

**HIGH LEVEL SEISMIC UPGRADE
COST ESTIMATE
FOR
CENTRE BLOCK, PARLIAMENT HILL**

Prepared for:
Public Works and Government Services Canada
Parliamentary Precinct Branch



Prepared by:
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14Y160-113A

May 2015

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PWGSC Client Reference Number: 20150336

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1. INTRODUCTION

1.1 Objective

This High Level Estimate is intended to provide an order of magnitude cost estimate of the structural cost of both a conventional seismic upgrade and a seismic isolation retrofit of the Centre Block. This estimate should be read in conjunction with the seismic upgrade options described in the Halsall report entitled “Supplemental Seismic Report for Centre Block, Parliament Hill” (Work Package 3).

1.2 General Description

1.2.1 Conventional Seismic Upgrade

The conventional seismic upgrade consists of inserting approximately 76 new reinforced concrete shear walls throughout the building, each with a reinforced concrete foundation with rock anchors. The design is based on 100% 2010 NBCC loads and includes no provisions for post-disaster performance. An allowance has been made to remove the slab on grade and rock in the basement where it is higher, to allow for sufficient head room for the construction equipment to build the foundations. An example of walls is shown in Figure 1 representing the general extent of the work throughout the building.

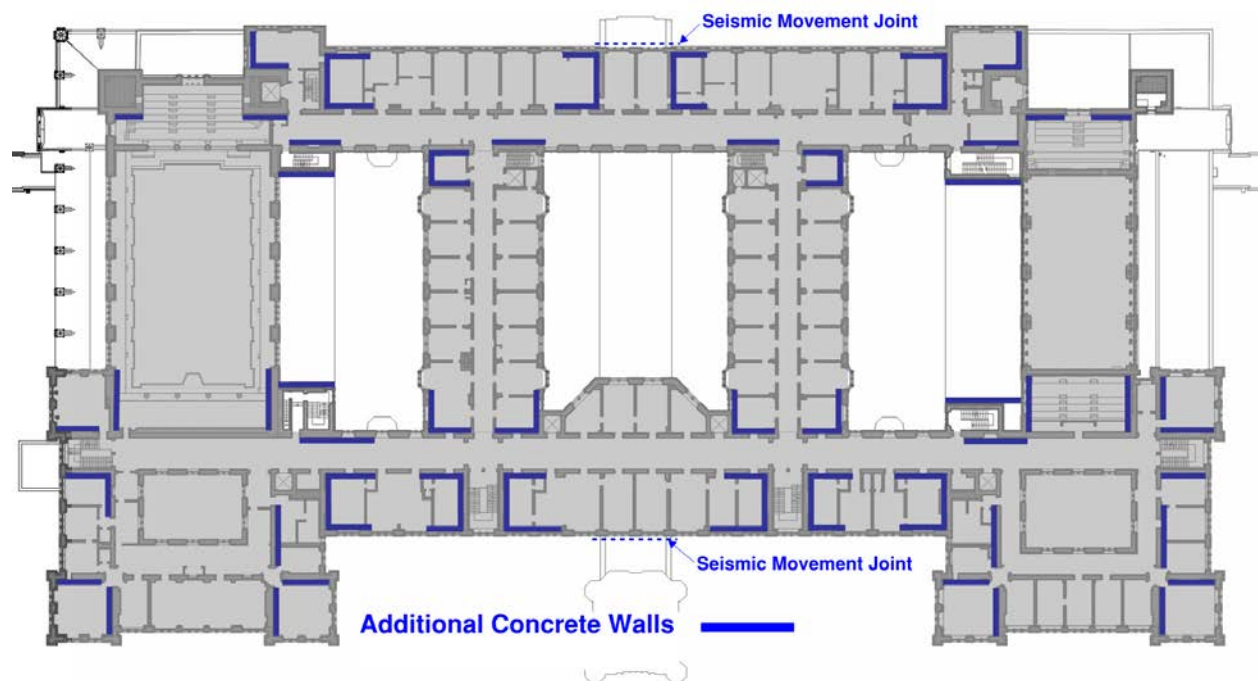


Figure 1 – General extent of new concrete shear walls for the conventional upgrade

The diaphragm upgrade will involve removing all of the existing topping and non-load bearing partitions and the floors and roof, and replacing the topping with a reinforced concrete diaphragm. An example of a process to install the new shear walls is shown in Figures 2 through 6.

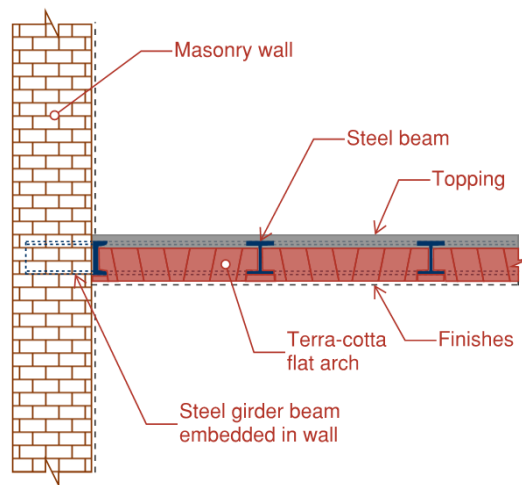


Figure 2 - Initial Condition

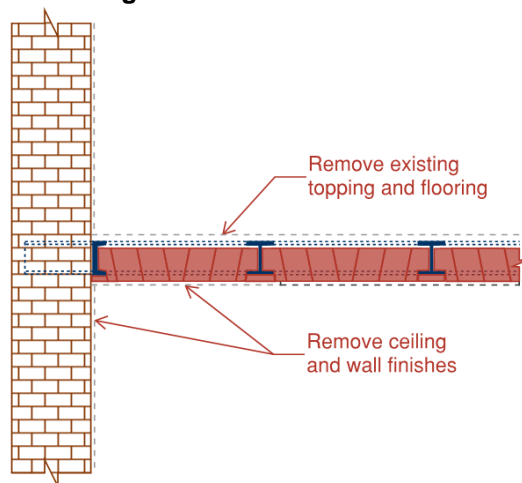


Figure 3 - Removal of topping and finishes

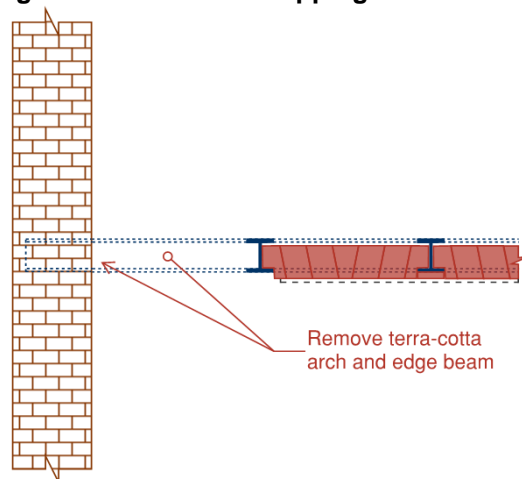


Figure 4 - Removal of floor

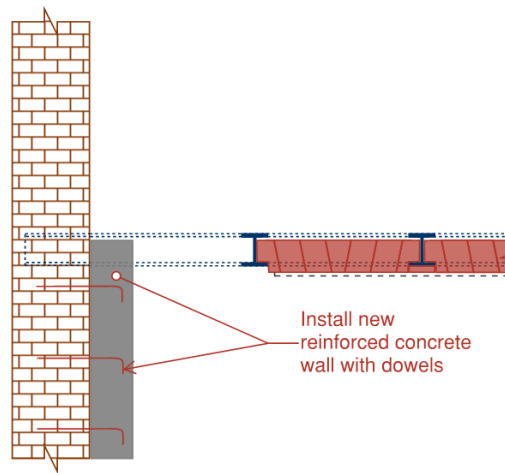


Figure 5 - Install new reinforced concrete wall

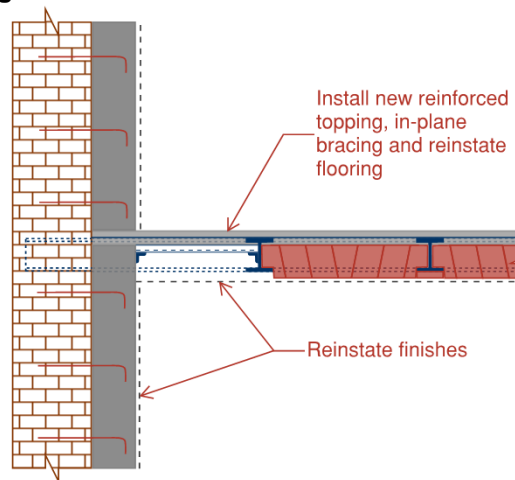


Figure 6 - Install reinforced diaphragm and reinstate finishes

An allowance has been made for the reinforcing of the two Water Towers, similar to the work currently taking place on the Ventilation Towers. An allowance for the Peace Tower conventional upgrade consists of reinforcing the piers by installing large steel anchors in the piers and structural steel framing behind the spandrel beams. The installation of the pier reinforcing could involve removing a strip of exterior stone masonry, chipping into the concrete, grouting the anchors in place and reinstating the exterior masonry. An allowance has been made for the reinforcement of the Upper Tower, above the observation deck level. A schematic elevation of the reinforcement of the Peace Tower is shown in Figures 7 and 8.



Figure 7 - Schematic layout of Peace Tower reinforcing

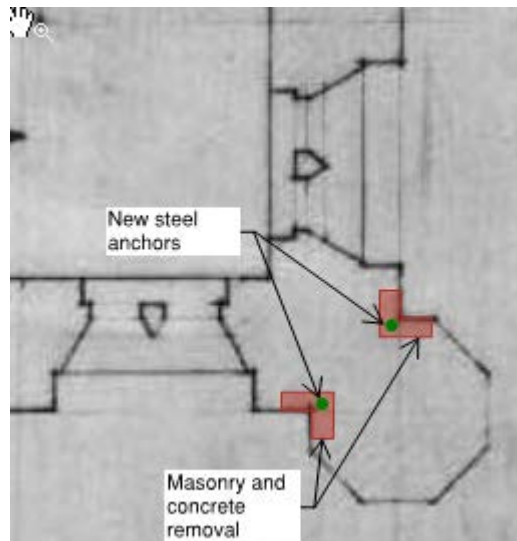


Figure 8 - Section showing steel anchors in Peace Tower piers

An allowance has been made for the seismic restraint of operational and functional components and secondary structural elements.

1.2.2 Base Isolation Seismic Upgrade

For the base isolation seismic upgrade option, the existing structure is sequentially shored in the basement, the existing concrete walls and columns are removed sequentially and new reinforced concrete piers are installed on foundations with small rock anchors. An allowance has been made to remove the slab on grade and rock in the basement where it is higher, to allow for sufficient head room for the construction equipment to build the foundations. An example of a potential isolator layout and schematic installation diagrams are shown in Figures 9 and 10.



Figure 9 - Base isolator potential layout plan

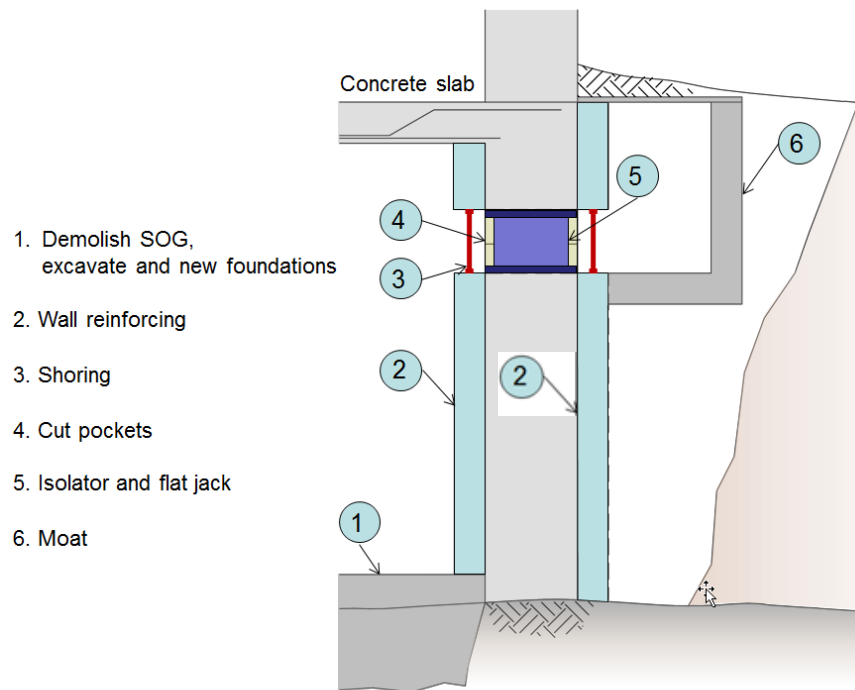


Figure 10 - Schematic diagram of base isolator installation at exterior wall

The isolators are then installed on top of the new concrete piers. A similar process has been allowed for the Peace Tower but with a more complicated shoring procedure. The diaphragm upgrade has included removing some of the existing topping and non-load bearing partitions, and replacing that topping with a reinforced concrete diaphragm. The base isolation seismic upgrade requires the installation of a retaining wall and cover around the building to create a “moat” that allows for the movement of the structure.

An allowance has been made for the reinforcement of the Upper Tower of the Peace Tower and the Water Towers of the Centre Block because these more slender elements often do not benefit from base isolation as much as stiffer components.

An allowance has been made for the seismic restraint of the few operational and functional components and secondary structural elements that would still be required with base isolation.

1.3 Methodology

The cost estimate was completed with the assumption that the seismic upgrade would take place in the context of an overall building rehabilitation project. Allowances or costs have not been included for the removal, installation or impact of architectural elements or finishes, or other building systems, for either seismic upgrade option.

A very preliminary structural design was completed in order to arrive at some parameters to be used in the cost estimate. Based upon the preliminary design, quantities of materials were calculated or assessed. Reasonable unit rates, taking into account the quantities and probable level of difficulty were used to arrive at the cost estimate of different components of the structural system. One

exception is the rate of rock excavation within the Centre Block of \$2,400/m³, which was provided by PWGSC. Where the quantities or the procedures are not known at this time and more detailed analysis is required, a reasonable allowance has been included.

1.4 Limitations

- < No party other than the Client shall rely on the Consultant's work without the express written consent of the Consultant. The scope of work and related responsibilities are defined in the Conditions of Assignment. Any use which a third party makes of this work, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Decisions made or actions taken as a result of our work shall be the responsibility of the parties directly involved in the decisions or actions. Any third party user of this report specifically denies any right to any claims, whether in contract, tort and/or any other cause of action in law, against the Consultant (including Sub-Consultants, their officers, agents and employees).
- < The work reflects the Consultant's best judgement in light of the information reviewed by them at the time of preparation. Unless otherwise agreed in writing by Halsall, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. This is not a certification of compliance with past or present regulations. No portion of this report may be used as a separate entity; it is written to be read in its entirety.
- < No physical or destructive testing and no design calculations have been performed unless specifically recorded. Conditions existing but not recorded were not apparent given the level of study undertaken. Only conditions actually seen during examination of representative samples can be said to have been appraised and comments on the balance of the conditions are assumptions based upon extrapolation.
- < Only the specific information identified has been reviewed. The Consultant is not obligated to identify mistakes or insufficiencies in the information obtained from the various sources or to verify the accuracy of the information.
- < Halsall is not investigating or providing advice about pollutants, contaminants or hazardous materials. This work is included only in the mandate of the environmental consultant
- < Budget figures are our opinion of a probable current 2015 dollar value of the work and are provided for approximate budget purposes only. Accurate figures can only be obtained by establishing a scope of work and receiving quotes from suitable contractors. We have no control over the cost of labour and materials or of market conditions. This report does not guarantee that bids or actual construction costs will not vary from the values given.



2. DOCUMENTATION

This cost estimate has been prepared based on the following documents:

- A variety of original architectural and structural drawings prepared by architects John Pearson and Jean-Omer Marchand, dated from 1916 to 1927;
- Original structural steel floor plan shop drawings prepared by the Dominion Bridge Co., dated to 1916;
- Centre Block “As-Found” drawings, prepared by the Heritage Conservation Directorate, Professional and Technical Service Management and PWGSC in 2002;
- Various Centre Block and Peace Tower alteration drawings, including:
 - Centre Block Underground Services Building;
 - Centre Block Chimney Stabilization Phase I;
 - Alterations & Additions Centre Block (1971 Courtyard Additions);
 - Fullers Gargoyle repair;
 - Extension to East & West Penthouses at South Corridor Elevators;
 - Centre Block South – Conservation;
 - Centre Block Phase 1 Renovations (1987 Stairwell extensions);
 - Centre Block Ventilation Towers Rehabilitation Project;
 - Peace Tower Alteration Parliament Hill (1980); and
 - Peace Tower Conservation of Masonry (1994).
- Scans of selected specifications, construction reports and letters prepared by John Pearson during the original construction;
- Photographs from the original construction period and several more recent restoration and repair projects; and
- Various Centre Block and Peace Tower studies and reports.



3. COST CONSIDERATIONS

3.1 BASE COST

The estimated costs included in this report are based on competitive bids being received by at least six (6) general contractors and at least four (4) sub-contractors for each trade. If the minimum number of general contractors and/or sub-contractors are not met, the bids received could exceed the estimate.

3.2 UNIT RATES

The unit rates used in this report include all labour and material, equipment, and subcontractor's overhead and profit.

3.3 TAXES

Taxes have not been included. It is recommended that PWGSC make provision for this in their project budget.

3.4 OWNER REVIEW

Halsall recommends that PWGSC carefully review this report for scope, individual item descriptions, unit prices and all assumptions stated. Any questions, comments or clarifications should be brought to our attention so the report can be amended as required.

3.5 EXCLUSIONS

The following items are not included in this cost estimate:

- Professional fees and expenses (it should be noted that professional fees may be higher for a base isolation design given the requirement to have the design evaluated by an independent 3rd party peer review;
- Design contingency;
- Construction contingency;
- Cost escalation beyond May 2015;
- General requirements;
- General contractor's fees;
- Cost of removal of hazardous materials;
- General demolition costs unless specifically identified in this estimate;
- Protection of heritage fabric of the building;
- Removal or replacement of finishes;

- General repair and rehabilitation of the exterior or interior masonry walls;
- Temporary enclosures;
- PWGSC internal management costs;
- Phased construction;
- Restriction on working hours and overtime;
- Legal fees and costs;
- Building permit fees;
- Taxes;
- Cash allowances; and
- Winter construction.

3.6 Limitations of This Estimate

This High Level Cost Estimate is meant to provide an order of magnitude of cost of only the structural elements of two seismic upgrade options described in Halsall's report: Supplemental Seismic Report for Centre Block (Work Package 3). Halsall has no control over the cost of labour and materials, as these are based on market conditions and pricing strategies of each contractor bidding on the project. Accurate prices can only be obtained by inviting bids based on final plans and specifications. The cost estimate included herein is only our opinion.

CONSTRUCTION COST ESTIMATE SUMMARY

OPINION OF PROBABLE HIGH LEVEL COST OF CONVENTIONAL UPGRADE OF CENTRE BLOCK USING CONCRETE SHEARWALLS								
ITEMS	L (m)	W (m)	H (m)	Quantity	Total	Units	Unit Rate	Cost
Works related to foundations for concrete shear walls (76)								
Remove basement slab on grade	144	75			10,800	m ²	\$ 500	\$ 5,400,000
Allow for lowering the existing floor level by 1.5 m (interior rock removal)	144	75	1.5		16,200	m ³	\$ 2,400	\$ 38,880,000
Interior basement rock removal at footings for shearwalls	10	5	1.2	76	4,560	m ³	\$ 2,400	\$ 10,944,000
Concrete for foundations	10	5	1.2	76	4,560	m ³	\$ 500	\$ 2,280,000
Formwork for foundations	30		1.2	76	2,736	m ²	\$ 250	\$ 684,000
Rebar (6400kg per footing)				76	486,400	kg	\$ 5	\$ 2,432,000
New rock anchors (4 per footing)					304	ea.	\$ 15,000	\$ 4,560,000
New slab on grade	144	75			10,800	m ²	\$ 200	\$ 2,160,000
Works related to concrete shear walls (76)								
Concrete for walls	6	0.5	29	76	6,612	m ³	\$ 500	\$ 3,306,000
Formwork for walls	12	1	29	76	28,652	m ²	\$ 250	\$ 7,163,000
Rebar (305kg/m ³) including dowels					2,016,660	kg	\$ 5	\$ 10,083,300
Area of floor to be removed and re-built (7 floor levels)	9	1.5		532	7,182	m ²	\$ 700	\$ 5,027,400
Works related to Diaphragm upgrade								
Remove existing topping					42,000	m ²	\$ 100	\$ 4,200,000
Remove terracotta partitions					31,000	m ²	\$ 300	\$ 9,300,000
New concrete for topping					42,000	m ²	\$ 125	\$ 5,250,000
Floor finishing					42,000	m ²	\$ 25	\$ 1,050,000
Rebar (420,00mx0.8kg/m)					336,000	kg	\$ 3	\$ 1,008,000
Steel angles (20,600mx7.3kg/m)					150,380	kg	\$ 5	\$ 751,900
Steel studs on existing beams					8,900	ea.	\$ 25	\$ 222,500
Drilled anchors					68,000	ea.	\$ 100	\$ 6,800,000
Sloped roof in-plane bracing and anchorage					2,200	m ²	\$ 1,000	\$ 2,200,000
Works related to Water Tower upgrade								
Total cost from construction estimate for Ventilation Towers from Hanscomb								\$ 6,000,000
Works related to Peace Tower								
Reinforcement of the Upper Tower								\$ 250,000
Pier upgrade (new Dywidag bars each pier)					4	ea.	\$ 125,000	\$ 500,000
Masonry reinstatement after installation of Dywidag bars		0.8	35	8	224	m ²	\$ 3,000	\$ 672,000
Spandrel beam over Porte Cochere (590kg/m structural steel for 5m)					1	ea.	\$ 50,000	\$ 50,000
Spandrel beam over Memorial Chamber (590kg/m structural steel for 5m)					3	ea.	\$ 50,000	\$ 150,000
Spandrel over Memorial Chamber north face(590kg/m structural steel for 5m; shoring, anchorage; removal of existing beam)					1	ea.	\$ 100,000	\$ 100,000
Spandrel beams over Bell Chamber (540kg/m structural steel for 6.0 m)					4	ea.	\$ 50,000	\$ 200,000



Seismic Restraint of OFCs and Secondary Structural								
<i>Seismic restraint of:</i>								
Partitions					31,000	m ²	\$ 5	\$ 155,000
Sculptures					500	ea.	\$ 1,000	\$ 500,000
Terra cotta fireproofing tiles					33,300	m ²	\$ 50	\$ 1,665,000
Existing heritage ceilings					8,000	m ²	\$ 100	\$ 800,000
New suspended ceilings					34,400	m ²	\$ 5	\$ 172,000
Heavy light fixtures					70	ea.	\$ 1,000	\$ 70,000
Grotesques					30	ea.	\$ 5,000	\$ 150,000
Skylights					4	ea.	\$ 25,000	\$ 100,000
Cantilevered masonry walls (anchors)					610	ea.	\$ 500	\$ 305,000
Sub-total (Structural costs only)								\$ 134,869,100



OPINION OF PROBABLE HIGH LEVEL STRUCTURAL COST OF SEISMIC ISOLATION RETROFIT OF CENTRE BLOCK								
ITEMS	L (m)	W (m)	H (m)	Quantity	Total	Units	Unit Rate	Cost
Exterior moat to allow seismic movement								
Exterior soil excavation	474	4	4		7,584	m ³	\$ 50	\$ 379,200
Exterior rock excavation (allowance)					100	m ³	\$ 300	\$ 30,000
Backfill	474	3	4		5,688	m ³	\$ 100	\$ 568,800
Moat cover	474	4			1,896	m ²	\$ 200	\$ 379,200
Retaining wall formwork (2 surfaces)	948		4		3,792	m ²	\$ 250	\$ 948,000
Concrete for retaining wall and footing	474	8	0.4		1,517	m ³	\$ 500	\$ 758,400
Rebar (60kg/m ³ of concrete)					91,008	kg	\$ 5	\$ 455,040
Works related to exterior basement wall								
<i>New continuous concrete beam below ground floor</i>								
Concrete	474	1	0.6		284	m ³	\$ 500	\$ 142,200
Formwork (3 faces: 1.2+.6+.6=2.4m)	474	2.4			1,138	m ²	\$ 250	\$ 284,400
Rebar (60 kg/m ³ of concrete)					17,064	kg	\$ 5	\$ 85,320
Dowels across existing wall (at 600mm c/c)					790	ea.	\$ 200	\$ 158,000
<i>New piers at isolator location (68 piers)</i>								
Rock excavation	1.5	1.5	0.3	68	46	m ³	\$ 300	\$ 13,770
Concrete	1	1	3	68	204	m ³	\$ 500	\$ 102,000
Formwork	4		3	68	816	m ²	\$ 250	\$ 204,000
Rebar (60 kg/m ³ of concrete)					12,240	kg	\$ 5	\$ 61,200
Rock anchors (4 each pier.)					272	ea.	\$ 3,000	\$ 816,000
Works related to the interior basement								
<i>Replace existing columns with new concrete piers supporting isolators</i>								
Remove existing basement slab	144	75			10,800	m ²	\$ 500	\$ 5,400,000
Allow for lowering the existing floor level by 1.5 m. This includes hand-held compressor tools for removal of rock.	144	75	1.5		16,200	m ³	\$ 2,400	\$ 38,880,000
Install shoring at each column (104 columns)					104	ea.	\$ 10,000	\$ 1,040,000
Remove columns in the basement in pre-designed sequence					104	ea.	\$ 2,000	\$ 208,000
Rock excavation for new piers	2	2	0.3	104	125	m ³	\$ 2,400	\$ 299,520
Concrete for new piers	1	1	3	104	312	m ³	\$ 500	\$ 156,000
Formwork for new piers	4		3	104	1,248	m ²	\$ 250	\$ 312,000
Rebar (60 kg/m ³ of concrete)					18,720	kg	\$ 5	\$ 93,600
Rock anchors (4 each pier.)					416	ea.	\$ 3,000	\$ 1,248,000



<i>Replace existing walls (1136m) below ground floor with new concrete beams and piers supporting isolators</i>								
<i>New Concrete beams below ground floor</i>								
Concrete	1136	1	0.8		909	m ³	\$ 500	\$ 454,400
Formwork (3 faces: 1+.8+.8= 2.6m)	1136	2.6			2,954	m ²	\$ 250	\$ 738,400
Rebar (60 kg/m ³ of concrete)					54,528	kg	\$ 5	\$ 272,640
Install shoring (166 locations)					166	ea.	\$ 10,000	\$ 1,660,000
Remove existing walls	1136		2		2,272	m ²	\$ 300	\$ 681,600
<i>New piers supporting concrete beams</i>								
Concrete	1	1	3	166	498	m ³	\$ 500	\$ 249,000
Formwork (4 faces)	4		3	166	1,992	m ²	\$ 250	\$ 498,000
Rebar (60 kg/m ³ of concrete)					29,880	kg	\$ 5	\$ 149,400
Rock anchors (4 each pier.)					1,600	ea.	\$ 3,000	\$ 4,800,000
Works related to diaphragm upgrade of upper levels								
Remove existing topping					20,000	m ²	\$ 100	\$ 2,000,000
Remove terracotta partitions					14,400	m ²	\$ 300	\$ 4,320,000
Place new concrete topping (65mm thick, 20000 sq.m.)					20,000	m ³	\$ 125	\$ 2,500,000
Concrete finishing					20,000	m ²	\$ 25	\$ 500,000
Rebar (200,000m x 0.8 kg/m)					160,000	kg	\$ 3	\$ 480,000
Steel angles (9,700m x 7.3kg/m)					70,810	kg	\$ 5	\$ 354,050
Shear studs on existing steel					4,200	ea.	\$ 25	\$ 105,000
Drilled anchors					32,000	ea.	\$ 100	\$ 3,200,000
Sloped roof in-plane bracing and anchorage					2,200	m ²	\$ 900	\$ 1,980,000
Works related to Water Tower upgrade								
Revised cost from Hanscomb estimate for Ventilation Towers								\$ 5,400,000
Works related to Peace Tower								
Underground foundation work to install isolators								\$ 5,000,000
Reinforcement of the Upper Tower								\$ 250,000
Works related to base isolators								
Supply and delivery of isolators (338)								\$ 3,400,000
Install isolators, including jacking (338)								\$ 5,100,000
Base isolators testing								\$ 500,000
Seismic Restraint of OFCs and Secondary Structural								
<i>Seismic restraint of:</i>								
Existing heritage ceilings					8,000	m ²	\$ 100	\$ 800,000
New suspended ceilings					34,400	m ²	\$ 5	\$ 172,000
Heavy light fixtures					70	ea.	\$ 1,000	\$ 70,000
Grotesques					30	ea.	\$ 5,000	\$ 150,000
Skylights					4	ea.	\$ 25,000	\$ 100,000
Cantilevered masonry walls (anchors)					610	ea.	\$ 500	\$ 305,000
Sub-total (Structural costs only)								
								\$ 99,212,140

