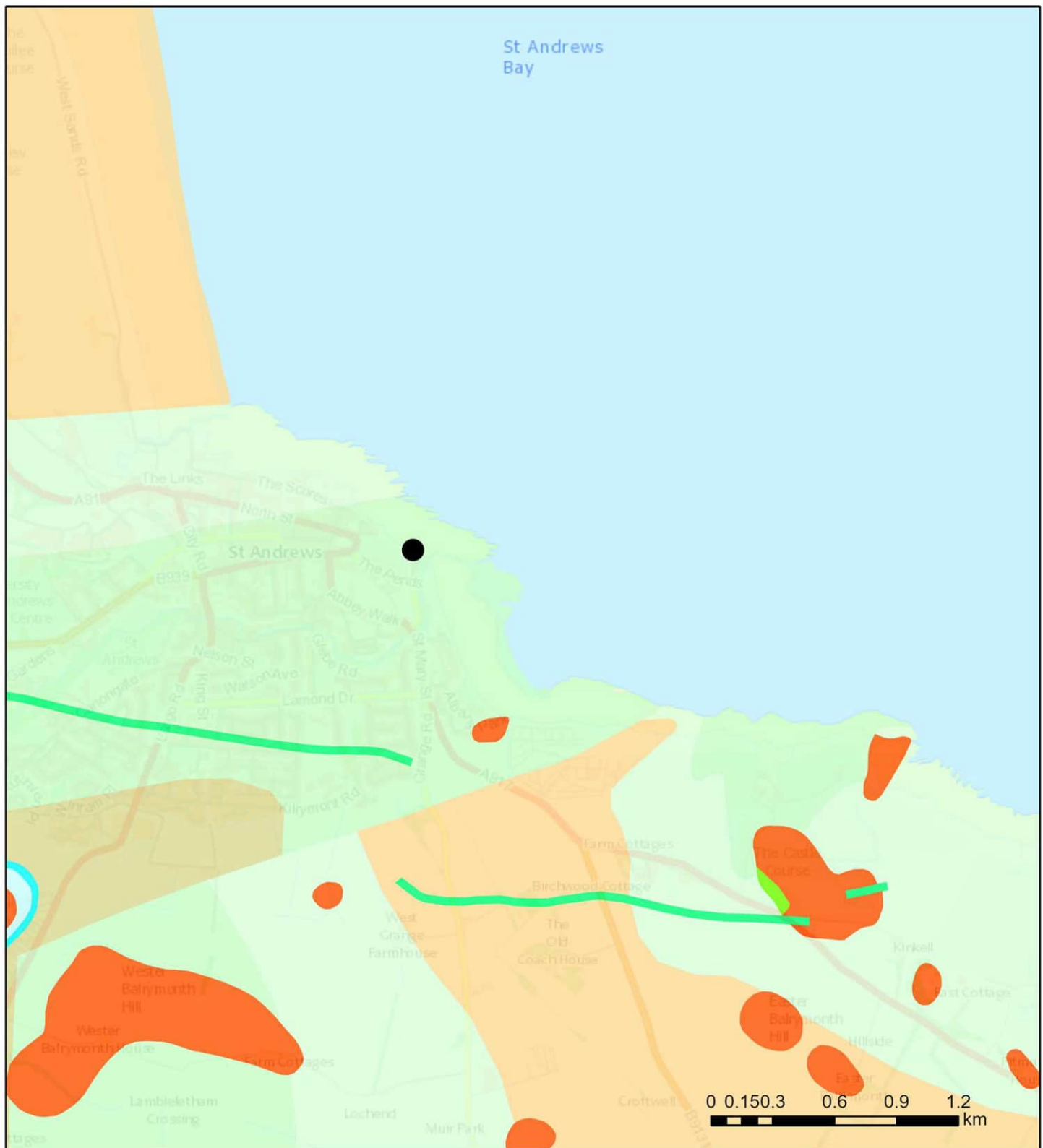


# Bedrock Geology












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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

## Map Key

Bedrock geology 1:50,000 scale

	<a href="#"><u>DINANTIAN TO WESTPHALIAN SILLS OF LOTHIAN AND FIFE - OLIVINE-BASALT</u></a>
	<a href="#"><u>LOWER LIMESTONE FORMATION - SEDIMENTARY ROCK CYCLES, CLACKMANNAN GROUP TYPE</u></a>
	<a href="#"><u>HURLET LIMESTONE - LIMESTONE</u></a>
	<a href="#"><u>PITTENWEEM FORMATION - SEDIMENTARY ROCK CYCLES, STRATHCLYDE GROUP TYPE</u></a>
	<a href="#"><u>ANSTRUTHER FORMATION - LIMESTONE</u></a>
	<a href="#"><u>SANDY CRAIG FORMATION - SEDIMENTARY ROCK CYCLES, STRATHCLYDE GROUP TYPE</u></a>
	<a href="#"><u>ANSTRUTHER FORMATION - SEDIMENTARY ROCK CYCLES, STRATHCLYDE GROUP TYPE</u></a>
	<a href="#"><u>PATHHEAD FORMATION - SEDIMENTARY ROCK CYCLES, STRATHCLYDE GROUP TYPE</u></a>
	<a href="#"><u>CENTRAL SCOTLAND LATE CARBONIFEROUS THOLEIITIC DYKE SWARM - QUARTZ-MICROGABBRO</u></a>
	<a href="#"><u>LIMESTONE COAL FORMATION - SEDIMENTARY ROCK CYCLES, CLACKMANNAN GROUP TYPE</u></a>
	<a href="#"><u>SCOTTISH LATE CARBONIFEROUS TO EARLY PERMIAN PLUGS AND VENTS SUITE - TUFF AND AGGLOMERATE</u></a>
	<a href="#"><u>SCOTTISH LATE CARBONIFEROUS TO EARLY PERMIAN PLUGS AND VENTS SUITE - BASALT, OLIVINE-MACROPHYRIC</u></a>
	<a href="#"><u>SCOTTISH LATE CARBONIFEROUS TO EARLY PERMIAN PLUGS AND VENTS SUITE - BASANITE</u></a>
	<a href="#"><u>MIDLAND VALLEY CARBONIFEROUS TO EARLY PERMIAN ALKALINE BASIC SILL SUITE - ANALCIME-GABBRO AND PICRITE</u></a>
	<a href="#"><u>MIDLAND VALLEY CARBONIFEROUS TO EARLY PERMIAN ALKALINE BASIC SILL SUITE - OLIVINE-BASALT</u></a>








# Superficial Deposits



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Geoindex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

## Map Key

Superficial deposits 1:50,000 scale

	<u>GLACIOFLUVIAL ICE CONTACT DEPOSITS - GRAVEL, SAND AND SILT</u>
	<u>TILL, DEVENSIAN - DIAMICTON</u>
	<u>ALLUVIUM - CLAY, SILT, SAND AND GRAVEL</u>
	<u>BLOWN SAND - SAND</u>
	<u>MARINE BEACH DEPOSITS - GRAVEL, SAND AND SILT</u>
	<u>RAISED MARINE DEPOSITS OF HOLOCENE AGE - SAND AND GRAVEL</u>
	<u>RAISED MARINE DEPOSITS, DEVENSIAN - CLAY, SILT, SAND AND GRAVEL</u>

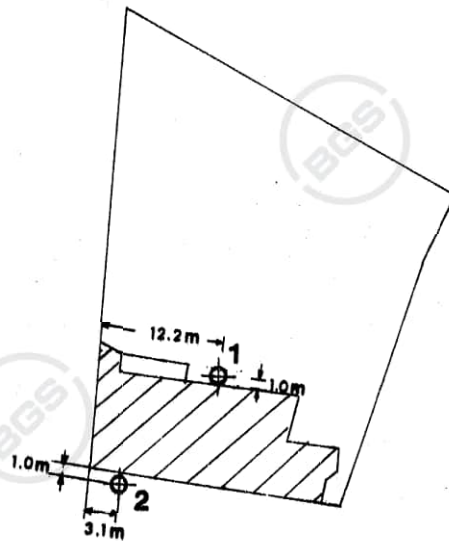
## Appendix 4 – Borehole Records for Large Structure

Boring method		Shell and Auger		Location		NO 5116		Record of BOREHOLE 1	
Boring diameter (mm)		150 to 4.45 m						(sheet 1 of 1)	
Casing diameter (mm)		150 to 4.15 m		Orientation		Vertical		Ground level (m.O.D.)	
Boring equipment		Hand operated rig.						Date commenced 5/5/76	
Samples and in situ tests		Casing Depth (m)	Water Depth (m)		Date and Depth (m)	DESCRIPTION OF STRATA		O.D. Level (m.O.D.)	Legend
Depth (m)	Type								
0.50	C6	-			2.75	CONCRETE		19.50	
1.00	BD					FILL (loose fine to coarse gravel sized fragments of brick, sandstone and shale in a matrix of dark grey clayey silty sand)			
1.25	C10	1.25							
1.50	BD								
2.00	C5	2.00			2.10			17.50	
2.50	BD					Loose becoming medium dense brown fine to coarse silty SAND with fine and medium angular and sub-angular gravel; clayey and silty above 2.50 m			
2.75	C9	2.75							
3.50	C13	3.50							
3.50	BD								
4.00	BD				4.15	Yellow and grey completely weathered fine and medium grained SANDSTONE (Possibly bedrock)		15.45	
4.30	D	4.15			4.45			15.15	
						END OF BOREHOLE			
<b>REMARKS</b> Ground-water was not encountered during boring. The borehole was advanced by chiselling between depths of 4.15 m and 4.45 m (1h).  For explanation of symbols and abbreviations see Notes, pages (i) and (ii)									
LAB Ref. No.		ST ANDREWS, GREGORY PLACE						Fig. 1	
8/11958/A		WIMPEY LABORATORIES LIMITED							





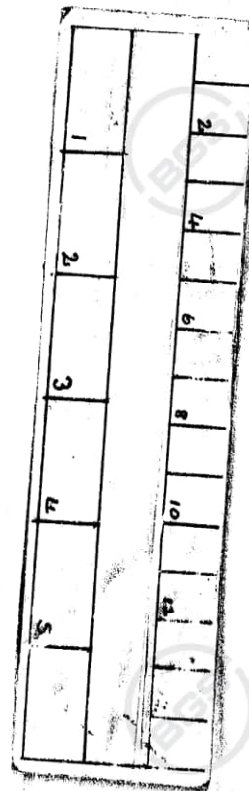
LOCATION PLAN  
Scale 1:2500



SITE PLAN

Scale 1: 500

⊕ Denotes Borehole



Lab. Ref. No.  
8/11958 A

ST. ANDREWS, GREGORY PLACE

Fig. 6

IMPNEY LABORATORIES LIMITED

## Appendix 5 – Borehole Records for Bridge





BOREHOLE RECORD SHEET

LOCATION : Shore Bridge - St. Andrews. WATER LEVELS : 2.74 INITIAL : 5.49 FINAL  
JOB NO. : 2024 BOREHOLE NO. : 1 DATE COMMENCED : 8-4-71  
SURFACE LEVEL : 3.79m. DIAMETER : 150mm. DATE COMPLETED : 12-4-71

MAP REF.

E									
N									

DESCRIPTION	Leg	Group Symbol	Depth	Thick- ness	Level	Samples	n (blows)	w (%)	$\gamma$ (lb./cu. ft.)	qu (lb./sq. ft.)	c (lb. sq. ft.)	$\phi$ (deg.)	L.L. (%)	P.L. (%)	P.I. (%)	INDICATED/RECOM- MENDED ALLOWABLE BEARING CAPACITY (Tons/sq. ft.)	
																Strip	Spread
Topsoil.			0.53	0.53	3.26												
Filling:- Soft Very Sandy Clay and Rubble.			0.99	0.46		U100											
					2.80	0.76											
Soft intact Dark Greyish (Silty) laminated Clay with traces of Peat.				2.44		D											
						1.22											
						U100		64.8	97		100	0	48	29	19	0.1	0.1
						1.67											
						D											
						2.13											
			3.43		0.36	U100		64.6	98		300	0				0.3	0.4
Soft intact Dark Greyish Sandy Clay containing Gravel.				0.84		3.20											
			4.27		-0.48	D											
						3.66											
CONTINUED/																	

REMARKS:

Sulphate content test at 1.67 m. :- 0.145%  
pH test at 1.67 m. :- 5.5

SYMBOLS: n - No. of blows per foot in standard penetration test w - Natural moisture content  $\gamma$  - Natural bulk density qu - Unconfined compressive strength c - Apparent cohesion  $\phi$  - Angle of internal friction  
L.L. - Liquid Limit P.L. - Plastic Limit P.I. - Plasticity Index U.4 - 4" Dia. Undisturbed Sample U.1.5 - 1.5" Dia. Undisturbed Sample D - Disturbed Sample B - Bulk Sample



BOREHOLE RECORD SHEET

LOCATION : Shore Bridge - St. Andrews.  
JOB NO. : 2024 BOREHOLE NO. 1 contd.  
SURFACE LEVEL : 150mm DIAMETER :

WATER LEVELS: 2.74 INITIAL : 5.49 FINAL  
DATE COMMENCED: 8-4-71  
DATE COMPLETED: 12-11-71

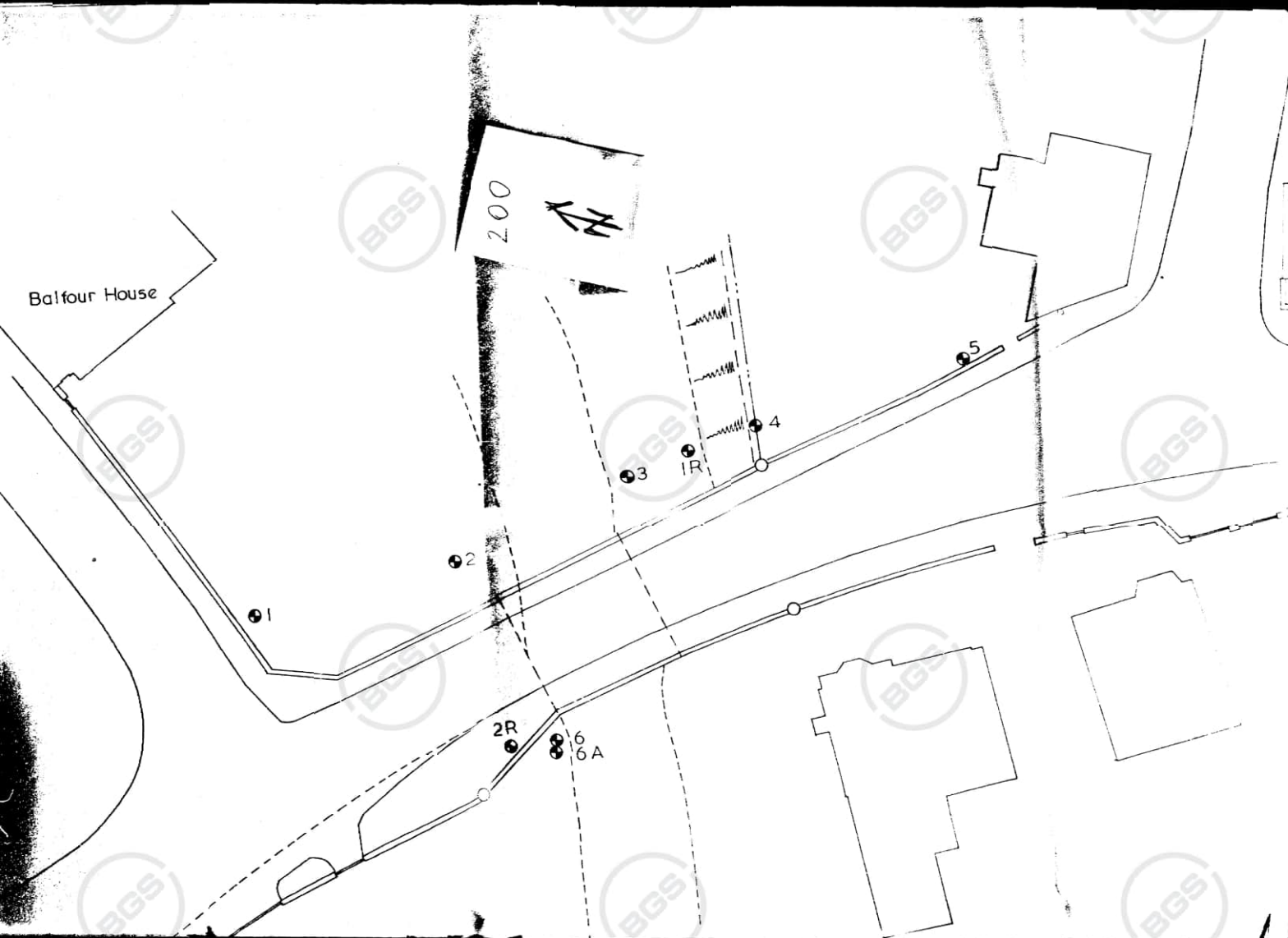
MAP REF.

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N					

DESCRIPTION	Leg	Group Symbol	Depth	Thick-ness	Level	Samples	n (blows)	w (%)	s (lb./cu. ft.)	qu (lb./sq. ft.)	c (lb. sq. ft.)	φ (deg.)	L.L. (%)	P.L. (%)	P.I. (%)	INDICATED/RECOM-MENDED ALLOWABLE BEARING CAPACITY (Tons/sq. ft.)	
																Strip	Spread
Stiff to Very Stiff intact Dark Brown (Sandy) Boulder Clay.			4.27			U100		13.7	135		1300	7	27	14	13	1.6	2.1
						4.57 D											
						5.18 U100		12.8	136		2450	3				2.4	3.1
						6.10 D											
						6.71 U100		12.3	137		1550	11				2.3	3.0
						7.62 D											
						8.23 U100											
						9.14 D											
			9.98		-6.19	9.75											
Soft Grey Shaley Sandstone.			10.89	0.91	-7.10												
Soft Sandstone.			11.81	0.92	-8.02	D											
						0.97											

REMARKS:

SYMBOLS: n - No. of blows per foot in standard penetration test w - Natural moisture content s - Natural bulk density qu - Unconfined compressive strength c - Apparent cohesion φ - Angle of internal friction  
L.L. - Liquid Limit P.L. - Plastic Limit P.I. - Plasticity Index U.4 - 4" Dia. Undisturbed Sample U.11 - 11" Dia. Undisturbed Sample D - Disturbed Sample B - Bulk Sample





BOREHOLE RECORD SHEET																																																					
LOCATION <u>Shore Bridge - St. Andrews.</u>		WATER LEVELS: <u>2.90</u> INITIAL: <u>2.90</u> FINAL		MAP REF. <table border="1"><tr><td>E</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>N</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>														E																		N																	
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JOB NO. <u>2024</u>	BOREHOLE NO. <u>2</u>	DATE COMMENCED: <u>31-3-71</u>																																																			
SURFACE LEVEL: <u>3.62m.</u> DIAMETER: <u>150mm.</u>		DATE COMPLETED: <u>8-4-71</u>																																																			
DESCRIPTION	Leg	Group Symbol	Depth	Thick-ness	Level m.	Samples	n (blows)	w (%)	s (lb. cu. ft.)	qu (lb. sq. ft.)	c (lb. sq. ft.)	φ (deg.)	L.L. (%)	P.L. (%)	P.I. (%)	INDICATED/RECOM-MENDED ALLOWABLE BEARING CAPACITY (Tons/sq. ft.)																																					
																Strip	Spread																																				
Topsoil.			0.69	0.69	2.93																																																
Filling:- Loose Sand and Rubble.				0.61		D	4*										0.2	0.2																																			
			1.30		2.32	1.22	0.76																																														
Loose fine to Medium Graded Brown Clayey Silty Sand and Gravel.				0.99		U100		25.9	119		200	1	20		19	1	0.2	0.3																																			
						1.52																																															
			2.29		1.33	D																																															
Soft intact Dark Greyish Silty Sandy Clay with layers of Sand and Gravel.				3.12		U100		32.9	113		150	4	26		18	8	0.2	0.3																																			
						2.44																																															
						3.05																																															
						U100		26.4	121		350	1					0.3	0.4																																			
						3.96																																															
			5.41		-1.79	D																																															
						4.57																																															
CONTINUED/																																																					
REMARKS: * Penetration test at 0.76m. :- 4 blows taken for initial penetration of 0.46m.																																																					
SYMBOLS: n - No. of blows per foot in standard penetration test w - Natural moisture content s - Natural bulk density qu - Unconfined compressive strength c - Apparent cohesion φ - Angle of internal friction L.L. - Liquid Limit P.L. - Plastic Limit P.I. - Plasticity Index U 4 - 4" Dia. Undisturbed Sample U 1 1/2 - 1 1/2" Dia. Undisturbed Sample D - Disturbed Sample B - Bulk Sample																																																					

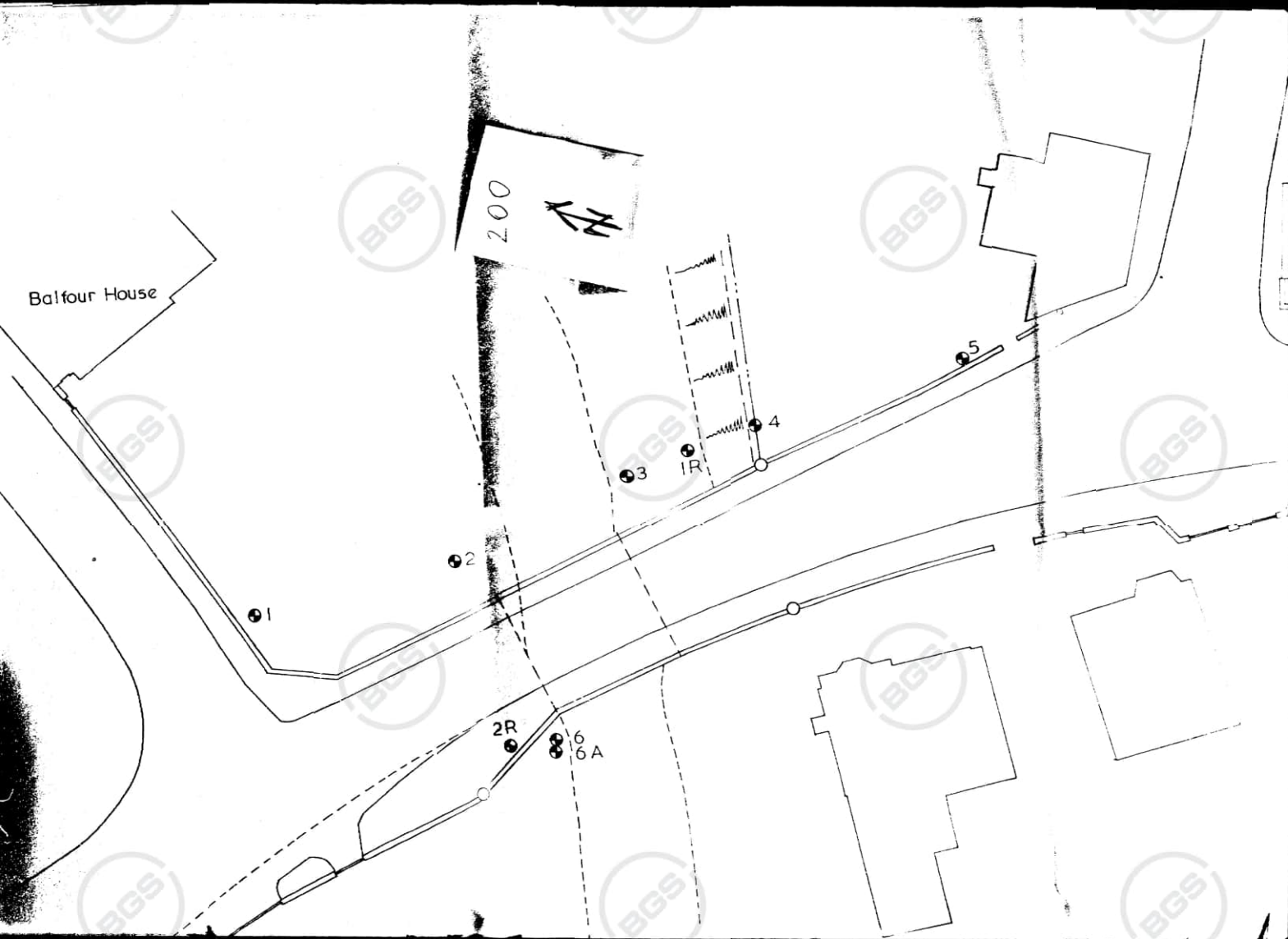




BOREHOLE RECORD SHEET																																																
LOCATION: <u>Shore Bridge - St. Andrews.</u>			WATER LEVELS: <u>2.90</u> INITIAL: <u>2.90</u> FINAL			MAP REF. <table border="1"><tr><td>E</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>N</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>											E																N															
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JOB NO. <u>2024</u> BOREHOLE NO. <u>2 contd.</u>			DATE COMMENCED: <u>31-3-71</u>																																													
SURFACE LEVEL: <u>3.62m.</u> DIAMETER: <u>150mm.</u>			DATE COMPLETED: <u>8-4-71</u>																																													
DESCRIPTION	Leg	Group Symbol	Depth	Thick-ness	Level m.	Samples	n (blows)	w (%)	s (lb./cu. ft.)	qu (lb./sq. ft.)	c (lb./sq. ft.)	φ (deg.)	L.L. (%)	P.L. (%)	P.I. (%)	INDICATED/RECOM-MENDED ALLOWABLE BEARING CAPACITY (Tons/sq. ft.)																																
																Strip	Spread																															
Stiff to Very Stiff intact Dark Brown Sandy Boulder Clay.			5.41	4.87		U100		11.9	139		2200	7	24	12	12	2.7	3.5																															
						5.64 D																																										
						6.10 U100		13.3	136		1100	1				1.0	1.3																															
						7.17 D																																										
						7.62 U100																																										
Soft Grey Shaley Sand-Stone.			10.28	0.92	-6.66	8.69 D																																										
			11.20		-7.58	10.97																																										
			12.11	0.91	-8.49																																											
Soft Sandstone.																																																

REMARKS: Sulphate content test at 1.52 :- 0.115% pH test at 5.64 :- 8.0  
pH test at 1.52 :- 8.0 Sulphate content test at 5.64 :- 0.096%

SYMBOLS: n - No. of blows per foot in standard penetration test w - Natural moisture content s - Natural bulk density qu - Unconfined compressive strength c - Apparent cohesion φ - Angle of internal friction  
L.L. - Liquid Limit P.L. - Plastic Limit P.I. - Plasticity Index U.4 - 4" Dia. Undisturbed Sample U.11 - 11" Dia. Undisturbed Sample D - Disturbed Sample B - Bulk Sample



## POKERFACE RECORD SHEET

LOCATION : Shore Bridge - St. Andrews.

WATER LEVELS: 0.30 INITIAL: 0.76 FINAL

MAP REF.

JOB NO. 2024 BOREHOLE NO. 3

DATE COMMENCED: 31-3-71

SURFACE LEVEL: 0.21m. DIAMETER: 150mm.

DATE COMPLETED: 7-4-71

E						
N						

[illegible]

## REMARKS:

\* Penetration test at 0.76 :- 3 blows taken for initial penetration of 0.46m.

\*\* U100 at 3.81 unsuccessful.

SYMBOLS: *n* - No. of blows per foot in standard penetration test  
*L.L.* - Liquid Limit    *P.L.* - Plastic Limit    *P.I.* - Plasticity Index

w - Natural moisture content       $\gamma$  - Natural bulk density       $q_u$  - Unconfined compressive strength       $c$  - Apparent cohesion       $\phi$  - Angle of internal friction  
U.4 - 4" Dia. Undisturbed Sample      U.15 - 1 1/2" Dia. Undisturbed Sample      D - Disturbed Sample      B - Bulk Sample





LOCATION : Shore Bridge - St. Andrews. WATER LEVELS: 0.30 INITIAL: 0.76 FINAL  
JOB NO. : 2024 BOREHOLE NO. 3 contd. DATE COMMENCED: 31-3-71  
SURFACE LEVEL: 0.21m. DIAMETER: 150mm. DATE COMPLETED: 7-4-71

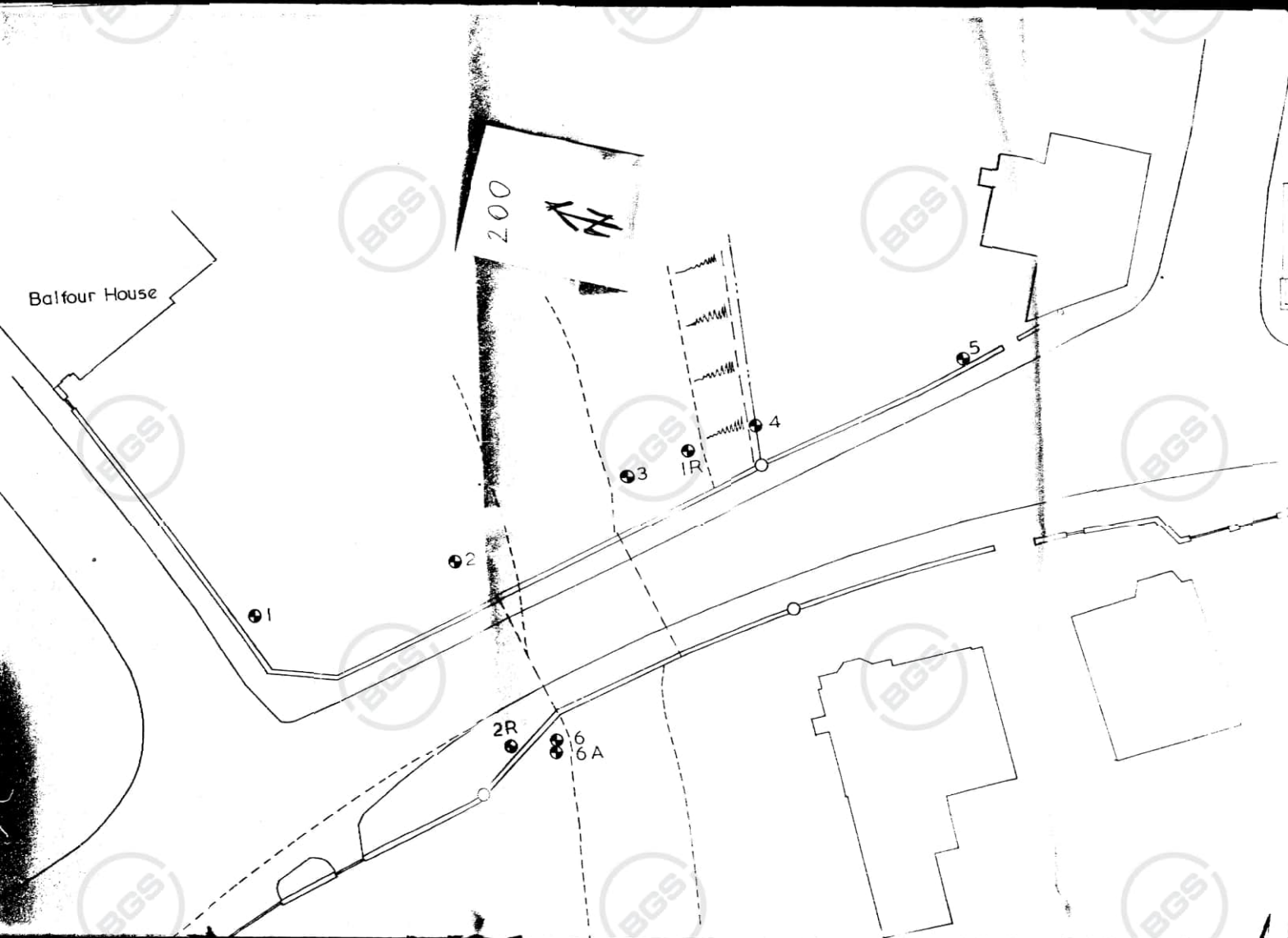
MAP REF. 

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N									

DESCRIPTION	Leg	Group Symbol	Depth	Thick-ness	Level	Samples	n (blows)	w (%)	s (lb./cu. ft.)	qu (lb./sq. ft.)	c (lb./sq. ft.)	φ (deg.)	L.L. (%)	P.L. (%)	P.I. (%)	INDICATED/RECOM-MENDED ALLOWABLE BEARING CAPACITY (Tons/sq. ft.)	
																Strip	Spread
Stiff intact Dark Brown (Sandy) Boulder Clay.			4.50	3.12		U100		13.3	137		1200	4	26	14	12	1.2	1.6
						4.57 D											
						5.18 U100											
						6.10 D											
			7.62		-7.41	6.71											
Soft Shaley Sandstone.			7.77	0.15	-7.56	D											
Soft Sandstone.			8.69	0.92	-8.48	7.77											

REMARKS:

SYMBOLS: n - No. of blows per foot in standard penetration test w - Natural moisture content s - Natural bulk density qu - Unconfined compressive strength c - Apparent cohesion φ - Angle of internal friction  
L.L. - Liquid Limit P.L. - Plastic Limit P.I. - Plasticity Index U.4 - 4" Dia. Undisturbed Sample U.1 1/2 - 1 1/2" Dia. Undisturbed Sample D - Disturbed Sample B - Bulk Sample





LOCATION Shore Bridge - St. Andrews. WATER LEVELS: 1.67 INITIAL: Dry FINAL  
JOB NO. 2024 BOREHOLE NO. 4 DATE COMMENCED: 23-3-71  
SURFACE LEVEL: 3.72m. DIAMETER: 150mm. DATE COMPLETED: 26-3-71

MAP REF.

E									
N									

DESCRIPTION	Leg	Group Symbol	Depth	Thick-ness	Level m.	Samples	n (blows)	w (%)	s (lb./cu. ft.)	qu (lb./sq. ft.)	c (lb./sq. ft.)	φ (deg.)	L.L. (%)	P.L. (%)	P.I. (%)	INDICATED/RECOM- MENDED ALLOWABLE BEARING CAPACITY (Tons/sq. ft.)	
																Strip	Spread
Topsail.			0.23	0.23	3.49	U100											
Filling:- Soft Very Sandy Clay, Sand and Gravel.				1.52		D											
			1.75		1.37	1.22	9										
Loose fine to Medium Graded Brown Sand and Gravel.				4.43		D	2.44									0.5	0.6
						D	2.74									0.5	0.6
						D	3.81									0.5	0.6
			6.18		-2.46	D	5.49										
Stiff intact Dark Brown (Sandy) Boulder Clay.				2.13		D	22										
						D	6.25									2.7	3.5
			8.31		-4.59	D	6.40									3.4	4.4
			8.84	0.53	-5.12	D	7.93										
Boulder. Stiff intact Dark Brown (Sandy) Boulder Clay.				2.13		D	33										
						U100	9.60	12.6	137		1800	3	29	15	15	4.8	5.0
						U100											
			10.97		-7.25	U100											
						U100											

REMARKS:

CONTINUED/

SYMBOLS: n - No. of blows per foot in standard penetration test  
L.L. - Liquid Limit P.L. - Plastic Limit P.I. - Plasticity Index

w - Natural moisture content  
U.4 - 4" Dia. Undisturbed Sample

s - Natural bulk density  
U.15 - 1 1/2" Dia. Undisturbed Sample

qu - Unconfined compressive strength  
D - Disturbed Sample

c - Apparent cohesion  
B - Bulk Sample

φ - Angle of internal friction

## DO NOT FORGET RECORDS - 5/1/68

LOCATION : Shore Bridge - St. Andrews.

WATER LEVELS: 1.67 INITIAL: Dry FINAL

MAP REF.

E					
N					

JOB NO. 2024 BOREHOLE NO. 4 contd.

DATE COMMENCED: 23-3-71

SURFACE LEVEL: 3.72m. DIAMETER: 150mm.

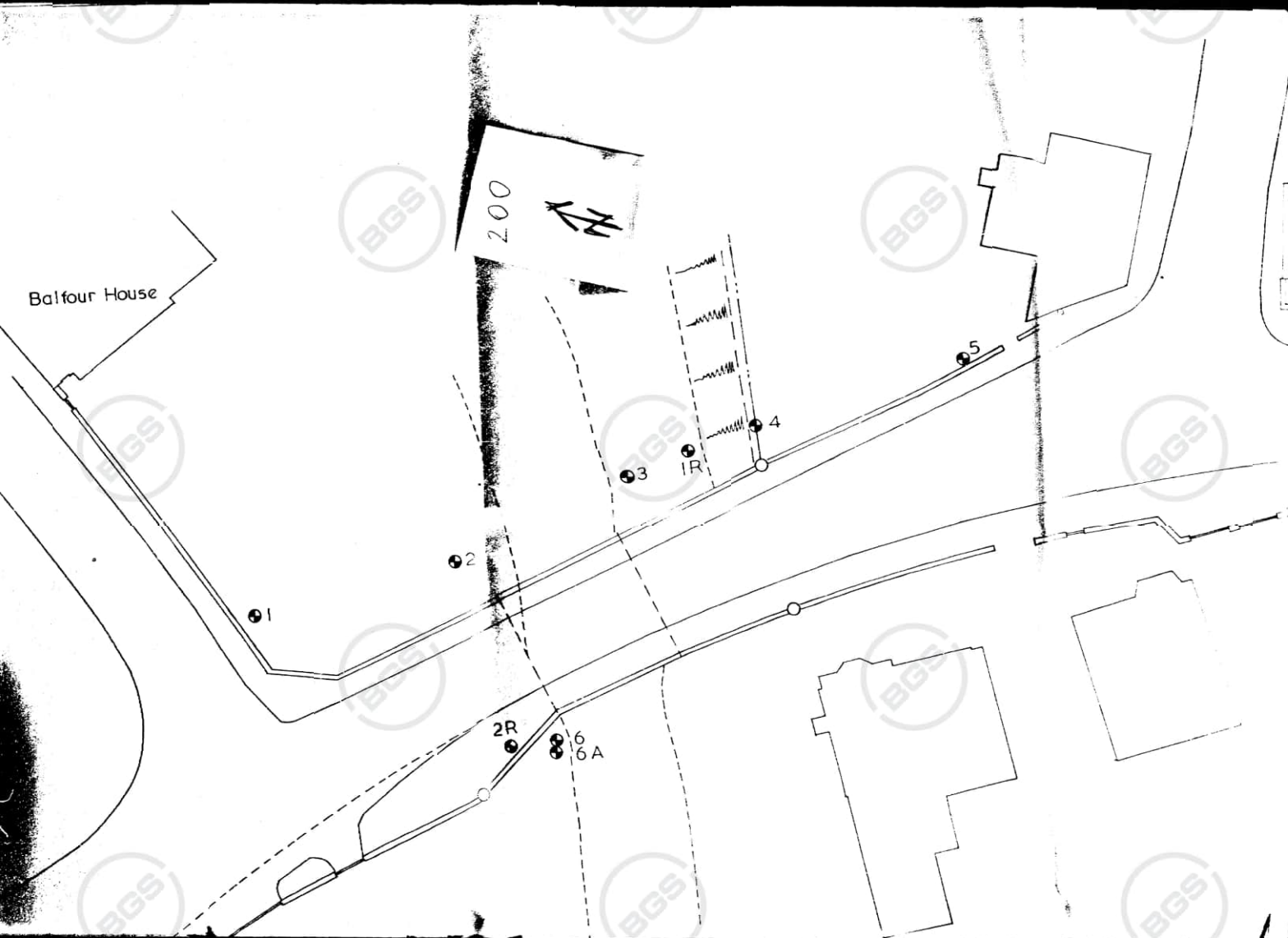
DATE COMPLETED: 26-3-71

[illegible]

REMARKS:

SYMBOLS:  $n$  - No. of blows per foot in standard penetration test     $w$  - Natural moisture content     $\gamma$  - Natural bulk density     $q_u$  - Unconfined compressive strength     $c$  - Apparent cohesion     $\phi$  - Angle of internal friction  
 $L.L.$  - Liquid Limit     $P.L.$  - Plastic Limit     $P.I.$  - Plasticity Index     $U_4$  - 4" Dia. Undisturbed Sample     $U_{12}$  - 12" Dia. Undisturbed Sample     $D$  - Disturbed Sample     $B$  - Bulk Sample







LOCATION : Shore Pridge - St. Andrews. WATER LEVELS: 5.41 INITIAL: 3.66 FINAL  
JOB NO. : 2024 BOREHOLE NO. 5 DATE COMMENCED: 26-3-71  
SURFACE LEVEL: 4.09m. DIAMETER: 150mm. DATE COMPLETED: 29-3-71

MAP REF.

E									
N									

DESCRIPTION	Leg	Group Symbol	Depth	Thick-ness	Level m.	Samples	n (blows)	w (%)	s (lb./cu. ft.)	q <sub>u</sub> (lb./sq. ft.)	c (lb./sq. ft.)	φ (deg.)	L.L. (%)	P.L. (%)	P.I. (%)	INDICATED/RECOM- MENDED ALLOWABLE BEARING CAPACITY (Tons/sq. ft.)	
																Strip	Spread
Topsoil.			0.23	0.23	3.86												
Filling:- Topsoil, Gravel and Sandstone.			0.69	0.46	3.40												
Filling:- Loose Sand, Gravel and Clay.				0.91		U100											
			1.60		2.49	D											
Soft intact Dark Greyish Silty Sandy Clay with layers of Sand and Gravel.				0.69		U100											
			2.29		1.80	D											
Soft intact Dark Greyish Silty Sandy Clay with traces of Peat.				3.12		U100		44.3	109		150	2	35	23	12	0.2	0.3
						D											
			5.41		-1.32	D											
Compact fine to Medium Graded Brown Sand and Gravel.				0.92		D	25									1.6	2.1
			6.33		-2.24	D	5.64										
						D	5.79										

REMARKS:

CONTINUED/

Sulphate content test at 2.44 :- 0.162% pH test at 2.44 :- 7.5

SYMBOLS: n - No. of blows per foot in standard penetration test w - Natural moisture content s - Natural bulk density q<sub>u</sub> - Unconfined compressive strength c - Apparent cohesion φ - Angle of internal friction  
L.L. - Liquid Limit P.L. - Plastic Limit P.I. - Plasticity Index U.4 - 4" Dia. Undisturbed Sample U.15 - 15" Dia. Undisturbed Sample D - Disturbed Sample B - Bulk Sample

## DOREHOLL RECORD SHEET

LOCATION : Shore Bridge - St. Andrews  
 JOB NO. 2024 BOREHOLE NO. 5 contd.  
 SURFACE LEVEL: 4.09m DIAMETER: 150mm

WATER LEVELS: 5.41 INITIAL: 3.66 FINAL  
DATE COMMENCED: 26-3-71  
DATE COMPLETED: 29-3-71

MAP REF.

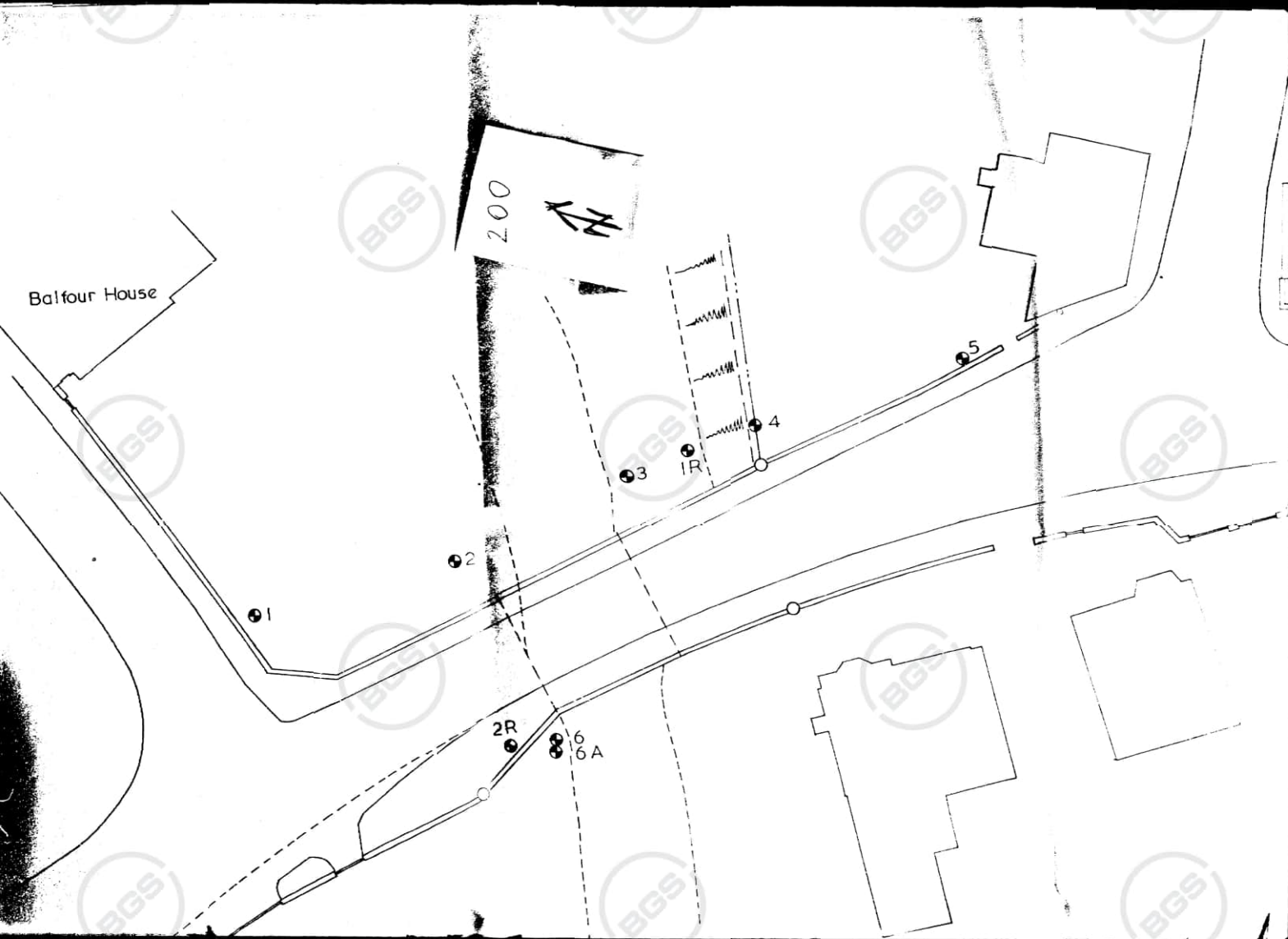
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REMARKS:

SYMBOLS:  $n$  - No. of blows per foot in standard penetration test       $w$  - Natural moisture content       $\gamma$  - Natural bulk density       $q_u$  - Unconfined compressive strength       $c$  - Apparent cohesion       $\phi$  - Angle of internal friction  
 $L.L.$  - Liquid Limit       $P.L.$  - Plastic Limit       $P.I.$  - Plasticity Index       $U_4 - 4"$  Dia. Undisturbed Sample       $U_{12} - 12"$  Dia. Undisturbed Sample       $D$  - Disturbed Sample       $B$  - Bulk Sample





## Appendix 6 – Report ‘Monitoring of Damage and Erosion of the North West Slipway, – October 202



## **Monitoring of damage and erosion of the North-west Slipway St Andrews Harbour**

Report compiled by:  
Neil Cunningham Dobson: Trustee and Archaeological Advisor

October 2020

## Location

Located at the north-west corner of the Shorehead, St Andrews harbour, the slipway/ramp is an integral part of the A-listed historic fabric of the harbour.



*The location of the NW Slipway at the Shorehead, St Andrews harbour.*

## Description

It was constructed in the 17<sup>th</sup> century to permit horse-drawn wagon access to the rocky foreshore for the purposes of quarrying rock. It was probably first constructed as part of the repair and upgrade plan for the harbour following disastrous storm damage in 1655 and rebuilt in 1656 with stone from the ruined castle.

Below the cliff, a slipway paved with large setts descends to the tidal rocks; its marginal slabs are hollowed to a shallow gutter. The slipway is 3.50m (12ft) wide and 16.50m (54ft) long and slopes from east to west. It leads to a 19th century rock-cut wagon way that heads off across the rock skerries towards St Andrews castle. Subsequent wave and sea action over time has removed the earth and exposed the underlying geology.

## Erosion Damage

Ongoing monitoring of the north-west slipway by St Andrews Harbour Trust and Fife Council's Archaeological Unit since 2002 has revealed an alarming rate of active structural deterioration caused by impact damage. Loose stone dumped around the base of the structure is being cast against the ramp during storm events. As a result, the outer bonded fabric is being removed and the inner rubble core is being exposed to wave action. This is an active and ongoing process which is becoming worse over time. Left unchecked it will result in the ever-increasing loss of historic harbour fabric, ultimately leading to the loss of the slipway/ramp.



**Background**

The loose stone causing the problem is not natural. It is alien material that was brought in and dumped near the ramp in the 1970s as part of a North East District Fife Council funded programme of coastal cliff stabilisation. The loose rock was dumped to create a rock armour defence (was also used for plant and machinery access) along the base of the eroding cliff face, the intention being to dissipate wave impact and so protect the cliff-face stabilisation works. However, time has shown this rock armour defence to have been ineffective. The rock was quickly scattered by wave action. The loose stone now serves only to scour the area and to be catapulted against the ramp during storms.

The rock armour failed within only a few years of its installation and as early as the 1980s, the problem of loose stone being cast against the ramp became apparent. Indeed, by 2002, the ramp was exhibiting alarming erosion damage.

This problem was addressed by the Harbour Trustees in 2003 when the Trust commissioned works to have the loose, scattered rock collected by digger and deposited in front of the sea-damaged ramp to form a rock armour defence.

It is now clear that this engineering approach has failed. The rock was quickly scattered by storm action and now, to an even greater extent than before, the loose rock is being regularly catapulted against the ramp during storm events.

**The Solution**

It is essential that the cause of this problem is stopped. The only way to achieve this to completely remove the loose boulders and displaced slipway stones from the area around the ramp and trackway and initiate rebuilding and repair of the slipway to where it connects to the trackway. It would be desirable for the original stones to be reinstated; with the intrusive beach cobbles removed from the ramp surface and replaced with more appropriate stones; and where necessary key elements, such as the lower kerbs, pinned or otherwise securely bonded to the underlying rock upon which they formerly rested.

Modern construction methods would be the preferred methodology along with the relevant planning consents and permissions.

**Monitoring of erosion damage**

In October 2003 following damage to the structure of the NW slipway leading down to the foreshore at the Shorehead a programme of works was proposed to apply a rock armour defence to the north of the slipway to mitigate further damage pending reinstatement of the displaced stones. On behalf of the St Andrews Harbour Trust an archaeological watching brief was carried out by the Scottish Institute of Maritime Studies, at St Andrews University during the remedial works. The works were carried out successfully and a layer of boulders placed over the trackway and in the corner over the base of the slipway



*The covered trackway and pile of mobile boulders at the base of the slipway October 2003*



*The exposed base of the slipway and area of shingle and boulders. October 2003.*





*Boulders removed to expose the trackway. October 2003*



*The side section of wall at the base of the slipway. October 2003.*



## Monitoring in March 2007



*Boulders moved by the sea and up against the side and base of the slipway. March 2007.*



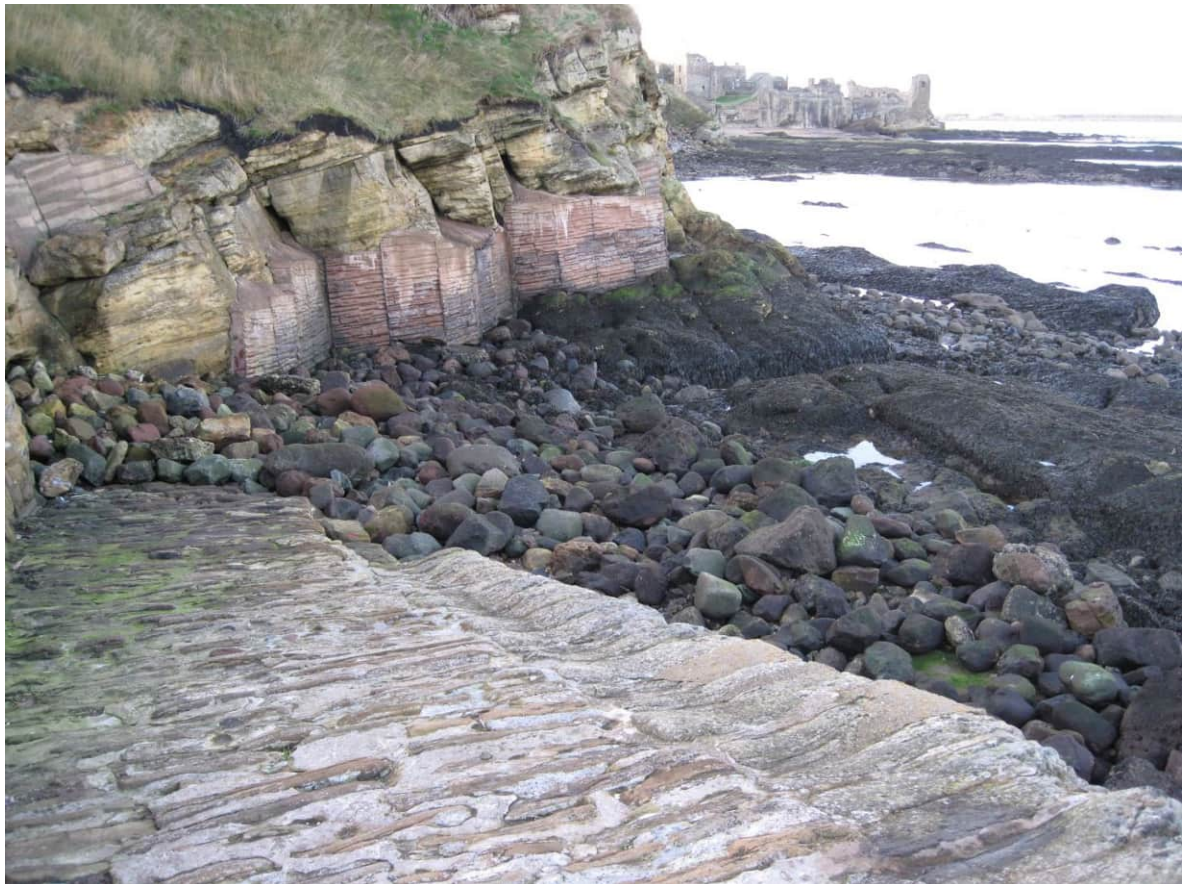
*Damage to the surface of slipway by mobile boulders. March 2007.*



## Monitoring in December 2011



*Boulder distribution at low water. December 2011.*



*Sea action piling boulders up against the slipway and corner of cliff. December 2011.*

### **Boulder removal during the early summer of 2014**

During the early summer of 2014 the Harbour Trust was able to secure a weekend of support from a British Army regiment based at Leuchars. As part of their local engagement they supplied men and equipment to conduct stone removal to ease the pressure of boulder damage to the slipway.



## Monitoring in March 2015



*Boulders slowly showing signs of creeping back to the slipway/ March 2015.*



*Sea action is starting to break away at the lower section of the slipway. March 2015.*