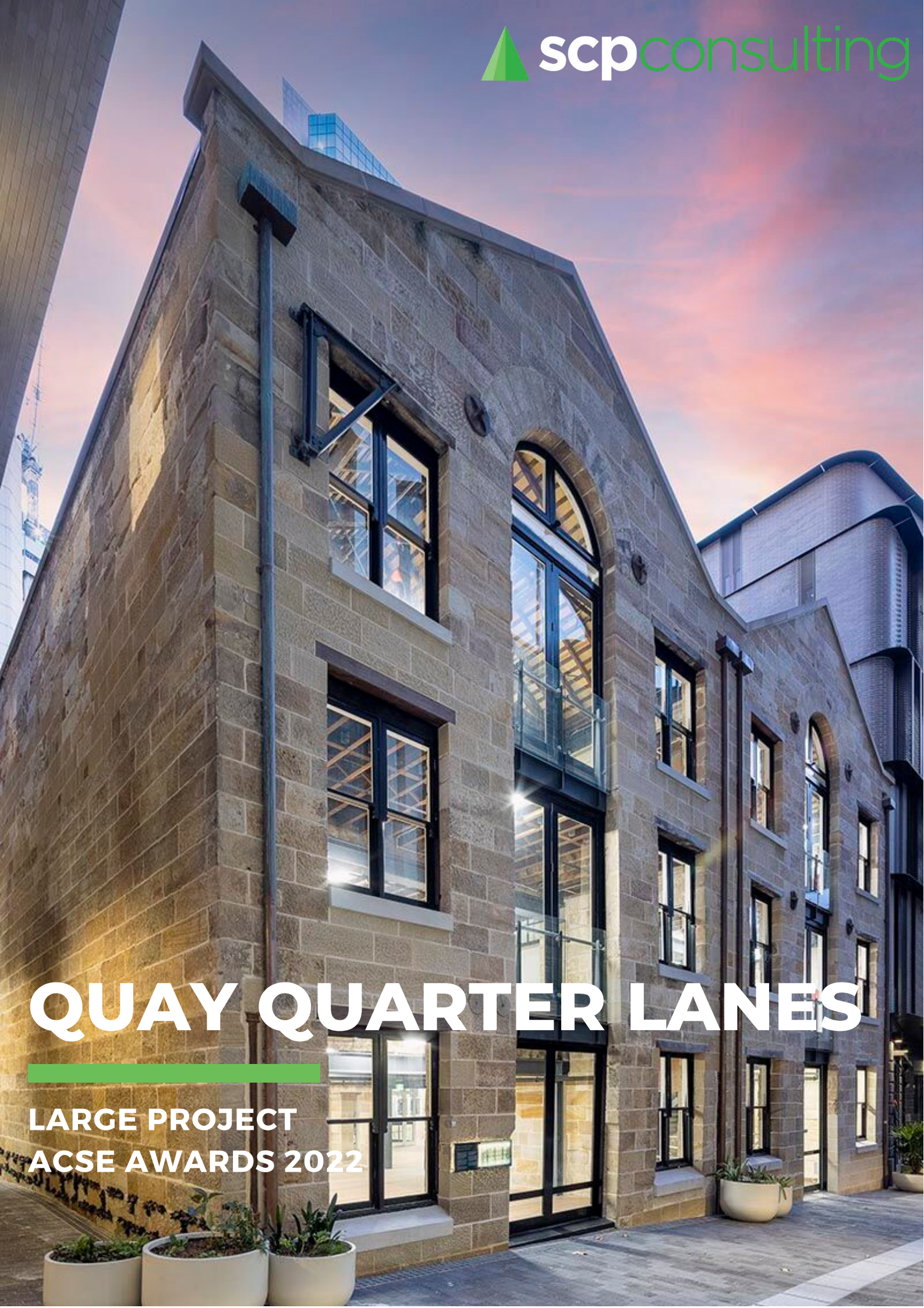

scpconsulting

QUAY QUARTER LANES

LARGE PROJECT
ACSE AWARDS 2022

Image: Loftus Lane

PROJECT SUMMARY

Client/Developer
AMP Capital Investors

Contractor
Richard Crookes Constructions

Architects:

- Studio Bright, Silvester Fuller, SJB Architects, Carter Williamson Architects, Lippman Partnership

Structural & Civil Engineers:
SCP Consulting

Construction Value: **$200 Million**
Completion Date: **April 2021**

INTRODUCTION

Quay Quarter Lanes (QQL) is a recently constructed, mixed-use development located in the heart of the Sydney CBD.

The project comprises three new buildings with basements, the refurbishment of the heritage listed Hinchcliff House (HH) and Gallipoli Memorial Club (GMC) and the creation of the Loftus Laneways Retail Precinct.

The buildings were built in close proximity to the existing 1850's heritage brick oviform stormwater tunnel known as the Bennelong Drain. The Bennelong Drain is a critical, functioning Sydney Water asset.

SCP Consulting provided structural and civil engineering design for the project working alongside Richard Crookes Constructions and a team of five leading Australian architects. The development was commissioned by AMP Capital Investors.

PROJECT BRIEF

Each building had its own unique architectural vision and design team, and each building required significant coordination, collaboration and specialised engineering design to meet the architectural intent.

The over-arching objective of the project was to preserve and enhance the heritage context of the precinct and to create a vibrant public realm of open laneways with dining, lifestyle and retail activation.

Existing site conditions and constraints presented a number of challenges for design and construction including:

- The structural integrity of the HH and GMC heritage buildings along the shared boundary needed to be carefully designed to and maintained during construction. Ensuring rock stability in proximity of the 5-storey deep basement excavation was of critical importance.
- The redevelopment of the HH and GMC buildings needed to conform to NCC adaptive reuse criteria which required an assessment of the existing structures and strengthening to achieve seismic compliance.
- The heritage listed Bennelong Drain crosses the site requiring careful protection during construction. The 160-year-old drain is a functional storm water asset and has strict build over limitations specified by Sydney Water.
- The presence of the GPO fault zone under the development precinct consisted of fractured rocks which reduced the rock strength for foundations and retention and increased water ingress into the excavation.
- New buildings were limited in height to avoid over-shadowing. This meant there was limited vertical clearance to accommodate deep structural transfer beams in floor slabs.
- The CBD rail link corridor passes beneath 18 Loftus Street which introduced onerous protection requirements for the provision of future rail lines.
- The new common podium for Building A, B and C slopes in two directions towards Sydney Harbour and straddles the Bennelong Drain creating complexity in stepping and folding the ground floor structure.
- The dilapidated existing basement and walls needed to be retained for heritage and cost reasons.

DESIGN & CONSTRUCTION PROCESS

BUILDING A

Building A is a 7 storey, concrete framed tower with post-tensioned (PT) floors and reinforced concrete (RC) columns and cores.

The super-structure is constructed over the new Gallipoli Memorial Club Museum, and to limit columns in the Museum and to maximise operational flexibility, a transfer floor plate (up to 2.18m thick) was adopted to support the super-structure over.

The transfer floor plate also enabled large floor plate projections to cantilever over the Bennelong Drain.

Image: Building B

BUILDING B

Building B is a 12 storey, concrete framed residential tower with PT floors and RC columns and cores. The building features a unique system of stepping shear walls for vertical load transfer which required bespoke jump forms during construction.

To maximise floor space in Building B, areas of the floor plate above Level 4 were designed to project over the GMC using long span, PT concrete floor elements.

This created some challenges in construction (as back-propping could not extend down to ground), and a solution of external scaffolding supported by cantilevered needles was implemented. The through link (inter-building lane way) also required unique support during construction using suspended slab scaffolding and reaction frames.

The soffits of all cantilevers in Building B were clad in brick masonry in keeping with the heritage theme of the development

BUILDING C

Building C is a 12 storey, concrete framed, PT floor building with RC columns and cores constructed over a podium transfer slab.

The Building C structure features stepped cores, triple-storey height arched windows and extensive masonry.

Building C is located immediately adjacent to the Bennelong Drain, and as the proposed basement excavation had potential to cause lateral movement and damage to the drain, SCP developed an innovative structural solution which involved encasing and drain with a deep shoring wall restrained by passive anchors.

The Building C structure features stepped cores, triple-storey height arched windows and extensive masonry.

Building C is located immediately adjacent to the Bennelong Drain, and as the proposed basement excavation had potential to cause lateral movement and damage to the drain, SCP developed an innovative structural solution which involved encasing and drain with a deep shoring wall restrained by passive anchors.

HINCHCLIFF HOUSE AND THE GOLLIPOLI MEMORIAL

Both the HH and GMC heritage buildings are constructed from unreinforced, masonry. They were originally built in 1865 and the 1880's (respectively). By inspection it was found the external leaf of the northern sandstone façade was not laterally restrained by the internal skin of masonry posing a risk of collapse due to construction vibration. To address this, remedial ties were installed and movement monitoring was carried out during construction.

The heritage buildings were particularly sensitive to vibration so vibration velocities (at various frequencies) were recorded and limited during the build to ensure compliance with AS2670.2. Construction noise that could adversely affect neighbouring properties was also limited to the criteria specified in the DA conditions and policed by way of visual and audible alarms.

Staged underpinning of the heritage buildings was undertaken to provide adequate support to the existing masonry walls during construction.

Image: Hinchcliff House

CREATIVITY & INNOVATION

The Bennelong Drain bisects the project site. With basements each side of the drain (10.35m deep on the north side and 15.95m deep on the south side), the protection strategy for the drain was one of the most critical aspects of design and construction on the project.

To minimise movement and to cater to potential rock faults, SCP designed a permanent retention system either side of the drain. The system comprised:

- Anchored soldiers pile walls with a loadbearing restraint lid to encapsulate the drain and preserve the current rock stress state. Shoring deflections were limited to achieve a Damage Category 0.
- 300 mm thick trafficable lid with void former under to ensure no vertical loads were transferred to the drain crown.
- Passive anchors were installed below the 2000mm exclusion zone below the drain soffit. This solution allowed for faults and fractures in the rock around the drain to be addressed with without the need for rock bolts.
- Building piles were positioned outside the 1000mm exclusion zone and sleeved to 400mm below the drain invert level to ensure all vertical loads and skin friction acted below the drain soffit (outside the zone of influence).

Image: Building B

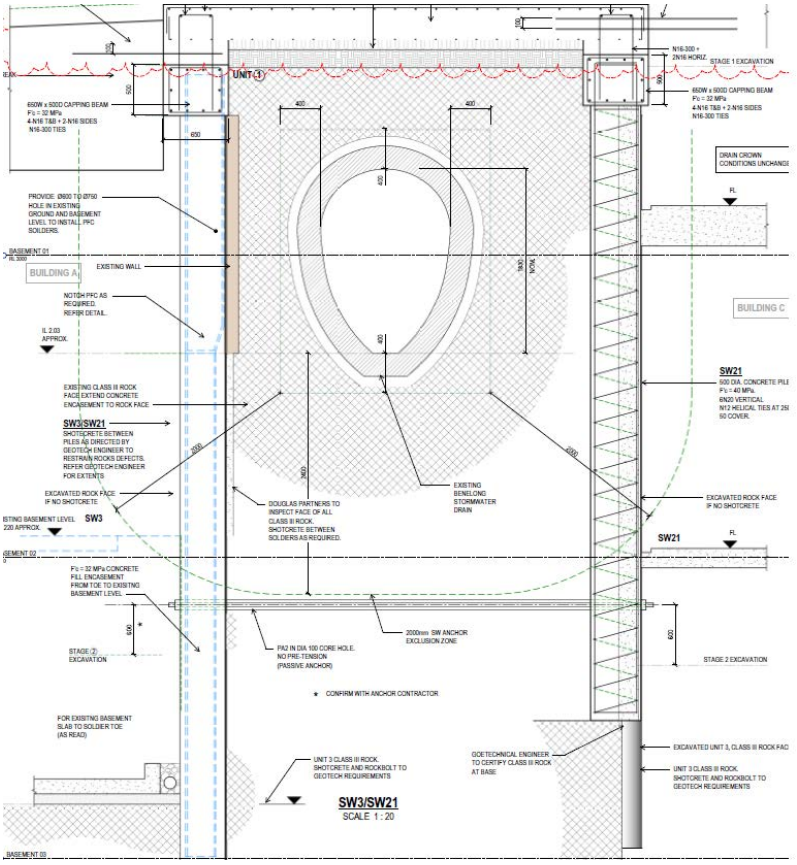

Image: SCP Bennelong Drain Confinement Structure

SUSTAINABILITY

In redeveloping the HH and GMC buildings, a number of sustainability initiatives were adopted including:

- A large amount of timber flooring was retained and recycled to reduce the requirement for new timber and to preserve historical significance. E.g., the GMC basement timber flooring was reused after adding a concrete subfloor acting as a termite barrier.
- All existing basement walls were retained through strengthening to eliminate the need for new shoring works.
- Rather than construct new basements, existing basements were extended within the existing footprint.

In Building B, the requirement for deep floor transfer beams (more concrete, PT and reinforcing steel) was eliminated by adopting the stepping wall load transfer system.

BUILT ENVIRONMENT HERITAGE

The HH and GMC buildings are both three-storey heritage structures constructed with masonry walls and timber floors, bearers and columns.

Dating back 162 years, the existing timber joists and bearers were severely decayed and damaged by termites in numerous locations requiring replacement.

The existing masonry is an inherently brittle material (with little tensile strength) and hence the existing stability system required major seismic upgrades to comply with AS3826– Strengthening existing buildings for earthquake. Prescribed strengthening and remedial works included:

- A new steel framed lift core and shear walls were added to HH replacing the existing lift core.
- Permanent ground anchors were installed to resist earthquake uplift. Piling was not appropriate for the constrained site conditions.
- New steel beam and column strengthening to the existing timber bearers in the GMC to support gravity loads and tie the external walls to the floor diaphragm and new lift shaft.

Image: Existing Hinchcliff house timber floor prior to upgrade

Image: Temporary steelwork supporting south portion over new basement excavation

- New basement extensions for HH and GMC were installed within the existing building footprint over a complex staged excavation with temporary propping and permanent columns.
- All floors including the roof were upgraded to AS3798 to comply with diaphragm construction requirements and the roof structure was re-supported with steel beams and steel columns (for tie down).
- The heritage sandstone walls along the southern and eastern extents of HH and GMC were heavily weathered and cracked confirming that the walls loading bearing/in-plane shear capacity had been compromised. These sandstone walls were refurbished in accordance with SCP heritage brickwork specifications and special material mixes and techniques were defined for heritage mortar use.

In aboriginal culture, the QQL site is a historically sacred place and respect was paid to the aboriginal people with a new public artwork exhibit which focused on traditional food sources of the indigenous people. Shells obtained from the original building mortar were used in the exhibit.

Image: Gallapoli Memorial Club South Wall Artwork

CHALLENGES & RESOLUTIONS

Unconventional Vertical Load Transfer System

Building B features an unconventional structural system for vertical load transfer which was dictated by the stepping nature of the building profile. A conventional slab transfer structure was not possible as deep beams would have reduced the floor-to-floor height which was restricted to 3.1m for planning reasons.

The vertical load transfer systems comprised the following:

- Various thin slab, PT column transfers at Level 10 and Level 11.
- RC stepping walls from Level 8 to Level 10 to transition eccentric column loads over to the exterior column line under. Resulting thrust forces were catered to at floor level by way of tension ties cast into the PT slab.
- A double-storey, 400 thick, RC cantilever transfer wall (with window perforations) to support a tower column over the open laneway.
- A hanging column to create a column free space at the corner of Loftus Laneway.

Ground Movement and Impact Assessment on Existing Structures

To satisfy heritage protection performance criterion, and to ensure that the impact of the construction to the surrounding buildings was minimised, SCP conducted an investigation into the anticipated effects of the proposed site retention and excavation. Particular attention was paid to likely rock movement resulting from the bulk excavation for buildings A, B and C which could cause damage to the existing buildings and the Bennelong Drain.

Image: Building A

Following a sophisticated analysis of the lateral movements in relation to building geometries / setbacks and material properties, the following results were obtained:

- The lateral rock movement under the HH and GMC footprints resulted in rock strains of 0.05% to 0.14% (max.). This equated to Damage Category 0-1 (Negligible – Very Slight risk of damage) with a minimum likelihood of movement damage. Therefore, the proposed retention/excavation would not cause adverse impacts to the existing heritage structures.
- Other neighbouring buildings at 31 Alfred Street and customs house 44 Bridge Street buildings were set back from the excavation by 5.5m and 6.1m (respectively). The horizontal strains calculated under these buildings equated to Damage Category 0 which was also acceptable.
- Strains in the rock adjacent to the Bennelong Drain equated to Damage Category 0 meeting the strict protection criteria specified by Sydney Water.

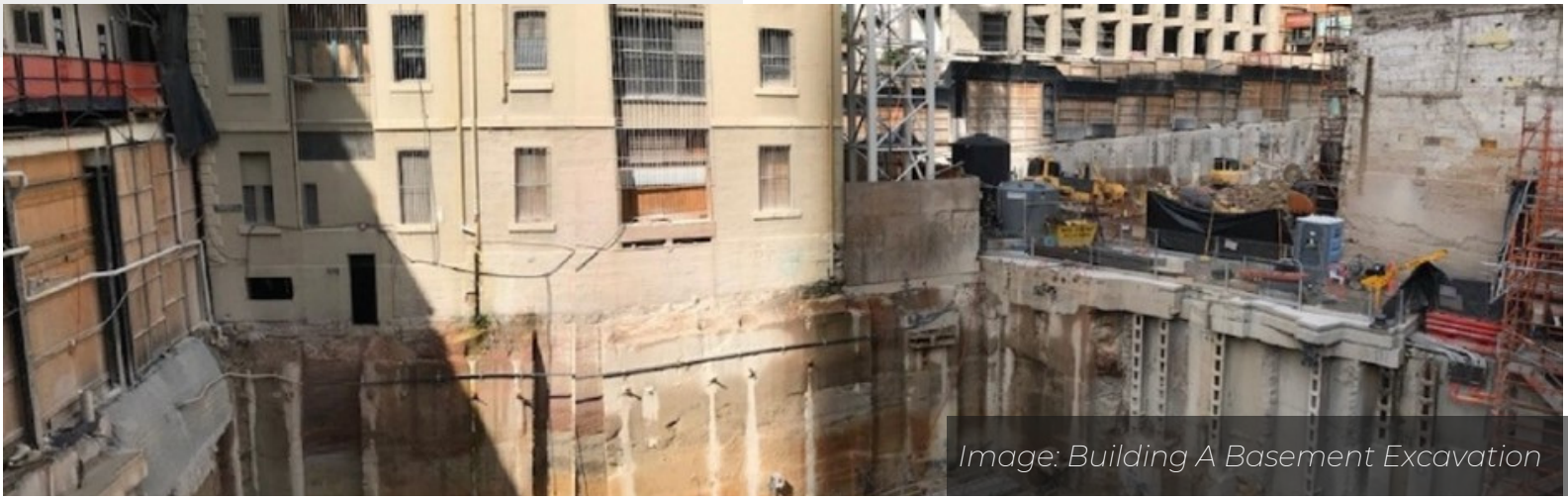

Image: Building A Basement Excavation