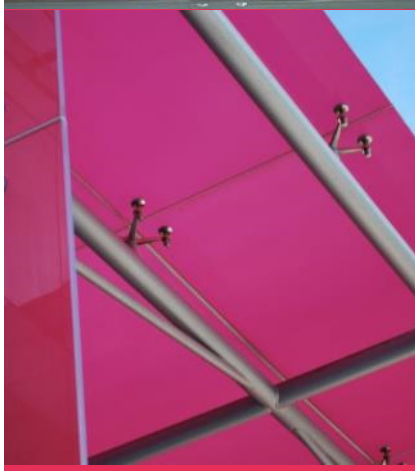
Appendix 18.8

HYDRAULIC TOWER CONDITION



Hydraulic Accumulation Tower at Bramley-Moore Dock Liverpool

Stage 1 Visual Structural Condition Appraisal (2020 Update)

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Client Address: Unity Building (Level 2), 20 Chapel Street, Liverpool L3 9AG

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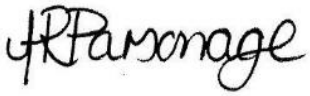
Allan Parsonage MEng (Hons) CEng MIStructE Principal Engineer		02/06/2020

Reviewed	Signature	Date
Tim Bingham BEng (Hons) CEng MIStructE Director		02/06/2020

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0.0 Executive Summary

0.1 Internal access to the building was limited during the inspection, however the structure appears to be in largely comparable structural condition compared with the inspection undertaken in April 2018, which in turn at that time concluded similarly that it was much the same when compared back to the Spring 2016 inspection.

0.2 Areas of cracking / structural defect previously identified appear to be of a comparable extent of propagation and magnitude.

0.3 Deterioration of the structure as a whole is 'decay-driven', not due to structural instability or ground-induced movement. Vegetation appears to have progressed further again since the date of the previous inspection at which time it had similarly progressed further since 2016.

0.4 The displacement observed to the coping stones at the head of the accumulation tower appears to have progressed since the previous inspection(s), commensurate with vegetation growth.

0.5 The rate of overall structural deterioration appears to remain slow, drawing on both previous inspections, given its age and exposure. However, the timber pitched roofs over the accumulation tower and office block have all but failed, leaving the wall heads prone to active water ingress, and deterioration is likely to progress rapidly thereafter.

0.6 The mono-pitch half-height extension to the original accumulator tower exhibits loosening and displacement of the skew corbelled verge masonry.

0.7 The office block on the roof of the boiler house warrants urgent attention to stabilise the arches, leaning walls and failed roof covering.

0.8 Due to the limited access currently, both internally and at height, further investigations are recommended to determine the root cause of some of the structural defects observed, and also any further structural defects that have not been identified thus far.

0.9 The proposed remedial works required to 'make safe' the building structurally ready for the upcoming stadium works have been split into 2 separate priority phases. Priority 1 being 'RED' emergency items which require actioning immediately, and which may therefore not require Listed Building Consent, subject to agreement with the Conservation Officer. Priority 2 being 'AMBER' items which can then follow in a second phase and are generally more intrusive and therefore may require Listed Building Consent.

0.10 Other relevant consents or permissions may need to be sought at each stage, such as Landowner approvals/licenses etc.

1.0 Introduction

1.1 Curtins were commissioned by Laing O'Rourke, the Client, to undertake an updated Stage 1 Visual Structural Condition Appraisal on the Hydraulic Accumulation Tower at Bramley-Moore Dock.

1.2 The primary purpose of this was to ascertain its current structural state, and inform of change(s) in condition from that identified in the previous inspection by this Practice in April 2018, undertaken at that time in favour of Everton Stadium Developments Ltd. The afore-mentioned 2018 report was in itself also an update of a similar inspection by Curtins in 2016, and so this is also made reference to in the ensuing report, as it provides useful insight into how the condition of the building has changed over the longer 4 year period, as well as primarily over the last 2 years.

1.3 Unlike the 2018 report (and 2016 report) however, the Client brief for this new inspection was specifically to inform the minimum works required structurally (generally referred to as "making safe" works) to ensure the building's overall stability during the proposed construction works for the new Everton Football Club stadium adjacent, which also includes infilling of the existing Bramley-Moore Dock itself. Any defects or recommendations from previous reports that could therefore be considered as aesthetic, or providing betterment over and above essential structural interventions, are to be deferred until a point in the future, when the building will be subject to a full refurbishment under a Listed Building Consent application.

1.4 Allan Parsonage, a Chartered Principal Structural Engineer from this Practice, visited the property on the 6th May 2020 to undertake the inspection. Reference can be made to the register held by the Institution of Structural Engineers.

1.5 The inspection was based on a visual appraisal only. No intrusive opening-up or testing was undertaken. It should be appreciated that such opening-up or testing may reveal additional defects that were not apparent from the purely visual inspection.

1.6 All observations were made from ground level only during the inspection, no access at height was undertaken, and all observations were made with the naked eye. The Client did however provide access to separate recent drone footage and imagery of the building at higher level, and following the inspection this was also reviewed visually on a standard computer monitor to provide additional reference to the building condition at higher level.

1.7 All observations were predominantly made from the outside of the building only, due partly to concerns over the stability of the roofs and the upper floors, and due partly to permanently bricked up door openings preventing internal access to some areas. The ground floor Boiler House however was able to be safely accessed during the inspection, as was the Electrical Switch Room which appears to have been built into the ground floor Boiler House later, circa 1960's based on archive drawings.

1.8 A 3D scan of the internal areas accessed was undertaken using a Matterport scanner, as well as external ground level 3D photographic imagery using the same equipment. A QR code and a web link are provided in Appendix D which allow access to this information saved on Matterport's cloud-based server, using suitable and compatible hardware (phone/tablet/computer).

1.9 Non-structural matters such as finishes, drainage, services, damp/water penetration, mould, pollution, contamination, or asbestos, etc. are not addressed unless they have a direct effect on the structure.

1.10 This report has been prepared on behalf of Laing O'Rourke and their immediate advisors, and it must not be reproduced in whole or part, or relied upon by any third party without the express prior written authority of Curtins Consulting Ltd.

2.0 Description of Building Structural Form

2.1 The Bramley Moore Tower is a hydraulic accumulator that was used to power the dock cranes, and was interconnected with the overhead railway. It is believed to have originally comprised the Main Tower, the Chimney, an Engine House and Boiler House with water tanks above. Above the Boiler House there were two small offices. The details of the original construction can be seen on the Mersey Docks and Harbour Board Drawing (MDHB) drawing numbered 280.4166 (reproduced in Appendix B)

2.2 The records indicate that the Main Tower was extended to the south-west. Inspection of the interfacing detail agrees with this assessment, the half-height tower extension with large, multi-storey window and mono-pitch roof over is butt-jointed to the tower proper, tied occasionally with brick bonding tooth-headers across the interface.

2.3 The records also show that the original Engine House has been demolished and the Chimney has been reduced in height. The original machinery equipment has been removed from the buildings. Remnants of the railway which served the tower remain in the surrounding yard.

Figure 1: Hydraulic accumulator tower at Bramley-Moore Dock with integral boiler house (2020).

2.4 The Main Tower, its SW Extension and the Office Block over the Boiler House have timber pitched roofs. The Boiler House has a solid flat roof deck.

2.5 Foundations were not investigated as part of this or previous appraisals. The historic record drawing indicates that the Accumulator Tower has a mass concrete pad spread foundation, placed on an interlocking grid of hardwood timber balks, in turn over 'black sand' (likely fuel ash) blinding a formation of gravelly natural ground. The Boiler House, Engine House and adjacent dock wall foundations are not recorded on this drawing. It is reasonable to suppose the Boiler House and Engine House have spread (strip) foundations although they may incorporate arches between pads.

2.6 The Boiler House superstructure comprises a perimeter masonry skeleton with a heavy-engineered Victorian roof structure comprising primary rivetted-plate girders carrying closely spaced secondary beams and in turn a solid flooring, possibly brick jack-arches across the secondary beams, or possibly solid plate deck, either way with concrete over. The girders and beams could be either wrought iron or early steel given the date of construction. According to the record drawings and visual appraisal, the office block comprises a masonry skeleton with timber pitched roof over, appearing to be constructed directly off the boiler house roof structure. The primary girders bear onto the masonry skeleton, received by blue engineering brick piers with mass stone padstones.

2.7 It is understood from the review of the historic function of the building complex that the heavy-engineered beam grillage and solid deck over the Boiler House appears to have historically serviced railway loading and/or coal storage, delivered by the high-level coal railway line (Fig. 2).

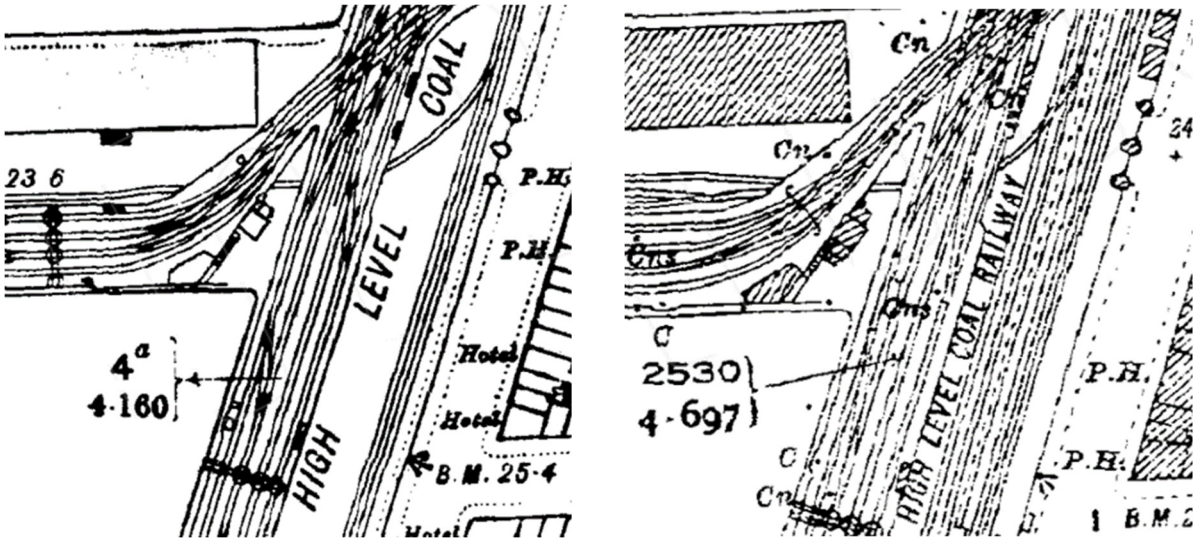


Figure 2(a-b): 1890s historic OS map showing Bramley-Moore Dock Accumulator Tower (left); 1920s historic OS Map of same. Note the addition of the tower extension in the 1920s map.

2.8 The structure is designated Grade II listed status, details of the listing are enclosed in Appendix C, Historic England's property listing. The features of heritage significance recorded in the listing comprise the Tower & Engine House overall structural assemblage form, and additionally the terracotta detailing of the brickwork fabric.

3.0 Survey Observations

3.1 The primary means of recording the survey observations is via the survey record drawings, enclosed in Appendix A. For the sake of clarity, only the primary observations are presented here.

Main Tower (Original)

3.2 The Accumulator Tower was sighted visually and observed to be plumb, its walls well-bonded to one another, free from evidence of structurally significant ground-induced movement and, for all intents and purposes, stable.

3.3 The main archway to the front elevation appears to be of sound structural geometry and form. Isolated defects of weathered joints and evidence of 'bridge-bashing' were observed but do not appear to be materially distressing the archway. Minor movement in the spandrel above indicate a slight flattening of the arch. It is unclear whether this may be related to the deep weathering of the joints. No material spread of abutments was observed. In any event, the movement in the masonry overhead appears to be minor and of a longstanding history.

3.4 The masonry fabric exhibits varying degrees of decay. This generally becomes more pronounced with height and is more prevalent at corners and areas of detailing, which attract the wind. The main decay driver is soluble salt precipitation, mobilised by wetting and drying cycles. Mortar joints generally exhibit preferential weathering relative to the brick units, although in areas of extensive weathering the bricks themselves are also heavily decayed. Visually, the general degree of decay appears to have worsened slightly since the 2018 inspection.

3.5 Vegetation growth at high level and local displacement of the mass stone copings was observed, with the corner units appearing to be thrusted out. As with the masonry fabric, vegetation growth appears to have worsened and become more extensive since the 2018 inspection.

3.6 The roof itself could not be sighted for meaningful appraisal. The findings of the recent drone survey therefore will be drawn upon in Section 4.

Chimney

3.7 The Chimney appears to be well bonded integral with the Main Tower. The Chimney thickens and widens towards its base, built to a gradual batter as the records inform. It does not appear to have a formal capping slab and is supporting vegetative growth at high level.

3.8 The facet panels which give the Chimney its octagonal form exhibit various degrees of cracking. Coarse vertical cracking generally following the centreline of the facet panels includes split masonry units. This cracking appears to be of a relatively longstanding history however, with evidence of past movement monitoring observed dating back as far as 1979. The crack width generally reduces with height and is most pronounced within the bottom 5m of the Chimney.

3.9 The masonry fabric condition of the Chimney is comparable to that of the Main Tower, as described in 3.4 above, and similarly appearing to have generally worsened slightly since the 2018 inspection, predominantly due to weathering.

SW Half-Height Extension to Accumulator Tower

3.10 This part of the Tower exhibits comparable overall structural condition to the Main Tower itself. Satisfactory verticality, free from structurally significant distress or ground-induced movement and in summary it appears to be stable.

3.11 Its interface with the main tower proper is largely a butt-joint which is occasionally cross-bonded with header “teeth”. It is well bonded at the head where the Tower has been corbelled out (downward) to preload the peak of the mono-pitch wall head of the extension. The butt-joint below is open, however, and the header “teeth” have sheared through, although the extension appears to remain plumb and has not materially moved away from the Main Tower. This defect appears to have a longstanding history.

3.12 The weathered condition of the masonry fabric of the tower south west extension is again comparable to that of the Main Tower, as described in 3.4 above, and similarly appearing to have generally worsened slightly since the 2018 inspection, predominantly due to weathering.

3.13 The mono-pitch roof slate cladding is in poor condition, particularly around the skew verges and the lower wall head. Evidence of active rainwater ingress down into the walls below is clear. Vegetation has taken hold, several masonry units have become displaced, loosened and a few have dropped out. The ends of a timber wall plate are exposed, and active decay is clear. Again, the vegetation growth appears to have worsened and become more extensive since the 2018 inspection.

Boiler House Lower

3.14 The walls of the perimeter structural masonry skeleton appear to be well bonded to vertical restraints (return walls) and horizontal restraints (the roof at wall head) for the most part. At the south-west corner however, the external wall does not appear to be bonded to the return wall (formerly an internal wall) for the upper half of its height. And to the lower half of its height a former door opening close to the corner has been poorly infilled, further compromising the buttressing effect. No evidence of structurally significant distress or ground-induced movement was observed however, notwithstanding the above observation, and the masonry skeleton appears stable.

3.15 Masonry arches form the openings in these walls and are all of satisfactory form and geometry without evidence of structurally significant distress.

3.16 Deterioration of the perimeter walls is “decay-driven” and not as a result of instability. The fabric is generally weathered however the west elevation (originally an internal dividing wall) is severely decayed, commensurate with the lesser durability of internal/backing bricks used at this location. A number of external fenestrations are also noted to be open through damage to the former window glass.

3.17 A significant amount of ancillary items and equipment fixed to the external walls (lighting, trunking, bracketry etc.) are also noted to be in a generally poor condition, and in many cases the fixings are failing, and these items are coming free and hanging precariously off the building.

3.18 Internally, the main Boiler House room exhibits extensive guano coverage on the ground floor, generally worsened toward the outer perimeter of the room, and a number of Pigeons were seen to be roosting up in the roof structure, as well as evidence of dead pigeons on the ground floor. Otherwise the space is generally empty and uncluttered for the most part. It was also noted that an environmental report confirmed the presence of bats within this section of the building, albeit their precise roosting location within the building is unknown at this point. WYG's environmental consultant was present during the inspection for guidance and support on this matter.

3.19 Reference to the 2016 report indicated water penetration through the roof was active and decay / corrosion driven deterioration to the roof members was present, particularly to the large primary roof girders. This was verified as still being present during the inspection, albeit due to the low lighting and conditions generally internally it is unclear whether this has worsened or not since 2016.

3.20 The newer (circa 1960's) Electrical Switch Room which has been built within the shell of the Boiler House room was seen to comprise a 'box within a box' type construction having its own independent masonry load-bearing skeletal walls supporting what appeared to be a precast reinforced wide-span concrete plank roof slab, set much lower than the flat roof of the main Boiler House structure itself. An original drawing pack showing the general construction and electrical installation of the Switch Room were found within, and generally confirmed the above. The Switch Room appeared to be still live and functional, with the lights working, and evidence that it is still accessed regularly for maintenance by Peel Ports personnel/sub-contractors. The general condition of the Switch Room structure appeared to be satisfactory, with walls appearing plumb and showing no signs of significant movement or distress. Some localised deterioration to the soffit of the roof slab units was evident however adjacent to the external access door, with corroding reinforcement having blown the concrete cover. This appeared to have been driven by the external door not being locked, and having been left or blown open often, allowing rain to be wind driven in locally.

Office Block on Boiler House Roof

3.21 Safe access up to inspect the Office Block more closely was not possible as part of this latest inspection. Visually from ground level however, and from review of the recent drone footage, the previous observations from 2018 were all still evident. Similar to the other elements of the building, the general level of decay to the masonry fabric appears to have worsened further, as does the level of vegetation growth noted.

3.22 The timber duo-pitch roof (hipped at both ends) is failing and decay of the structural timbers is active. Wall heads are exposed to water penetration and this is evidenced by the vegetative growth and

displacement of wall head masonry units. There remains therefore the risk of collapse of the roof and displacement of the walls.

3.23 Several of the brick arched openings show signs of structural deterioration. The cause of movement varies between a shift in abutments (the wall into which the arches thrust) and flattening of the arches due to decay of the mortar between the voussoirs. The effects of both are visible through the full thickness of the wall.

3.24 The walls on the south and west elevations appear to be stable and free from structurally significant distress of deformation. Deterioration of these walls is “decay-driven” i.e. weathering of the fabric and localised movement in the wall head due to water penetration.

3.25 The north-east chamfer wall and the northern wall exhibit significant structural movement.

3.26 The north-east wall leans north west (i.e. it is rotating in its own plane), folding from the window opening downwards out towards the middle of the roof deck. Referred damage to the arch over this opening is evident.

3.27 The north wall appears to have moved downwards from a fold point around the western window (the crack up the western jamb), and a slight longitudinal dip eastward towards the tower was observed.

4.0 Interpretation of Primary Observations

Detailed observations by location are recorded on the enclosed survey drawings (Appendix A). For the sake of clarity, the primary observations only are discussed in the text.

Overall Structural Complex

4.1 Taking a broad view, the masonry skeleton overall appears generally stable (excepting the small Office Block on the Boiler House roof). Several signs of minor movement were noted; however, verticality, integrity and stability by and large were satisfactory to the Accumulator Tower and Boiler House structures.

4.2 No evidence of structurally significant ground-induced movement was exhibited in the masonry superstructure. The recorded timber balk mattress below the mass concrete pad footing for the Accumulator Tower, theoretically, is liable to decay depending on the depth at which it is founded, fluctuation of the water table vs. its position, etc. However, judging by the evidence presented by the superstructure, this does not appear to be a problem and by inference the foundations appear to be adequate.

Fabric Condition Generally

4.3 The exposed setting of the building renders it particularly liable to masonry decay processes, especially salt weathering. By and large, the fabric appears to be in fair condition with the exception of exposed elements such as piered corners and projecting architectural detailing which attract the wind, and particularly saturated areas of masonry, which exhibit pronounced fabric decay.

Figure 3: Fabric decay and vegetation particularly prevalent at structural elements which attract the wind

4.4 Mortar joints exhibit particularly weathered states at exposed locations, and where the masonry is saturated, the weathering of the mortar is extensive. This has the potential (and is already evident sporadically across the building) for the masonry units to drop out, leading to local instability of discrete elements e.g. corbelled wall head detailing, arches etc. The deep weathering also gives water a deeper foothold, accelerating salt and frost-induced decay.

4.5 The weathering of high-level masonry has allowed vegetative growth to take hold and it appears to be disrupting the masonry: the mass coping stones at the top of the tower are becoming displaced, and wall heads generally are loosened where vegetation is observed.

4.6 The timber roofs over the various elements of the overall building within the overall complex are in very poor condition and are ineffective for protecting the masonry wall-head from water ingress. Rainwater handling goods are practically non-existent. Sustained wall head water ingress significantly accelerates decay processes and can quickly give rise to local instability. Where the timber roofs bear onto the wet masonry significant decay is anticipated. The consequence of this is that their effectiveness as diaphragm restraints to the masonry wall head is significantly impaired, and the potential for local collapse is significant.

Figure 4: Drone survey image from 2020 condition appraisal. Timber boarding deterioration and vegetation growth appears to have progressed and the mass coping stones appear to have moved further.

Accumulator Tower

4.7 The root cause of the cracking observed in the Chimney to the Tower is believed to be thermal, arisen during operation of the Tower, for the following reasons:

- The crack is coarsest within the bottom 5m of the chimney, reducing in severity with height (by implication, worst at close proximity to the furnace, best at cooler areas).
- The crack is vertical and follows the centreline of the facet panels finding the thinnest point in the flue (the outer corners of the octagonal external face are the thickest points vs the circular inner face).
- This defect is characteristic of chimney towers of this nature.

Figure 5: Coarse vertical cracking following the centreline of the facet panels of the chimney

4.8 Given this suspected cause, the issue is likely dormant i.e. inactive and not progressive. The old tell-tales indicate a longstanding history and appear to have been monitored since 1979. Cement tell-tales

do not give reliable information so the fact that they have cracked does not necessarily mean the crack is getting worse.

4.9 The propagation extent and severity of the crack are not considered to be at a stage whereby they impair the Chimney to the point of instability, although it does represent a structural weakening which warrants remedial work in the medium term.

4.10 The half-height extension to the Accumulator Tower, apparently being a retrospective addition to the original Main Tower, is in essence butt-jointed to the Main Tower. The header teeth (visible to the outer face) have snapped, indicating some relative vertical movement between the two parts of the Tower. However, by and large the mortar bed joints and brick courses line through, so the relative movement is minor and not considered structurally significant. In any case the extension appears well bonded at the top, appears plumb, stable: the defect can be recorded, repaired if desired and resolved.

Boiler House

4.11 Infestation with pigeons due to open fenestrations has resulted in significant amounts of guano within the Boiler House, and this is serving to exacerbate the deterioration of the fabric and structure internally. This requires addressing.

Figure 6: Internal images of the heavy-engineered roof deck over the Boiler House.

4.12 Active water ingress through the roof deck is noted, and associated corrosion of the roof structure is observed, particularly on the primary girders. Given their stocky shape they may be twin-web and the actual extent of the corrosion may not be informed by that visible on the outer faces. This applies also to the compression flange which is likely in direct contact with the (leaking) solid decking and may be of more pronounced extent of decay.

4.13 No evidence of significant movement or distress was noted to the Boiler House structure; however, the lighting is poor internally within the space, which impeded detailed visual inspection of the roof structure. This, plus the structural movement observed to the office block overhead (discussed below), suggests that the beam grillage and solid roof deck to the Boiler House do warrant further investigation.

4.14 Similarly, the apparent lack of suitable restraint/buttressing to the south-west corner wall junction requires addressing to ensure the stability of structure locally.

4.15 The minor deterioration to the roof slab within the newer Electrical Switch Room within the Boiler House has been caused simply by the external door adjacent not being secure and being either left open or blown open. The door requires securing properly for health and safety reasons given the nature of the room, and this will in turn serve to halt further deterioration. Temporary propping locally to soffit of the concrete slab is also recommended to ensure their stability in the immediate term.

Figure 7: Internal images of the later Switch Room constructed within the Boiler House.

Office Block on Boiler House Roof

4.16 The pattern of movement observed to the walls of the Office Block points towards two likely scenarios:

- Deflection of the Boiler House roof deck, relative to the “fixed” (stiffer) foundation for the south and west walls of the Office Block (built off masonry walls below).
- Roof thrust from the failing Office Block timber roof structure, compounding with thrust from the arches to push the north-east corner out.

Given our understanding of the overall structural assemblage, we believe the former to be more likely. This may be a past defect which could have arisen during the time of the high level elevated coal railway (loading/un-loading i.e. deflection-cycling of the roof deck relative to the stiff foundation of the outer walls, etc., initiating cracks which have then been exploited over time by decay processes). Either way it appears to be problematic and warrants further investigation and remedial work.

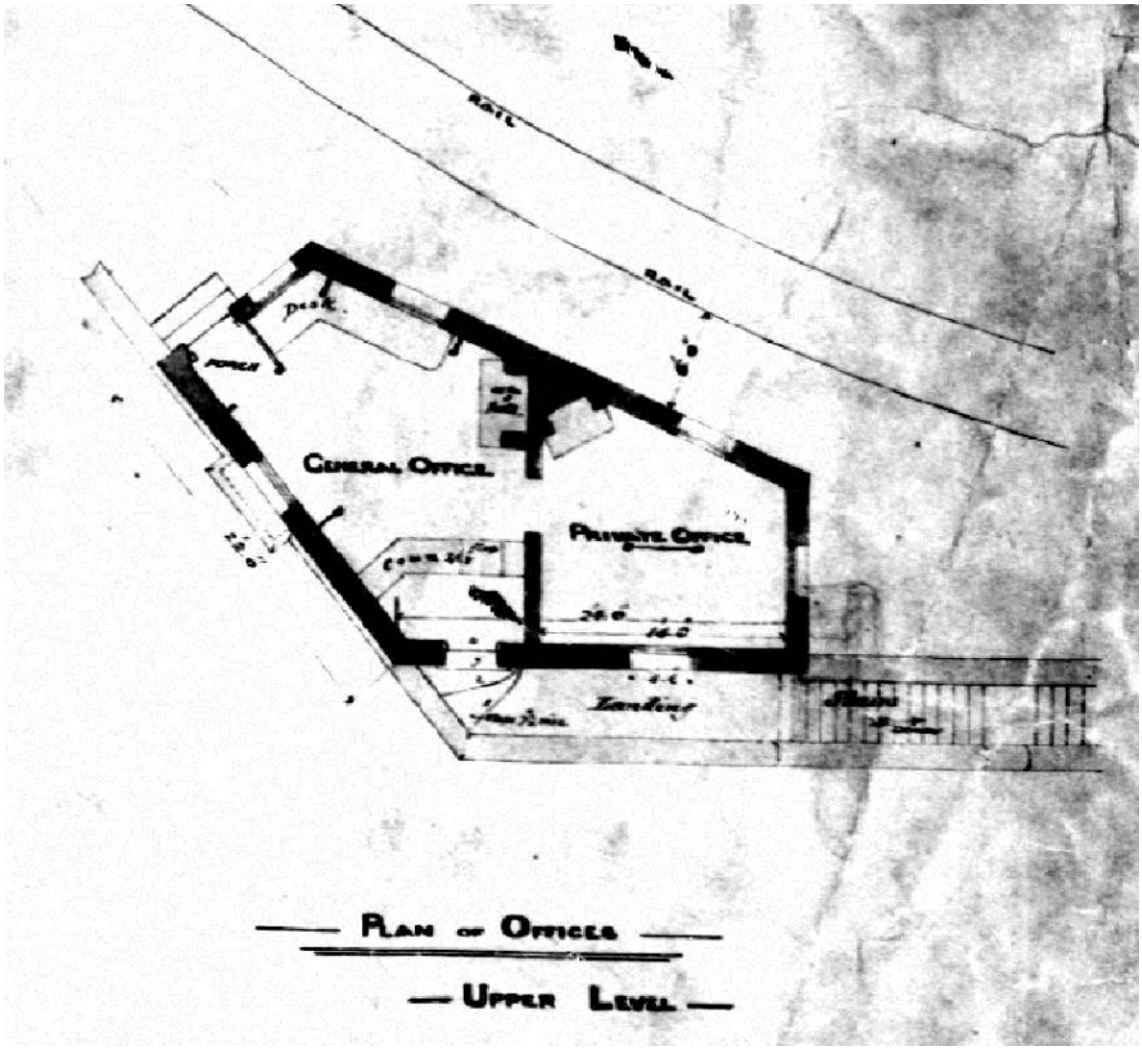


Figure 8: Record extract plan on office block showing coal railway adjacent on roof deck.

5.0 Review of Condition in 2020 vs. 2018 (and 2016)

5.1 Following our reappraisal of the Bramley-Moore Accumulator Tower, we have reviewed the current condition against that observed in the 2018 report, and in some cases also against that observed earlier again in the 2016 report. Certain areas of the earlier surveys were not accessed during our reinspection, and as such we have commented on these aspects using recent drone imagery where provided, or if not by directing back to the earlier surveys to make a judgement on the possible rate of deterioration since then.

5.2 The fabric condition overall appears generally similar to that determined by the 2018 report, and indeed therefore the 2016 report also. The vegetative growth on the masonry wall heads appears to have progressed significantly, and the residual roof cladding appears to have deteriorated further also. Similarly, the general masonry fabric externally has deteriorated further, particularly on the prevailing south-west facing facades. These issues are serving to increase the water ingress to the structural masonry.

5.3 Broadly, the structural condition of the masonry skeleton appears in similar condition to that noted in the 2018 report. The primary areas of cracking or structural distress were generally identified in the previous report, and from a purely visual perspective most do not appear to have materially worsened in propagation extent or severity.

5.4 Access to the roof of the Boiler House and close-quarters appraisal of the Office Block was not achieved, unlike that which was achieved in 2018. Review of the 2018 photos vs. the current condition (from distance and drone imagery) reveal the same overall movement pattern however, and it is likely that the walls of the office block are in comparable condition to that of 2018, although its roof appears to have deteriorated further since, and is at even greater risk of localised collapse.

5.5 Access into the Boiler House was achieved, which was not achieved in 2018, but had been during the 2016 inspection. Review of the 2016 photos vs. the current condition reveal broadly similar observations, although infestation by pigeons has resulted in significant guano build up within the space since 2016.

6.0 Interim Conclusions

Overall Structural Complex

6.1 Taking a broad view, we consider that the structural condition of the overall building complex to be generally satisfactory in terms of stability, excepting the small Office Block on the boiler house roof, and the roof to the Main Tower.

6.2 The overall building complex appears to be in comparable structural condition to that determined by the 2018 and 2016 reports, although vegetative growth and localised movement in the wall heads of high-level masonry appears to have progressed since then, together with further deterioration of the structural timbers.

Fabric Condition Generally

6.3 The masonry fabric generally exhibits a range of states of weathering, from minor to moderate with localised areas of more extensive decay, notably those areas/elements which attract the wind or are south-west facing.

6.4 The masonry skeleton is effectively open to the elements; the roof coverings are ineffective at keeping the water out of the wall head. The provision of temporary roof coverings is recommended to all pitched timber roofs.

6.5 Structural roofing timbers are typically rotting, to various degrees, leading to compromised capability of effective diaphragm action to restrain the supporting masonry walls. Temporary bracing & tying of the walls of the office block is recommended, as well as 'collar' tying around the Main Tower at high level.

Accumulator Tower

6.6 The crack pattern observed on the Tower appears to be consistent with the thermal cracking associated with the function of the Chimney flue. This defect appears to have a relatively longstanding history and does not present cause for immediate concern, however we recommend it be monitored as part of the immediate works, and it would also be prudent to consider installing more permanent designed and approved repair works (most likely using stainless steel embedded crack stitch bars), subject to agreement with the LCC Conservation Officer.

6.7 Internal access to the Tower was not possible to ascertain the condition of floors, roofs or other structure, due largely to the potential risk of collapse of its roof. Some limited remote imagery that the Client was able to obtain has been provided within the SW Extension, and review of this requires further consideration in due course. It was however clearly evident that there is a substantial depth of guano at its base, appearing to be possibly chest high. As part of the scaffolding package, further safe access into the Tower and adjoining SW Extension needs to be made to be able to fully inspect them and advise on any potential further internal works required to make them safe. This is likely to take the form of further remote scanning and/or drone survey initially, to inform the feasibility and/or need for

subsequent safe physical access. The latter may never be practically possible due to the risk of the roof above collapsing into the Tower.

6.8 Temporary roof covering over the Tower and chimney is also advised as part of the temporary scaffolding works, to mitigate ongoing deterioration of the roof structure and the potential for its complete collapse.

Boiler House

6.9 We consider that the structural masonry skeleton of the Boiler House is generally in satisfactory structural condition in terms of stability. Continued decay of the masonry fabric is tied to the water retentivity and ingress through the roof. Careful removal of vegetation growth in due course will allow more detailed inspection and locating of leaks which could then be temporarily covered to mitigate further deterioration.

6.10 Similarly, careful removal of loose and precarious brickwork and other items around the perimeter edge of the roof will ensure that these elements do not end up falling from the building. This will however require the involvement of the heritage consultant to document and log all elements before removal, which will then need to be stored somewhere safe and secure on site for replacement in the permanent scheme if required.

6.11 The structural condition of the Boiler House roof could not be properly appraised during this survey owing to access constraints and poor lighting; however, we know that there are roof leaks and the beam grillage exhibits corrosion. The extent of structurally relevant corrosion is unknown and should be investigated further. Removal of the pigeons and associated guano will need to be undertaken first however, and the open fenestrations will need to be covered with a suitable mesh to prevent pigeons from re-entering the building.

6.12 The lack of tying and restraint between the walls at the south-west corner appears to have a relatively longstanding history and does not present cause for immediate concern, however we recommend it be temporarily clamped around the corner as part of a scaffolding package, whilst more permanent tying works are designed and approved (again possibly using stainless steel embedded stitching bars).

Office Block

6.13 The masonry walls of the Office Block exhibit structural movement, are leaning, and are of compromised stability. The referred implications are manifested in distress of the arches which form the openings in the walls. The root cause of the movement is at the moment unclear however we suspect that it may be due to deflection of the roof structure off which that portion of the Office Block is built. It may be compounded by thrust from its failing roof (e.g. rotten tie beam bearing) but the cause should be investigated. We recommend further investigation, and installation of temporary structural restraints and a temporary roof covering all as part of a scaffolding package.

7.0 Recommendations

We make the following recommendations, purely on the basis of structural works required to 'make safe' the building structure during the stadium works, as per the brief.

Any serviceability or general fabric 'betterment' measures are assumed will be incorporated into the detailed redevelopment proposals in the future, albeit some items fall very much on the boundary between essential and betterment, and as such these are highlighted below for further consideration.

Some specific further investigations are also recommended, due to the limited building access that has been possible thus far, to ensure that the full structure of the building has been inspected.

We recommend the Priority 1 items be undertaken urgently, as part of an initial Phase 1 'emergency' package. These are generally the non-intrusive items, and the further investigations, and may not therefore require Listed Building Consent, subject to agreement with the LCC Conservation Officer.

Priority 2 items are then recommended to be undertaken in a secondary Phase 2 package. These are generally the more intrusive works which may require Listed Building Consent, subject to agreement with the LCC Conservation Officer. They are also at this stage not an exhaustive list, as the further investigations recommended in Phase 1 may inform other structural items internally which will need to be included in Phase 2.

All works need to be in place prior to commencement of potentially disruptive permanent Stadium works commencing.

All Temporary Works items (scaffolding, propping, collar tying etc.) are to be developed with the Contractor in due course, and are 'Contractor Design' elements. Curtins would however provide a performance specification for these.

Refer to the remedial recommendations table below for prioritisation described above.

Remedial Recommendations: Priority 1 'RED' Urgent/Emergency Actions

7.1 Immediate provision of a secure 3m 'exclusion zone' around the base of the entire structure, to keep people from straying too close to the building, should any debris fall from height down to ground. This is likely to take the form of a secured Herras fence with suitable signage.

7.2 Securing of the Electrical Switch Room external door. This is also a significant health and safety issue due to the unrestricted access to a live electrical room and requires immediate securing.

7.3 Provision of both vibration and movement monitoring equipment, mounted sympathetically to the building, to continuously review any adverse effects on the building throughout the main project works.

7.4 Provision of temporary works external scaffolding to the single-storey Boiler House on the south elevation. This is to provide safe access to the south elevation along the dock edge, but also to provide a base for subsequent scaffolding to the Office Block on the Boiler House roof.

7.5 Provision of temporary works external scaffolding to the single-storey Boiler House on the west elevation. This is to provide safe access and minimum 1m high edge protection to the Boiler House roof, but also to provide a base for subsequent scaffolding to the Office Block on the Boiler House roof, and to provide temporary clamping of the south west corner wall junction of the Boiler House. This scaffold may therefore require ballast to its base.

7.6 Provision of temporary works external scaffolding to the single-storey Boiler House on the north elevation. This is to provide safe access and minimum 1m high edge protection to the Boiler House roof for further survey, investigative and repair works.

7.7 Provision of temporary works external scaffolding to brace out the Office Block walls on all 4 sides, and temporarily 'collar tie' the structure. This scaffold should also have a temporary roof covering over the top of the Office Block to mitigate further water ingress causing ongoing deterioration of the roof structure and the potential for its complete collapse.

7.8 Provision of temporary works external scaffolding to the Accumulator Tower and its SW extension on all sides. This is to 'collar' tie the upper walls of the Tower below the roof, but also to provide safe access to inspect the internal spaces of both the Tower and SW Extension, noting its dangerous roof. This scaffold should also have a temporary roof covering over the top of the Tower to mitigate further water ingress causing ongoing deterioration of the roof structure and the potential for its complete collapse.

7.9 Provision of suitable mesh to all open ground floor fenestrations to prevent further pigeon ingress.

7.10 Cleaning out of the Boiler House at ground floor of all Pigeons and extensive guano coverage, and provision of suitable temporary lighting, to allow proper access to safely undertake further investigations/works as required.

7.11 Treatment of vegetation growth generally throughout where it is possible safely. Removal of rootlets is not recommended at this stage, as these are potentially intrinsically tied into the structure and may cause further harm, instead simply cutting back as far as possible.

7.12 Careful removal of all immediately loose and precarious items generally throughout where it is possible safely, to prevent them from potentially falling uncontrolled during the stadium works. This will most likely require Heritage Consultant site attendance to document and log all such items, which will then need to be stored securely on site for re-use in the permanent works as required.

7.13 Further investigation of the Boiler House roof structure to properly ascertain its condition and whether any works are required to stabilise it. Also, to prove support to Office Block overhead, and in general further investigation of the root cause of the Office Block movement is recommended. This will include crack width and wall verticality monitoring.

7.14 Further investigation of the Tower and SW Extension to properly ascertain their condition and whether any works are required to stabilise them internally. This may involve the use of remote scanning or drone equipment initially, to inform potential for safe physical access. This may also in due course (most likely Priority Phase 2) involve deconstruction of the brick infill to the ground floor door accesses into these parts of the building.

Remedial Recommendations: Priority 2 'AMBER' Actions

7.15 Deep-pack-pointing / deep-tamping of heavily weathered mortar joints to structural elements such as arches, piers, corbels etc. where the loosening of the masonry units has direct short-term structural implications. The extent of this is to be agreed in due course.

7.16 Securing of loosened masonry units typically at high level wall heads e.g. skew verge of Tower SW Extension. Securing and deep-pack pointing of the mass coping stones to the head of the Main Tower is also recommended. Again the extent of this is to be agreed in due course.

7.17 Installation of designed remedial works to the vertical thermal crack on the Tower Chimney.

7.18 Installation of designed remedial works to reintroduce robust tying at the junction of the external walls to the south west corner of the Boiler House.

7.19 Potential further internal works to the Boiler House, Office Block, Tower and SW Extension subject to the outcome of 7.12 and 7.13 during Priority/Phase 1.

7.20 Consideration of potential deconstruction of the brick infill to the ground floor door accesses into these parts of the building, subject to the outcome of 7.13 during Priority/Phase 1.

7.21 Consideration of careful removal of remaining vegetation rootlets where possible, or treatment with a suitable approved herbicide where not possible to kill off all rootlet growth, allowing repair of defective roof covering or provision of temporary roof covering to mitigate rainwater ingress into the Boiler House solid roof, noted to be leaking.

7.22 Consideration of removal of pigeons and extensive build-up of pigeon guano from the Tower and its SW Extension, and provision of suitable mesh to all remaining high-level fenestrations to prevent further pigeon ingress.

8.0 Appendices

Appendix A

Survey Record Drawings

Appendix B

Historic Record Drawing

Appendix C

Historic England Listing Entry

Appendix D

Matterport Survey QR Code and Web Link

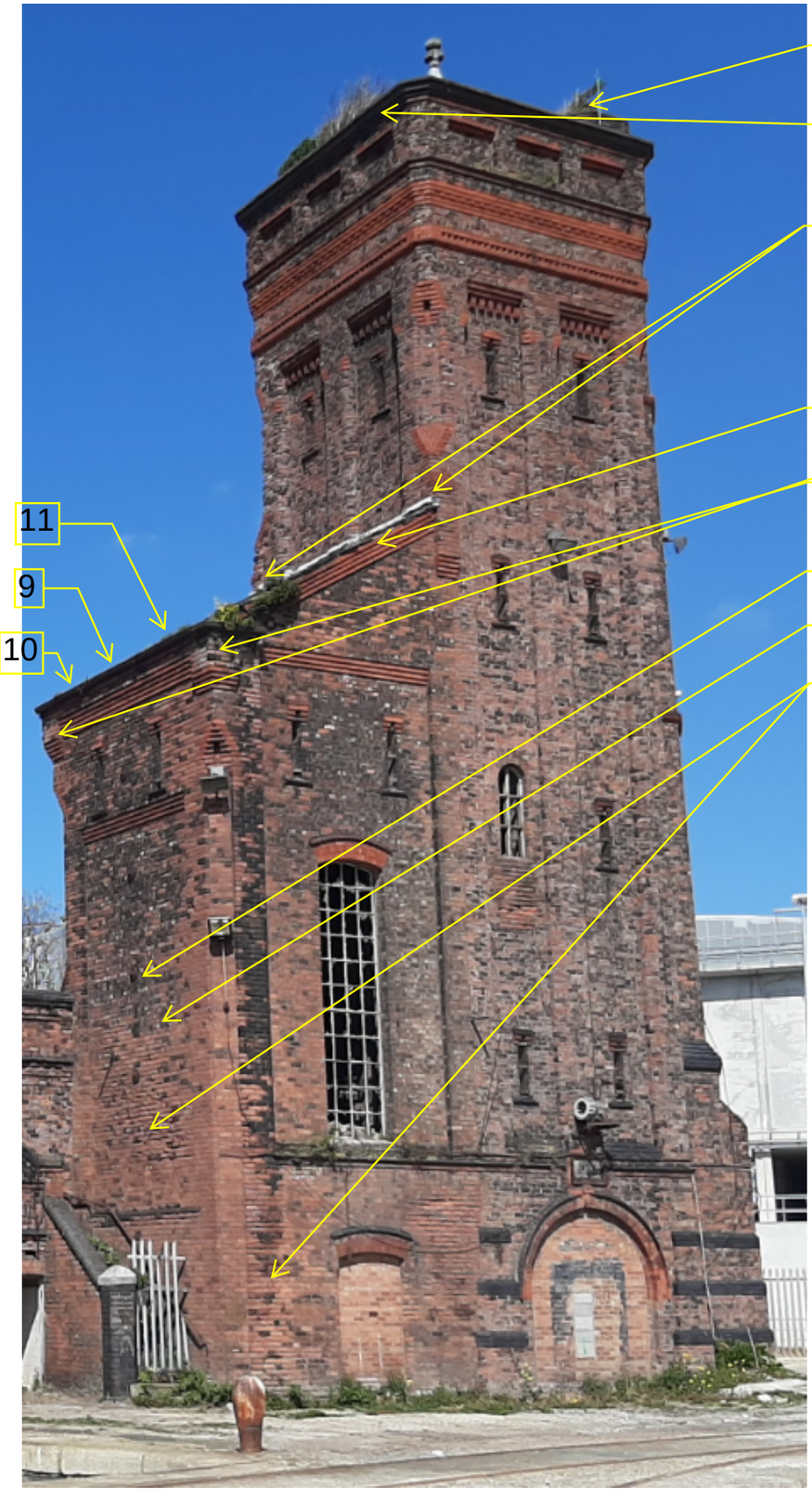
Appendix E

Significant Residual Hazards Identified

Appendix A: Survey Record Drawings

LIST OF SURVEY RECORD DRAWINGS

- 075808-CUR-OO-XX-DR-S-100 – TOWER 1 OF 4
- 075808-CUR-OO-XX-DR-S-101 – TOWER 2 OF 4
- 075808-CUR-OO-XX-DR-S-102 – TOWER 3 OF 4
- 075808-CUR-OO-XX-DR-S-103 – TOWER 4 OF 4
- 075808-CUR-OO-XX-DR-S-104 – BOILER HOUSE 1 OF 4
- 075808-CUR-OO-XX-DR-S-105 – BOILER HOUSE 2 OF 4
- 075808-CUR-OO-XX-DR-S-106 – BOILER HOUSE 3 OF 4
- 075808-CUR-OO-XX-DR-S-107 – BOILER HOUSE 4 OF 4



BRAMLEY-MOORE HYDRAULIC ACCUMULATION TOWER		
FACE	DEFECT #	DEFECT DESCRIPTION
SW	(GEN NB)	Weathering generally exacerbates with height
	1	Pattress plate anchors evident, possibly for internal machinery or restraint to wall. No local cracking / crushing / displaced masonry observed however they appear to be corroding (rust visual)
	2	Quite pronounced decay of masonry units and very weathered mortar joints in this area
	3	Corbelled pier corners appear to employ a different type of brick, appear to be of durable quality, however moss and vegetation indicate wall-head penetration
	4	Some sporadic embedded ironwork / fixing features, corroding
	5	Roof leading deteriorated, slates dislodged and missing especially along verges (5b). Roof in poor / failing condition, water ingress evident.
	6	Pier corners weathered, extensive recessing of mortar joints leading to locally displaced / missing masonry units.
	7	Vegetation appears to be getting worse at height. Roof structure expected to have deteriorated since the April 2016 inspection.
	8	*Coping stones at tower wallhead appear to have been displaced slightly since the April 2016 inspection. Suspected ratchet mechanism whereby vegetative growth is widening the perpends and debris accumulates in crack.*
	9	*Timber wallplate sighted with powerful binoculars and appraised to be rotten. The gutter appears to be displaced outwards. Wallhead water penetration evident.*
	10	*Vegetation appears to be getting worse at wallhead with rotten wallplate and displaced gutter.*
	11	*Condition of pitched slate clad roof appears to be similar compared with April 2016 on main pitch, although slightly deteriorated around the verges and at the lower bearing onto the masonry wallhead.*

curtins

Bramley Moore Dock
Hydraulic Accumulation Tower
Visual Condition Appraisal - Update
Drawing: 75808-CUR-00-XX-DR-S-100
Date Prepared: 15/05/2020