Report on the Structural Condition of the Remaining Built Fabric, Of Kilbarron Castle, Creevy, Co. Donegal[1]

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Contents:

1: Introduction & Scope.

1.1 Gerry McManus, Conservation Architect, contacted J.A.Gorman Consulting Engineers and requested an outline Structural Engineer's report on the visible remaining built fabric of Kilbarron Castle.

1.2 The purpose of the inspection and report is to identify the main structural issues with the remains and to recommend follow up actions to develop a prioritised repair strategy to mitigate against further degradation of the remaining fabric.

1.3 The inspection of the remains was visual and was carried out from ground level.

1.4 Due to a lack of safe access, it was not possible to examine the North elevations of the keep structure.

2: Description.

2.1 Kilbarron Castle remains are shown on the plan attached at Appendix A (Lockwood 1913) Even though the map dates from 1913, the visible remains are largely similar in extent.
The castle is built from locally quarried sandstone. Walls vary from c.1-3m in thickness and consist of a facing stone layer with a central core of infill random stone and mortar.

2.2 The Castle remains have been severely damaged by weathering and only small sections remain visible above ground. The main sections remaining are Building A – The Keep/Gatehouse, Building B, Building C, there is also a section of the curtain wall intact. These are marked on the plan at Appendix A.

3: Inspection Discussion

3.1 The inspection was carried out on September 29th 2014.

3.2 Generally the masonry that remains is in poor to moderate condition. The mortar is spalling away in centre part of the walls and causing loosening of remaining stones. Vegetation growth in some areas, particularly ivy growth is loosening, dislodging mortar and stones. There is also evidence of local soil erosion, which is undermining some sections of the remains.

3.3 Herebelow is a schedule of the main structural issues noted during the course of the inspection. The remains have been broken into sections as described above and as labelled on the key plan attached at Appendix A. It should be noted that this is not an exhaustive list but gives selected examples of the typical structural problems that exist and will need further attention.

Section	Item:	Issue:	Priority	Photo:
General	1	Vegetation growth – ivy and root growth damage to masonry	Medium	
	2	Undermining – soil erosion at base of some remaining masonry sections	High	
Building A - Keep	3	Local undermining of keep wall noted on North East Elevation of keep.	High	2
	4	Local soil erosion noted at East elevation near causeway entrance to keep.	Medium	3
Building B	5	Undermining of facing stones of the South wall fragment.	Medium	4
	6	Excessive cantilever projection on remaining masonry of North Wall remains	High	5
	7	Remaining North Wall masonry leaning out of plumb - stability concerns.	High	6

	8	Infill masonry in centre section of wall is loose and spalling in places	Medium	
Building C	9	Local undermining of sections of wall.	High	7
	10	Vegetation growth generally.	Medium	
	11	Loose spalling masonry at North end of remaining wall	High	8
Curtain Wall	13	Significant undermining of curtain wall end and concern regarding extent of resulting masonry cantilever	High	9
	14	Infill masonry in centre section of wall thickness is loose in places and spalling	Medium	

4.0: <u>Recommendations:</u>

4.1 General:

a. This was an initial inspection only and a much more detailed inspection & report will be required assessing each section of remains and planning a tailored repair strategy in each case.
b. Keep wall North elevation was not generally accessible and will require specialist climbing equipment or marine access to inspect.
c. Site investigation will be required to design new foundations for masonry to pick up undermined sections of wall
d. Mortar repairs and Rough Racking to be applied to centre sections of remaining masonry to prevent further washing away and spalling of mortar in these areas. Specification for repair mortar to be confirmed after analysis of existing mortar and testing of sample repair mortars.
e. Repair masonry to be sourced locally to match as closely as possible, existing local sandstone used.
f. Temporary propping works will need to be considered and carefully designed for the remaining sections of masonry, to allow for safe access to the repair works.
g. Structural Repairs will need to be prioritised in order of greatest risk of potential collapse/instability and a detailed risk assessment & priority list will need to be created to determine a suitable overall repair strategy.
h. A Project Supervisor Design Process will need to be appointed per Construction Health & Safety Regulations SI 291 of 2013, to consider the Health & Safety aspects of the repair design and to co-ordinate the design inputs as required from other professionals.

4.2 Building A – Keep:

a. Locally undermined section to be temporarily propped and new masonry installed to reduce overhang to a safe dimension on a new local foundation.
b. Eroding soil/missing mortar visible in parts of the East elevation wall to be raked out and replaced with repair mortar/masonry to stabilise this section of the keep East elevation wall.
c. Masonry/rough racking repairs will be required to locally spalled sections of infill masonry in centre of walls.

4.3 Building B –

a. North Wall – Concerns regarding instability and excessive cantilever/leaning section of wall remaining.
   Investigate stabilisation by drilling and grouting in Stainless Steel rods into remaining masonry or possibly concrete shell encasement to ends of remaining masonry walls with bolt through clamping details. Suitability of existing masonry structure to be assessed by specialist contractors to check if such a repair strategy will be feasible in this case.
b. South Wall - Local undermining issues noted on facing stone outer layer facing North. Rebuilding of masonry is required to stabilise façade stone. New repair masonry to be recessed to differentiate from original facing stones.
c. Loose masonry and spalling of masonry to be stabilised by rough racking repairs to centre sections of walls.

4.4 Building C:

a. Undermining issues/erosion and local repairs will be required
b. Spalling masonry at end of wall will require rough racking and masonry repairs to stabilise.

4.5 Curtain Wall:

a. Significant Undermining issue and excessively cantilevering section of masonry – stability concerns, high priority. Locally undermined section to be temporarily propped and new masonry installed to reduce overhang to a safe dimension on a new local foundation

Signed: Dated:

_____ _____

Joe Gorman BE, C.Eng, MIEI 17th November 2014
Chartered Structural Engineer

Appendix A:

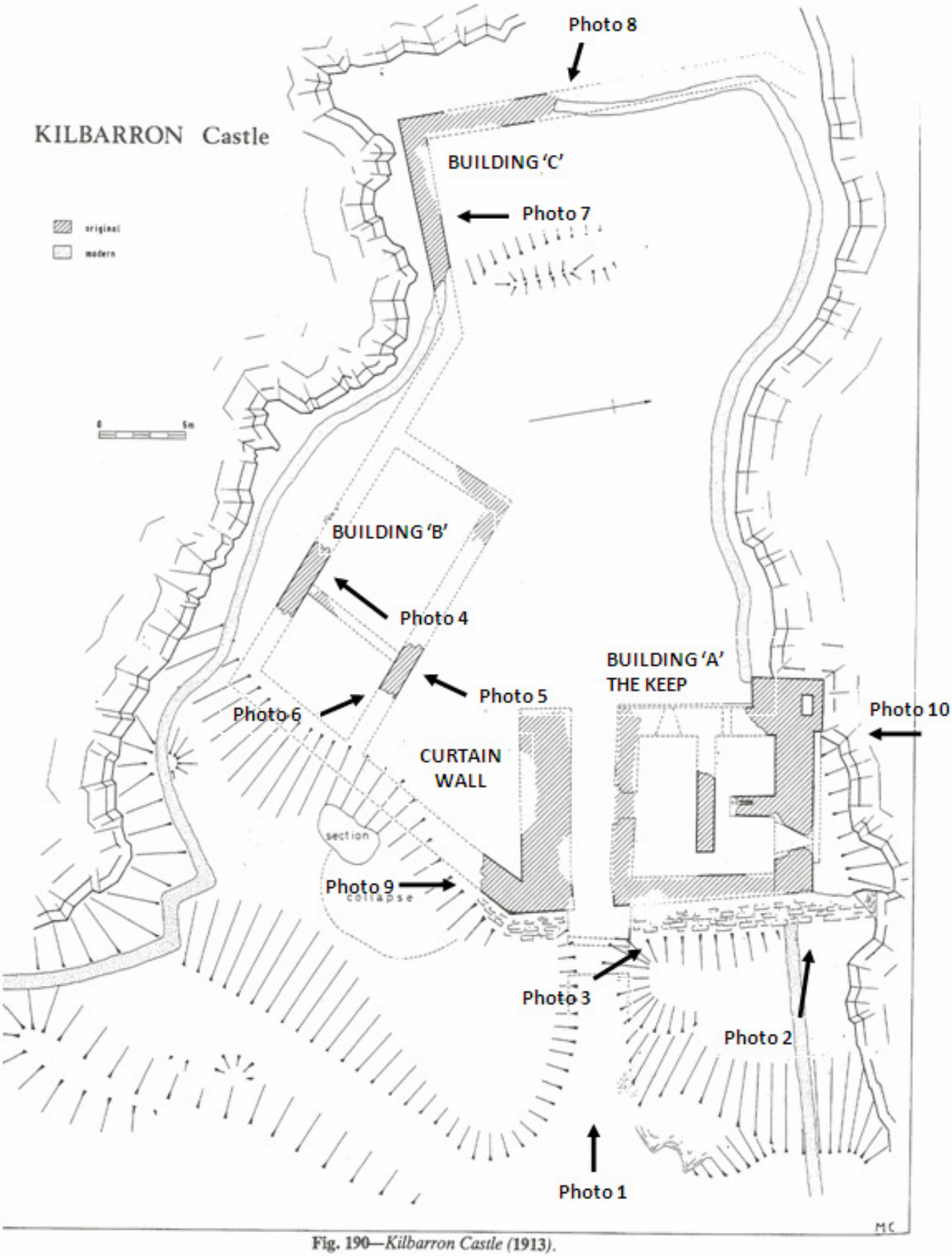

Fig. 190—*Kilbarron Castle* (1913).

Appendix B:

Photo 1.

Photo 2.

Photo 3.

Photo 4.

Photo 5.

Photo 6.

Photo 7.

Photo 8.

Photo 9

Photo 10

Kilbarron Castle

Co. Donegal

ARCHITECT'S REPORT

ASSESSMENT OF VISIBLE REMAINING BUILT FABRIC

November 2014

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CONTENTS *page*

Kilbarron Castle

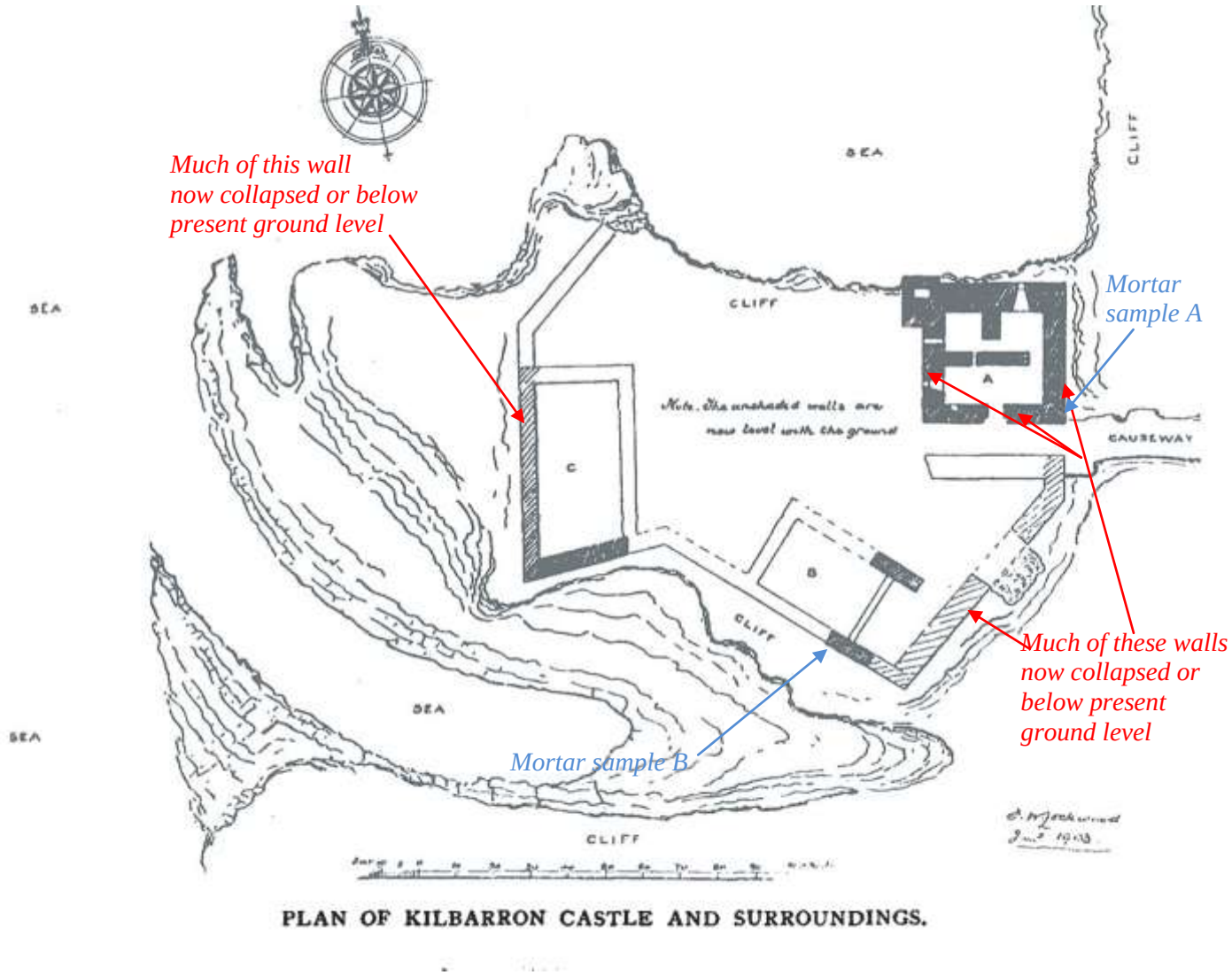
INTRODUCTION

This report is prepared as part of the conservation report which was commissioned by the Creevy and District Community Development Co-operative Society, funded with grant aid from the Heritage Council. The purpose of the Conservation Report is to

1. *Assess the cultural significance of Kilbarron Castle and site by identifying its various characteristics and attributes and establish how they contribute to its value.*
2. *Formulate policies which when implemented will ensure the preservation of the cultural significance of Kilbarron Castle and site. For the proper formulation of policies the relative value of all the different aspects of the place must be assessed. Recommendations for the method of conservation of the place including its built elements form part of the Conservation Report.*

The Architect's Report was prepared following several visits to the site during 2014, and taking account of and utilising inputs from the other authors involved in the preparation of the Conservation Report. Inspection was limited to those parts of the site which could be accessed safely.

ASSESSMENT OF VISIBLE REMAINING BUILT FABRIC



PLAN OF KILBARRON CASTLE AND SURROUNDINGS.

F.W. Lockwoods plan of Kilbarron Castle 1903 for the Ulster Archaeological Society

The Castle enclosure and its buildings

View approaching from south along coastal path.

DESCRIPTION

A comprehensive description of the present remains of the castle from an archaeological point of view is made by Rory Sherlock in his report. This updates and builds on the description by Brian Lacey et al[1].

The castle is built of sandstone, locally quarried, and possibly including roughly squared fieldstone. Lewis[2] refers to sandstone and whinstone being found at Kildoney, which is nearby. The walls are generally of double skin construction with facing stone in random rubble and a central core of rough stone and mortar. Walls are from 1 metre thick up to about 3 metres thick, the external north wall of the gate-house being one of the thickest sections of walling.

Facing stones are for the most part roughly squared but without surface tooling. Mortar contains a high proportion of coarse material including entire small shells and pieces of larger shells. Much of it appears really hard and concrete-like. C.1900 photos show traces of interior plaster on the remains of the southern wall of building B which has since further collapsed. No traces of plaster were seen on the day of inspection on 19 July 14 but it is likely that the exterior had at least one coat of rough harling.

Mortar samples have been analysed – see Stoneware Studios analysis at the back of Report.

Views of mortar in the wall core areas

Mortar close to where sample B was taken. *Mortar in area of sample A*

OVERALL CONDITION

The condition of the castle enclosure and its buildings is generally poor with many parts in danger of further collapse. Most surviving walls are less than 2m in height. Only the small section of the north wall of the southern building (marked 'B' on plan above) survives to about 5m in height and this is in a precarious state. Facing stone has been lost on probably 50% + of the remaining upstanding walls in the castle compound. There are several areas where masonry is overhanging dangerously.

[1] Archaeological survey of Co. Donegal. A description of the field antiquities of the Couty from the Mesolithic Period to the 17th Century. Compiled by Brian Lacey with Eamon Cody, Claire Cotter, Judy Cuppage, Noel Dunne, Vincent Hurley, Celie O'Rahilly, Paul Walsh and Sean O Nuaillin, 1983

[2] Samuel Lewis Topographical dictionary of Ireland

Stones appear to be generally in good condition although there is some fracturing along bedding planes and slight scaling on some stones. There is widespread lichen growth on the stones. There is some cracking, mostly along the beds but occasionally along other lines of weakness. However thare is no spalling of the stone faces. Stone decay could be classified as mild. Structural collapse is due primarily to washing out/loss of mortar rather than failure in the stone. Vegetation growth is also a contributory factor though the grass mat on the wall heads seems to be reasonably stable and is generally functioning as a 'soft capping' and preserving rather than causing decay of the ruin. The exposed situation inhibits the growth of trees and larger plants whose roots would cause damage where they penetrate the wall structure. However, ivy is widespread on the remaining wall of the south-western building (building c) and is likely to be causing destabilisation.
See also Engineer's Report.

ARCHITECTURAL ASSESSMENT AND CULTURAL SIGNIFICANCE
The importance of Kilbarron is attributable to several factors.

1. ***Archaeological significance.***
   The visible remains, though poorly preserved indicate a complex of much interest and considerable archaeological potential. See Rory Sherlock's Archaeological Report. He points out that Kilbarron is an important site in Co. Donegal where castles are relatively uncommon and that further archaeological research (perhaps judicious trial trenches, removal of the grass covering layer) could reveal valuable information on the form of the castle and the lives of its occupants. This would be worthwhile as it is perhaps the historic associations which are the most important aspect of Kilbarron.
2. ***Historic significance.***
   Fergus Cleary has researched and discussed the history of Kilbarron comprehensively in his report. It is known from historical sources that it was occupied by the learned family of ollamhs, the Uí Scingins, from the early 13th century but it is likely to have been an important occupied site from much earlier times due to its strategic location. As suggested in the Archaeological Report, various techniques used to assist archaeological investigation, including topographic survey and geophysical prospection, could confirm earlier settlement at the site. The castle is inextricably linked to the history of Donegal and the prominent Gaelic families of the region. It was the location of an important school of learning from the early 15th century till the end of the 16th century or longer. It was there that Br Michéal Uí Cléirigh and the other scholars compiled the Annals of the Four Masters during the 17th century. The ruins of Kilbarron are the physical link with important past events, people and activities in Gaelic Ulster prior to the Ulster Plantation.
3. ***Ecological value.***
   The castle site itself is not protected under the wildlife acts but the cliffs and coast line are important sites for nesting birds and home to many plant species. Some plant specimens found within the site may have been originally planted by the former inhabitants for medicinal purposes. The Ecological Report outlines the importance of the site as Coastal Heath which is an endangered habitat globally and has a very restricted distribution in Europe.
4. ***Architectural value.***
   The castle structures retain little of their original detailing. The remaining architectural features consist of the remnants of the built form and their method of construction – a stone walled enclosure containing at least three buildings located on the cliff top and surrounded by the sea on three sides and a ditch on the fourth. Sufficient remains to give some idea of how this dramatic site was inhabited. Indeed the forms of the ruins themselves are dramatic in their precarious state, seeming to defy gravity with overhanging masonry. It was perhaps this dramatic and romantic aspect that appealed to the Victorian engravers and photographers who provide us with evidence of the condition of the castle in the mid and late 19th century.
   The quality of the stonework is good and the walls are well made. Only the carefully made slot for the drawbar in the internal wall of the gate-house is easily visible as an example

of the skilled detailing in the building. The seaward façade retains the outlet for the garderobe chute at its base.

The architectural significance of the site is not readily apparent. The ruins demand interpretation to uncover their significant characteristics and attributes. This could be provided by written descriptions or drawn reconstructions.

It is the magnificent site and its wildlife which is most easily appreciated by the public but it is the very fact that the site was inhabited that makes it so dramatic. The robust and solid forms constructed in the native stone which seem to grow from the landscape are wholly appropriate in their setting. This is best appreciated from the sea view where the form of the lower parts of the gate-house keep are reasonably intact.

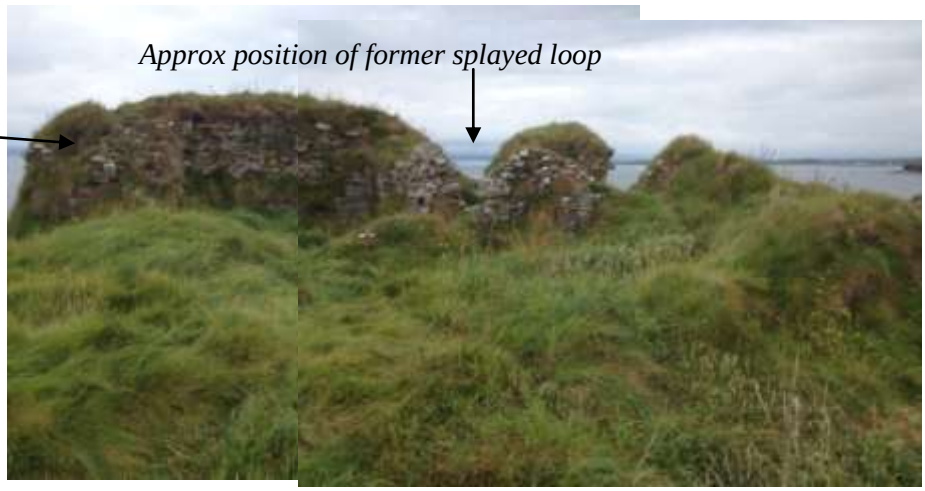
Some general annotated photographs

East wall of gate-house keep has largely collapsed and remaining section has lost all its facing stone on the outside leaving the core exposed.

View of gate-house keep from the east with causeway/entrance passageway in foreground

Approx position of former splayed loop

Garderobe



View of remains of gate-house keep from the south with the garderobe on the left. View is of inside face of external north wall with the remains of E-W internal wall in the foreground.

Garderobe shaft from above.

Garderobe. *Internal wall dividing NW and NE rooms*

Facing stone survives
View of keep from west.

Internal wall running E-W

Some facing stone remaining in internal NE corner of NW room of keep.
Location of drawbar hole serving doorway in W wall of NE room referred to by Lacy

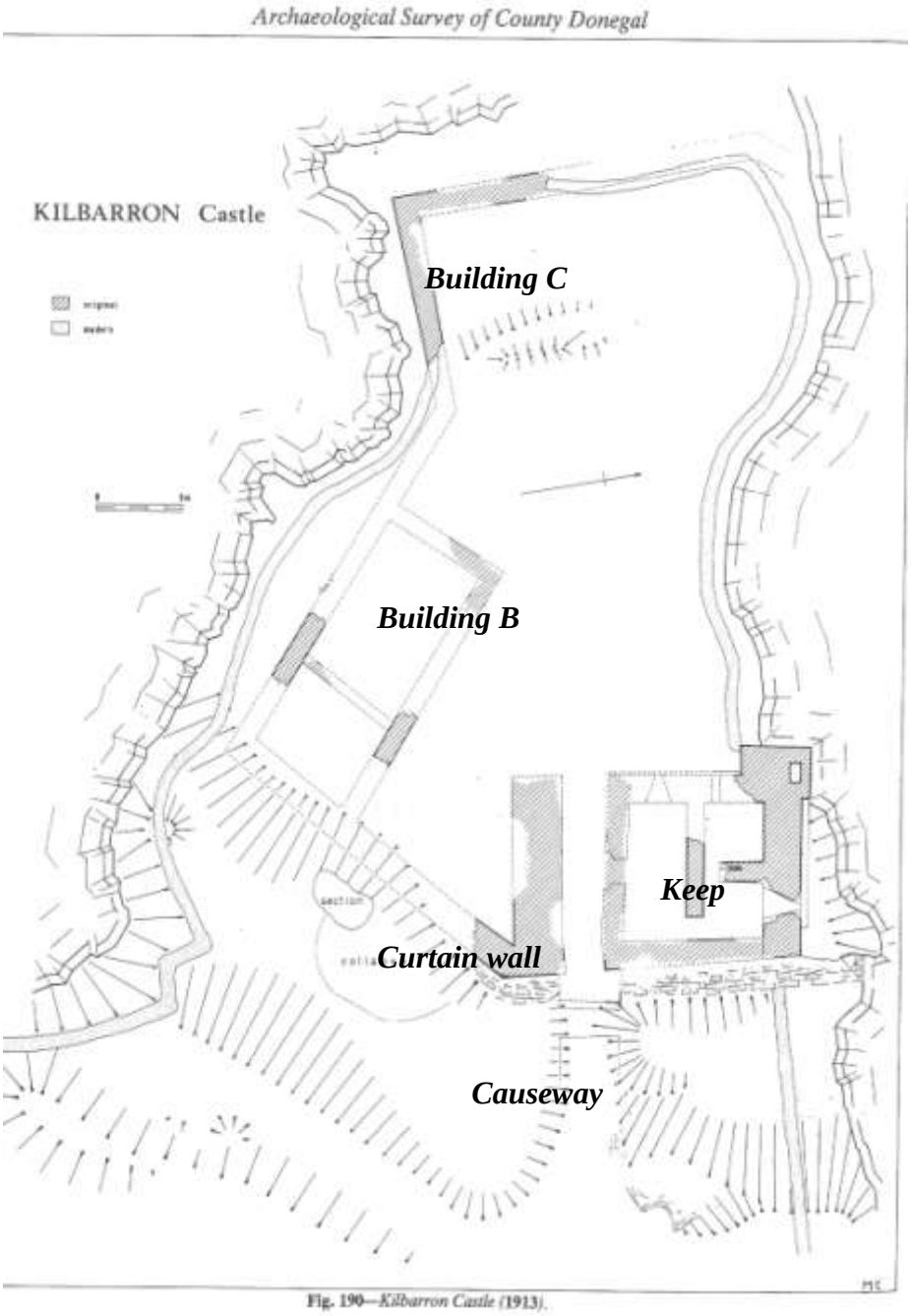
Facing stone on lower part of north face of internal wall running E-W

Section of curtain wall

View from the east of causeway, gate-house keep and a section of the curtain wall.

DESCRIPTION AND CONDITION OF PARTS

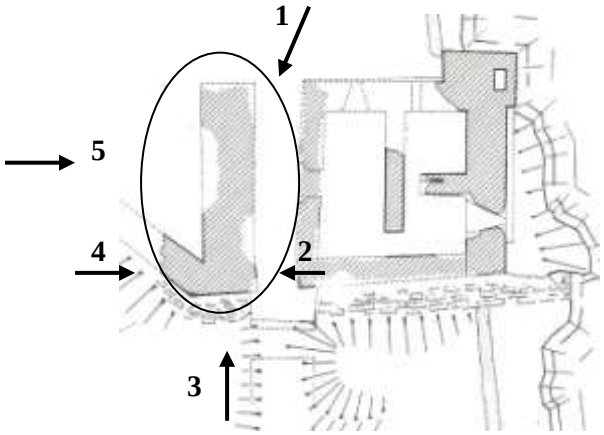
The plan below will be used in this section as a key plan



Site Plan (after Lacy *et al* 1983, Fig. 190)

Upstanding remains of curtain wall

Key plan



View 3

View 5 (distant view)

View 4

View 1

View 2

Only a short section of the curtain wall remains upstanding. The wall is about 1500mm thick by about 3.2m long and about 2m high. There is another sizeable piece intact but fallen over a short distance to the south. The upstanding piece includes an external corner of somewhat more than 90degrees on one

end where the wall turned and continued in a south westerly direction. At the other end was the external corner where the wall joined the wall running east-west parallel to the wall of the keep. This east-west section of wall is collapsed and appears as a grass covered mound *(view 5).* The upstanding curtain wall retains its facing stone on the east face *(view 3)* but the core is exposed at both ends *(views 4 and 2)* and the back (west face) is largely grass covered and the visible stone appears partially displaced and unstable *(view 1).*

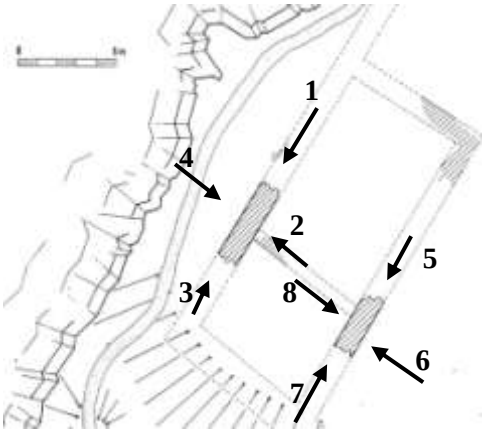
Condition

The condition of the south end of this wall section is the most problematic. Here the base of the wall has been undermined, extensive areas of the wall core are exposed and there are areas of unsupported facing stone *(view 4).* It may be that facing stones at the base of the wall were robbed out to build nearby field walls and that this, possible damage from animals, and weathering and washing out of mortar all contributed to damage the wall. There is mortar loss from facing stone to a depth of 30mm or more on this and all parts of the building complex. The degree of instability of this section of masonry is commented on in the Engineer's report.

The grass covering on the wall head and elsewhere is protecting the fabric to some extent. However, if the growth is allowed to become too vigourous or if woody plants start to invade this will ultimately damage the structure.

Towards the top of the wall, on the east face, there has been some loss of facing stone. This is likely to be due to mortar wash-out and vigourous grass/plant growth behind the top stones pushing them outwards and eventually causing them to fall. Grass growth is starting to encroach down the wall face.

Building B
Key plan



View 6

View 5

View 8

View 7

The remaining section of the north wall of Building B *(views 5-8)* is the most dramatic element of the ruined building complex as seen from the land. It consists of a piece of masonry a little over 1m thick and about 4.5m high, roughly shaped like an hourglass, the upper section seeming to defy gravity as it overhangs the section below. The facing stone is extant on both wall faces but there are no stone features (corners, lintels) remaining. See Fergus Cleary Report for c.1910 photograph by William Arthur Green showing remains of a window in the south wall of this building, now collapsed. Much

less now remains of the south wall than the north wall. *(Views 1-4 below)* A roughly triangular section of masonry remains, about 2.75m high, and about 1.2m thick. The facing stone is intact on what was the inner (north) face of the fragment, while much of it has fallen away from the upper parts of the south side, exposing the core. A 'hole' in the facing stone at the bottom of the inner face appears in the c. 1900 photographs. It has been there for a long time – was it simply that stone was robbed out or was there some sort of a feature there? The Laurence photo of c.1890-1900 (see F Cleary) shows the remains of the projecting stone eaves course along the south side of this section of wall.

View 2

View3

View 4

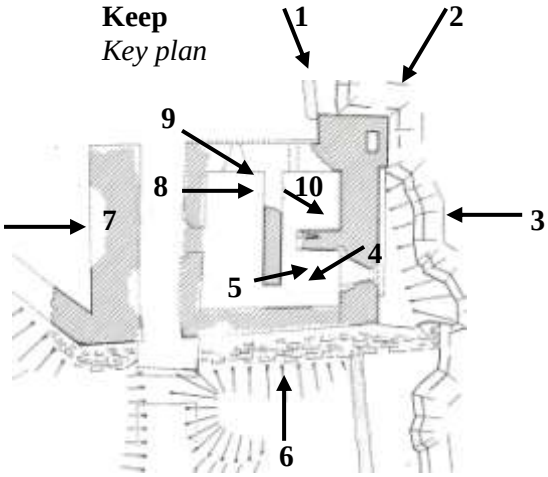
View 1

Condition

Both sections of walling forming the remains of this building are in a precarious state. The south piece of wall consists only, on its upper half, of the inner facing stones with a little of the core material attached *(views 1and 3)*. This upper part of the wall is in danger of collapse in the short term. Only the base of the exposed core areas is affected by vegetation growth to any extent.

The north section of wall appears also to be in imminent danger. Facing stone is mostly in place though missing in part at the critical narrowest section *(view 8).* See Engineer's comments. There is grass and small plant growth on the exposed wall head. Both sections of wall are affected by mortar loss from between facing stones, similar to that on all other parts of the ruin complex.

Keep
Key plan



View 3

View 6

View 2

View 1

View 7 (distant view)

View 8

View 10

Close-up of drawbar hole

View 5

View 4

The gatehouse keep is the building of which most remains. It was, as described by the Archaeologist, roughly 11m square on plan with a projecting turret in the north-west corner and must have been multi-storeyed. Some walls remain to about 2m in height above cliff top ground level, while parts of the north wall extend down the cliff face about 6m.

The outlet for the latrine chute in the north-west turret is at the base of this north wall *(view 3).* It consists of a rectangular opening resembling a door with a single roughly squared stone forming the head. The back wall of the chute slopes outwards towards the base of the opening. The stone faces forming the walls of the chute are brought to a fairly smooth finish, no doubt to aid the discharge of the waste.

The other architectural feature consists of the drawbar hole *(view 10)* in the internal north-south cross-wall. This is carefully made using suitably squared stone.

Quoin stones at the external corners of the turret are well squared but not surface dressed. The remaining part of the north face including the projecting turret retains practically all its facing stone. There is one quoin stone missing about half way down the north-west corner.

Only a small section of facing stone is intact on the inner face of this north wall and the adjoining wall which contains the drawbar hole *(view 8)*. The other side of this wall also retains some facing stone *(view 5)*. The internal east-west wall also retains some facing stone on its north side – close to its base *(view 4)*. Other walls and parts of walls are completely grass covered or consist of extensive areas of exposed core work.

Condition

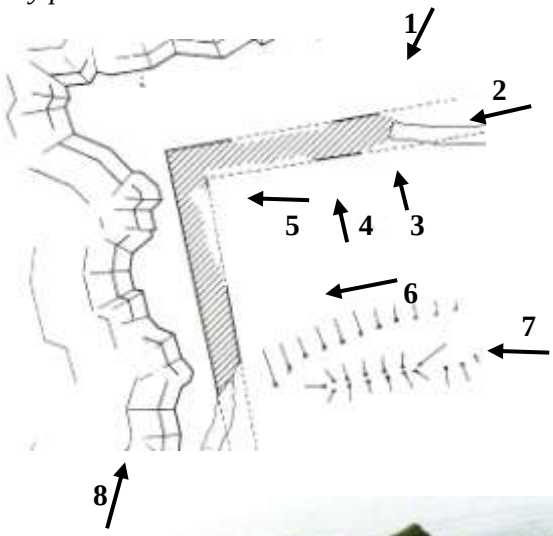
The remains of the north façade and the north-west turret make up the best preserved part of the whole building complex. It is impossible to make a physical examination as this part of the building is completely inaccessible. The following observations are made from studying the photographs. The facing stone is in good condition though there is general mortar loss from joints as noted elsewhere.

Some facing stones at the top of the wall appear loose and may be in danger of being dislodged by vegetation growth. Isolated loss of quoin stones increase the vulnerability of the wall.

The outer face of the remains of the east wall of the keep *(view 6)* has lost all its facing stone while the inner face is almost entirely grass covered. The outer face appears particularly vulnerable with the base of the wall fallen away leaving core work overhanging above. The extent of exposed core makes further collapse likely. The middle part of the wall has already collapsed entirely.

Building C

Key plan



View 7 (distant)

View 8

View 6

View 4

View 5

View 3

View 2

View 1

The remains of Building C are scant, only sufficient remaining to outline the south and west walls. Two short sections reach about 2m in height, one in the centre of the south wall *(views 5 and 6)*, the other at the north end of the west wall *(views 1 and 2).* Both these areas retain some facing stone. Otherwise the remains of the walls are low and extensively ivy covered. There appears to have been a considerable amount of robbing of stone from these walls and it seems to have been a favoured spot for building open air fires. As elsewhere, stone has been lost at the base of the walls leaving vulnerable overhanging areas above.

Condition

The condition of these walls is poor, much being largely collapsed but the detailed condition obscured by ivy. It is likely that the ivy roots have extensively penetrated the core of the walls and are destabilising the remains. Small remaining sections of facing stone are close to collapse due to loss of stone below.

FACTORS GOVERNING THE PLANNING OF CONSOLIDATION AND NECESSARY REPAIR

The approach to consolidation and repair will be governed by the following:

1. The safety of visitors.
2. The preservation of what remains of the building complex, particularly remaining important features.
3. The accessibility of the buildings.
4. The desire to make the remains legible to visitors.
5. Protection of the site as a whole in the medium and longer term.
6. Availability of resources.

All of the above will influence which parts of the building complex will be worked on, and which parts will be prioritised.

It appears likely that the availability of resources, or the lack of them, will require that the work be phased. This being the case, safety of visitors must be the first consideration. However the structures in most danger of collapse (see Engineer's report and opinion) may not be those of greatest architectural/archaeological/aesthetic merit. For example – building C is near collapse in parts but is probably not the most interesting part of the building complex. However it does provide a guarding function at this side of the site.

Choices will have to be made – should valuable resources be spent on conserving a dangerous section of wall of little merit? If not, how could such a structure be dealt with – should it be cordoned off? Would signage be sufficient?

The most intact and probably the most important remaining structure is the north wall and north-west turret of the gatehouse keep - but it cannot be seen except from the sea and its situation would make any works very difficult to undertake. Yet it would undoubtedly benefit from a programme of consolidation to ensure its long term survival.

The consolidation of the wall containing the drawbar hole should be prioritised as it is the only architectural detail which is readily accessible.

The remains of Building B are dramatic and also in imminent danger of collapse and pose a safety hazard – they must be dealt with.

The east wall of the keep is in danger and also poses a hazard (see engineer's report), as does the surviving upstanding section of curtain wall.

A list of works must be drawn up in consultation with all the interest groups involved and with the advice of the consultants.

METHODS OF CONSOLIDATION AND REPAIR

The DoEHLG[3] 'Advice' Series *Ruins* provides excellent guidance on the approach to the consolidation and repair of ruins. English Heritage 'Practical Building Conservation' 2012 volume on Stone is also very useful.

The principles:

- ***Minimum intervention*** In general, only minimum intervention should be made. Rebuilding should only happen when it is necessary for reasons of stability and when the form is known or apparent.
- ***Records*** Prior to commencement of repair work a full set of record photographs should be taken. Further record photos should be taken during works and on completion. Photos should be marked up to record repair work.
- ***Vegetation*** Vegetation should be carefully removed prior to consolidation work, or in tandem with the work, as appropriate.
- ***Limited necessary rebuilding of stonework*** Consolidation may involve some very limited necessary rebuilding of stonework. Where collapsed rubble stonework is obviously associated with a particular part, or known to be from a particular part of the wall, then this stone may be used in any limited rebuilding of that part. However, where fallen stone of unknown origin is proposed to be used for necessary repair, then the specific agreement of DAHG National Monuments Section must be sought. Note that under no circumstances may fallen stone be re-cut or re-dressed. Otherwise newly quarried stone of as close a match as possible to the original should be used.
  New facing stone, if required, to be cut and dressed by hand and etched with year of erection.
- ***Mortar*** Mortar mixes to be lime/sand mixes to spec. Work should ideally be done between May1st and Sept 15th. Sand should be well graded and locally sourced to the approval of the conservation advisor. Max sand particle size to be 1/3rd the width of the mortar joint. Where joints are wide about 5% by volume of 6mm grit may be added.
- ***Grout*** Grouting if required to be weak gravity grouting where specified by engineer or architect. Pressure grouting is NOT to be used.
- ***Protection of wall head*** Soft capping of grasses to be left in place or wall head to be finished 'rough racked' as per architect's spec.
- ***Scaffold etc.***
  Scaffold and temporary propping and protection works to be erected as required and to approval of Engineer. On no account should scaffold or any temporary works be supported off the ruined structure.
- ***Detailed schedules of work and specifications*** must be drawn up by appropriate professionals and agreed with the National Monuments Service prior to works being undertaken.

Notes:
In the case of Kilbarron, some minimal reinstatement of core and facing stone will need to be done where stone at the base of walls has fallen away leaving overhanging masonry above.

If the fallen stone remains in situ where it fell, perhaps buried in the grass scraw, then this should be salvaged under archaeological supervision and used to do the necessary rebuilding. In this case facing stones can be reinstated. If the stone has been removed, then rebuilding of the core only should be done, using suitable stone salvaged from elsewhere on the site or locally. The core should be built out sufficient to support any overhanging stone above it but kept back at least 100mm from the outside face of any facing stone.

The engineer to design specialist methods of repair if appropriate such as pinning and grouting, in consultation with architect.

[3] Department of Environment Heritage and Local Government

At Kilbarron many of the walls effectively already have a 'soft cap' which has established naturally over time. At present this seems, for the most part, to be beneficial and to be protecting the wall heads. The exposed situation seems to be preventing growth becoming too vigorous in most places. However, this is not the case with Building C, and locally elsewhere. Ivy growth on the ruins of building C is extensive and causing damage. Soft capping must be monitored and controlled to be beneficial and is only recommended where this is possible.

Where wall ends and higher structures have exposed core-work, it is recommended that the 'rough racking' technique be used for their consolidation. This entails the cleaning off of vegetation, earth and humus and re-bedding any stone which it was necessary to temporarily remove during the cleaning. It may be necessary to introduce a small amount of suitable other stone from elsewhere to provide a satisfactory finish to the exposed wall end or cap. The exposed area should be finished with the stones bedded in mortar laid to fall in such a way that rainwater drains off the wall. Mortar used in all repair and consolidation work should be lime/sand mortar to spec.

Persons undertaking the works should be experienced in the use of lime/sand mortar and should be skilled stonemasons. Appropriate professional advice should be sought.

As part of the next phase of the Kilbarron project a list of urgent works should be agreed and the implementation of this work planned.

RECOMMENDATIONS FOR PHASING OF CONSOLIDATION WORK AT KILBARRON.

Below is a suggested plan for the consolidation of the extant building remains. This can be elaborated and fine tuned in consultation with all the stakeholders and professional advisors.

Phase 1 *to include works classified as 'high priority*' by Engineer and works necessary for the preservation of areas of particular architectural or archaeological merit*.

Necessary immediately for the protection of the public and for the preservation of the most significant unstable parts of the ruins.

1. Building B; Stabilisation and consolidation of the north wall* and south wall* (to preserve what is left of the form of the building). Method of stabilisation to be designed by Engineer in consultation with Architect. Include 'rough racked' finish to wall heads and exposed ends.
2. Keep: Consolidation of section of keep wall containing draw bar hole including probable reinstatement of some facing stone to provide stability and protection for the draw bar hole feature*.
3. Keep: Necessary stabilisation of north - east wall of keep and other parts affected by soil erosion*. To be designed by Engineer in consultation with Architect.
4. Curtain wall: Necessary stabilisation of remaining upstanding part of curtain wall*. To be designed by Engineer in consultation with Architect.
5. Building C: Cordon off undermined areas* until funds available for consolidation work.

Phase 2

1. Further consolidation of the curtain wall and east wall of keep (classified 'medium priority' by Engineer).
2. Consolidation of remaining internal wall faces of keep and any other accessible parts. 'Rough racked' finish to accessible wall heads and exposed core areas.

Phase 3

1. Consolidation works to Building C.

Phase 4

1. Consolidation works to 'inaccessible' parts of the keep – may be possible using steeplejacks or other specialists.

All works will require the approval of the National Monuments Service.

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Structure & Reference:	**Kilbarron Castle, built c. 1400's.**
Address:	**Co. Donegal**

Sample supplied by:	**Gerry McManus, Conservation Architect**
Reason for sampling material:	Material Identification & consolidation

Location on building:	**Building mortar**
Phase:	Probable original or early repair.
Feature:	**Building mortar of ruin**

Description of location:	Rural location with high exposure and marine conditions.
Photographs:	Supplied by client

ANALYTICAL PROCEDURES

The selected sample of material was dried to a constant weight and examined under a binocular microscope at x40 and x100 magnification.

An assessment of the binder type was made by evaluating the physical characteristics of the mortar based on our knowledge, experience and understanding of materials.

18% Hydrochloric acid was used to enact a dissolution of the binder enabling relative proportions of carbonate binder to aggregate to be determined. Proportions of insoluble binder were determined and factored into this calculation. Subsequent aggregate characterisation was undertaken by means of dry sieve analysis and microscopic analysis.

The analysis results and interpretations made from it provide information on the composition and characteristics of the mortar sample received by the Stoneware Studios laboratory.

Provided the sample was representative of the mortar generally, the analysis will give a reasonable indication of the original materials and provide a basis for specification of repair mortars. If more detailed information is required (for example, for purposes of historic research) more sophisticated analytical procedures can be undertaken using XRD or SEM analytical tools.

Filtration

20 -25 μm PAPER TYPE: Whatman Type 41

Mortar Description

One of the remains of Kilbarron Castle, Co. Donegal, from which the sample was taken – Photograph supplied by client.

Selection of mortar sample pieces as supplied. On the left is a piece of mortar with a substantial shell embedded. In the middle is a piece of masonry debris (sandstone) with some mortar attached. On the right is a piece or mortar eroded into a conical shape.

Visual:
This sample was supplied as a comprehensive selection of cohesive, intact, pieces of mortar coupled with a quantity of mortar fragments and dust.
The mortar was supplied as two distinct samples that were separated by our client on site. One sample contains a thin cream-coloured coating of limewash-like material which will have protected the underlying material. The majority of the material supplied however does not have any remains of this protective coating. The primary difference between the mortar that has the protective coating and the one that has not is that the protected sample appears to have had less loss of binder due to weathering and erosion. This is to be expected. Other than that, they are largely comprised of the same component parts and for the purpose of this analysis are being treated as one and the same.

Large, +35mm in size, stone (sandstone) inclusions are bedded into the mortar sample. These are unlikely to be part of the original mix but added during building to use up masonry debris and spalls from stone shaping. The addition of these stones can have a positive effect on the overall performance of the mortar giving it more stability and durability.

Shell, up to 17mm in size, is also a significant component of the mortar mix. The inclusion of shells, crushed and whole, can have a strengthening contribution to a traditional mortar. They can have a mildly pozzolanic effect on the mortar but also their lamellar nature can be quite robust and durable. The source of these shells, which make up c. 1/5 of the overall aggregate mix is likely to be from sand drawn from the shore nearby and used in the mortar. Shells (or even sea sand comprised of a high proportion of calcareous material) can also be burned in a kiln to make the lime binder. This was very common in coastal Ireland and may be the providence of the lime binder but the shells in this sample did not go through a kiln.

There are some small pockets of lime discovered in the mortar but little in the way of kiln slag, over-burned lime or under-burned lime were found.

No hair or other armature found in this sample.

No gypsum found in this sample.

The overall colour of the mortar is reflected in the sand particle colours which range from purple through to orange, buff and cream. There are flakes of mica and particles of granite giving the mortar a general cream colour with a sparkly lustre.

Aggregate mix after removal of lime binder and shell aggregate.

Aggregates in Undercoat and other observations:
The overall size of the aggregates range from 3mm- micron size (see sieve analysis), and would be classified as ranging from Granules to Fine/Medium Sand by the Udden-Wentworth Grade scale. Note that c. 20% of the aggregate was shell. This is not included in the photograph below nor is it included in the sieve analysis below.

The size and sharp shape of these aggregates will have contributed positively to a reasonably strong mortar. However, it would have been difficult to spread and may have been somewhat crudely applied.

Aggregates are largely angular or sub-rounded, likely sourced from the shore or dredged from an estuary. They are geologically sandstone's, silica's and quartz's with some feldspar.
Note that carbonate aggregates including some of the shell, unlike silica's, are porous and will absorb and retain moisture for longer in the mortar. Given that a lime mortar needs some moisture to facilitate the absorption of carbon dioxide during the hardening process, these calcareous inclusions will have aided the hardening of the mortar and contributed positively to its long term strength.

Small lime inclusions are abundant throughout the sample. Given the age of the mortar and the ruinous state of the structure it is difficult to establish whether the mortar was laid as a 'hot-lime' mortar are used some time later. In all likelihood it would be been a combination of both. See conclusion below for hot lime mortar explanation.

No particles of kiln fuel; turf, coal, culm, firewood or charcoal or others were found in this sample. This could indicate that the lime binder was calcined in a standing kiln, rather than a running kiln, which would not be out of place in the 15th or 16th century.

Microscopic observations 100 x: Under microscopic examination the sample showed a very open pore structure.

This sample shows very few fractures and fissures; indicative of mortar that experienced only very minor shrinkage as the mortar hardened.

The open pore structure is derived from the composition of the mortar, how it dried and the manner in which it was laid. The open pore structure is also due to the secondary dissolution of the carbonate binder over time while exposed to rainwater as a ruin.

Chemical Analysis

The sample took some modest pressure to disaggregate despite no hydraulic compounds in evidence in this sample.

Scanning electron Microscopy/Energy Dispersive X-Rays (SEM/EDX) tests results:
Not applicable.

Pore test
Pore structure – as percentage of mortar mass 8.1%.

Binder proportion
Binder dissolution was very fast with full dissolution taking just 12 minutes.

Total Weight of sample:	136g
Weight before dissolution of carbonate binder :	50g
Weight after dissolution of carbonate binder and removal of shell:	21.7g

Sieve Analysis
Tested to BS410/1986 Sieve

Particle size	Weight	Percentage of composition
5mm – 3.35mm	0.6 grammes	2.8% of total
3.35mm – 2.36mm	0.3 grammes	1.4% of total
2.36mm – 1.18mm	0.6 grammes	2.8% of total
1.18mm – 600 microns	2.0 grammes	9.2% of total
600 microns – 300 microns	17.5 grammes	80.5% of total
300 microns – 150microns	0.1 grammes	0.5% of total
Less than 150 microns	0.6 grammes	2.8% of total

Recommendations/conclusions:

This sample is a traditionally produced 'Common Mortar' which is a technique of producing mortar by adding aggregates and sands to calcium oxide directly (rather than calcium hydroxide) and water. The resulting mix can be used immediately in its warm state as a 'hot-lime' mortar following the chemical 'slaking' or can be given some time to 'slake and sour' and is sometimes screened for finer work.
Souring allows the un-slaked calcium oxide to slake slowly over a period of weeks. The resulting mortar is a lime rich fatty workable material which was one of the primary building mortars in Ireland for such a long time that it is referred by most now as 'Common Mortar'.

In this case it is likely that the sand was sourced very close to site and local sea shell may have even been the origin of the lime binder. However, lime manufacture from quarried limestone has a long history in south Donegal and may have been in this case.

The mortar was not screened.

The present mix ratio of c. 50% binder / 50% combined (sand and shell) aggregates measured by weight (In volume terms this is approximately 1.5 parts binder to 1 part aggregate) does not take into account the substantial loss of binder over time. Allowing for loss of binder over time, and the expansion of quicklime during slaking, the original mix of this mortar is likely to be c. 3 parts calcium oxide to 4 parts combined aggregates. This is very lime rich.

The repair of old mortars in a 'like-for-like' basis is technically and aesthetically appropriate when carrying out repairs. However different criteria come into play when repairing *very* old mortars. Repairing 'like-for-like' also does not imply that poor mortars should be matched, particularly where their use might be harmful to the original fabric.

In this case, we suggest the criteria for replacing this mortar, if desired, should be based of producing a durable mortar, given the location, yet sacrificial to the host masonry. The mortar could be based on a weaker Naturally Hydraulic Lime, no stronger than NHL2. This should be mixed at 1 part NHL2 to 3 parts washed sharp 5mm down sand.

Alternatively, a ‘hot-lime’ mix may be considered. This is traditionally just quicklime and sand. Great care needs to be taken when mixing any lime due to its high alkalinity, but quicklime, particularly lump lime, should only be handled by operatives who know exactly what they are handling and take the necessary safety precautions.

The final option that is available is a hot-lime hybrid mix. A mix favoured presently is 1 part CL90 quicklime, 1 part NHL5 and 6 parts sand. This hybrid mix is considered by some as the most appropriate mix for masonry of this nature. Please note that this is a very workable, plastic mortar and is likely to be very durable also. Although there is little historic precedent in Ireland, to our knowledge, of mixing quicklime and naturally hydraulic lime together, this repair mortar should be given some consideration.

Please note that mortars made in a ‘Common’ or ‘Hot lime’ fashion mortars are now available again from some suppliers and can be supplied for this project if desired. Please contact Stoneware Studios to discuss further if required.