Dunning Thornton consultants

Structural Engineers

# Masterton Town Hall
# Structural Options Report


**Job number: 8934**

**Report prepared by: JW**

**Report reviewed by: AGC**

# Masterton Town Hall
# Structural Options Report

## Contents



Report Rev A 13/11/2024 - AGC – Resource Consent

This report has been prepared for Masterton District Council to communicate the feasibility of structural options for the Masterton Town Hall structure, to be submitted for Resource Consent. It shall not be used by others or for alternate purposes without the approval of Dunning Thornton Consultants Ltd.

# 1 Executive Summary

This report has been carried out for Masterton District Council with the intention of communicating structural options for the Masterton Town Hall and adjoining Municipal Building.

The most important aspect of strengthening a heritage building is to consider all of the options and their corresponding benefits and risks. This report discusses the feasibility of options for full seismic strengthening, partial retention, façade retention, decommissioning, and demolition with a new build.

The structural complexity, programme and cost risk of the options considered have been summarised in the table below. This is only intended as a relative comparison and not an evaluation of any single option.

| Metric | Demolish and Build New | Façade Retention | Municipal Building Retention | Decommission | Strengthen *>80%NBS* | Strengthen *>34%NBS* |
|---|---|---|---|---|---|---|
| | Option 1 | Option 2a | Option 2b | Option 3 | Option 4a | Option 4b |
| **Structural Design Complexity** | Low | Medium | High | Low | High | Medium |
| **Programme Risk** | Medium | Medium | High | Low | High | High |
| **Structural Cost Risk** | Low | Medium | High | Low | Very High | High |
| **Combined Risk** | Low-Medium | Medium | High | Low | High | Medium-High |
| | | | | | | |
| **Structural Performance** | Good | Good | Average-Good | Poor | Average | Poor |

# 2 Building Summary

## 2.1 General

The Town Hall and Municipal building, located at 64 Chapel Street, Masterton, were both originally constructed from unreinforced masonry (URM) in 1915, with modifications and additions to the structure since. The structures are briefly summarised below, refer to the structural report by LGE Consulting, dated 27/9/2016, for further details.


*Figure 2.1 – Site Location Plan*

The Town Hall was originally constructed as a 6m high single storey unreinforced masonry building with timber trusses with minimal internal walls. There is a connected two-storey portion at the front housing the entrance and the cloak room which is part of the Municipal Building.

The adjacent Municipal building was originally constructed as a separate two storey unreinforced masonry building with a timber and steel joist floor structure. There are some internal unreinforced masonry walls.

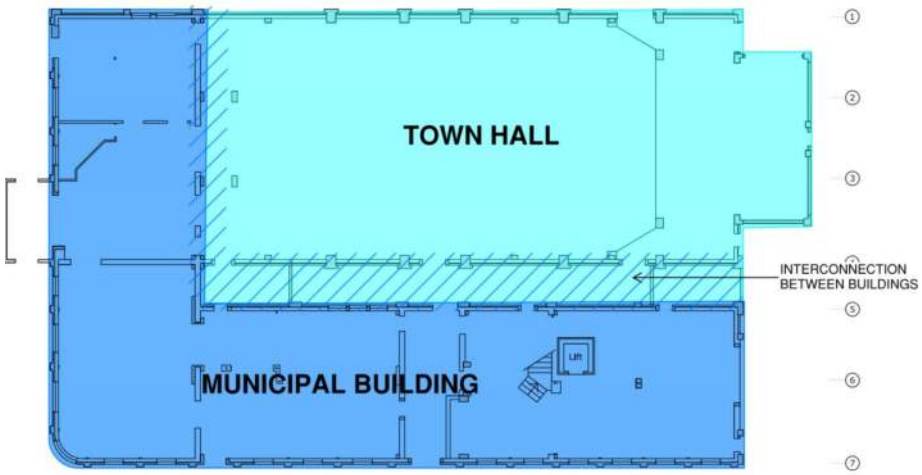


*Figure 2.2 - Relationship of Town Hall and Municipal Building*

After damage in the 1942 Wairarapa earthquakes there was significant work completed to both the Town Hall and Municipal Building in 1954;

- The ornamental unreinforced masonry parapets of the Town Hall were removed and the roof was raised by approximately 5m, with new lightly reinforced concrete frames and parapets.
- A lightly reinforced concrete extension and elevated projector room was added to the rear of the Town Hall.
- The unreinforced masonry façades on the street frontages of the Municipal Building were overlaid with a reinforced concrete ‘skin’ with a steel mullions on the internal face fixed through with steel rods.
- The two buildings were lightly connected together with a roof extension and timber floor at level 1. A length of the side wall of the Municipal building was removed as part of this.
- It is noted that some construction issues (e.g. bony concrete, exposed reinforcement) were identified in the concrete works completed at this time.

Subsequent alterations have removed internal unreinforced masonry walls in both the entrance to the Town Hall and in the Municipal building.

The Civil Defence Building constructed in 1984 also adjoins the Municipal Building but is not considered further in this report, as it is not considered to have heritage significance (refer Heritage Significance Assessment, WSP, August 2024).

## 2.2 Site Conditions

A geotechnical seismic assessment has been undertaken by Tonkin & Taylor, refer report dated 29/3/2017 for further information. The report identified a risk of localised pockets of

liquefaction. This carries increased risk for building retention options, as it has shallow foundations that may be vulnerable to ground settlement.

## 2.3 Current Status of the Buildings

The following seismic ratings are summarised from the Structural Report prepared by LGE Consulting, dated 27/9/2016, which had a high-level peer review completed by Dunning Thornton (letter dated 6/1/2017).

- Masterton Town Hall: 10 to 20%*NBS*(IL3)
- Municipal Building: 20 to 30%*NBS*(IL2)

The assessment also identified some areas of floor potentially vulnerable to a loss of gravity support.

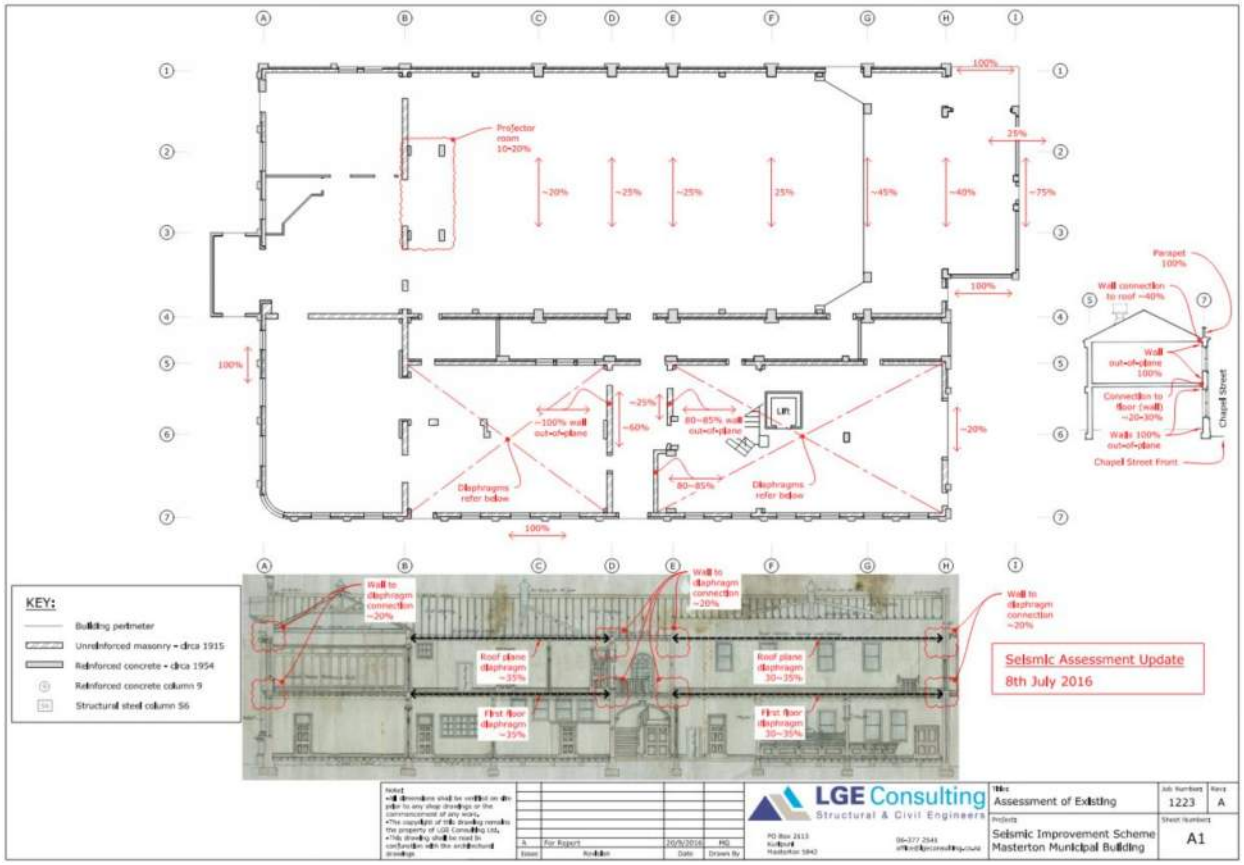


*Figure 2.3 - Excerpt from Appendix A of Structural Report by LGE Consulting, 27/9/2016*

We note that the assessment was completed prior to the publication of the MBIE Technical Guidelines for Assessment of Existing Buildings, July 2017. A full comparison has not been completed, but we note the following;

- There is some interconnection between the structures, which could require both buildings to be given the lowest rating of all the structures (clause A4.3.3). This may also require both buildings to be considered Importance Level 3.
- The assessment of the loss of floor seating may be more onerous, as this is required to be reviewed against twice the expected building displacement.

## 2.4 Earthquake Prone Building Act Time Frames

The building received an Earthquake Prone Building (EPB) notice, dated 26/08/2018, and was deemed a Priority Building, which has a shortened time frame to carry out seismic work. The EPB notice states that owner is required to complete seismic work by 26/02/2026. We note that this deadline is expected to be extended by four (4) years if the Building (Earthquake-prone Building Deadlines and Other Matters) Amendment Bill is passed by Parliament.

# 3 Structural Options

A number of structural options have been considered for the buildings, including full and partial retention. The structural aspects of each of these options are outlined and discussed below. Refer also to supporting documentation including LGE Consulting's Structural Report (section 6) dated 27/09/2027, Dunning Thornton Outline Peer Review and Options Evaluation letter dated 6/01/2017, and LGE Consulting's demolition feasibility sketches (SK01 to SK09) dated 23/11/2023.

## 3.1 Retention and Seismic Strengthening for Active Use

### *3.1.1 General Considerations*

When strengthening buildings, the compatibility between various new and existing elements is important, as the stiff existing elements contribute to the building's resistance. The seismic assessment and strengthening framework for existing buildings focuses on life-safety. As such, 'typical' strengthening philosophies do not necessarily protect the heritage fabric of the building.

There are geotechnical risks (pockets of liquefaction) that have been identified on the site, and the existing building is vulnerable to ground settlement as it is shallowly founded. There are likely to be higher structural costs due to this risk and this increases with a higher target *%NBS* of structural improvement. This would impact full retention more than new build or façade retention options (which can be designed to better suit the ground conditions).

Structural works on existing buildings carries construction risk as there are many unknowns. Discrepancies between available documentation and the existing building are often discovered once construction starts, which can lead to additional strengthening scope, resulting in cost and programme overruns. As the Masterton Town Hall and Municipal buildings have both had many alterations over their lifetime, this would be considered a high risk to the project.

This risk can be mitigated through extensive investigation prior to the design being completed, which requires longer design phases and the engagement of a contractor prior to the design process. Alternatively, appropriately high cost and programme contingency can be allowed for in the cost-benefit review.

For the purposes of the options outlined below retaining the current uses, it is assumed that both buildings are considered Importance Level 3 due to the occupancy of the Town Hall and the interconnection of the structures. This could be investigated further in the design process but is not considered significant in the scope of strengthening required.

### *3.1.2 Strengthening to Greater than 80%NBS(IL3)*

In our experience, 70-80*%NBS*(IL3) is a reasonable target for the strengthening of a building of this era. Targeting higher seismic rating can significantly increase structural intervention with proportionately little corresponding increase in performance.

We note that if a ‘change-of-use’ of the buildings was considered, this may be required to achieve as near as reasonably practicable to 100*%NBS*, increasing the structural forces by ~30% therefore requiring normally disproportionately greater than 30% more structural intervention.

The LGE scheme that has been costed for this options comparison consists of rebuilding the concrete frames around the Town Hall while retaining the unreinforced masonry, and building new steel portal frames (with new foundations). New roof and floor diaphragms would be required, which, in our experience, typically require extensive retrofit to ‘sub-diaphragm’ elements (connections between the façade and the floor or roof). This option would retain the current “look” (but not fabric) of the Town Hall. Significant temporary works would be required for this option as existing bracing elements are demolished and rebuilt in-situ.

Alternative strengthening options are outlined briefly below.

Town Hall

- Traditional hall / theatre strengthening would include adding new structural elements to provide the seismic capacity required, including new sprayed concrete walls to the auditorium and extensive cross-bracing through the roof. This would create a ‘braced box’ rather than portalised behaviour which may have some minor cost advantages to the hall itself, but would make compatibility with the Municipal Building more complex (and by implication, negating these possible savings).
- Targeted strengthening of existing elements to retain as much heritage fabric as possible, for example, post-tensioning the existing roof beams and adding energy dissipation devices (dampers) to absorb seismic energy. This option has significant careful intervention for each element, which can be complex with high structural costs.
- All the options outlined above could also include selective demolition of smaller elements that have lesser heritage significance, e.g. projector box, to reduce strengthening scope.

Municipal Building

- Minor modification could be made to the LGE scheme to reduce material cost, but the overall scope of work would be the same. This includes adding a central column line to the frames to make them stiffer.
- Adding internal walls or braced frames at regular intervals in the length of the building would be a more efficient structural solution. This may compromise the open-plan use of the space and may impact future adaptability. May require deep foundations due to locally high loads. This may get closer to 100*%NBS* and suit a change of use proposal (e.g. hotel). This would likely be the most structurally efficient option and would revert the interior to more of its cellular original form. If done well, this could reflect the original layout somewhat: positive in a heritage sense but likely limiting from a planning/usability sense. If not carefully placed, it could create both a poor heritage and usability outcome even though on the face of it may appear more economic.

#### *3.1.3 Greater than 34%NBS(IL3)*

There are options to strengthen the buildings to less than 80*%NBS*(IL3), to meet the minimum statutory requirements under the Earthquake Prone Building Act (i.e. greater than 34*%NBS*(IL3)). This would consist of similar interventions as the options outlined above but with smaller member sizes (noting that reduction in strength does not translate directly to reduction in cost). This is especially so in buildings with masonry and timber floors as much of

the work is “knitting” the building together”. In our experience, there can be commercial disadvantages to lower seismic ratings.

## 3.2 Partial Demolition (including Façade Retention)

Two options with different levels of retention of the existing Municipal Building have been considered. Options to retain the façade of the Town Hall have not been considered directly, as retaining the Town Hall façade is the majority of the work in a full strengthening scheme, including temporary works.

Partial retention carries similar construction risks as strengthening, with likely unknowns in the existing building, but these can be mitigated by placing the majority of the bracing elements in the new building.

Existing interior heritage elements of the Town Hall (that do not form the primary structure) could also be retained, such as the ground floor, stage and tiered seating but these would require protection or temporary removal/reinstatement during construction.

### *3.2.1 Municipal Building Façade Retention*

Two-sided façade retention can be structurally complex due to the weight of the façade being offset from the new building, typically requiring additional structural capacity and stiffer elements to a complete new build.

The existing façade has had significant alterations over its life, with a new concrete ‘skin’ and retrofit steel elements added in the 1950’s. This carries risk as the structural integrity of the original elements are less known. They have previously been modified and construction issues associated with this period were noted in LGE Consulting’s Structural Report. New sub-diaphragm structure would be required to the perimeter fixing through the existing brick into the 1950’s concrete ‘skin’.

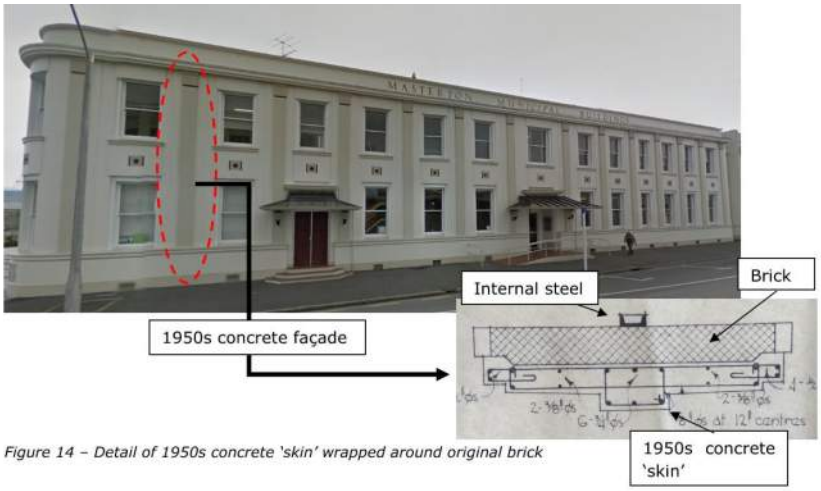


*Figure 3.1 - Facade Works Completed in 1950's (excerpt from LGE Consulting Structural Report)*

Due to this, the design needs to consider the compatibility of new and existing structures. This could be addressed in two ways;

- By demonstrating that the existing façade can brace its own weight, and providing a compatible (stiff) bracing structure to brace the new portion of the building. This keeps the heritage fabric (and weathertightness) of the existing façade, but requires complex analysis to “tune” the structure and show that the two systems can work together. This carries higher risk due to the more complex design and some construction risk as the existing elements are required structurally.

- By considering the existing façade as a “decorative panel element” and providing new structure to brace both the new portion of the building and the façade weight. This option would require “destiffening” of the façade but would have a simpler (and lower risk) structural solution, with an offset bracing layout toward the façade to account for the heavy façade mass. Destiffening of the façade could be achieved through vertical saw-cuts to add movement joints which are then filled with sealant similar to an expressed precast concrete panel joint, as shown on elevation in Figure 3.4.

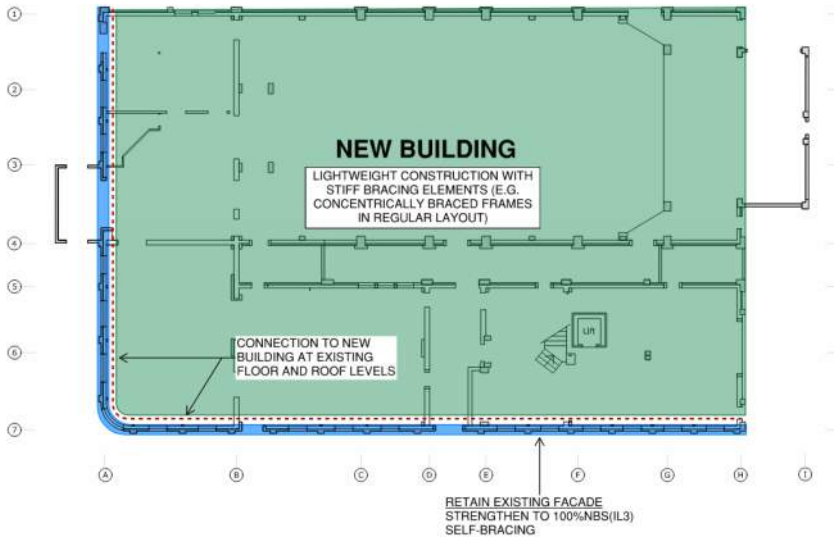


*Figure 3.2 - Facade Retention Option – Structural Facade*

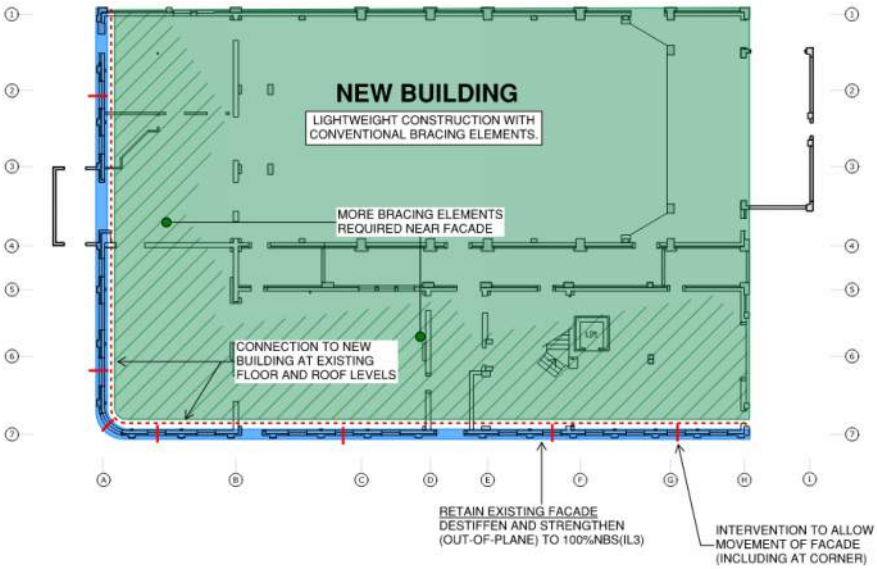


*Figure 3.3 - Facade Retention Option – Non-Structural Façade*


*Figure 3.4 - Possible Intervention to Destiffen Façade*

For both options, the façade would need to be connected to the new building at existing floor levels, which has been incorporated into the option by Silverwood Architects through an amenity corridor. We have noted this would be lightweight construction, i.e. lighter than the existing façade but this would include steel frame, concrete-composite flooring, and other similar modern construction methods.

We would expect the existing façade to be required to achieve 100%*NBS*(IL3) as the majority of the structure is effectively new. In our experience it is not justifiable to achieve less than this as the façade is directly adjacent to the area where people may congregate. Small localised elements that are not considered "significant life safety hazards" may be acceptable at lower seismic ratings on a case-by-case basis. The assessment (LGE Consulting, 2016) indicates that the façade achieves at least 100%*NBS*(IL2) which is ~30% less than 100%*NBS*(IL3) so some strengthening to in-plane and out-of-plane capacity may be required.

The façade will require temporary support during the construction of the new building. This would likely consist of a structural steel frame outside the footprint of the site. The temporary works could be placed inside the site, but this may increase the complexity of the construction logistics as the new building is constructed.

*Figure 3.5 - Example of Facade Retention Temporary Works (Wellington District Court)*

### *3.2.2 Municipal Building Retention and Demolish Town Hall*

This option would reduce intervention inside the Municipal Building as the new Town Hall structure could be designed to brace both buildings, while remaining compatible with the façade. Unlike the façade retention option, the façade would likely need to remain as a structural element so 'structural tuning' would be required. Complex analysis of how the new and existing structures interact, particularly due to the off-set weight of the façade at the perimeter. This is similar to the detailed retention and strengthening undertaken on the Old Public Trust building in Wellington, where the front and rear façades provide over two thirds of the bracing longitudinally. Similarly, to the façade retention options, this carries both design and construction risk.

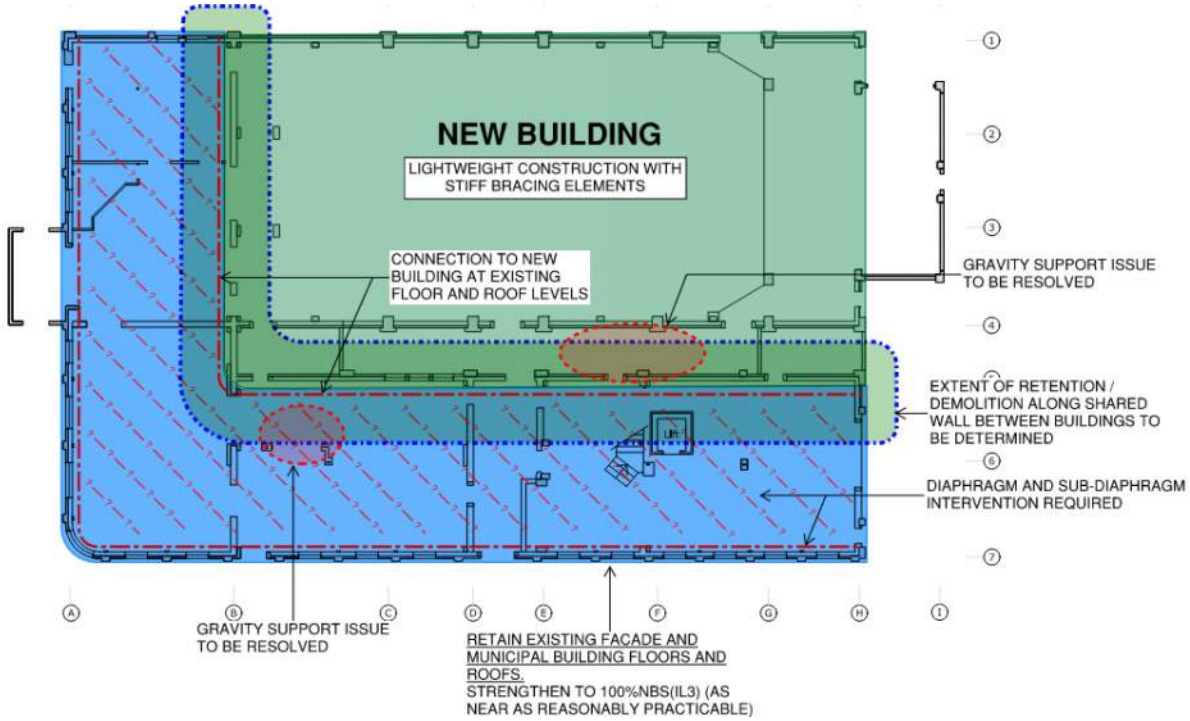


*Figure 3.6 - Municipal Building Retention*

*Figure 3.7 - Old Public Trust, Wellington, Photo: Paul McCredie*

The scope of re-used or replaced elements is a structural risk. Significant intervention is required for existing diaphragm and sub-diaphragm connections in the Municipal building will still be required, even if the primary bracing is in the new portion of the building. There are also areas with potential gravity support issues which would require intervention as part of the works. As noted by LGE Consulting, the extent of the demolition of the shared wall between the Town Hall and the Municipal Building needs to be resolved, which may impact the heritage fabric that can be feasibly retained. The most economical solution from a structural point of view would be for this to be replaced as part of the new construction.

Partial demolition of the buildings will require detailing staging and temporary works as the buildings are interconnected. LGE Consulting have prepared a demolition feasibility study (SK1 to SK9, 23/11/2023) showing the connectivity of the buildings and the extent of demolition of the Town Hall (while retaining the Municipal Building).

Temporary works would likely utilise the existing building where possible, but may require gravity support (props) for the floor and roof structures, as well as lateral support to the façade. Unlike, the façade retention option, we would expect the temporary works required to support the retained building to be inside the site footprint.

Existing elements incorporated into the new building may need to achieve as near as reasonably practicable to 100%*NBS*(IL3), but there could be justification for achieving a lower rating (100%*NBS*(IL2)) as the retention is not directly adjacent to the area where people may congregate. Alternatively if the new use does not require IL3 (<300 people in one space), then the whole building would be considered IL2.

## 3.3 Decommissioning

Even if the building is not accessible to the public, the statutory obligations under Earthquake Prone Building Act would still require strengthening to greater than 34%*NBS*. The Importance Level of the target strengthening would need to be agreed with the Territorial Authority, but we would expect this could be justified as Importance Level 2 (30% less force than IL3).

If the building is unoccupied, primary bracing could use the void space, e.g. large cross-bracing across the Town Hall and floor-to-floor in the Municipal Building. This would require diaphragm strengthening, as well as specific strengthening or demolition of elements with low ratings, e.g. projector room.

Strengthening elements would need to meet the durability requirements of the NZBC, so ongoing maintenance of these elements would be needed, in conjunction with weathertightness, etc.

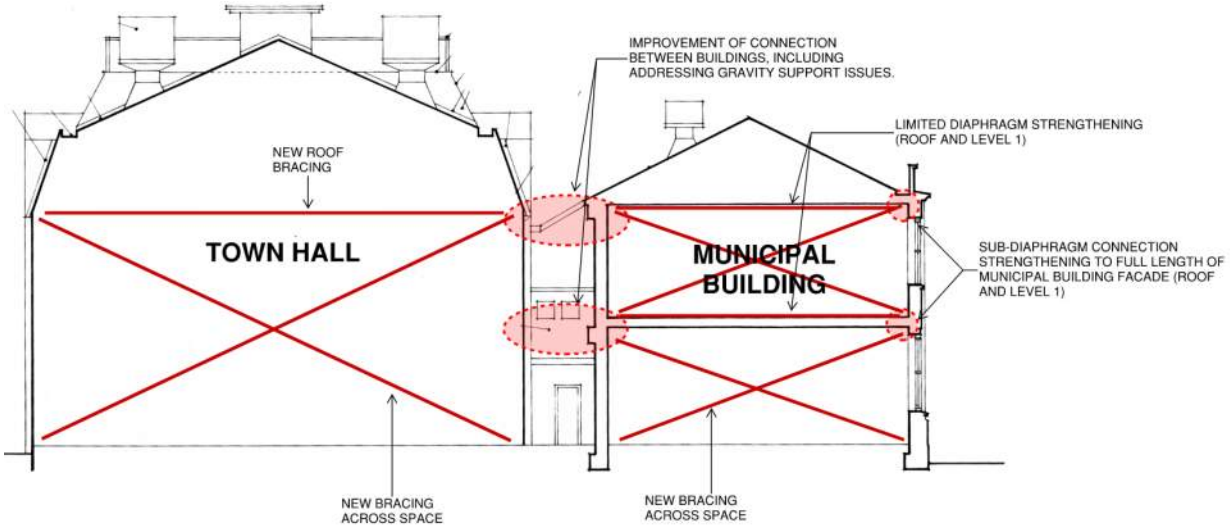


*Figure 3.8 - Possible Bracing Configuration for Decommissioning*

Other options such as isolation of the building, e.g. public separation with hoardings, could be considered for the Town Hall but is unlikely to be feasible for the Municipal Building due to the proximity to State Highway 2. We note that “container walkway” gantry options along the main road can tend to create anti-social spaces which may need to be addressed.

## 3.4 Demolition and New Build

Total demolition and the construction of a new building (without façade retention) is an option for the site. A new building is simpler structurally, with lower design and construction risk.

### 3.5 Comparison of Options

The following table compares the structural complexity, programme and risk of the options considered. This is only intended as a relative comparison and not an evaluation of any single option.

Note this does not include any consideration of heritage aspects, cost, etc. as these are covered in separate reports prepared by others.

| Metric | Demolish and Build New | Façade Retention | Municipal Building Retention | Decommission | Strengthen >80%*NBS* | Strengthen >34%*NBS* |
|---|---|---|---|---|---|---|
| | Option 1 | Option 2a | Option 2b | Option 3 | Option 4a | Option 4b |
| **Structural Design Complexity** | Low | Medium | High | Low | High | Medium |
| **Programme Risk** | Medium | Medium | High | Low | High | High |
| **Structural Cost Risk** | Low | Medium | High | Low | Very High | High |
| **Combined Risk** | Low-Medium | Medium | High | Low | High | Medium-High |
| | | | | | | |
| **Structural Performance** | Good | Good | Average-Good | Poor | Average | Poor |

# 4 Information Sources

### 4.1 Existing Documents

The following reference documents relating to the Masterton Town Hall and Municipal Buildings were used in undertaking this options study:

- Structural Report prepared by LGE Consulting, dated 27/9/2016
- Outline Peer Review and Options Evaluation letter prepared by Dunning Thornton dated 6/1/2017
- Geotechnical Seismic Assessment Report prepared by Tonkin & Taylor, dated 29/3/2017
- Demolition Feasibility Study (SK1 to SK9) prepared by LGE Consulting, 23/11/2023
- Heritage Significance Assessment prepared by WSP, 21/08/2024