

7.0 APPENDIX

7.3 APPENDIX 3:  
MATERIALS ANALYSIS

**HIGHGATE CEMETERY:  
CHAPELS & ENTRANCE BUILDING, SOUTH LODGE**

**RIBA STAGE 3 SCHEDULE OF WORKS APPENDIX 3**

**MATERIALS ANALYSIS**

WEST SCOTT ARCHITECTS  
Issue P2: Draft final: October 2024

# 1. MORTAR ANALYSIS

Carried out by Peter Ellis FSA

HIGHGATE CEMETERY

SCHEDULE OF SAMPLING AND INVESTIGATIONS  
MORTAR AND RENDER ONLY

Building	Sample No	Sample location	Sample details	Sample date	Analysis	Results
<b>Chapel</b>						
	1/M1		Brickwork bedding mortar	Not yet available		
	1/M2		Stone bedding mortar	Not yet available		
<b>Cuttings catacombs</b>						
	5/M1	Gap at Vault 8	Brick pointing mortar	27/03/2024		
	5/M2	Gap at Vault 8	Brick bedding mortar	Not yet available		
	5/M3	Vault 13 façade	Render, 2 coats, possibly modern	27/03/2024		
	5/M4	Vault 11 (Baxter)	Render historic	27/03/2024		
<b>Egyptian Avenue</b>						
	6/M1	Avenue lower façade	Render	Not yet available		
	6/M2	RH obelisk	Render (Roman cement?) 3 samples	27/03/2024		
	6/M3	LH obelisk	Render (Roman cement?) 1 sample	27/03/2024		
<b>Circle of Lebanon</b>						
	7/M1	Inner circle façade	Brickwork bedding mortar	Not yet available		
	7/M2	Inner circle façade	Historic render previously reattached with s-steel pin	23/03/2024		
	7/M3	Outer circle East steps plinth	Render 1 sample	27/03/2024		
<b>Terrace catacombs</b>						
	8/M1	East wing façade	Yellow render base coat	27/03/2024		
	8/M2	East wing façade	Yellow render top coat	27/03/2024		
	8/M3	East wing façade	Grey render base coat	27/03/2024		
	8/M4	East wing façade	Grey render top coat	27/03/2024		
	8/M5	West wing transept	Internal render from door jamb	27/03/2024		
	8/M6	West wing transept	Internal plaster wall and vaulted ceiling	27/03/2024		
	8/M7	East wing ramp retaining wall	Render backing coat	22/04/2024		
	8/M8	East wing ramp retaining wall	Render finish coat	22/04/2024		
<b>Mausolea</b>						
<b>Beer</b>						
	9b/M1	Lower level entrance court	Brickwork pointing mortar	27/03/2024		
	9b/M2	Lower level entrance court	Gateway render	27/03/2024		
	9b/G1	Upper level interior	Pate de verre tile fragments	27/03/2024		

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Materials, Method & Analysis

June 17, 2024.

**Highgate Cemetery, London N6.  
Mortar Analysis. Results Summary - 5809/HC/01-06.**

The results of my analysis of the six samples are as follows.

**Sample 5/M4 (5809/HC/01).** This render sample from Vault 11 (Baxter) in the Cuttings catacombs comprises a thin pale grey finish coat applied to a yellow-brown backing coat. The finish coat has not been tested but it is almost certainly Portland cement mixed with fine sand probably at circa 1: 3. The backing coat has not fully carbonated and is Portland cement and washed yellow-brown quartz sand at circa 1 : 4 to 5. I understand this vault may date from circa 1850 and whilst it is possible that this render dates from then, I think it more likely to be later. Portland cement was not in common use in London until the 1860s and the lack of full carbonation and the washed sand may suggest a late 19<sup>th</sup> or early 20<sup>th</sup> century material.

**Sample 6/M2 (5809/HC/02).** This render sample from the RH Obelisk in Egyptian Avenue is a Roman cement binder and fine quartz sand at circa 1: 2. Roman cement was patented in 1796 and produced by calcining natural concretions known as septaria. It was a fast-setting material used primarily for external renders and run mouldings. It was gradually superseded by early Portland cements in the 2<sup>nd</sup> half of the 19<sup>th</sup> century. This is likely to be the original 1839 material.

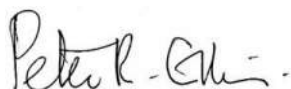
**Sample 6/M3 (5809/HC/03).** This render sample from the LH Obelisk in Egyptian Avenue is also a Roman cement binder and fine quartz sand at circa 1: 2. It is similar to Sample 6/M2 and likely to be the original 1839 material.

**Sample 7/M2 (5809/HC/04).** This render sample from the inner circle façade of the Circle of Lebanon is also a Roman cement binder and fine quartz sand at circa 1: 2. It is similar to Samples 6/M2 and 6/M3 and likely to be the original 1839 material.

**Sample 8/M7 (5809/HC/05).** This backing coat render from the east wing ramp retaining wall to the Terrace catacombs is Portland cement mixed with a medium quartz and flint sand at circa 1: 3 to 4. Portland cement was not manufactured until the mid-1840s and not in common use in London until the 1860s and this material cannot date from 1839.

**Sample 8/M8 (5809/HC/06).** This finish coat render from the east wing ramp retaining wall to the Terrace catacombs is Portland cement mixed with fine quartz sand at circa 1: 3 and as with Sample 8/M7 cannot date from 1839.

Please do come back to me if you would like to discuss my findings.



## Mortar Analysis

### Test Report No. 5809/HC/01.

### Highgate Cemetery, London N6.

### Cuttings Catacombs. Sample 5/M4.

A sample (39.5g) of external backing coat render collected from Vault 11 (Baxter) in the Cuttings catacombs has been analysed chemically and microscopically.

#### Sample Assessment and Microscopic Observations.

Thin (2mm-3mm) hard pale grey finish coat removed prior to analysis. Intact yellow-brown render fragments c.12mm thick. High strength (sample could not be broken by hand nor crumbled in fingers; disrupted using pestle with difficulty). Aggregate is principally yellow quartz with occasional particles of other geological types. Calcareous aggregate not positively determined. Kiln-fuel particles not found. Hair or fibre reinforcement not present.

#### Preliminary Tests.

Damp sample. Partially carbonated (phenolphthalein carbonation test).  
Apparent water permeability low (water droplet absorption on dried surface).  
Moderate effervescence on addition of dilute hydrochloric acid.

#### Chemical Dissolution Analysis (% dry mass) to BS4551:2005+A2:2013 (+ICP-OES).

%	Initial Moisture (oven @ 100 <sup>0</sup> C)	8.56
%	Total Calcium as CaO (titrimetric method)	10.83
%	Total Magnesium as MgO (ICP-OES method)	0.28
%	Acid & alkali soluble Silicon as SiO <sub>2</sub> (gravimetric method)	2.59
%	Soluble Aluminium as Al <sub>2</sub> O <sub>3</sub> (ICP-OES method)	1.18
%	Soluble Iron as Fe <sub>2</sub> O <sub>3</sub> (ICP-OES method)	0.77
%	Total (acid-soluble) sulphate as SO <sub>3</sub> (gravimetric method)	0.58
%	Total Acid Insolubles	76.1

#### BINDER

The binder in this sample is partially carbonated Portland cement as confirmed by the elevated soluble silica, alumina and iron test results.

#### AGGREGATE

**Insoluble particle size range: 3.35mm to 45µm ( 97.1%) : <45µm ( 2.9%)**

The acid-insoluble residue is a washed sand principally comprising:

Yellow-brown quartz

Occasional particles of other geological and mineral types.

Yellow-brown fines - principally clay and very fine quartz.

## **TEST REPORT 5809/HC/01**

### **MORTAR BY VOLUME**

Acid-soluble calcareous aggregate was not positively determined, and an allowance has therefore not been made. The results adjusted for typical bulk density indicate a volumetric mix of approximately:

1 part	(Early?) Portland cement
4 to 5 parts	Aggregate

### **COMPARATIVE HYDRAULICITY**

The hydraulicity determined is more hydraulic than modern NHL5.

### **SUGGESTED MATCHING MIX**

**This is not a specification for a repair mortar, nor must it be treated as one.**

The 'Portland cement' patented by Joseph Aspdin in 1829 was in fact an artificial hydraulic lime, and it wasn't until the mid-1840s that his son William developed a material that would be recognised today as Portland cement. The binder in this sample must be later than 1845 and partial carbonation may suggest it is late 19<sup>th</sup> or early 20<sup>th</sup> century.

If this mortar were to be matched on a 'like-for-like' basis, the following approximate volumetric matching mix recipe might be helpful.

This does not necessarily imply that I recommend a 'like-for-like' repair mortar mix design in this particular situation, as there are many relevant factors in addition to mortar analysis that must be taken into account when deciding on mortar specification.

1 part	Portland cement
4 to 5 parts	Yellow-brown quartz sand <3.35mm

### **SOURCES OF MATERIALS**

Many limes, sands, stonedusts and aggregates are available from Rose of Jericho.

### **NOTES:**

1. Sample mixes must always be prepared to ensure suitability and an accurate colour and texture match.
2. Sands and aggregates conforming to the relevant European Standard and with a particle size and grading appropriate for the intended use must be selected.
3. Manufacturers advice should be sought and recommended application mix proportions and 'Best Practice' guides must be complied with.
4. It should be remembered that mortars change over time. When analysing an aged material, one is ascertaining what it now is and looking for evidence for what it originally was. Calcium hydroxide carbonates to form calcium carbonate, and calcium silicate hydrate (C-S-H), the principal reaction product in hydraulic limes and pozzolanic limes itself reacts over time with carbonic acid to produce calcium carbonate and hydrous siliceous, aluminate and silico-aluminate gels.

15.06.2024

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**TEST REPORT 5809/HC/01**

**IMAGES OF SAMPLE & INSOLUBLE RESIDUES**



5809/HC/01  
Sample as tested



5809/HC/01  
Insolubles >45 $\mu$ m  
Stereomicroscope x10



5809/HC/01  
Insoluble fines <45 $\mu$ m  
Stereomicroscope x20



## Mortar Analysis

### Test Report No. 5809/HC/02.

### Highgate Cemetery, London N6.

### Egyptian Avenue. Sample 6/M2.

A sample (36.3g) of render collected from the RH Obelisk has been analysed chemically and microscopically. This is thought to be the original early/mid-19<sup>th</sup> century material.

#### Sample Assessment and Microscopic Observations.

Intact brown render fragments c.15mm thick. High/moderate (variable) strength (fragments could not be broken by hand nor crumbled in fingers; disrupted using pestle with some difficulty). Aggregate is principally fine yellow-brown quartz. Calcareous aggregate not positively determined. Kiln-fuel particles not found. Hair or fibre reinforcement not present.

#### Preliminary Tests.

Dry sample. Fully carbonated (phenolphthalein carbonation test).  
Apparent water permeability moderate/low (water droplet absorption on dried surface).  
Moderate effervescence on addition of dilute hydrochloric acid.

#### Chemical Dissolution Analysis (% dry mass) to BS4551:2005+A2:2013 (+ICP-OES).

%	Initial Moisture (oven @ 100 <sup>o</sup> C)	3.31
%	Total Calcium as CaO (titrimetric method)	16.74
%	Total Magnesium as MgO (ICP-OES method)	0.44
%	Acid & alkali soluble Silicon as SiO <sub>2</sub> (gravimetric method)	3.87
%	Soluble Aluminium as Al <sub>2</sub> O <sub>3</sub> (ICP-OES method)	1.51
%	Soluble Iron as Fe <sub>2</sub> O <sub>3</sub> (ICP-OES method)	0.85
%	Total (acid-soluble) sulphate as SO <sub>3</sub> (gravimetric method)	5.66
%	Total Acid Insolubles	61.1

#### BINDER

The binder in this sample is hydraulic as confirmed by the elevated soluble silica, alumina and iron test results, and is a binder of the 'Roman cement' type. The elevated sulphate is likely to indicate a surface reaction in a polluted sulphurous environment and does not indicate gypsum to be a deliberate mix component.

#### AGGREGATE

**Insoluble particle size range: 1.60mm to 45µm ( 90.8%) : <45µm ( 9.2%)**

The acid-insoluble residue principally comprises:

Yellow-brown quartz

Occasional particles of other geological and mineral types.

Reddish-brown fines - principally clay.

## **TEST REPORT 5809/HC/02**

### **MORTAR BY VOLUME**

Acid-soluble calcareous aggregate was not positively determined, and an allowance has therefore not been made. The results adjusted for typical bulk density indicate a volumetric mix of approximately:

1 part	Roman cement
2 parts	Aggregate

### **COMPARATIVE HYDRAULICITY**

The hydraulicity determined is more hydraulic than modern NHL5.

### **SUGGESTED MATCHING MIX**

**This is not a specification for a repair mortar, nor must it be treated as one.**

Roman cements were manufactured in the late 18<sup>th</sup> and 19<sup>th</sup> century by calcining septaria, a natural calcareous 'concretion' and are no longer produced. Repair mixes are normally based on Vicat Prompt natural cement.

If this mortar were to be matched on a 'like-for-like' basis, the following approximate volumetric matching mix recipe might be helpful.

This does not necessarily imply that I recommend a 'like-for-like' repair mortar mix design in this particular situation, as there are many relevant factors in addition to mortar analysis that must be taken into account when deciding on mortar specification.

1 part	Prompt Natural Cement*
1.5 parts	Yellow-brown quartz sand <1.60mm
0.5 parts	Hornton brown sand <1.18mm

**\*Note:** This is a fast-setting binder and a set-retarder may be necessary

### **SOURCES OF MATERIALS**

Many limes, sands, stonedusts and aggregates are available from Rose of Jericho.

### **NOTES:**

1. Sample mixes must always be prepared to ensure suitability and an accurate colour and texture match.
2. Sands and aggregates conforming to the relevant European Standard and with a particle size and grading appropriate for the intended use must be selected.
3. Manufacturers advice should be sought and recommended application mix proportions and 'Best Practice' guides must be complied with.
4. It should be remembered that mortars change over time. When analysing an aged material, one is ascertaining what it now is and looking for evidence for what it originally was. Calcium hydroxide carbonates to form calcium carbonate, and calcium silicate hydrate (C-S-H), the principal reaction product in hydraulic limes and pozzolanic limes itself reacts over time with carbonic acid to produce calcium carbonate and hydrous siliceous, aluminate and silico-aluminate gels.

14.06.2024

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**TEST REPORT 5809/HC/02**

**IMAGES OF SAMPLE & INSOLUBLE RESIDUES**



5809/HC/02  
Sample as tested



5809/HC/02  
Insolubles >45 $\mu$ m  
Stereomicroscope x10



5809/HC/02  
Insoluble fines <45 $\mu$ m  
Stereomicroscope x20

## Mortar Analysis

### Test Report No. 5809/HC/03.

### Highgate Cemetery, London N6.

### Egyptian Avenue. Sample 6/M3.

A sample (44.7g) of render collected from the LH Obelisk has been analysed chemically and microscopically. This is thought to be the original early/mid-19<sup>th</sup> century material.

#### Sample Assessment and Microscopic Observations.

Intact brown render fragments c.15mm thick. Moderate strength (fragments could be broken by hand but not crumbled in fingers; disrupted using pestle with some difficulty). Aggregate is principally yellow-brown quartz and fine flint. Calcareous aggregate not positively determined. Kiln-fuel particles not found. Hair or fibre reinforcement not present.

#### Preliminary Tests.

Moist sample. Fully carbonated (phenolphthalein carbonation test).  
Apparent water permeability moderate/low (water droplet absorption on dried surface).  
Moderate effervescence on addition of dilute hydrochloric acid.

#### Chemical Dissolution Analysis (% dry mass) to BS4551:2005+A2:2013 (+ICP-OES).

%	Initial Moisture (oven @ 100 <sup>o</sup> C)	10.53
%	Total Calcium as CaO (titrimetric method)	15.45
%	Total Magnesium as MgO (ICP-OES method)	0.54
%	Acid & alkali soluble Silicon as SiO <sub>2</sub> (gravimetric method)	3.77
%	Soluble Aluminium as Al <sub>2</sub> O <sub>3</sub> (ICP-OES method)	1.59
%	Soluble Iron as Fe <sub>2</sub> O <sub>3</sub> (ICP-OES method)	1.12
%	Total (acid-soluble) sulphate as SO <sub>3</sub> (gravimetric method)	2.77
%	Total Acid Insolubles	65.7

#### BINDER

The binder in this sample is hydraulic as confirmed by the elevated soluble silica, alumina and iron test results, and is a binder of the 'Roman cement' type. The elevated sulphate is likely to indicate a surface reaction in a polluted sulphurous environment and does not indicate gypsum to be a deliberate mix component.

#### AGGREGATE

**Insoluble particle size range: 1.60mm to 45µm ( 94.7%) : <45µm ( 5.3%)**

The acid-insoluble residue principally comprises:

Yellow-brown quartz

Occasional particles of fine flint and other geological and mineral types.

Reddish-brown fines - principally clay.

## **TEST REPORT 5809/HC/03**

### **MORTAR BY VOLUME**

Acid-soluble calcareous aggregate was not positively determined, and an allowance has therefore not been made. The results adjusted for typical bulk density indicate a volumetric mix of approximately:

1 part	Roman cement
2 parts	Aggregate

### **COMPARATIVE HYDRAULICITY**

The hydraulicity determined is more hydraulic than modern NHL5.

### **SUGGESTED MATCHING MIX**

**This is not a specification for a repair mortar, nor must it be treated as one.**

Roman cements were manufactured in the late 18<sup>th</sup> and 19<sup>th</sup> century by calcining septaria, a natural calcareous 'concretion' and are no longer produced. Repair mixes are normally based on Vicat Prompt natural cement.

If this mortar were to be matched on a 'like-for-like' basis, the following approximate volumetric matching mix recipe might be helpful.

This does not necessarily imply that I recommend a 'like-for-like' repair mortar mix design in this particular situation, as there are many relevant factors in addition to mortar analysis that must be taken into account when deciding on mortar specification.

1 part	Prompt Natural Cement*
1.5 parts	Yellow-brown quartz sand <1.60mm
0.5 parts	Hornton brown sand <1.18mm

**\*Note:** This is a fast-setting binder and a set-retarder may be necessary

### **SOURCES OF MATERIALS**

Many limes, sands, stonedusts and aggregates are available from Rose of Jericho.

### **NOTES:**

1. Sample mixes must always be prepared to ensure suitability and an accurate colour and texture match.
2. Sands and aggregates conforming to the relevant European Standard and with a particle size and grading appropriate for the intended use must be selected.
3. Manufacturers advice should be sought and recommended application mix proportions and 'Best Practice' guides must be complied with.
4. It should be remembered that mortars change over time. When analysing an aged material, one is ascertaining what it now is and looking for evidence for what it originally was. Calcium hydroxide carbonates to form calcium carbonate, and calcium silicate hydrate (C-S-H), the principal reaction product in hydraulic limes and pozzolanic limes itself reacts over time with carbonic acid to produce calcium carbonate and hydrous siliceous, aluminate and silico-aluminate gels.

14.06.2024

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**TEST REPORT 5809/HC/03**

**IMAGES OF SAMPLE & INSOLUBLE RESIDUES**



5809/HC/03  
Sample as tested



5809/HC/03  
Insolubles >45 $\mu$ m  
Stereomicroscope x10



5809/HC/03  
Insoluble fines <45 $\mu$ m  
Stereomicroscope x20

## Mortar Analysis

### Test Report No. 5809/HC/04.

### Highgate Cemetery, London N6.

### Circle of Lebanon. Sample 7/M2.

A sample (48.1g) of render collected from the Inner Circle facade has been analysed chemically and microscopically. This is thought to be original early/mid-19<sup>th</sup> century material.

#### Sample Assessment and Microscopic Observations.

Intact brown render fragments c.30mm thick applied in two coats. High/moderate strength (sample could not be broken by hand nor crumbled in fingers; disrupted using pestle with some difficulty). Aggregate is principally yellow-brown quartz. Calcareous aggregate not positively determined. Kiln-fuel particles not found. Hair or fibre reinforcement not present.

#### Preliminary Tests.

Dry sample. Fully carbonated (phenolphthalein carbonation test).  
Apparent water permeability moderate/low (water droplet absorption on dried surface).  
Vigorous effervescence on addition of dilute hydrochloric acid.

#### Chemical Dissolution Analysis (% dry mass) to BS4551:2005+A2:2013 (+ICP-OES).

%	Initial Moisture (oven @ 100 <sup>o</sup> C)	2.28
%	Total Calcium as CaO (titrimetric method)	14.91
%	Total Magnesium as MgO (ICP-OES method)	0.52
%	Acid & alkali soluble Silicon as SiO <sub>2</sub> (gravimetric method)	3.51
%	Soluble Aluminium as Al <sub>2</sub> O <sub>3</sub> (ICP-OES method)	1.63
%	Soluble Iron as Fe <sub>2</sub> O <sub>3</sub> (ICP-OES method)	1.09
%	Total (acid-soluble) sulphate as SO <sub>3</sub> (gravimetric method)	2.70
%	Total Acid Insolubles	64.2

#### BINDER

The binder in this sample is hydraulic as confirmed by the elevated soluble silica, alumina and iron test results, and is a binder of the 'Roman cement' type. The elevated sulphate is likely to indicate a surface reaction in a polluted sulphurous environment and does not indicate gypsum to be a deliberate mix component.

#### AGGREGATE

**Insoluble particle size range: 1.60mm to 45µm ( 92.9%) : <45µm ( 7.1%)**

The acid-insoluble residue principally comprises:

Yellow-brown quartz

Occasional particles of other geological and mineral types.

Reddish-brown fines - principally clay.

## **TEST REPORT 5809/HC/04**

### **MORTAR BY VOLUME**

Acid-soluble calcareous aggregate was not positively determined, and an allowance has therefore not been made. The results adjusted for typical bulk density indicate a volumetric mix of approximately:

1 part	Roman cement
2 parts	Aggregate

### **COMPARATIVE HYDRAULICITY**

The hydraulicity determined is more hydraulic than modern NHL5.

### **SUGGESTED MATCHING MIX**

**This is not a specification for a repair mortar, nor must it be treated as one.**

Roman cements were manufactured in the late 18<sup>th</sup> and 19<sup>th</sup> century by calcining septaria, a natural calcareous 'concretion' and are no longer produced. Repair mixes are normally based on Vicat Prompt natural cement.

If this mortar were to be matched on a 'like-for-like' basis, the following approximate volumetric matching mix recipe might be helpful.

This does not necessarily imply that I recommend a 'like-for-like' repair mortar mix design in this particular situation, as there are many relevant factors in addition to mortar analysis that must be taken into account when deciding on mortar specification.

1 part	Prompt Natural Cement*
1.5 parts	Yellow-brown quartz sand <1.60mm
0.5 parts	Hornton brown sand <1.18mm

**\*Note:** This is a fast-setting binder and a set-retarder may be necessary

### **SOURCES OF MATERIALS**

Many limes, sands, stonedusts and aggregates are available from Rose of Jericho.

### **NOTES:**

1. Sample mixes must always be prepared to ensure suitability and an accurate colour and texture match.
2. Sands and aggregates conforming to the relevant European Standard and with a particle size and grading appropriate for the intended use must be selected.
3. Manufacturers advice should be sought and recommended application mix proportions and 'Best Practice' guides must be complied with.
4. It should be remembered that mortars change over time. When analysing an aged material, one is ascertaining what it now is and looking for evidence for what it originally was. Calcium hydroxide carbonates to form calcium carbonate, and calcium silicate hydrate (C-S-H), the principal reaction product in hydraulic limes and pozzolanic limes itself reacts over time with carbonic acid to produce calcium carbonate and hydrous siliceous, aluminate and silico-aluminate gels.

14.06.2024

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**TEST REPORT 5809/HC/04**

**IMAGES OF SAMPLE & INSOLUBLE RESIDUES**



5809/HC/04  
Sample as tested



5809/HC/04  
Insolubles >45 $\mu$ m  
Stereomicroscope x10



5809/HC/04  
Insoluble fines <45 $\mu$ m  
Stereomicroscope x20

## Mortar Analysis

**Test Report No. 5809/HC/05.**

**Highgate Cemetery, London N6.**

**Terrace Catacombs. Sample 8/M7.**

A sample (41.2g) of external backing coat render collected from the east wing ramp retaining wall has been analysed chemically and microscopically.

### **Sample Assessment and Microscopic Observations.**

Intact yellow-brown render fragments c.15mm thick. High strength (sample could not be broken by hand nor crumbled in fingers; disrupted using pestle with difficulty). Aggregate is principally yellow quartz with particles of flint and other geological types. Calcareous aggregate not positively determined. Kiln-fuel particles not found. Hair or fibre reinforcement not present.

### **Preliminary Tests.**

Dry sample. Fully carbonated (phenolphthalein carbonation test).  
Apparent water permeability low (water droplet absorption on dried surface).  
Vigorous effervescence on addition of dilute hydrochloric acid.

### **Chemical Dissolution Analysis (% dry mass) to BS4551:2005+A2:2013 (+ICP-OES).**

%	Initial Moisture (oven @ 100 <sup>0</sup> C)	2.60
%	Total Calcium as CaO (titrimetric method)	15.67
%	Total Magnesium as MgO (ICP-OES method)	0.46
%	Acid & alkali soluble Silicon as SiO <sub>2</sub> (gravimetric method)	3.99
%	Soluble Aluminium as Al <sub>2</sub> O <sub>3</sub> (ICP-OES method)	1.62
%	Soluble Iron as Fe <sub>2</sub> O <sub>3</sub> (ICP-OES method)	0.95
%	Total (acid-soluble) sulphate as SO <sub>3</sub> (gravimetric method)	1.81
%	Total Acid Insolubles	66.4

### **BINDER**

The binder in this sample is Portland cement as confirmed by the elevated soluble silica, alumina and iron test results. The sulphate is somewhat elevated.

### **AGGREGATE**

**Insoluble particle size range: 3.35mm to 45µm ( 93.3%) : <45µm ( 6.7%)**

The acid-insoluble residue principally comprises:

Yellow-brown quartz

Occasional particles of flint and other geological and mineral types.

Yellow-brown fines - principally clay.

## **TEST REPORT 5809/HC/05**

### **MORTAR BY VOLUME**

Acid-soluble calcareous aggregate was not positively determined, and an allowance has therefore not been made. The results adjusted for typical bulk density indicate a volumetric mix of approximately:

1 part	(Early?) Portland cement
3 to 4 parts	Aggregate

### **COMPARATIVE HYDRAULICITY**

The hydraulicity determined is more hydraulic than modern NHL5.

### **SUGGESTED MATCHING MIX**

**This is not a specification for a repair mortar, nor must it be treated as one.**

The 'Portland cement' patented by Joseph Aspdin in 1829 was in fact an artificial hydraulic lime, and it wasn't until the mid-1840s that his son William developed a material that would be recognised today as Portland cement. The binder in this sample must be later than 1845 and very likely later than 1850.

If this mortar were to be matched on a 'like-for-like' basis, the following approximate volumetric matching mix recipe might be helpful.

This does not necessarily imply that I recommend a 'like-for-like' repair mortar mix design in this particular situation, as there are many relevant factors in addition to mortar analysis that must be taken into account when deciding on mortar specification.

1 part	Portland cement (sulphate resisting)
4 parts	Yellow-brown quartz and flint sand <3.35mm

### **SOURCES OF MATERIALS**

Many limes, sands, stonedusts and aggregates are available from Rose of Jericho.

### **NOTES:**

1. Sample mixes must always be prepared to ensure suitability and an accurate colour and texture match.
2. Sands and aggregates conforming to the relevant European Standard and with a particle size and grading appropriate for the intended use must be selected.
3. Manufacturers advice should be sought and recommended application mix proportions and 'Best Practice' guides must be complied with.
4. It should be remembered that mortars change over time. When analysing an aged material, one is ascertaining what it now is and looking for evidence for what it originally was. Calcium hydroxide carbonates to form calcium carbonate, and calcium silicate hydrate (C-S-H), the principal reaction product in hydraulic limes and pozzolanic limes itself reacts over time with carbonic acid to produce calcium carbonate and hydrous siliceous, aluminate and silico-aluminate gels.

15.06.2024

Page 2 of 3

**TEST REPORT 5809/HC/05**

**IMAGES OF SAMPLE & INSOLUBLE RESIDUES**



5809/HC/05  
Sample as tested



5809/HC/05  
Insolubles >45µm  
Stereomicroscope x10



5809/HC/05  
Insoluble fines <45µm  
Stereomicroscope x20

## Mortar Analysis

**Test Report No. 5809/HC/06.**

**Highgate Cemetery, London N6.**

**Terrace Catacombs. Sample 8/M8.**

A sample (23.9g) of external finish coat render collected from the east wing ramp retaining wall has been analysed chemically and microscopically.

### **Sample Assessment and Microscopic Observations.**

Intact pale grey-brown render fragments c.3mm thick. High strength (thin fragments could be snapped by hand with some difficulty but not crumbled in fingers; disrupted using pestle with difficulty). Aggregate is principally fine yellow quartz. Calcareous aggregate not positively determined. Kiln-fuel particles not found. Hair or fibre reinforcement not present.

### **Preliminary Tests.**

Dry sample. Fully carbonated (phenolphthalein carbonation test).  
Apparent water permeability low (water droplet absorption on dried surface).  
Vigorous effervescence on addition of dilute hydrochloric acid.

### **Chemical Dissolution Analysis (% dry mass) to BS4551:2005+A2:2013 (+ICP-OES).**

%	Initial Moisture (oven @ 100 <sup>0</sup> C)	3.17
%	Total Calcium as CaO (titrimetric method)	17.83
%	Total Magnesium as MgO (ICP-OES method)	0.53
%	Acid & alkali soluble Silicon as SiO <sub>2</sub> (gravimetric method)	3.62
%	Soluble Aluminium as Al <sub>2</sub> O <sub>3</sub> (ICP-OES method)	1.29
%	Soluble Iron as Fe <sub>2</sub> O <sub>3</sub> (ICP-OES method)	0.96
%	Total (acid-soluble) sulphate as SO <sub>3</sub> (gravimetric method)	3.87
%	Total Acid Insolubles	63.5

### **BINDER**

The binder in this sample is Portland cement as confirmed by the elevated soluble silica, alumina and iron test results. The sulphate is elevated, likely as a result of a surface reaction in a polluted environment.

### **AGGREGATE**

**Insoluble particle size range: 1.18mm to 45µm ( 92.3%) : <45µm ( 7.7%)**

The acid-insoluble residue principally comprises:

Yellow quartz

Occasional particles of other geological and mineral types.

Yellow-brown fines - principally clay.

## **TEST REPORT 5809/HC/06**

### **MORTAR BY VOLUME**

Acid-soluble calcareous aggregate was not positively determined, and an allowance has therefore not been made. The results adjusted for typical bulk density indicate a volumetric mix of approximately:

1 part	(Early?) Portland cement
3 parts	Aggregate

### **COMPARATIVE HYDRAULICITY**

The hydraulicity determined is more hydraulic than modern NHL5.

### **SUGGESTED MATCHING MIX**

**This is not a specification for a repair mortar, nor must it be treated as one.**

The 'Portland cement' patented by Joseph Aspdin in 1829 was in fact an artificial hydraulic lime, and it wasn't until 1844 that his son William developed a material that would be recognised today as Portland cement. The binder in this sample must be later than 1845 and very likely later than 1850.

If this mortar were to be matched on a 'like-for-like' basis, the following approximate volumetric matching mix recipe might be helpful.

This does not necessarily imply that I recommend a 'like-for-like' repair mortar mix design in this particular situation, as there are many relevant factors in addition to mortar analysis that must be taken into account when deciding on mortar specification.

1 part	Portland cement (sulphate resisting)*
3 parts	Yellow quartz sand <1.18mm

### **SOURCES OF MATERIALS**

Many limes, sands, stonedusts and aggregates are available from Rose of Jericho.

### **NOTES:**

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2. Sands and aggregates conforming to the relevant European Standard and with a particle size and grading appropriate for the intended use must be selected.
3. Manufacturers advice should be sought and recommended application mix proportions and 'Best Practice' guides must be complied with.
4. It should be remembered that mortars change over time. When analysing an aged material, one is ascertaining what it now is and looking for evidence for what it originally was. Calcium hydroxide carbonates to form calcium carbonate, and calcium silicate hydrate (C-S-H), the principal reaction product in hydraulic limes and pozzolanic limes itself reacts over time with carbonic acid to produce calcium carbonate and hydrous siliceous, aluminate and silico-aluminate gels.

15.06.2024

Page 2 of 3

**TEST REPORT 5809/HC/06**

**IMAGES OF SAMPLE & INSOLUBLE RESIDUES**



5809/HC/06  
Sample as tested



5809/HC/06  
Insolubles >45 $\mu$ m  
Stereomicroscope x10



5809/HC/06  
Insoluble fines <45 $\mu$ m  
Stereomicroscope x20

## **CHAPEL BUILDING:**

Dissolution tests and analysis not yet available

The bedding mortar for 19<sup>th</sup> century brickwork and stonework dating from 1838 and 1853 can be identified as a lime mortar from observation.

All repointed in 20<sup>th</sup> Century using a cement mortar with a struck joint.

The bedding and pointing mortar for works carried out 1982-3 is understood from records and observation to be in a cement mortar, also finished with a struck joint.



## **2. STONE ANALYSIS**

Carried out by **British Geological Survey**

Selected analysis from buildings for which replacement stone is known to be required.

HIGHGATE CEMETERY

SCHEDULE OF SAMPLING AND INVESTIGATIONS  
STONE ONLY

Building	Sample No	Sample location	Sample details	Sample date	Analysis	Results
<b>Chapel</b>						
	1/S1	LH gate pier cap	Stone sample from gate pier cap	26/02/2024	BGS	
		Sample representative of consistent stone used throughout the building exterior		Purpose: Indent repairs to existing stonework and the replacement of complete missing elements (pinnacles etc) in matching stone		
<b>Mausolea</b>						
<b>Kelman and Rosa</b>						
	13/S1	Rear wall Kelman	Stone sample	27/03/2024	BGS	
		Sample detached from damaged block on rear wall		Purpose: Indent repairs to existing stonework		
<b>Da Silva</b>						
	16/S1	LH rear corner cornice	Stone sample	27/03/2024	BGS	
		Sample detached from fracture to cornice at LH rear corner				

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West Scott Architects  
The Studio  
3A Bath Road  
Bedford Park  
London  
W4 1LL  
Email: [john@westscottarchitects.co.uk](mailto:john@westscottarchitects.co.uk)

## Highgate Cemetery, London

Part 1: Gate piers associated with main east entrance  
to West Cemetery

### Building Stone Assessment:

The BGS Building Stone Assessment service combines geological expertise and building conservation expertise to provide authoritative advice to clients wishing to specify natural stone for repairing or building stone structures. Samples of stone supplied by clients are compared with samples from active quarries held in the BGS Collection of UK Building Stones to identify the closest-matching currently available stone(s). Using the closest-matching stone type in repairs to stone structures maximises the likelihood that the replacement stone will co-exist harmoniously with the 'original' stone and will weather sympathetically.

GeoReport ID: BGS\_339061/1  
BGS sample number: ENQ20067  
Client reference: Highgate Cemetery Funerary Buildings  
(sample 1/S1)  
Date of report: 11/07/2024

## Executive Summary

**Site name:** Highgate Cemetery, Camden, London<sup>1</sup>.

**Architectural/structural element(s) sampled:** Stone capping to left-hand octagonal pier associated with the gateway adjacent to the southern former mortuary chapel<sup>2</sup>; presumably original C19<sup>th</sup> (c. 1839) stonework.

**Nature of planned repairs:** Indent repairs to stonework of the type represented by the supplied sample and reinstatement of missing elements in matching stone.

<sup>1</sup> See List Entry Number: 1000810 (<https://historicengland.org.uk/listing/the-list/list-entry/1000810>).

<sup>2</sup> See List Entry Number: 1378877 (<https://historicengland.org.uk/listing/the-list/list-entry/1378877>).

### The sample(s) of building stone supplied to BGS comprise(s):

#### *Sample '1/S1' (BGS sample number ENQ20067)*

Two formerly attached pieces of stone<sup>3</sup> comprising a largely cohesive, light buff coloured<sup>4</sup>, essentially medium-grained<sup>5</sup>, ooidal, peloidal and bioclastic **limestone** with a pervasive intergranular (slightly ferroan) calcite spar and microspar cement. There is little doubt that this limestone is a variety of '**Bath Stone**', originating from within the Middle Jurassic **Great Oolite Group** succession of the Bath–Bradford-on-Avon–Corsham area. Detailed provenancing of 'Bath Stone' samples is always hampered by the variability (both vertically and laterally) of the source limestone beds, and consequent variation in character through time of the stone originating from particular workings, but comparison with historical BGS-held reference specimens suggests that the source of this 'Bath Stone' was one of the underground quarries in the Corsham area of Wiltshire (where the beds of the **Chalfield Oolite Formation**<sup>6</sup> were, and still are, worked). Stone such as this was marketed historically under a number of different names, typically linked to the specific quarry/mine of origin and also more generally as 'Corsham Down Stone'. The exact origins of this particular 'Corsham Down Stone' are indeterminable petrographically, but we note that its characteristics are reminiscent of current production 'Hartham Park Stone'.

<sup>3</sup> When restored to their true relative positions, these yield a piece of stone with overall maximum dimensions of 125 x 55 x 32 mm, which is bounded by a combination of weathered dressed/sawn and broken surfaces. A thin section was prepared from the sample to enable petrographic analysis of the stone. The section was cut so as to show the 55 x 32 mm plane, but with an unknown orientation with respect to the sedimentary bedding.

<sup>4</sup> Most similar to shades of 'very pale brown' (10YR) on a Munsell<sup>®</sup> Soil Color Chart.

<sup>5</sup> Denotes a grain size of 0.25–2 mm. Bioclasts > 2 mm in size (i.e. *coarse-grained*) occur sporadically and a subordinate amount of *fine-grained* material (< 0.25 mm in size) is present.

<sup>6</sup> See relevant BGS Lexicon entry at: <https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=CFDO>.

### The closest-matching currently available stone is:

Amongst the limited range of 'Bath Stone' varieties in active production, '**Hartham Park Stone**' (ideally in its 'Top Bed' guise) should be pursued in the first instance. Contact details for the relevant producer-supplier are as follows:

## **Lovell Stone Group**

Hartham Park Quarry, Park Lane, CORSHAM, Wiltshire

Tel. 01929 439255

Email: [sales@lovellstone.com](mailto:sales@lovellstone.com)

Website: <https://www.lovellstonegroup.com/>

We urge you to approach Lovell Stone Group and discuss your requirements, requesting samples of their most recent production for the purposes of conducting an on-site comparison exercise with the existing masonry (to confirm colour and textural suitability). Note that the 'T2 Basebed' variety would not be appropriate in this case.

## **Other possible replacement stones are:**

In the event that an alternative to 'Hartham Park Stone' has to be pursued, then '**Park Lane Bath Stone**' should be regarded as the 'next-best' alternative. The 'Base Bed' and 'Top Bed' varieties will need to be considered, with the final decision being based on which one of the two offers the better gross textural match for the existing 'Bath Stone' of the gate pier (impossible to determine from small *ex situ* samples) and the specific structural locations of the planned repairs. Comparison of the supplied sample with reference specimens of 'Park Lane Bath Stone' held by BGS suggests that the 'Top Bed' will offer the more satisfactory match, but an on-site comparison exercise will still be necessary. It should be borne in mind that the colour of the replacement stone is liable to 'warm' to a degree over time as it weathers. The relevant producer-supplier contact details are as follows:

### **Blockstone Ltd.**

Park Lane Mine, Park Lane, The Ridge, CORSHAM, Wiltshire

Tel. 01246 927100 (main Blockstone contact number) or 01277 568050

Email: [sales@parklanebathstone.com](mailto:sales@parklanebathstone.com) or [sales@blockstone.com](mailto:sales@blockstone.com)

Website: <https://blockstone.com/> and <https://parklanebathstone.com/>

## **Other remarks:**

Prior to specification, representative samples of each replacement stone under consideration should always be obtained and examined alongside the existing stonework. The blocks of stone ultimately used should ideally be selected at the quarry by the stonemason undertaking the repairs. Do not hesitate to contact us for further advice if required.

Mortar plays an important role with respect to the free movement of moisture and air through stonework. It will be important, therefore, to use a permeable mortar (e.g. lime mortar, which ideally should be at least as permeable as the 'original' stone), as well as a compatible replacement stone, in any repair, to increase the chances of a long-lasting, successful outcome. Portland cement, which is essentially impermeable, should not be used as mortar in stonework.

**Dr. Stephen F. Parry**

**British Geological Survey, Keyworth, Nottingham, UK.**

**23 July 2024**

## Information about this Report

### Introduction:

This report is designed for use by qualified professionals involved in building repair and/or conservation.

### Limitations of the report:

- This report is based on an analysis of the sample or samples provided and cannot be assumed to be applicable to all materials in a building or structure unless an on-site assessment has been carried out by BGS or a suitably qualified professional.
- The mention of a specific stone type(s) should not be taken as an endorsement, or otherwise, of the quality of a particular product. Equally, recommendations made with respect to a replacement stone do not constitute a repair specification. All aspects of the building (location, detailing, other materials) must be considered in competent repair work.
- The report is based on petrographic analysis. This does not guarantee that a replacement stone is suitable for a particular purpose (e.g. carved detail), nor does it guarantee specific properties of a stone such as strength.
- The characteristics of stone from a quarry source can vary over time and from place to place within the quarry; there is therefore no guarantee that a sample of quarried stone held by BGS is representative of the stone being supplied by the quarry at any particular point in time. One or more samples of stone should be obtained from a quarry operator prior to stone specification, to confirm the appearance and character of the stone currently being supplied.
- Recommendations made with respect to a replacement stone are based on and limited to an interpretation of the records in the possession of BGS at the time the analysis is carried out.

## BGS Building Stone Assessment

A BGS Building Stone Assessment is usually performed in three stages.

(i) The sample of 'original' stone (usually supplied by the client) is first subjected to a detailed petrographic examination, to establish the range and character of its intrinsic properties.

(ii) The range of properties is then compared with those of stone samples held in the BGS Petrological Collections, to constrain the source of the stone. Historical records and other forms of documentary evidence, if available, and the likelihood that the stone was sourced locally or 'imported', are also taken into account.

(iii) Finally, the closest-matching currently available stone(s) are identified. If the quarry from which the stone was sourced originally has been identified and is still open, it will usually provide the closest-matching stone.

If the quarry from which the stone was sourced originally has not been identified, or is closed, the closest-matching currently available stones are identified by comparing the properties of the 'original' stone with those of samples of currently available stones held in the BGS Collection of UK Building Stones.

Comparing stone properties to identify the source and/or the closest-matching stones is known as stone matching.

## Stone matching

Where possible, the source (quarry and bedrock unit) of the 'original' stone is determined by comparing it with samples held in the BGS Petrological Collections; historical records and other forms of documentary evidence, if available, and the likelihood that the stone was sourced locally or 'imported', are also taken into account, if appropriate. Many thousands of quarries in the UK have supplied building stone in the past, and in many instances it is not possible to relate a stone sample back to one particular quarry or bedrock unit.

Where the source cannot be identified unambiguously, the closest-matching currently available stone(s) are identified by comparing the intrinsic properties of the 'original' stone with those of similar stones that are currently being supplied by quarries in the UK.

The following factors are taken into account when comparing an 'original' stone with a potential replacement stone.

- 1) *Mineral and textural features* – ideally, these should be as similar as possible in the replacement stone and 'original' stone, to increase the likelihood that the two stones will respond in similar ways and at similar rates to the various physical and chemical processes associated with weathering, and will therefore co-exist harmoniously. Replacement stones are selected to match the 'original' stone in its fresh (rather than weathered/decayed) state, unless otherwise requested.
- 2) *Permeability* – ideally, the replacement stone and 'original' stone should have similar permeability characteristics, thereby minimising the degree to which fluid (water and air) migration between adjacent blocks of 'original' and replacement stone might be impeded. Accelerated stone decay can occur where fluid migration is impeded.
- 3) *Appearance* – for aesthetic reasons, the replacement stone and 'original' stone ideally should look similar to the unaided eye in terms of colour and stone fabric at the time the repair is made. However, the closest-matching stones in terms of the properties that govern weathering performance (mineral-textural features and permeability) are not necessarily the closest match in terms of appearance. A repair using stone selected primarily because it is the closest match in terms of appearance may look good initially but could quickly show signs of decay or of being incompatible with the 'original' stone. For that reason, priority is generally given to the properties that govern weathering performance, thereby maximising the likelihood of long-term compatibility of the 'original' stone and replacement stone.

A degree of compromise may in some cases be desirable and acceptable if the closest-matching stones in terms of 'weathering properties' are not a close match in terms of appearance. Immediately following repair, the fresh surfaces of a stone insert or indent will usually contrast in appearance with the soiled or discoloured surfaces of adjacent 'original' masonry, but if the 'weathering properties' of the two stones are a good match the new stone should blend in over time and the contrast should become less obvious.

- 4) *Functional and performance requirements* – specific functional and performance requirements of a replacement stone are taken into account if requested. For example, if the 'original' stone performed a load-bearing role, the choice of matching stones should include only those that are at least as strong; and if the 'original' stone was carved or shaped in a particular way, the choice of matching stones ideally should include only those that can be carved or shaped in a similar way, with a similar level of detail and quality of finish.

One or more replacement stone types are proposed taking these factors into account.

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## Terms and Conditions

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### Important notes about this Report

- The data, information and related records supplied in this Report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail, which is clearly defined and accurately depicted on large-scale maps, may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
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- Data, information and related records, which have been donated to BGS, have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

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**Report issued by  
BGS Enquiry Service**

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## Highgate Cemetery, London

Part 2: Family mausoleum of James Anderson Kelman

### Building Stone Assessment:

The BGS Building Stone Assessment service combines geological expertise and building conservation expertise to provide authoritative advice to clients wishing to specify natural stone for repairing or building stone structures. Samples of stone supplied by clients are compared with samples from active quarries held in the BGS Collection of UK Building Stones to identify the closest-matching currently available stone(s). Using the closest-matching stone type in repairs to stone structures maximises the likelihood that the replacement stone will co-exist harmoniously with the 'original' stone and will weather sympathetically.

GeoReport ID: BGS\_339061/2  
BGS sample number: ENQ20068  
Client reference: Highgate Cemetery Funerary Buildings  
(sample 13/S1)  
Date of report: 11/07/2024

## Executive Summary

**Site name:** Highgate Cemetery, Camden, London<sup>1</sup>.

**Architectural/structural element(s) sampled:** Rear wall of the family mausoleum of James Anderson Kelman; presumably original early C20<sup>th</sup> (c. 1907) stonework.

**Nature of planned repairs/usage:** Indent repairs to stonework of the type represented by the supplied sample.

<sup>1</sup> See List Entry Number: 1000810 (<https://historicengland.org.uk/listing/the-list/list-entry/1000810>).

### The sample(s) of building stone analysed by BGS comprise(s):

#### Sample '13/S1' (BGS sample number ENQ20068)

A single piece<sup>2</sup> of a mostly cohesive, off-white, predominantly fine- to medium-grained<sup>3</sup>, ooidal, peloidal and bioclastic **limestone** with a patchily developed intergranular calcite spar cement. Shell fragments of several mm in size (i.e. coarse-grained<sup>3</sup>) occur sporadically, and there is a minor content of siliciclastic material. This limestone is a variety of '**Portland Stone**', originating from within the Upper Jurassic (Tithonian) **Portland Stone Formation**<sup>4</sup> (more specifically, the **Portland Freestone Member**<sup>5</sup>) succession cropping out on the Isle of Portland, Dorset. The characteristics of this particular sample suggest, on balance, that it represents stone extracted from the horizon known as the **Basebed**, but we would not discount the possibility that it represents a shell-poor variant of **Whitbed**. There is nothing sufficiently diagnostic about the stone in terms of its mineral-textural characteristics to enable its actual quarry of origin to be pinpointed.

<sup>2</sup> With maximum dimensions of 45 x 28 x 13 mm. The bounding surface corresponding to the exposed face of the sampled masonry unit is fully covered by a green algal growth. A thin section was prepared from the sample to enable petrographic analysis of the stone. The section was cut so as to show the 45 x 28 mm plane, but with an unknown orientation with respect to the sedimentary bedding.

<sup>3</sup> *Fine-grained* denotes a grain size of 0.064–0.25 mm and *medium-grained* a grain size of 0.25–2 mm. *Coarse-grained* denotes a grain size of > 2 mm.

<sup>4</sup> See relevant BGS Lexicon entry at: <https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=POST>.

<sup>5</sup> See relevant BGS Lexicon entry at: <https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=POFR>.

### The closest-matching currently available stone is:

'**Portland Stone**' of an appropriate shade of white and relatively low shell content. The **Basebed** variety, specifically, should be pursued, although it would be worthwhile considering shell-poor variants of **Whitbed**, with the final choice being dictated by the degree of shell-related 'flecking' exhibited by the existing stone on a larger scale and the current quarry output. Contact details for the relevant producer-suppliers are provided below. We urge you to approach Albion Stone and Portland Stone Firms and discuss your specific requirements, requesting samples of their most recent relevant production.

#### **Albion Stone plc**<sup>6</sup>

(continued on following page)

## **Albion Stone plc** <sup>6</sup>

Independent Offices, Easton Street, PORTLAND, Dorset

Tel: 01305 860369 (Mine & Factory, Portland) or 01737 771772 (Head Office in Surrey)

Email: [enquiries@albionstone.com](mailto:enquiries@albionstone.com)

Website: <https://www.albionstone.com/>

<sup>6</sup> Albion Stone currently supply *Basebed* in two guises, marketed as 'Bowers Basebed' and 'Jordans Basebed'. Note, however, that these stones are becoming increasingly similar in character as the source workings become ever closer geographically. Nonetheless, it would be worthwhile examining specimens of both alongside the existing Portland Stone masonry in order to determine which offers the better gross colour and textural match.

## **Portland Stone Firms Ltd.** <sup>7</sup>

99 Easton Street, PORTLAND, Dorset

Tel: 01305 820331

Email: [sales@stonefirms.com](mailto:sales@stonefirms.com)

Website: <https://www.stonefirms.com/>

<sup>7</sup> The stone marketed as 'Perryfield Basebed' should be pursued in the first instance. It would also be worthwhile considering shell-poor variants of 'Perryfield Whitbed' and 'Broadcroft Whitbed'.

## **Other possible replacement stones are:**

N/A

## **Other remarks:**

Representative samples of the *Basebed* and shell-poor *Whitbed* currently being supplied by both Albion Stone and Portland Stone Firms should be obtained and used for the purposes of an on-site comparison exercise with the existing stonework. The variant providing the closest visual match should then be selected accordingly. The specifics of the structural setting/location of use also warrant consideration.

The blocks of stone ultimately used should ideally be selected at the quarry by the stonemason undertaking the repairs.

Mortar plays an important role with respect to the free movement of moisture and air through stonework. It will be important, therefore, to use a permeable mortar (e.g. lime mortar, which ideally should be at least as permeable as the 'original' stone), as well as a compatible replacement stone, in any repair, to increase the chances of a long-lasting, successful outcome. Portland cement, which is essentially impermeable, should not be used as mortar in stonework.

Do not hesitate to contact us for further advice if required.

**Dr. Stephen F. Parry**

**British Geological Survey, Keyworth, Nottingham, UK.**

**23 July 2024**

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## BGS Building Stone Assessment

A BGS Building Stone Assessment is usually performed in three stages.

(i) The sample of 'original' stone (usually supplied by the client) is first subjected to a detailed petrographic examination, to establish the range and character of its intrinsic properties.

(ii) The range of properties is then compared with those of stone samples held in the BGS Petrological Collections, to constrain the source of the stone. Historical records and other forms of documentary evidence, if available, and the likelihood that the stone was sourced locally or 'imported', are also taken into account.

(iii) Finally, the closest-matching currently available stone(s) are identified. If the quarry from which the stone was sourced originally has been identified and is still open, it will usually provide the closest-matching stone. If the quarry from which the stone was sourced originally has not been identified, or is closed, the closest-matching currently available stones are

identified by comparing the properties of the 'original' stone with those of samples of currently available stones held in the BGS Collection of UK Building Stones.

Comparing stone properties to identify the source and/or the closest-matching stones is known as stone matching.

## Stone matching

Where possible, the source (quarry and bedrock unit) of the 'original' stone is determined by comparing it with samples held in the BGS Petrological Collections; historical records and other forms of documentary evidence, if available, and the likelihood that the stone was sourced locally or 'imported', are also taken into account, if appropriate. Many thousands of quarries in the UK have supplied building stone in the past, and in many instances it is not possible to relate a stone sample back to one particular quarry or bedrock unit.

Where the source cannot be identified unambiguously, the closest-matching currently available stone(s) are identified by comparing the intrinsic properties of the 'original' stone with those of similar stones that are currently being supplied by quarries in the UK.

The following factors are taken into account when comparing an 'original' stone with a potential replacement stone.

- 1) *Mineral and textural features* – ideally, these should be as similar as possible in the replacement stone and 'original' stone, to increase the likelihood that the two stones will respond in similar ways and at similar rates to the various physical and chemical processes associated with weathering, and will therefore co-exist harmoniously. Replacement stones are selected to match the 'original' stone in its fresh (rather than weathered/decayed) state, unless otherwise requested.
- 2) *Permeability* – ideally, the replacement stone and 'original' stone should have similar permeability characteristics, thereby minimising the degree to which fluid (water and air) migration between adjacent blocks of 'original' and replacement stone might be impeded. Accelerated stone decay can occur where fluid migration is impeded.
- 3) *Appearance* – for aesthetic reasons, the replacement stone and 'original' stone ideally should look similar to the unaided eye in terms of colour and stone fabric at the time the repair is made. However, the closest-matching stones in terms of the properties that govern weathering performance (mineral-textural features and permeability) are not necessarily the closest match in terms of appearance. A repair using stone selected primarily because it is the closest match in terms of appearance may look good initially but could quickly show signs of decay or of being incompatible with the 'original' stone. For that reason, priority is generally given to the properties that govern weathering performance, thereby maximising the likelihood of long-term compatibility of the 'original' stone and replacement stone. A degree of compromise may in some cases be desirable and acceptable if the closest-matching stones in terms of 'weathering properties' are not a close match in terms of appearance. Immediately following repair, the fresh surfaces of a stone insert or indent will usually contrast in appearance with the soiled or

discoloured surfaces of adjacent 'original' masonry, but if the 'weathering properties' of the two stones are a good match the new stone should blend in over time and the contrast should become less obvious.

- 4) *Functional and performance requirements* – specific functional and performance requirements of a replacement stone are taken into account if requested. For example, if the 'original' stone performed a load-bearing role, the choice of matching stones should include only those that are at least as strong; and if the 'original' stone was carved or shaped in a particular way, the choice of matching stones ideally should include only those that can be carved or shaped in a similar way, with a similar level of detail and quality of finish.

One or more replacement stone types are proposed taking these factors into account.

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- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

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**Report issued by  
BGS Enquiry Service**



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## Highgate Cemetery, London

### Part 3: Mausoleum of Eliza Morris da Silva

#### Building Stone Assessment:

The BGS Building Stone Assessment service combines geological expertise and building conservation expertise to provide authoritative advice to clients wishing to specify natural stone for repairing or building stone structures. Samples of stone supplied by clients are compared with samples from active quarries held in the BGS Collection of UK Building Stones to identify the closest-matching currently available stone(s). Using the closest-matching stone type in repairs to stone structures maximises the likelihood that the replacement stone will co-exist harmoniously with the 'original' stone and will weather sympathetically.

GeoReport ID: BGS\_339061/3

BGS sample number: ENQ20069

Client reference: Highgate Cemetery Funerary Buildings  
(sample 16/S1)

Date of report: 11/07/2024

## Executive Summary

**Site name:** Highgate Cemetery, Camden, London<sup>1</sup>.

**Architectural/structural element(s) sampled:** Cornice of the mausoleum of Eliza Morris da Silva; presumably original stonework dating to the second half of the C19<sup>th</sup>.

**Nature of planned repairs/usage:** No details have been provided, but it is assumed that the planned works will involve full-block and/or indent repairs to stonework of the type represented by the supplied sample.

<sup>1</sup> See List Entry Number: 1000810 (<https://historicengland.org.uk/listing/the-list/list-entry/1000810>).

### The sample(s) of building stone analysed by BGS comprise(s):

#### Sample '16/S1' (BGS sample number ENQ20069)

A single piece<sup>2</sup> of weathered moulded stonework comprising a mostly cohesive, off-white, predominantly fine- to medium-grained<sup>3</sup>, ooidal, peloidal and bioclastic limestone with a widespread (though by no means complete) micritic matrix. Shell fragments of several mm in size (i.e. coarse-grained<sup>3</sup>) occur sporadically, which stand proud of weathered surfaces. There is a minor content of siliciclastic material. This limestone is a variety of 'Portland Stone', originating from within the Upper Jurassic (Tithonian) **Portland Stone Formation**<sup>4</sup> (more specifically, the **Portland Freestone Member**<sup>5</sup>) succession cropping out on the Isle of Portland, Dorset. We note that this particular 'Portland Stone' is a lower porosity variant (cf. sample '13/S1' from the family mausoleum of James Anderson Kelman, for example), extracted from either the **Basebed** or (perhaps more likely) the **Whitbed** horizons. There is nothing sufficiently diagnostic about the stone in terms of its mineral-textural characteristics to enable its actual quarry of origin to be pinpointed.

<sup>2</sup> With maximum dimensions of 71 x 69 x 42 mm, and bounded by a combination of weathered dressed/sawn and freshly broken surfaces; there is a green algal growth on the surfaces corresponding to the exposed part of the sampled masonry unit. A thin section was prepared from the sample enable petrographic analysis of the stone. The section was cut so as to show the moulding in profile, but with an unknown orientation with respect to the sedimentary bedding.

<sup>3</sup> *Fine-grained* denotes a grain size of 0.064–0.25 mm and *medium-grained* a grain size of 0.25–2 mm. *Coarse-grained* denotes a grain size of > 2 mm.

<sup>4</sup> See relevant BGS Lexicon entry at: <https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=POST>.

<sup>5</sup> See relevant BGS Lexicon entry at: <https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=POFR>.

### The closest-matching currently available stone is:

'Portland Stone' – specifically, lower porosity variants of 'Portland Whitbed' and 'Portland Basebed', with the final choice being dictated by the degree of shell-related flecking exhibited by the existing stone on a larger scale and the current quarry output. Contact details for the relevant producer-suppliers are provided on the following page. We urge you to approach Albion Stone and Portland Stone Firms and discuss your specific requirements (in particular, your interest in relatively low porosity *Whitbed* and *Basebed*), requesting samples of their most recent relevant production.

## **Albion Stone plc** <sup>6</sup>

Independent Offices, Easton Street, PORTLAND, Dorset

Tel: 01305 860369 (Mine & Factory, Portland) or 01737 771772 (Head Office in Surrey)

Email: [enquiries@albionstone.com](mailto:enquiries@albionstone.com)

Website: <https://www.albionstone.com/>

<sup>6</sup> Amongst the current production range, 'Jordans Whitbed' and 'Bowers Whitbed' should be considered in the first instance. Nonetheless, it would be worthwhile examining specimens of Albion Stone's *Basebed* alongside the existing 'Portland Stone' masonry in order to determine which variant offers the best gross colour and textural match.

## **Portland Stone Firms Ltd.** <sup>7</sup>

99 Easton Street, PORTLAND, Dorset

Tel: 01305 820331

Email: [sales@stonefirms.com](mailto:sales@stonefirms.com)

Website: <https://www.stonefirms.com/>

<sup>7</sup> The stone marketed as 'Broadcroft Whitbed' and 'Perryfield Mid-tier Whitbed' should be pursued in the first instance. Nonetheless, it would be worthwhile examining specimens of other *Whitbed*, and indeed *Basebed*, variants alongside the existing 'Portland Stone' masonry in order to determine which offers the best gross colour and textural match.

## **Other possible replacement stones are:**

N/A

## **Other remarks:**

Representative samples of the relevant 'Portland Stone' variants currently being supplied by both Albion Stone and Portland Stone Firms should be obtained and used for the purposes of an on-site comparison exercise with the existing stonework. The variant providing the closest visual match should then be selected accordingly. The specifics of the structural setting/location of use also warrant consideration.

The blocks of stone ultimately used should ideally be selected at the quarry by the stonemason undertaking the repairs.

Mortar plays an important role with respect to the free movement of moisture and air through stonework. It will be important, therefore, to use a permeable mortar (e.g. lime mortar, which ideally should be at least as permeable as the 'original' stone), as well as a compatible replacement stone, in any repair, to increase the chances of a long-lasting, successful outcome. Portland cement, which is essentially impermeable, should not be used as mortar in stonework.

Do not hesitate to contact us for further advice if required.

**Dr. Stephen F. Parry**

**British Geological Survey, Keyworth, Nottingham, UK.**

**23 July 2024**

## Information about this Report

### Introduction:

This report is designed for use by qualified professionals involved in building repair and/or conservation.

### Limitations of the report:

- This report is based on an analysis of the sample or samples provided and cannot be assumed to be applicable to all materials in a building or structure unless an on-site assessment has been carried out by BGS or a suitably qualified professional.
- The mention of a specific stone type(s) should not be taken as an endorsement, or otherwise, of the quality of a particular product. Equally, recommendations made with respect to a replacement stone do not constitute a repair specification. All aspects of the building (location, detailing, other materials) must be considered in competent repair work.
- The report is based on petrographic analysis. This does not guarantee that a replacement stone is suitable for a particular purpose (e.g. carved detail), nor does it guarantee specific properties of a stone such as strength.
- The characteristics of stone from a quarry source can vary over time and from place to place within the quarry; there is therefore no guarantee that a sample of quarried stone held by BGS is representative of the stone being supplied by the quarry at any particular point in time. One or more samples of stone should be obtained from a quarry operator prior to stone specification, to confirm the appearance and character of the stone currently being supplied.
- Recommendations made with respect to a replacement stone are based on and limited to an interpretation of the records in the possession of BGS at the time the analysis is carried out.

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**Report issued by  
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*Issue P2:  
16<sup>th</sup> October 2024: Draft final to Hopkins Architects only*



## 7.0 APPENDIX

### 7.4 APPENDIX 4: AUDIT OF EXISTING ACCOMMODATION (UNDERTAKEN AT RIBA STAGE 1)

6.0 | Accommodation Schedule

6.1 | Audit of Existing Accommodation - Introduction

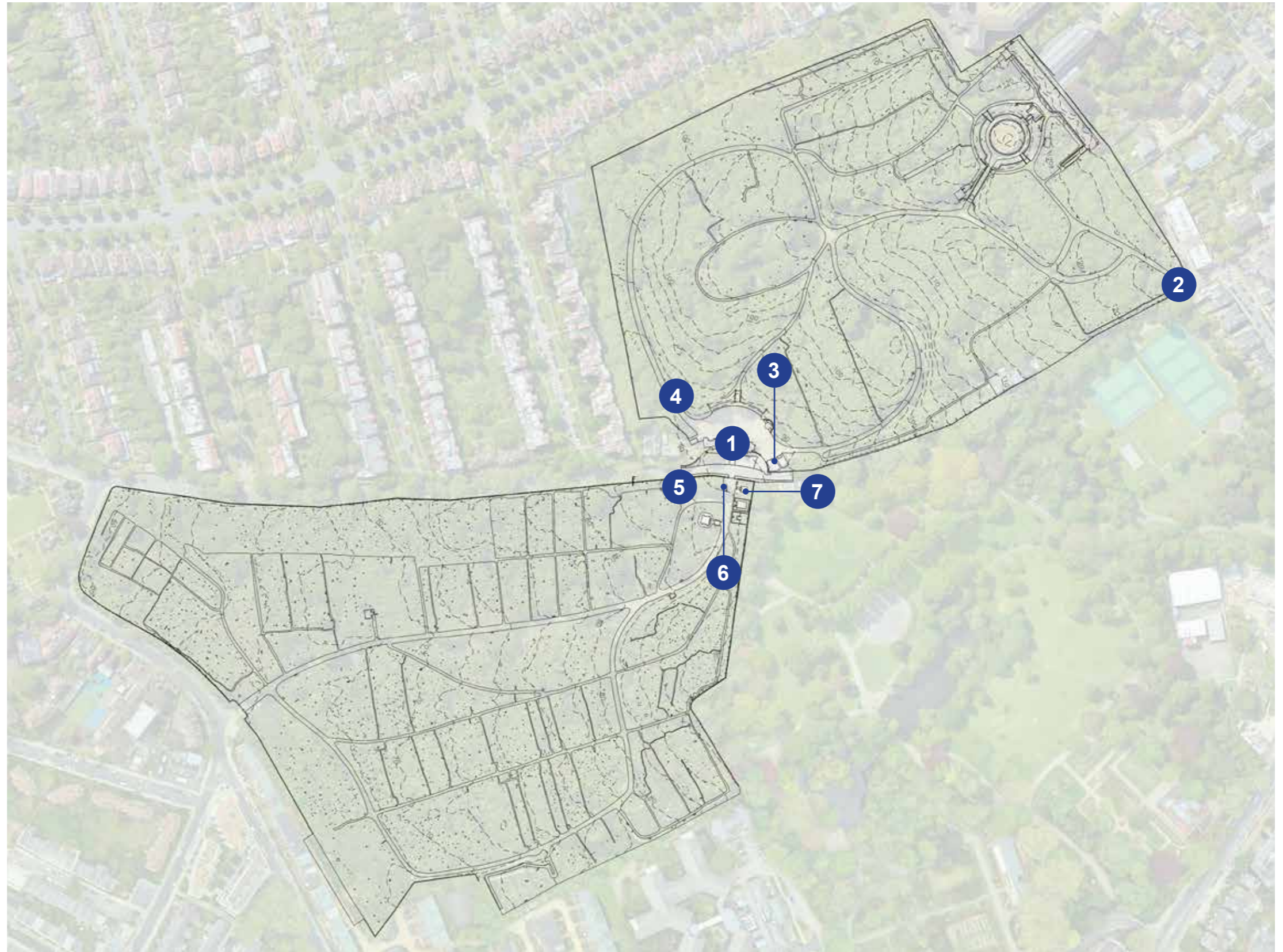
An audit of the Cemetery's existing buildings has been undertaken to evaluate the area (m<sup>2</sup>) and function of these spaces. This has been based on historic survey information, existing plans (where available) and Digital Inc.'s measured survey (where available).

This audit (which is work-in-progress) evaluated the has been undertaken for the following reasons:

- To help inform the proposed accommodation schedule for the proposed projects.
- To assist with the statutory applications to Camden Planning Dept. and Historic England and provide a basis for the justification of adding the new spaces required by the Cemetery.

- Staff Area (Operations)
- Staff Area (Gardener's)
- Shared Area (Staff / Visitors)
- Volunteers Area
- Visitor Area

KEY	Space	ID No.
1	Chapel (Anglican, Dissenters' & WCs)	W.CH
2	North Lodge	W.NL
3	South Lodge	W.SL
4	West Compound	W.WC
5	East Compound	E.EC
6	East Cemetery Ticket Booth	E.TB
7	Strathcona Mausolea	E.SM



**6.0 | Accommodation Schedule**  
**6.1 | Audit of Existing Accommodation - Chapels**

The Chapel is the largest building at the Cemetery. Set across four levels it provides space for a range of different uses, including spaces for staff and visitors.

The interior of the Anglican Chapel, the main space for visitors, was recently restored and gives a good indication of the potential to 'unlock' this historic asset as a whole if sensitively restored and its function at the Cemetery re-planned. The remaining spaces vary in condition.

**Basement:**

The existing basement is accessed from ground level via a constrained spiral stair located in the south-west corner of the Chapels. There is a single enclosed space (base of former coffin-drop) and external 'cutting' which is the entrance to the passage running below Swain's Lane.



Access spiral stair



Gardener's Mess entrance



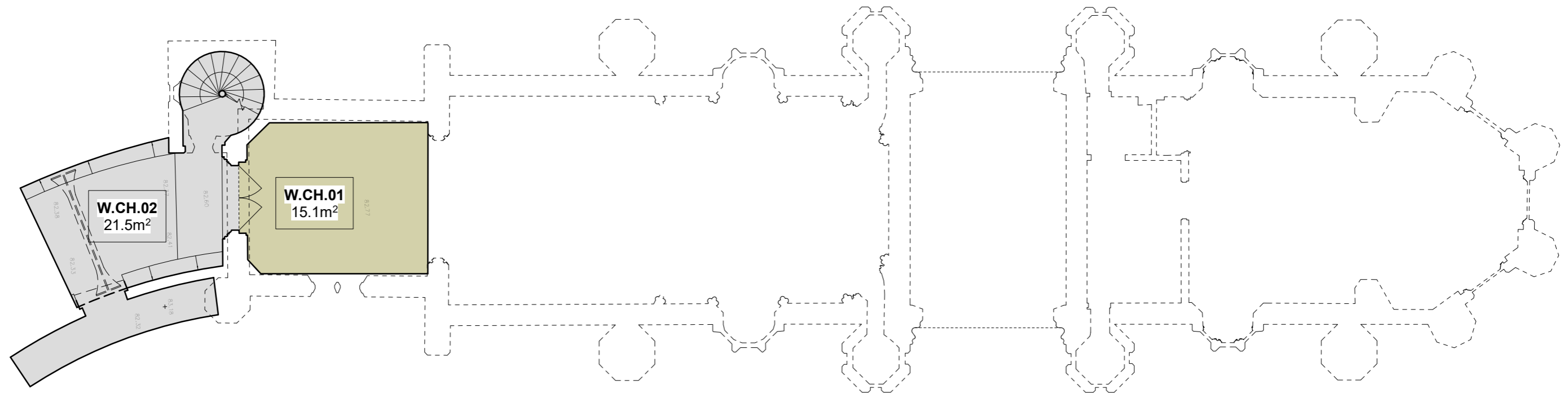
Tunnel Cutting, view up.



Gardener's Mess

**Area & Use Assessment:**

Room ID.	Level	Space / Observations	Usable Area (m <sup>2</sup> )
W.CH.01	Basement	Gardeners Mess Gardener's welfare area (seating/kitchenette) Constrained access. Poor state of repair, damp. Intrinsic heritage value - former coffin-drop. Potential to form part of visitor experience.	15.1
W.CH.02	Basement	Tunnel Cutting / Turret Stair Stepped access to basement, constrained. External space not used. Intrinsic heritage value - former coffin passage. Potential to form part of visitor experience.	21.5
<b>Basement</b>		<b>Sub-total</b>	<b>36.6</b>



**1** Space Audit - Chapel - Basement Level  
 0101 1:100

**Undercroft:**

The undercroft is a mezzanine floor retrofitted into the shaft of the former coffin drop (which would have taken coffins from the Anglican Chapel to the underground passage below Swain's Lane).

It is accessed via a concealed stair descending from the Anglican Chapel. It is used as a storage space by the Operations Staff (papers, guidebooks, signs, etc.).



Shelved storage space



Access stair, bottom



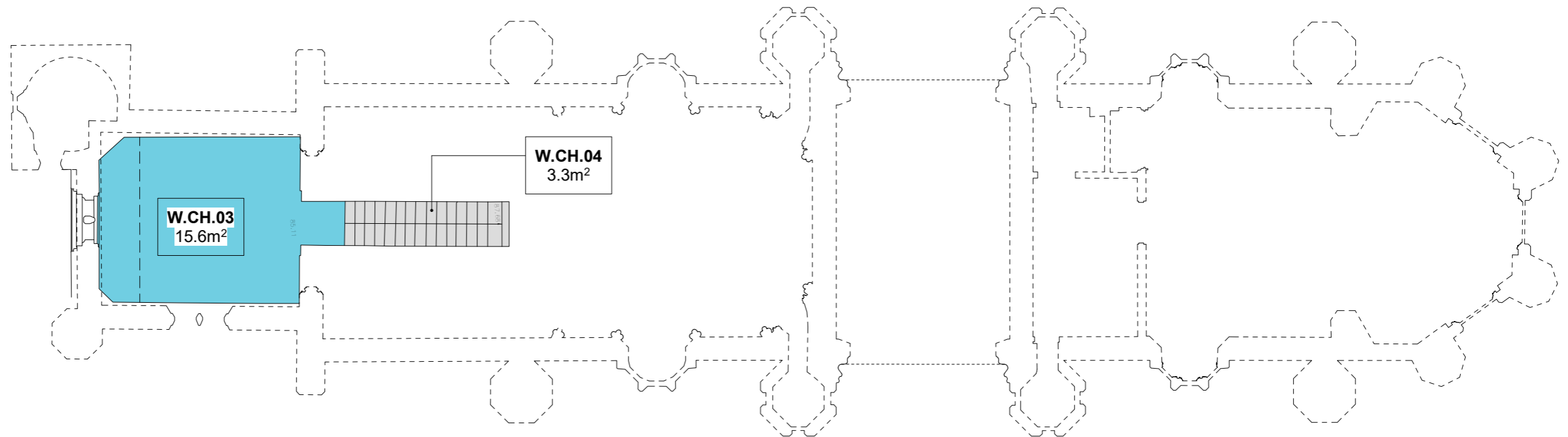
Access stair, to ground level



Hatch concealing stair

**Area & Use Assessment:**

Room ID.	Level	Space / Observations	Usable Area (m <sup>2</sup> )
W.CH.03	Undercroft	Document Store Under-sized for intended use. Not readily accessible and poorly located.	15.3
W.CH.04	Undercroft	Coffin Drop Stair Can only be access when Chapels are not in use. Safety concern: perimeter railing does not appear to be used, risk of falling.	3.3
<b>Undercroft (Sub-Total)</b>			<b>18.6 m<sup>2</sup></b>



6.0 | Accommodation Schedule  
 6.1 | Audit of Existing Accommodation - Chapels

**Ground Level:**

At ground level, the Chapel is divided into two by a central gated archway which forms an entrance passageway into the West Cemetery from Swain's Lane.

An Anglican Chapel is on the 'south-side', and was recently restored. This is accessible to visitors and serves the following purposes:

- Funeral Services
- Visitor Ticketing / Guidebook Sales
- Space for Trustee Meetings
- Informal storage space

The 'north-side' is a Dissenter's Chapel, this was modified c.1980's to create office space and is used by the Cemetery's Operations Staff. The Dissenters' Chapel has intrinsic heritage value and could be restored and made accessible to the visiting public.



Anglican Chapel, ticketing.



Dissenters' Chapel, desks



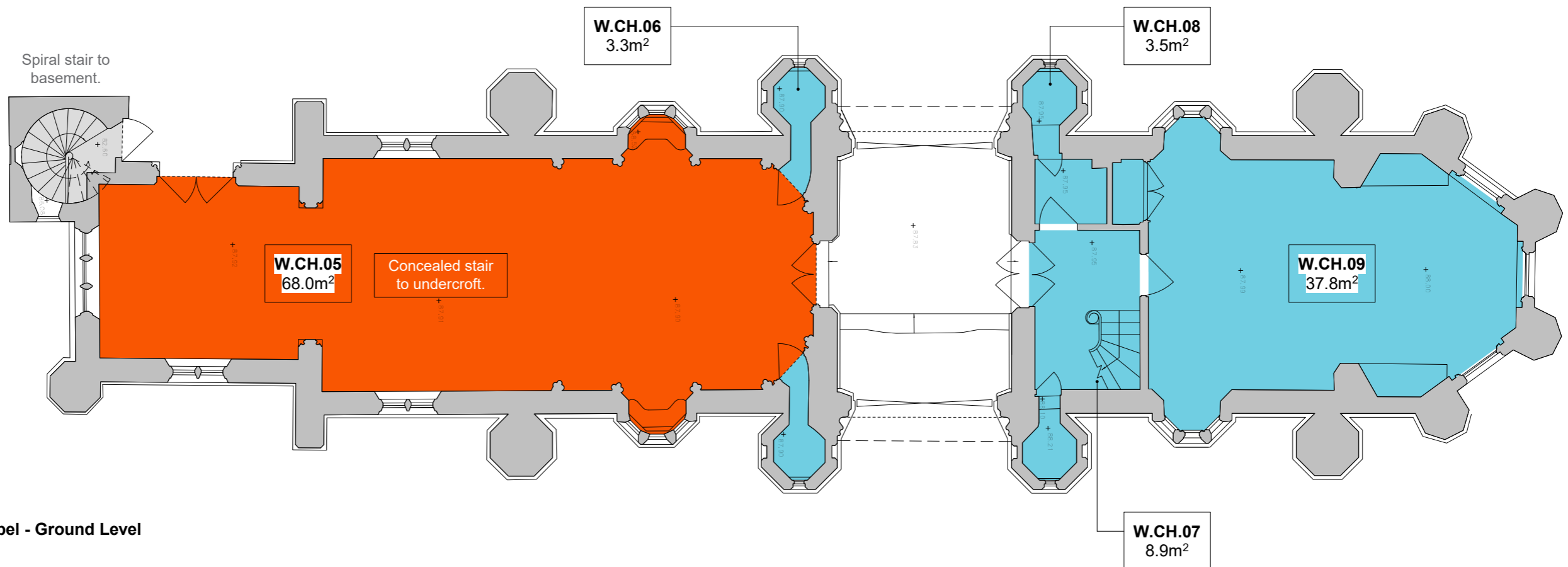
Anglican Chapel, temp. screen.



Dissenters' Chapel, offices.

**Area & Use Assessment:**

Room ID.	Level	Space / Observations	Usable Area (m <sup>2</sup> )
W.CH.05	Ground	Anglican Chapel Nave / Apse Conflict between different functions (funeral services / visitors / staff) - desire to be used for services only. Has become cluttered due to informal storage	68.0
W.CH.06	Ground	Anglican Chapel BOH Space within octagonal turrets, constrained access.	3.3
W.CH.07	Ground	Dissenters' Chapel WC Not adequate provision for staff numbers.	3.5
W.CH.08	Ground	Dissenters' Chapel Stair & Lobby	8.9
W.CH.09	Ground	Dissenters' Chapel Office 6 Workstations with limited storage.	37.8
<b>Ground (Sub-Total)</b>			<b>121.5 m<sup>2</sup></b>



**6.0 | Accommodation Schedule**  
**6.1 | Audit of Existing Accommodation - Chapels**

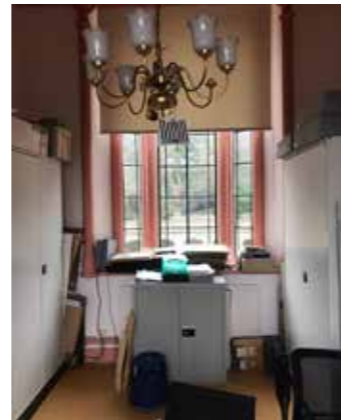
**First Level:**

The First level is comprised of a mezzanine floor (created as part of the internal modifications completed c.1980) and an elevated space above the arched passage which is currently used as an archive. Access is via stair.

The perception is that an immediate issue is a lack of storage and working space for the Cemetery's Operations staff with the spaces appearing cluttered. The building is understood to be cold in winter and hot in summer.



Office on mezzanine.



Archive on first level.



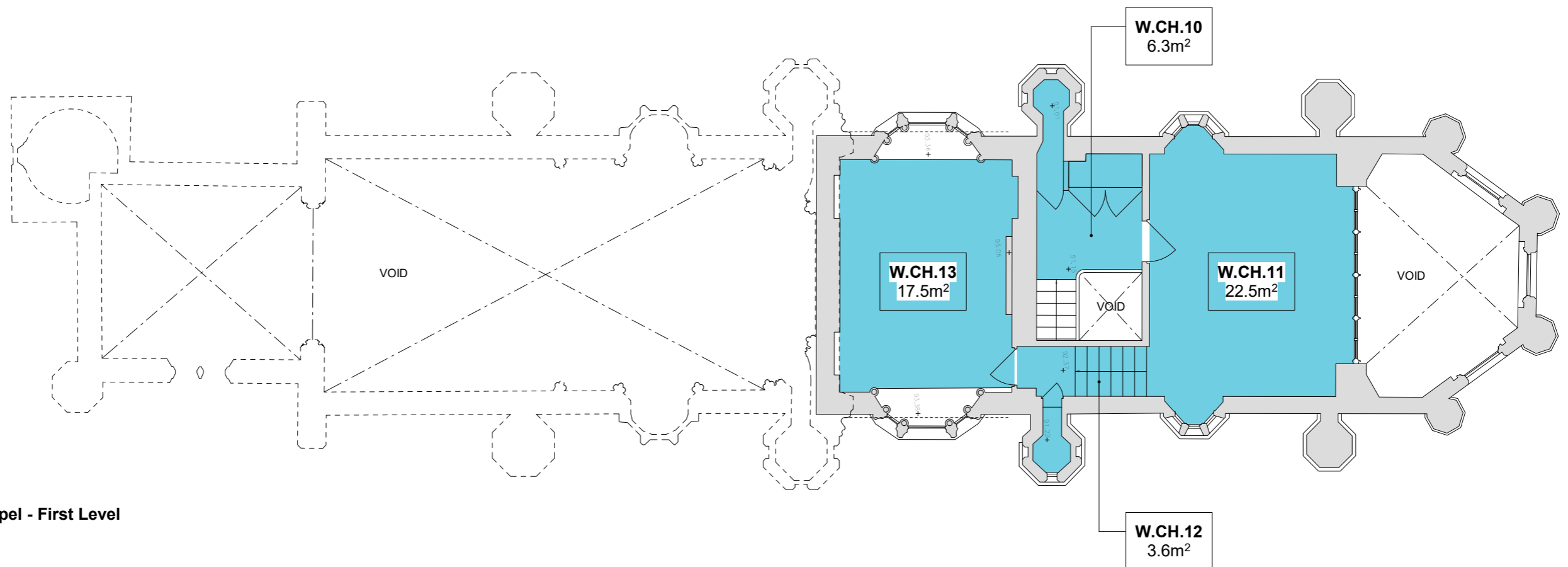
Office on mezzanine.



Cupboard-kitchenette, lobby.

**Area & Use Assessment:**

Room ID.	Level	Space / Observations	Usable Area (m <sup>2</sup> )
W.CH.10	First/Mez.	Dissenters' Chapel Stair & Kitchenette Cupboard Kitchenette is small and accessed from the stair landing. No seating area for staff.	6.3
W.CH.11	First/Mez.	Dissenters' Chapel Office Cluttered due to lack of storage space. No private meeting areas Lack of natural light and ventilation.	22.5
W.CH.12	First	Dissenters' Chapel Stair & Lobby Narrow stair.	3.6
W.CH.13	First	Dissenters' Chapel Archive Cluttered due to lack of storage space.	17.5
	<b>First</b>	<b>(Sub-Total)</b>	<b>49.9 m<sup>2</sup></b>



6.0 | Accommodation Schedule

6.1 | Audit of Existing Accommodation - Chapels' WC Block

Chapels' WC Block

The WC Block is located adjacent to the Chapels and to the south-side of the Courtyard. In terms of WC provision it accommodates a male toilet containing 1 WC, 2 urinals and 1 WHB; and a separate unisex accessible WC.

The WC provision is critically under-sized for the Cemetery's visitor numbers with queues known to form at peak times.

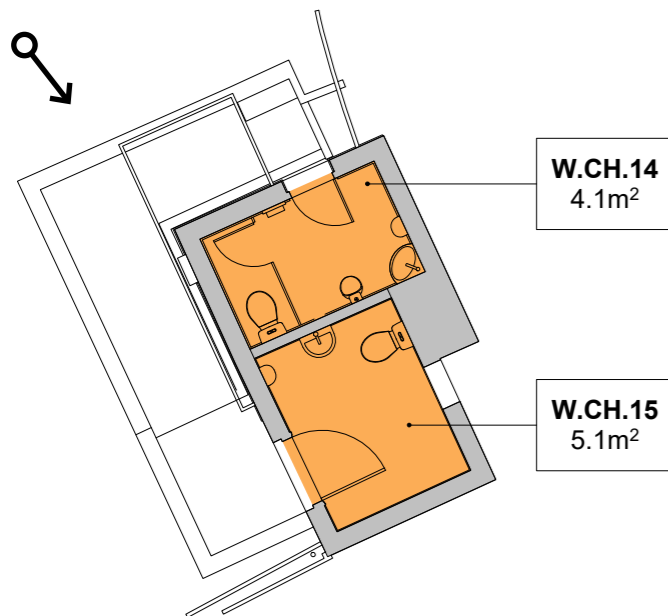
Architecturally it is generally agreed that the WC Block has a detrimental effect on the heritage setting of the Chapels and Courtyard.

Area & Use Assessment (WCs):

Room ID.	Space	Area (m <sup>2</sup> )
W.CH.14	Male WC	4.1m <sup>2</sup>
W.CH.15	Accessible WC	5.1m <sup>2</sup>
<b>(Sub-Total)</b>		<b>9.2 m<sup>2</sup></b>

Area: Total for Chapels & WC Block

Room ID.	Level	Space / Observations	Usable Area (m <sup>2</sup> )
W.CH.01	Basement	Gardeners Mess	15.1
W.CH.02	Basement	Tunnel Cutting / Turret Stair	21.5
W.CH.03	Undercroft	Document Store	5.3
W.CH.04	Undercroft	Coffin Drop Stair	3.3
W.CH.05	Ground	Anglican Chapel Nave / Apse	68.0
W.CH.06	Ground	Anglican Chapel BOH	3.3
W.CH.07	Ground	Dissenters' Chapel WC	3.5
W.CH.08	Ground	Dissenters' Chapel Stair & Lobby	8.9
W.CH.09	Ground	Dissenters' Chapel Office	37.8
W.CH.10	First	Dissenters' Chapel Stair & Kitchenette	6.3
W.CH.11	First	Dissenters' Chapel Office	22.5
W.CH.12	First	Dissenters' Chapel Stair & Lobby	3.6
W.CH.13	First	Dissenters' Chapel Archive	17.5
W.CH.14	Ground	WC Block - Male	4.1
W.CH.15	Ground	WC Block - Accessible	5.1
<b>All</b>	<b>Total</b>		<b>235.8 m<sup>2</sup></b>



WC Block

2 Chapels WC  
0103 1:100

6.0 | Accommodation Schedule

6.1 | Audit of Existing Accommodation - North & South Lodges

North Lodge

The structure is Grade II Listed and currently functions as a remote welfare area in the West Cemetery with a Kitchenette and single WC for gardening staff. A second space has some seating and storage space.

The space is in poor condition with damp, but remains a functional space for the gardening staff. The Lodge has intrinsic heritage value and the internal space could be re-planning and re-purposed to form a part of the visitor experience.

It is located near a second entrance to the West Cemetery, and opening this up to visitors is to be explored.

Area & Use Assessment:

Room ID.	Space	Area (m <sup>2</sup> )
W.NL.01	Storage Damp Under-utilised	7.3
W.NL.02	Kitchenette Damp Poor condition	2.8
W.NL.03	WC Damp Poor condition	1.1
<b>Total</b>		<b>11.2 m<sup>2</sup></b>

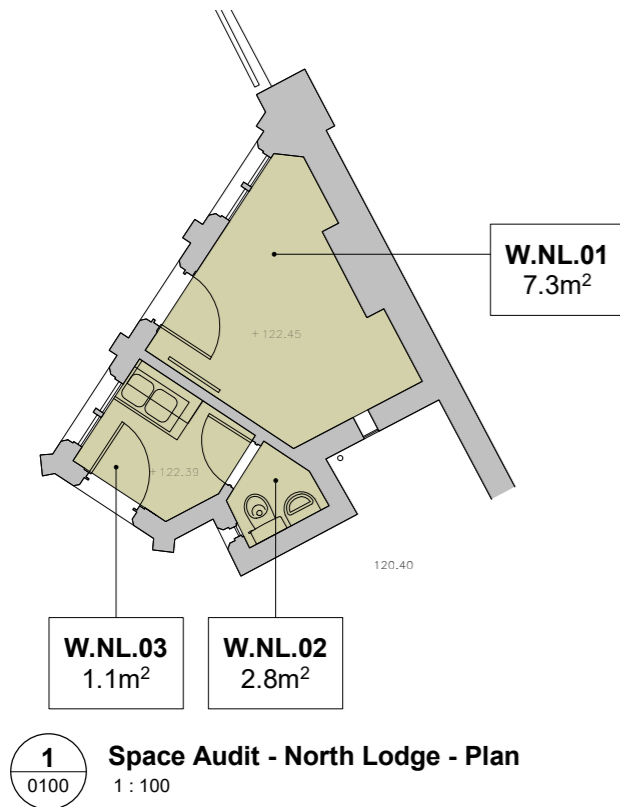
South Lodge

The structure is Grade II Listed and located at the vehicular entrance to the West Cemetery. It accommodates a kitchenette & Rest Area for Volunteers, overnight accommodation for the Sexton, informal storage and a single WC.

The space is in poor condition with damp, but remains a functional space for the staff and volunteers. The Lodge has intrinsic heritage value and the internal space could be re-planned and re-purposed to form a part of the visitor experience.

Area & Use Assessment:

Room ID.	Space	Area (m <sup>2</sup> )
W.SL.01	Vol. Kitchenette / Rest Area Damp Under-utilised	20.7
W.SL.02	Sexton Damp Poor condition	12.0
W.SL.03	WC Damp Poor condition	1.3
<b>Total</b>		<b>34.0 m<sup>2</sup></b>



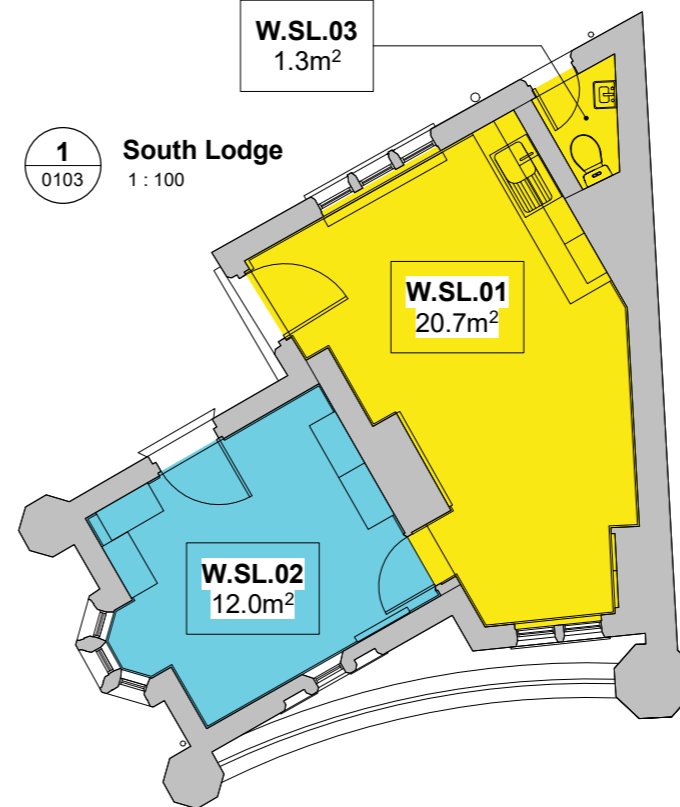
Exterior view of North Lodge (© WSA)



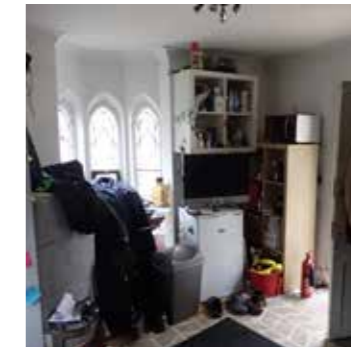
Kitchenette & WC (© WSA)



Storage (© WSA)



Volunteer Kitchen & Rest Area (© WSA)



Sexton Office (© WSA)



WC (© WSA)



6.0 | Accommodation Schedule

6.1 | Audit of Existing Accommodation - West Compound

The West Cemetery Compound is currently comprised of 3 shipping containers which are accessed via a staff-only road leading from the south-side of the Courtyard.

The containers are used as storage for vehicles and a small workshop area by the Gardening Team. They are in poor condition, inadequate and not fit-for-purpose.

A lack of storage means that additional equipment and materials are kept on the side of the road, meaning that this area is kept off-limits to Cemetery Visitors.



Containers on path.



Vehicle Storage



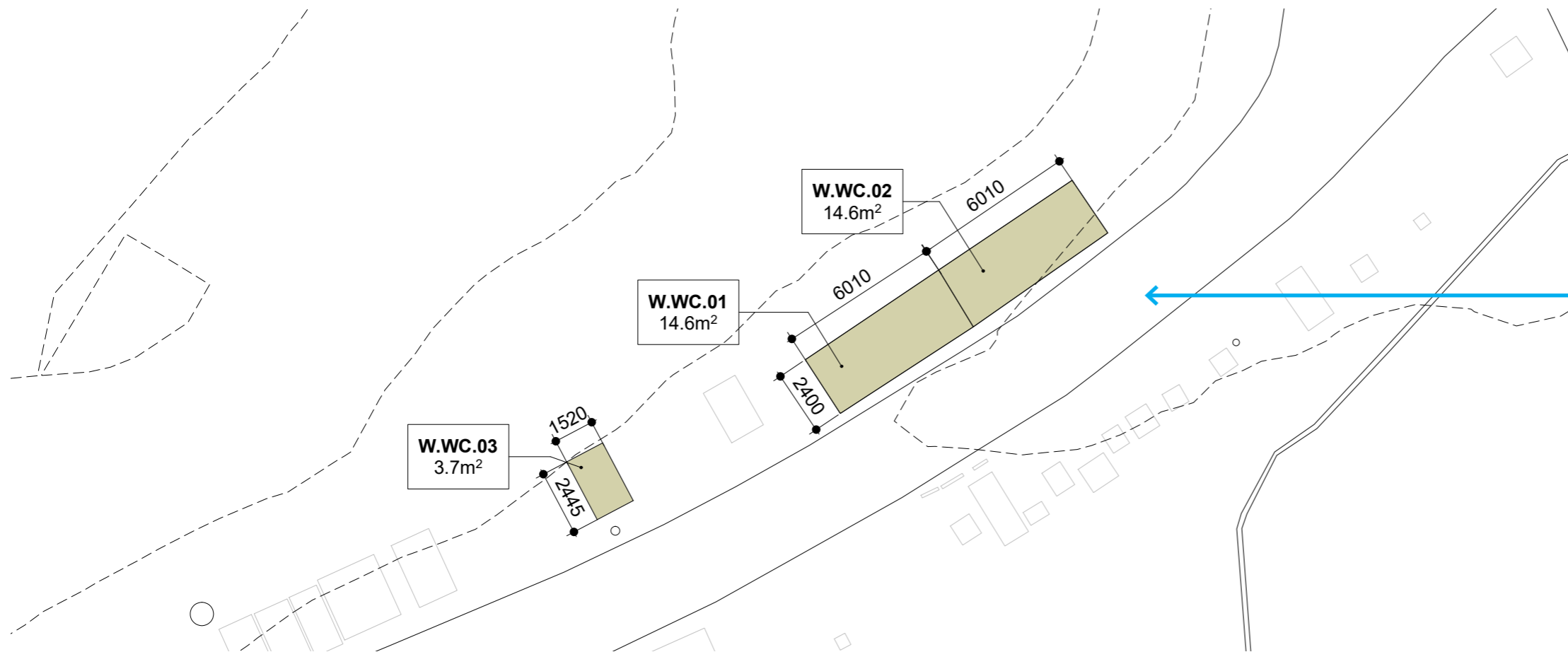
Container Workshop.



Hazardous Mat. Storage (?)

Area & Use Assessment:

Room ID.	Space / Observations	Usable Area (m <sup>2</sup> )
W.WC.01	Container 1 (20ft?) Poor condition, inadequate & not fit-for-purpose.	14.6
W.WC.02	Container 2 (20ft?) Poor condition, inadequate & not fit-for-purpose.	14.6
W.WC.03	Container 3 (10ft?) Poor condition, inadequate & not fit-for-purpose.	7.3
<b>Total</b>		<b>35.6 m<sup>2</sup></b>



Gardener's Access path from Courtyard to West Compound

6.0 | Accommodation Schedule

6.1 | Audit of Existing Accommodation - East Compound

The East Cemetery compound is comprised of a ground and basement level, it is located on the west boundary with Swain's Lane. It is primarily used by the gardening staff for equipment storage, maintenance and welfare. The ground level also accommodates 3 WCs, accessed externally; these were a later addition to the building.

Accommodation at basement level incorporates part of the old (disused) coffin tunnel. This heritage asset could be unlocked / revealed.

The Compound does not provide adequate space for the gardeners (notably WC provision) and their equipment and would not be fit to accommodate the Cemetery's aspirations for additional space for volunteers.

WC provision is inadequate for the visitor & staff numbers, with queue reported at peak times.



Exterior of East Compound.



Visitor WC



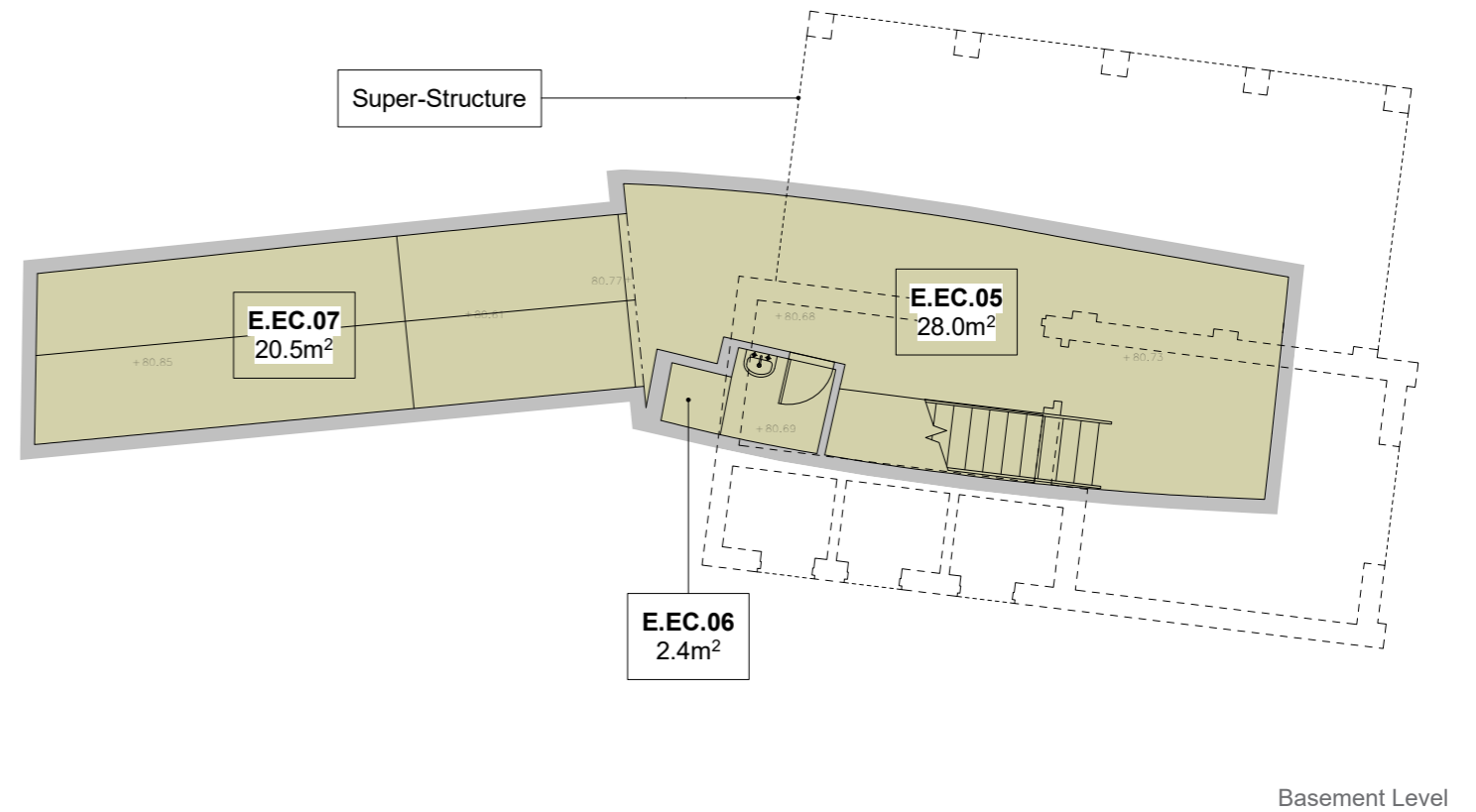
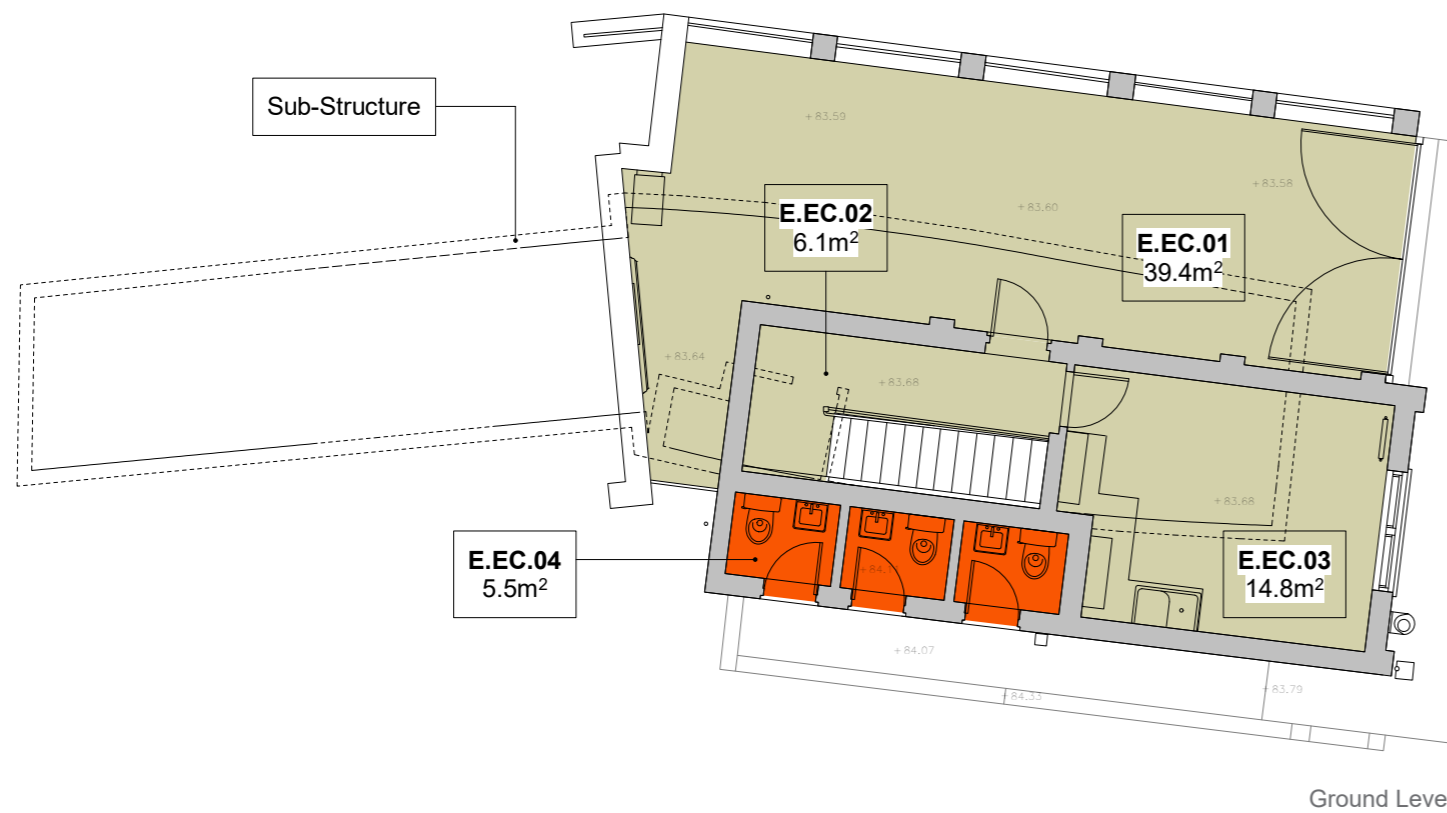
Kitchenette & Lockers



Workshop / Storage

Area & Use Assessment:

Room ID.	Level	Space / Observations	Usable Area (m <sup>2</sup> )
E.EC.01	Ground	Covered Garage / Storage	39.4
E.EC.02	Ground	Circulation / Notice-boards	6.1
E.EC.03	Ground	Kitchenette & Lockers	14.8
E.EC.04	Ground	Visitor WCs (3 No.) Provision under-sized for occupancy.	5.5
E.EC.05	Basement	Workshop	28.0
E.EC.06	Basement	Shower	2.4
E.EC.07	Basement	Tunnel Storage	20.5
<b>Total</b>			<b>116.7 m<sup>2</sup></b>



6.0 | Accommodation Schedule

6.1 | Audit of Existing Accommodation - East Cemetery Ticket Booth & Orientation

**Strathcona Mausoleum**

A visitor orientation space at the entrance to the East Cemetery. Contains info-graphic panels a digital screen. No level access.

**East Cemetery Ticket Booth**

A small pre-fabricated unit sitting inside the East Cemetery entrance on Swain's Lane. Desk for a single staff / volunteer with a small gift shop area.

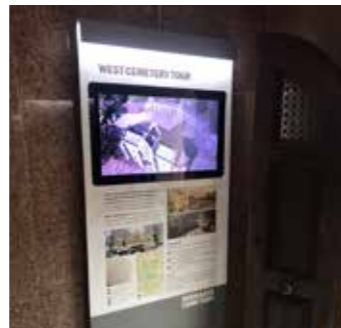
The building is not in-keeping and ill-suited with the Cemetery's architectural fabric.



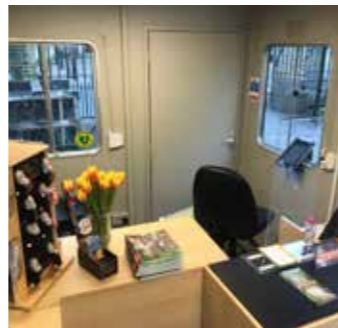
Strathcona Mausoleum



Ticket Booth Exterior



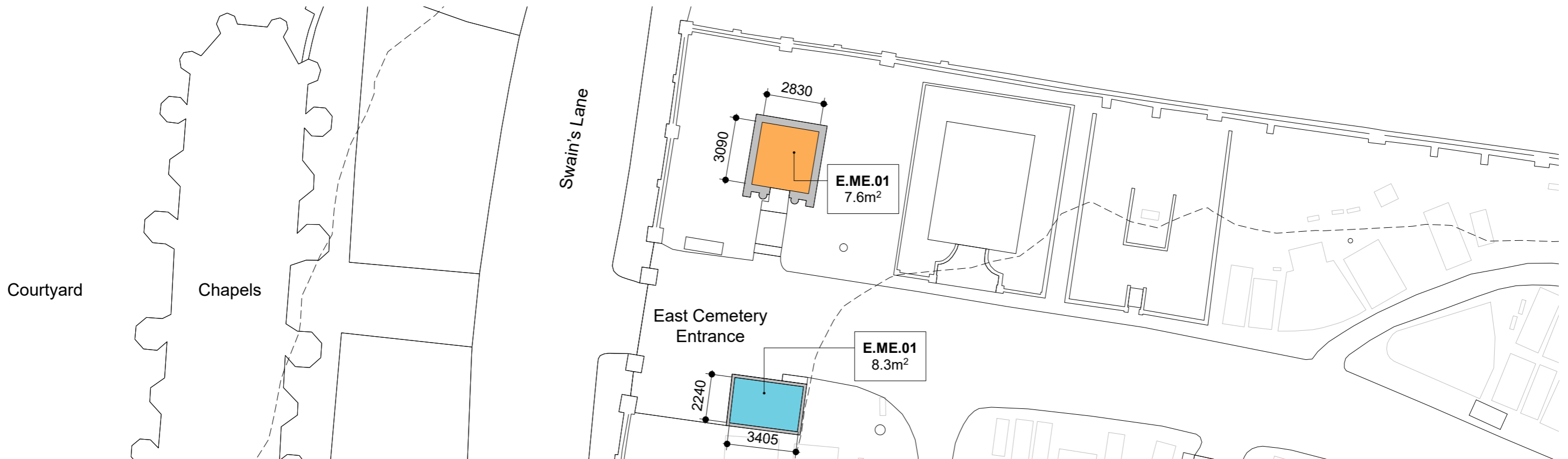
Digital displays in Strathcona



Ticket Booth Interior

**Area & Use Assessment:**

Room ID.	Space / Observations	Usable Area (m <sup>2</sup> )
E.ME.10	Strathcona Mausoleum	8.3
E.TB.01	Ticket Booth	7.6
<b>Total</b>		<b>15.9 m<sup>2</sup></b>



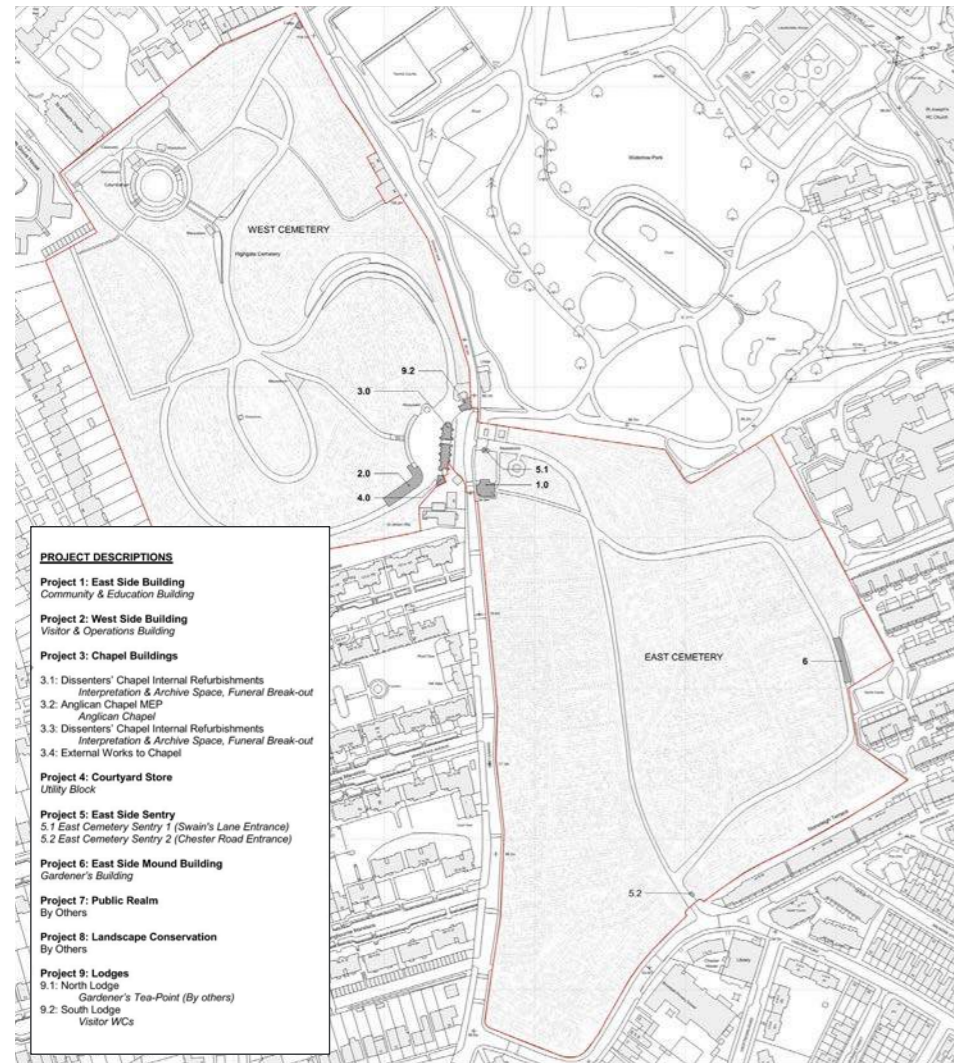
# 7.0 APPENDIX

## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

### 1. Introduction

The report outlines the modelling results and assumptions of the embodied carbon assessment of Stage 3 Highgate Cemetery buildings:

- Project 1: Community Building
- Project 2: Visitor and Operations Building
- Project 3: Dissenters' Chapel (refurbishment)
- Project 4: Utility Block
- Project 5.1: East-side Sentry at the Swain's Lane Entrance
- Project 6: Gardener's Building
- Project 9.2: South Lodge

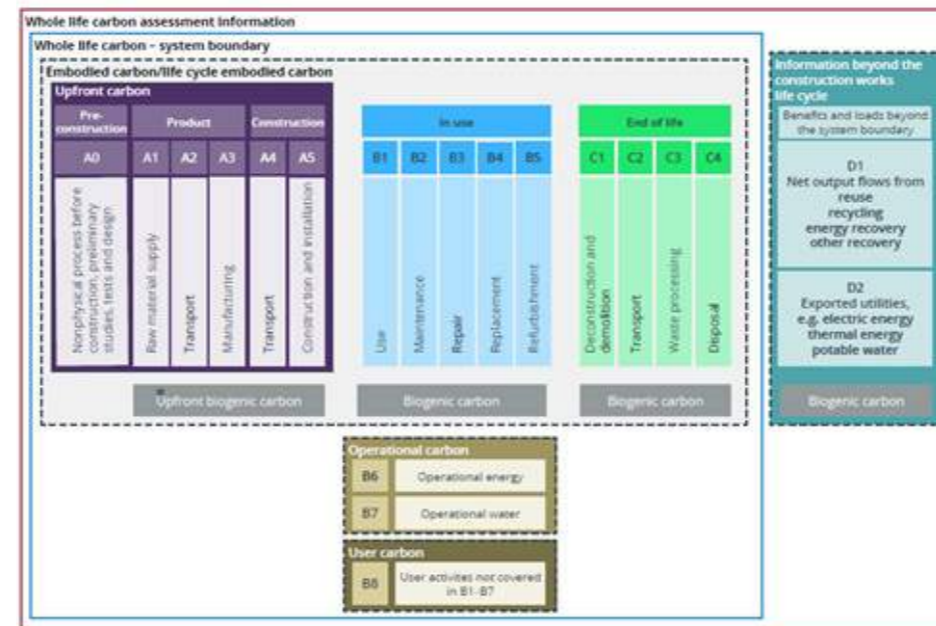


Site Plan with location of Proposed Projects

### 2. Methodology

The embodied carbon assessment was carried out in accordance with the RICS Lifecycle Assessment, reporting the results for Stages A1 to A5 (Upfront Carbon), which reflect the embodied carbon up to the construction phase of the project. The assessment also covered Stages A to C (Embodied Carbon), excluding Stages B6 and B7, which encompass impacts from maintenance, repair, replacements, and refurbishment (B1 to B5), as well as demolition and disposal at the end of the building's life (C1 to C4).

The modelling was carried out in line with the methods specified in Version 2 of the RICS Whole Life Carbon Assessment for the Built Environment, which took effect on July 1, 2024. The One Click LCA software by Bionova was used for this assessment.



Overview of Whole Life Carbon

### 3. Overall Assumptions and Model Accuracy

- Contingency factor: To address uncertainty, a contingency has been incorporated into the project based on the level of uncertainty present at the time of the assessment. In accordance with RICS Version 2 guidance for this stage, a default contingency factor of 15% has been applied.
- Non-Decarbonisation scenario: A non-decarbonisation future grid scenario has been accounted in the modelling as a conservative approach.
- Benchmarks and Targets: Targets were set by Useful Projects reflecting those set of London Plan, Whole Life Carbon for referable projects, New Camden Plan (2024 Draft) and LETI. Target upfront embodied carbon emissions for new buildings to be < 600kgCO<sub>2</sub>e/m<sup>2</sup> (LETI band C for Offices), with aspirations to stretch to LETI band B (<475 kgCO<sub>2</sub>e/m<sup>2</sup>). Target whole life embodied carbon emissions for new buildings to be <970kgCO<sub>2</sub>e/m<sup>2</sup> (LETI band B for Offices), with aspirations to stretch to LETI band B (<750 kgCO<sub>2</sub>e/m<sup>2</sup>).
- Building lifetime: Even though the project target is to build for longevity with target of 100 year plus lifespan the Reference Study Period for the modelling was set to 60 years to align with the benchmarks set.

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### 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

#### 4. Materials

It is recognised that certain material selections contribute more significantly to embodied carbon than others. The selection and application of the layered concrete material has not been taken lightly and its use responds to a number of factors - structural properties as retaining wall elements, longevity and aesthetically being a material which is suitable for the setting of the proposed buildings, visually portraying a sense of permanence; and is sympathetic and subservient - and differentiated - to the materiality of the Cemetery buildings and monuments which are predominately brick and stone.

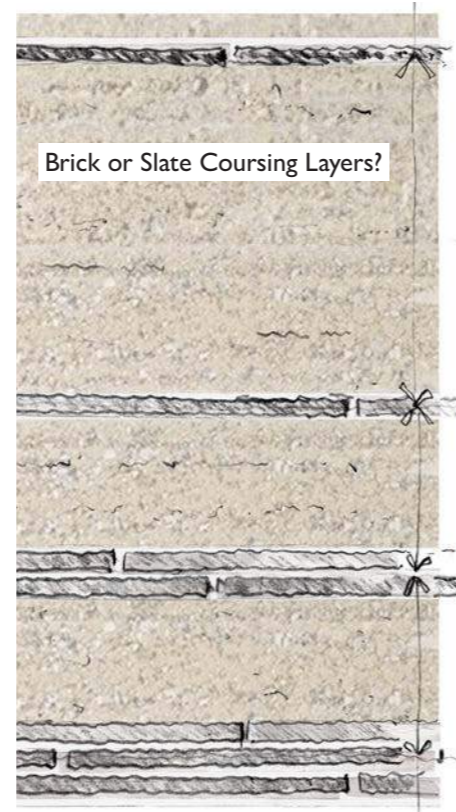
In most buildings, concrete and reinforcement are the primary contributors to embodied carbon. To assess potential reductions in this impact, the following measures were incorporated into the carbon calculation, drawing on input from structural engineers and available data in OneClick LCA:

- The concrete mix incorporates a 25% cement replacement with GGBS. Although this is a conservative approach, we plan to evaluate practical improvements in the mix during the next phase to further reduce upfront and embodied carbon.
- Reinforcement steel (rebar), generic, 97% recycled content (typical), A615 with reinforcement rates:  
Substructure: 300 kg/m<sup>3</sup>  
Superstructure (columns): 175 kg/m<sup>3</sup>  
Superstructure (beams and arches, walls): 100 kg/m<sup>3</sup>

We have considered the use of void formers within the raft slabs for P2 and P6 to reduce the overall volume of concrete this will studies further in Stage 4.

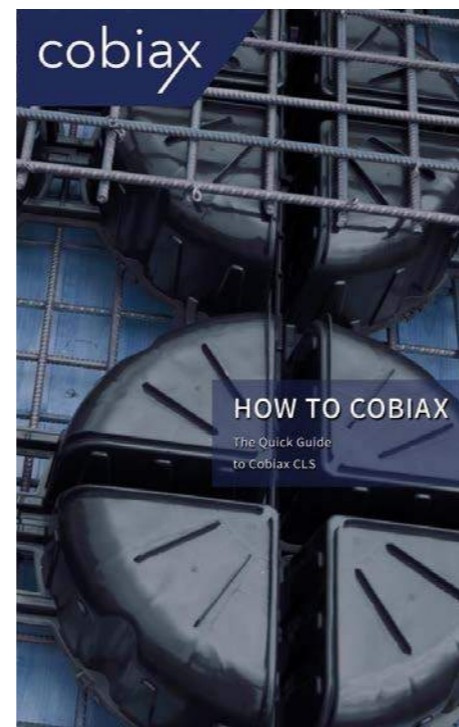
One system we looked into for the raft slabs is Cobiax is a void former product which could be looked into for the raft slabs. This shows a reduction if effective carbon emissions of 29 kgCO<sub>2</sub>e/m<sup>2</sup> of slab area,

This accounts for loss of concrete volume and for the carbon footprint of the product itself. A quick volume calculation suggested that this would reduce the carbon rate of the raft slab concrete to about 95 kgCO<sub>2</sub>e/m<sup>3</sup>.

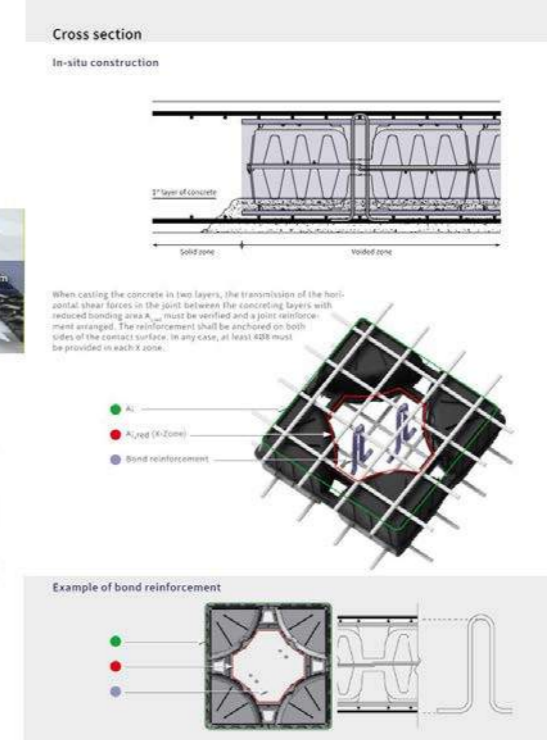
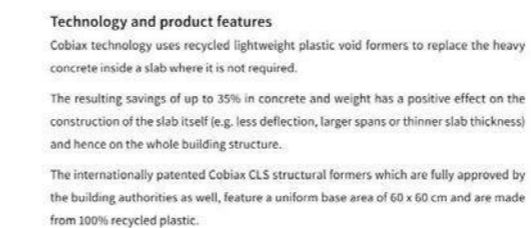


Could a layered aggregated material, incorporating re-used fragments?

The Weston at the Yorkshire Sculpture Park (reference project)



Cobiax Data Sheet Extract



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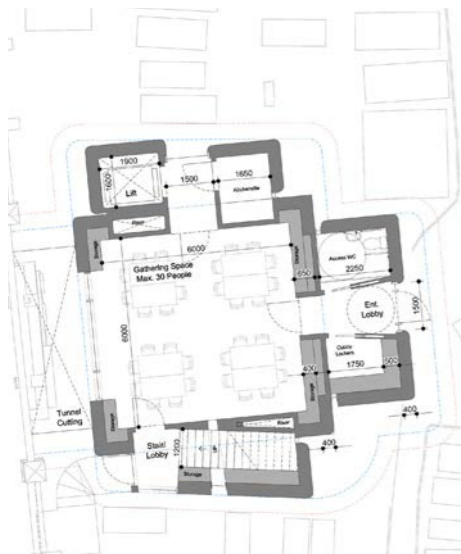
## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

### Project 1: Community & Education Building

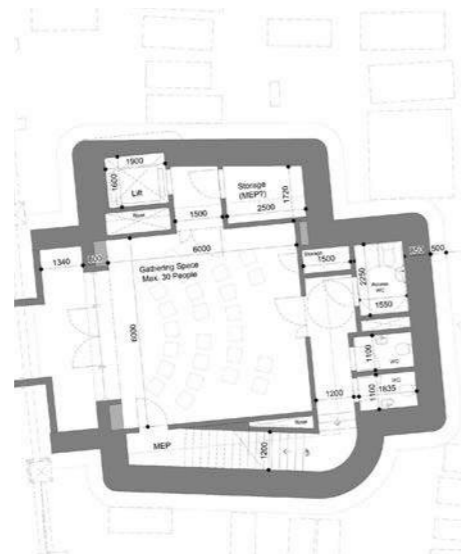
Below-ground construction requires large quantities of concrete and reinforcement, making it challenging to meet Upfront Carbon A1-A5 target. A conservative assumption of 25% cement replacement has been allowed for in the calculation; the impact of an aspirational 75% cement replacement has been indicated.



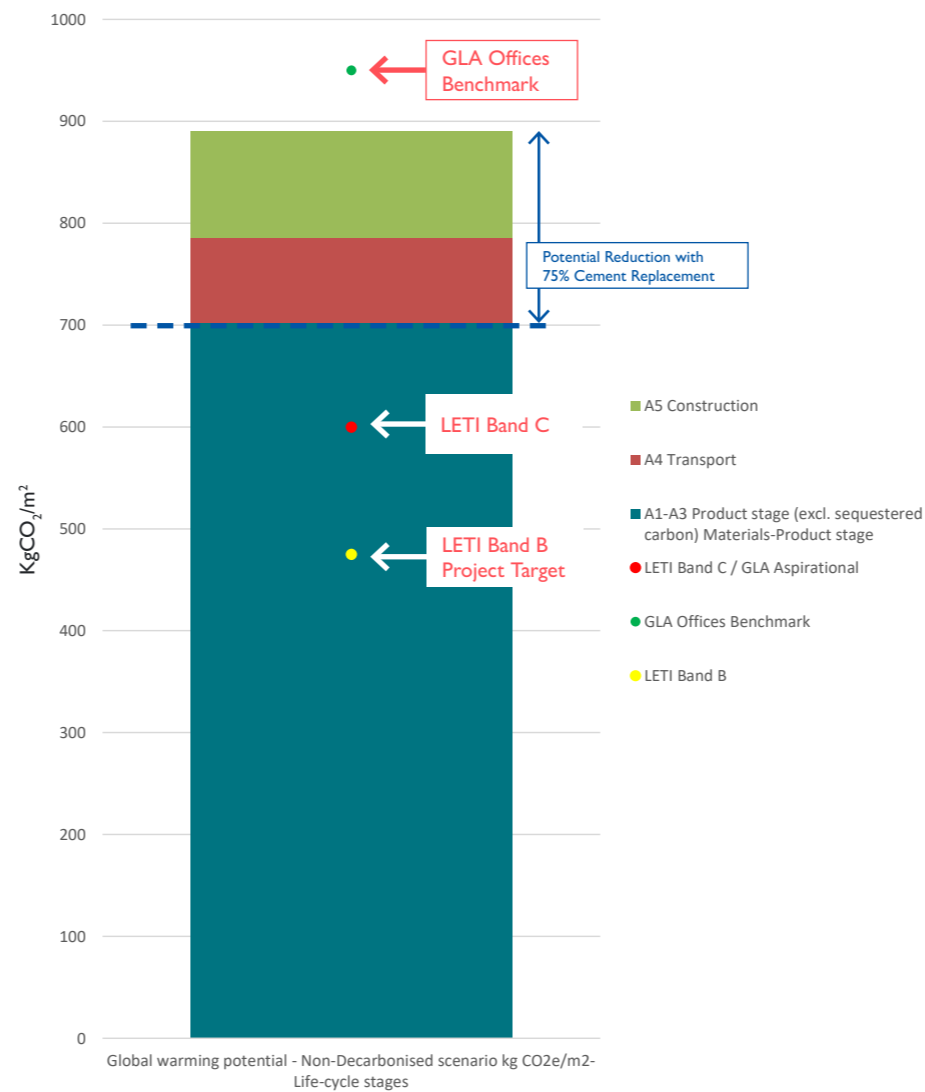
Visualisation of Proposed Education & Community Building



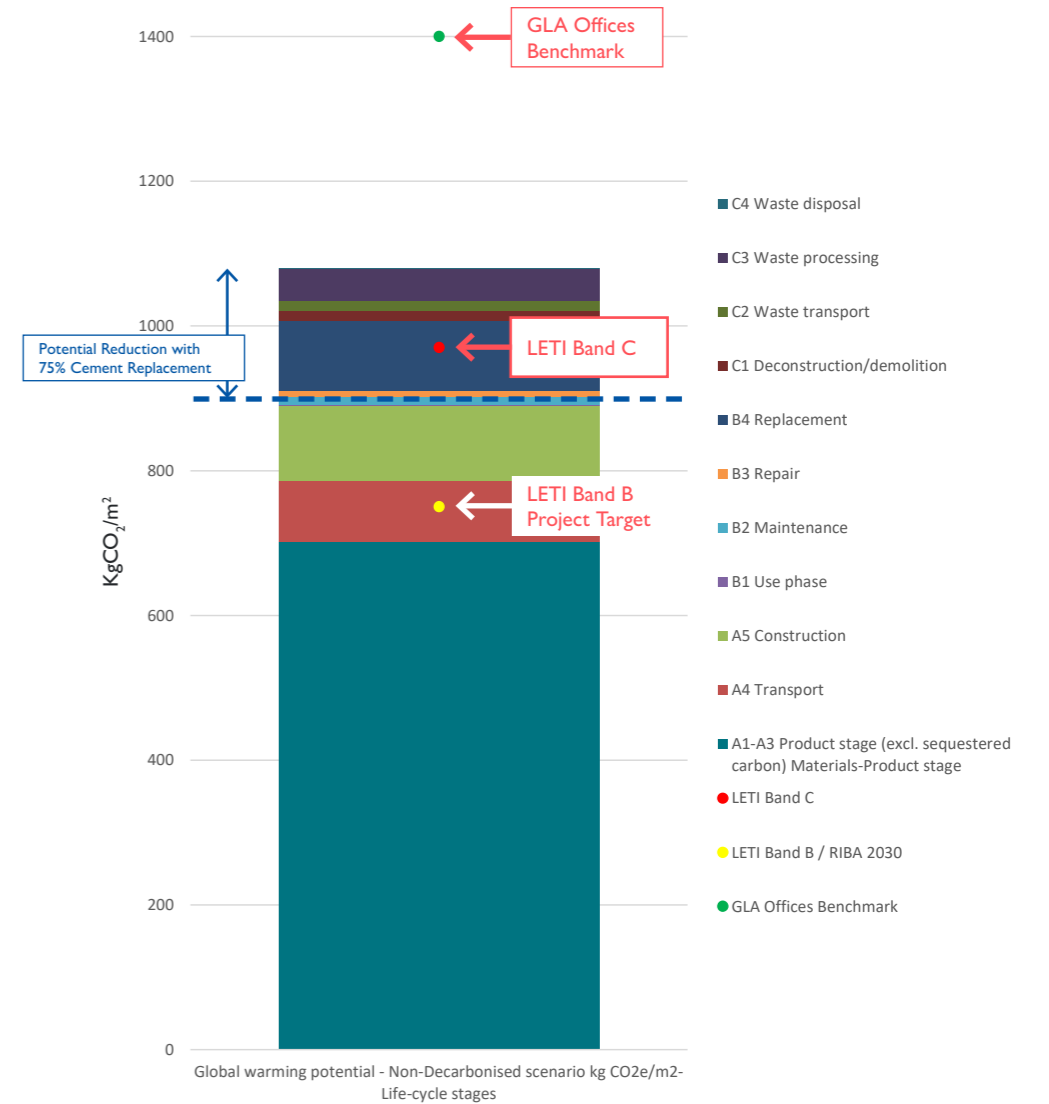
Ground Level Plan



Basement Level Plan



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A1 to A5)



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A to C)

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### 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

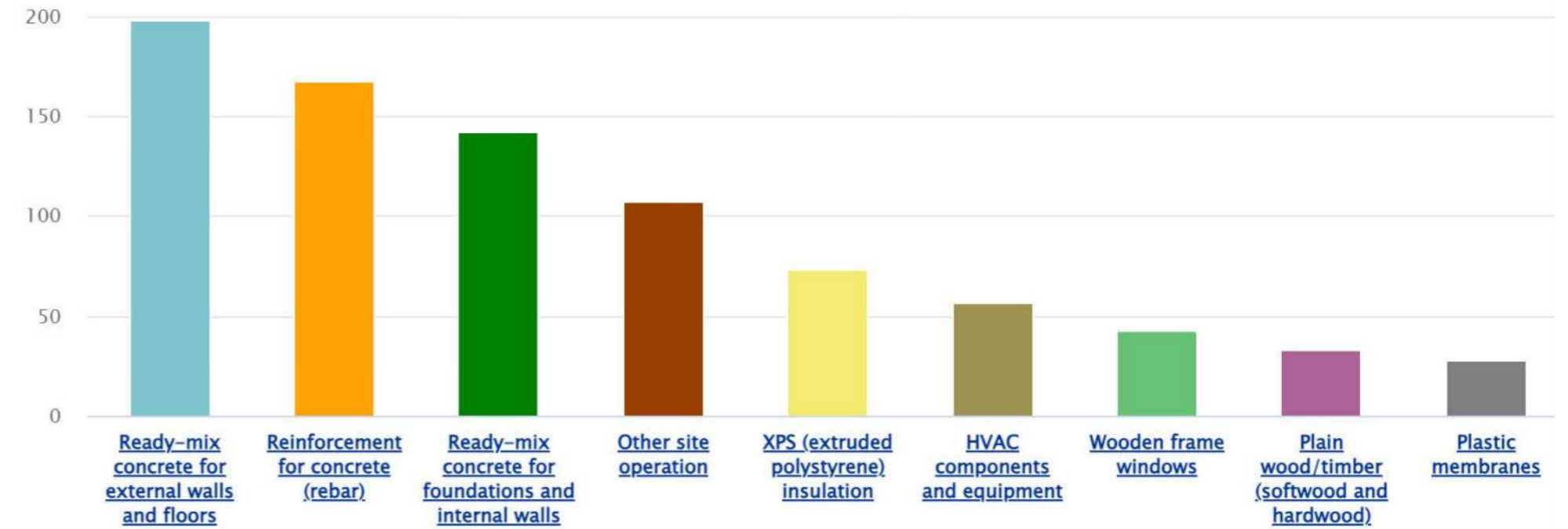
#### Project 1: Community & Education Building

Targets A1 to A5	
LETI Band C	600
LETI Band B / RIBA 2030	475 (Project Target)
GLA Offices Benchmark	950

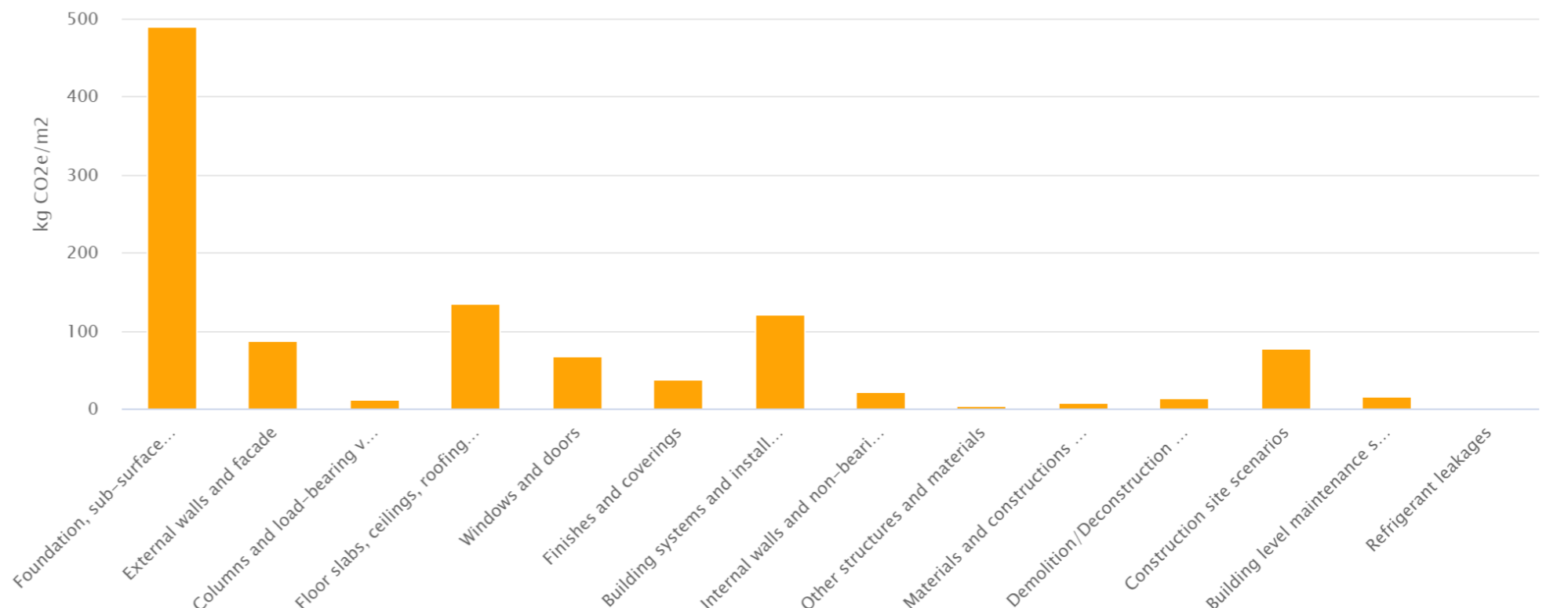
Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	702.5
A4 Transport	82.9
A5 Construction	104.7
Total	890 (703.5 with 75% Cement Replace.)

Targets A to C	
LETI Band C	970
LETI Band B / RIBA 2030	750 (Project Target)
GLA Offices Benchmark	1400

Assessment of Project 2:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	702.5
A4 Transport	82.9
A5 Construction	104.7
B1 Use Phase	0.2
B2 Maintenance	12.1
B3 Repair	8.1
B4 Replacement	96.0
C1 Deconstruction/Demo	14.5
C2 Waste Transport	13.6
C3 Waste Processing	44.0
C4 Waste Disposal	0.1
Total	1079 (888.8 with 75% Cement Replace.)



Building Materials



Building / Construction Elements

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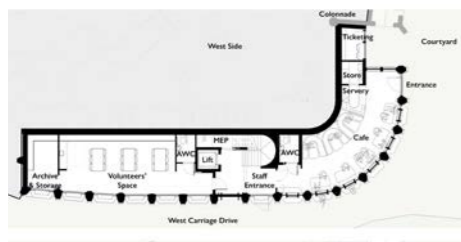
## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

### Project 2: Visitor & Operations Building

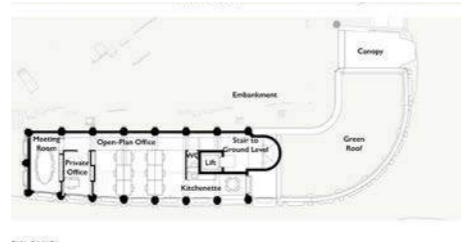
The considerable amount of concrete and reinforcement used for the layered concrete construction, additionally within the internal walls, further challenges the achievement of the Upfront Carbon A1-A5 targets.



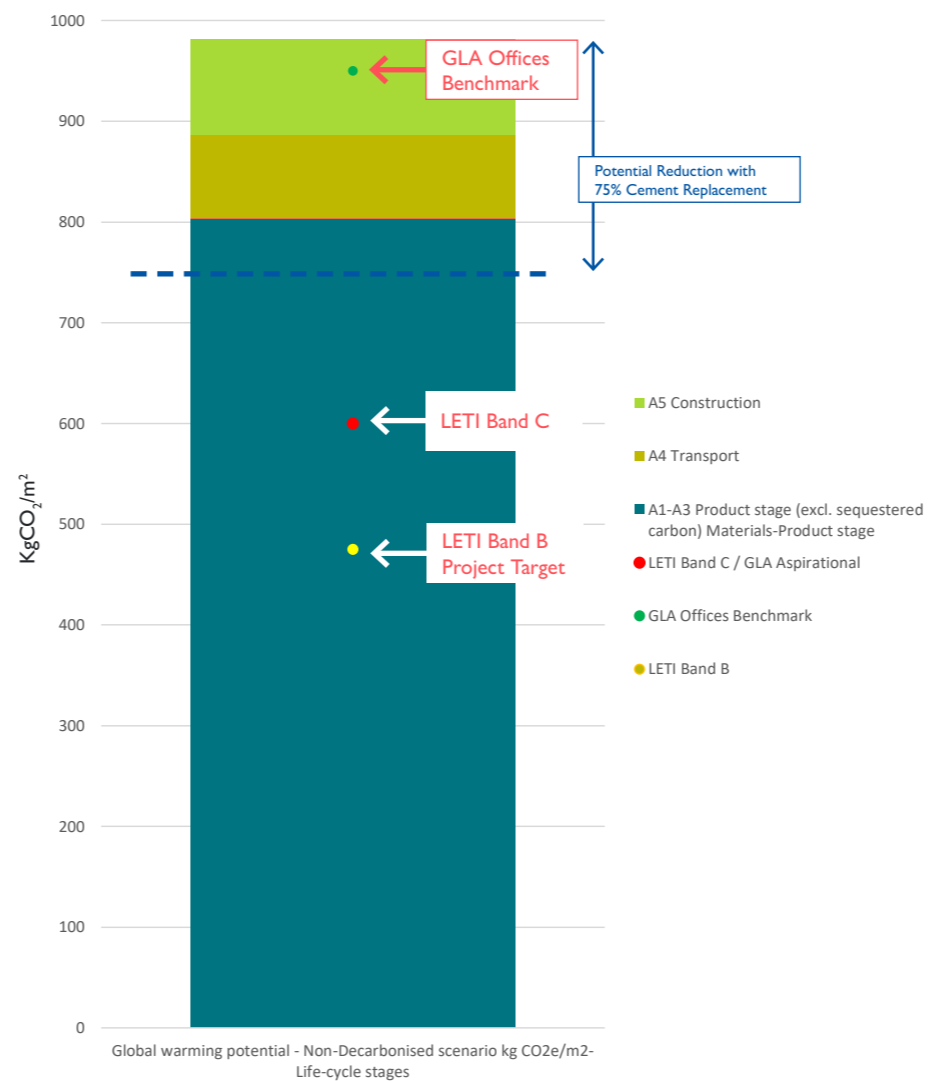
Visualisation of Proposed Visitor & Operations Building



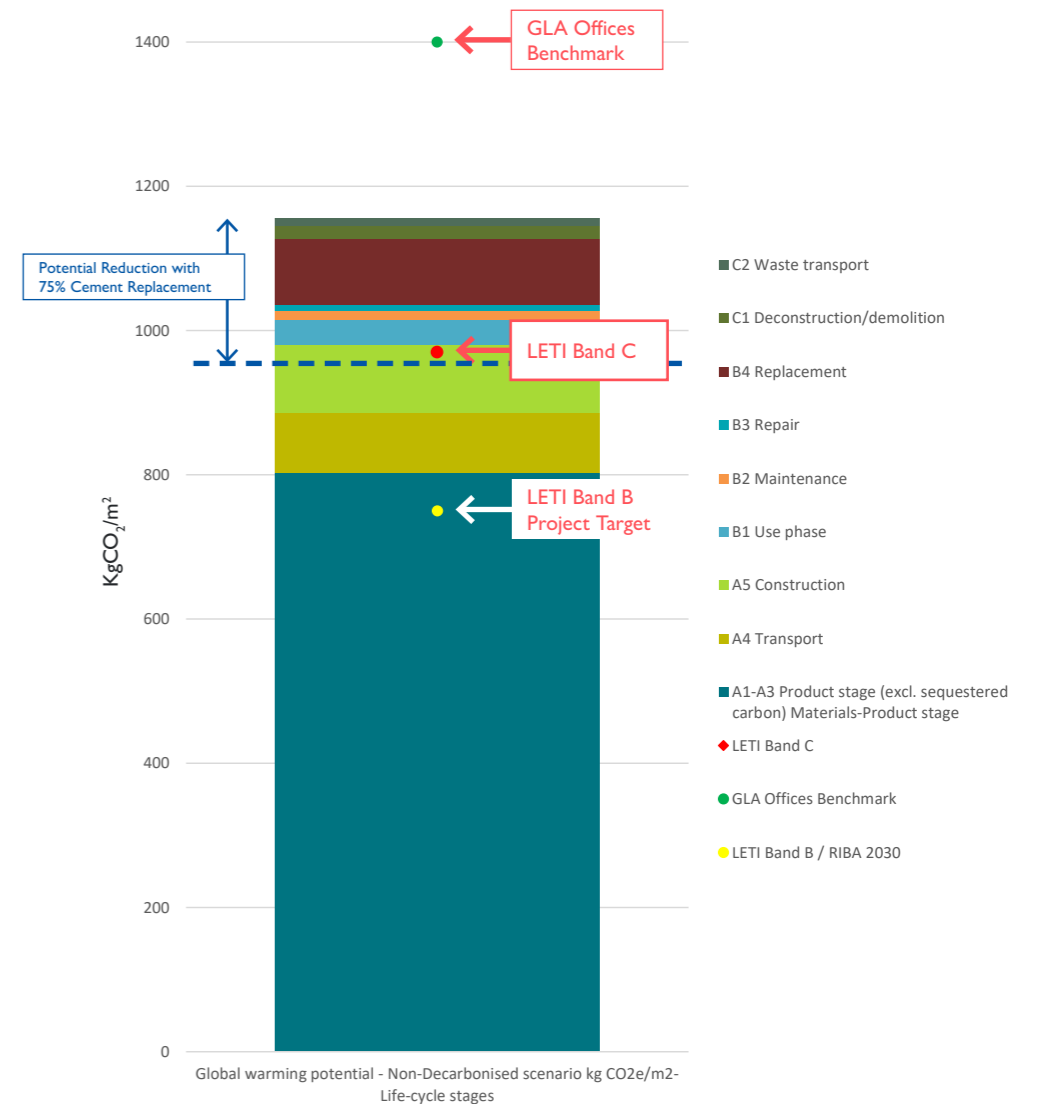
Ground Level Plan



First Level Plan



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A1 to A5)



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A to C)



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### 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

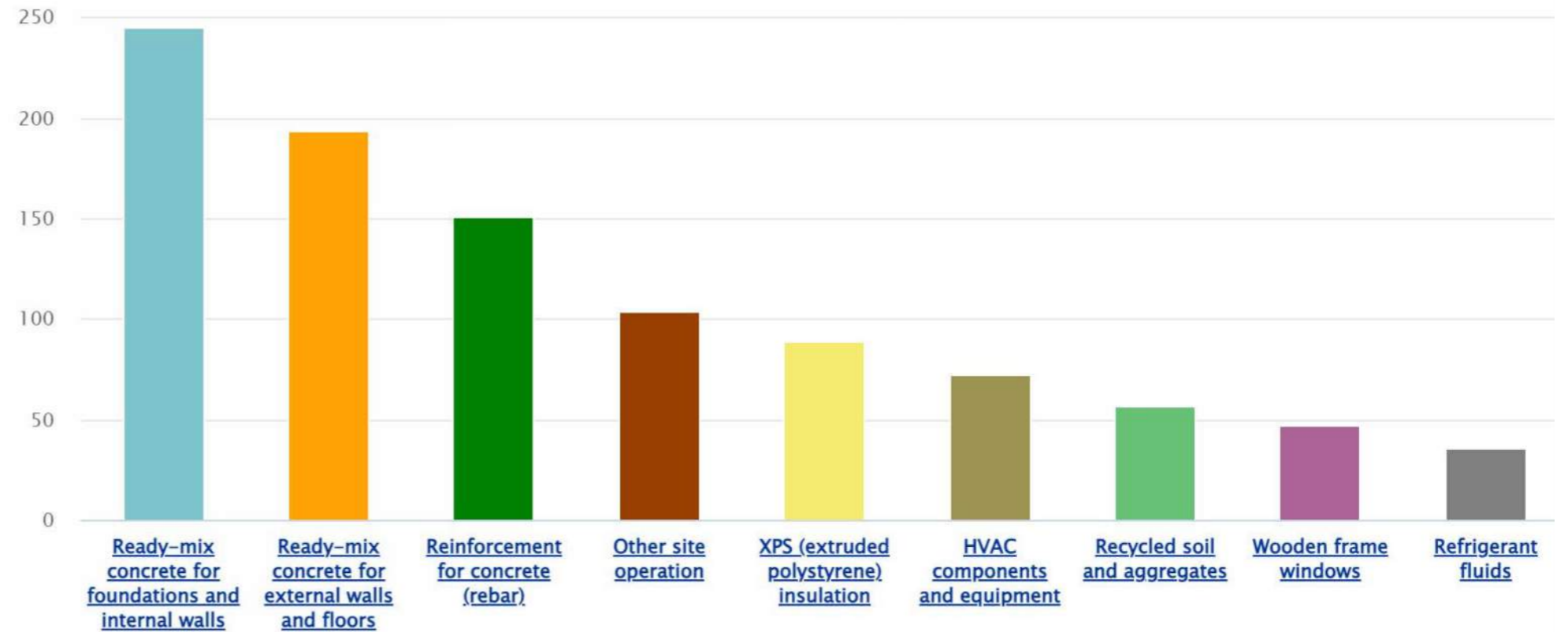
#### Project 2: Visitor & Operations Building

Targets A1 to A5	
LETI Band C	600
LETI Band B / RIBA 2030	475 (Project Target)
GLA Offices Benchmark	950

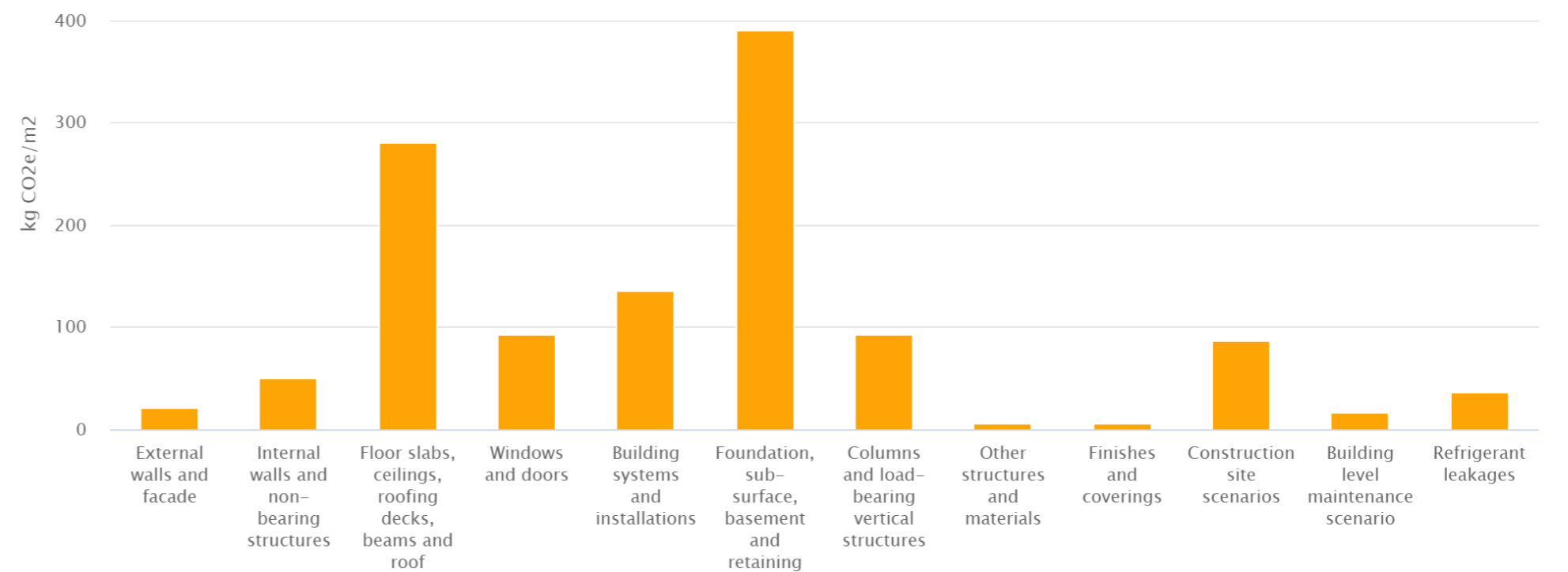
Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	803.6
A4 Transport	81.9
A5 Construction	94.9
Total	980 (750 with 75% Cement Replace.)

Targets A to C	
LETI Band C	970
LETI Band B / RIBA 2030	750 (Project Target)
GLA Offices Benchmark	1400

Assessment of Project 3:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	803.6
A4 Transport	81.9
A5 Construction	94.9
B1 Use Phase	33.6
B2 Maintenance	13.6
B3 Repair	9.0
B4 Replacement	90.1
C1 Deconstruction/Demo	18.7
C2 Waste Transport	10.7
C3 Waste Processing	43.1
C4 Waste Disposal	0.1
Total	1199 (965 with 75% Cement Replace.)



Building Materials



Building / Construction Elements

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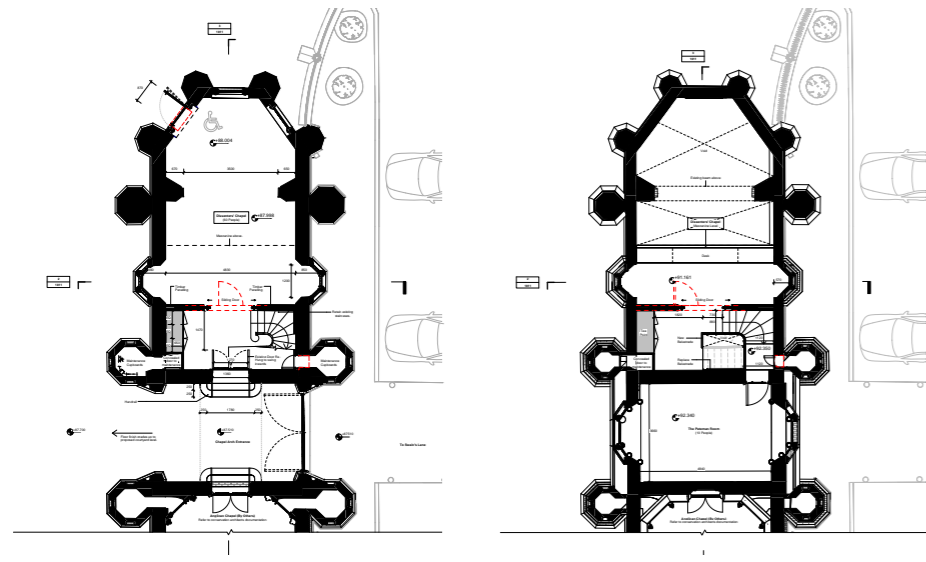
## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

### Project 3: Chapel Entrance Building

The project has significantly lower embodied carbon by comparison, as it is a refurbishment rather than a new build and meets targets. Assessment is for the interior refurbishment of Dissenters' Chapel only and excludes conservation repairs to the exterior of the Chapel Entrance Building.

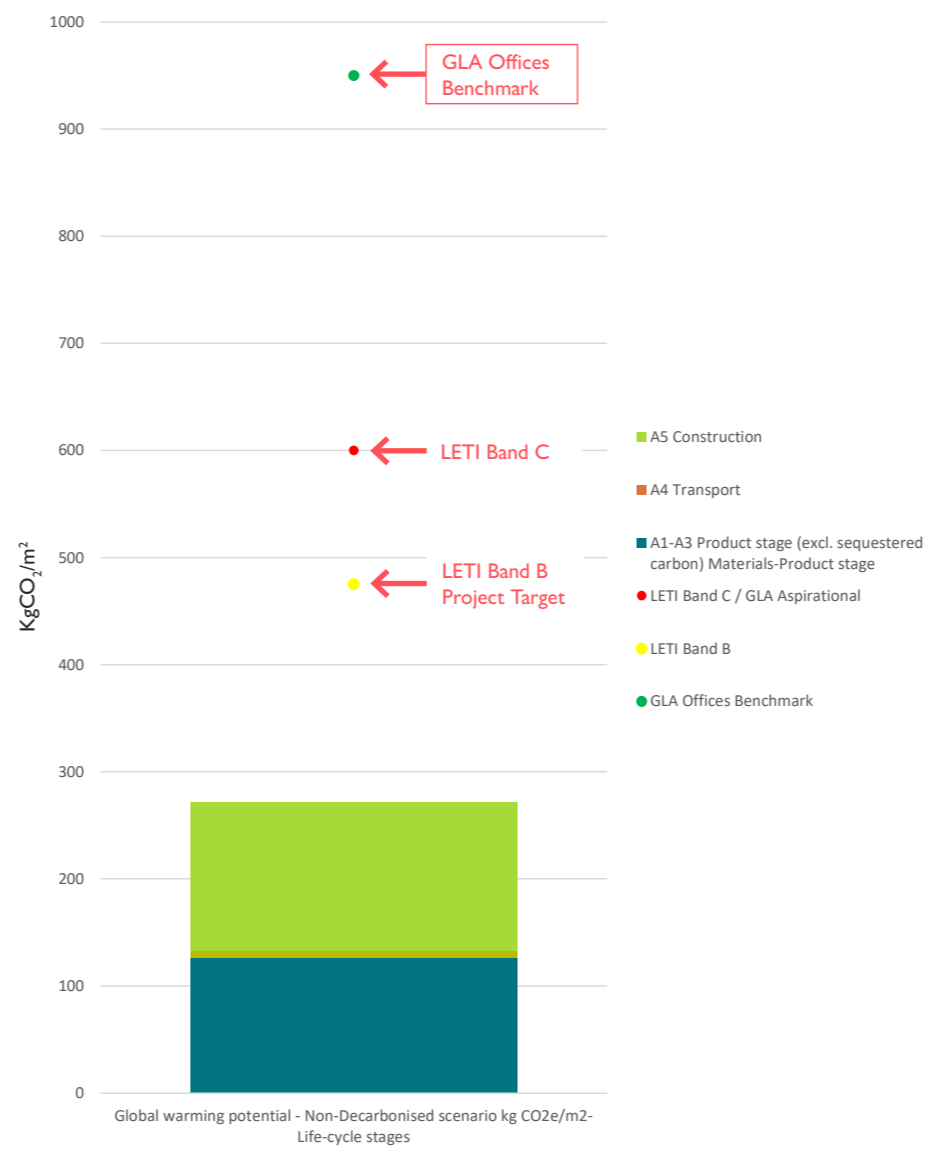


Visualisation of Proposed Refurbishment to the interior of the Dissenters' Chapel



Ground Level Plan

First Level Plan



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A1 to A5)



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A to C)

## 7.0 APPENDIX

### 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

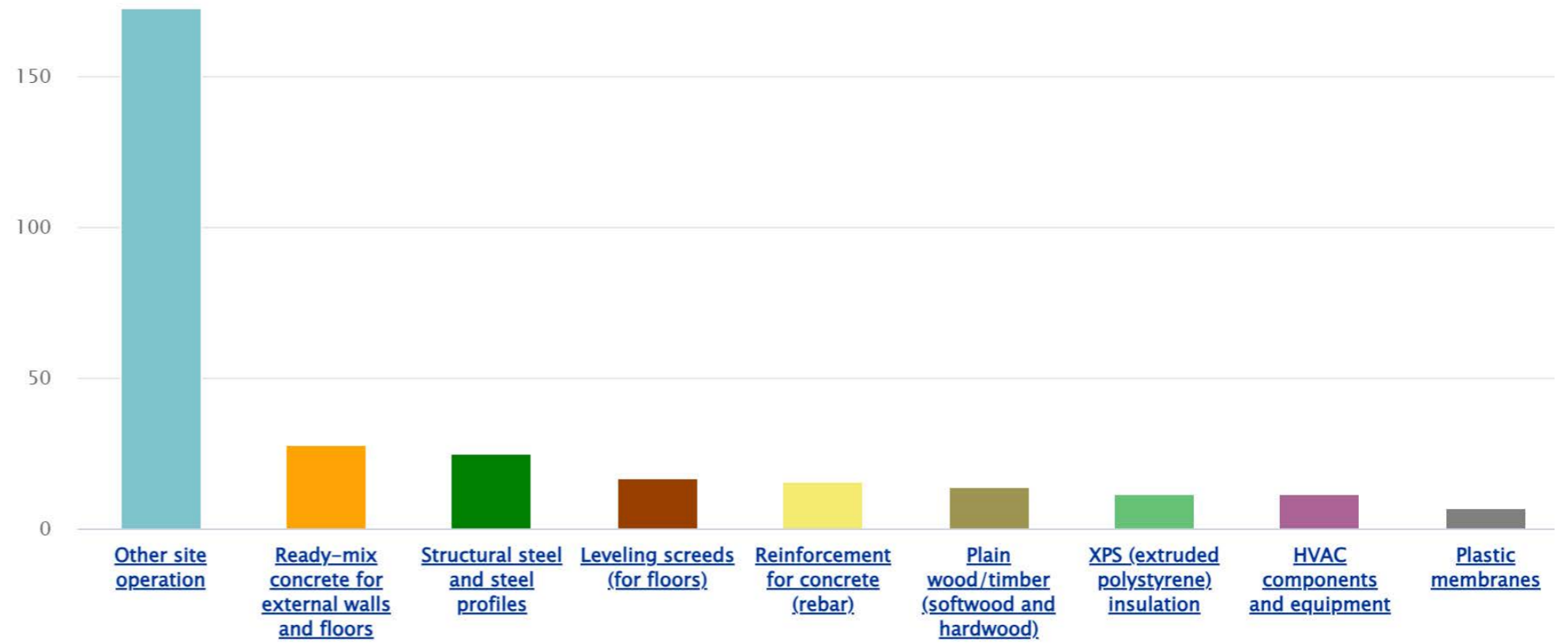
#### Project 3: Chapel Entrance Building

Targets A1 to A5	
LETI Band C	600
LETI Band B / RIBA 2030	475 (Project Target)
GLA Offices Benchmark	950

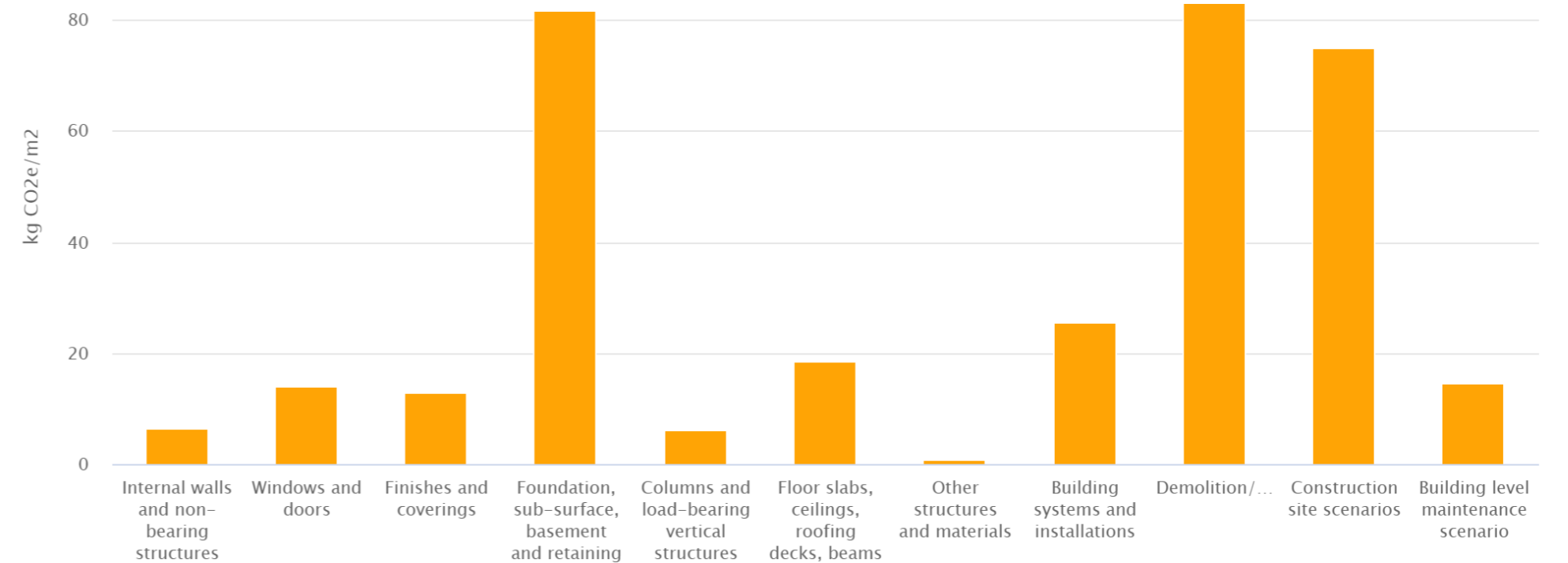
Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	126.4
A4 Transport	6.6
A5 Construction	138.4
Total	271 (257 with 75% Cement Replace.)

Targets A to C	
LETI Band C	970
LETI Band B / RIBA 2030	750 (Project Target)
GLA Offices Benchmark	1400

Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	126.4
A4 Transport	6.6
A5 Construction	138.4
B1 Use Phase	NA
B2 Maintenance	11.7
B3 Repair	4.3
B4 Replacement	13.8
C1 Deconstruction/Demo	14.0
C2 Waste Transport	2.1
C3 Waste Processing	7.7
C4 Waste Disposal	0.0
Total	325 (311 with 75% Cement Replace.)



Building Materials



Building / Construction Elements

# 7.0 APPENDIX

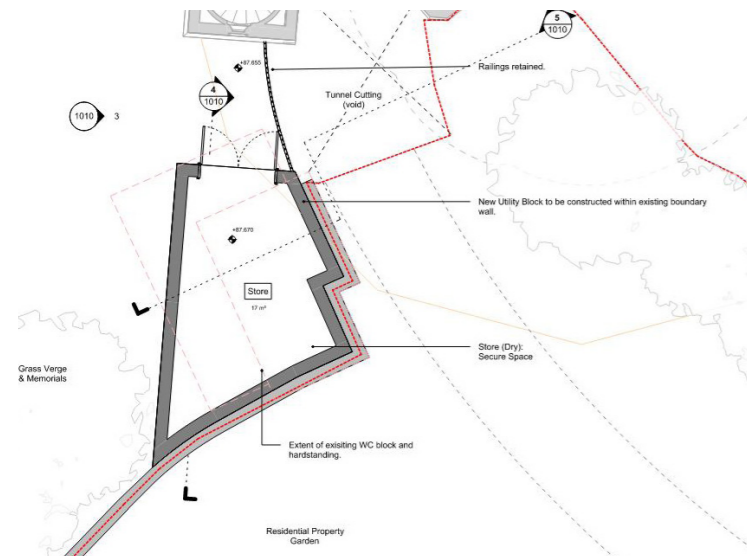
## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

### Project 4: Utility Block

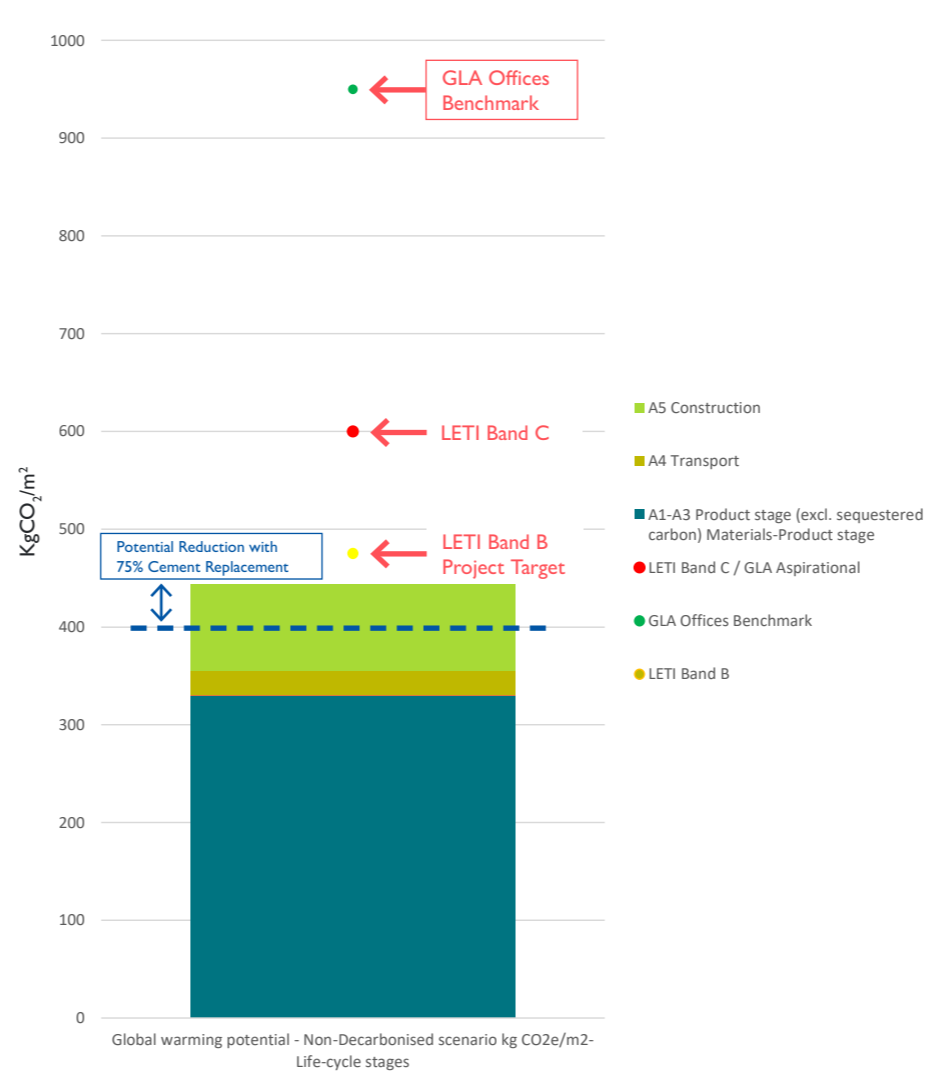
The embodied carbon is very low due to the reduced amount of materials and services required, given its function as a utility space. A lower embodied carbon could potentially be achievable if the flat roof build-up and finish are specified as gravel instead of aluminium.



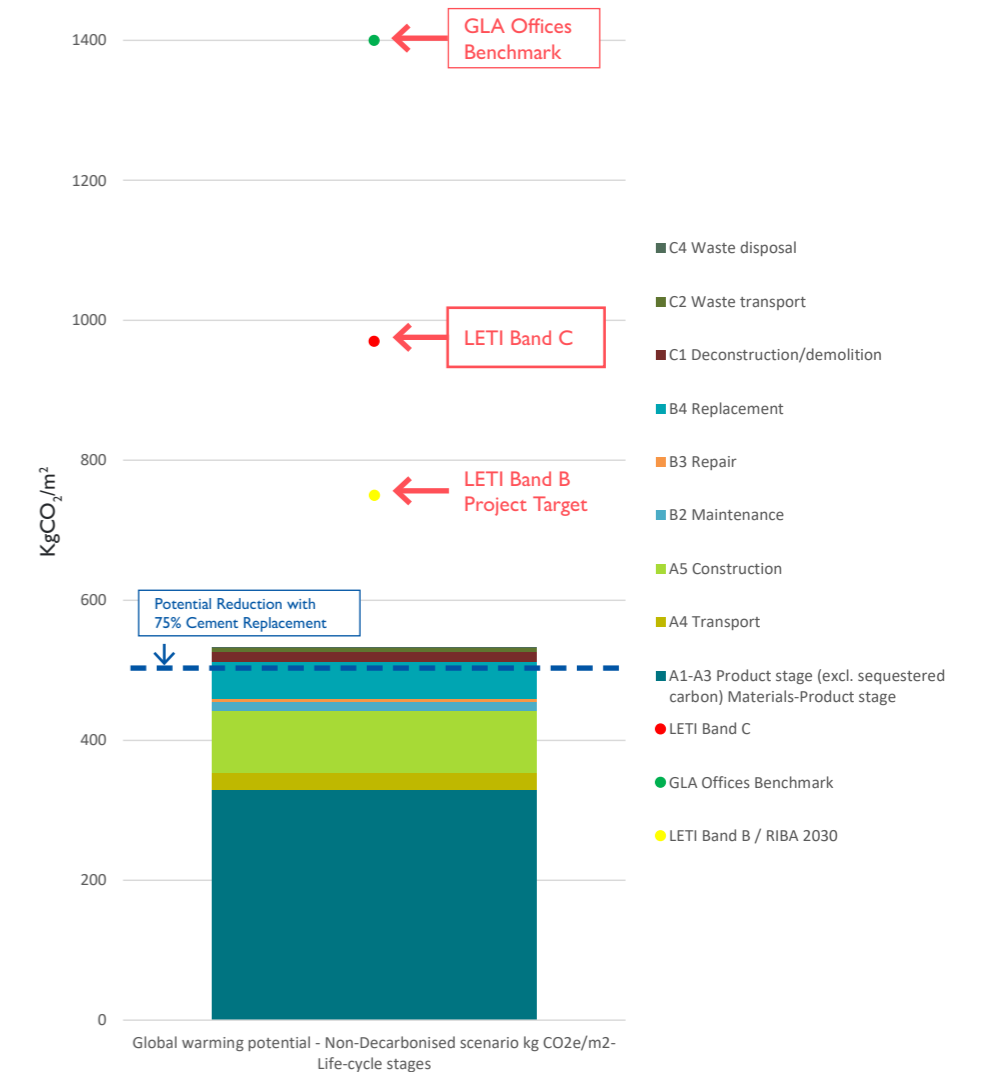
Visualisation of Proposed Utility Block



Ground Level Plan



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A1 to A5)



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A to C)

## 7.0 APPENDIX

### 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

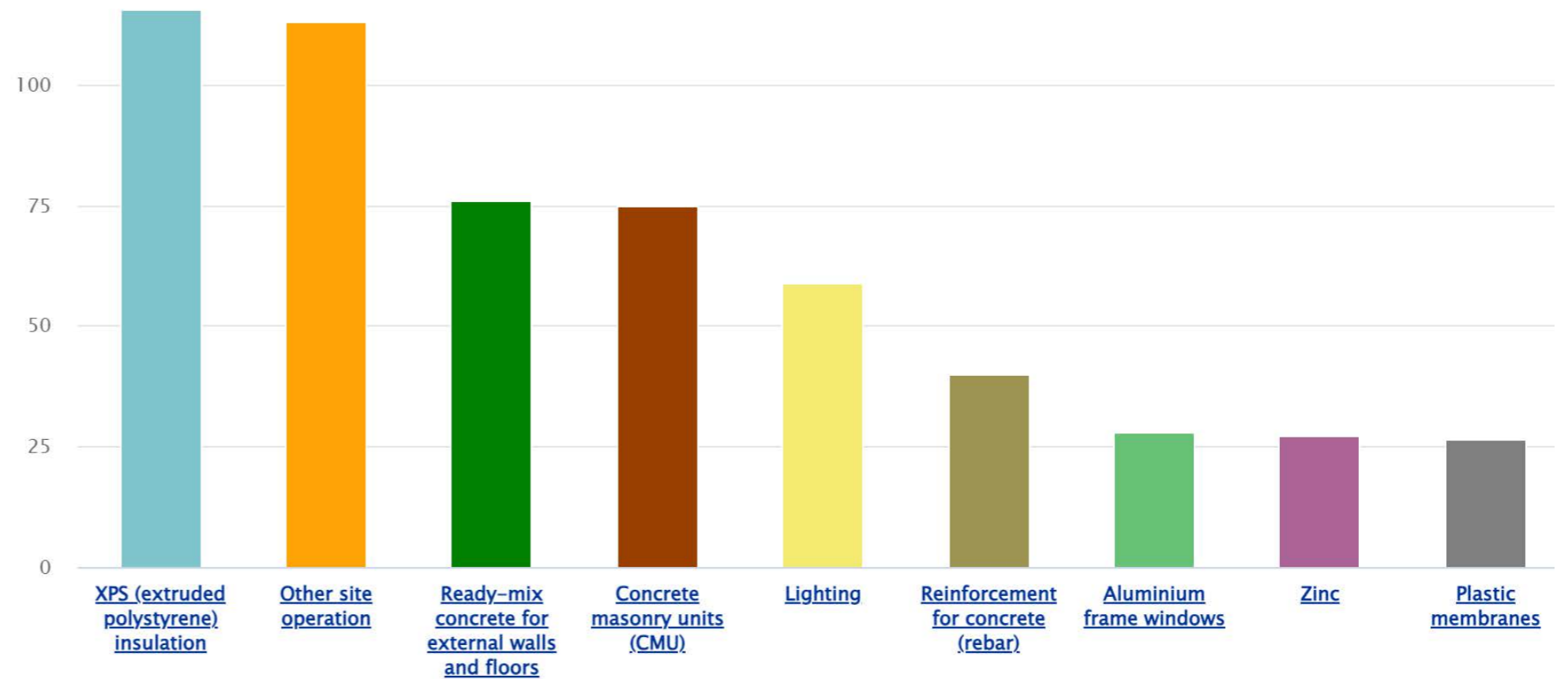
#### Project 4: Utility Block

Targets A1 to A5	
LETI Band C	600
LETI Band B / RIBA 2030	475 (Project Target)
GLA Offices Benchmark	950

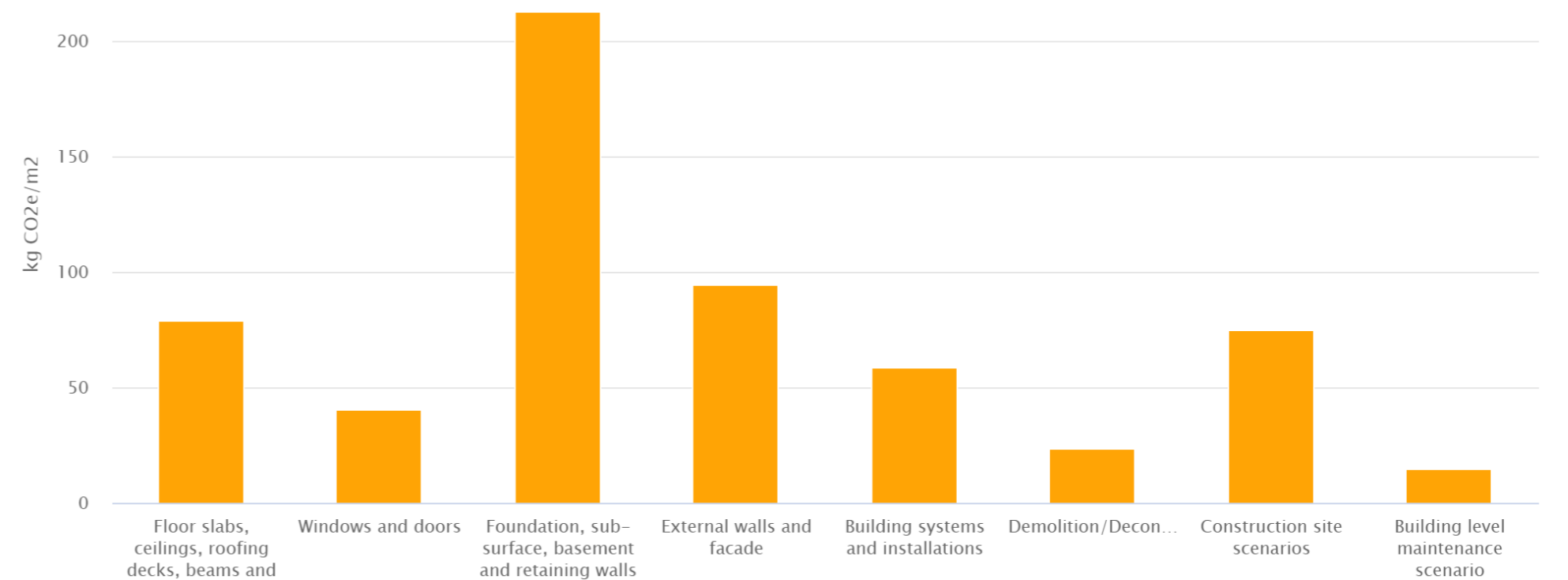
Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	329.6
A4 Transport	24.9
A5 Construction	88.6
Total	443 (401 with 75% Cement Replace.)

Targets A to C	
LETI Band C	970
LETI Band B / RIBA 2030	750 (Project Target)
GLA Offices Benchmark	1400

Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	329.6
A4 Transport	24.9
A5 Construction	88.6
B1 Use Phase	NA
B2 Maintenance	11.7
B3 Repair	4.1
B4 Replacement	52.9
C1 Deconstruction/Demo	14.0
C2 Waste Transport	6.4
C3 Waste Processing	51.7
C4 Waste Disposal	0.0
Total	584 (542 with 75% Cement Replace.)



Building Materials



Building / Construction Elements

# 7.0 APPENDIX

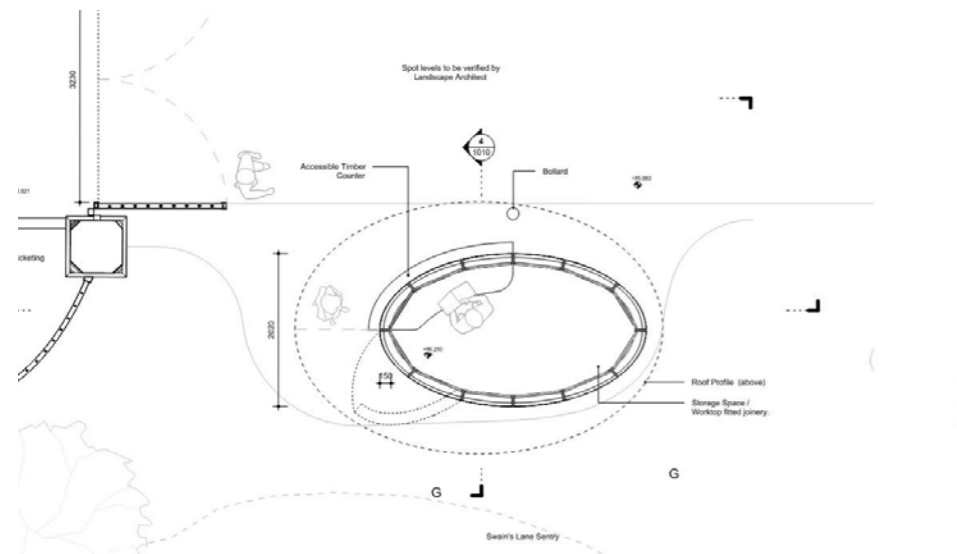
## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

### Project 5: Sentry (Swain's Lane)

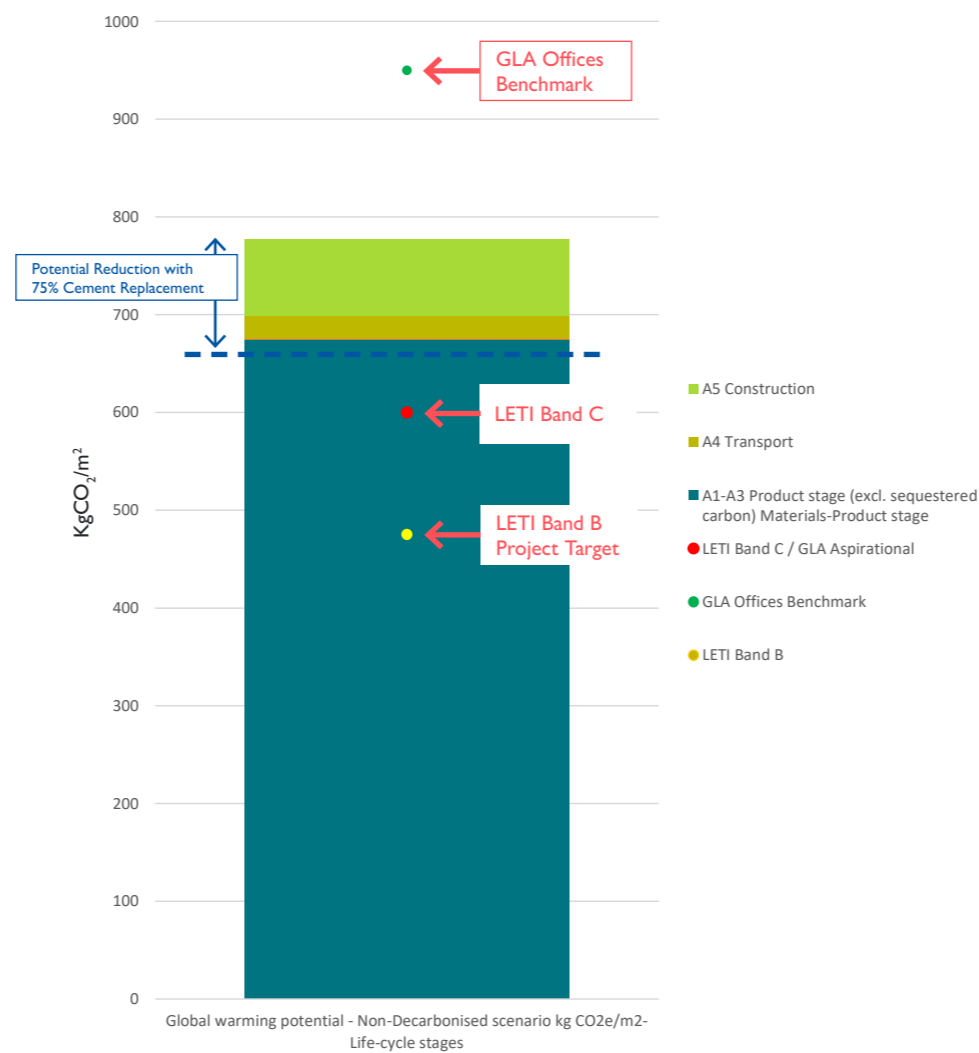
The A1-A5 target could potentially be achievable if the roof build-up and finish are specified as alternatives with lower embodied carbon. The model will be reviewed in the next stage to assess this adjustment.



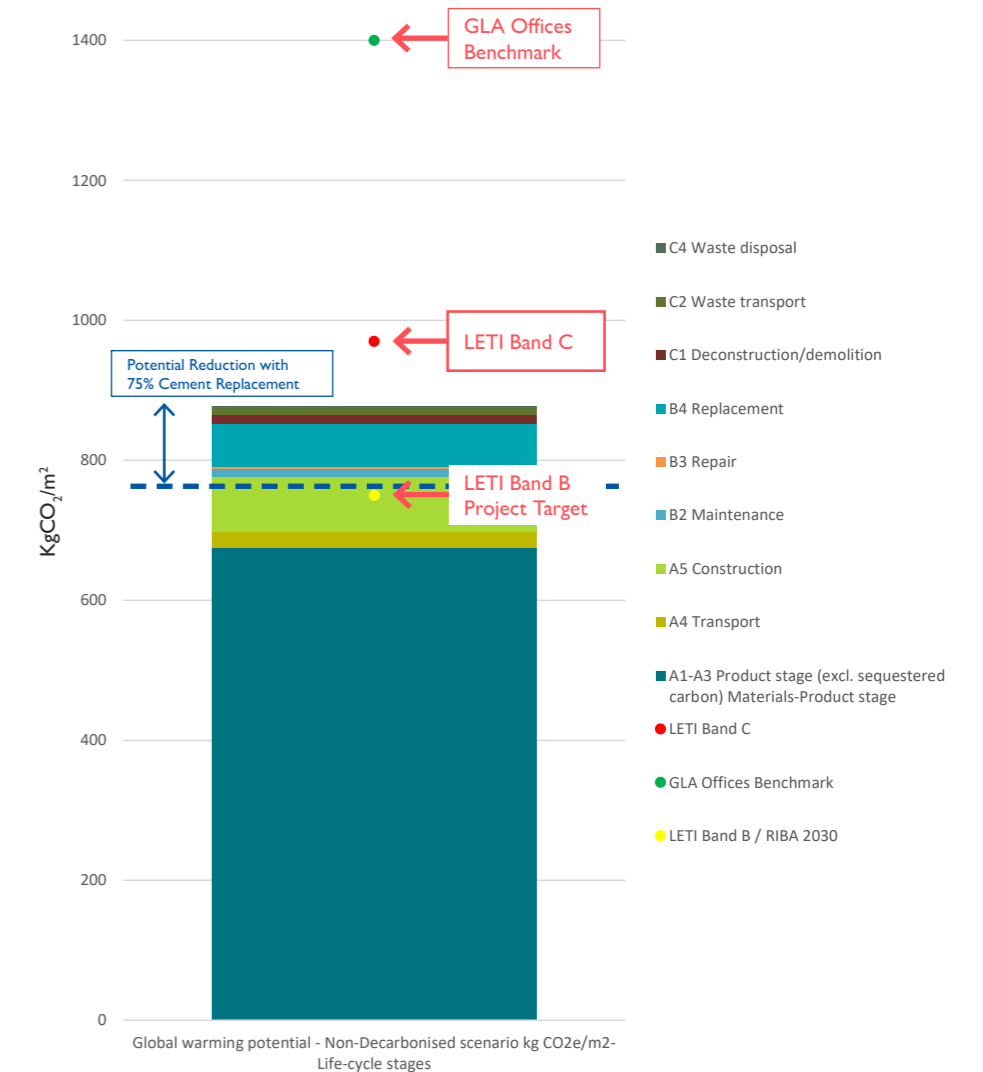
Visualisation of Proposed Utility Block



Ground Level Plan



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A1 to A5)



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A to C)

## 7.0 APPENDIX

### 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

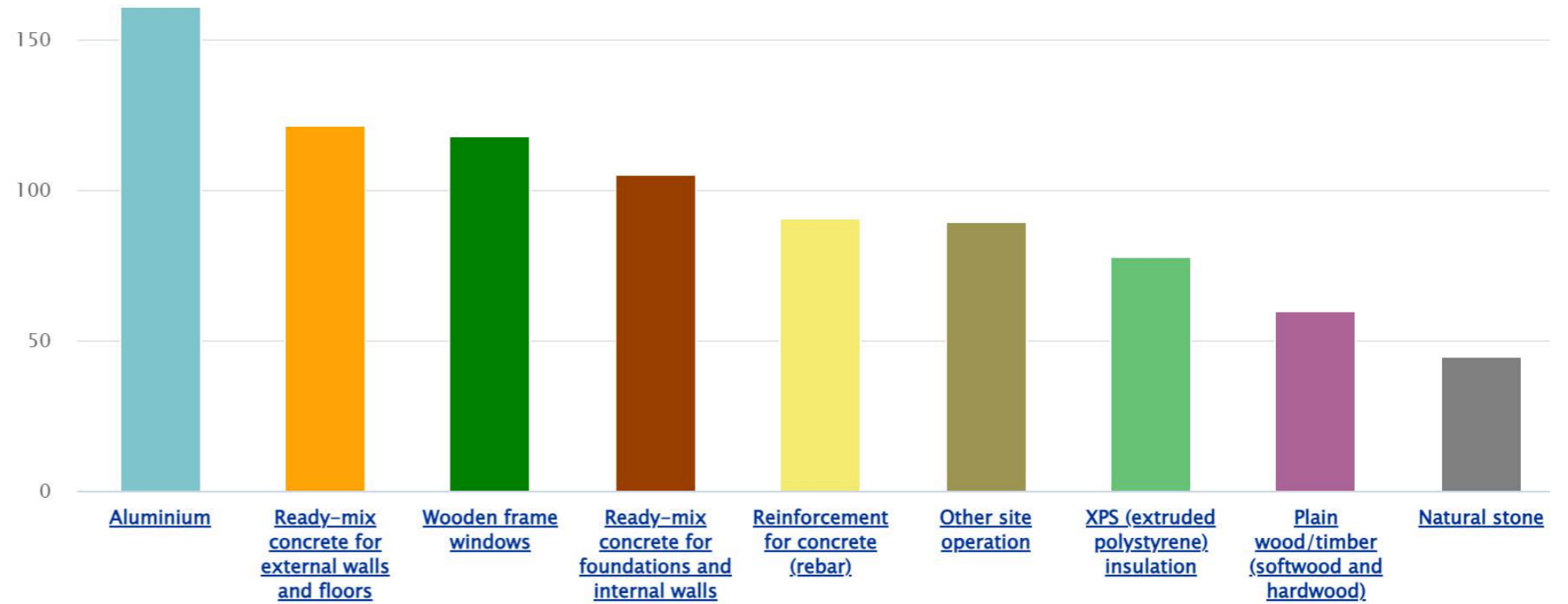
#### Project 5: Sentry (Swain's Lane)

Targets A1 to A5	
LETI Band C	600
LETI Band B / RIBA 2030	475 (Project Target)
GLA Offices Benchmark	950

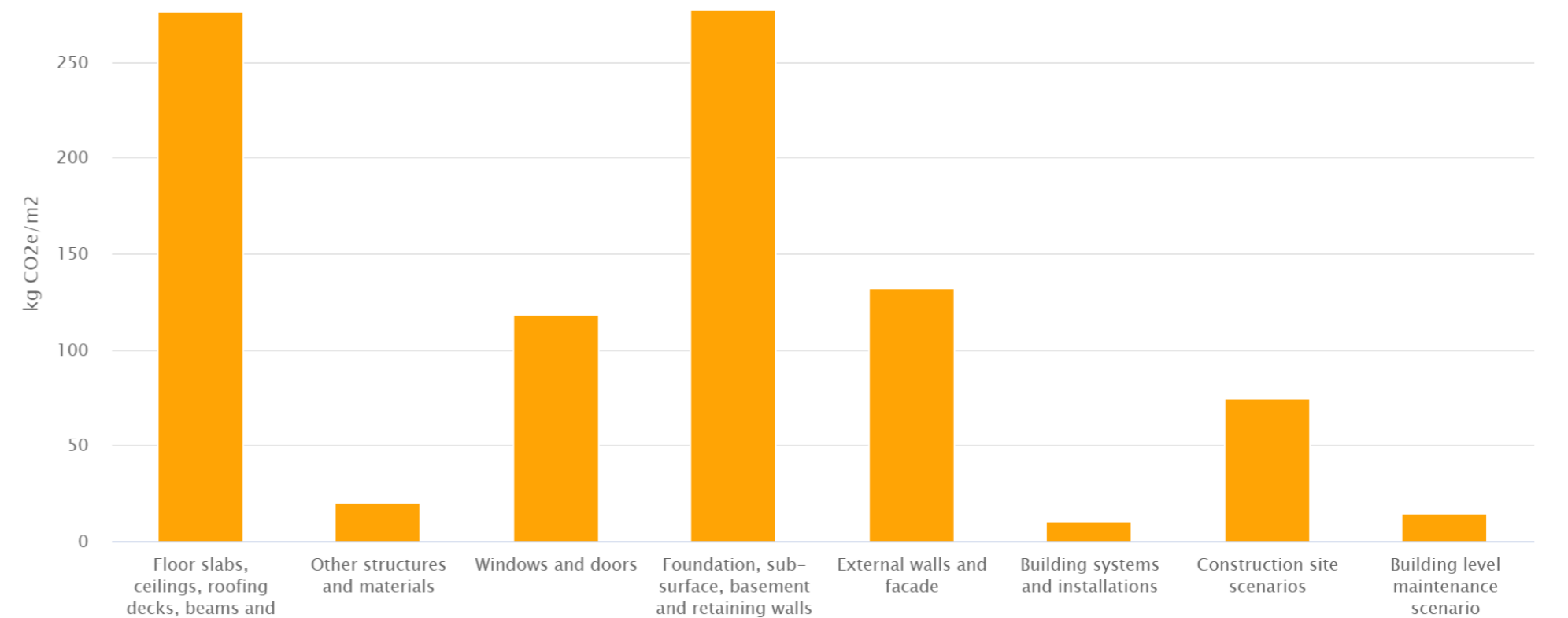
Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	674.1
A4 Transport	24.0
A5 Construction	77.9
Total	776 (658 with 75% Cement Replace.)

Targets A to C	
LETI Band C	970
LETI Band B / RIBA 2030	750 (Project Target)
GLA Offices Benchmark	1400

Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	674.1
A4 Transport	24.0
A5 Construction	77.9
B1 Use Phase	NA
B2 Maintenance	11.7
B3 Repair	3.7
B4 Replacement	60.1
C1 Deconstruction/Demo	14.0
C2 Waste Transport	10.6
C3 Waste Processing	34.2
C4 Waste Disposal	0.0
Total	910 (792 with 75% Cement Replace.)



Building Materials



Building / Construction Elements

# 7.0 APPENDIX

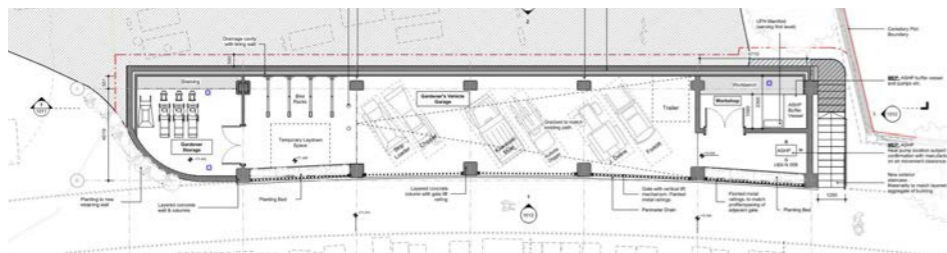
## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

### Project 6: Gardener's Building

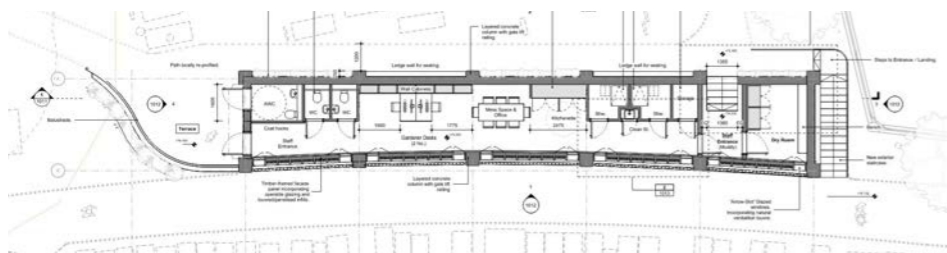
The high amount of concrete and reinforcement required for the retained walls, along with the use of steel for the gates and stair railings, presents challenges in meeting the targets. This is because the model already includes favourable assumptions, such as accounting for the steel in the gates and railings being modelled with 80% recycled content.



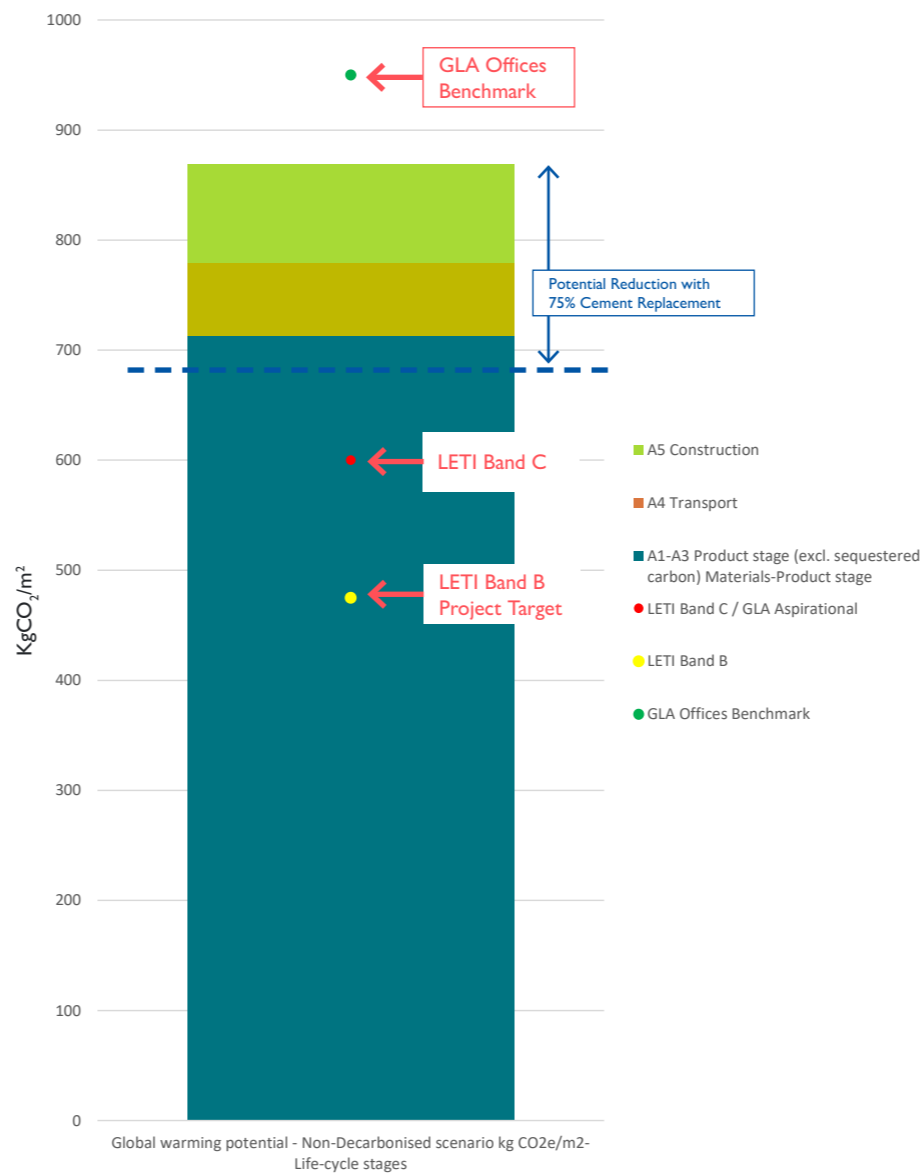
Visualisation of Proposed Utility Block



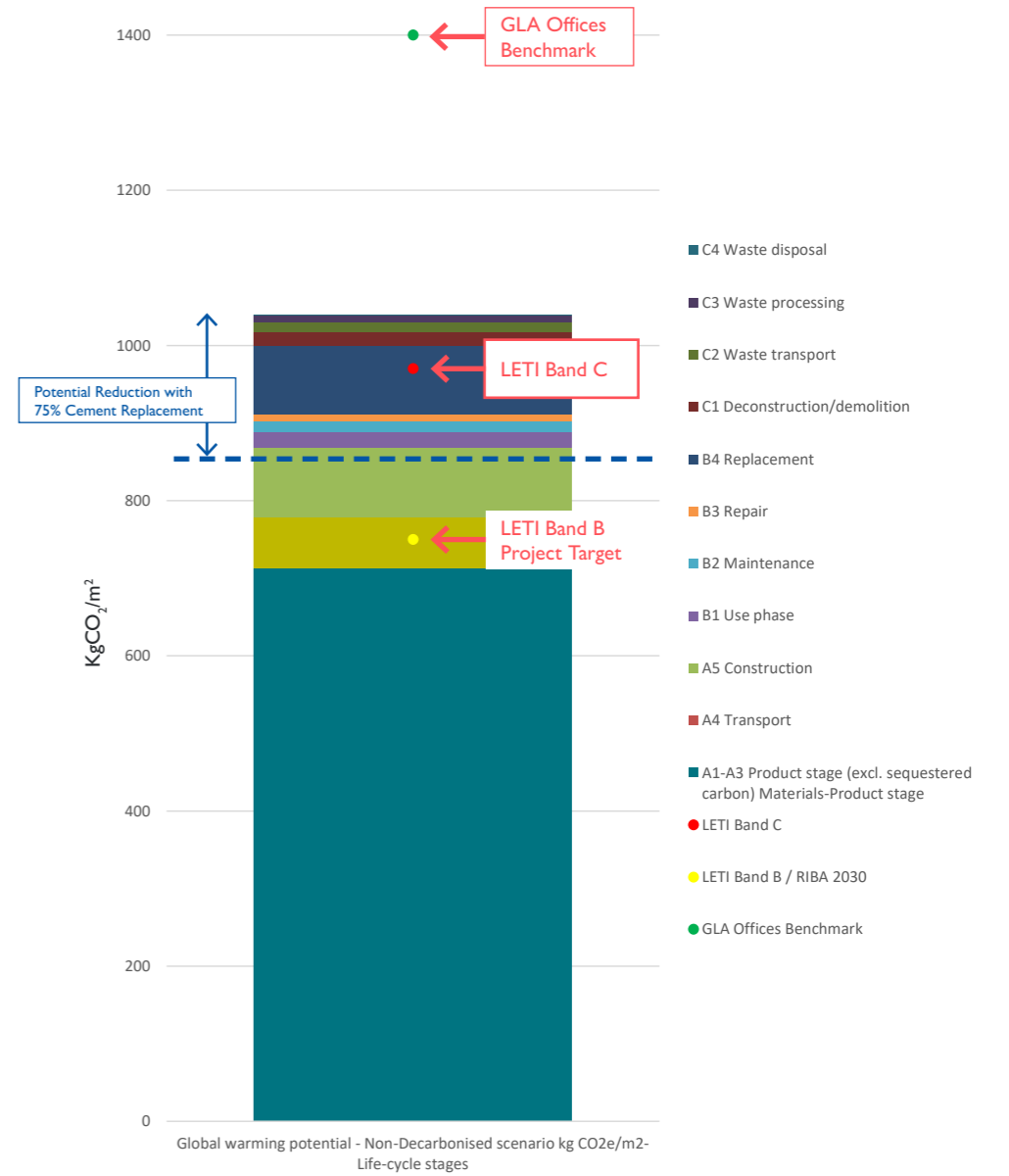
Ground Level Plan



First Level Plan



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A1 to A5)



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A to C)



# 7.0 APPENDIX

## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

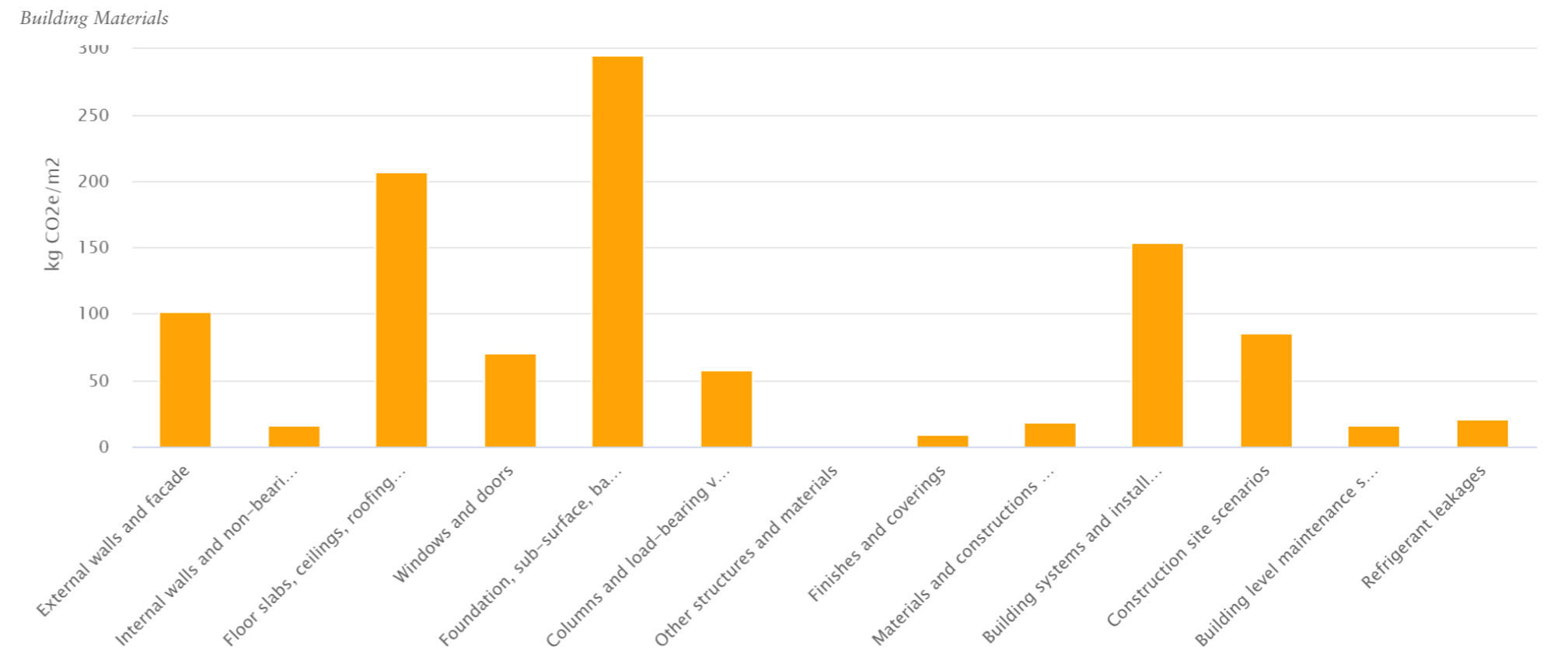
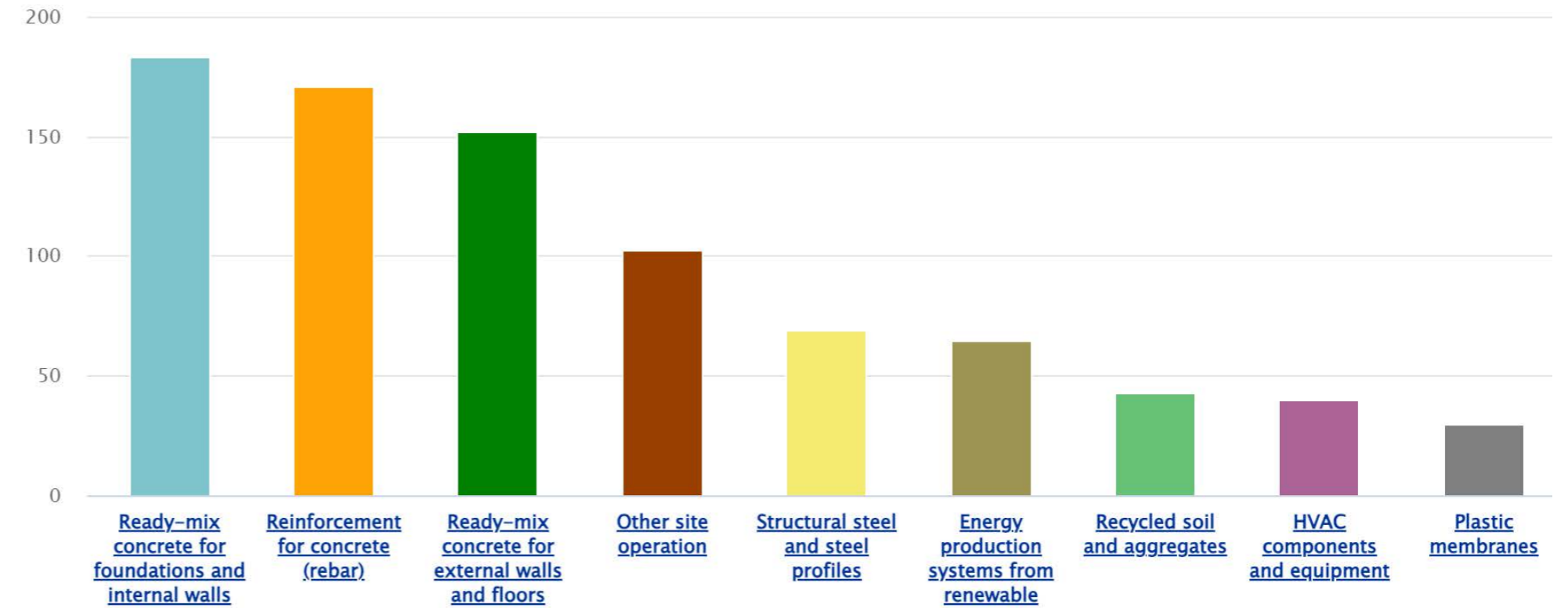
### Project 6: Gardener's Building

Targets A1 to A5	
LETI Band C	600
LETI Band B / RIBA 2030	475 (Project Target)
GLA Offices Benchmark	950

Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	713.1
A4 Transport	65.7
A5 Construction	89.8
Total	869 (684 with 75% Cement Replace.)

Targets A to C	
LETI Band C	970
LETI Band B / RIBA 2030	750 (Project Target)
GLA Offices Benchmark	1400

Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	713.1
A4 Transport	65.7
A5 Construction	89.8
B1 Use Phase	19.8
B2 Maintenance	13.4
B3 Repair	9.7
B4 Replacement	88.1
C1 Deconstruction/Demo	17.5
C2 Waste Transport	12.6
C3 Waste Processing	9.4
C4 Waste Disposal	0.1
Total	1030 (842 with 75% Cement Replace.)



# 7.0 APPENDIX

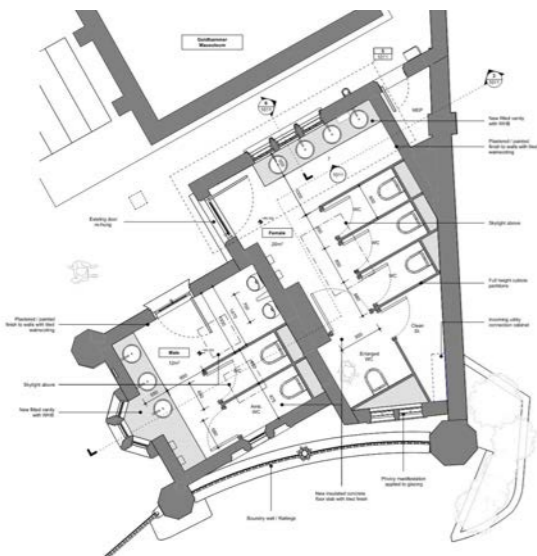
## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

### Project 9: South Lodge (Interior Refurbishment to Visitor Toilets)

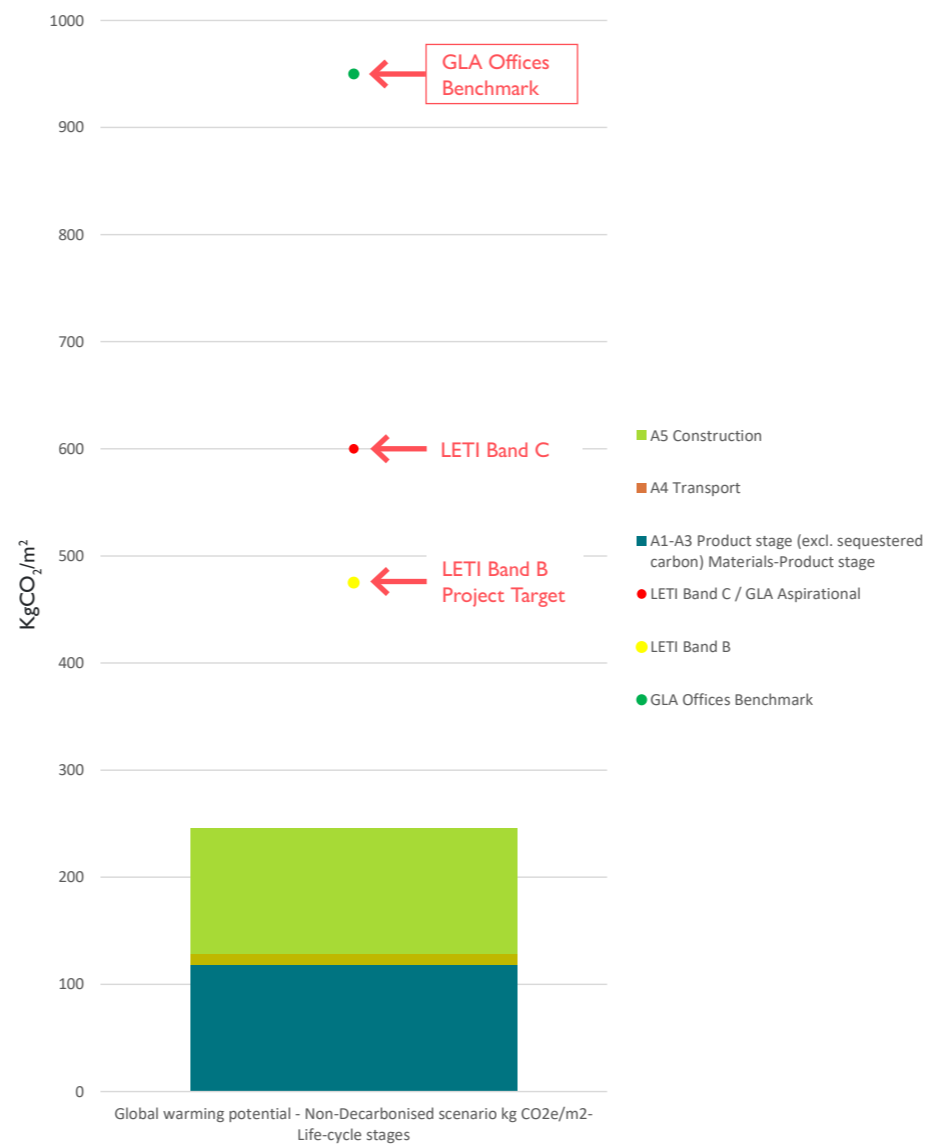
The embodied carbon is very low since this is a refurbishment project rather than a new build, allowing it to meet the targets. Please note that assessment excludes conservation repairs to the exterior of the building.



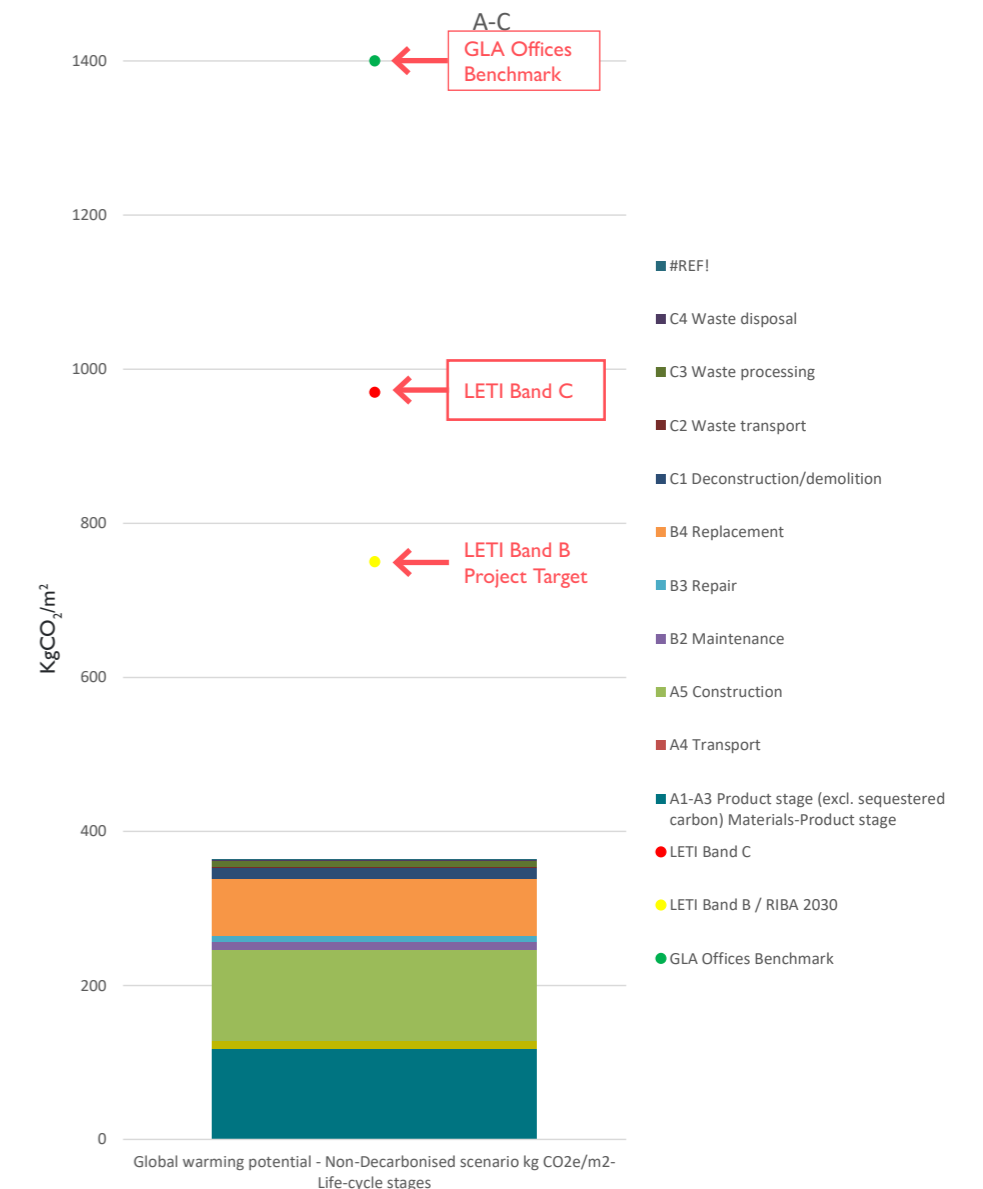
Visualisation of Proposed Utility Block



Ground Level Plan



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A1 to A5)



Global Warming Potential (Non-Decarbonised Scenario) Kg CO<sub>2</sub>e/m<sup>2</sup> (Stage A to C)

# 7.0 APPENDIX

## 7.5 APPENDIX 5: EMBODIED CARBON ASSESSMENT NEW & REFURBISHED BUILDINGS.

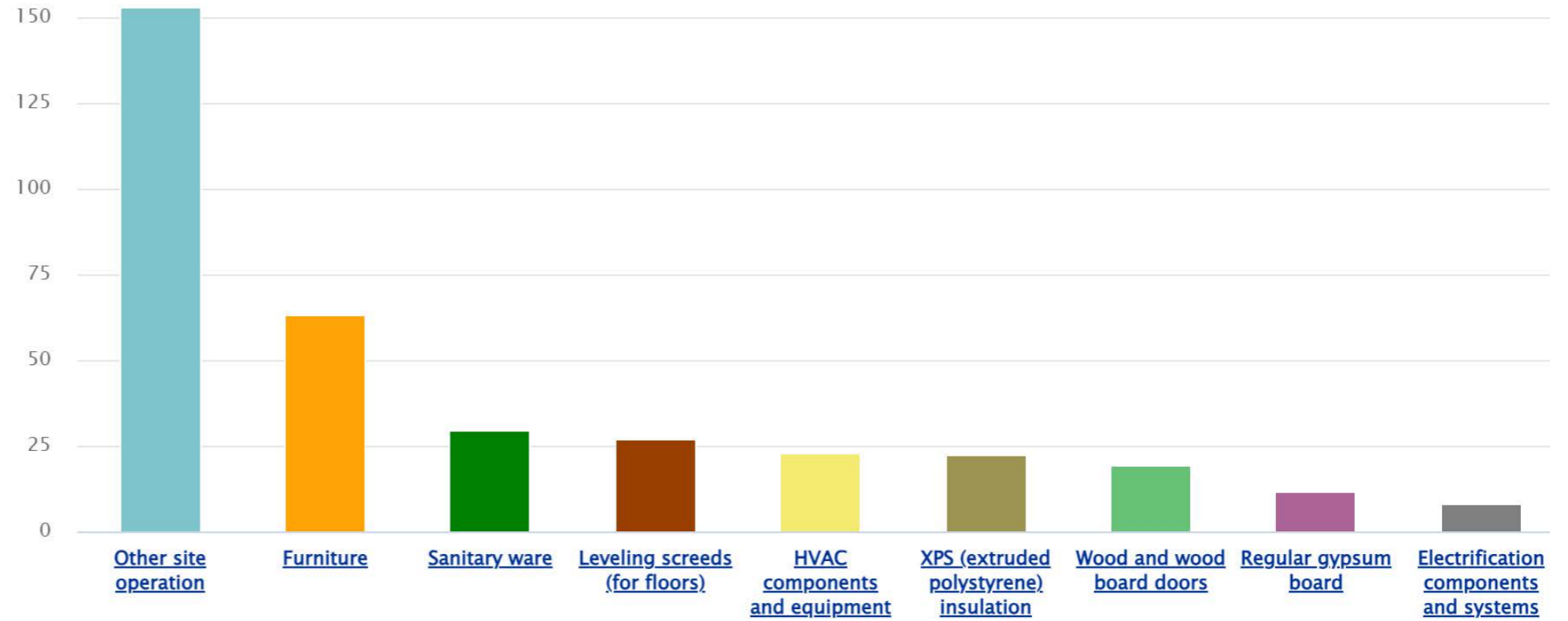
### Project 9: South Lodge (Interior Refurbishment to Visitor Toilets)

Targets A1 to A5	
LETI Band C	600
LETI Band B / RIBA 2030	475 (Project Target)
GLA Offices Benchmark	950

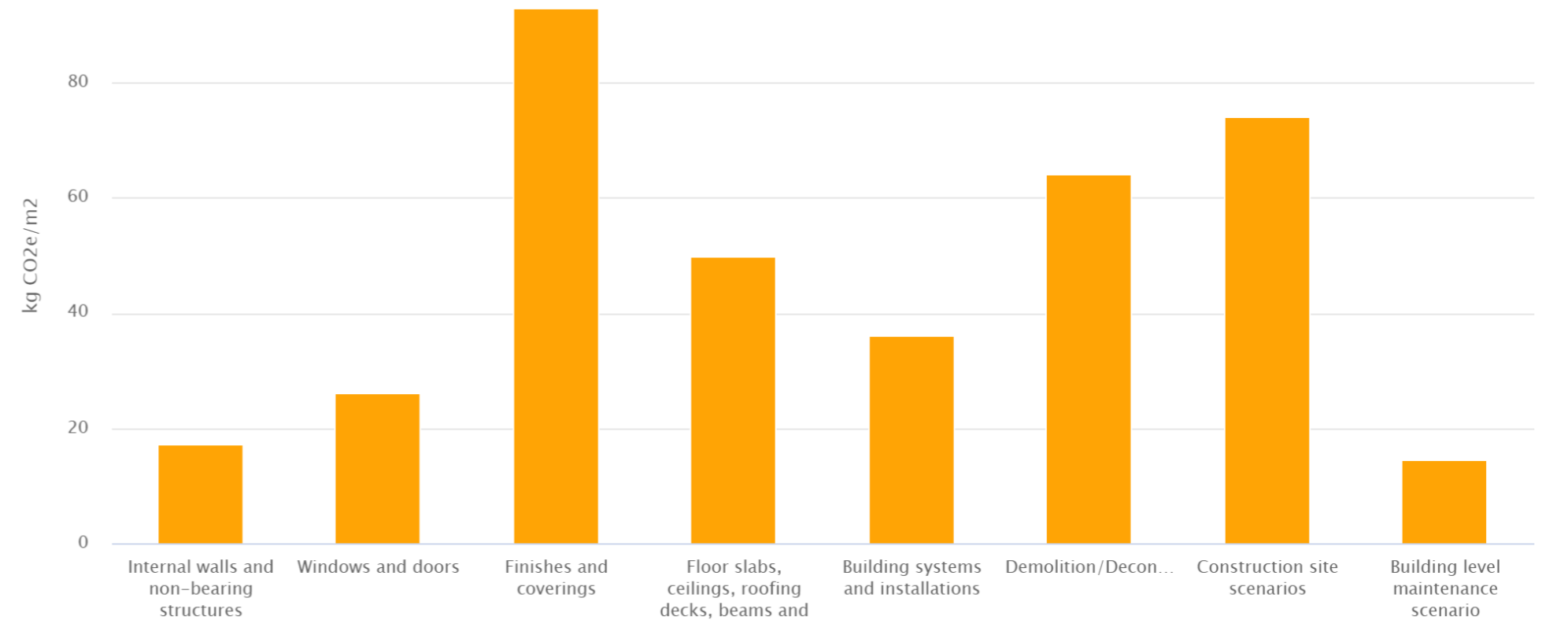
Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	118.4
A4 Transport	9.8
A5 Construction	117.4
Total	246

Targets A to C	
LETI Band C	970
LETI Band B / RIBA 2030	750 (Project Target)
GLA Offices Benchmark	1400

Assessment of Project 1:	
Category	Global Warming Potential Non-Decarbonised Scenario Kg CO <sub>2</sub> e/m <sup>2</sup> Life Cycle Stages
A1-A3 Product Stages (excl. Sequestered Carbon)	118.4
A4 Transport	9.8
A5 Construction	117.4
B1 Use Phase	NA
B2 Maintenance	11.6
B3 Repair	6.7
B4 Replacement	75.0
C1 Deconstruction/Demo	13.9
C2 Waste Transport	1.5
C3 Waste Processing	8.5
C4 Waste Disposal	0.0
Total	363



Building Materials



Building / Construction Elements