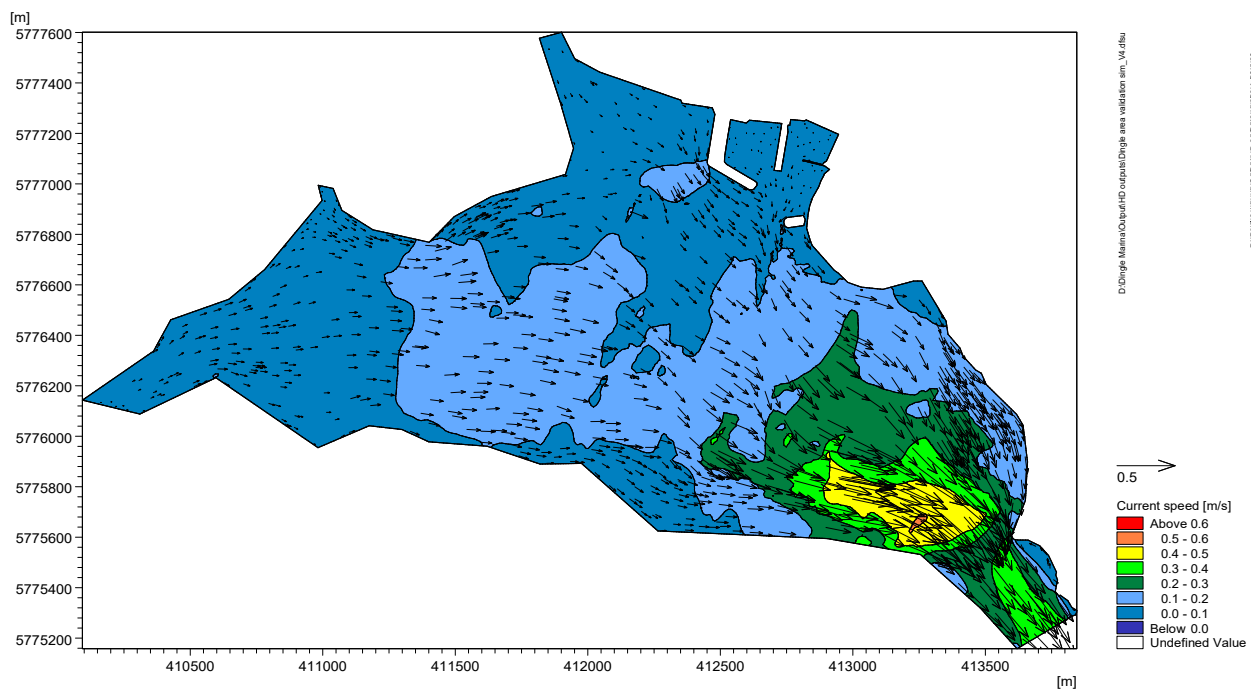
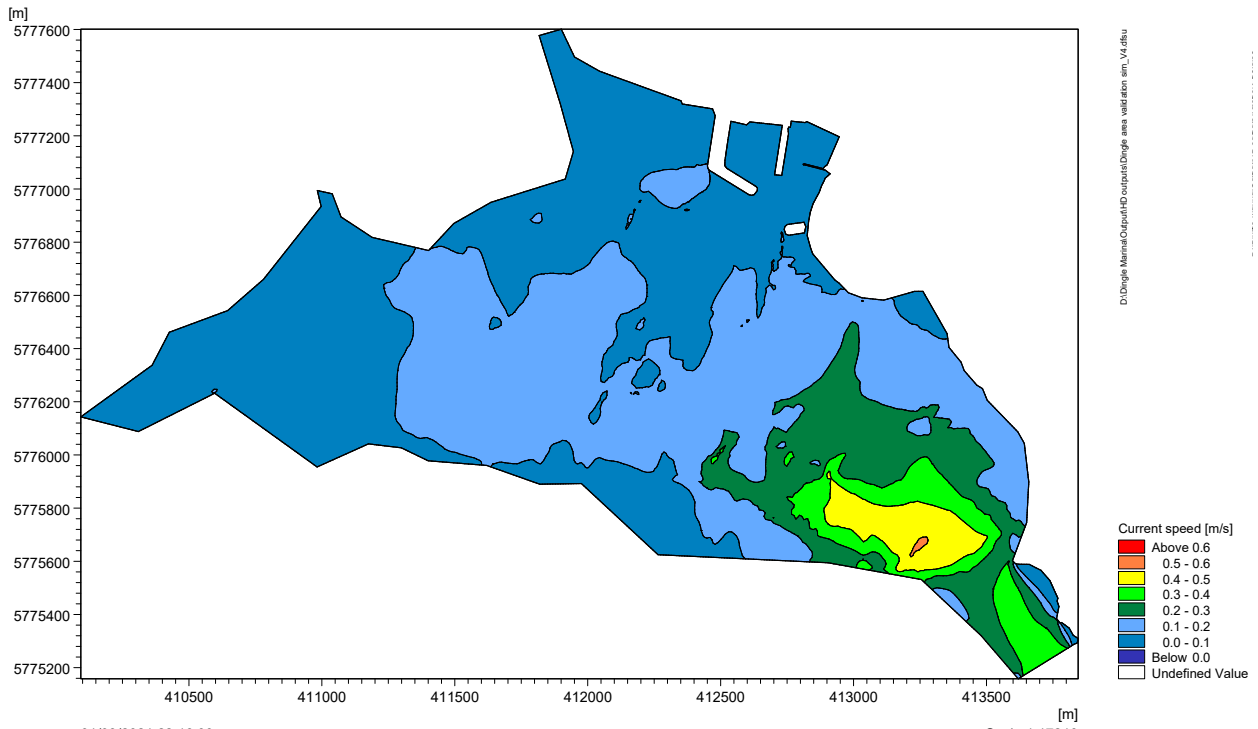


Figure 13 Inner Harbour Spring Tide Mid-Ebb Tidal Currents

Suspended Sediment Concentration (SSC)

The dredge plume sediment disperses after each dredging operation. Figure 14 shows the typical pattern of dispersion when the tide is incoming (flooding), while Figure 16 shows the corresponding dispersion pattern for an outgoing (ebbing) tide.

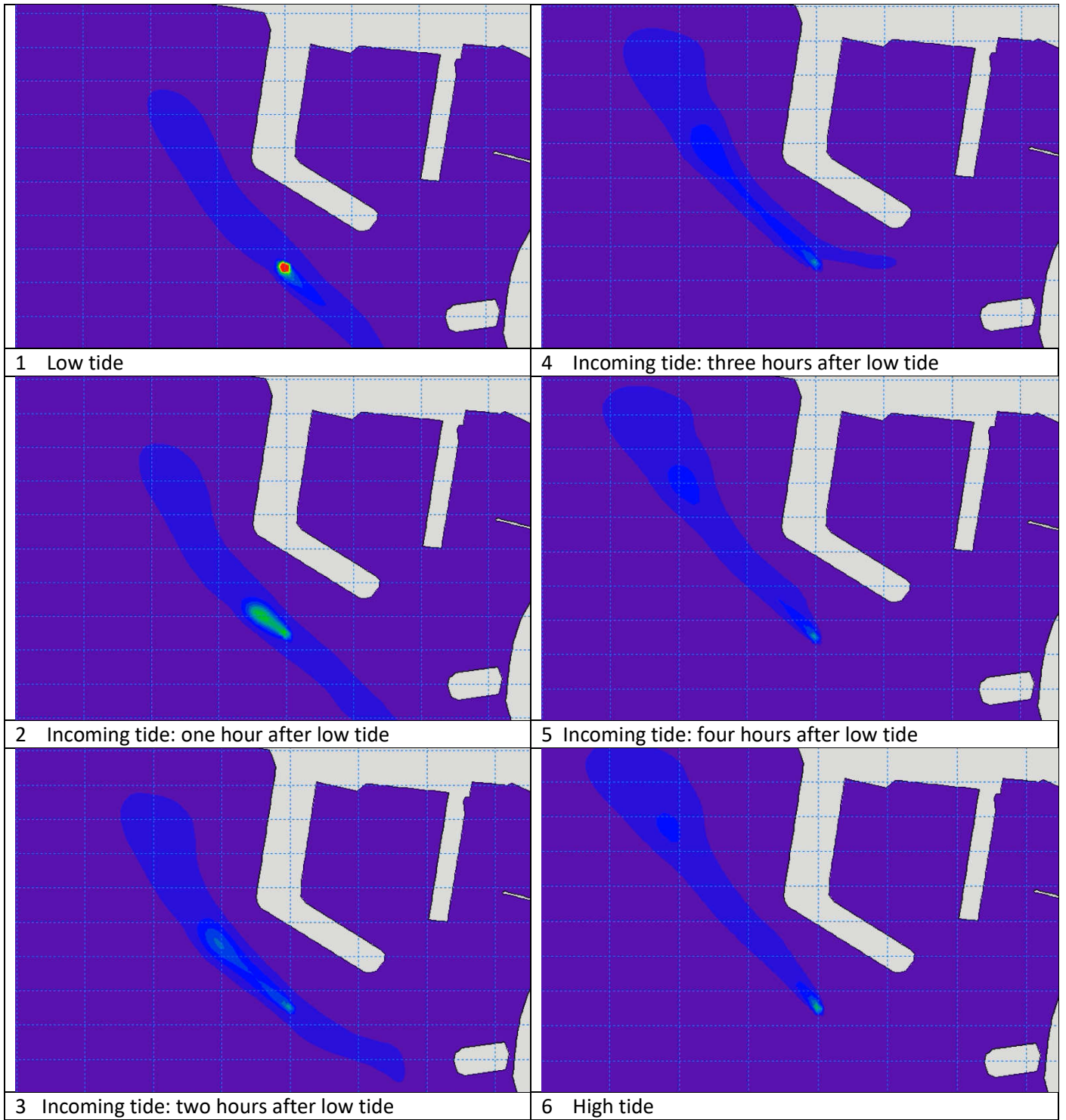


Figure 14 Inner Harbour: Dispersion Pattern of Dredge Plume Sediments with Flooding Tide

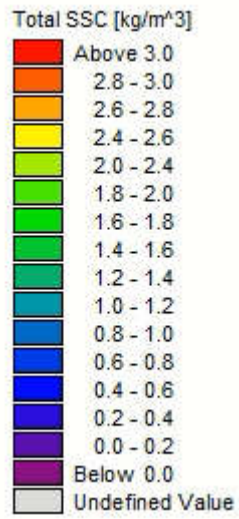


Figure 15 SSC Legend for Figure 14 and Figure 16

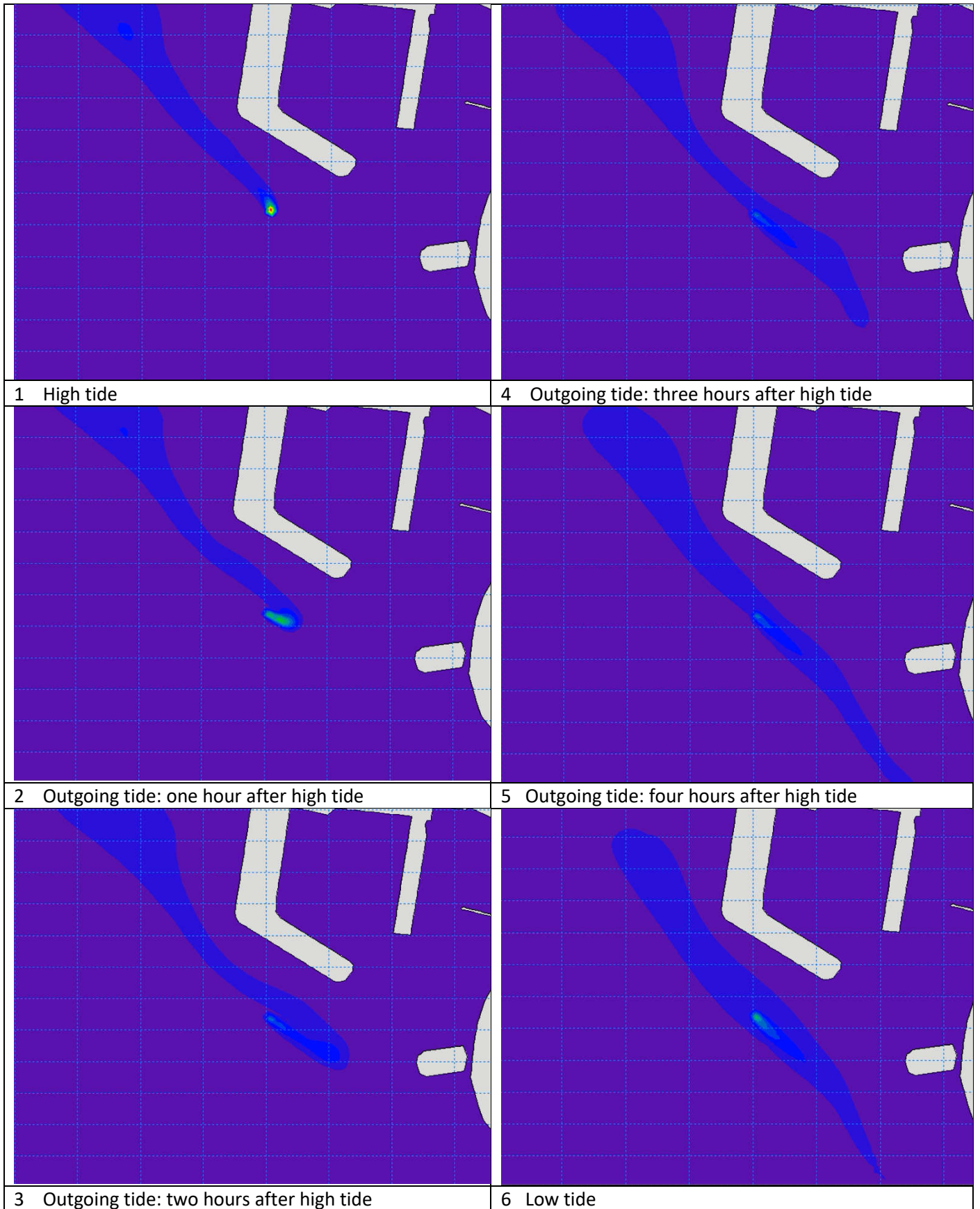


Figure 16 Inner Harbour: Dispersion Pattern of Dredge Plume Sediments with Ebbing Tide

Time series of SSC dispersion at two locations, namely the dredge site and at the mouth of the harbour, show the dispersion of the SSC at the end of the dredging campaign. The two locations are shown in Figure 17. Figure 18 and Figure 19 show SSC at these locations over a 20-day period at the end of the dredging campaign. This period includes the last ten days of the dredging campaign and ten days after the campaign ends.

The SSC values in figure 18 are high as they are taken immediately adjacent to the dredging operation and are more a measure of initial dilutions and quickly fall off away from this point, see Figures 14 and 16. Note that values taken at the harbour mouth, Figure 19, are several orders of magnitude lower.

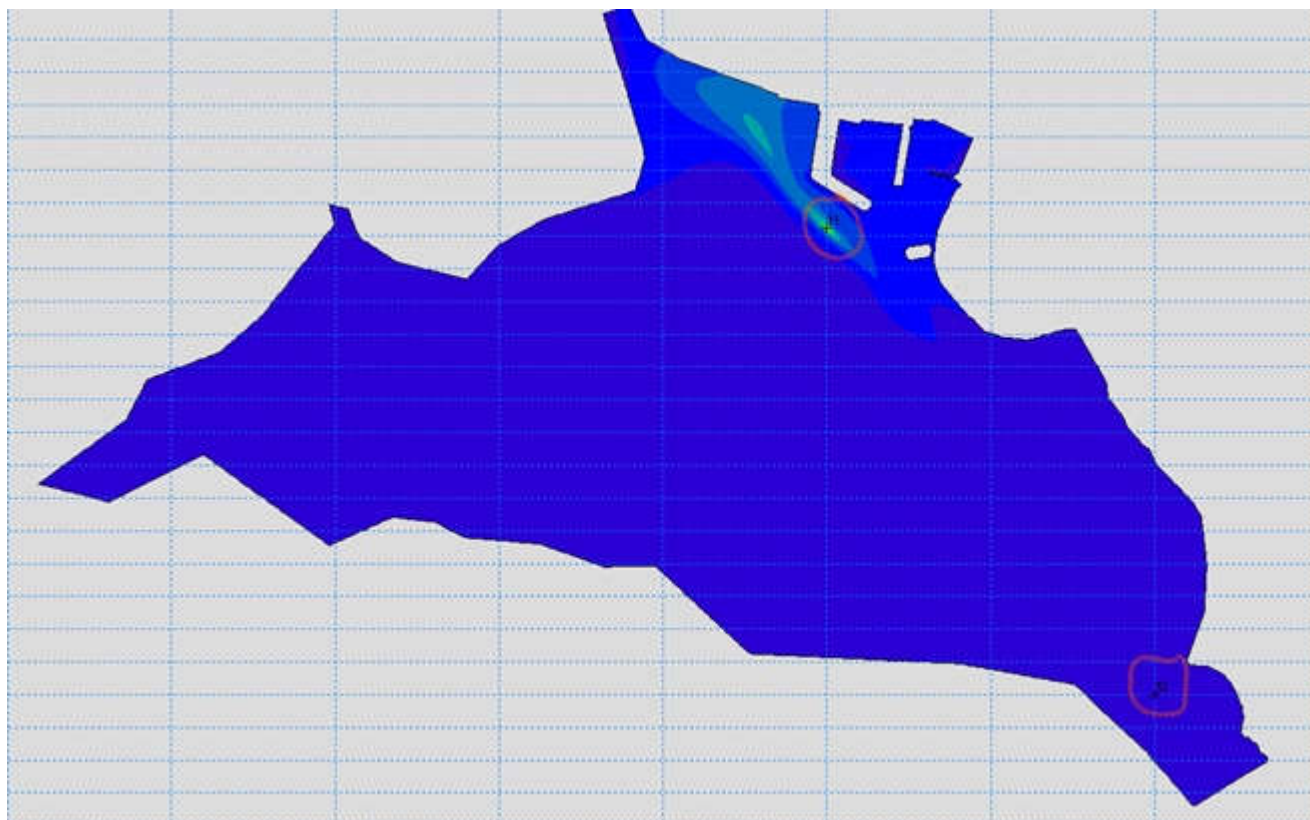


Figure 17 Dredging Analysis Time Series Locations – at dredging site and at mouth of harbour

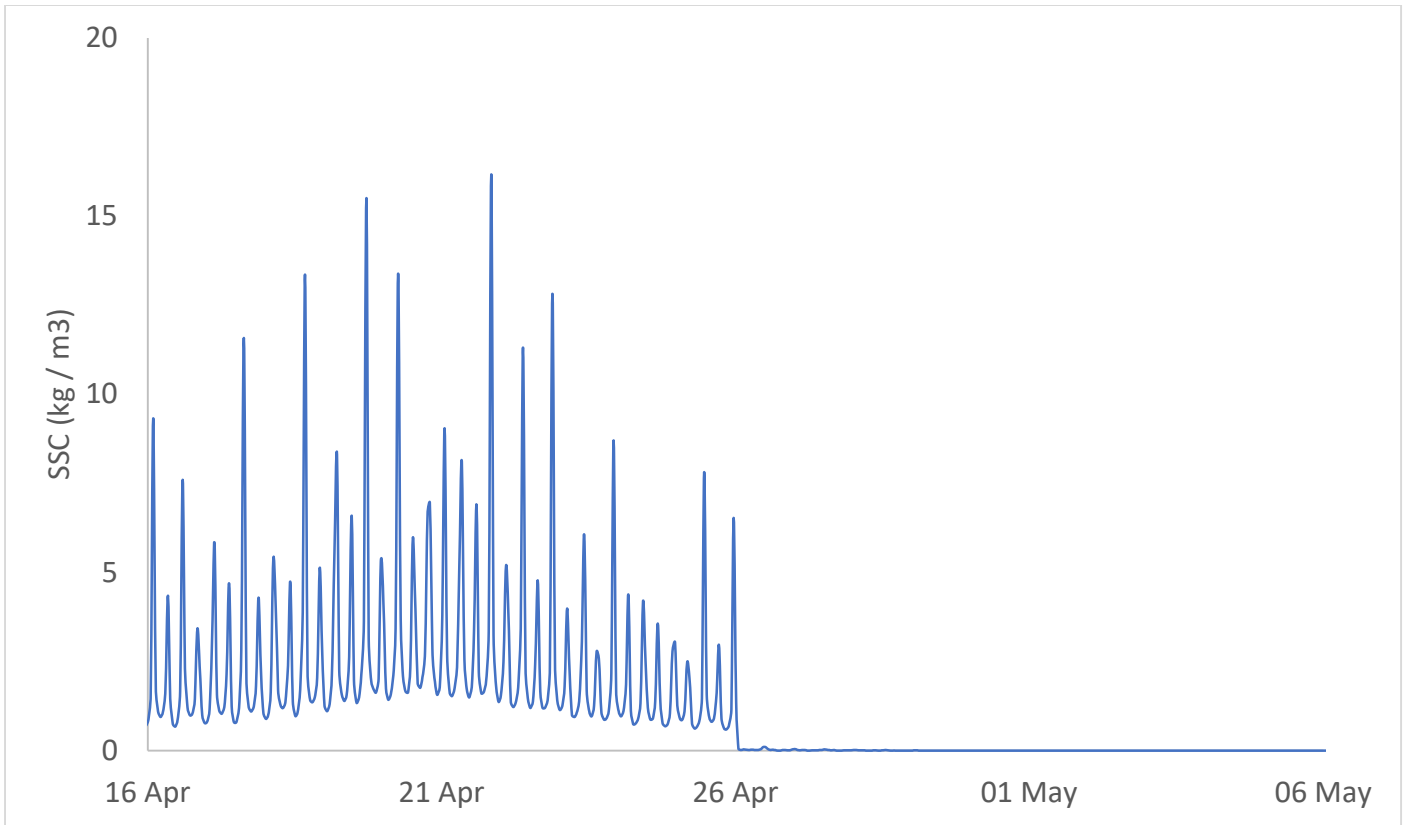


Figure 18 Inner Harbour: SSC at Dredge Site due to Dredge Plume (end of dredging operations)

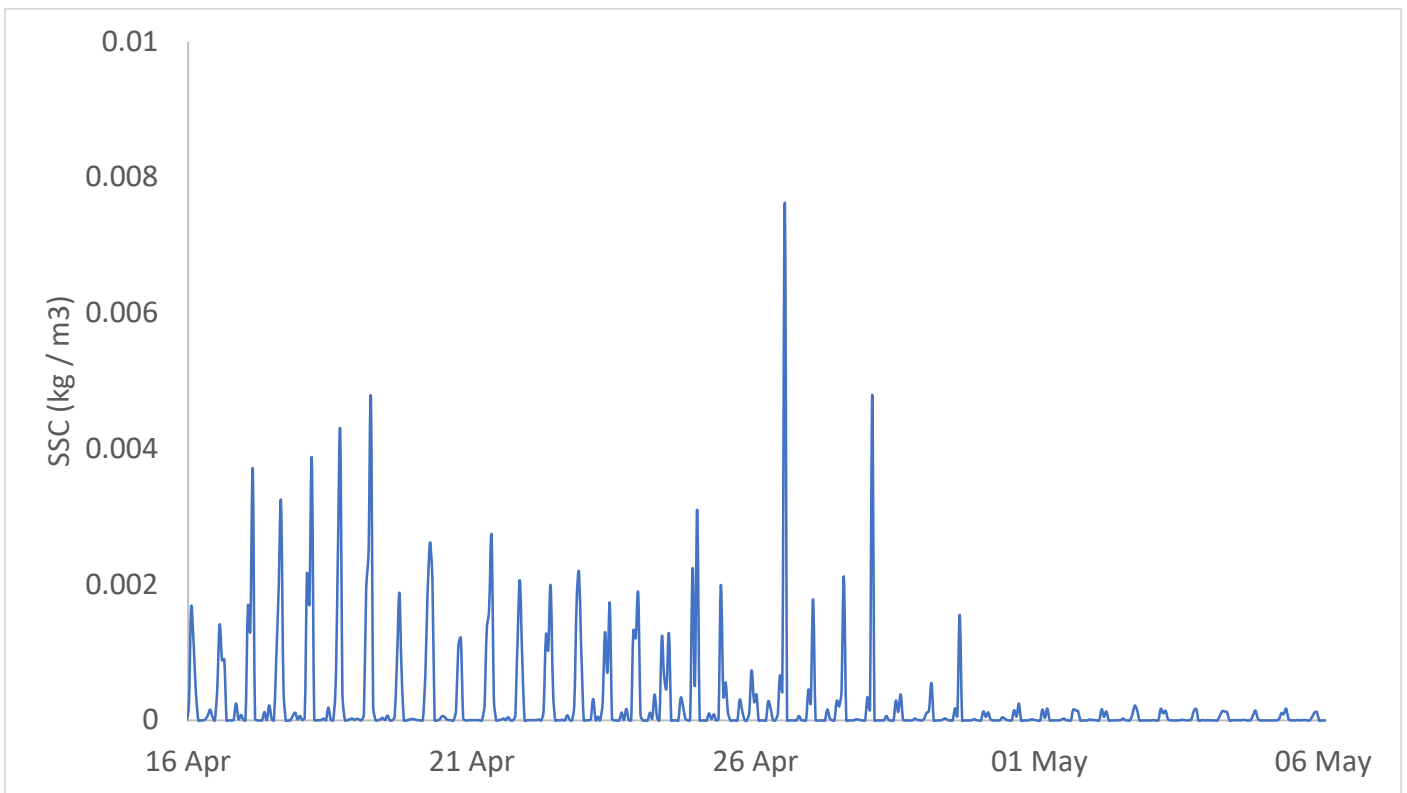


Figure 19 Inner Harbour: SSC at Harbour Mouth due to Dredge Plume (end of dredging operations)

5.0 Wave Modelling

The 50-year 10min wind speed from 140 (SE) is estimated to be 22m/s. The all direction 10min 50-year wind speed is 27.5m/s and there is a reduction factor of 0.8 for the SE. Wave modelling output below was completed using both 22m/s and 27.5m/s wind speeds from 140 degrees (SE).

5.1 Wave One: South East 50-year 10min wind speed

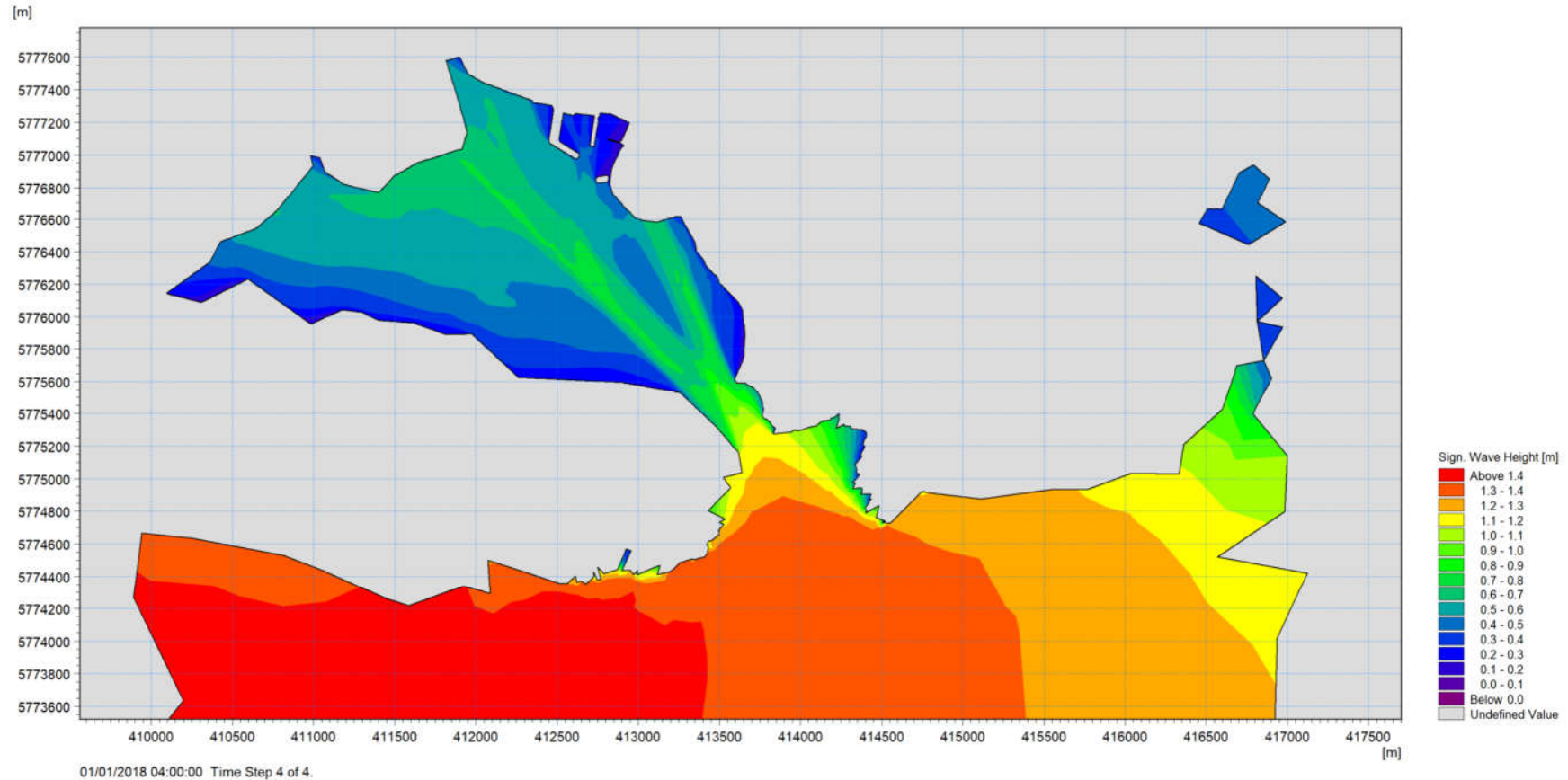


Figure 20 South East Waves: Significant Wave Height, Wind 22m/s at 140 degrees N

Table 1 Key Values for 22m/s wave at 140 degrees

Hs	Hmax	Tp	Dir P (rad)	Dir mean
0.58717	1.19327	3.36583	2.73127	147.108

5.2 Wave Two: All Direction 50-year 10min wind speed applied as SE wind

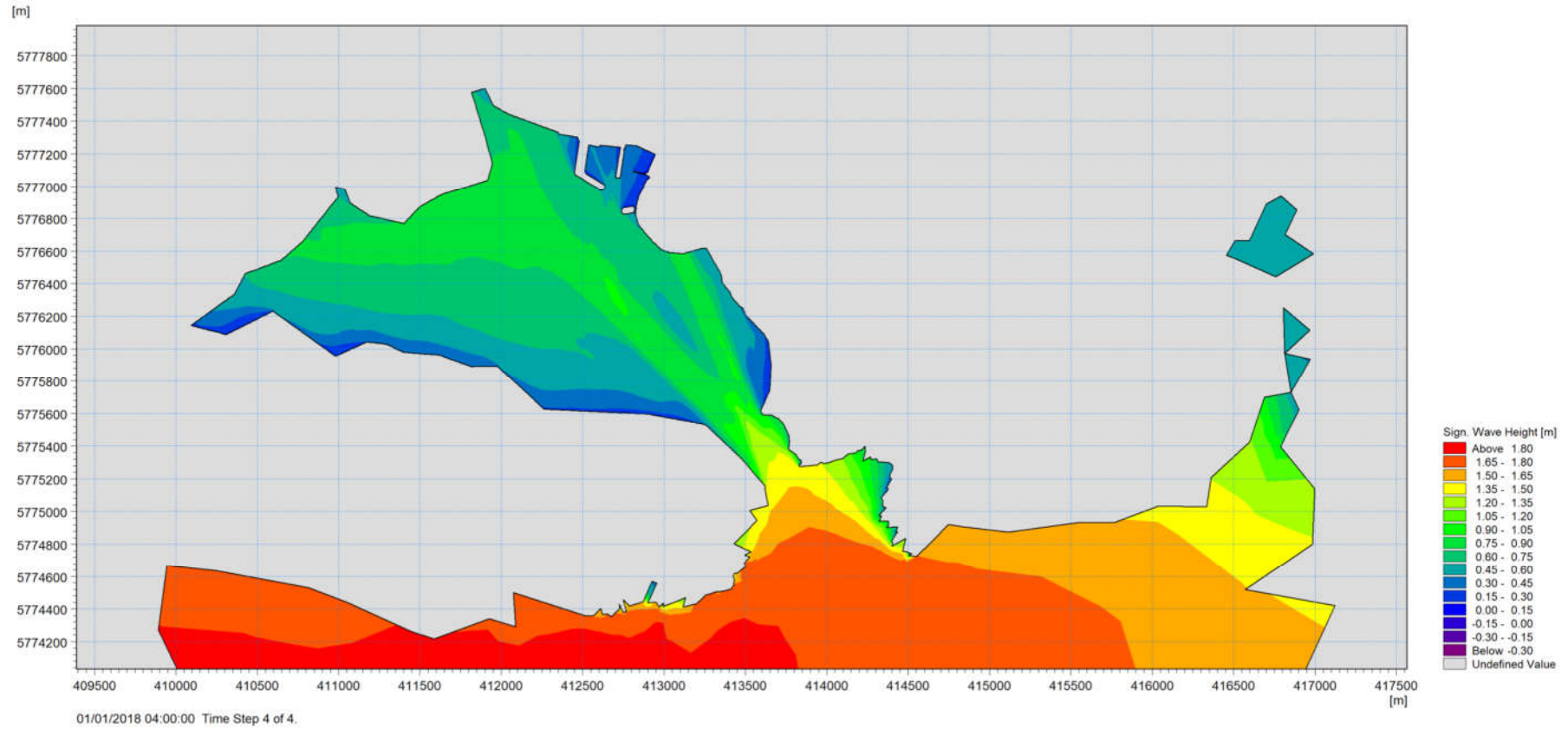


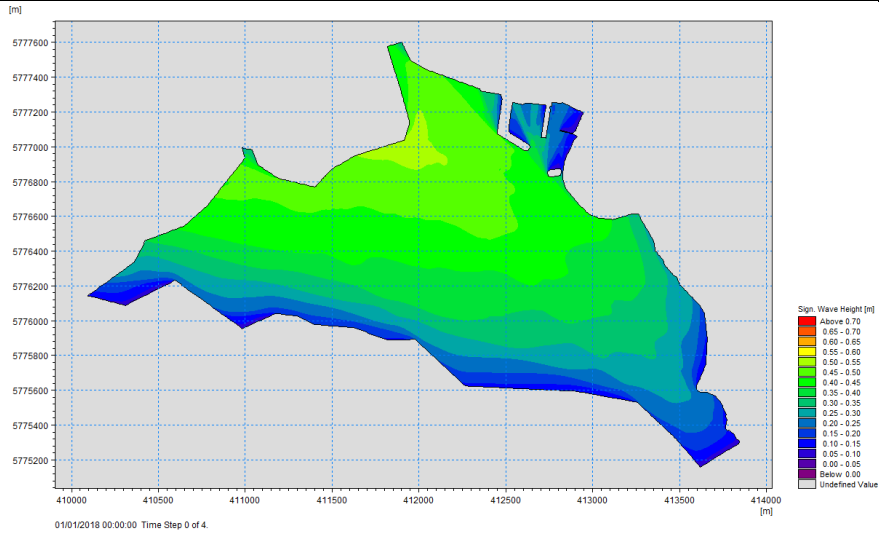
Figure 21 South East Waves, Significant Wave Height, Wave 27.5m/s at 140 degrees N

Table 2 Key Values for 27.5m/s wave at 140 degrees

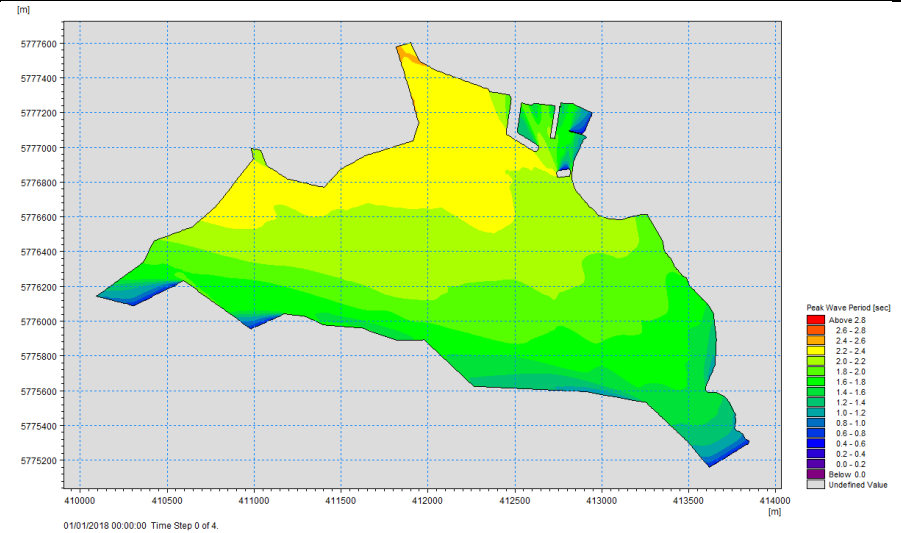
Hs	Hmax	Tp	Dir P (rad)	Dir mean
0.738832	1.49001	3.81654	2.73127	147.108

5.3 Inner Harbour: Locally Generated 50-year waves for varying wind directions

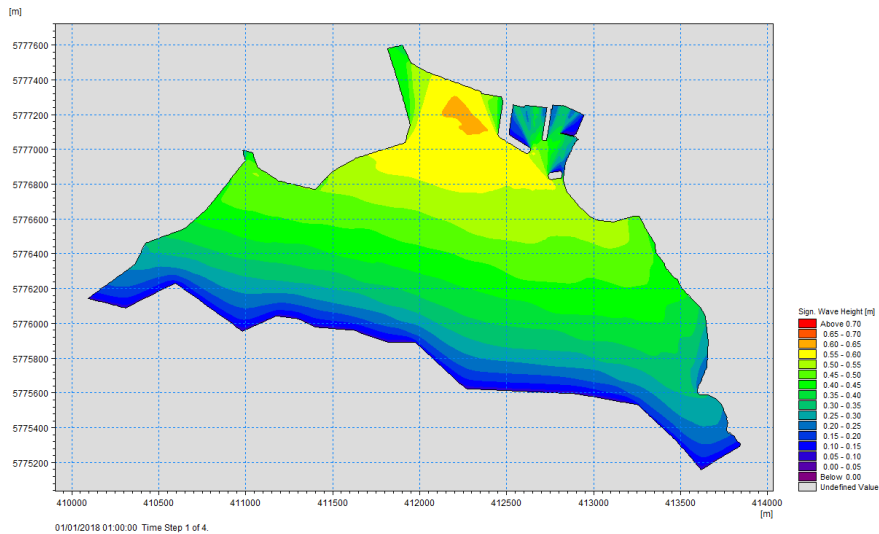
Figure 22 shows the locally generated 50-year significant wave heights and peak wave periods for various wind directions.



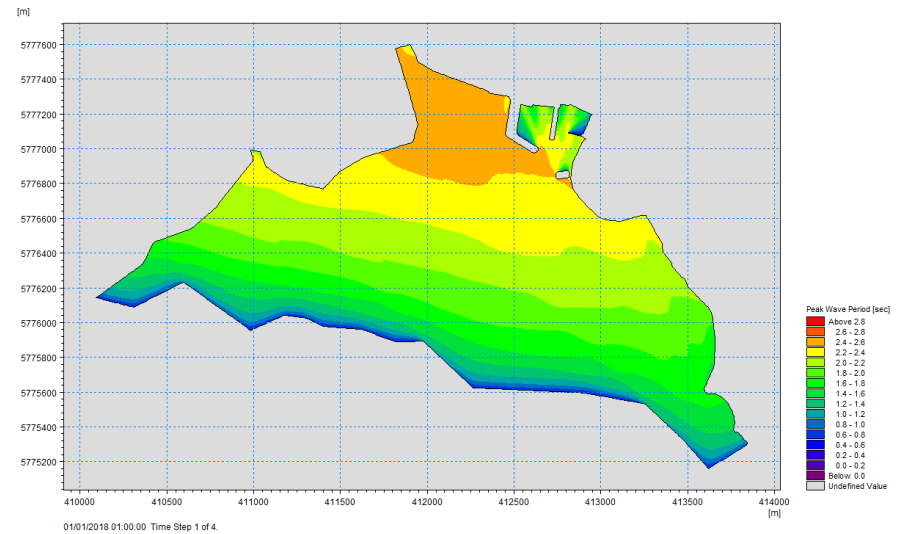
Hs 150 degrees (South East)



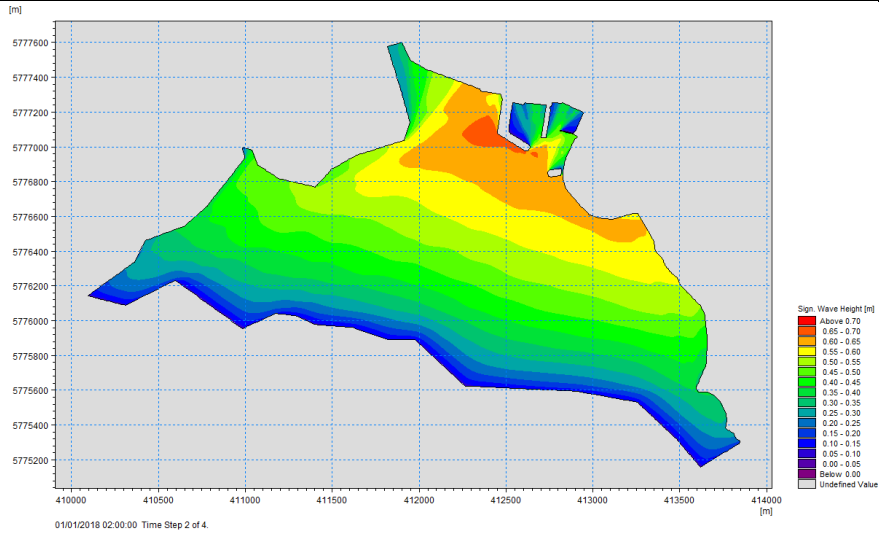
Tp 150 degrees (South East)



Hs 180 degrees (South)

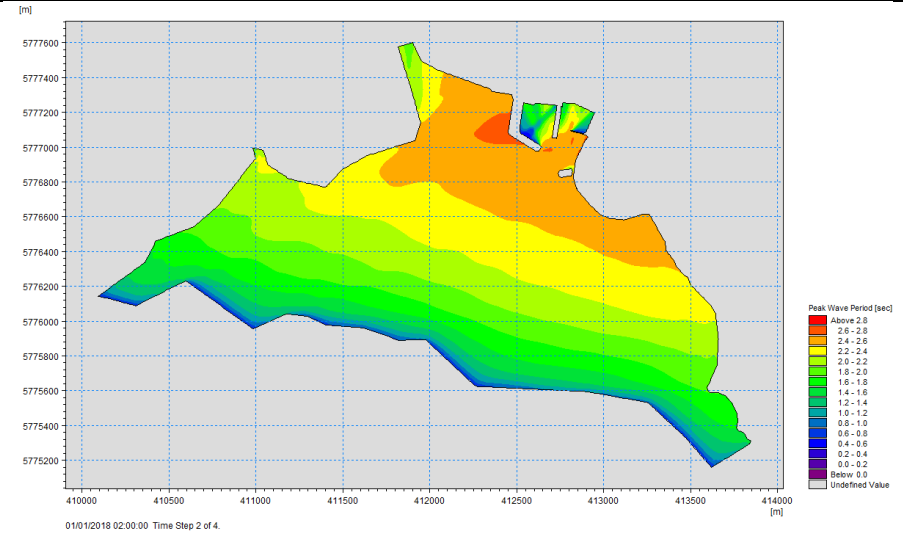


Tp 180 degrees (South)



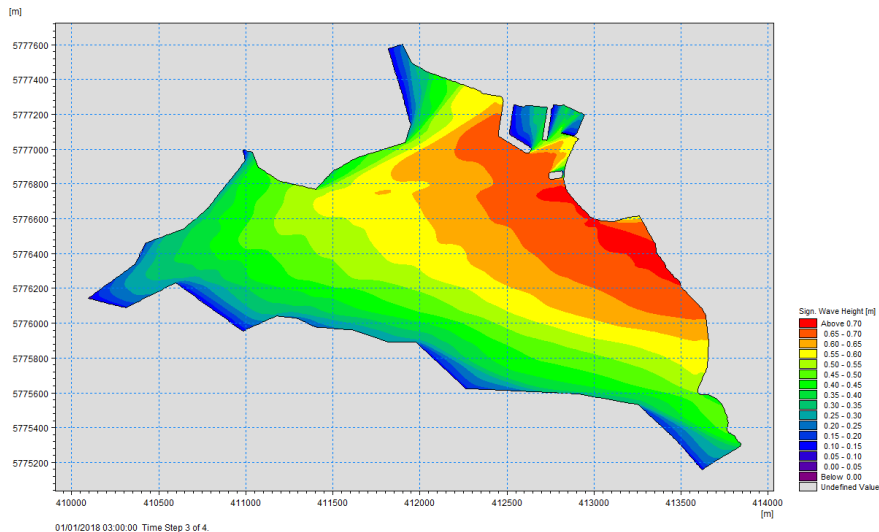
01/01/2018 02:00:00 Time Step 2 of 4.

Hs 210 Degrees (South South West)



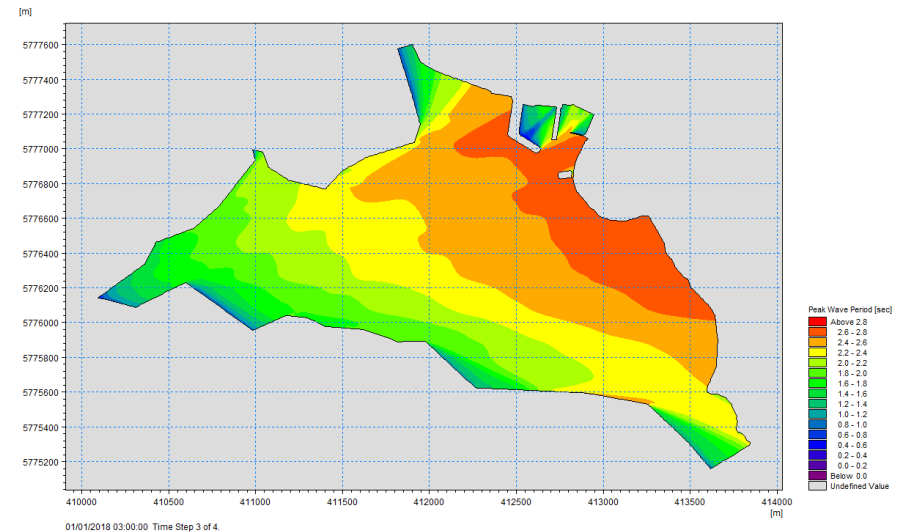
01/01/2018 02:00:00 Time Step 2 of 4.

Tp 210 degrees (South South West)



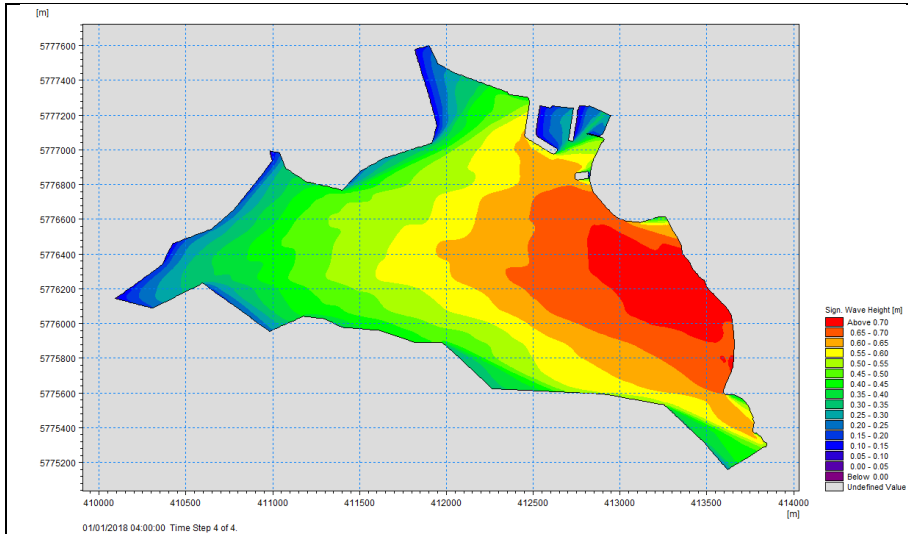
01/01/2018 03:00:00 Time Step 3 of 4.

Hs 240 degrees (South West)

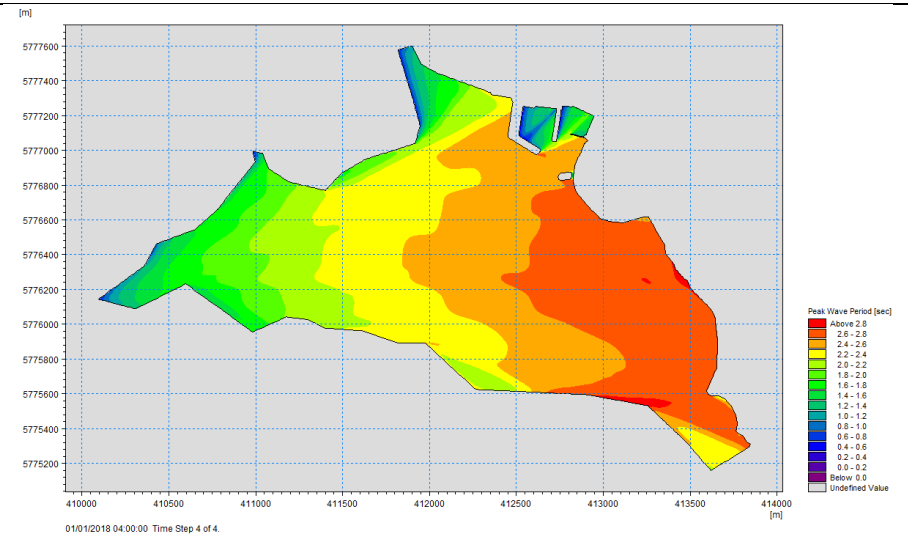


01/01/2018 03:00:00 Time Step 3 of 4.

Tp 240 degrees (South West)



Hs 270 degrees (West)



TP 270 degrees (West)

Figure 22 Inner Harbour: Locally Generated 50 year Significant Wave Heights and Peak Wave Periods various wind directions