masonclarkassociates
civil and structural engineering consultants

INSPECTION REPORT
River Ouse Riverbank

CITY OF YORK COUNCIL

Report 22594-H-RP-001-R0
20 November 2024

INSPECTION REPORT
River Ouse Riverbank

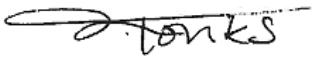
CONTENTS

REPORT AUTHOR AND PROFESSIONAL QUALIFICATIONS:

Signature ……

Andy Thompson *BEng (Hons), CEng, MICE*

Director - Bridges



Signature ……

Samuel Tonks *MEng (Hons), GMICE*

Graduate Structural Engineer

ISSUE LOG FOR REPORT 22594-H-RP-001

Rev	*Date*	*Description*	*Author*	*Checked*
R0	20/11/2024	**FIRST ISSUE**	*ST*	*AT*

Issuing office Mason Clark Associates (Hull).

1.0 EXECUTIVE SUMMARY

1.1 Mason Clark Associates were commissioned by the City of York Council to undertake an inspection of the River Ouse riverbank and produce a report to comment on its current condition.

1.2 The primary aim of the report is to comment on the impact of its current condition on the existing site and its future interaction with the proposed riverside path located above it, and then recommend remedial actions to reduce its impact.

1.3 Inspection of circa 270m of riverbank located to the west of Scarborougth Railway Bridge was carried out on the 14th of October 2024. The inspection was conducted from the bank and within the water, on foot.

1.4 The structure inspected consists of a pitched stone embankment, concrete slab, concrete retaining wall, reinforced concrete beam and piles. It provides flood protection and pedestrian access along the river.

1.5 Condition of each element along the 270m length is recorded within this report. The inspection generally found that the slab, beam, and piles have widespread moderate defects. One case of total element failure has been identified.

1.6 Previous condition assessments, carried out by WSP, have been summarized and included. The defects noted in previous assessments are compared to recent findings to indicate the deterioration over time. Findings show that the condition has got worse, with previous defects becoming more severe and extensive.

1.7 The current condition and its deterioration since previous reports suggests the riverbank condition will become worse over time until, with more elements failing in the medium term, and potentially multiple cases of collapse in the long term.

1.8 The condition has a negative impact on the site for its current use. The present defects pose a risk to pedestrians.

1.9 The condition will also have a negative impact on the proposed riverbank pathway. The current construction is coming to the end of its design life and will likely fail. Failure will expose the proposed pathway to the effects of the river.

1.10 Two remedial options are explored. Firstly, general repairs to make the embankment safe for its current use. Secondly, replace critical elements to extend its design life and reduce impact on the proposed pathway.

2.0 LOCATION PLAN AND GENERAL ARRANGEMENT

Figure 1: Google Maps Satellite View

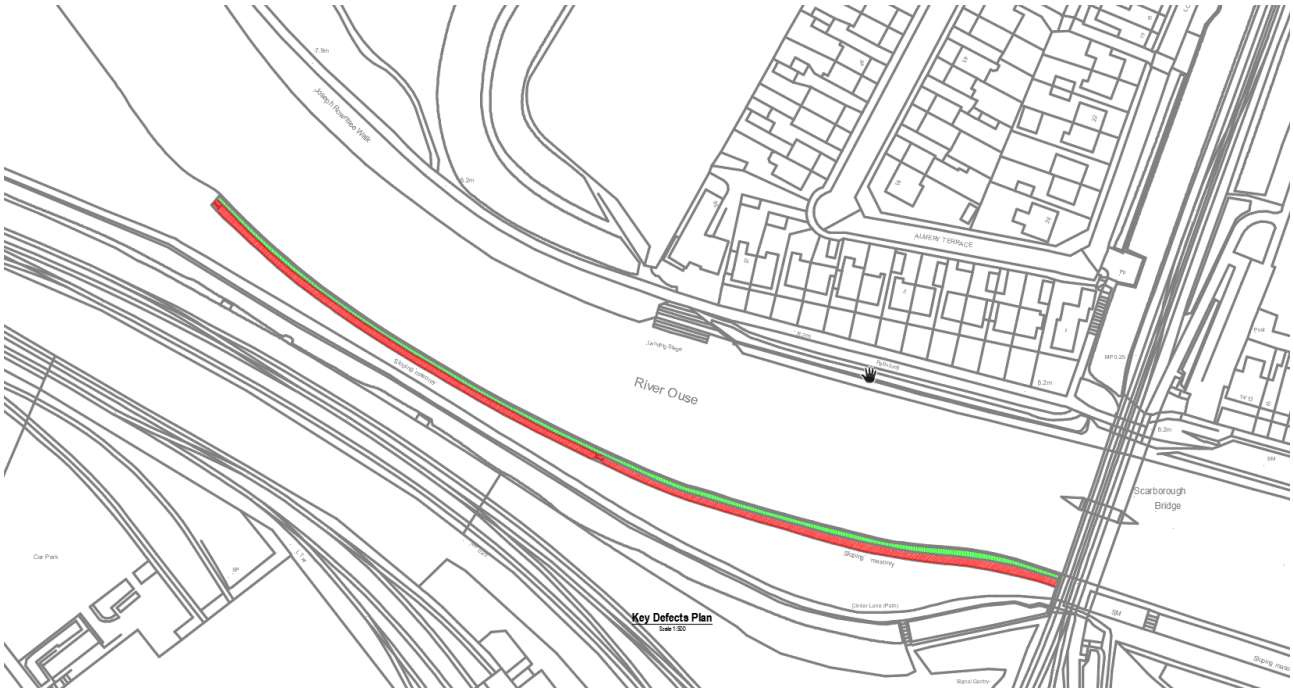


Figure 2: Plan of Riverbank

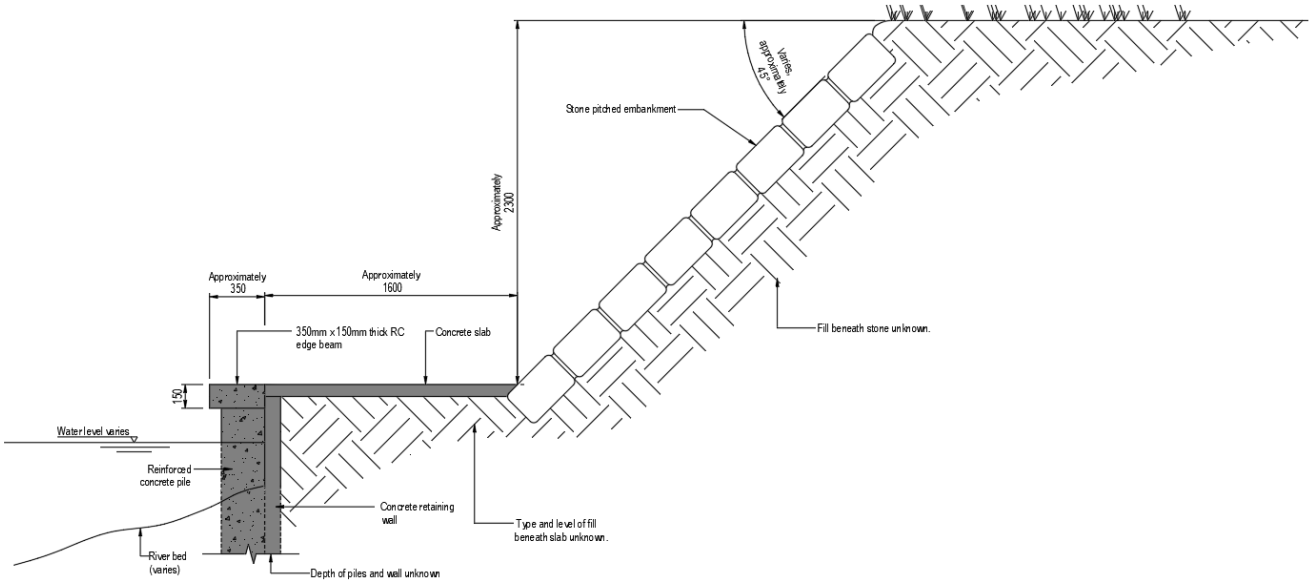


Figure 3: Section Through Embankment Construction Type 1

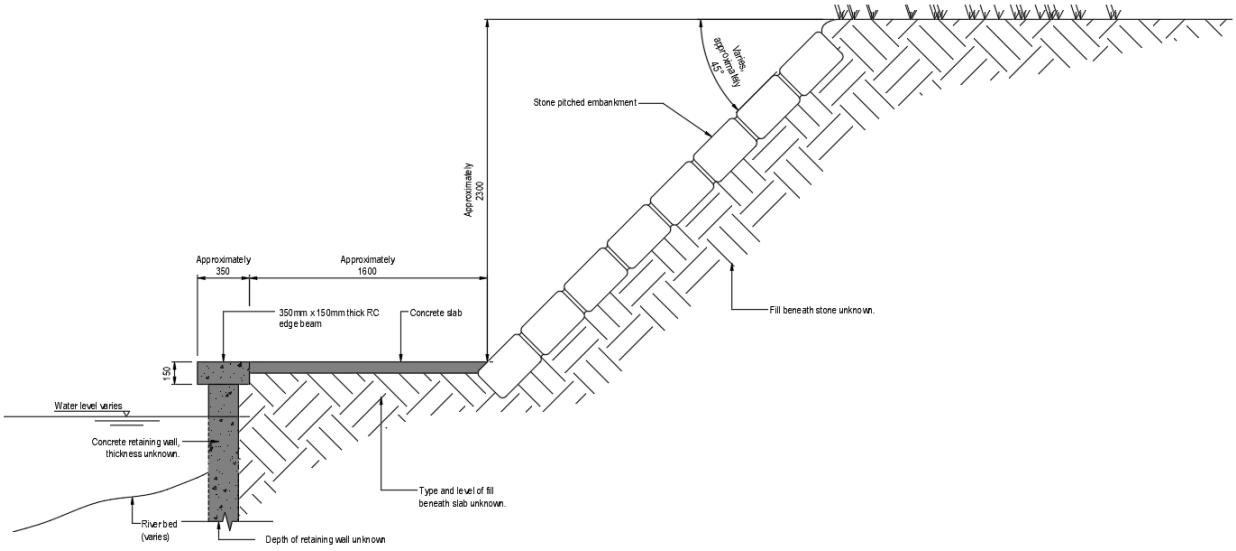


Figure 4: Section Through Embankment Construction Type 2

3.0 DESCRIPTION OF STRUCTURE

Table 1: Structure Details

Field	Description
Construction	Stone, concrete and reinforced concrete
Grid Reference	SE 595520
Obstacle Crossed	River Ouse
Highway Carried	Pedestrian Footway
Highway Alignment - Horizontal	West-East following River Ouse
Highway Alignment – Vertical	Generally Flat
Approximate Date of Construction	Unknown

3.1 General

3.1.1 The construction from the landside on Cinder Lane to the River Ouse starts with a pitched stone embankment. The top of the embankment runs down on a 45-degree slope to a lower footpath.

3.1.2 The lower footpath is constructed in a mixture of concrete and reinforced concrete vertical and horizontal members.

3.2 Stone Embankment

3.2.1 The pitched stone embankment provides slope stability to the riverbank and access to the lower footpath. It acts as a barrier to floods and protects the pathway above.

3.3 Lower Footpath

3.3.1 A mass concrete ground bearing slab and reinforced concrete capping beam act as the deck of the lower footpath.

3.3.2 The concrete slab is approximately 1600mm wide x 75mm thick and bears onto an unidentified earth fill, according to the report by WSP dated February 2021.

3.3.3 The reinforced concrete capping beams are approximately 350mm wide x 150mm deep, according to the report by WSP dated February 2021. They are continuous over their supports.

Table 2: List of deck ancillaries

Surfacing and finishes	There is no surfacing to the top of the concrete slab.
Expansion joints	No expansion joints.
Bearings	Capping beams bear directly onto piles and slab is ground bearing.
Waterproofing	None
Parapets/Safety fencing	No parapets or safety fencing is provided.

3.4 Retaining Wall

3.4.1 The ground underneath the concrete slab is retained by a concrete wall. The concrete wall has an unknown depth into the riverbank. It also provides protection from the river to the earth underneath the slab.

3.5 Foundation

3.5.1 Reinforced concrete piles transfer vertical loads from the capping beam and horizontal loads from the retaining wall into the ground. The piles extend down into the riverbank to an unknown depth.

3.5.2 Some of the reinforced concrete piles also have a steel anchor tie.

3.6 Drainage system and services

3.6.1 No drainage system is provided to the embankment.

3.6.2 At the Scarborough Railway Bridge side there are two outlets that run underneath the pitched embankment and through the retaining walls. Openings to the footpath slab are provided for access. One opening is full exposed, whilst the other has a timber covering to allow pedestrian access.

4.0 SUMMARY OF PREVIOUS INSPECTIONS

4.1 Condition Inspection (dated 2nd October 2020).

4.1.1 Site inspection undertaken by WSP on behalf of the City of York Council. Inspected on foot only. The inspection focused on the stone embankment, concrete path, and capping beam.

4.1.2 Stone embankment in fairly good condition. Only some minor defects observed, including displaced blocks and loss of mortar due to tree roots.

4.1.3 Concrete path in variable condition, some areas intact. Gaps between the capping beam and concrete slab. Gaps in the concrete slab between the capping beam and stone embankment. Concrete slab broken up with multiple cracks.

4.1.4 Concrete capping beam in variable condition, some areas intact. Sections of capping beam not level and rotated towards the river. Areas of cracked and spalled concrete, with sections of exposed steel reinforcement. Sections of major deterioration where the capping beam is heavily spalled and no longer supported.

4.1.5 Concrete piles inspected in one location. Concrete spalling and exposed rebar at the top of the pile.

4.2 Condition Inspection (dated 2nd December 2020).

4.2.1 Site inspection undertaken by WSP on behalf of the City of York Council. Inspected on foot only. The inspection focused on the concrete retaining wall and piles. Only the visible and above water section of wall and piles is inspected.

4.2.2 Concrete retaining wall generally in good condition except for some hairline cracks.

4.2.3 Reinforced concrete piles are generally in good condition. Multiple piles are out of plumb, generally leaning towards the river. The concrete on some pile has cracked or spalled at the top. Steel reinforcement is exposed in some cases at the top of the pile, with minor corrosion.

4.3 Conclusion of Previous Report (dated February 2021).

4.3.1 Condition assessment report produced by WSP on behalf of the City of York Council. The report summarises the findings of the two condition inspections as described in section 4.1 and 4.2. There are also two remedial options and recommendations provided in the report.

4.3.2 The assessment report suggests two remedial options:

Option A: Repair the most damaged elements of the existing structure, to return the riverbank to a 'good' condition. Repairs mostly focused on the capping beam and concrete slab. A high-level cost analysis estimates this to cost £400,000 to £600,000.

Option B: Rebuild the concrete pile and retaining wall with steel sheet pile wall in front of the existing structure. Extending the life expectancy of the structure to 100+ years. A high-level cost analysis estimates this to cost up to £1,000,000

4.3.2 The following recommendations are considered in the report:

4.3.2.1 Consider actions to address defects, specifically those that pose a risk to pedestrians.

4.3.2.2 Consider a structural assessment of the full structure.

4.3.2.3 Consider installing monitoring instruments to measure movement of the structure.

4.3.2.4 Review the existing inspection regime, factor the findings of the condition assessment.

4.3.2.5 Consider closing the concrete path until the hazards to pedestrians have been addressed.

4.3.2.6 Carry out a more comprehensive cost estimate for the remedial options.

5.0 RESULTS OF PRINCIPAL INSPECTION

Inspectors	Andy Thompson and Sam Tonks from Mason Clark Associates
Date	14th October 2024
Weather	Overcast and dry throughout, temperature varying from 3 to 10 degrees Celsius
Access	On foot along pathway and on foot in the water (chainage 0m to 250m)
Areas Inspected	Approximately 270m, working downstream, to the Scarborough Rail Bridge.

5.1 Notation

5.1.1 The following gives brief details of the condition of the structure together with any significant defects noted during the inspection. The following descriptions are used:

Extent of Defect	A	No significant defect
	B	Slight, not more than 5% of surface area/length/number
	C	Moderate, 5% to 20% of surface area/length/number
	D	Wide, 20% to 50% of surface area/length/number
	E	Extensive, more than 50% of surface area/length/number
Severity of Defect	1	As new condition or defect has no significant effect on the element
	2	Early signs of deterioration, minor defect/damage, no reduction in functionality of element
	3	Moderate defect/damage, some loss of functionality could be expected
	4	Severe defect/damage, significant loss of functionality and/or element is close to failure/collapse
	5	Element is non-functional/failed
Priority	L	Low, repairs not required for a long duration before the defect is expected to get worse and negatively impact functionality.
	M	Medium, repairs should be considered soon, defect is likely to worsen and negatively impact functionality.
	H	High, repairs should be made as soon as possible as functionality is lost and collapse has or is about to occur.

5.2 Observations

5.2.1 Chainage 0-9

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	From 0m-5.2m is overgrown with a large build-up of earth at the base of the stone embankment. The pitched stone embankment is in good condition with no observable defects.	New	Stone Embankment	1A	Remove earth (<10m^3) and overgrown vegetation.	L
2.	From 0m-5.2m is overgrown with a large build-up of earth on top of the concrete slab, concealing the condition for this section. The concrete slab footpath is in good condition with no observable defects.	New	Concrete Slab	1A	As in item 1	L
3.	Mostly the beam is in good condition. In one location the beam is not fully supported by the piles and spalling to the underside of the beam.	Pre-existing, condition the same.	Capping Beam	3B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	One pile not supporting the capping beam. With some exposed reinforcement at the gap between the capping beam and top of the pile.	Pre-existing, condition the same.	Reinforced Concrete Pile	3C	Reinstate concrete (<0.1m ^{3}) at top of the pile.	M

5.2.2 Chainage 10-19

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Transverse cracks from the capping beam to the pitched stone. Cracking along the joint between the slab and capping beam.	Pre-existing condition the same.	Concrete Slab	2C	Break out and reinstate concrete (<1m ^{3}).	L
3.	Step at the joint between two capping beams. Also, a 300mm x 200mm x 25 mm deep volume of concrete spalled off the underside of the beam. Exposed steel reinforcement. The aggregate is visible at the surface, indicating poorly graded concrete mix.	New	Capping Beam	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Cracking to the rear of the pile, between the pile and the retaining wall.	New	Reinforced Concrete Pile	2B	Reinstate concrete at the back of the pile (<0.1m ^{3}).	M

5.2.3 Chainage 20-29

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Signs of possible infill to the slab. Very noticeable slope on the path. Gap in the path.	Pre-existing condition the same.	Concrete Slab	3C	Break out and reinstate concrete (<2m ^{3}), to regain level.	L
3.	Spalling and exposed steel reinforcement on the front of the beam.	Pre-existing condition the same.	Capping Beam	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling at the top of the pile. Locations with loose concrete and exposed steel reinforcement.	Pre-existing condition the same.	Reinforced Concrete Pile	3D	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.4 Chainage 30-39

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Exposed aggregate on the path. Crack at joint between slab and capping beam.	Pre-existing condition the same.	Concrete Slab	2C	Break out and reinstate concrete (<2m ^{3}).	L
3.	Crack through the beam with reinforcement exposed and deformed on the top and bottom of the beam. Hollow sound when tapping the surface of the beam.	Pre-existing condition slightly worse.	Capping Beam	4C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.2m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Exposed steel reinforcement at the top of the pile.	New	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.5 Chainage 40-49

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking in the concrete between the slab and capping beam. Water pooling on top of the path.	Pre-existing condition slightly worse.	Concrete Slab	3D	Break out and reinstate concrete (<2m ^{3}).	M
3.	Exposed steel reinforcement and concrete spalling on the underside of the beam near the pile.	New	Capping Beam	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Cracking on the top of the face of the pile.	New	Reinforced Concrete Pile	3C	Break out and reinstate concrete (<0.1m ^{3}).	M

5.2.6 Chainage 50-59

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Appears to be three separate constructions making up the path from 51.7m-54.4m. All in concrete. Void to the rear of the path at the base of the pitched stone.	New	Concrete Slab	2D	Break out and reinstate concrete (<2m ^{3}).	M
3.	No noticeable defects.	N/A	Capping Beam	1A	N/A	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Concrete cover on the pile is missing and steel reinforcement is exposed.	Pre-existing, condition is worse.	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.7 Chainage 60-69

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Crack down the middle of the slab in the direction of the path. Large cracks in the slab with loose concrete. Void to the rear of the path at the base of the pitched stone.	New	Concrete Slab	3D	Break out and reinstate concrete (<2m ^{3}).	M
3.	Spalling to the underside of the beam with exposed steel reinforcement.	New	Capping Beam	3B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling concrete on the top of the pile exposing the steel reinforcement. A gap between the pile and retaining wall. Crack in the slab exposing the steel reinforcement in the top of the pile.	Pre-existing, condition is worse.	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.8 Chainage 70-79

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Void to the rear of the path at the base of the pitched stone. Cracking down the middle of the path and large gaps between slab and capping beam.	Pre-existing, condition is worse.	Concrete Slab	3D	Break out and reinstate concrete (<2m ^{3}).	M
3.	Beam moving away from the slab, creating a large crack between the two. The beam is clearly tilting, about its minor axis, towards the river. Exposed steel reinforcement on the underside of the beam.	Pre-existing, condition is worse.	Capping Beam	4E	Demolish beam, recast identical beam. Concrete (<0.5m ^{3}) Steel (<80kg)	H
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling to the top of the pile causing large losses in section and exposing steel reinforcement bars.	Pre-existing, condition is the same.	Reinforced Concrete Pile	4D	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	H

5.2.9 Chainage 80-89

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking in the slab to the rear near the base of the pitched stone.	Pre-existing, condition is worse.	Concrete Slab	3C	Break out and reinstate concrete (<1m ^{3}).	M
3.	Spalling and exposed steel reinforcement to the underside of the beam at the pile support.	New	Capping Beam	3B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling to the top of the pile causing large losses in section and exposing steel reinforcement bars.	Pre-existing, condition is the same.	Reinforced Concrete Pile	4D	Replace steel reinforcement (<5kg) and reinstate concrete (<0.2m ^{3}).	H

5.2.10 Chainage 90-99

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking at the surface of the slab.	Pre-existing, condition is worse.	Concrete Slab	3C	Break out and reinstate concrete (<1m ^{3}).	M
3.	Significant section loss to the top of the beam. With exposed, rusted and deformed steel reinforcement.	Pre-existing, condition is worse.	Capping Beam	4C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.2m ^{3}).	H
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Concrete on top of pile failed, cover missing, exposing steel reinforcement, including shear links.	Pre-existing, condition is the same.	Reinforced Concrete Pile	4C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	H

5.2.11 Chainage 100-109

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	Loose stones with missing mortar.	New	Stone Embankment	3B	Relay and repoint stones. (<0.25m^2 area)	M
2.	Cracking along the rear of the path, at the base of the pitch stone.	New	Concrete Slab	3C	Break out and reinstate concrete (<1m ^{3}).	M
3.	Condition ok.	N/A	Capping Beam	1A	N/A	-
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling to the top of the pile with exposed steel reinforcement.	Pre-existing, condition is the same.	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.12 Chainage 110-119

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking on the slab along the joint with the capping beam.	Pre-existing, condition is worse.	Concrete Slab	3B	Break out and reinstate concrete (<1m ^{3}).	M
3.	Condition ok.	N/A	Capping Beam	1A	N/A	-
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Condition ok.	N/A	Reinforced Concrete Pile	1A	N/A	-

5.2.13 Chainage 120-129

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking in the slab.	Pre-existing, condition is same.	Concrete Slab	3B	Break out and reinstate concrete (<1m ^{3}).	M
3.	Beam condition ok.	N/A	Capping Beam	1A	N/A	-
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling at the top of the pile, loss of cover, exposing steel reinforcement bars and shear links.	Pre-existing, condition is worse.	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.14 Chainage 130-139

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects. Concrete pavers at the top of the steps are displaced.	N/A	Stone Embankment	3B	Relay the top pavers	-
2.	Cracking and steps in the slab.	Pre-existing, condition is the same.	Concrete Slab	3C	Break out and reinstate concrete (<1m ^{3}).	M
3.	Step in the capping beam, between two beams. Large area of concrete cover broken off, exposing steel reinforcement.	Pre-existing, condition is the same.	Capping Beam	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling and exposed steel reinforcement at the top of the pile.	Pre-existing, condition is the same.	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.15 Chainage 140-149

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking in the slab with large areas of loose concrete.	Pre-existing, condition is worse.	Concrete Slab	3D	Break out and reinstate concrete (<1m ^{3}).	M
3.	Drop in the level of the beam. Beam clearly tilted, about its minor axis, towards the river.	Pre-existing, condition is the same.	Capping Beam	3D	Demolish beam, recast identical beam. Concrete (<0.5m ^{3}) Steel (<80kg)	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling and exposed steel reinforcement to the top of the pile.	Pre-existing, condition is worse.	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.16 Chainage 150-159

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Large cracks in slab. Gap forming at the base of the pitched stone embankment and at the joint to the capping beam.	Pre-existing, condition is the same.	Concrete Slab	3D	Break out and reinstate concrete (<2m ^{3}).	M
3.	Condition ok.	N/A	Capping Beam	1A	N/A	-
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling and exposed steel reinforcement to the top of the pile.	Pre-existing, condition is the same.	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.17 Chainage 160-169

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking along the joint to the capping beam.	Pre-existing, condition is the same.	Concrete Slab	2B	Break out and reinstate concrete (<1m ^{3}).	L
3.	Collapse of beam at pile support, only held together by deformed and exposed steel reinforcement at 164.2m. Beam now freely supported at one end, forming a cantilever.	Pre-existing, condition is worse.	Capping Beam	5E	Demolish beam, recast identical beam. Concrete (<0.5m ^{3}) Steel (<80kg)	H
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Exposed steel reinforcement and spalling at point of capping beam collapse.	Pre-existing, condition is worse.	Reinforced Concrete Pile	3B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.18 Chainage 170-179

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	Loose stones with missing mortar.	N/A	Stone Embankment	3C	Relay and repoint stones. (<2m^2)	M
2.	Crack along the front of the slab where it meets the capping beam.	Pre-existing, condition is the same	Concrete Slab	2B	Break out and reinstate concrete (<1m ^{3}).	L
3.	Crack completely through the section of the beam, exposing steel reinforcement at 176.2m. Free unsupported end of the beam formed.	Pre-existing, condition is worse.	Capping Beam	5E	Demolish beam, recast identical beam. Concrete (<0.5m ^{3}) Steel (<80kg)	H
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Condition of pile ok.	N/A	Reinforced Concrete Pile	1A	N/A	-

5.2.19 Chainage 180-189

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Slab condition ok.	N/A	Concrete Slab		N/A	-
3.	Cracking at the top of the beam with missing concrete and exposed steel reinforcement.	Pre-existing, condition is the same.	Capping Beam	4B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Piles in ok condition.	N/A	Reinforced Concrete Pile	1A	N/A	-

5.2.20 Chainage 190-199

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking in the slab.	Pre-existing, condition is the same.	Concrete Slab	3C	Break out and reinstate concrete (<1m ^{3}).	M
3.	Area of concrete missing from beam with exposed steel reinforcement.	Pre-existing, condition is the same.	Capping Beam	3B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling and exposed steel reinforcement to the top of the pile.	Pre-existing, condition is worse.	Reinforced Concrete Pile	3C	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.21 Chainage 200-209

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Condition of slab ok.	N/A	Concrete Slab	1A	N/A	-
3.	Condition of the beam is ok.	N/A	Capping Beam	1A	N/A	-
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	Spalling and exposed steel reinforcement to the top of the pile. Large gap between the last pile and capping beam. After 205.1m the construction changes and the piles are no longer visible.	Pre-existing, condition is worse.	Reinforced Concrete Pile	3D	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M

5.2.22 Chainage 210-219

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking along the rear of the slab at the base of the pitched stone.	Pre-existing, condition is the same.	Concrete Slab	3B	Break out and reinstate concrete (<1m ^{3}).	M
3.	Cracking in the capping beam.	Pre-existing, condition is same.	Capping Beam	3B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-

5.2.23 Chainage 220-229

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-
2.	Cracking along the rear of the slab at the base of the pitched stone.	Pre-existing, condition is the same.	Concrete Slab	3B	Break out and reinstate concrete (<1m ^{3}).	M
3.	Crack and step down in the beam.	Pre-existing, condition is same.	Capping Beam	3B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-
5.	The pitched stone embankment is in good condition with no observable defects.	N/A	Stone Embankment	1A	N/A	-

5.2.24 Chainage 230-239

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	Loose stones with missing mortar.	N/A	Stone Embankment	3B	Relay and repoint stones.	M
2.	Cracks in the slab.	Pre-existing, condition is the same.	Concrete Slab	3C	Break out and reinstate concrete (<1m ^{3}).	M
3.	Crack in the beam.	Pre-existing, condition is same.	Capping Beam	3B	Replace steel reinforcement (<5kg) and reinstate concrete (<0.1m ^{3}).	M
4.	Crack running down the retaining wall, in line with the crack in the beam.	New	Retaining Wall	3C	Replace any eroded steel reinforcement (<10kg) and reinstate concrete (<0.5m ^{3}).	M

5.2.25 Chainage 240-249

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	Loose stones with missing mortar.	Pre-existing, condition is the same.	Stone Embankment	3E	Relay and repoint stones.	M
2.	Step in the slab with cracking. Rotting timber service cover. Open chamber in slab with missing steel floor plate.	Pre-existing, condition is worse.	Concrete Slab	3D	Break out and reinstate concrete (<1m ^{3}). Replace the service covers.	M
3.	Beam condition is ok only minor spalling on top.	Pre-existing, condition is same.	Capping Beam	2B	Reinstate concrete (<0.1m ^{3}).	L
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-

5.2.26 Chainage 250-259

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	Loose stones with missing mortar. Service valve protruding from slope.	Pre-existing, condition is the same.	Stone Embankment	3E	Relay and repoint stones.	M
2.	Cracking in the slab around a manhole.	Pre-existing, condition is the same.	Concrete Slab	3D	Break out and reinstate concrete (<1m ^{3}).	M
3.	Condition of beam ok.	N/A	Capping Beam	1A	N/A	-
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-

5.2.27 Chainage 260-265.5

	Description	New / Pre-Existing Defect	Item	Severity/Extent	Recommendation	Priority
1.	Loose stones with missing mortar.	Pre-existing, condition is the same.	Stone Embankment	3E	Relay and repoint stones.	M
2.	Minor cracking on the slab surface.	Pre-existing, condition is the same.	Concrete Slab	2B	Break out and reinstate concrete (<1m ^{3}).	L
3.	Condition of beam ok.	N/A	Capping Beam	1A	N/A	-
4.	The retaining wall is in good condition above the water level.	N/A	Retaining Wall	1A	N/A	-

6.0 DISCUSSION

6.1 Summary of Defects

6.1.1 Section 5.0 provides a comprehensive assessment of the riverbank divided into chainage segments, detailing structural observations, defect conditions, recommended interventions, and the urgency to repair. The following paragraphs summarize each element individually.

6.1.2 The stone embankment is generally stable with minor issues like loose stones or missing mortar. These defects were identified in previous assessments and the condition has remained the same. Suggested maintenance involves repointing stones, generally with a medium priority.

6.1.3 On the concrete slab the most common defects are frequent cracking, gaps, and steps. The condition has worsened since the previous reports, with cracks and gaps clearly widening. As in previous inspections water pooling and slope issues occasionally arise, requiring re-levelling. Repairs include breaking out and reinstating concrete, with most repairs rated low or medium in priority. It should be noted however that pooling water can pose a particular hazard in freezing weather and if not addressed in the short term, signage should be provided to highlight this.

6.1.4 The capping beam is primarily affected by spalling and exposed reinforcement, particularly around supporting piles. Some beams exhibit significant defects, leading to high-priority recommendations, such as demolition and reconstruction in cases of severe tilting or failed sections. The severity and extent of defects has increased for the vast majority of capping beams.

6.1.5 Observed defects on the reinforced concrete piles include spalling and exposed steel reinforcement at the top of the piles. The condition of the piles could only be assessed above water level. Overall, the piles' condition has remained relatively the same, with a few new cases of spalling that exposes steel. Recommended repairs involve reinstating concrete and replacing reinforcement steel, typically at medium priority.

6.1.6 The retaining wall is generally in sound condition above water level, with no major repair needs observed. Based on the results of the previous condition assessments, the condition of the retaining wall has not changed. Below water level, soft spots in the riverbed were noticed. At these soft spots, the underside of the retaining wall was easily reached by scraping away a thin layer of silt. This could be due to scouring of the riverbed and should be investigated further.

6.2 Impact of Defects

6.2.1 In the short term, the current condition of the riverbank will probably not change if left unrepaired. The current condition negatively impacts the health and safety of pedestrians, especially regarding the cracked concrete path and tilted capping beams. These defects are widespread along the riverbank and crucially they form trip and slip hazards, especially in winter. The failed capping beam could collapse if loaded over the short term, reducing the width of the pathway and causing instability of the construction behind.

6.2.2 In the medium term, the condition of the riverbank is likely to deteriorate further if left unrepaired. The defects currently present, on the concrete capping beam and slab especially, will extend further along the riverbank and become more severe. The pathway will become less accessible with more risk to the safety of pedestrians. There is also an increased risk that floods will wash away the fill material beneath the pathway way through the gaps in the slab. This could potentially undermine the slab and lead to deterioration of the stone pitched embankment.

6.2.3 In the long term, the observed defects will expand and ultimately lead to the failure of numerous elements along the riverbank. The capping beams and slab will fail first, subsequently leading to an accelerated deterioration of the retaining wall, piles and pitched stone embankment. The structure as a whole depends on the earth fill underneath the slab to be maintained. Overtime floods will wash the infill away if the pathway is not maintained.

6.2.4 The typical design life of a concrete river embankment in a high flood-risk area is generally 50 to 100 years. The life expectancy depends heavily on construction quality and effective maintenance. The existing structure is estimated to be approximately 100 years old according to the previous condition assessment carried out by WSP. To add to this, the construction quality is standard; it appears no effort has been made to reach a higher design life. Additionally, there are minimal signs that the structure has been properly maintained in the recent past. Based on these observations, and the clear signs of deterioration, the existing structure has probably exceeded its initial design life.

6.2.5 In the event of ultimate failure of the structure, the riverbank will no longer be protected from flood events or scouring from the river. The stability of the riverbank will rely on the soil stability alone. The current soil conditions are unknown; however, existence of the current structure suggests the soil is insufficient to resist failure due to the river. Therefore, if the structure fails, anything above the pitched stone embankment could be undermined and damaged by the effects of the river. This would include the proposed pathway scheme.

6.2.6 The proposed pathway scheme would have little impact on the existing structure during its operational phase. Currently, above the riverbank structure there already exists a pathway, therefore the loading conditions during the new scheme's operation phase would not change. However, during the construction phase of the new scheme, plant and equipment operated near the riverbank may overload the structure in its current condition.

7.0 FURTHER INVESTIGATIONS

7.1 Concrete Slab Core Drilling

7.1.1 The concrete slab appears to have been designed as a ground bearing slab, however, through gaps in the slab it was observed that there are voids in the material underneath. Voids underneath the slab induces additional stress in the slab, due to the slab being required to span over the voids. The additional stress will lead to more cracks forming and therefore should be addressed in order to maintain the slab. Core drilling at multiple locations along the length of the slab would provide information on the extent of these voids and the material underneath the slab.

7.2 Scour Investigation

7.2.1 The loose riverbed that can easily be scraped away to reveal the underside of the retaining wall could be due to scouring. The extent of this should be investigated further to determine whether the scouring of the riverbed could undermine the retaining wall. This would require professional divers to carry out a survey on the base of the retaining wall.

8.0 REMEDIAL ACTIONS

8.1 Aims of Remedial Action

8.1.1 The City of York Council has commissioned Mason Clark Associates to explore the remedial actions required for two scenarios. Firstly, to repair the riverbank so that the embankment is safe to use as it stands and in preparation for the riverside path scheme construction. Secondly, the remedial actions required to optimise the lifespan of the proposed riverside path scheme.

8.2 Remedial Option 1

8.2.1 Remedial option 1 will focus on the actions required to make the embankment safe as it stands and in preparation for the riverside path scheme construction. This option will focus on targeting the most severely damaged elements and make patch repairs along the riverbank to resolve minor defects.

8.2.2 The riverbank will be repaired so that all the highlighted defects are removed. The defects and recommended repairs are identified in section 5. This remedial option will include the following actions:

8.2.2.1 **Pitched Stone Embankment:**

- Remove vegetation.
- Relay any loose stone and repoint mortar.

8.2.2.2 **Slab:**

- Break out areas of concrete with defects and reinstate with new cast in situ

8.2.2.3 **Capping Beam:**

- Break out area of concrete with defects.
- Clean or replace the existing steel reinforcement.
- Reinstate concrete.
- Demolish and replace beam like for like in areas of collapse/ severe deterioration.

8.2.2.4 **Piles:**

- Break out areas of concrete with defects.
- Clean or replace the existing steel reinforcement.
- Reinstate concrete.

8.3 Remedial Option 2

8.3.1 Remedial option 2 will focus on the remedial actions required to optimise the lifespan of the proposed riverside path scheme. This option will focus on replacing the structural elements that are most critical to the stability of the river embankment and protecting it from future degradation.

8.3.2 As discussed in section 6, the long-term expectation of the existing river embankment is that its condition worsens and eventually leads to widespread failure. To prevent this impacting the proposed river pathway scheme, remedial option 2 proposes constructing a new steel sheet pile retaining wall and reconstructing the lower concrete pathway. Remedial option 2 will give the river embankment a design life expectancy of 120 years.

8.3.3 The preferred construction method is to install the sheet piles in front of the existing structure, demolish the existing concrete elements, then construct a new concrete path between the sheet pile and pitched stone embankment. This, however, will mean the riverbank encroaches further into the river, and therefore requires approval by the Marine Management Organization (MMO) and Environmental Agency (EA).

8.3.4 If this was not approved, remedial option 2 could be constructed so that the new construction does not expand into the river. The existing structure would be demolished, then the sheet piles installed in the same position as the existing, and finally a new concrete path constructed. This method is more expensive because the concrete demolition is not protected by the new sheet pile retaining wall.

8.3.5 In summary, the following remedial actions should be considered:

8.3.5.1 **Pitched Stone Embankment**

- Remove vegetation.
- Relay any loose stone and repoint mortar.

8.3.5.2 **Slab, Capping Beam, Piles, and Retaining Wall**

- Demolish

8.3.5.3 **Steel Sheet Piles:**

- Construct a new sheet pile retaining wall in front of/ in line with the existing reinforced concrete embankment.
-

8.3.5.4 **New Concrete Path:**

- Construct a new concrete path in between the sheet piles and existing pitched stone embankment.

9.0 COSTING

9.1 Remedial Option 1

9.1.1 A high level estimate of the cost to repair the existing structure, as described in section 8.2, estimates a project total of:

Option 1 Project Total = **£529,192** (including VAT)

9.1.2 Refer to appendix C for cost estimate breakdown.

9.2 Remedial Option 2

9.2.1 A high level estimate of the works to demolish the existing concrete structure and construct a new steel retaining wall, as described in section 8.3, predicts a total of:

Option 2 Project Total = **£2,571,198** (including VAT)

9.2.2 Refer to appendix C for cost estimate breakdown.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusion

10.1.1 An inspection of the river embankment identified numerous defects along the structure. Most defects were found on the reinforced concrete capping beam, reinforced concrete piles and concrete slab. Common defects were concrete spalling and exposed steel reinforcement to the reinforced concrete elements, with one case of total loss of functionality in the beam. The slab has widespread cracking and voids. The concrete retaining wall and pitched stone embankment are generally in good condition.

10.1.2 Comparison to previous condition surveys shows that new defects have appeared, and most pre-existing defects have become more severe and extensive.

10.1.3 The current condition of the embankment has a negative impact on current use of the riverbank and is likely to have severe impacts in the future on any potential development, for example the proposed riverbank pathway.

10.1.4 Two remedial options are suggested. Remedial option 1, addressing the short-term impact of the condition, making the riverbank safe to use. Remedial option 2, addressing the long-term impact of the embankments condition, future proofing the riverbank.

10.1.5 Option 1 involves repairing all the identified defects. This is expected to cost £529,192.

10.1.6 Option 2 involves demolishing the concrete slab, capping beam and columns then constructing a new steel sheet pile retaining wall and concrete path. This option is expected to cost £2,571,198.

10.2 Recommendations

10.2.1 Investigate underneath the concrete slab. In areas there appeared to be voids underneath the slab. The result of this investigation may lead to the requirement of structural calculations to prove the slab is sufficient to span over voids and soft spots.

10.2.2 Investigate the level of the riverbed and the potential scouring at the base of the retaining walls.

10.2.3 Install monitoring equipment to measure the movement of the structure over time. This would aid in future condition assessments and inform maintenance.

10.2.4 Consider a vegetation management plan to help maintain the pitched stone embankment.

11.0 LIMITATIONS

11.1 Sampling and testing of materials is beyond the scope of this report.

11.2 We have not inspected woodwork or other parts of the structure which are covered, unexposed or inaccessible and we are therefore unable to report that any such part of the property is free from defect.

11.3 This report is applicable to the condition and state of the structure at the time of inspection. The structure may be subject to deterioration in the future and the opinions expressed in this report may need to be revised accordingly.

11.4 The report has been prepared for the client alone and no third party should rely on it. For the avoidance of doubt, the Contracts (Rights of Third Parties) Act 1999 shall not apply to this contract

11.5 The above recommendations do not constitute a full list of works to be carried out, but refer to the main areas of work associated with structural aspects of the structure, based on a visual inspection only and under the limitations of our inspection

11.6 All construction works are covered by the requirements of the CDM regulations. Owners/Clients have legal responsibilities to engage persons and companies with appropriate level of skills knowledge and experience to ensure that the requirements of the CDM regulations are met. The works required will be covered by the CDM regulations 2015 and you should understand your obligations and act accordingly.

11.7 Unless specifically mentioned no comment is made in the report as to the presence of new or old mine workings or tunnelling, heavy metals, chemical, biological, electromagnetic or radioactive contamination or pollution, or radon methane or other gases, underground services or structures, springs and water courses, sink holes or the like, noise or vibratory pollution, mould, asbestos and asbestos products.

APPENDIX A

01 Photo of the river embankment from the Scarborough Rail Bridge looking eastwards towards York city centre.

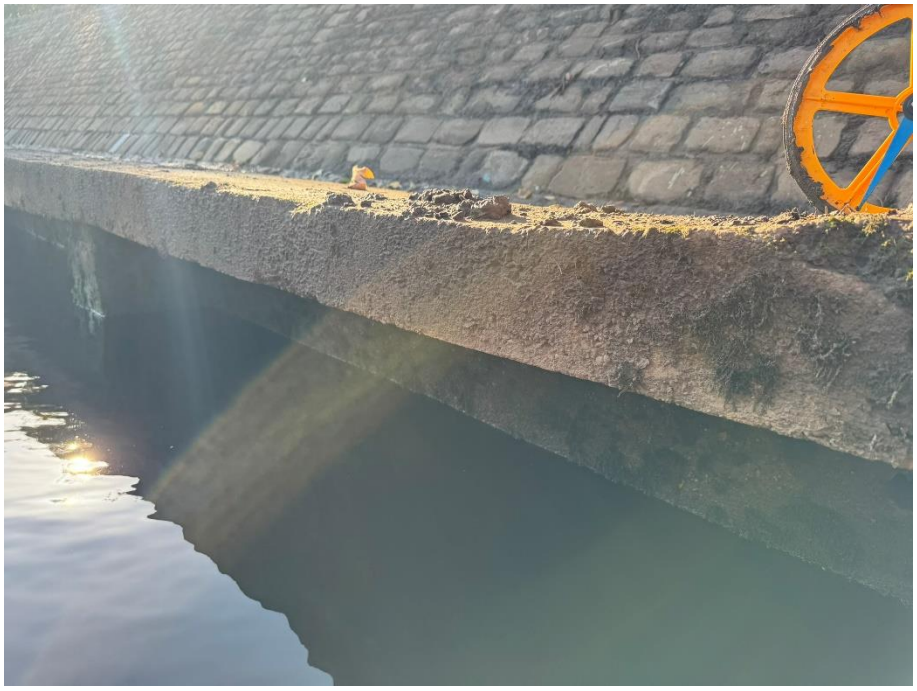
02 Capping beam at the furthest point along the riverbank, approximately 270m upstream from the Scarborough Rail Bridge.

03 Looking downstream towards the Scarborough Rail Bridge.

04 Gap between the capping beam and pile. The capping beam not bearing onto the pile. Steel reinforcement exposed on the top of the pile.

05 Cracking at the top of the pile and side of the capping beam. Retaining wall is ok.

06 Cracking in the capping beam. Retaining wall okay.



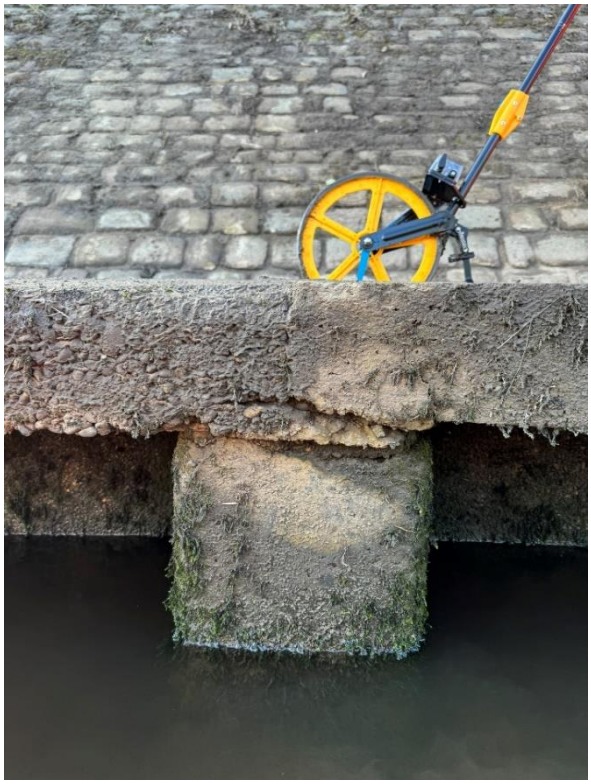
07 Photo of capping beam in ok condition.

08 Cracking in capping beam and top of the pile.

09 Photo of capping beam in ok condition.

10 Photo of capping beam in ok condition. Cracks in the top of the pile.

11 Photo of capping beam in ok condition.



12 Cracking on the bottom of the capping beam.

13 Photo of concrete spalling on the bottom of the capping beam.

14 Spalled concrete under the capping beam with exposed and corroded steel reinforcement.

15 Spalled concrete under the capping beam with exposed and corroded steel reinforcement.

16 Aggregate visible at the surface of the capping beam. Crack at the back of the pile.

17 Aggregate visible at the surface of the capping beam. Crack at the back of the pile.

18 Aggregate visible at the surface of the capping beam. Gap between the retainig wall and pile.

19 Aggregate visible at the surface of the capping beam. Crack at the back of the pile.

20 Aggregate visible at the surface of the capping beam. Spalling at the back of the pile with exposed and corroded steel reinforcement.

21 Spalling at the back of the pile with exposed and corroded steel reinforcement.

22 Spalling at the back of the pile and underside of the capping beam.

23 Concrete spalling and exposed corroded steel reinforcement on the capping beam. Cracking to the rear of the pile.

24 Cracking in the side of the capping beam. Concrete spalling at the top of the pile with exposed corroded steel reinforcement.

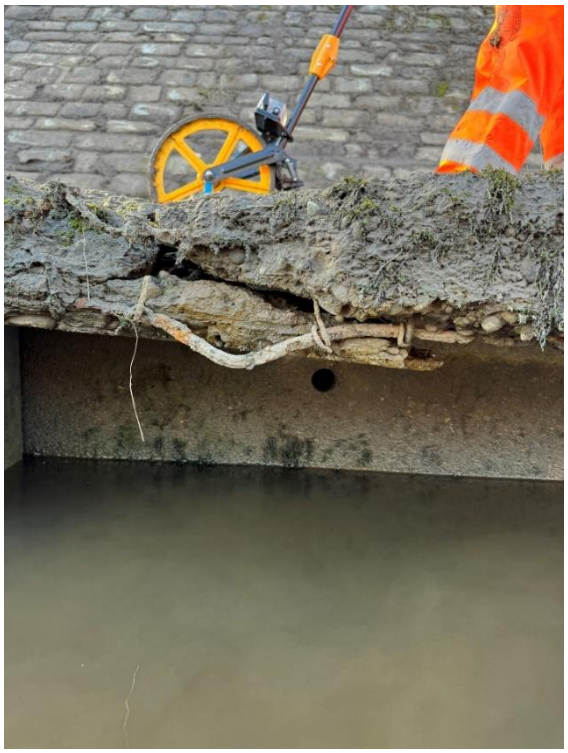
25 Close up of concrete spalling at the top of the pile with exposed corroded steel reinforcement.

26 Close up of concrete spalling at the top of the pile with exposed corroded steel reinforcement.

27 Steel anchor threaded through concrete pile.

28 Severe cracking in the capping beam, with concret spalling. Exposed, deformed and corroded steel reinforcement.

29 Top of retaining wall is visible through the capping beam. There is a void behind the retaining wall.



30 Severe cracking in the capping beam, with concret spalling. Exposed, deformed and corroded steel reinforcement.

31 Top of retaining wall is visible through the capping beam. There is a void behind the retaining wall.

32 Top of retaining wall is visible through the capping beam. There is a void behind the retaining wall.

33 Concrete spalling and exposed corroded steel reinforcement in the capping beam. Surface cracks on the pile.

34 Concrete spalling and exposed corroded steel reinforcement in the capping beam. Surface cracks on the pile.

35 Spalling on on the top of the concrete pile, exposed steel reinfocement.

36 Cracking at the top of the pile. Spalling on on the top of the concrete pile, exposed steel reinfocement.

37 Cracking at the top of the pile. Spalling on on the top of the concrete pile, exposed steel reinfocement.

38 Cracking at the top of the pile. Spalling on on the top of the concrete pile, exposed steel reinfocement.

39 Cracking at the top of the pile. Spalling on on the top of the concrete pile, exposed steel reinfocement.

40 Spalling on on the top of the concrete pile, exposed steel reinfocement.

41 Spalling on on the top of the concrete pile, exposed steel reinfocement.

42 Spalling on on the top of the concrete pile, exposed steel reinfocement.

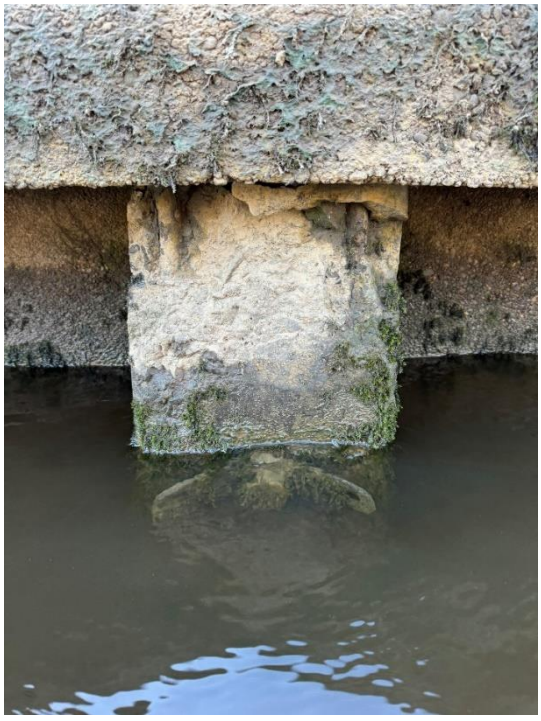
43 Spalling on on the top of the concrete pile, exposed steel reinfocement.

44 Concrete spalling on the side of the concrete capping beam and top of the pile. Spalling has exposed the steel reinforcement. The reinforcemet is corroded.

45 Cracking on the top of the pile, concrete is loose.

46 Spalling of concrete at the top of the pile.

47 Spalling of concrete to the underside of the capping beam. Corroded steel reinforcement is exposed.



48 Spalling of concrete at the top of the pile. Steel reinforcement bars are exposed.

49 Spalling of concrete at the top of the pile. Steel reinforcement bars are exposed.

50 Spalling of concrete at the top of the pile. Corroded steel reinforcement bars are exposed.

51 Spalling of concrete at the top of the pile. Corroded steel reinforcement bars are exposed.

52 Spalling of concrete at the top of the pile and underside of the capping beam. Corroded steel reinforcement bars are deformed and exposed.

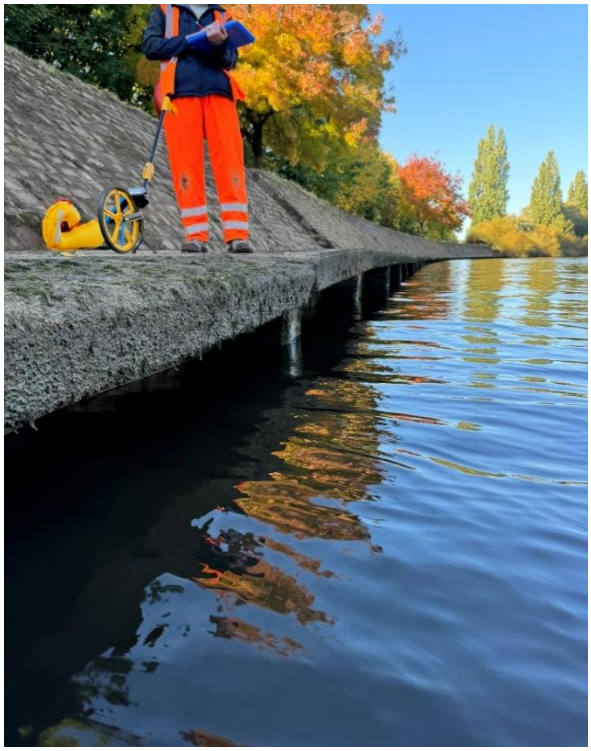
53 Spalling to top corner of the concrete pile, with exposed steel reinforcement.

54 Spalled and loose concrete on top of the capping beam and pile, with corroded and deformed steel exposed.

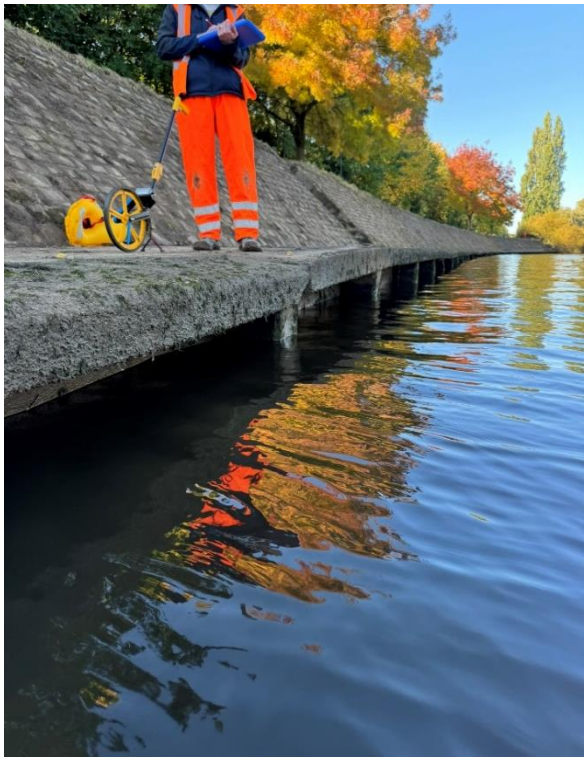
55 Spalled and loose concrete on top of the capping beam and pile, with corroded and deformed steel exposed.

56 Spalled concrete at the top of the pile, with corroded steel reinforcement exposed.

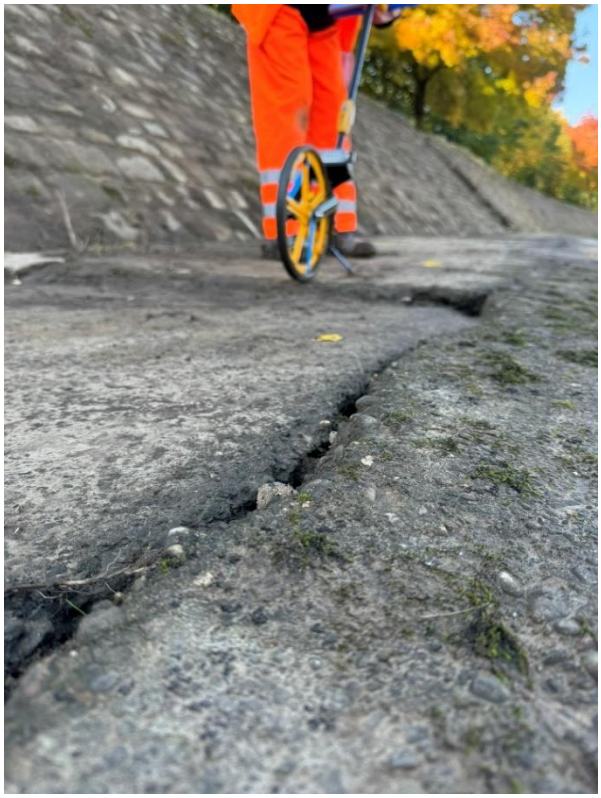
57 Spalled concrete on the side of the capping beam and top of the pile. Corroded and deformed steel exposed.



58 Capping beam tilting towards the water.

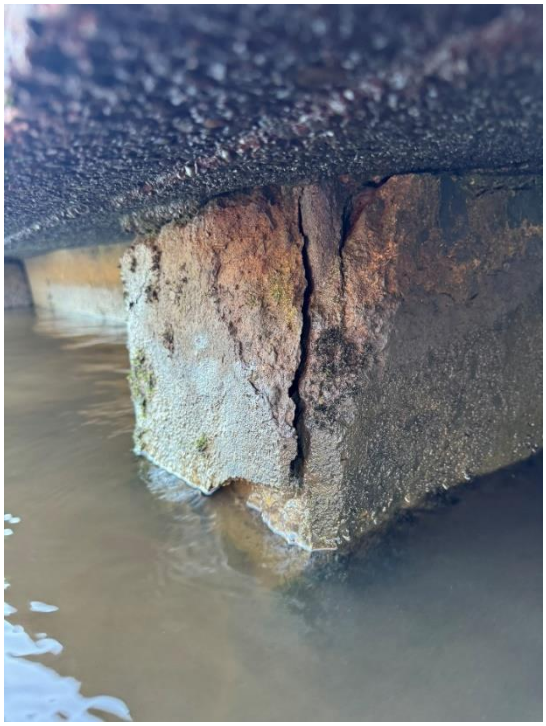


59 Capping beam tilting towards the water.



60 Crack between the concrete path and capping beam.

61 Capping beam and pile in ok condition.



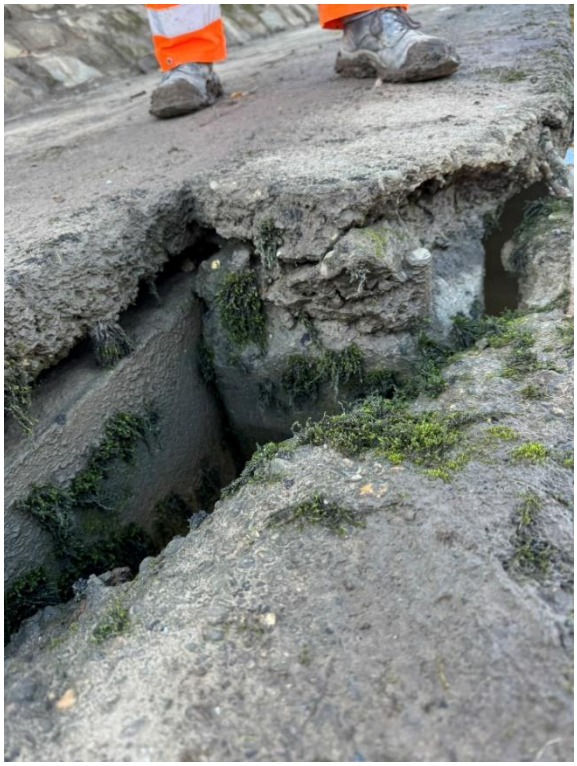
62 Spalled concrete at the top of the pile, with corroded steel reinforcement exposed.

63 Minor spalling to top corners of the pile.

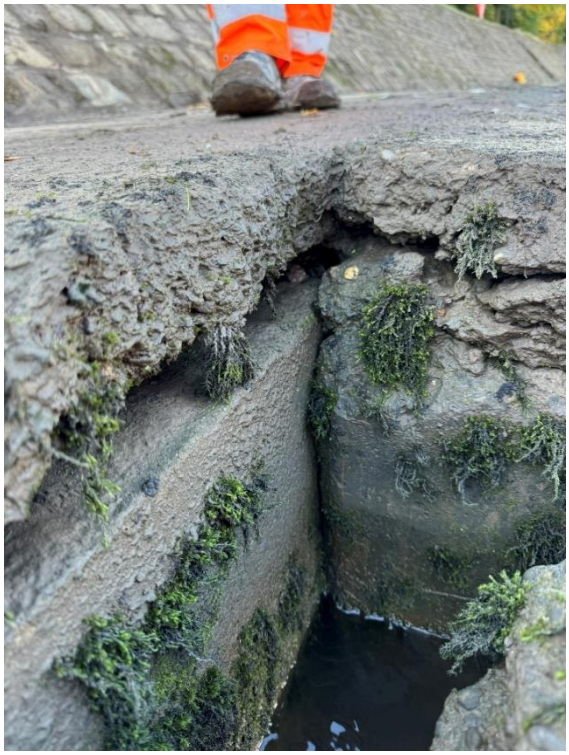
64 Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and deformed steel reinforcement exposed in the capping beam and pile.

65 Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and deformed steel reinforcement exposed in the capping beam and pile.

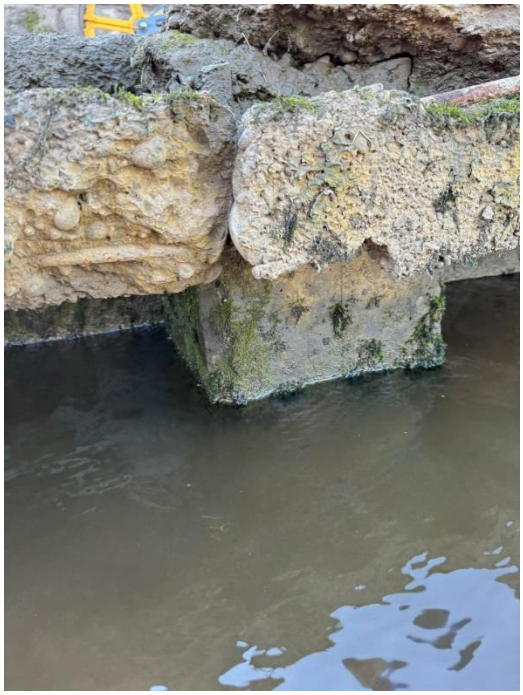
66 Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and deformed steel reinforcement exposed in the capping beam and pile.



67 Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and deformed steel reinforcement exposed in the capping beam and pile.



68 Gap between the concrete path and top of the retaining wall.



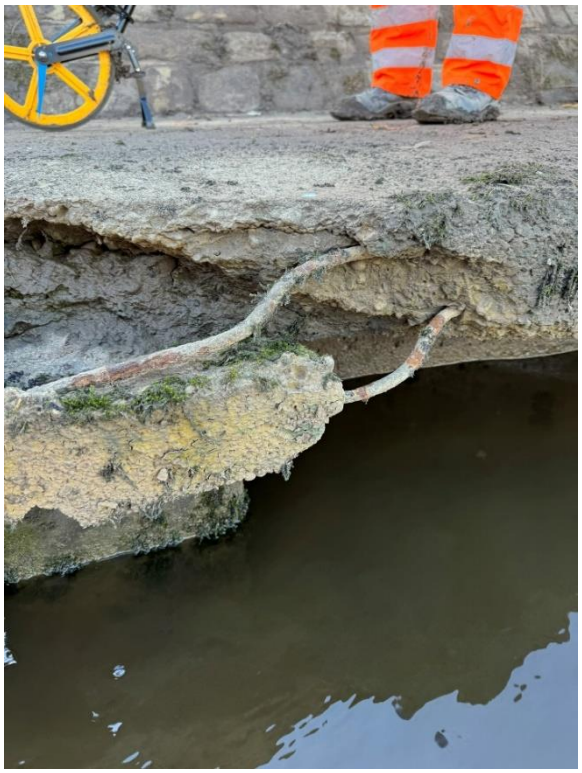
69 Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and deformed steel reinforcement exposed in the capping beam and pile.

70 Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and deformed steel reinforcement exposed in the capping beam and pile.

71 Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and deformed steel reinforcement exposed in the capping beam and pile.

72 Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and deformed steel reinforcement exposed in the capping beam and pile.

73 Large gap between the top of the retaining wall and concrete path.



74 Deformed steel reinforcement in the capping beam at point of failure.

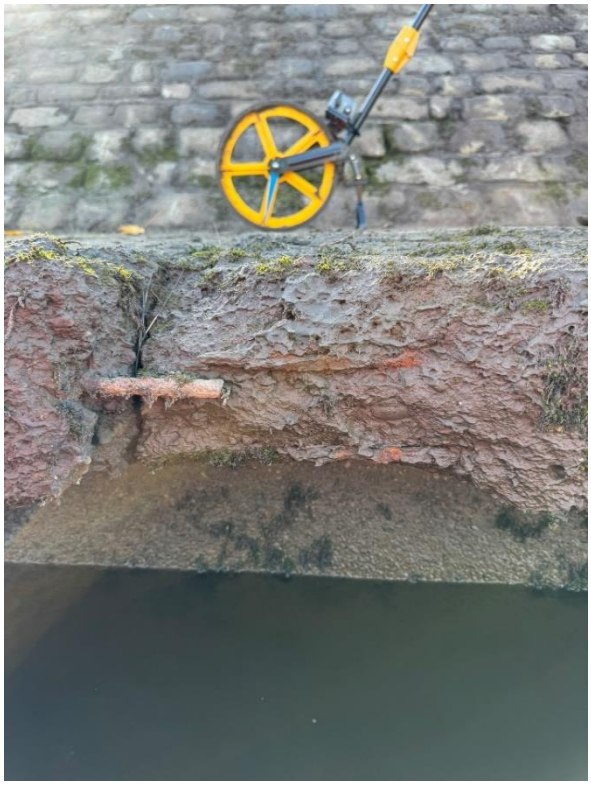
75 Capping beam in ok condition.

76 Large gap between the capping beam and concrete path. Exposed steel reinforcement.

77 Large gap between the capping beam and concrete path. Exposed steel reinforcement.

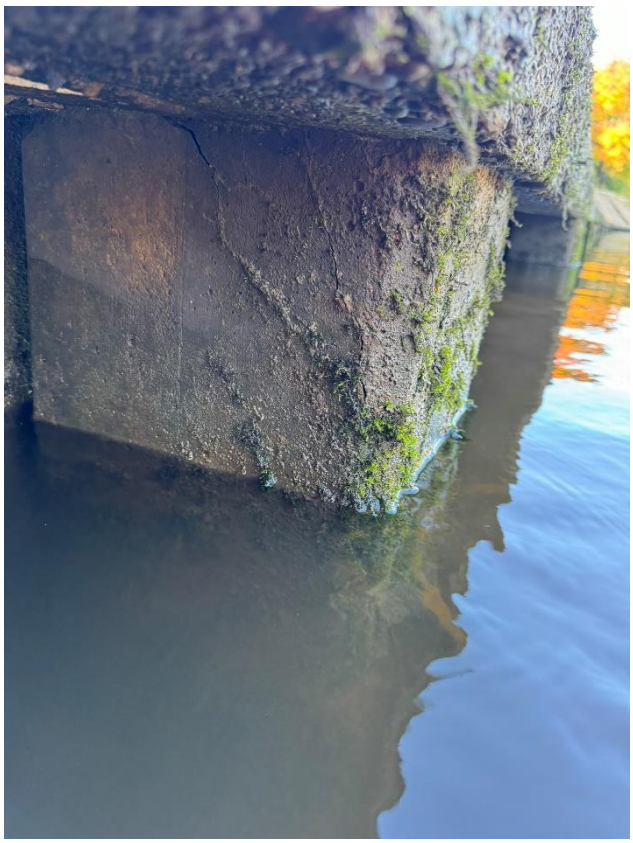
78 Top of the capping beam at point of failure.

79 Top of the capping beam at point of failure.



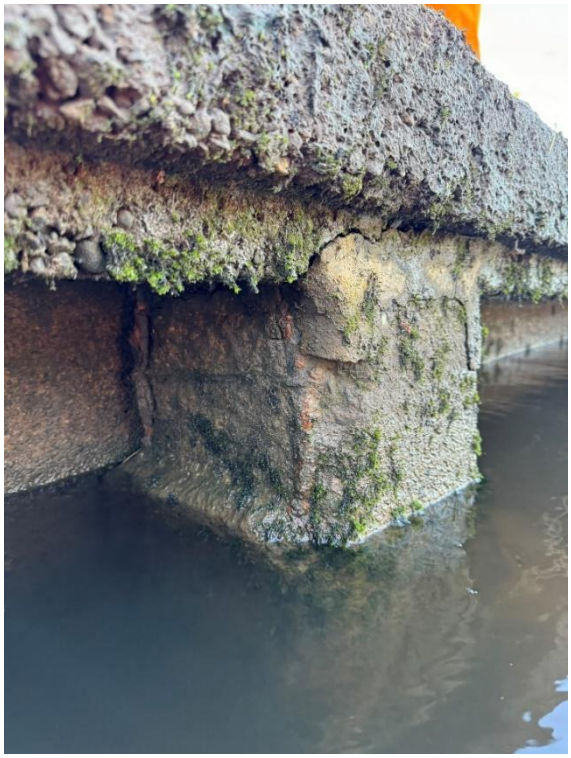
80 Large section loss in capping beam with exposed steel reinforcement.

81 Large section loss in capping beam with exposed steel reinforcement. Crack through the width of the capping beam.



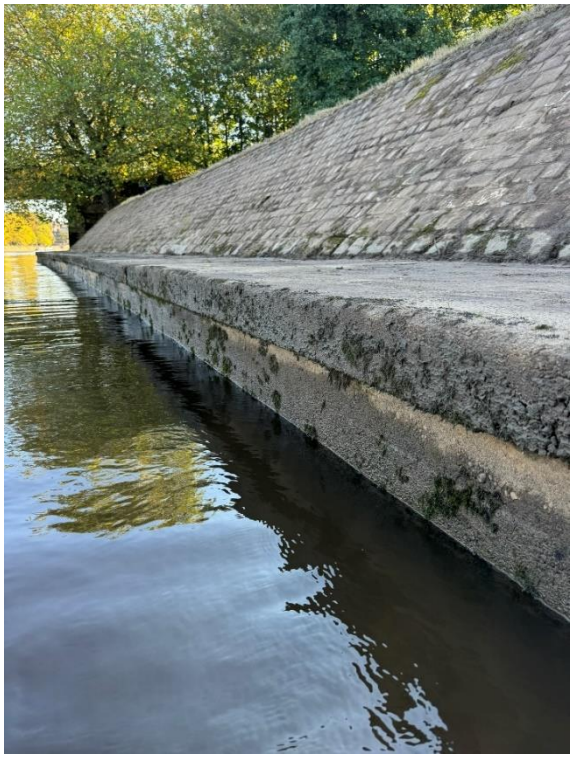
82 Surface cracking at the top of the pile.

83 Concrete spalled and exposed steel reinforcement at the top of the pile.



84 Concrete spalled and exposed steel reinforcement at the top of the pile.

85 Large gap between the top of the pile and capping beam. Aggregate visible at the surface of the capping beam. Start of the retaining wall to the left of the pile.



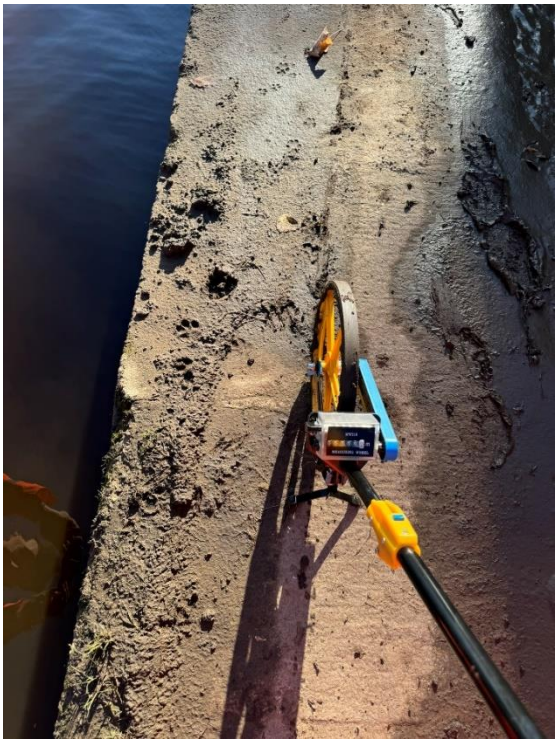
86 Change in construction, piles are replaced by concrete retaining wall. Looking downstream towards the Scarborough Rail Bridge.

87 Concrete retainnig wall in good condition.

88 Crack down the capping beam and down the retaining wall.

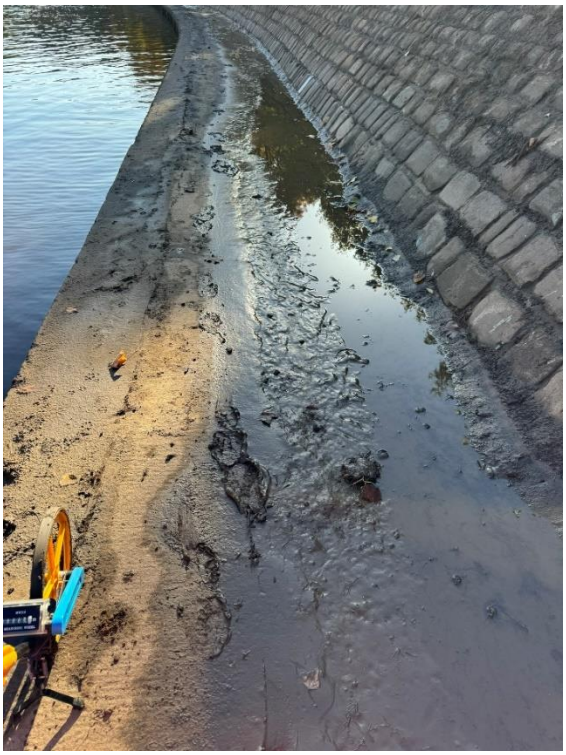
APPENDIX B

01 Overgrown vegetation and large build-up of earth at the base of the pitched stone, on top of the concrete path.



02 Top of reinforced concrete capping beam and concrete path.

03 Build-up of silt on top of concrete path.



04 Build-up of silt on top of concrete path and pooling water.

05 Build-up of silt on top of concrete path.

06 Build-up of silt on top of concrete path and pooling water.

07 Crack between the concrete path and capping beam.

08 Loose aggregate on concret slab surface.

	
09	Loose aggregate on concret slab surface.
	
10	Loss of section on the capping beam, concrete spalled and broken away exposing deformed steel reinforcement. Can see through the capping beam to the top of the pile underneath.

11 Loss of section on the capping beam, concrete spalled and broken away exposing deformed steel reinforcement. Can see through the capping beam to the top of the pile underneath.

12 View from the concrete path looking eastwards, towards the Scarbourough Rail Bridge that is visible in the background. Silt build-up on path.

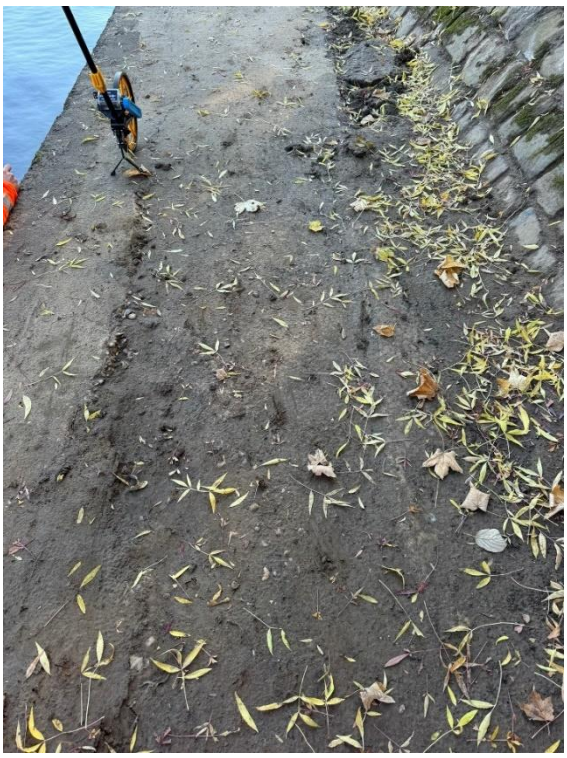
13 View from the concrete path looking westwards, away from the Scarbourough Rail Bridge. Silt build-up and water pooling on the path.

14 Crack between the concrete path and capping beam.

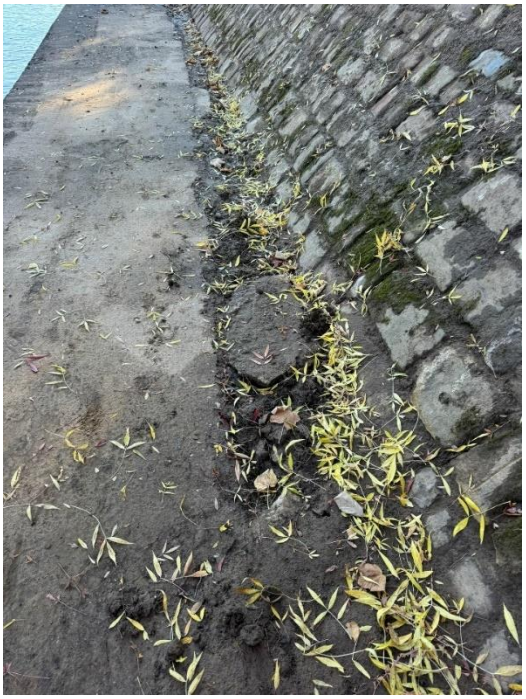
15 Silt build-up on the path. Crack between the concrete path and capping beam.

16 Concrete path covered in silt. The concret is broken up and easily displaced when aggetated by foot.

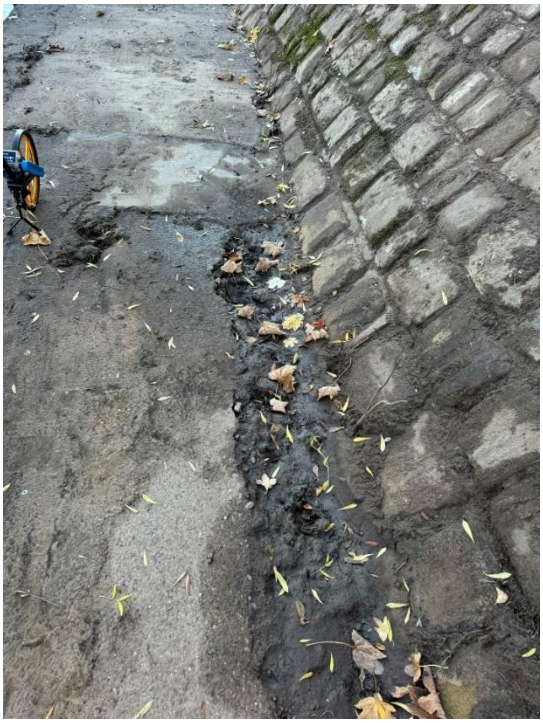
17 Concrete path covered in silt. The concret is broken up and easily displaced when aggetated by foot.



18 Concrete path in ok condition.

	
19	Void and broken up concrete slab at the base of the pitched stone. Areas of loose concrete at the surface.
	
20	Void and broken up concrete slab at the base of the pitched stone. Areas of loose concrete at the surface.

21 Void and broken up concrete slab at the base of the pitched stone. Areas of loose concrete at the surface.



22 Void and broken up concrete slab at the base of the pitched stone. Areas of loose concrete at the surface.

23 Small gap in joint between the concrete path and capping beam.

24 Cracks in the slab and various patches of slab construction.

25 Exposed pile steel reinforcement, protruding through gap in capping beam and concrete path.

26 Exposed pile steel reinforcement, protruding through gap in capping beam and concrete path.

27 Cracks in the slab and various patches of slab construction.

28 Small gap in joint between the concrete path and capping beam.

29 Void and broken up concrete slab at the base of the pitched stone. Areas of loose concrete at the surface.

30 Void and broken up concrete slab at the base of the pitched stone. Areas of loose concrete at the surface.

31 Loose concrete aggregate on top of the capping beam.

32 Large crack between the capping beam and concrete path.

33 Large crack between the capping beam and concrete path.

34 Large crack between the capping beam and concrete path.

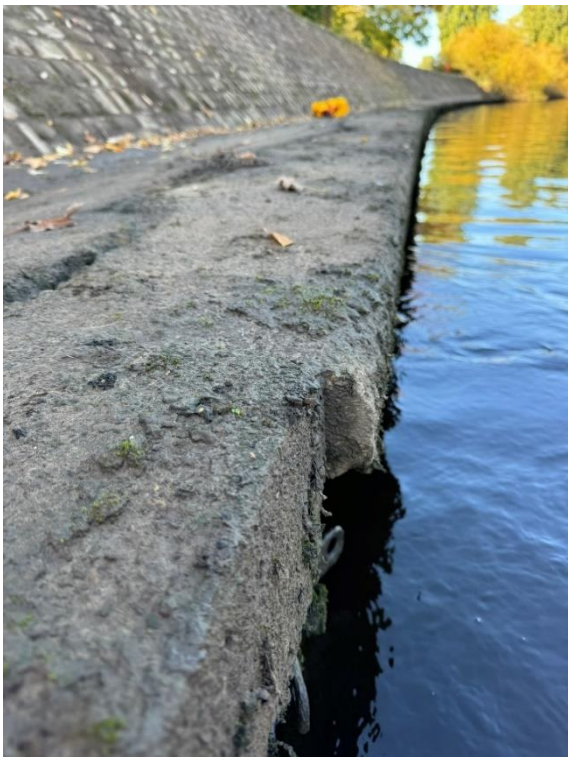
35 Large crack between the capping beam and concrete path.

36 Build up of silt on the concrete path.

37 Large crack between the capping beam and concrete path.

38 Large crack between the capping beam and concrete path.

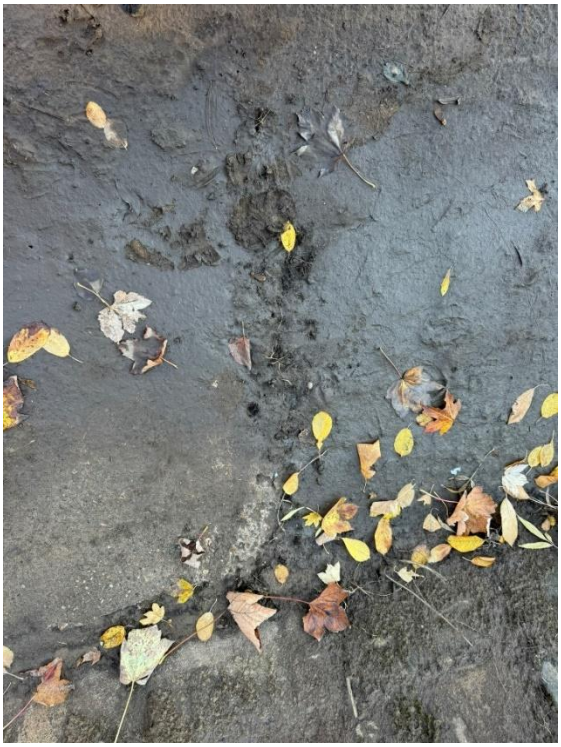
39 Large crack between the capping beam and concrete path.



40 Large crack between the capping beam and concrete path. The capping beam is tilting towards the river, braking away from the concrete path.

41 Large crack between the capping beam and concrete path. The capping beam is tilting towards the river, braking away from the concrete path.

42 Build up of silt on the concrete path.



43 Build up of silt on the concrete path.

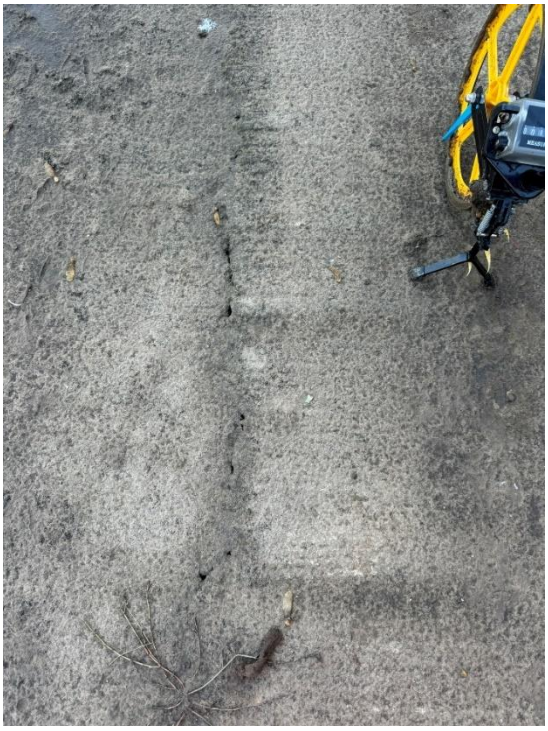
44 Surface cracks on the concrete path.

45 Loss of section on the capping beam, concrete spalled and broken away exposing deformed steel reinforcement.

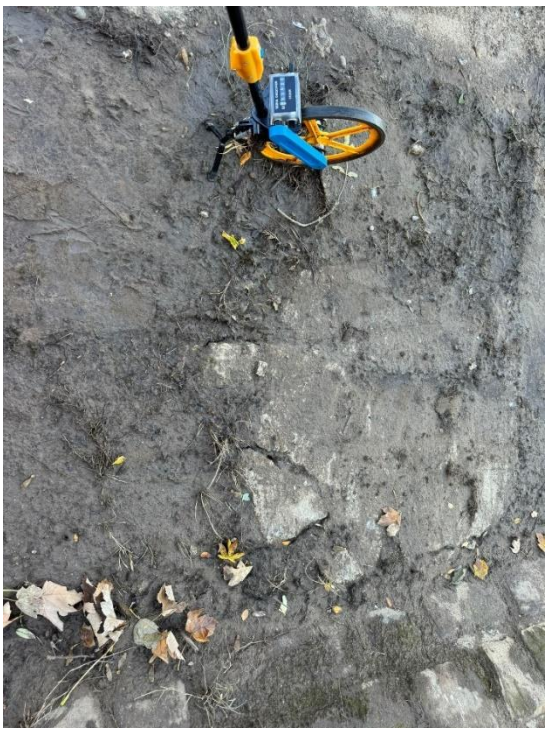
46 Loss of section on the capping beam, concrete spalled and broken away exposing deformed steel reinforcement.

47 Gap forming between the concrete path and capping beam.

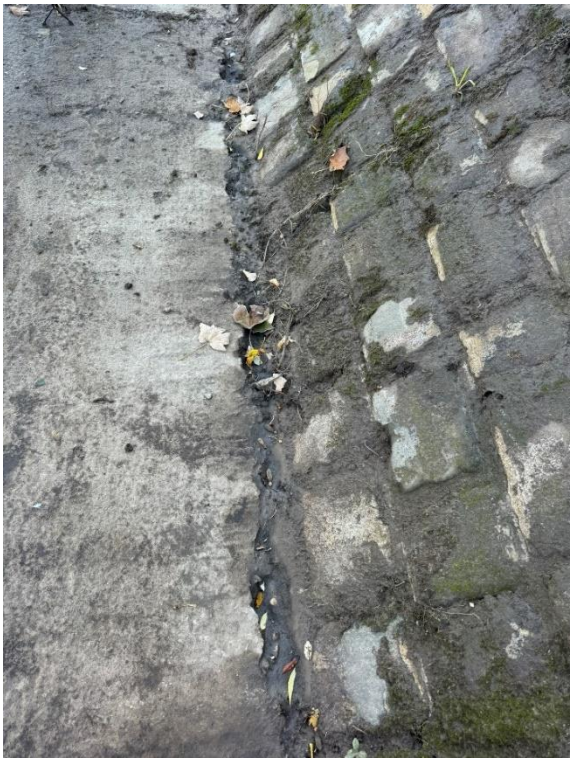
48 Gap forming between the concrete path and capping beam.



49 Gap forming between the concrete path and capping beam.



50 Wide spread cracking and loose areas of concrete at the surface of the concrete path. Build-up of silt and loose aggregate.



51 Void in concrete slab at the base of the pitched stone.

52 Top of concrete path and capping beam in ok condition.

53 Gap between the concrete path and capping beam.

54 Gap between the concrete path and capping beam. Step in the path.

55 Crack forming between the concrete path and capping beam. Step in the capping beam.

56 Crack forming between the concrete path and capping beam. Step in the capping beam.

57 Void and broken up concrete slab at the base of the pitched stone. Areas of loose concrete at the surface.

58 Crack between the concrete path and capping beam. Broken up concrete slab at the base of the pitched stone retainig wall. Areas of loose concrete at the surface.

59 Build-up of silt on top of the concrete path.

60 Gap forming between the pitched stone and concrete path.

61 Build-up of silt on top of the concrete path. Large crack in the slab propogating from the capping beam to the bottom of the pitched stone.

62 Build-up of silt on top of the concrete path. Large crack in the slab propogating from the capping beam to the bottom of the pitched stone.

63 Crack between the capping beam and concrete path.

64 Crack between the capping beam and concrete path.

65 Crack between the capping beam and concrete path. The capping beam is moving away from the concrete path.

66 Failed capping beam, no longer sufficiently supported and breaking away from the concrete path. Large cracking, exposed and deformed steel reinforcement in capping beam.

67 Gap between the concrete slab and capping beams. Gap between two slabs. The construction changes at this point from piles to a retaining wall.

68 Gap between the concrete slab and capping beams. Gap between two slabs.

69 Failed capping beam, no longer sufficiently supported and breaking away from the concrete path. Large cracking, exposed and deformed steel reinforcement in capping beam.

70 Cracking between two capping beams with exposed steel reinforcement over the pile support. Gap between the capping beam and concrete path formed.

71 Cracking between two capping beams with exposed steel reinforcement over the pile support. Gap between the capping beam and concrete path formed.

72 Cracking between two capping beams with exposed steel reinforcement over the pile support. Gap between the capping beam and concrete path formed.

73 Cracking between two capping beams with exposed steel reinforcement over the pile support. Large gap between the capping beam and concrete path formed, can see the top of the retaining wall.

74 Cracking between two capping beams with exposed steel reinforcement over the pile support. Large gap between the capping beam and concrete path formed, can see the top of the retaining wall.

75 Large crack between the capping beam and concrete path.

76 Cracking and loose concrete on the side of the capping beam above the pile.

77 Small crack forming on the concrete path.

78 Spalled concrete with exposed corroded steel reinforcement on the capping beam.

79 Crack in the concrete capping beam.

80 Top of the concrete path in ok condition.

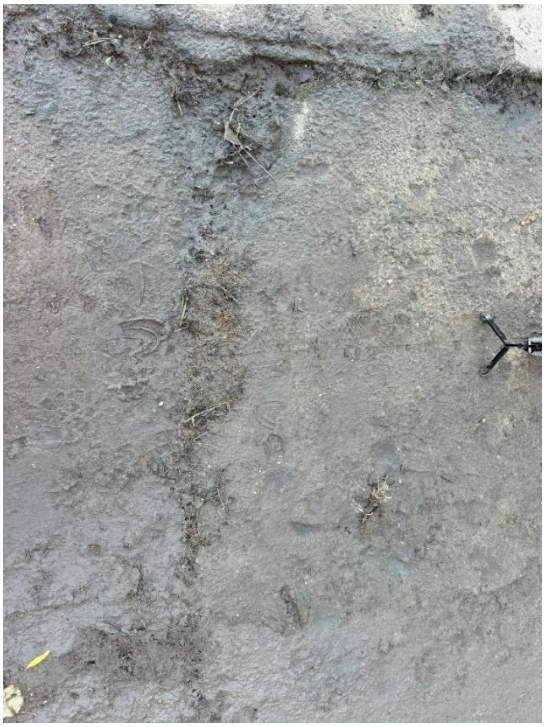
81 Gap forming between the pitched stone and concrete path.

82 Gap between the concrete path and capping beam.

83 Step in the capping beam.

84 Top of the concrete path coverd in silt.

85 Crack in the top of the capping beam.



86 Crack in the concrete path, propogating from the capping beam to the pitched stone.

87 Timber service cover in poor condition, timber is rotting.

88 Timber service cover in poor condition, timber is rotting.

89 Step in the concrete path, corner is a trip hazard.

90 Step in the concrete path, corner is a trip hazard.

91 Gap between the capping beam and concrete path.

92 Service void with no hatch/cover.

93 Cracking in the concrete path around manhole.

94 Gap between the concrete path and capping beam. End of the path, Scarborough Rail Bridge masonry visible.

95 Minor spalling on the surface of the concrete path.

96 Top of concrete path.

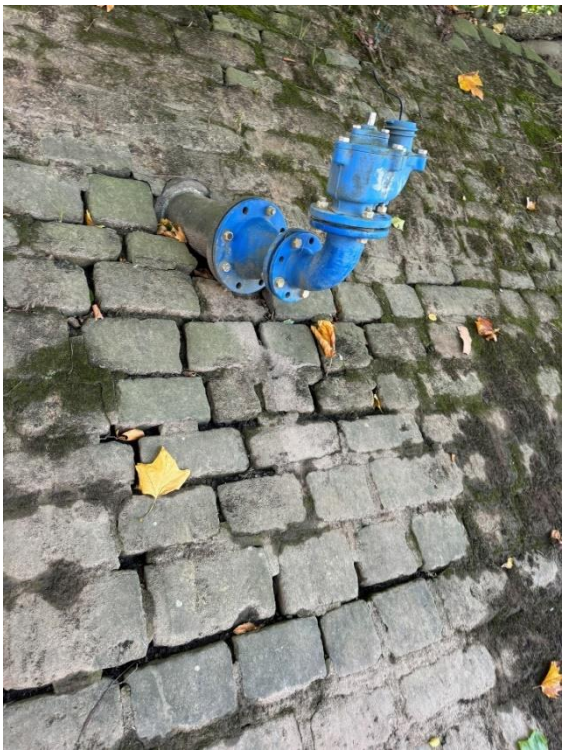
97 Service void with no cover.

98 Rotting timber service cover.

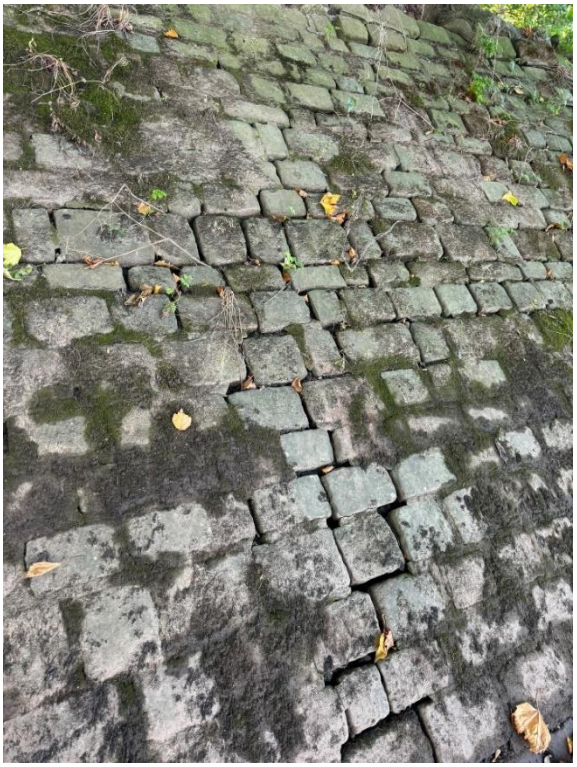
99 Missing mortor between stones on the pitched stone embankment.

100 Missing mortor between stones on the pitched stone embankment.

101 Missing mortor between stones on the pitched stone embankment.



102 Missing mortor between stones on the pitched stone embankment around a service valve.



103 Missing mortor between stones on the pitched stone embankment.

104 Missing mortor between stones on the pitched stone embankment.

105 Missing mortor between stones on the pitched stone embankment.

106 Missing mortor between stones on the pitched stone embankment.

107 Paved steps in good condition.

108 Top of embankment.

109 Top of embankment.

110 Top of embankment.

111 Top of embankment steps.

112 Top of embankment.

113 Top of embankment.

114 Manhole on top of embankment.

115 Top of embankment steps. The top steps are out of place.

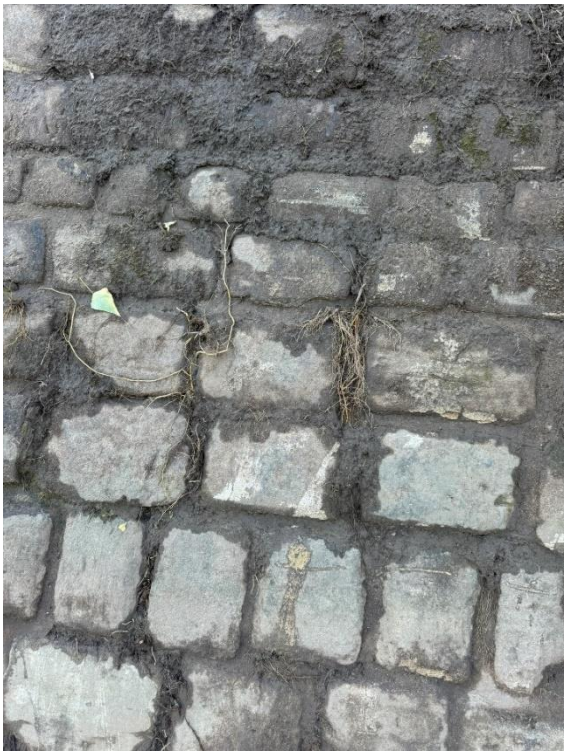
116 Top of embankment.

117 Top of embankment.

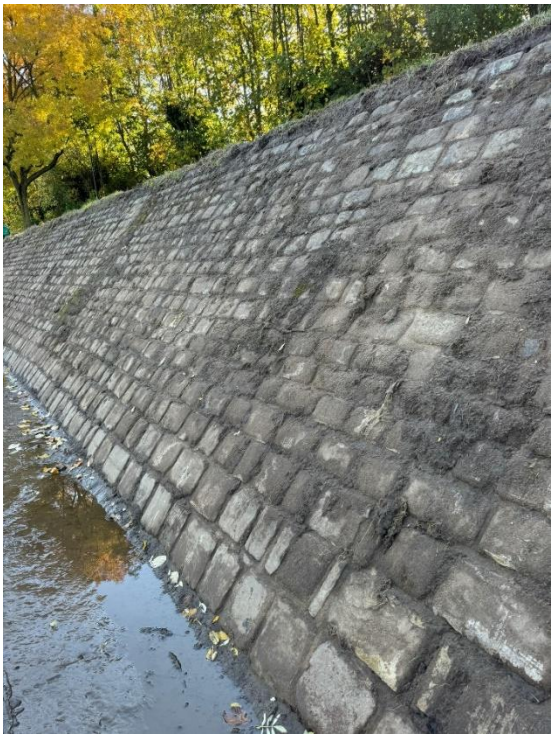
118 Top of embankment.

119 Top of embankment.

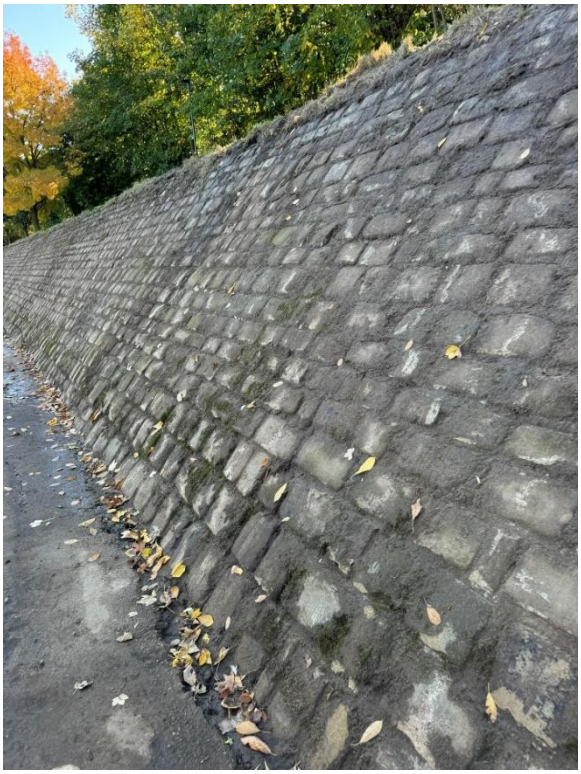
120 Top of embankment, showing the whole structure to the Scarborough Rail Bridge.



121 Close up of pitched stone, stone and mortar ok.



122 Pitched stone and mortar ok.



123 Pitched stone and mortar ok.

124 Some loose mortar on pitched stone embankment.

125 Embankment steps, top step needs relaying.

126 Embankment steps, top step needs relaying.

127 Top of embankment steps.

128 Missing mortar on pitched stone embankment.

129 Missing mortar on pitched stone embankment.

130 Pitched stone embankment ok.

131 Missing mortar on pitched stone embankment.

132 Missing mortar on pitched stone embankment.

133 Missing mortar on pitched stone embankment.

134 Missing mortar on pitched stone embankment.

135 Large steel plate cover on top of embankment.

136 Large steel plate cover on top of embankment.

137	 Large steel plate cover on top of embankment.

APPENDIX C

masonclarkassociates
civil and structural engineering consultants

River Ouse Riverbank
Cost Estimate

Commissioned by
City of York Council

CITY OF YORK COUNCIL

22594-H-SH-001-R0-High Level Budget Estimate.xlsx
19/11/2024

City of York Council
River Ouse Riverbank
Cost Estimate

INTRODUCTION

I Mason Clark Associates were commissioned by City of York Council to provide an estimate for the Options of (1)repair at a 270m length of revetment (2) replacement of 270 m of piled wall

II This estimate is a High Level Budget

BASIS OF ESTIMATE

III Option 1
Option 2

INFORMATION USED

IV 22594-H-RP-001-R0-River Ouse Riverbank Survey

ESTIMATE BASE DATE

V This estimate has been priced in 4Q2024 and an allowance for tender inflation to 4Q2025 has been included

EXCLUSIONS

VI Cost inflation past 4Q25

ASSUMPTIONS

VII assume mud and silt deposited from river can be washed back into the river

Option 1 is patch repairs using epoxy mortar
Option 1 assume minimal grouting

The proximity of the East Coast Mainline on the Northern elevation precludes the craneage from bankside and therefore it is assumed working from a barge

City of York Council
River Ouse Riverbank
Cost Estimate

SUMMARY OPTION 1

1	Revetment repairs	270	m	£925	£249,750
2	Risk Allowance / Optimism Bias	44	%	£249,750	£109,890
3	Allowance for Tender Inflation - 4Q24 to 4Q25	3	%	£359,640	£10,789
	TOTAL: BUILDING WORKS ESTIMATE (excluding Fees & VAT)				**£370,429**
4	Project and Design Teams Fees	15	%	£370,429	£55,564
5	Site Investigation, Permits and Approvals	1	item	£15,000	£15,000
	PROJECT ESTIMATE (excluding VAT)	**270**	**m^2**	**£1,633**	**£440,994**
6	VAT	20	%	£440,994	£88,199
	OPTION 1 PROJECT TOTAL				£529,192

City of York Council
River Ouse Riverbank
Cost Estimate

SUMMARY OPTION 2

1	Project Works	270	m	£4,620	£1,247,400
2	Risk Allowance / Optimism Bias	44	%	£1,247,400	£548,856
3	Allowance for Tender Inflation - 4Q24 to 4Q25	3	%	£1,796,256	£53,888
	TOTAL: BUILDING WORKS ESTIMATE (excluding Fees & VAT)				**£1,850,144**
4	Project and Design Teams Fees	15	%	£1,850,144	£277,522
5	Site Investigation, Permits and Approvals	1	item	£15,000	£15,000
	PROJECT ESTIMATE (excluding VAT)	**270**	**m^2**	**£7,936**	**£2,142,665**
6	VAT	20	%	£2,142,665	£428,533
	OPTION 2 PROJECT TOTAL				£2,571,198

masonclarkassociates

To **develop and sustain** the built environment through **technical excellence**, and to **nurture a successful business** in which our teams can **thrive**.

Encouraging all our staff to achieve their full potential.

Collaborating effectively across our offices in an open, inclusive and supportive culture.

Valuing our Clients and helping them to achieve their objectives.

Developing synergy with our professional colleagues across disciplines.

Delivering professional and technical expertise through our skilled and motivated teams.

Providing timely, cost effective and environmentally sustainable solutions.

Embracing change and innovation in our business practices and services.

Celebrating the Company's skills and successes through effective communication.

CIVIL ENGINEERING ● STRUCTURAL ENGINEERING
BRIDGE ENGINEERING ● CONSERVATION ENGINEERING
BUILDING SURVEYING ● COST CONSULTANCY
PROJECT MANAGEMENT & CDM

We are an **Equal Opportunities Employer**, and our services are delivered to the highest standard under our fully accredited **Quality and Environmental Management Systems**.

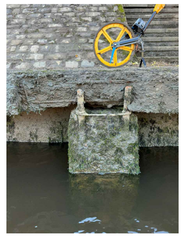
HULL | LEEDS | YORK

www.masonclark.co.uk

Version 4.0

Chainage 26m
Concrete spalling and exposed steel reinforcement on the capping beam. Additionally concrete spalling is visible on the reinforced concrete pile.

Chainage 76m
Large crack between the concrete path and reinforced concrete capping beam. The capping beam is tilting about its minor axis towards the river.

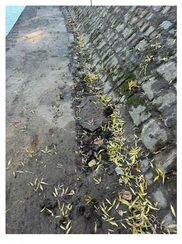


Chainage 131m
Concrete has spalled and broken away from surface of capping beam. Corroded steel reinforcement is exposed on the capping beam and pile.

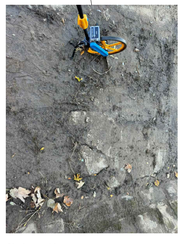
Chainage 176m
Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and exposed steel reinforcement in the capping beam.

Key Defects Plan
Scale 1:500

Chainage 0-5m
Overgrown vegetation and large build up of earth at the base of the pitched stone embankment.

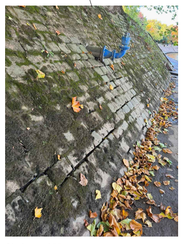


Chainage 55m
Void and broken up concrete slab at the base of the pitched stone retaining wall. Areas of slab loose at the surface.



Chainage 98m
Cracking and loose areas of concrete at the surface of the concrete path. Build up of silt on the concrete path slab and loose aggregate.

Chainage 176m
Failed capping beam, no longer sufficiently supported and breaking away from concrete path. Large cracking and exposed steel reinforcement in the capping beam.



Chainage 255m
Missing mortar and loose stones in the pitched stone embankment.

Notes

1. This drawing is subject to copyright and must not be reproduced, stored or transmitted in any form without prior permission from Mason Clark Associates.
2. This drawing is not to be scaled. All dimensions are to be checked on site by the contractor. Any discrepancies are to be notified to Mason Clark Associates. Obtain instructions prior to works commencing.
3. This drawing is to be read in conjunction with all the relevant contract drawings and specifications.
4. All dimensions are in millimetres and all levels are in metres AOD unless noted otherwise.
5. All work shall be carried out in accordance with Local Authority, Statutory Authority and Health & Safety Regulations.
6. Mason Clark Associates are not responsible for determining the appropriate fire period, fire boundary conditions or the associated design of fire protection or inherent fire resistance to any elements of structure, including all frames, posts, beams, joists, roof members and secondary structural elements such as lintels. Refer to the Architect or Project Manager for this information.

Health & Safety Information

In addition to the hazards and risks normally associated with the type of works detailed on this drawing, please note the following abnormal risks to Health & Safety.

Refer to Mason Clark Associates project specific Design Risk Assessment (DRA).

Construction Phase	
HAZ-C1	
HAZ-C2	
Maintenance Phase	
HAZ-M1	
HAZ-M2	
Demolition Phase	
HAZ-D1	
HAZ-D2	

It is assumed that all works will be carried out by a competent contractor working where appropriate to an approved method statement

Key:

- Reinforced concrete capping beam
- Concrete path slab
- Pitched Stone Embankment

Rev	Details	By	Date
P1	Preliminary - Initial Issue	ST	20.11.2024

masonclarkassociates
civil and structural engineering consultants
Hull +44 (0) 1482 345797
Leeds +44 (0) 113 277 9542
York +44 (0) 1904 438005
www.masonclark.co.uk

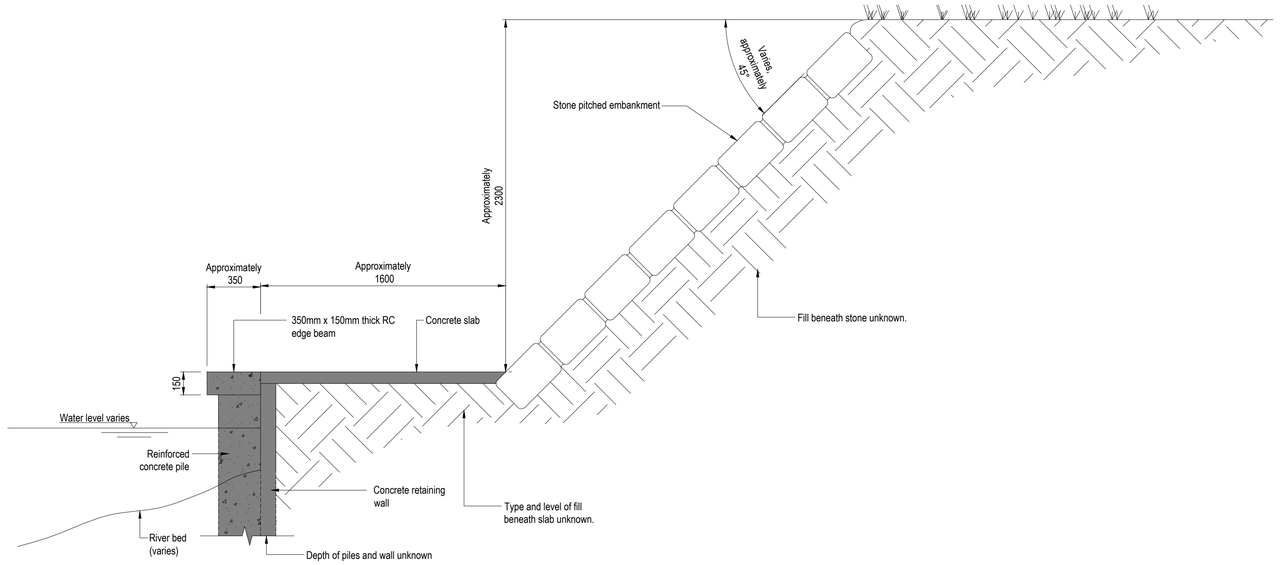
Client.
City of York Council

Project.
River Ouse
Riverbank Survey

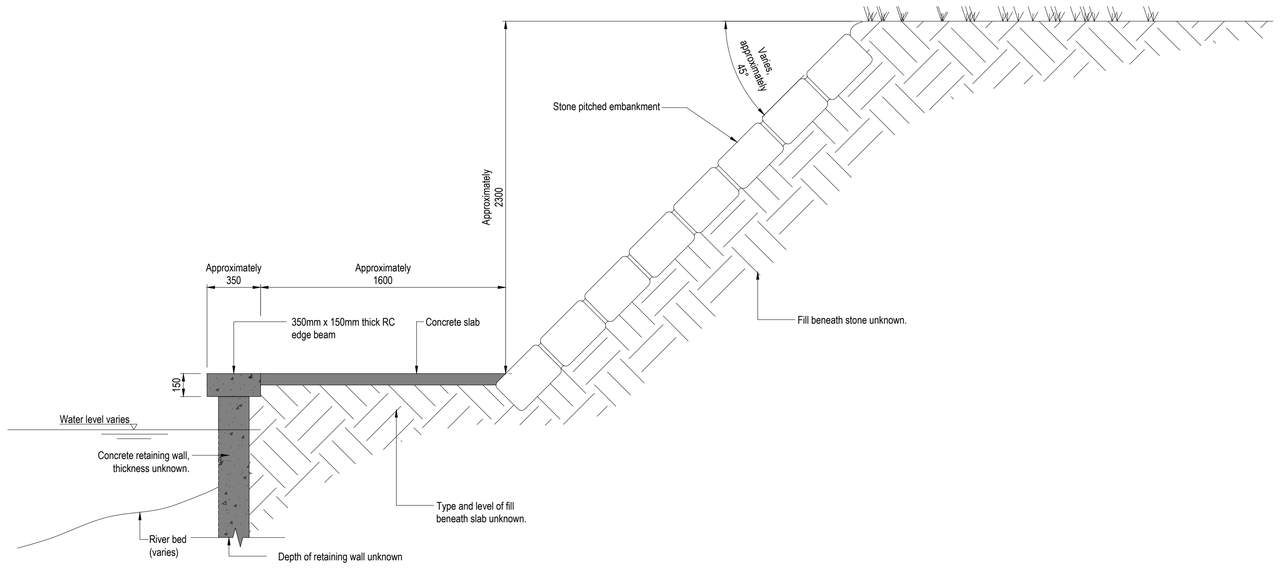
Title.
Key Defects Plan

Drawn: ST	Checked: AT	Date: Nov 2024
Scale @ A1 : As Shown		
Drawing No : 22594-H-DR-001		Rev: P1

W:\MCA Jobs\22500-22599\22594H - Co\YC - River Ouse Riverbank Survey\Drawings\Working Drawings\22594-H-DR-001 - Key Defects Plan.dwg



Section A-A
Wall Type 1
Scale 1:20



Section B-B
Wall Type 2
Scale 1:20

Notes

1. This drawing is subject to copyright and must not be reproduced, stored or transmitted in any form without prior permission from Mason Clark Associates.
2. This drawing is not to be scaled. All dimensions are to be checked on site by the contractor. Any discrepancies are to be notified to Mason Clark Associates. Obtain instructions prior to works commencing.
3. This drawing is to be read in conjunction with all the relevant contract drawings and specifications.
4. All dimensions are in millimetres and all levels are in metres AOD unless noted otherwise.
5. All work shall be carried out in accordance with Local Authority, Statutory Authority and Health & Safety Regulations.
6. Mason Clark Associates are not responsible for determining the appropriate fire period, fire boundary conditions or the associated design of fire protection or inherent fire resistance to any elements of structure, including all frames, posts, beams, joists, roof members and secondary structural elements such as lintels. Refer to the Architect or Project Manager for this information.

Health & Safety Information

In addition to the hazards and risks normally associated with the type of works detailed on this drawing, please note the following abnormal risks to Health & Safety.

Refer to Mason Clark Associates project specific Design Risk Assessment (DRA).

Construction Phase	
HAZ-C1	
HAZ-C2	
Maintenance Phase	
HAZ-M1	
HAZ-M2	
Demolition Phase	
HAZ-D1	
HAZ-D2	

It is assumed that all works will be carried out by a competent contractor working where appropriate to an approved method statement

Rev	Details	By	Date
P1	Preliminary - Initial Issue	ST	20.11.2024

Hull +44 (0) 1482 345797
Leeds +44 (0) 113 277 9542
York +44 (0) 1904 438005
www.masonclark.co.uk
masonclarkassociates
civil and structural engineering consultants

Client.
City of York Council

Project.
River Ouse
Riverbank Survey

Title.
Sections

Drawn: ST	Checked: AT	Date: Nov 2024
Scale @ A1 : As Shown		
Drawing No : 22594-H-DR-002		Rev: P1