PROJECT SCOPE

This project entails upgrading the following elements of the Museum of Anthropology's Great Hall:

Seismic upgrading of the structure to comply with BC Building Code requirements

The seismic upgrade will be achieved by isolating the Great Hall from the ground and the adjoining Museum structures. The main floor slab will be suspended on base isolators located in a new crawlspace below.

Isolation of the Great Hall will impact the connecting elements between the Great Hall and adjoining building. These will include the floor, walls, and roof assemblies. During severe seismic events, up to 12 inches of differential movement is projected to occur between the base isolated Great Hall and the adjoining structure. Movement joint cover plates will be incorporated at the junction of slabs. These plates will respond to a seismic event by either decreasing or increasing the planned movement gap. The metal plates will be covered with carpeting, maintaining the integrity of the adjacent coverings in the entire Museum and allowing for unimpeded traffic over the separated slabs.

In addition, to accommodate the seismic upgrade work, the glass walls facing the landscape will need to be removed and replaced with tempered laminated glass. The glass supporting system will be replicated to maintain the transparency of the existing system. The anticipated movement at the glass walls connecting to the adjoining non-isolated structures will be achieved by incorporating laminated glass panels that will hinge out of the way. The design objective is to minimize changes to the existing glass wall assembly and detailing and to not endanger occupants during a potential seismic event.

The column at the entry to the O'Brian Gallery will be removed and replaced with a new column located approximately 12 inches away from the gun emplacement wall, from foundation to roof, to allow for the anticipated movement during a seismic event. A portion of the low roof of the O'Brian Gallery entry will be demolished and rebuilt with a combination of pre-cast concrete beams and structural steel decking. This portion of the low roof is part of the Great Hall structural system and will be disengaged from the rest of the O'Brian Gallery roof and the adjoining concrete gun emplacement wall. Furthermore, the vertical and horizontal movement joints between the O'Brian Gallery and the low roof entry will be expressed with dark bronze metal plates that will be hinged. The existing entry doors to the O'Brian Gallery will be replaced with a sliding glass door.

Skylight replacement and upgrading

The cascading vaulted single-glazed acrylic skylights forming the roof of the Great Hall will be replaced by vaulted double glazed sealed units, matching the existing configuration. They will be specified to achieve required U-values and shading coefficients, and will be tested through mock-ups for desirable light rendering over exhibit areas.

Lighting improvements and additions

The fluorescent lighting strips at the base of each vaulted skylight bay will be replaced with LED light strips. The principle function of these fixtures is to provide a light wash on the faces of the inverted U-shaped structural beam elements, approximating a night version of the day lighting.

The track lighting within the U structure which provides general lighting to the Great Hall and highlights to exhibits will be replaced with new tracks and LED fixtures. Lighting for special events in the Great Hall will also be incorporated within the tracks. Additional lighting opportunities for exhibits will be incorporated by means of electrical power outlets in the floor. All lighting will be computer controlled. New recessed uplighting in the exterior concrete pads will create a soft wash at the base of the columns.

Enhanced fire suppression upgrades

This project includes the addition of a pre-action sprinkler system with concealed heads to the ramp area east of the Great Hall and to the unsprinklered portion of the transversal corridor as it intersects with the main entrance ramp. A new pre-action sprinkler cabinet will be installed in the existing mechanical room located above the Koerner Gallery. An enhanced fire detection system will be installed in the Great Hall.

A new electrical and storage room will be located on top of the burster shell / courtyard adjacent to the south end of the Great Hall.

Roll-down shading

The Great Hall has considerable heat gain and glare issues from the low westerly afternoon sun. This problem is magnified during large gathering events and performances. To mitigate this problem, roll-down blinds will be incorporated into the west glass façades.

Additional museum upgrades

Seismic upgrades at the main entrance concrete frames will be achieved by introducing a thin structural steel frame mounted on top of the new skylights. The steel frame will follow the curvature of the skylights and be inset one bay from the edges to minimize the visual impact.

Main entry lighting located at the stair and roof structures will be converted to LEDs. In addition, the vaulted acrylic skylights beyond the Great Hall will all be replaced with vaulted double-glazed sealed units. The specifications will be the same as the Great Hall.

Conservation of Cultural Importance

A key question throughout the design process is how to complete the necessary upgrades while at the same time maintaining the cultural importance of the Great Hall. Working with a heritage consultant, several conservation principles outlined in the August 2017 Statement of Significance have been identified in reference to the Great Hall. These conservation principles have and continue to guide the Great Hall upgrades and are as follows:

- Retain in original locations the massive Northwest Coast First Nations carvings specifically conceived with the sequence of spaces.
- Preserve the character-defining elements of the Great Hall's concrete and glass enclosure.
- Maintain the original materials palette of the spaces; maintain the original simple detailing that uses concrete, glass, curved skylights bridging between concrete stepped concrete beams, and wall-to-wall carpet; new material to match original material.
- Preserve the views of the building's stepped concrete frames and window walls of the Great Hall.
- Maintain the evergreen tree screening of the building portions that flank the concrete frame elements of the Great Hall.

STRUCTURAL DESIGN

Analysis of the existing structure, seismic performance, and upgrade options for the Great Hall

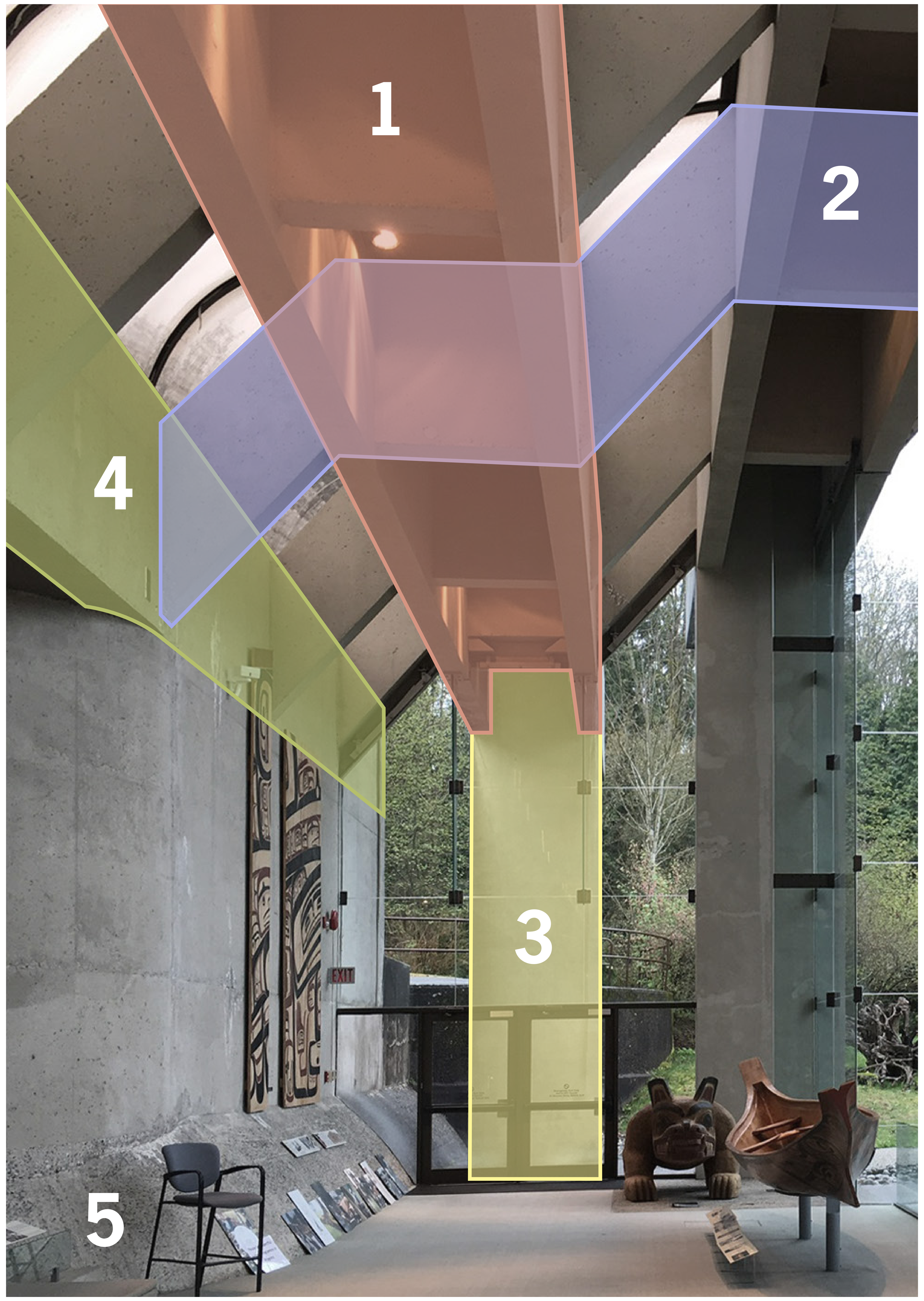


Fig 1. Great Hall Structural Elements

The Great Hall concrete structure is visible throughout the space and creates the expressive architectural form. The deceptively simple beam and column system is in fact a two-way spanning roof diaphragm supported on large columns and the adjacent roof of the Museum. The main structure is made up of the following elements:

1. **Precast channel beams** - The precast channels are upside down "U" shaped beams than span the long direction of the Great Hall. They were built in sections, lifted into place, and post-tensioned together.
2. **Cast-in-place link beams** - The link beams weave between the precast channels to provide critical two-way action of the roof system. These link beams also tie the channels together forming a rigid diaphragm at the roof, meaning that during an earthquake the frames largely move together as one, rather than moving as individual frames.
3. **Precast columns** - Two precast columns support each channel beam. The existing drawings show 1'-8" wide x 6'-0" long solid precast concrete columns (see Fig 2, top). Site investigations have revealed that the columns are actually hollow and prestressed (see Fig 2, bottom). This change was not documented and greatly affects the seismic performance of the existing structure. The hollow columns are supported on small pad foundations below grade.
4. **Support beam/wall** - Vertical support to the two-way spanning Great Hall roof beams is also provided by the reinforced concrete structure of the adjacent main building of the Museum.
5. **Gun Emplacement and Burster Shell** - The Museum was constructed in 1975 on remnants of a 1939 military battery. Parts of the burster shell structure are visible in the Great Hall.

Seismic Performance of Existing Structure

As originally designed (with solid concrete columns), the Great Hall would have about **25% of the capacity to resist seismic loads that is required according to the 2018 BC Building Code**.

In addition to our own analysis, UBC had engaged Arup to take on a campus-wide seismic assessment that included a review of the Museum of Anthropology. Arup found that in all 11 earthquake simulations they ran, their model of the Great Hall collapsed early in the earthquake. Arup had completed their analysis before the concrete columns were discovered to be hollow (see illustration below), so their model did not account for this additional weakness.

The main collapse mechanism of the Hall appears to be caused by the flexibility of the columns combined with the rigidity of the roof. The Great Hall roof is rigidly tied back to the main building by the link beams. While the flexible columns want to sway in an earthquake. The link beams are not strong enough to restrain the roof and are likely to be the first elements to fail. Upon failure of the link beams, the two-way roof system will become a one-way roof system. The weakness of the columns combined with the unsupported long span channels would likely lead to complete collapse of the Hall.

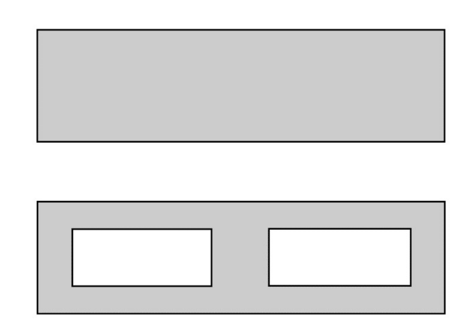


Fig 2. Cross section of precast column as designed (top) and precast column as built (bottom)

Upgrade Options

The design team explored a number of strategies for the seismic upgrade of the Great Hall, these include:

- Add shearwalls or braces. Additional walls or braces to stiffen the Hall would be visible and disruptive to the openness of the space. This was judged to be an unacceptable solution from an architectural and heritage standpoint.
- Strengthen the roof structure with new braces in the skylight space between the channel beams and the link beams. This solution would significantly reduce the amount of light in the Great Hall and was judged to impact the architectural character of the space too much. In addition, there would be intrusive upgrades required to the channel beams, and the hollow columns would very likely also require replacement, making this option unacceptable from multiple points of view.
- Wrap the existing structure with fibre reinforced polymer (FRP). Wrapping the columns with FRP would help strengthen the columns, however the roof structure would still require substantial upgrading at the link beams. The FRP would hide the concrete finish and thus is not an acceptable solution from an architectural and heritage standpoint.
- Base isolate the existing superstructure. This would involve shoring the existing structure and installing isolators below the columns with new footings and a new suspended floor slab. With this approach, we would still need to reinforce the roof, however these upgrades and the base isolation below grade would have been largely concealed from view. This was the design approach we took until we learned that the existing columns were hollow.
- Rebuild the Great Hall as is, with no base isolation. Without base isolation or drastically changing the member dimensions, we would not be able to achieve the strength and stiffness that the system would need to prevent likely collapse in a significant earthquake. This option was judged by the design team and the Working Committee to fall short of the objective to protect the contents, occupants, and architecture of the Hall.
- Rebuild the Great Hall on base isolators. This is the current design approach.

BASE ISOLATION

Guiding principles for the structural design approach

Base isolation is a common technology in Japan and New Zealand and is often used in high seismic zones when the building or contents are culturally or economically significant. A base isolated building will exceed the life-safety performance level and often will meet post-disaster or low-damage performance levels, offering more protection to the building and contents than most other structural systems.

Isolation is achieved by placing the structure on rubber or sliding bearings. As the ground shakes with high acceleration, the building on the isolators moves with higher displacement and lower acceleration. Base isolation reduces the loads on the structure by allowing the isolators to take up most of the flex.

Fig 3 shows the schematic performance of a cross section of the building in an earthquake without isolation: the superstructure takes the flex and the forces of the earthquake directly. This image is contrasted with Fig 4, which shows most of the flex being taken in the base isolators, limiting the flex and forces on the superstructure.

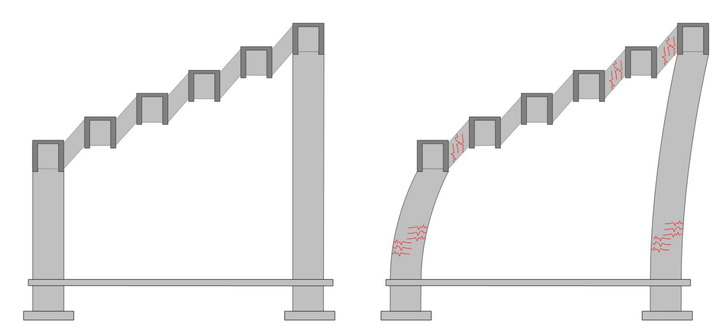


Fig 3. Schematic performance in an earthquake

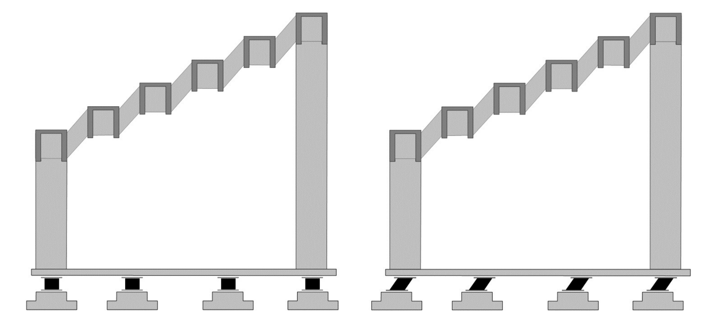


Fig 4. Schematic performance in an earthquake with base isolation

Structural Design Approach

The best chance at protecting the architecture, the occupants, and the building's priceless contents is to rebuild the Great Hall on a base-isolated slab. Together with the Architect, the Working Committee, and other stakeholders, the guiding principles for the current design have been developed as follows:

1. Carefully demolish the existing Great Hall completely including all foundations and the concrete support beam against the main building. Provide shoring for the adjacent main building structure that is supported by the structure of the Great Hall.

2. Rebuild the superstructure dimensionally identical to the existing Great Hall structure. The structural system above grade will be largely the same, with precast channel beams, precast columns, and cast-in-place link beams. A rebuild means that we can provide a substantially stronger and stiffer system by using high-strength concrete and adequate reinforcement.

3. A concrete suspended slab supported on isolators will become the Great Hall floor structure with a 300 – 350mm movement "moat" (see Fig 5) around it, including at the interface between the Great Hall and the main building. At the building exterior, the movement moat will be covered by river rock and will not be visible. There will be a crawlspace below the Great Hall slab to access the isolators.

4. Provide a movement joint at the Great Hall roof between the main building and the new concrete support beam (see Figure 6). The movement joint will be almost entirely concealed from view from within the Great Hall except for a continuous horizontal joint along the concrete walls at the elevation of the underside of the support beam.

5. Replace the concrete suspended slab and beams connecting the Great Hall to the roof of the O'Brian Gallery with a lightweight and flexible structural steel and metal deck system connected to the Great Hall and separated from the O'Brian roof with a movement joint.

6. All skylights and glazing at the interface between the Great Hall and the main building or O'Brian Gallery will be detailed to allow movement in an earthquake.

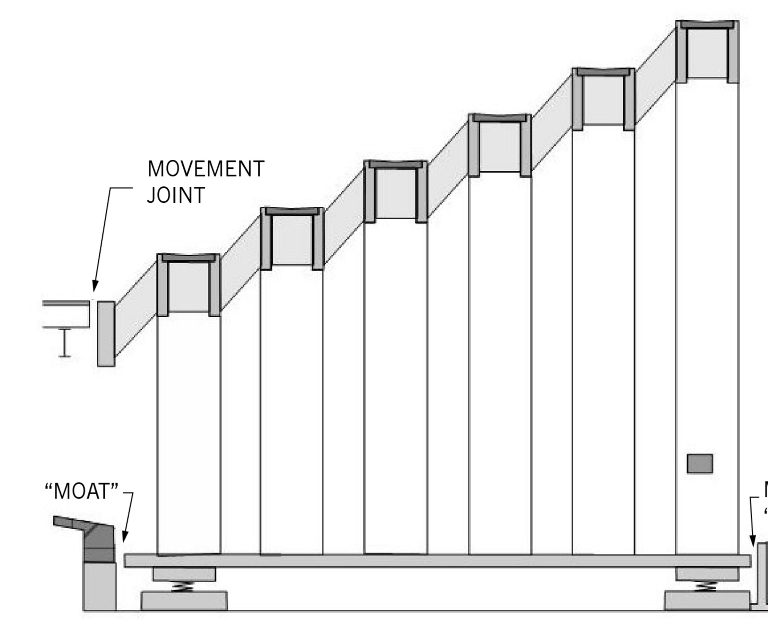
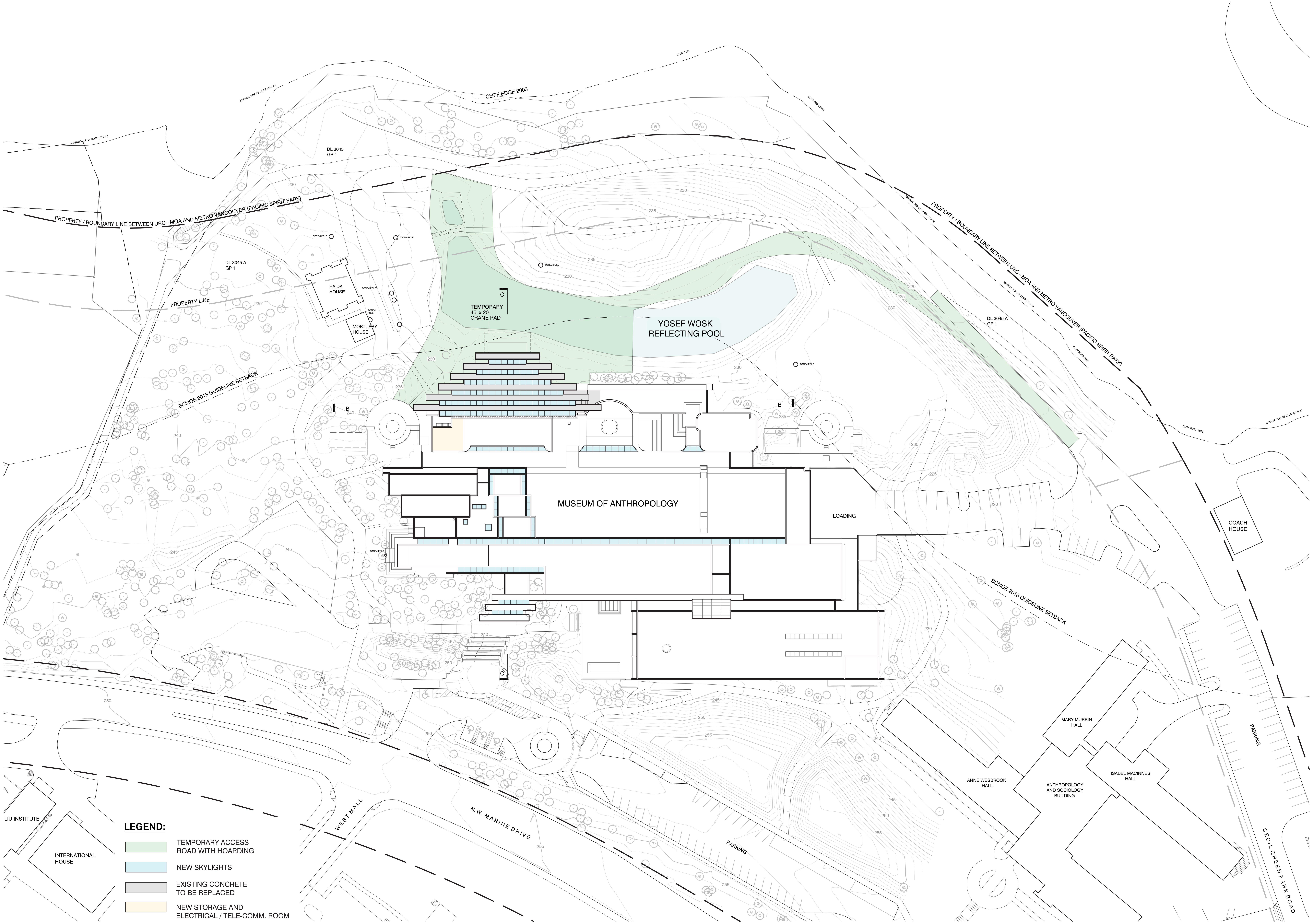


Fig 5. Great Hall movement "moat"/joint



1 SITE PLAN
1:500

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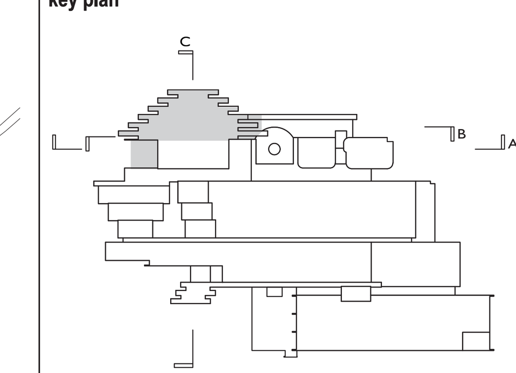

project title

MUSEUM OF ANTHROPOLOGY

GREAT HALL SEISMIC UPGRADE

6393 NW MARINE DRIVE
VANCOUVER, B.C.

drawing title

SITE PLAN

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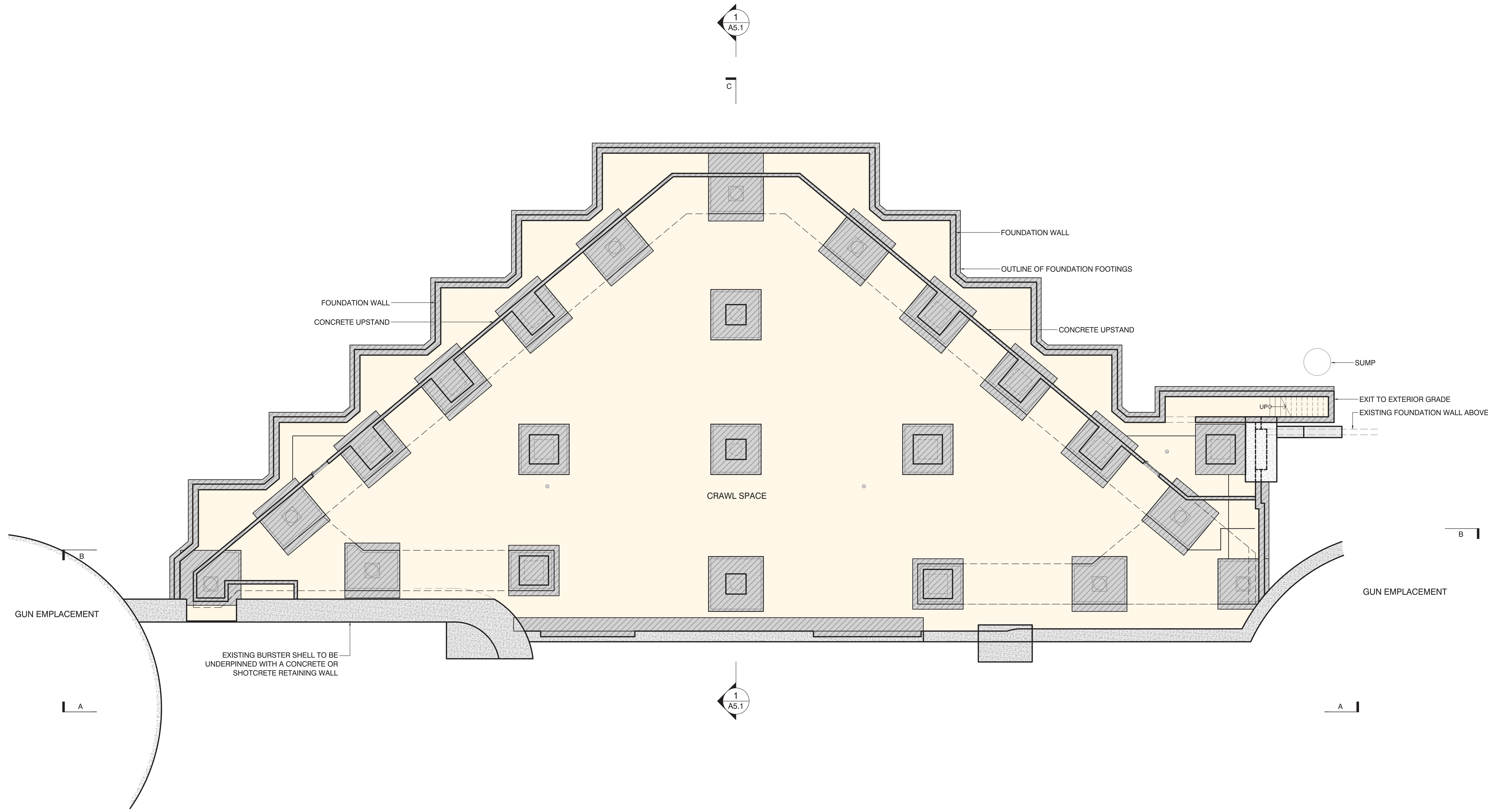
drawing date 2020/05/29	**printed** 2020/05/29
project no. 17005	**drawing no.** A1.0
rev.	



1 CRAWL SPACE LEVEL PLAN
1:100

LEGEND:

- NEW CRAWL SPACE
- NEW ELEMENT
- MOVEMENT JOINT

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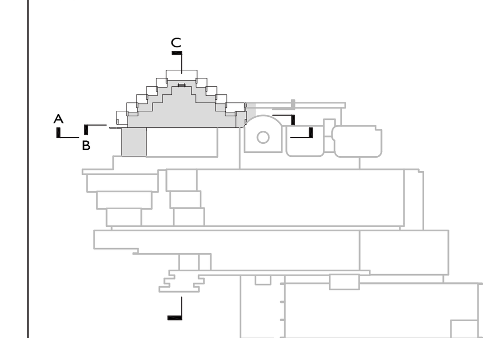

project title

MUSEUM OF ANTHROPOLOGY

GREAT HALL
SEISMIC UPGRADE

6393 NW MARINE DRIVE
VANCOUVER, B.C.

drawing title

GREAT HALL
CRAWL SPACE LEVEL PLAN

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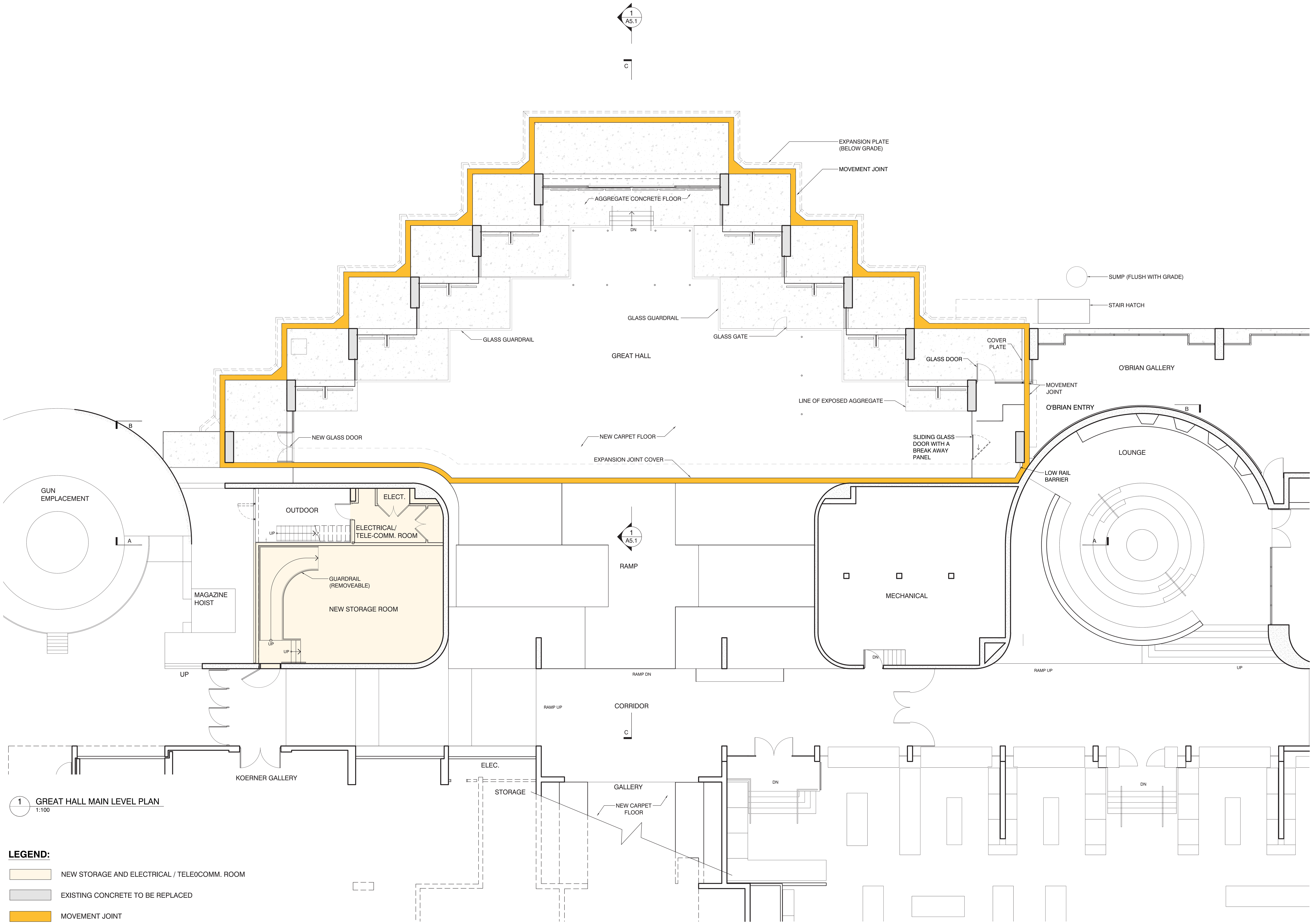
printed	2020/05/29
project no.	17005
drawing no.	A2.1
rev.	

project north



1 GREAT HALL MAIN LEVEL PLAN
1:100

LEGEND:

- NEW STORAGE AND ELECTRICAL / TELE0COMM. ROOM
- EXISTING CONCRETE TO BE REPLACED
- MOVEMENT JOINT

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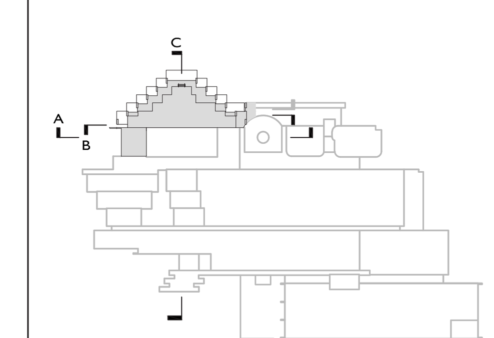

project title

MUSEUM OF ANTHROPOLOGY

GREAT HALL SEISMIC UPGRADE

6393 NW MARINE DRIVE
VANCOUVER, B.C.

drawing title

GREAT HALL
MAIN LEVEL PLAN

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project no. 17005	drawing no. A2.2
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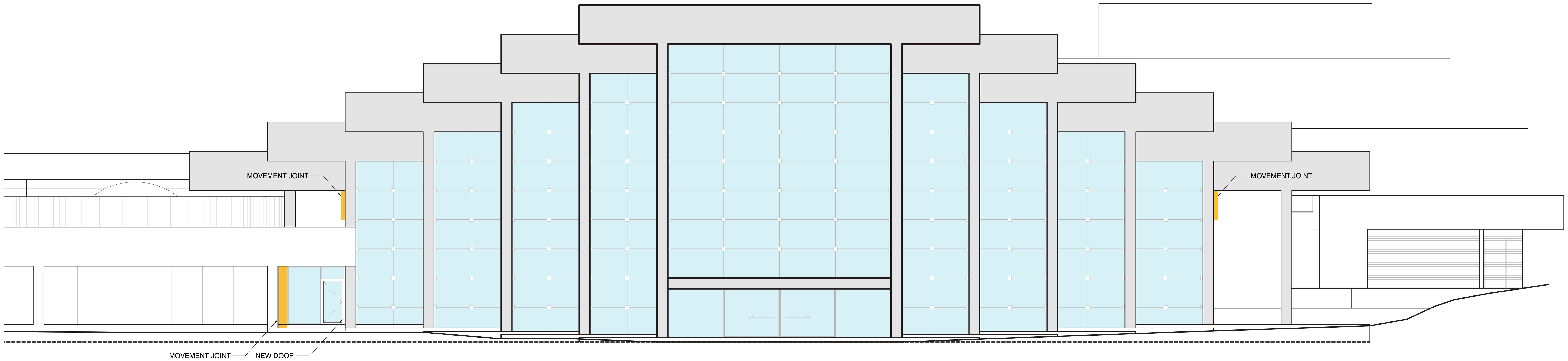

1 / 3.1 WEST ELEVATION
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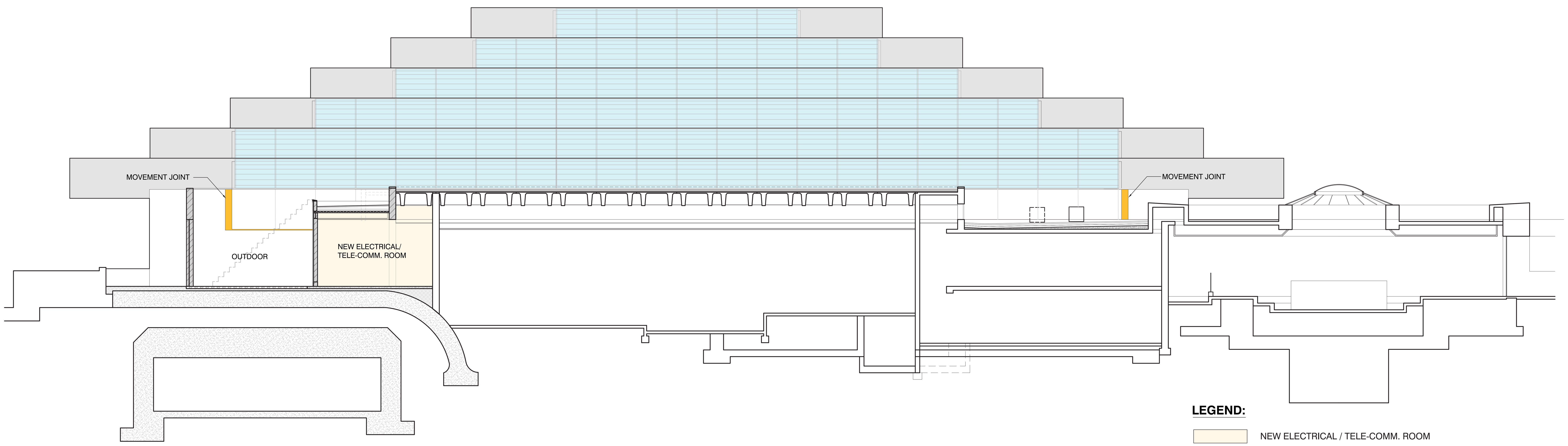

2 / 3.1 SECTION A-A
1:100

LEGEND:

- NEW ELECTRICAL / TELE-COMM. ROOM
- NEW SKYLIGHT & VERTICAL GLAZING
- EXISTING CONCRETE TO BE REPLACED
- NEW ELEMENT
- MOVEMENT JOINT

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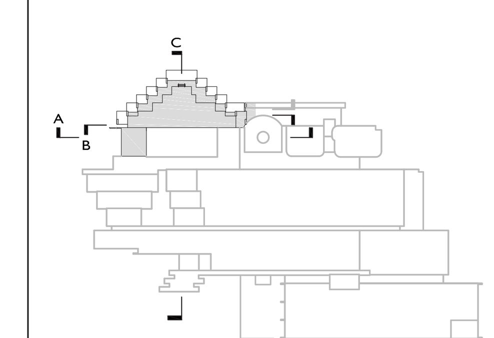

project title
MUSEUM OF ANTHROPOLOGY
GREAT HALL SEISMIC UPGRADE
6393 NW MARINE DRIVE
VANCOUVER, B.C.

drawing title
GREAT HALL
WEST ELEVATION
SECTION A-A

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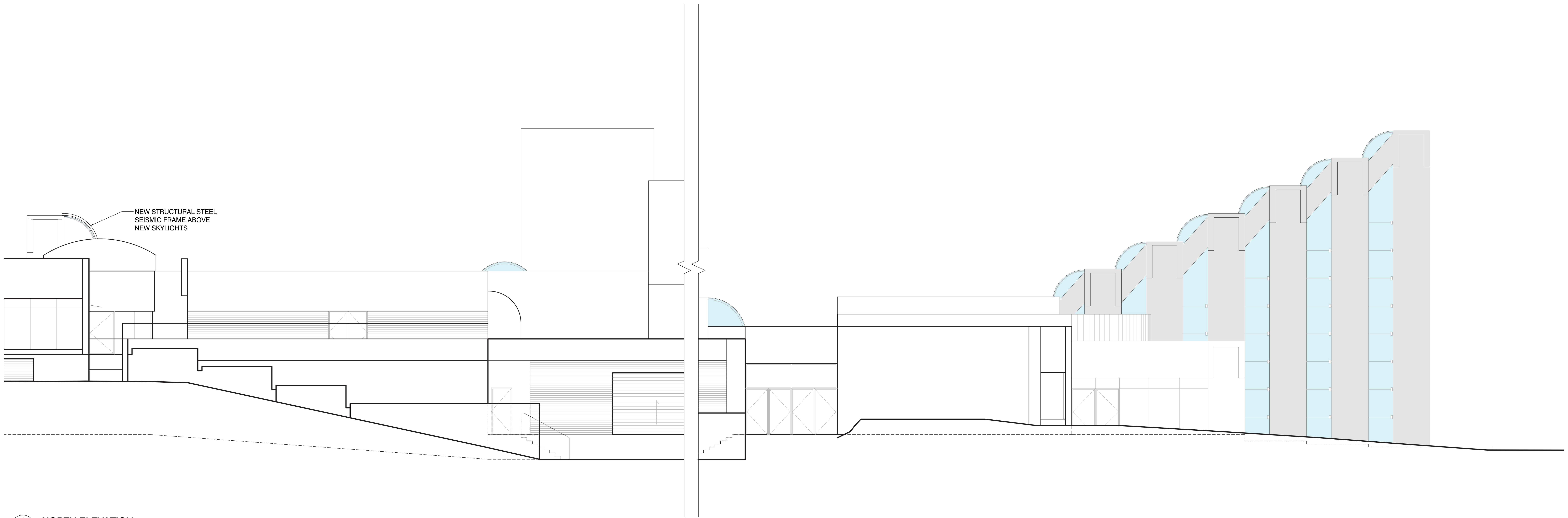
project no.	17005	drawing no.	A3.1
rev.			



1 A3.2 NORTH ELEVATION
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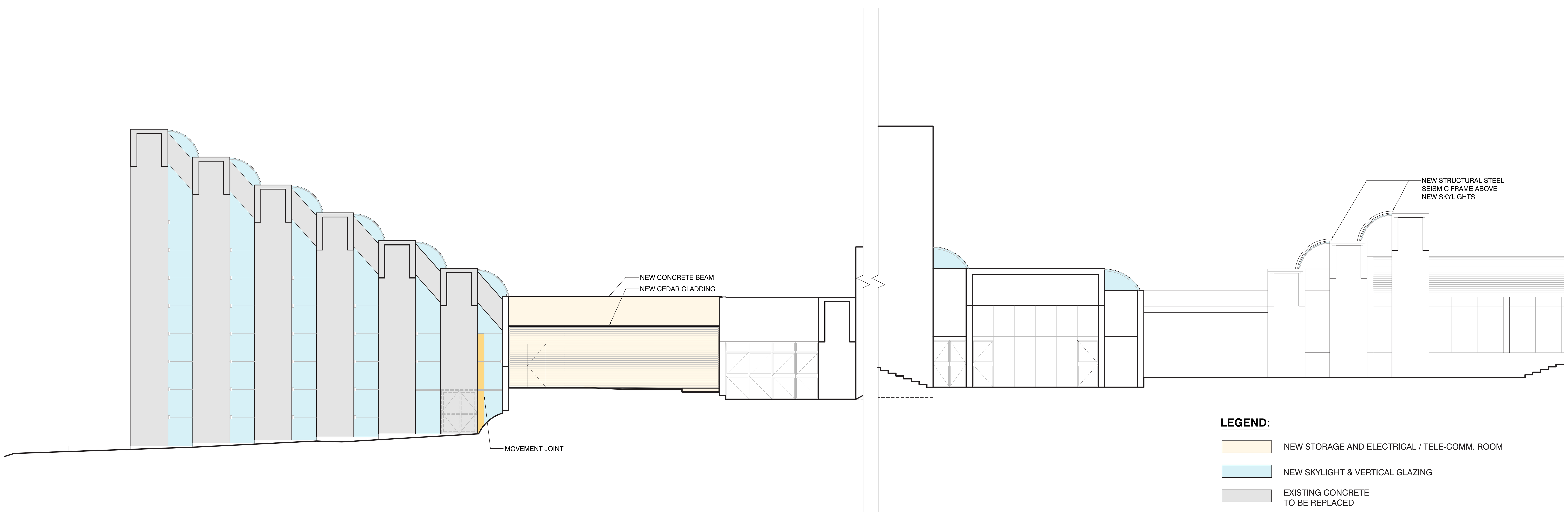

2 A3.2 SOUTH ELEVATION
1:100

LEGEND:

- NEW STORAGE AND ELECTRICAL / TELE-COMM. ROOM
- NEW SKYLIGHT & VERTICAL GLAZING
- EXISTING CONCRETE TO BE REPLACED
- MOVEMENT JOINT

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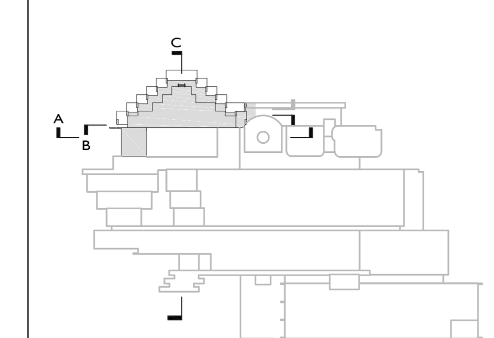

project title

MUSEUM OF ANTHROPOLOGY
GREAT HALL SEISMIC UPGRADE
6393 NW MARINE DRIVE
VANCOUVER, B.C.

drawing title

GREAT HALL
NORTH ELEVATION
SOUTH ELEVATION

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project no.: 17005	drawing no.: A3.2
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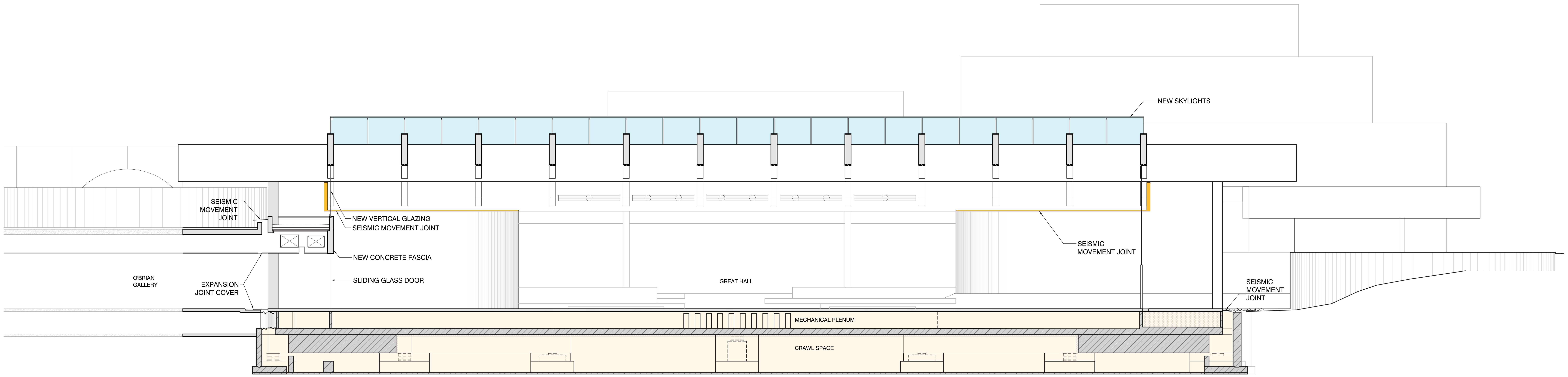

1 SECTION B-B
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LEGEND:

NEW MECHANICAL PLENUM AND CRAWL SPACE

NEW SKYLIGHT

EXISTING CONCRETE TO BE REPLACED

NEW ELEMENT

MOVEMENT JOINT

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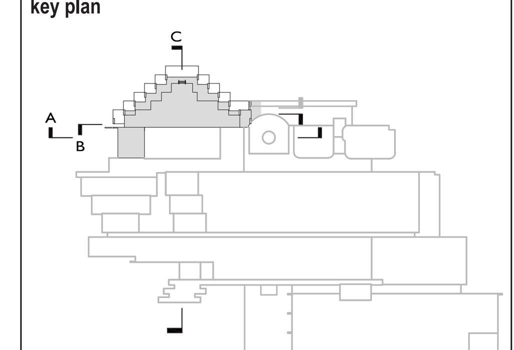

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MUSEUM OF ANTHROPOLOGY

GREAT HALL SEISMIC UPGRADE

6393 NW MARINE DRIVE
VANCOUVER, B.C.

drawing title

SECTION B-B

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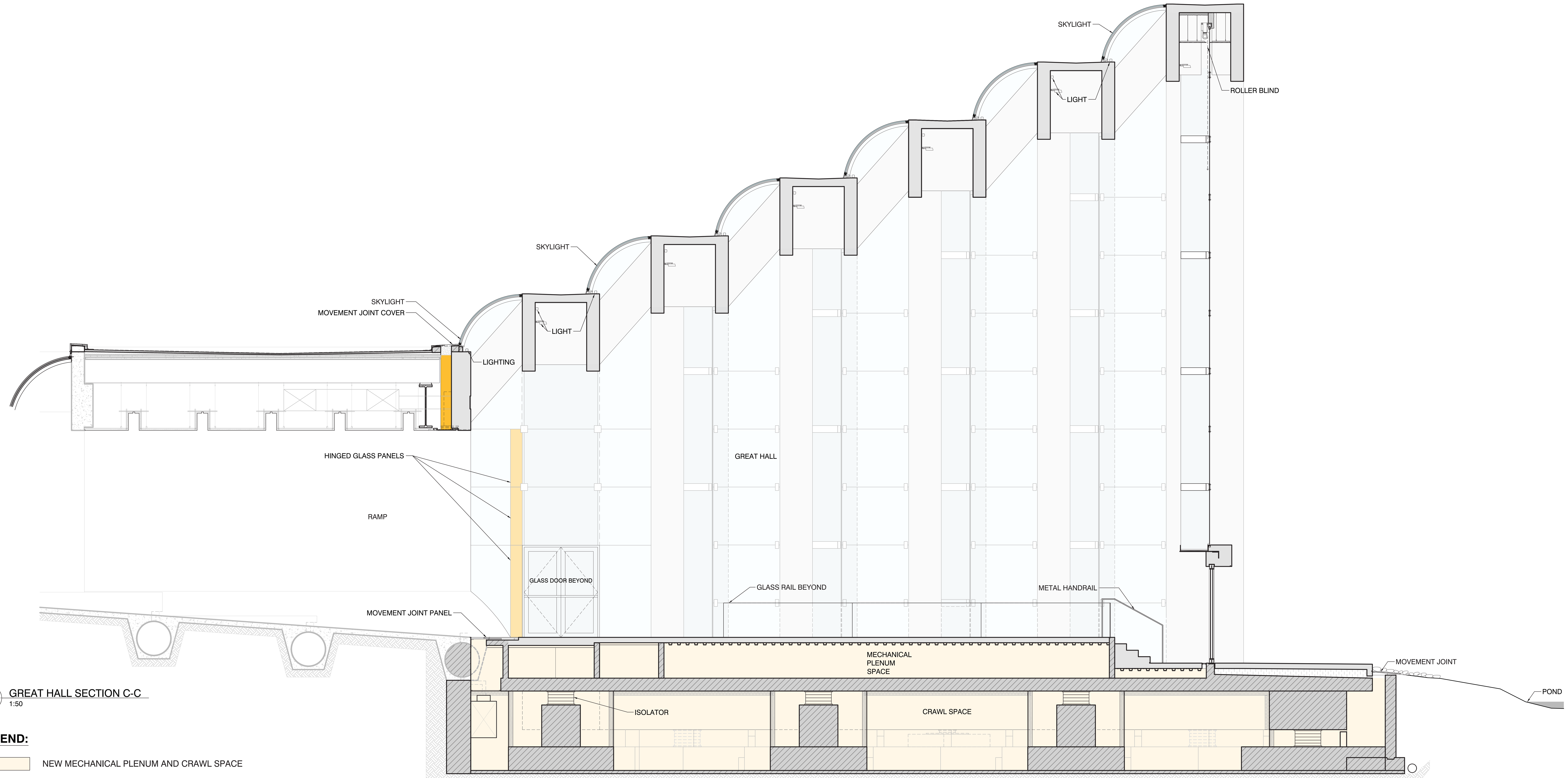

1 GREAT HALL SECTION C-C
1:50

LEGEND:

- NEW MECHANICAL PLENUM AND CRAWL SPACE
- NEW SKYLIGHT
- NEW VERTICAL GLAZING - BEYOND
- EXISTING CONCRETE TO BE REPLACED
- EXISTING CONCRETE TO BE REPLACED - BEYOND
- NEW ELEMENT
- MOVEMENT JOINT
- MOVEMENT JOINT - BEYOND

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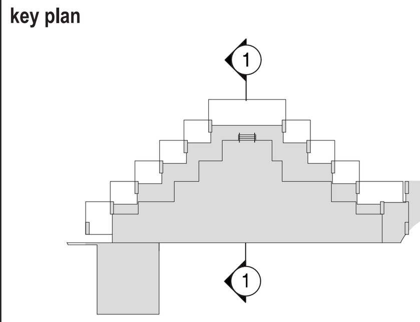

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MUSEUM OF ANTHROPOLOGY

GREAT HALL SEISMIC UPGRADE

6393 NW MARINE DRIVE
VANCOUVER, B.C.

drawing title

GREAT HALL SECTION C-C

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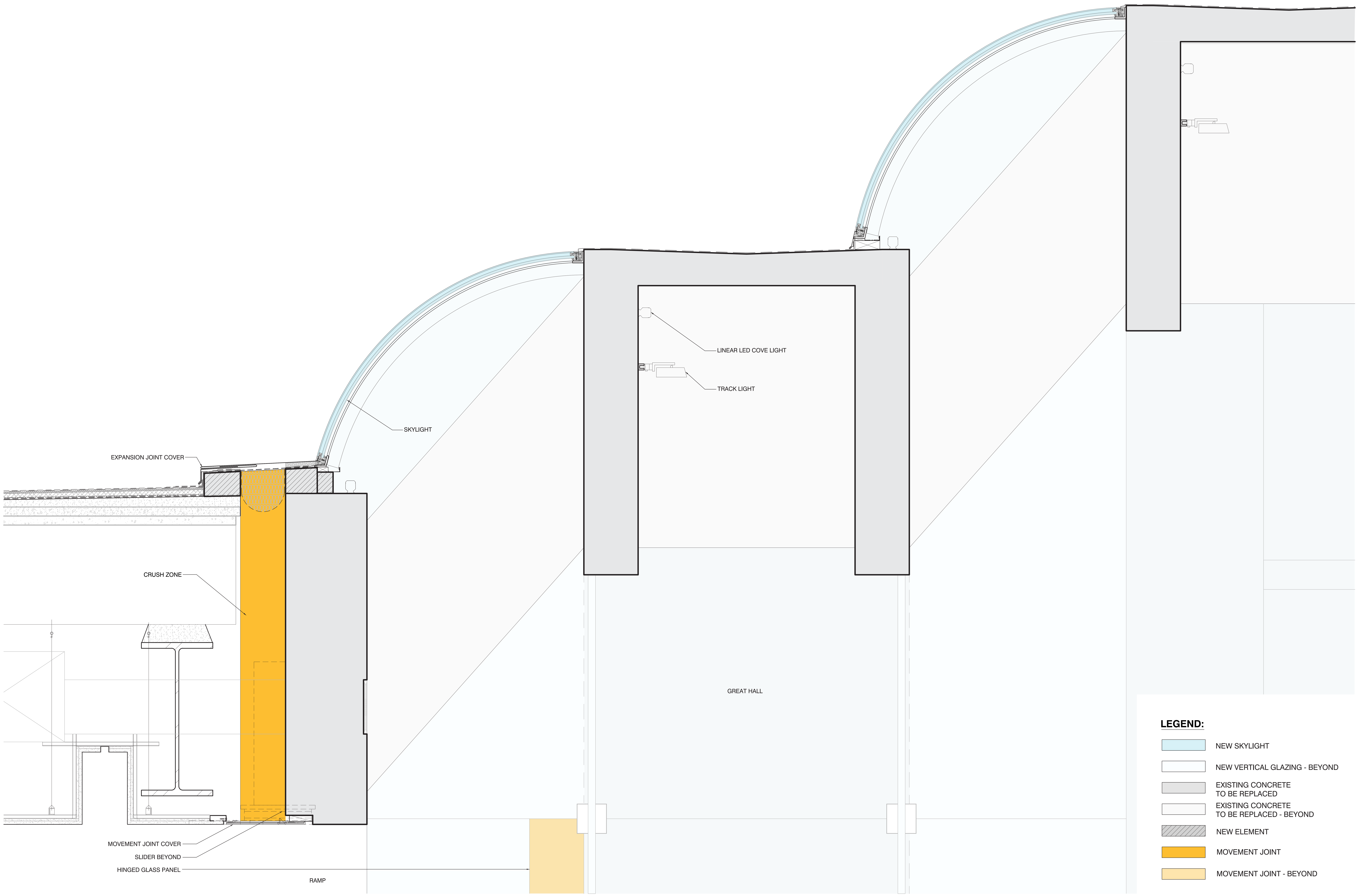

1
A8.1
GREAT HALL SKYLIGHT DETAIL
1:10

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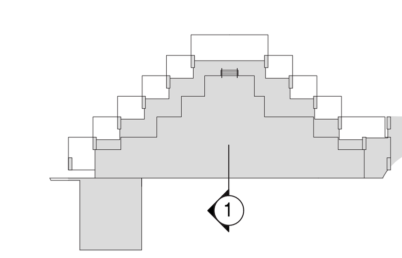

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MUSEUM OF ANTHROPOLOGY

GREAT HALL
SEISMIC UPGRADE

6393 NW MARINE DRIVE
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drawing title

GREAT HALL
SKYLIGHT DETAIL

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scale 1:10	
drawing date 2020/05/08	**printed** 2020/05/29
project no. 17005	**drawing no.** A8.20
rev. 1	

Understanding an Iconic Landscape Design
Approach to Protection and Restoration

Protection of an Iconic Landscape Design

The role of the landscape architecture team is to assist in the protection and restoration of site vegetation, topography, features, and elements impacted by construction activities. Drawings and documents detailing protection and restoration strategies are in development.

Working collaboratively with the consultant team and Musqueam Nation, strategies will continue to evolve for the retention and enhancement of an iconic landscape that responds to the architecture, as well as spirit of place, history, diverse cultures, ecology, and landscape aesthetics and function.

Vegetation, surface materials, and site elements will be carefully protected during construction. Restoration and rehabilitation strategies will be informed on a case-by-case basis and established before construction commences.

Landscape Conservation and Restoration

The guiding rationale for landscape conservation is to retain the significance of the existing designed landscape while allowing for adaptation and revitalization –– a need to consider new land uses and standards for accessibility, sustainability, biodiversity, and rehabilitation.

Specific measures will be undertaken to restore the landscape following construction– including the repair, replacement, and restoration of landform, surfaces, and vegetation. Planning for any additional / replacement planting required will be developed in consultation with stakeholders and partners. Landscape conservation and restoration necessitates land stewardship in partnership with Musqueam Nation, upon whose ancestral homeland the Museum of Anthropology is located.

Documentation of Landscape and Place

Site walks and consultations with landscape architect Cornelia Hahn Oberlander, Museum of Anthropology representatives, architects Nick Milkovich and Anne Gingras, and representatives of the Musqueam Nation have taken place, with emphasis on the cultural significance and history of the land.

A comparative inventory of the planting history between 1973 and 2018, and a planting matrix of native and culturally significant species on Musqueam traditional territory, have been completed.

Detailed photographic and topographic surveys form a catalogue of information about the site; photographs, notes and drawings, together with retained samples of site materials, are part of this documentation. Detailed documentation reflects the philosophy that recording should be an integral part of the conservation process of places of significance. This process will assist in developing a record and understanding of the techniques and technologies used to construct the original landscape and the changes made to the landscape post-1973.

During the construction process, impacts on the landscape will be carefully documented and recorded to assist with the repair and restoration of the landscape and to provide a record of the works for future reference.

UBC Campus context plan.
Not to scale.

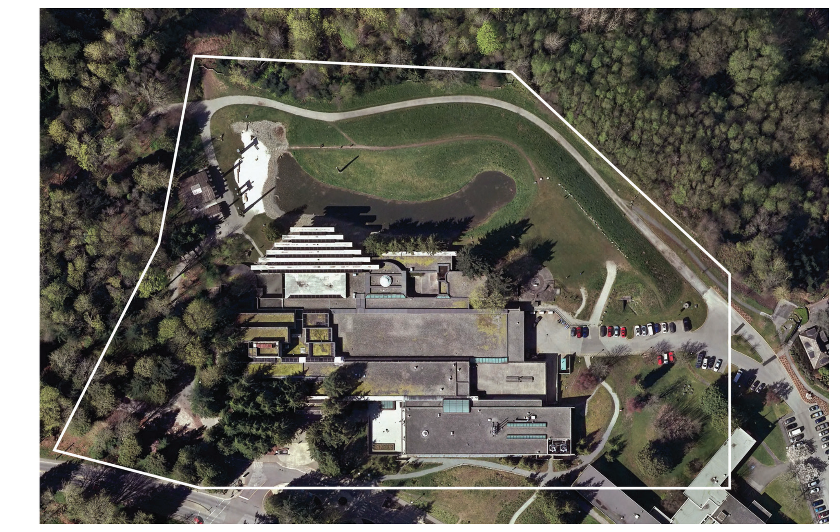
Process of Careful Site Documentation. *Photos representative of existing conditions in site areas potentially impacted by construction.*

Protecting an Iconic Landscape

Critical Areas to be Protected During Construction

Plan showing site area potentially impacted by Great Hall seismic and envelope upgrade construction activities, and key landscape protection measures.

Scale 1:400 N



Legend

Proposed Areas where Construction will Impact the Landscape. *Protection and restoration will be undertaken.*

- **C.1 TEMPORARY SITE ACCESS ROAD** Temporary site access road for construction requirements.
- **C.2 MOUND** Existing mound will be excavated for the temporary construction access road.
- **C.3 PROTECTIVE FENCING** Areas with proposed protective fencing.
- **C.4 MATERIALS STORAGE AREA** Proposed area for temporarily storing materials.

Specially-Protected Landscape and Site Elements

- **L.1 SHELL BEACH** Will be protected during construction activities.
- **L.2 CULTURALLY-SIGNIFICANT SITE ELEMENTS** House Posts and site signage will be carefully protected during construction.
- **L.3 ARMORY** Armory structure will be protected from construction activities.
- **L.4 TOTEM** Culturally-significant site element will be protected from construction activities.
- **L.5 'SALISH FOOTPRINT', SUSAN POINT, 2010** Protection of the work, 'Salish Point', by artist Susan Point.

Specially-Protected Vegetation

- **V.1 PROTECTION OF TREES AND VEGETATION** Protective fencing will be used to protect trees and vegetation during construction.

Landscape Elements, Art, and Artefacts Temporarily Removed and Stored Off-Site

- **S.1 COBBLES** Cobbles will be carefully removed and stored, and reinstalled following construction.
- **S.2 SHELL BEACH PATH** The pathway materials will be removed and stored, and reinstalled following construction.
- **S.3 CULTURAL ELEMENTS AND SIGNAGE** The totem and plaque will be removed and stored, for protection. These will be re-installed.

Landscape Elements to be Reinstated Following Construction

- **R.1 GRAVEL PATH** Existing path will be restored following construction.
- **R.2 YOSEF WOSK REFLECTING POOL** Water will be removed during construction. The pond will be rehabilitated following construction.
- **R.3 REMOVAL OF TWO HEMLOCK TREES** Two hemlock trees will be required to be removed to carry out the seismic upgrades. These trees will be replaced.
- **R.4 REMOVAL OF ONE CEDAR TREE** One cedar tree will be required to be removed to carry out the seismic upgrades. This tree will be replaced.

Top of Bank

Property / boundary line between Metro Vancouver (Pacific Spirit Park) and UBC-MOA

Existing Wood Fence

Chain-link Fence

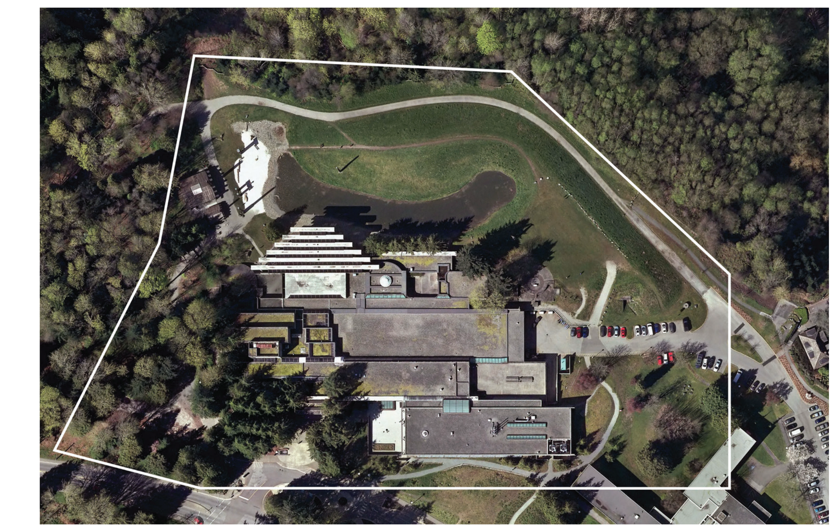
Protected Area During Construction

Restoring an Iconic Landscape

Critical Areas to be Restored After Construction

Plan showing key landscape restoration work to be undertaken following seismic and envelope upgrade construction activities for the Great Hall.

Scale 1:400 N



Legend

Area of Restored Vegetation and Landform

V.1 **RESTORATION OF LANDFORM AND EDGES**
Mound, vegetation, and grasses will be fully reinstated to the original design and specifications. Non-native perennials will be removed from the seed mix.

V.2 **RESTORATION OF LAWN**
Path and lawn will be restored to original design and specifications.

V.3 **ECO-CULTURAL RESTORATION OF VEGETATION**
Fence and existing planting will be removed. Replace with eco-cultural indigenous planting developed with partners.

All vegetation will be restored and rehabilitated within the areas impacted by construction activities, including areas where protective fencing was erected. All grading and materials will be restored to pre-existing conditions.

Landscape Elements, Art, and Artifacts to be Placed Back in the Landscape at their Original Location and in their Original Condition

S.1 **SHELL BEACH PATH**
Materials to be stored during construction. Path will be reinstalled to the original design and specifications.

S.2 **CULTURAL ELEMENTS AND SIGNAGE**
The totem and plaque removed and stored for protection during construction will be re-installed.

Landscape Elements Restored to their Original Condition following Construction

R.1 **GRAVEL PATH**
Pathway will be reinstalled to original layout, width, grade, design, and material specifications.

R.2 **YOSEF WOSK REFLECTING POOL**
The pond area will be rehabilitated, reinstated to the original design, and filled with water.

R.3 **COBBLES**
All cobbles will be carefully reinstalled to the original design and specifications.

R.4 **SHELL BEACH**
The shell beach will be rehabilitated.

R.5 **SMALL GROVE OF CONIFERS**
To compensate for the loss of one hemlock tree, a small grove of conifers will be planted.

R.6 **THREE NEW CEDAR TREES**
To compensate for the loss of one cedar tree, three new cedar trees will be planted in woodland area.

Tree locations of new trees will be developed in consultation with partners, to achieve an eco-cultural restoration of the woodland.

Top of Bank

Property / boundary line between Metro Vancouver (Pacific Spirit Park) and UBC-MOA

Existing Wood Fence

Chain-link Fence

Protected Area During Construction