Head Office:

Laughton, Sleaford
Lincolnshire. NG34 0HE
Tel: 01529 497449
Fax: 01529 497518
email: hirst@hirst-conservation.com

London Office:

75 Cowcross Street
London.
EC1M 6EL
Tel: 0800 917 8664
Website: www.hirst-conservation.com

Title: Cleaning and Consolidation Trials

Great Hall Ceiling. Manchester Town Hall

Doc number: OTH-HIR-TH-XX-RPT-X-0016

Status: For Approval

Rev: P01

Document Type: Technical Submittal

Date: 15/06/2021

Issue History:

Revision Nr	Details	Date	Created By	Check by
P01	Document created	27/07/2021	Hirst Conservation	

Head Office
Laughton, Sleaford,
Lincolnshire NG34 0HE

Tel: 01529 497449
hirst@hirst-conservation.com
www.hirst-conservation.com

HIRST Conservation

Manchester Town Hall

Cleaning and Consolidation Trials



MANCHESTER

JUNE 2021

Neither the whole nor any part of this Report, or any reference contained within, may be included in any published document, circular or statement, or published in any other way, without Hirst Conservation's written approval of the form and content in which it may appear.

Hirst Conservation is the trading name of Hirst Conservation Limited.
Registered Office: Laughton, Sleaford, Lincolnshire NG34 OHE
Company Registration No. 09797372

Summary

Project	Concise trials of select panels to develop methodology for consolidation of friable areas as well as removal of surface dirt.
Address	Manchester Town Hall, Albert Square, Manchester, M2 5DB
List Entry Number: Listing: Date first listed: National Grid Reference:	1207469 Grade I 25th February 1952 SJ 83867 98089
Name and address of Client	Lendlease 20 Triton Street Regent's Place London NW1 3BF
Name and address of Architect	Purcell St James' 79 Oxford Street Manchester M1 6FQ
Name and Address of Conservator undertaking work	Alex Radford and Alison Aynesworth ACR Hirst Conservation Laughton, Sleaford, Lincolnshire, NG34 0HE
Author and Date of Report	Alex Radford Hirst Conservation July 2021
Date of Works	28th – 30th June 2021
Relevant Documentation	Hirst Conservation, *Condition Survey with Preliminary Cleaning Trials and Recommendations for Treatment of the Great Hall Ceiling,* April 2021
Methods employed	Consolidation trials; Cleaning trials; Limited void filling and retouching; Photographic recording; Documentation;

Contents

Summary 3
1 Introduction 5
2 Summary of Consolidation Trials 8
2.1 Discussion of Results 9
2.1.1 Large, brittle flakes of non-original paint 9
2.1.2 Areas of powdering 10
3 Summary of Cleaning Trials 11
3.1 Discussion of Results 16
4 Proposed Cleaning Methodology 17
4.1 Removal of surface dirt from areas of original paint affected by salts 17
4.2 Water sensitive paint 17
4.3 Powdering paint 17
4.4 1894 overpaint 18
4.5 Modern 'oil-alkyd' overpaint 18
4.6 Areas of gilding (original and non-original) 18
5 Proposed Consolidation Methodology 25
5.1 Revaluation of Condition 25
5.2 Cleaning the Reverse of the Panels 25
5.3 Flaking Paint 25
5.4 Areas of powdering 26
5.5 Filling of losses in the plaster substrate 29
5.6 Retouching 29

1 Introduction

Hirst Conservation was commissioned by Lendlease to undertake a programme of investigations to the decorated ceiling of the Great Hall, Manchester Town Hall in April 2021. Following on from the condition survey and preliminary cleaning trials, Hirst Conservation were invited back to conduct further cleaning and consolidation trials by invitation of Jordan Boland of Lendlease. The trials were undertaken by Alex Radford and Alison Aynesworth ACR of Hirst Conservation in June 2021.

The aims of the trials were to develop a methodology for the effective removal of surface dirt across the paint schemes to achieve an even clean and to determine the most effective method of paint flake consolidation to restore tensile strength to the more friable sections of paint films. The trials were undertaken across areas of select panels, specifically '*Dublin'*, *'Liverpool'* and '*Victoria Regina'* which were specifically selected due to their condition, see Figure 1 and **F**igure 2. None of the panels were fully cleaned or consolidated during these trials as the aim was to use this data to form a sound and scalable methodology for the conservation of all 28no. ceiling panels.

The tests also included limited filling of voids to the plaster substrate and retouching to determine the suitability of void filling as part of the treatment of the panels.

Access to the ceiling was attained from the fixed tubular scaffold erected within the Great Hall, which provides good access to the majority of the surface of the painted panels. However, a small 600mmx600mm platform was required in order to access the upper metre of the panels at the apex of the ceiling.

Following the condition survey undertaken in by Hirst Conservation (Hirst Conservation, *Condition Survey with Preliminary Cleaning Trials and Recommendations for Treatment of the Great Hall Ceiling,* April 2021) the decorative roof timbers surrounding the ceiling panel have been dry cleaned and vacuumed. Therefore this report will not address cleaning the timber as this is outside the scope of this report.

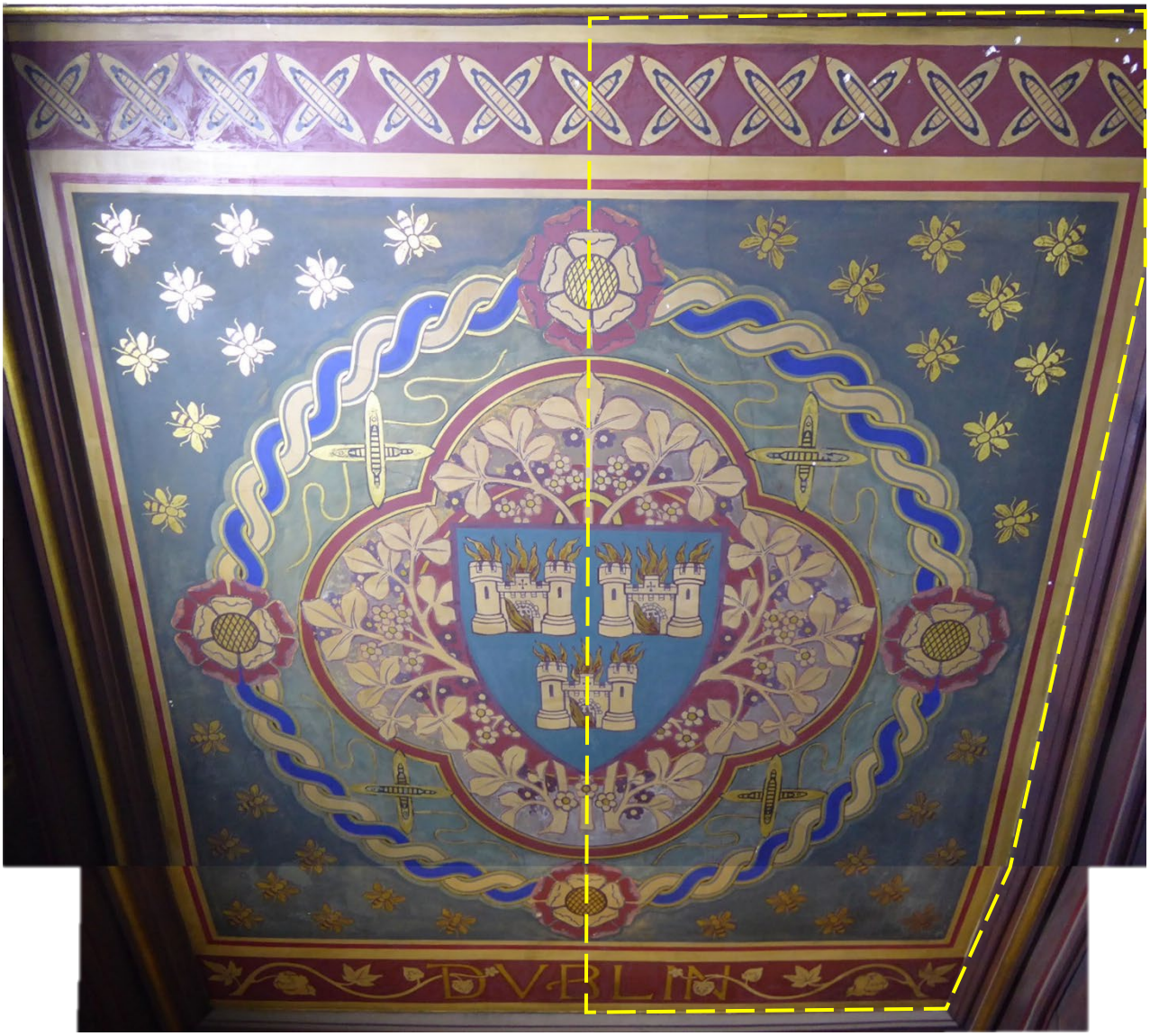


Figure 1 DUBLIN panel selected for cleaning trials. The right side of the panel within the rectangle identifies the cleaning test area.



Figure 2 Overview photos of VICTORIA REGINA*, specifically selected for consolidation trials due to extensive paint failure. Some areas of panel obstructed due to poor access. The bottom image within the rectangle represents the consolidation test area.*

2 Summary of Consolidation Trials

To reduce the risk of further failure, all areas flaking, blistering, powdering, and historic loss in the paint layer will need to be consolidated. The chosen consolidant is required to be stable, reversible, and slightly weaker than the existing alternative forces within the object to which it is applied. It is also important that the consolidant does not result in excessive saturation of the paint layers, and that any excess adhesive can be safely cleared from the surface without affecting the paint layers.

Pre-treatment tests established the paintings' potential sensitivity to any carrier solvents that may be in a consolidant, and to the solvents required to clear any excess adhesive from the paint surface following consolidation. The painted surface's sensitivity to heat was also tested due to the likely use of a heated spatula and/or hot air pen to consolidate the paint.

The passages of original and non-original paint layers that were tested proved stable to the controlled swab application of white spirits, xylene and acetone. It was not feasible, however, to test every passage of original and non-original paint present on the ceiling; it is therefore advised that each paint type to be consolidated is tested for solvent sensitivity prior to treatment as work proceeds.

The heat sensitivity of the original paint layers and various passages of retouching were tested using a thermostatically controlled spatula, with the degree of heat (applied to the paint surface through silicone release paper) gradually increased during testing. The use of heat can be required for the plasticisation of paint layers to lay them flat during the consolidation process. The effects of a hot air pen were also tested. The original and non-original paint proved tolerant to temperatures up 70°C.

For the consolidation trials, *Victoria Regina* was selected as it displays considerable paint failure having several losses as a result of detachment, see

Figure 2. The panel presents with both flaking paint and powdering paint that will require different interventions to consolidate.

The materials used in the trials involved:

- Paraloid B72 is an ethyl methacrylate/methyl acrylate co-polymer, Paraloid B72 (dissolved in xylene or acetone in varying concentrations) has been widely used in conservation over the last 30 years as a retouching medium, and as an isolating or final varnish. It remains chemically stable overtime and is not affected by light.

- Klucel G is a non-ionic cellulose ether. It is used as a consolidant and adhesive. Klucel is soluble in water below 38 C, and insoluble in water above 40 C. It is also soluble in many polar organic solvents, including methyl alcohol, ethyl alcohol, and isopropyl alcohol (95%). It is insoluble in toluene, xylene, and tri-chloethylene. Klucel G is highly surface-active, and extremely flexible without plasticizers in films and coatings.

- Lascaux 4176 Medium for Consolidation is an aqueous dispersion of an acrylic copolymer based on acrylic ester, styrene, and methacrylate ester. It can be thinned with water but can be used at much greater concentrations than other consolidants without causing shiny surface residue or

darkening. It has a very low viscosity, so it has excellent ability to penetrate even the smallest fissures by way of capillary action. Excess adhesive on the surface does not appear shiny or cause darkening, which is why it is so useful for use on matt paints. Once dried, excess consolidant can be removed using acetone or aromatics. It will dry quickly but forms a proper film after 24 hours. Once dried the film is thermoplastic so can be flattened and fixed into position using a heated spatula.

2.1 Discussion of Results

Following extensive trials and testing of materials and techniques, the following methods and materials were found to be effective in consolidation of flaking and delaminating paint. The method of application varied slightly according to the type of delamination, outlined below.

2.1.1 Large, brittle flakes of non-original paint.

A 10% solution of Paraloid B72 in acetone was found to be effective for the consolidation of delaminated original and non-original paint. Excess adhesive could be effectively removed from the paint surface following consolidation using acetone applied with a cotton swab.

For severely lifted and deformed flakes, the consolidant was carefully applied behind the paint flake using a small brush or fine hypodermic syringe. A hot air pen set at a temperature of 65°C and then used to gently re-plasticise the curled and brittle paint flake, allowing it to be gently pressed back into position with the end of a swab stick. Further adhesive was then applied to the edges of then flake and the adhesive allowed to dry, after which the area was protected with silicone release paper and a thermostatically controlled heated spatula set at 70°C used to gently iron flat the still slightly lifted paint through the use of heat and pressure.

To stabilise the edges of existing areas of paint loss and areas of less severe cupping in the original and non-original paint, the consolidant was applied behind the flake using a small brush or hypodermic syringe. The paint surface was then protected with silicone release paper and a thermostatically controlled heated spatula set at 70°C used to gently lay flat the lifted paint through the use of heat and pressure.

In areas of severe and extensive cupping, the affected area was first protected with a localised facing of Japanese tissue paper adhered to the paint surface using Klucel G, a water-based hydroxypropyl cellulose adhesive (7% in de-ionised water). The facing provides increased rigidity for the fragile paint layers, thereby reducing the potential for damage or loss of paint during the reattachment of the paint to the plaster substrate. The consolidant was applied through the tissue using a hypodermic syringe. The area was then protected with silicone release paper and a thermostatically controlled heated spatula set at 70°C used to gently lay flat the lifted paint through the use of heat and pressure. Following treatment, the tissue was removed with de-ionised water, and the excess consolidant with acetone.

2.1.2 Areas of powdering

The powdering brown outlines of original paint were consolidated using Lascaux 4176 Medium for Consolidation (1:4 in de-ionised water). Lascaux 4176 is an aqueous dispersion of an acrylic co-polymer, which dries to a clear and flexible film, and is light resistant and does not yellow with age.

The adhesive was applied with a brush through acid-free tissue paper to avoid disruption of the painted surface. The area was then protected with silicone release paper and pressed lightly with a gloved finger to further adhere the powdered paint to the plaster substrate. Following full consolidation and removal of the tissue, residues of adhesive were safely cleared from the surrounding paint surface using acetone applied with cotton swabs. Where safe, the adhesive was applied to areas of flaking without the assistance of the tissue, allowed to partially dry, and then covered with silicone release paper and pressed flat with a gloved finger.

3 Summary of Cleaning Trials

The aim of the cleaning trials was to devise a suitable methodology capable of creating an effective and consistent clean that could be applied to the entire surface of the painted panels. For these works, the right half of one panel, *Dublin*, was selected for the trials, see Figure 1. This was largely due to the numerous conditions and interventions present on the panel; this included visible surface salts with associated blanching, powdering paint, abraded gilding, deposition on surface dirt, deposition of smeared and ingrained dirt, tacky yellowed surface coating, original paint and several stages of non-original paint.

A considerable number of the paintings have multiple schemes of later interventions, which meant it was necessary to find cleaning methods suitable for both original paint as well as the later schemes of redecoration, which can be challenging owing to the different properties of the paint. It was important to maintain a consistent level of dirt removal allowing the different painted elements to appear unanimous. Initially, the test area of the panel was dry cleaned using a soft bristle brush to remove any loosely bound surface dirt prior to the wet cleaning trials.

Once a working methodology was developed, these reagents were tested across a small section of *Liverpool* (not pictured), the panel directly below *Dublin*. This was to ensure that the same cleaning methods would be suitable and to assess the tonal balance between the cleaned overpainted blue background and the cleaned original blue background.

The materials used in the trials involved:

- Melamine sponges is a mildly abrasive melamine resin sponge, which can be dampened with deionised water for cleaning. These are effective in the removal of intransigent dirt from painted surfaces without the need for chemicals.

- Deionised water (highly purified through the removal of most of its natural ions) represents the starting point for wet cleaning tests in the cleaning of painted surfaces. Elements of surface dirt may either be soluble in or dispersed by deionised water, but it can be difficult to wet out oil-painted surfaces with water alone.

- Tri-ammonium citrate (TAC) is a chelating agent, a term indicating types of molecules that are capable of forming complexes with metal ions in solution. In conservation, TAC is used as a cleaning reagent and has found particular application in the removal of certain types of dirt characterised by the presence of combustion products. Areas treated with TAC must cleared with de-ionised water and then dried with cotton wool.

Table 1 Results of the cleaning trials on the DUBLIN *panel, seperated by test area.*

Agent	Location	Result
Blue Background		
Deionised water (Cotton wool swab)	*Dublin*, lower right corner, blue background, and green band surrounding lattice	• A consistent clean. • Solubilised and removed the sticky dribbled surface dirt. • No detrimental effects on painted surface.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, lower right corner, blue background, and green band surrounding lattice	• A consistent clean. • No greater than deionised water. • Some minor blanching noted following removal. • No detrimental effects on painted surface.
Gilding		
Deionised water (Cotton wool swab)	*Dublin*, lower right corner, gilded bees	• A consistent clean. • Removed the dark surface coating on the gilding. • Care needs to be taken around brown/black outline which is brittle and flaking.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, lower right corner, gilded bees	• A consistent clean. • More effective at removing the surface coating over the gilding. • Less abrasion required.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, gilded text of *DUBLIN*	• A consistent clean, very effective. • Little abrasion required. • Care should be taken not to clean the red background.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin,* lower rose, centre of Tudor rose	• A consistent clean. • Little abrasion required. • Brown cross-hatched lines area overpaint and very stable and can also be cleaned with the TAC 3%.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin,* lower right corner, gilt shuttle, and thread	• Cleaned well, but care required as surface is brittle with possibility of cotton fibres snagging on raised brittle paint flakes. • Most effective when carefully rolled over surface.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, gilt band of coiling lattice, gilt band of quatrefoil, gilt semi-circular ring above shield, gilt flower centres within quatrefoil, gilt flames of castles	• Very effective clean. • Improved reflective properties following clean. • All gilding very stable. • Care should be taken when cleaning narrow bands of quatrefoil to avoid contact with the water sensitive red.

Beige		
Deionised water (Cotton wool swab)	*Dublin*, lower right corner, horizontal beige border	• Cleaned well and mobilised dirt. • Multiple applications were required to create a consistent clean. • Better control over areas being cleaned.
Deionised water (Melamine Sponge)	*Dublin*, lower right corner, horizontal beige border	• Cleaned well and mobilised dirt. • Worked well in areas of light surface dirt, may not be appropriate in areas of built-up dirt. • Care needs to be taken to control area cleaned with Melamine sponge as red band in the border is very sensitive.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, lower right corner, horizontal beige border	• Cleaned very well, readily mobilising dirt. • Create blanching despite being neutralised with water, a second coat of deionised water was applied to reduce blanching which was partially successful.
Deionised water (Cotton wool swab)	*Dublin*, centre within quatrefoil, beige flower petals, leaves and stems, castles within shield	• Somewhat effective but did not achieve an even clean. • Considerable pressure required to mobilise and remove dirt. • Paint layer is very stable but beige application is streaky.
Deionised water (Melamine Sponge)	*Dublin*, centre within quatrefoil, beige flower petals, leaves and stems, castles within shield	• Effectively removed more dirt that deionised water swabs. • The brown outlines cannot be cleaned with the melamine sponge and care must be taken when using sponge in confined areas of beige, swabs may be more appropriate here. • Noticeably lightens the beige, in areas this draws more attention to the patchy inconsistent brush application.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, centre within quatrefoil, beige flower petals, leaves and stems, castles within shield	• Very effective cleaning method readily removed dirt. • It did lighten the beige as was found with cleaning with deionised water which made the inconsistent application more visible. • Some blanching was found on the beige after TAC was removed with deionised water and dried with cotton wool.
Deionised water (Cotton wool swab)	*Dublin,* lower Tudor Rose, beige inner petals	• Cleaned well with deionised water. • Some pressure applied to remove surface dirt, but paint layer is very stable. • Did not test TAC 3% as a result of blanching in several other areas of beige paint.
Deionised water (Cotton wool swab)	*Dublin*, lower right corner, beige coiling band within lattice	• A consistent clean but did not appear particularly soiled. • Could not test Melamine sponge in this area due to narrow band of beige.

Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, lower right corner, beige coiling band within lattice	• A consistent clean but blanching evident once area had dried despite TAC removal with deionised water. • Some pressure required to achieve consistent clean.
Deionised water (Cotton wool swab)	*Dublin*, bottom horizontal band, beige cotton plants and top horizontal band, beige shuttles	• Very stable paint layer cleans well with water. • Some pressure required to achieve consistent clean. • Care should be taken around the water sensitive red leaf veins, as well as the red background. • TAC 3% not tested due to previous evidence of blanching on beige surface. • Care should be taken when cleaning beige shuttle as red lined detailing is sensitive to water.
Red		
Deionised water (Cotton wool swab)	*Dublin*, lower right corner, horizontal red band in border	• Water sensitive • Small traces of red pigment on swab as well as dirt, even when gently rolled across surface. • Cleaning of red band discontinued
Deionised water (Cotton wool swab)	*Dublin*, lower right corner, red background of *DUBLIN* border	• Water sensitive • Saturated well when wet, but areas blanched considerably upon drying, tested in multiple areas to confirm reaction. • Removed surface dirt and traces of red pigment. • Areas cleaned presented with a matt appearance. • Cleaning of the red background discontinued.
Deionised water (Cotton wool swab)	*Dublin*, lower Tudor Rose, outer petal, inside red	• Fairly stable red and cleaned relatively well. • Damp swab was rolled over the red which appeared to clean somewhat, but little pressure was applied as the reds appeared to be water sensitive.
Deionised water (Cotton wool swab)	*Dublin*, lower Tudor Rose, outer petal, outside red edge	• Water sensitive • Traces of red pigment on the swab • Cleaning of red outer petal edge discontinued.
Deionised water (Cotton wool swab)	*Dublin,* red quatrefoil band, inner red background within quatrefoil	• More stable than other red paints, but still sensitive to swab cleaning applied with some pressure. • Areas were rolled to provide clean, but not overly effective.
Blue		
Deionised water (Cotton wool swab)	*Dublin,* blue coiling of lattice and adjacent thin blue band	• A consistent clean but did not appear to be particularly soiled. • Stable paint layer can be cleaned with some applied pressure.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin,* blue coiling of lattice and adjacent thin blue band	• Provided a consistent clean, but not considered greatly more effective that deionised water.
Deionised water (Cotton wool swab)	*Dublin*, blue of heraldic shield	• A consistent clean but did not appear particularly soiled. • Very stable paint layer.

Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, blue background of heraldic shield	• The paint mobilised some surface dirt but results were not starkly different, suggesting the blue shield did not have a significant build-up of surface dirt.
Brown		
Deionised water (Cotton wool swab)	*Dublin,* brown outline of bees	• Friable and not stable enough to be cleaned with swabs. • Cleaning discontinued.
Deionised water (Cotton wool swab)	*Dublin*, brown flowers within quatrefoil	• Brown is stable, likely overpaint. • Was lightly rolled with deionised water swab, somewhat effective. Some dirt removed, not visually enhanced by cleaning.
Deionised water (Cotton wool swab)	*Dublin,* brown outline of leaves within quatrefoil	• Friable and not stable enough to be cleaned with swabs. • Cleaning discontinued.
Deionised water (Cotton wool swab)	*Dublin,* brown background of quatrefoil	• Friable and not stable enough to be cleaned with swabs. • Cleaning discontinued.
Black		
Deionised water (Cotton wool swab)	*Dublin*, top horizontal border, black detailing to shuttles	• Very stable to clean with swabs. • Difficult to determine how soiled this paint is as swabs did not visibly remove much dirt.
Tri-Ammonium Citrate 3% (Cotton wool swab)	*Dublin*, top horizontal border, black detailing to shuttles	• Similar results to cleaning with deionised water. • Little dirt on swab. • Layer is very stable.

3.1 Discussion of Results

In line with the findings of the preliminary cleaning trials, the more extensive trials undertaken confirmed that no single cleaning strategy was appropriate for the entire painted surface due to the presence of several types of paint with different levels of sensitivity and soiling. Cleaning strategies should therefore be tailored to the different techniques employed in the execution of the paintings and to the various paint-types present, whilst accommodating variations in the paint surface caused by deterioration. In doing so, cleaning should aim to retain the integrity of the painted scheme as a whole.

For the more vulnerable areas, specifically some water-sensitive reds, the best approach may be to dry clean and conduct initial test areas to determine the sensitivity prior to cleaning.

All panels should be dry cleaned with a soft bristle brush and vacuum extraction prior to wet cleaning to remove loosely bound surface dirt. Care will be taken only to dry clean areas of stable paint, and therefore any areas deemed unstable for dry cleaning will be consolidated prior to cleaning.

Dublin was selected because of both original and overpainted sections present on the panel, but the results may not be indicative of the properties of the paint layers across all 28no. panels. Using these cleaning trials as a guide, it is recommended that small discreet areas are cleaned with the selected reagents to confirm suitability.

Swabs of deionised water proved most suitable on the following areas…

- Areas of original paint exhibiting white veil of salts (Green background of panel)
- Stable Overpaint (Beiges and select blues)
- Original paint (Select browns)

Swabs of Tri-ammonium Citrate (3%) proved most suitable on the following areas…

- Select areas of overpaint (Select blues and blacks)
- Gilding (Original and later)

4 Proposed Cleaning Methodology

4.1 Removal of surface dirt from areas of original paint affected by salts

The use of water-based cleaning treatment can lead to damaging deliquescence and crystallisation of salts on or below the painting surface. All effective cleaning options in the preliminary trials contained water; the use of dry sponges had little visible effect on the removal of dirt and abraded the paint surface and the paints were found to be too sensitive to non-aqueous solvents.

The use of wet cleaning treatments must use the minimal amount of water possible and the surface dried thoroughly after treatment. De-ionised water applied with cotton swabs proved effective in removing dirt from the original blue background decorated with bees and from the mushroom-coloured paint within the quatrefoils. The treated area was thoroughly dried immediately after treatment using dry cotton wool. Such areas should be closely monitored post-treatment for evidence of salt crystallisation.

A small test area, seen in Figure 3, outlines the effectiveness of deionised water and tri-ammonium citrate 3% in reducing the salt presence and removing the darkened tacky coating on the blue background. Despite successful results from both reagents, deionised water is deemed more suitable as no additional application is required to neutralise; a necessary process when using tri-ammonium citrate. A wider test area displaying the effective removal of the tacky coating is identified in Figure 4.

4.2 Water sensitive paint

Areas of extreme sensitivity identified in the trials include the yellow found beneath the mushroom-brown within the quatrefoil, the red of the '*DUBLIN*' banner as well as the red banner containing the crossed shuttles in the upper tier of panel nearest to the roof apex, and the narrow red band adjacent to the beige band around the panel. These latter red areas are coated with a water-soluble paint or red pigmented substance which is highly sensitive to water. Limited cleaning identified that water solubilised this pigmented layer and where removed, the red paint appeared paler and blanched.

Dry cleaning with a Akapad® sponge or eraser removes very little visible dirt and has the potential to cause abrasion to the painted surface. It is therefore recommended that such sensitive passages of paint, and others that may yet be identified but which display similar sensitivity to water, may be cleaned with a soft brush only. The water sensitive coating is seen in Figure 5.

4.3 Powdering paint

The powdering original paint of the brown outlines found in all of the panels should be consolidated where failure is visible. However, the susceptibility of these areas to further flaking prohibits surface cleaning; the dark colour of the outlines means that any surface dirt present is not readily apparent, and that no extreme visual imbalance will be created by the presence of surface dirt.

4.4 1894 overpaint

When referring to the 1894 intervention, this report refers to the first 'restoration' carried out by C.E Greenwood, Tom Ingham and C. Staunton in 1894. The current understanding is that this scheme of restoration encompasses the beige (also referred to in Hirst Conservation, *Condition Survey with Preliminary Cleaning Trials and Recommendations for Treatment of the Great Hall Ceiling* as 'cream'). This layer of paint is likely to be oil. It responds well to tri-ammonium citrate (3% in deionised water) applied with cotton swabs, cleared with deionised water, and dried with cotton wool, results of tri-ammonium citrate 3% are exemplified in Figure 6 and Figure 7.

4.5 Modern 'oil-alkyd' overpaint

In preliminary tests, these areas of oil alkyd overpaint showed no sensitivity to the cleaning methods used. A chemical sponge dampened with deionised was effective in removing dirt from these areas. The areas were thoroughly dried with cotton wool after treatment.

4.6 Areas of gilding (original and non-original)

A solution of tri-ammonium citrate (3% in deionised water) applied with cotton swabs, cleared with deionised water, and dried with cotton wool removed the surface dirt safely and effectively from the original and non-original gilding. This process effectively removed the dirt coating on the gilding and greatly improved the reflectance properties, seen in Figure 8.



Figure 3 Bottom right corner of DUBLIN*, with test areas for deionised water (upper blue rectangle) and TAC 3% (lower red rectangle), note the darkened coating on the surface of the background.*



Figure 4 A section of blue background and gilding following cleaning with deionised water and TAC 3% respectively. Note the clear distinction where the tacky darkened coating remains.



Figure 5 The water sensitive red pigment/coating in the lower right corner of the DUBLIN *panel.*



Figure 6 The beige band was cleaned very successfully using TAC 3%.



Figure 7 The right side of the lower Tudor rose following cleaning with TAC 3%.



Figure 8 On DUBLIN*, the right half of the Tudor rose centre following cleaning of gilding, note the improved radiance of the gold after removal of the surface coating, against the uncleaned section which appears more muted.*

5 Proposed Consolidation Methodology

5.1 Revaluation of Condition

As part of the April 2021 condition survey by Hirst Conservation, any structural conditions affecting the plaster panels were documented, specifically fracturing, misalignment and hollow areas. At the time of the condition assessment, no concerning movement was noted, but several areas of fracturing and misalignment were recorded. It is understood that extensive structural work to re-roof the Great Hall. Whilst it is understood that extensive control measures have been put in place by others to mitigate changes in environment, it remains a potential issue. It is speculated during the process of removing the existing roof slates that, consequently, the roof timbers will have the potential to 'spring'. Despite excellent monitoring and mitigation, this has the potential to cause damage to the plaster panels. The condition of the ceiling panels should be monitored visually throughout works and , in the event of changes to condition, it may be necessary to undertake emergency protection/ works as required.

Changes in temperature and humidity levels have the ability to cause cyclical salt dissolution and crystallisation, it is these variations that create stresses that may lead to damage and eventually loss. The condition survey in April 2021 outlined extensive salt activity in many of the panels, which is thought to be partly responsible for areas of paint failure and loss.

It is strongly advised that prior to conservation works on the panels, the ceiling should be re-appraised by a plaster and paint conservator to determine that their conditions are unchanged from those recorded in April 2021.

5.2 Cleaning the Reverse of the Panels

Some of the panels were accessed from behind during the condition survey in April 2021 by Hirst Conservation, where it was possible to see extensive loose lying dirt and debris on the reverse of the panel. These hygroscopic particles serve to absorb and hold moisture on the backs of the panels and can exacerbate salt formations and migration within the plaster. It is advised that access be gained, and that cleaning be undertaken by suitable personnel to reduce the risk of moisture absorption and the associated problems as a result. A safe and suitable method of access to the reverse side of the ceiling will need to be agreed in order to undertake cleaning. Whilst cleaning using vacuum on extension poles will reduce the level of access required, this runs a very high risk of damaging the plaster nibs and destabilising the plaster panels.

5.3 Flaking Paint

The most urgent treatment is the consolidation of flaking paint, as it was actively failing, with evidence of detached paint flakes on the scaffolding during the condition survey in April 2021.

A 10% solution of Paraloid B72 in acetone was found to be the most effective for consolidating delaminated original and non-original paint. Paraloid B72 provided enough tack strength to hold the paint flakes without requiring any excess pressure, which lowers the risk of breakage. Any excess adhesive

could be effectively removed from the paint surface following consolidation using acetone applied with a cotton swab, with no detrimental effects to the surrounding paint. Paraloid B72 has good reversibility properties also, making it ethically suitable consolidant.

For the more severe deformation of flaking paint, the flakes can be manipulated into place using a hot air pen at a temperature of 65°C to re-plasticise the flakes, returning a degree of flexibility to the flake in order to lay it back in position whilst it is adhered in place. Additionally, using a thermostatically controlled heated spatula at 70°C can aid the flakes to lay flat against the wall surface. For both methods, the paint surface is protected with a later of silicone release paper. The effectiveness of this method is outlined in Figure 9 and Figure 10.

During the trials, the areas displaying the most extensive cupping were first protected with a localised facing of Japanese tissue paper adhered with Klucel G, a water-based hydroxypropyl cellulose adhesive (7% in de-ionised water). This provided increased rigidity for the fragile paint layers, thereby reducing the potential for damage or loss of paint during the reattachment of the paint to the plaster substrate. The Paraloid solution was applied through the tissue using a hypodermic syringe. Following treatment, the tissue was removed with de-ionised water, and the excess consolidant with acetone.

It should be noted that whilst this is deemed the most appropriate method of consolidation for flaking paint on the ceiling panels, inevitably there were still losses. Despite best precautions to protect the integrity of the paint films, it will not always be possible to save and reattach every fragmented flake of paint. Where breakages occur it may still be possible to reattach with the same methods of adhering and re-plasticising the paint flakes. Further losses should be anticipated when consolidation work is undertaken.

5.4 Areas of powdering

To treat the powdering brown outlines of original paint, Lascaux 4176 Medium for Consolidation (1:4 in de-ionised water) was found to be the most suitable consolidant. Lascaux 4176 is an aqueous dispersion of an acrylic co-polymer, which dries to a clear and flexible film, and is light resistant and does not yellow with age.

As the surface already displayed paint failure, Lascaux 4176 was applied with a brush through acid-free tissue paper thereby avoiding disruption of the painted surface. Light pressure was applied through silicone release paper to further adhere the powdered paint to the plaster substrate. Lascaux 4176 can be applied directly with a brush or, for more vulnerable areas, through acid free tissue appear. The acting conservator will determine whether the paint films are stable enough for Lascaux 4176 to be applied without the assistance of the tissue.

Following full consolidation and removal of the tissue, residues of adhesive were safely cleared from the surrounding paint surface using acetone applied with cotton swabs.



Figure 9 Detail of paint flake consolidation to a bee on VICTORIA REGINA. The severe paint failure and losses prior to consolidation (left) and the same area after consolidation with Paraloid B72 10% in acetone with the hot air pencil and heated spatula (right).



Figure 10 Detail of consolidation and retouching to the lower banner of VICTORIA REGINA*. The* O *of* VICTORIA *presented losses and areas of flaking paint (top), following consolidation this area, the losses were retouched (bottom).*

5.5 Filling of losses in the plaster substrate

During the test, two areas of loss in the plaster, caused by pellets fired from an air rifle, were filled using Toupret® powder combined with de-ionised water to a suitable consistency.

Prior to filling, the areas of loss in the plaster were cleaned with a soft brush to remove debris and dust. The area was then dampened to control suction, and the filling material applied. Once dry, the filling was shaped flush with the surrounding paint surface using de-ionised water and cotton swabs. These fills were then suitably retouched as outline in 6.2 Retouching.

Alternatively, as there are many voids in the plaster substrate across multiple panels, it might be considered more suitable to clean these voids to remove any loosely bound dirt or debris and retouch the substrate directly without filling the void. It should be noted that applying fill material onto a ceiling has inherent risks, specifically the risk of detachment of the fill material in the future and falling from the ceiling. Given the height of the ceiling and the frequency of use of the Great Hall, it may be considered safer and therefore more favourable to retouch the voids as they appear within prior filling.

5.6 Retouching

Retouching should integrate areas of new filling material and exposed plaster only. Detailed retouching of losses in the design is not recommended in line with the preferred approach of low intervention, and with consideration of the distance at which the panels are viewed. Retouching of exposed areas of plaster and new fillings is necessary to maintain the unity and presentation of the scheme when viewed from the ground.

A small trial was undertaken to integrate a filled loss and an area of consolidated missing paint that exposed the plaster substrate using acrylic paints matched to the surrounding surface. Care was taken to keep the retouching within the area of loss, and not to encroach upon the surface of the original paint.

Retouching was undertaken using acrylic paints, but the use of dry pigments in Paraloid may also be considered an appropriate option, subject to further trials. Results of filling and retouching can be seen in Figure 11.



Figure 11 Filling and retouching of an air-rifle pellet hole within right side of quatrefoil of DUBLIN *panel (Left top, Left bottom). Filling and retouching of blue background along right-side edge of quatrefoil band of* DUBLIN *panel (right top, right bottom).*