



**NECAG Coast Protection Assets
and Coastal Slope Condition Analysis**

**Sunderland City Council
Final Report**



April 2009

Preamble

The North East Coastal Authorities Group (NECAG) comprises the following organisations, each of whom has certain responsibilities for managing the coastline between the River Tyne and Flamborough Head:

- South Tyneside Council;
- Sunderland City Council;
- Easington District Council;
- Hartlepool Borough Council;
- Redcar and Cleveland Borough Council;
- Scarborough Borough Council;
- East Riding of Yorkshire Council;
- Environment Agency;
- North York Moors National Park;
- Natural England;
- The National Trust.

Collectively, NECAG produced a 'second generation' Shoreline Management Plan (or 'SMP2') for its coastal frontage in 2007. In this SMP2, recommendations were made for condition assessments of the coastal protection assets and coastal cliffs and slopes along this frontage, as part of a broader coastal monitoring programme.

To this end, Scarborough Borough Council, acting as the 'lead authority' for NECAG, commissioned a team from Royal Haskoning and Halcrow to undertake the '*NECAG Coastal Protection Assets and Coastal Slope Condition Analysis*' between August 2008 and January 2009. Fieldwork was undertaken in the summer to winter of 2008.

The joint team approach between Royal Haskoning and Halcrow has enable skilled staff with previous expertise of the specific stretches of frontage to work together and offer best value to NECAG. The asset and slope inspectors have included Chartered Engineers (focusing mainly on the built coastal protection structures) and Engineering Geomorphologists (focusing mainly on the natural cliffs and coastal slopes) ensuring suitable skills are applied to each length of frontage.

To ensure a consistency of approach in reporting, a standard template has been used for each of the seven Local Authorities within NECAG. In addition, the findings from the inspections have been entered into the Environment Agency's National Flood and Coastal Defence Database (NFCDD) for each identified length of 'defence', be it an engineered structure or a natural cliff/slope. This ensures that each Local Authority is complying with its High Level Target to ensure that the NFCDD is regularly updated.

Following these initial 2008/09 inspections, it is intended that future inspections are undertaken within the recently commissioned Cell One Coastal Monitoring Programme, which again is being undertaken jointly by Royal Haskoning and Halcrow under Scarborough Borough Council's leadership. This ensures that future work will be undertaken by the same teams and that the 2008/09 inspections will provide a baseline against which future changes, such as deterioration of defences or erosion of cliffs, can be compared.

1. Introduction

Methodology

The structural assessment of coastal protection assets along the Sunderland City Council frontage was carried out by a team of asset inspectors and structural engineers during November and December 2008. All assets were graded based on their condition, residual life and urgency of repair work. Observations were photographed and all data were stored in the National Flood and Coastal Defence Database (NFCDD). Brief descriptions of the condition of the coastal margin for any areas of undefended coastline were also entered into the NFCDD. All assessments were based on a visual inspection, with no intrusive investigations or investigations below the water level carried out as part of the present study.

The assets were graded based on the Environment Agency Condition Assessment Manual. The manual was created in order to allow performance based asset management of flood defence assets. The standard descriptions adopted by the Environment Agency to reflect the condition according to performance are listed in the table below:

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed.
5	Very Poor	Severe defects resulting in complete performance failure.

The asset descriptions provide an overview of findings, summarising each locality and identifying individual assets of poor condition, failing structures and assets that have the potential to fail. It is anticipated that this will help identify areas for investment, including repair work, replacement or the installation of a different asset type. This report will also highlight assets with a certain level of importance or interest.

The asset condition assessment for the Sunderland City Council frontage was conducted on 26th November, 1st and 16th December 2008 by a structural engineer and a coastal and rivers asset inspector working from North to South. The weather experienced during the surveys was fair with no visibility problems.

Study Area

Sunderland City Council's frontage extends from The Bents, to Ryhope Dene in the south. The northern section of the frontage to South Bents is made up of undefended limestone cliffs backing rock outcrops and a sand and shingle beach. North of the River Wear, the frontage is defended by 3.3km of concrete and masonry structures through Seaburn and Roker. The entrance to Sunderland Harbour lies between Roker Pier and the New South Pier. South of the Harbour entrance 4.3km of the frontage is backed by private property as it protects the docks and infrastructure of the Port of Sunderland. To the south of the port boundary, there is a 1km length of defended frontage at Hendon, south of which 3km of the coastline is undefended and characterised by Magnesian Limestone cliffs capped with boulder clay.

2. Overview

Condition Assessment

The coastal defence assets of the Sunderland City Council frontage are generally in good condition. Minor remedial work as part of a routine maintenance programme carried out alongside regular asset inspections will provide an appropriate solution to the majority of issues/defects identified. However, some structures were also identified as requiring urgent remedial action. These are described below:

- North East Pier, Port of Sunderland
The concrete and masonry structure was in very poor condition due to significant erosion, undercutting, and washout of material. The roundhead of the structure has collapsed, leaving the pier more susceptible to further damage.
- South West Breakwater, Port of Sunderland
The concrete and masonry structure is generally in fair condition although local areas of significant damage require attention. Concrete blocks on the northern face are significantly displaced, forming voids in the structure. Previous underwater surveys have identified degradation of toe piling (both holing and undermining).

Comparison with Previous Assessments and Recommendations

Previous asset condition information compiled by Sunderland City Council in 1998 was available from NFCDD. The condition grading of several assets was improved due to remedial works or replacement carried out since the last survey. Several assets were downgraded due to degradation over time or following extreme events. Many assets were found to be in a very similar state as previously and therefore their residual life classification was changed accordingly.

Recommended actions for all coastal defence assets are presented in Section 6 of this report.

3. Condition Assessment

The Bents

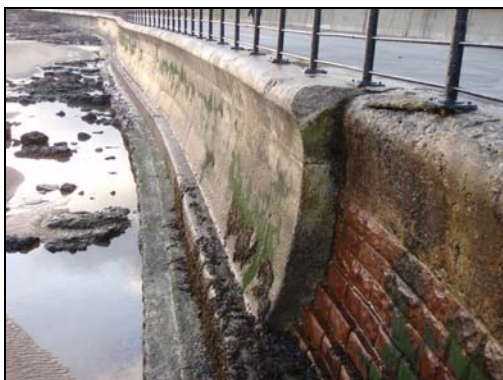
The frontage is undefended landward of the Whitburn Steel outcrop. Here shingle has accreted on the upper beach (pictured, below left). The steep coastal slopes to the north gradually reduce in level to the south, where a grassed embankment fronted by vegetated sand and shingle dunes is present (pictured, below right).



From South Bents to Seaburn the sea defence consists of a concrete seawall and a masonry seawall with a concrete crest fronting the promenade (pictured, right). The promenade is backed by concrete and masonry walls and a grass embankment leading up to the main coastal road. The concrete wall is in fair condition with several longitudinal cracks and vertical cracks which extend for the full height of the wall. The larger cracks have vegetation growth which should be removed before infilling the cracks.



The beach level reduces to the south. The sea wall requires minor repointing, specifically at the joint between the masonry and the concrete crest which appeared to have widened slightly along a significant length of the wall. There was evidence of repairs to several large settlement cracks although these cracks appeared to have extended beyond the previous repairs and were in need of further remedial work. Timber piles and a concrete apron were exposed at the toe where the beach level was lower towards the southern end of the wall (pictured, below left). Water storage at the toe of the wall prevented detailed inspection of the toe along the southern section of the wall. The seawall past Seaburn includes a concrete crest wall in which previous cracks had been infilled.



The masonry wall has a concrete facing for 89 metres at the southern extent of Whitburn Sands. The beach level appeared lower immediately in front of and to the north of the encased length which is indicative of the high wave energy environment in this area. The concrete is in good condition with some minor damage to the crest.

Parson's Rocks

Most of the construction joints in the concrete splash wall to the rear of the promenade are missing sealant (pictured, below). This should be replaced to prevent water egress into the structure. The concrete units are in good condition with only minor cracking evident at the crest and slight surface deterioration around drainage outlets.



There is some local damage to the grouted stone revetment to the rear of the promenade (pictured, right). Voids are opening up, with water collecting inside the revetment. These voids should be infilled to prevent the voids widening and erosion of the fill material, which could compromise the stability of the revetment and embankment above. The low concrete wall in front of the revetment is cracked with evidence of significant spalling. These sections of wall should be replaced/repared.



The masonry wall is built over the rock outcrop at Parson's Rock (pictured, below left). The wall ties in with the rock and there have been several repairs made with grouted rubble to fill voids which had opened up between the wall and the rock. To the rear of the promenade is a concrete wall incorporating benches which was cracked and rust-stained. Above this wall are cliffs. Local erosion and minor slope failure had taken place exposing geotextile material below the topsoil/vegetation at the crest. In places the cliffs are fronted by a grouted stone revetment at the toe which was in good condition (pictured, below right).



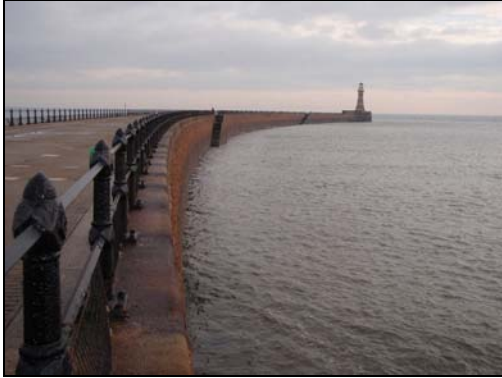
South of Parson's Rocks the defence is a masonry seawall with a concrete block crest (pictured, right). The crest level of the structure varies. The masonry is generally in good condition although several blocks are cracked and in need of repair. Repointing should be carried out to replace missing mortar which is particularly evident in the lower, intertidal section of the wall.



The lower concrete wall fronting Marine Walk is in very good condition (pictured, left). Towards the southern end of the asset there is an older concrete wall supported by the lower wall. This structure was in fair condition with cracks and damage to the crest in places.

Roker Pier

The pier is constructed from masonry and concrete and appeared in good condition above the waterline (pictured, below). More recent repointing works were evident and appeared to be working well.



There is a small beach retained between Roker Pier and the Old North Pier. The defences between the two structures consist of a low masonry and concrete seawall and a concrete seawall fronted by a rock armour revetment. The car park to the rear of the concrete seawall contains concrete splash walls. All the assets were in good condition. An additional degree of protection is offered by the high beach levels in this area.

Old North Pier

The Old North Pier was not included in the MAFF Coast Protection Survey, Halcrow 1994 and is assumed to be a river defence. The pier is not included in Sunderland City Council's coastal revenue or capital programmes. Although located within the sheltered area between Roker Pier and New South Pier, the structure will continue to offer some protection to the Harbour entrance and helps retain the small beach to the north. The structure is included in the present condition assessment for reference.

The structure was not accessed due to warning signs prohibiting access to the unsafe structure. An assessment of the condition of the structure was made from the landward end.



The northern face of the structure is formed by a grouted stone revetment (pictured, left). Several masonry blocks were missing, with concrete patch repairs to the surface which were showing signs of erosion.

The southern face of the structure is constructed from masonry, with timber piles also visible (pictured, right). The masonry at the landward end appeared to be in fair condition with the need for some repointing and replacement of missing blocks.



A concrete crest wall runs along the centre of the structure and appeared in good condition. A detailed survey of the pier is recommended to determine the full extent of the structural problems and to establish an appropriate level of remedial work or possible replacement.

Port of Sunderland

The frontage south of the entrance to the River Wear is inaccessible to members of the public as it is within the boundary of the Port of Sunderland.

The most northern defence is a grouted stone revetment fronted by a rock armour toe which is in good condition (pictured, below left). The revetment ties in to a masonry seawall with a concrete crest wall (pictured, below right). The wall is also in good condition, with minor cracking and spalling of the surface.



The tie-in between the two defences is in poor condition as there is no crest wall (pictured, right). Here the infill behind the wall is exposed and appears to be becoming washed out from the structure. Loss of fill material may leave the structure more vulnerable as water from overtopping waves will penetrate the rear of the seawall.



There was an area of sand and shingle foreshore between the seawall and the New South Pier (pictured, below left). The New South Pier (pictured, below right) appeared to be in good condition with minor mortar loss between masonry blocks and minor cracking to concrete elements. The pier provides important shelter to the harbour entrance and therefore should be regularly monitored and maintained.



The masonry wall with concrete crest of the pier continues to the south with the crest level falling to create a seawall (pictured, right). The seawall is fronted by rock armour. The 1998 inspection reported the wall to be undermined and in poor condition. Works have been carried out to repair/replace sections of the wall in the interim although it was not possible to inspect the toe due to the presence of the rock armour and the high water level. However, the visible section of the wall showed no evidence of any undermining of the toe. The rock armour appeared in good condition, with appropriate voids between armour units and no significant movement or loss of material.



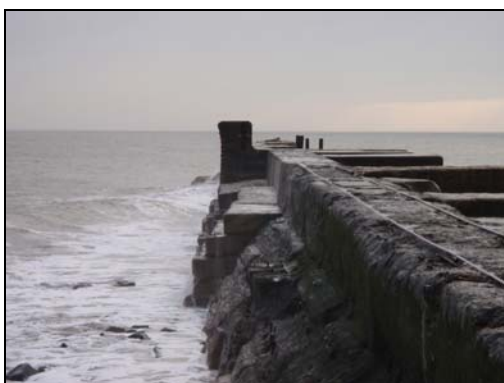
South of this length of seawall, the sea defence consists of a rock revetment (pictured, below left). The rock revetment was in fair condition, with some displacement of material and a slumping of the crest. Halfway along the revetment is a former concrete groyne which has now collapsed (pictured, below right). The remains of the structure will have a negligible effect on wave energy or sediment transport and may act to increase scour at the toe of the rock revetment. The structure will provide limited protection to the frontage.



South of the groyne, the rock revetment is interspersed with short lengths of masonry, concrete and sheet piles which appear to have been a part of the North East Pier. The rock volume could be topped up around these structures to improve the standard of defence.

South Outlet

The South Outlet is formed between the North East Pier and the South West Breakwater and the bay is defended on all sides by rubble revetments. The rear of the bay is defended by sheet piles with rubble backfill. The North East Pier (pictured, below) was in poor to very poor condition. The structure was deemed unsafe to access due to the poor condition and the high water level.



Significant erosion had taken place to the seaward face of the structure, with displacement of large concrete blocks and steel piles exposed and badly rusted. Although the toe was not visible due to the water level, the visible section of the wall was displaced in a manner which suggested undercutting of the toe of the pier was occurring.

The landward face of the structure was in marginally better condition, although loss of material and displacement of concrete blocks was evident. The roundhead of the pier had failed (pictured, left) and the seaward end of the structure was vulnerable to wave attack. There had been significant loss of material from the seaward end of the structure.

The South West Breakwater is generally in fair condition although there was an area of significant damage on the northern face around an area of displaced concrete blocks (pictured, right). There was evidence of undercutting and excavation of material below the blocks. The roundhead appeared to be in good condition although the concrete deck was almost completely absent. The southern face was in good condition although the upper section was badly eroded with exposed reinforcement.



The South West Breakwater requires extensive remedial work and the North East Pier requires major refurbishment or possible replacement, although the importance of maintaining the South Outlet may not be significant enough to justify the capital expenditure. The structures do, however, provide important coastal defence to the area of old dock land forming a barrier between the sea and the Hudson Dock.

A detailed survey of the structures should be conducted in order to establish the condition and performance of the structures which will aid the development of a strategy for the coastal defences around the South Outlet. The strategy would need to be integrated with the development plans of the port.

Two concrete seawalls with concrete aprons and sheet piles along the toe form the sea defences running down the outer South West Breakwater (pictured, right). The structure is in good condition with minor surface deterioration including rust-staining and small cracks. There is a large longitudinal crack running across the full width of a concrete slab on the lower apron. This should be infilled to prevent the loss of a section of the slab.



To the south of the outer South West Breakwater the sea defences consist of concrete seawalls with concrete walls set back from the crest which are generally in good condition.



The Hendon Foreshore Barrier (pictured, left) is in fair condition. The lower concrete wall is in poor condition with exposed timber and steel piles and voids opening up in the wall and the revetment below. The concrete wall to the rear of the original barrier is in very good condition. The original barrier is in need of major remedial work although the standard of defence could be significantly upgraded by the addition of rock armour similar to that in

front of the Hendon Tip seawall to the south.

A large precast concrete crest unit is missing from the Hendon Banks Barrier seawall (pictured, right), in front of the sewage works and should be replaced or the gap infilled to prevent loss of further units and damage to the material behind.



The breakwater marking the southern extent of the Port of Sunderland frontage has failed at the seaward end (pictured, below). A detailed survey of the breakwater is necessary to establish an appropriate course of action. It is likely that the seaward end of the structure is beyond repair so it may be necessary to remove the damaged section and make good the remaining structure.



Hendon, Grangetown & Ryhope

South of the port boundary the coastal defence consists of rock armour backed by a concrete seawall (pictured, below left). There is an access ramp to the foreshore at the southern extent of the defence which passes through the rock armour revetment (pictured, below right).



Towards the south there is a concrete crest wall which is in fair condition. Construction joints were missing sealant and scour damage around the drainage holes had exposed reinforcement (pictured, below).



South of the Hendon Sewall, the frontage is characterised by natural cliff exposures of Magnesian Limestone overlain with glacial till (picture, below left). The level of the boundary between the relatively harder limestones and the till varies quite considerably resulting in different depths and exposure conditions to the till. The frontage is punctuated by two principal headlands, at Salterfen and Pincushion, but also by more local hard points, as different strengths in the limestone are exposed. The cliff line between Hendon and Salterfen was eroding, with little vegetation. To the south, between Salterfen and Pincushion, there was a greater punctuation of the coast with narrow sections of harder material and outcrops such as Maiden's Flat and Jane Jiverson's Rock locally resisting erosion. The variation and scale of these local hard points was evidenced by the small arches and stacks; particularly around Pincushion (pictured, below right).



Evidence of recent minor slope failure towards the crest was visible along most of the frontage, most notably at Halliwell Banks (pictured, below left). Evidence of a more significant slope failure was present between the Pincushion and Ryhope Dene (pictured, below right).



There are two failed structures within the undefended length of frontage. A set of concrete steps providing access to the foreshore from Salterfen Lane, south east of Grangeown has been outflanked and cut off from the cliff behind (pictured, right). The steps have been displaced and now appear to be acting to exacerbate scour to the natural cliffs to either side. Signs at the top of the access inform members of the public that the structure is not to be used.



The second failed structure is at the landward end of an outfall to the east of Ryhope Beach Road (pictured, left). Concrete slabs have failed and washed away to expose rubble infill material. The masonry and concrete walls have been outflanked and infill material was being washed out from the structure. Cabinet approval has been obtained to remove the two failed structures in order to close the access at Salterfen and construct a new access at Ryhope Beach Road.

4. Comparison with Previous Assessment

The previous assessment available from NFCDD was carried out in March 1998. However, this data was frequently incomplete, lacking sufficient detail, spatially incorrect or missing entirely. Most asset inspections required the re-digitisation of assets within NFCDD to correct spatial positioning. As a result it was possible to make only very few direct comparisons.

The previous assessment suggested that a policy of 'No Repairs' was applicable for many assets. The current survey suggests that a routine monitoring and maintenance programme is more appropriate.

Differences in the condition grading between the 1998 and the 2008 data were found in several cases. The differences were due to repaired or replaced assets, or assets which had experienced degradation.

Significant improvements/upgrades to assets due to remedial works or replacement in the interim period are described below:

- The condition of the masonry seawall at Seaburn (NFCDD Ref No 121AB901B0603C02) was upgraded from Grade 3 (fair) to Grade 2 (good) following remedial works.
- The condition of the concrete seawall along Marine Walk, Roker (NFCDD Ref No 121AB901B0605C02) was upgraded from Grade 4 (poor) to Grade 1 (very good) due to concrete re-facing of the original wall.
- The condition of the masonry seawall with concrete crest to the north of the New South Pier in the Port of Sunderland (NFCDD Ref No 121AB901B0703C02) was upgraded from Grade 3 (fair) to Grade 2 (good) following remedial works.

Significant degradation of assets since the 1998 survey are described below:

- The condition of the concrete and rock armour revetment at the northern extent of the Port of Sunderland (NFCDD Ref No 121AB901B0703C03) was downgraded from Grade 1 (very good) to Grade 2 (good).
- The condition of the North East Pier along the Port of Sunderland frontage (NFCDD Ref No 121AB901B0802C04) was downgraded from Grade 3 (fair) to Grade 4 (poor).
- The South West Breakwater, to the south east of Hudson Dock (NFCDD Ref No 121AB901B0802C04) was downgraded from Grade 1 (very good) to Grade 2 (good).

5. Problems Encountered and Uncertainty in Analysis

All assets were inspected at suitable stages of the tide. Local tides tables provided key information for the appropriate planning of each day's inspections.

Access to the North Pier at Roker was prohibited with signs informing that the structure was unsafe. The structure could only be inspected from the landward end.

The Port of Sunderland frontage is not accessible to members of the public and access to the frontage was arranged with the cooperation of the port authorities. The seaward end of the New South Pier was not inspected due to rough sea conditions on the day of inspection. The North East Pier within the Port of Sunderland boundary was inaccessible due to the poor condition of the structure and rough sea conditions.

These issues are not considered to have affected the quality of the assessment.

6. Conclusions and Recommended Actions

It is highly recommended that continued monitoring is undertaken for all assets, with specific recommendations for individual assets given in the table below:

NFCDD Asset Reference	Defence Reference	MAFF CPSE Reference	Location	Priority*	Date	Recommended Action
121AB901B0603C01		220/6901/01	Whitburn Sands	Low	Dec 2008	Remove vegetation & infill cracks.
121AB901B0603C02		220/6902/01	Whitburn Sands	Low	Dec 2008	Replace missing mortar at masonry/concrete joint.
121AB901B0603C03		220/6903/02	Whitburn Sands	Low	Dec 2008	Repoint. Replace missing mortar at masonry/concrete joint.
121AB901B0604C02		220/6905/03	Parson's Rocks	Low	Dec 2008	Repoint masonry wall.
121AB901B0605C01		220/6906/01	Roker	Low	Dec 2008	Infill cracks/replace cracked masonry blocks. Repoint masonry wall.
121AB901B0605C02		220/6907/01	Roker	Low	Dec 2008	Infill cracks in upper concrete wall.
121AB901B0702C05		220/6908/01	Roker	Low	Dec 2008	Minor repointing to masonry wall.
121AB901B0702C04		220/6909/01	Roker Pier	Medium	Dec 2008	Minor repointing. Repairs to surface.
121AB901B0702C01		220/6910/02	Roker	Low	Dec 2008	Infill cracks in concrete wall.
121AB901B0703C02		220/6913/01	Port of Sunderland	Low	Dec 2008	Infill cracks in concrete. Patch repairs to spalling of surface. Make good tie in with revetment to north.
121AB901B0801C01		220/6917/01	Port of Sunderland	Low	Dec 2008	No action – concrete groyne has collapsed.
121AB901B0801C06		220/6917/02	Port of Sunderland	Medium	Dec 2008	Increase volume of armour or redistribute around exposed walls/piles.
121AB901B0801C05		220/6929/03	Port of Sunderland	Medium	Dec 2008	Provide rock armour to undefended frontage.
121AB901B0801C07		220/6927/02	Port of Sunderland	High	Dec 2008	Large scale remedial work to/replacement of derelict breakwater.
121AB901B0801C04		220/6918/02	North East Pier	High	Dec 2008	Full survey of structure. Large scale remedial works or replacement.
121AB901B0802C05		220/6929/03	South West Breakwater	Medium	Dec 2008	Full survey of structure. Local repair works to north face and upper level of south face.
121AB901B0802C04		220/6919/03	Spur Barrier	Low	Dec 2008	Replace sealant in construction joints and infill cracks in concrete.
121AB901B0802C03		220/6920/04	Port of Sunderland	High	Dec 2008	Patch repairs to concrete seawall. Add rock armour revetment or similar to protect concrete seawall at Hendon Foreshore Barrier.
121AB901B0802C02		220/6921/02	Port of Sunderland	Low	Dec 2008	Infill cracks and patch repairs to concrete surface damage around drainage holes and construction joints.
121AB901B0802C01		220/6922/03	Hendon	Medium	Dec 2008	Replace missing concrete crest wall section.
121AB901B0803C02		220/6923/08	Hendon	Medium	Nov 2008	Full survey of structure. Remedial work to remove failed seaward end of breakwater and make good exposed structure. Replace sealant in construction joints.

* The priority level encompasses the asset condition, residual life and weighting of the asset in addition to the nature, scale and cost of remedial work required. A guide to each of the priority levels is provided below:

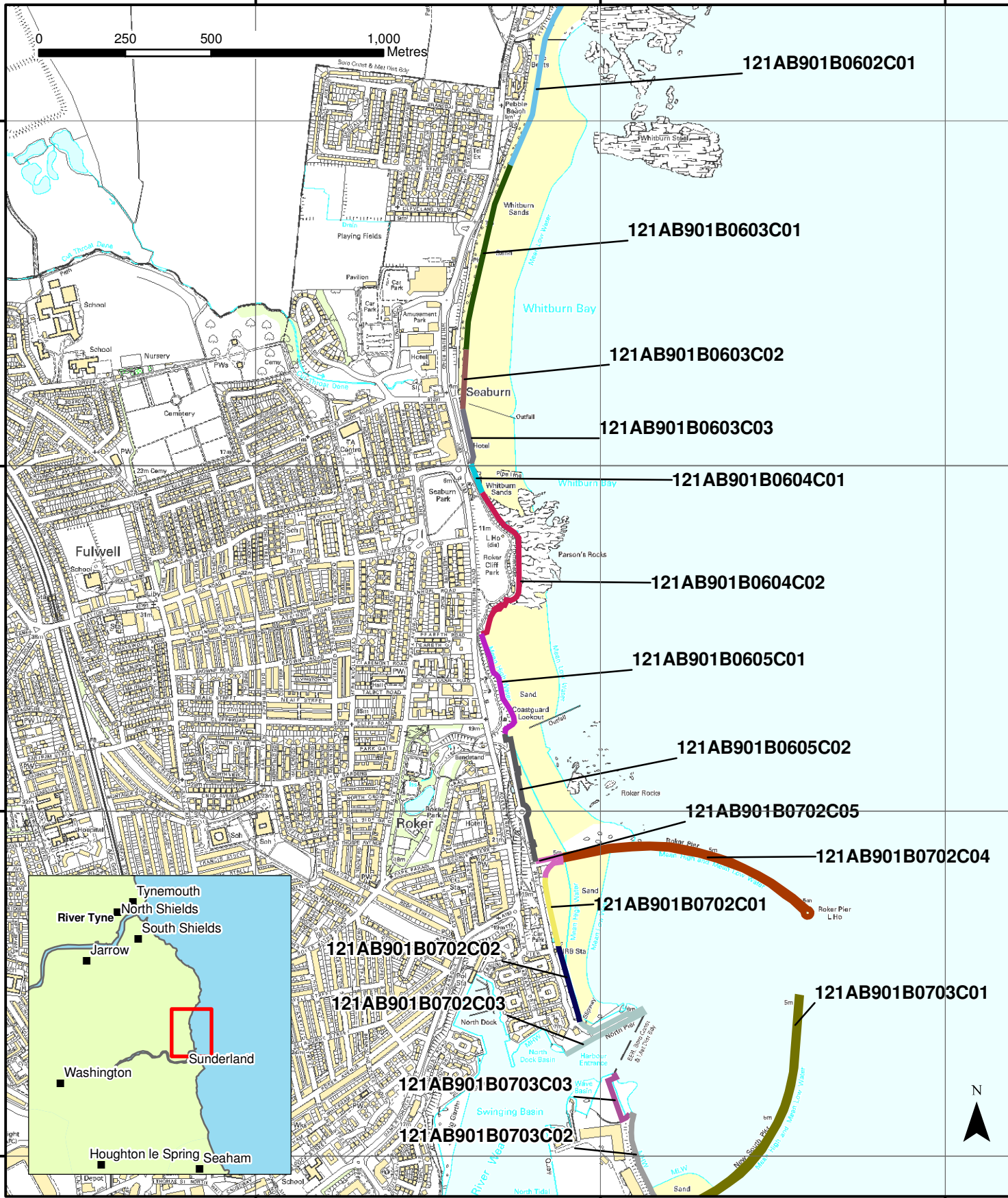
Priority	Description
Low	Routine maintenance or local repairs
Medium	More significant survey and/or maintenance work
High	Urgent investigation and/or repair works. Potential replacement of asset elements or asset as a whole

440000

441000

442000

0 250 500 1,000 Metres



Legend

-  Asset location
-  NFCDD Asset Number



Client: North East Coastal Authorities Group

Project: Coastal slope and asset condition inspection, summer 2008

Map 1 - Sunderland City Council Frontage

Asset Condition 2008

Drawing Scale 1:15,000 at A4



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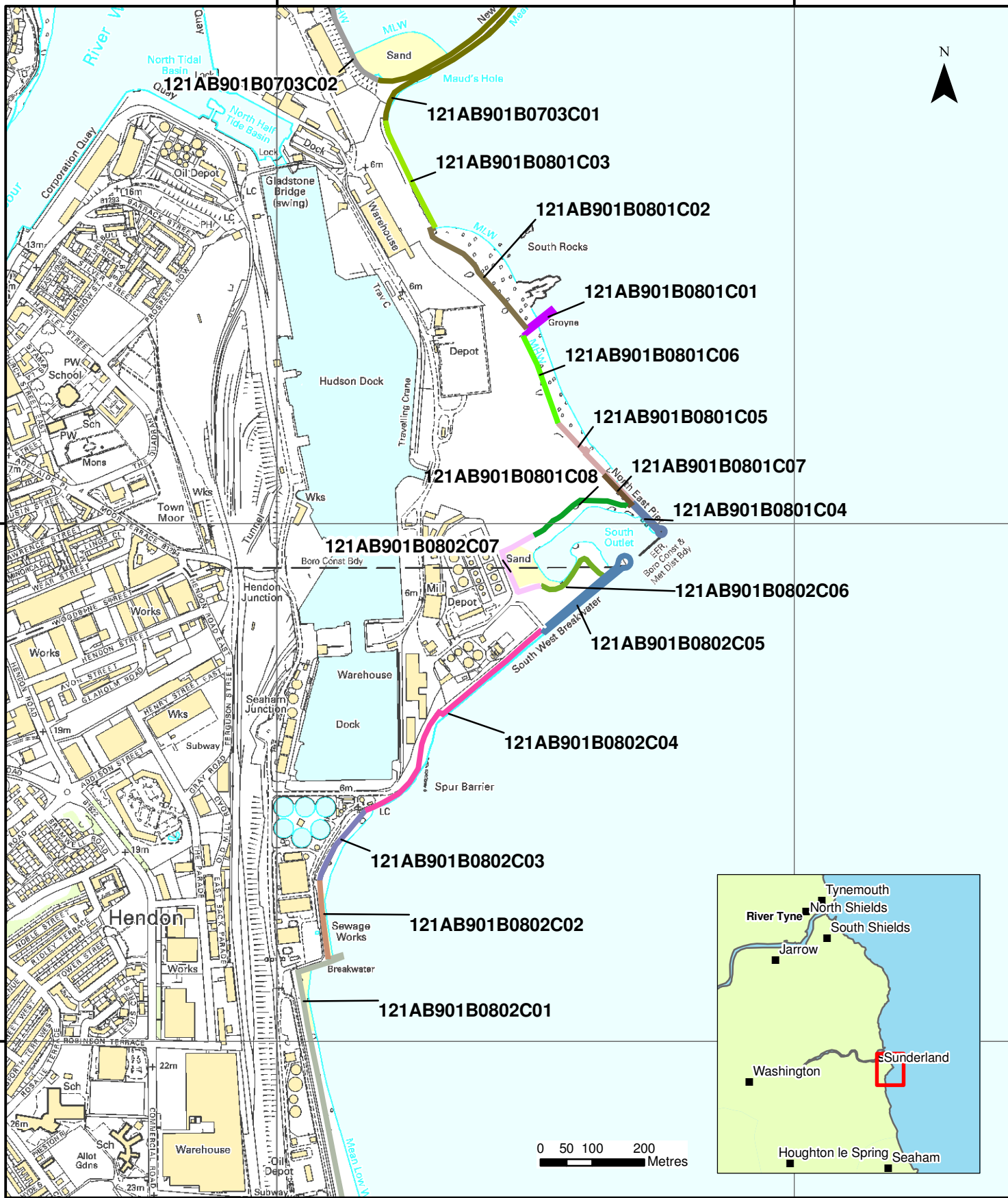


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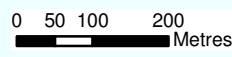
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Legend

-  Asset location
-  NFCDD Asset Number



Client: North East Coastal Authorities Group

Project: Coastal slope and asset condition inspection, summer 2008

Map 2 - Sunderland City Council Frontage

Asset Condition 2008

Drawing Scale 1:10,000 at A4



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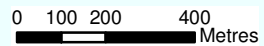
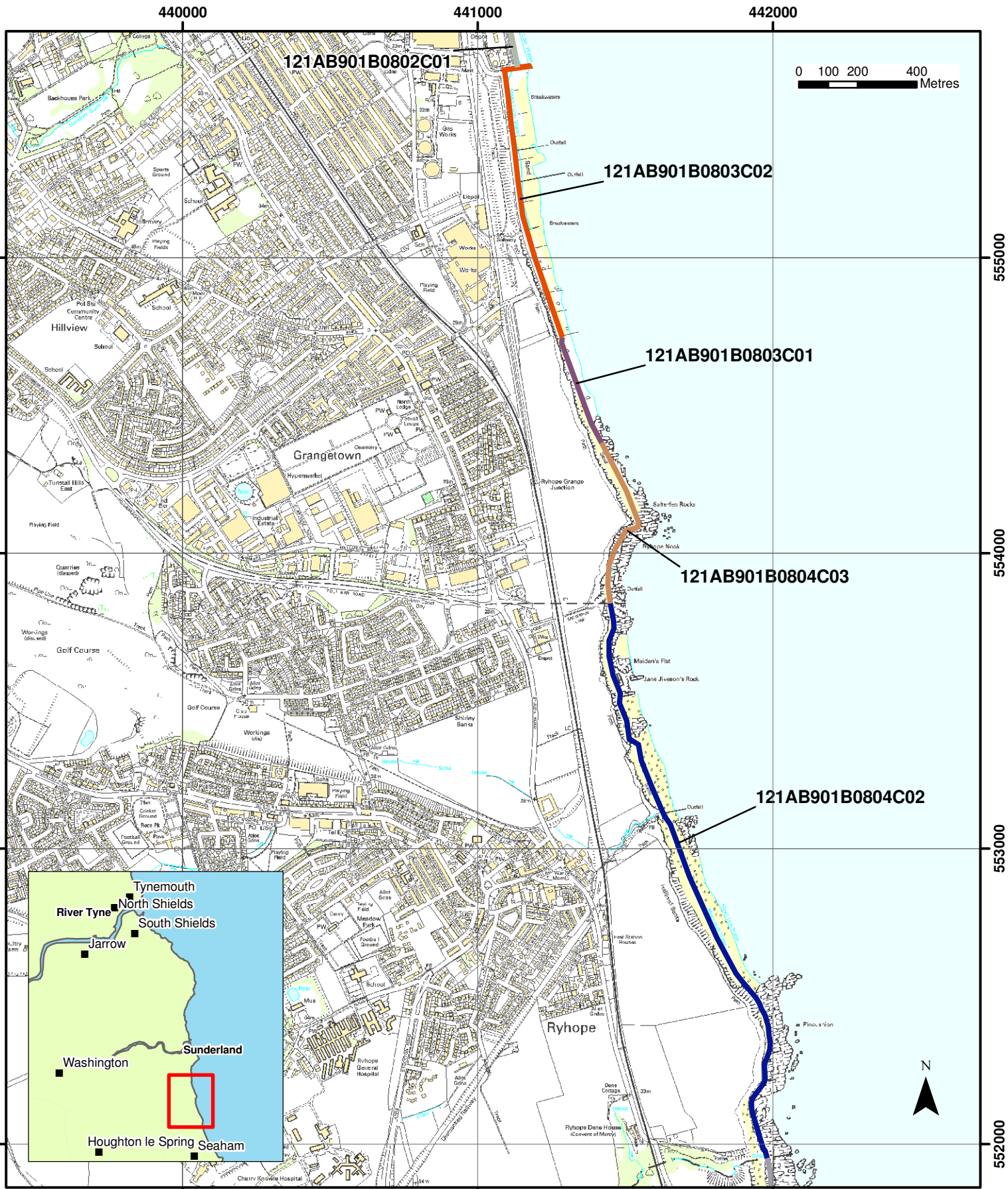




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Legend
 Asset location
 NCFDD Asset Number

Client: North East Coastal Authorities Group
 Project: Coastal slope and asset condition inspection, summer 2008
Map 3 - Sunderland City Council Frontage
 Asset Condition 2008
 Drawing Scale 1:17,000 at A4

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