LIFE CYCLE ASSESSMENT - CENTER FOR INTERACTIVE RESEARCH ON SUSTAINABILITY (C I R S)

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CIVL 498C

November 19, 2013

PROVISIO

This study has been completed by undergraduate students as part of their coursework at the University of British Columbia (UBC) and is also a contribution to a larger effort – the UBC LCA Project – which aims to support the development of the field of life cycle assessment (LCA).

The information and findings contained in this report have not been through a full critical review and should be considered preliminary.

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CIVIL 498C

LIFE CYCLE ASSESSMENT - CENTER FOR INTERACTIVE RESEARCH ON SUSTAINABILITY (C I R S)

FINAL REPORT

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2013/11/19

Executive Summary

The Centre for Interactive Research on Sustainability (CIRS) located on 2210 West Mall; is one of the greenest buildings in British Columbia at its time of construction - developed primarily in response to the challenge of creating a more sustainable society. The LCA study was completed at the request of UBC Social Ecological Economic Development Studies (SEEDS) to transparently communicate the environmental benefits of University's first net-zero energy and regenerative building and further pave the ways for similar future ventures. Although first of its kind study of a Green Building in UBC, CIRS LCA study is a part of UBC wide academic building LCA data repository and would contribute to knowledge built up of that database.

A formulated approach as per ISO 14044 standard, was adopted to complete the LCA study as comprehensively as possible. The approach was carried off from quantity take-off using Onscreen TakeOff software, to preparing as thorough an sorting 3 level element & assemblies as was possible from the available information, modeling was done with Athena Impact Estimator which has one of the largest life cycle inventory database in North America. Assumptions and

According to the bill of material and summary measure of each level 3 element, which of their performance should be compared. The output data of product stage and construction process stage of CIRS building and each level 3 element.

From the analysis it is evident that CIRS stand up to the test of being sustainable and contributing positively towards its environment. Despite the challenges of whole building LCA study we are confident that this study would be a contribution towards knowledge built up and would encourage further such studies; strengthening the process and providing knowledge based information tool for future policies.

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1.General Information on the Assessment

1.1 Purpose of the assessment

1.1.1 Intended application.

This LCA study will be used in the ways: Conduct a study as a proof of concept for the sustainability claim of CIRS (LEED Platinum) by ascertaining the environmental impact footprint of this first-of-its-kind regenerative building. Model developed for this study is intended to be a factual knowledge contribution and testing ground for newer tools of Life cycle inventory; for that will be used to create further avenues for future Green building LCA studies.

1.1.2 Reasons for carrying out the study.

The LCA study was completed at the request of UBC Social Ecological Economic Development Studies (SEEDS) to transparently communicate the environmental benefits of University's first net-zero energy and regenerative building and further pave the ways for similar future ventures. Secondly, the report itself is an educational asset to help disseminate education on LCA and help further the development of this scientific method into sustainability in building construction practices at UBC and the green building industry. This study, therefore, contributes to a pool of knowledge for propagating LCA understanding and practices that are gaining acceptance at all scales of sustainable construction standards and corporate social responsibility policy.

1.1.3 Intended audience

The results of this study are to be primarily communicated to the public. In addition to the general public, the LCA report is intended as a knowledge benchmark to encourage researchers and practitioners to further develop LCA studies on sustainable green buildings.

1.1.4 Intended for comparative assertions

The intended for comparative assertions that describes state whether the results of this LCA study are to be compared with the results of other LCA studies. There were no comparative assertion made within the study of CIRS building, however as it is a part of a larger database, the study can be used for comparative assertions with other UBC building LCA studies.

1.2 Identification of building

The Centre for Interactive Research on Sustainability (CIRS) located on 2210 West Mall is one of the greenest buildings in UBC. The Centre for Interactive Research on Sustainability (CIRS) was developed in response to the challenge of creating a more sustainable society. Its intention is to be an internationally recognized research institution that accelerates the adoption of sustainable building technologies and sustainable urban development practices in society. CIRS was designed to be the most innovative and high performance building in North America at the time of its construction. Integrated building systems, comprehensively monitored and centrally controlled, are designed to meet goals of zero carbon emissions, water self-sufficiency, net-positive energy performance and zero waste.

The building itself acts as a "living laboratory" that allows research and investigation of current and future sustainable building technologies, as well as the impact of inhabitant's actions and engagement with the systems. Partners from private, public, and non-government organization sectors share the research facility, working with dedicated CIRS researchers to identify areas for innovation in sustainable technologies and practices and to create a springboard for their development and widespread implementation.

As a concept and a process, CIRS has been an ongoing venture since 1999. The project went through three different iterations, at different sites and with different owners and inhabitants over that time. Dr. John Robinson proposed an idea to create a "BC Showcase" for the CIRS program. CIRS was constructed with a total cost of $23 Million and was officially inaugurated in September 2011.

CIRS building is 5,675 m2 (61,085 ft^2) on a site area of 2,008 m2 (21,614 ft^2). The structure is comprised of a pair of four-storey office/lab blocks running east west, linked by an atrium which acts as building lobby and entry to a 450-seat lecture auditorium for general campus use. The program of interior spaces contains a mix of academic office spaces, dry labs, meeting rooms, social spaces and service spaces. The basement of the building holds building services, storage facility, a locker and shower facility, and electrical, mechanical and plumbing spaces for the building systems

Figure 1 - Center for Interactive Research on Sustainability

Figure 2 - Rendering Initial CIRS design

1.3 Other Assessment Information

The table below is a summary of general assessment information. This help better to understand the system of the study. The project was complete reference to life cycle assessment on CIRS building completed on 2011.

Table 1 Information on assessment

Client for Assessment	Completed as coursework in Civil Engineering technical elective course at the University of British Columbia.
Name and qualification of the assessor	Jian Sun, MEng Civil Engineering Student
Impact Assessment method	On Screen TakeOff Version 3.9.0.6 "Cradle to Gate" method Athena impact estimator for building Version4.2.0208
Point of Assessment	2 years
Period of Validity	5 years.
Date of Assessment	Completed in December 2013.
Verifier	Student work, study not verified.

2.0 General Information on the Object of Assessment

2.1 Functional Equivalent

Functional unit

A performance characteristic of the product system being studied that will be used as a reference unit to normalize the results of the study.

Definition of the functional unit or performance characteristics is the foundation of an LCA ,

because the functional unit sets the scale for comparison of two or more products including improvement to one product (system). All data collected in the inventory phase will be related to the functional unit. When comparing different products fulfilling the same function, definition of the functional unit is of particular importance.

One of the main purposes for a functional unit is to provide a reference to which the input and output data are normalized. A functional unit of the system shall be clearly defined and measurable. The result of the measurement of the performance is the reference flow.

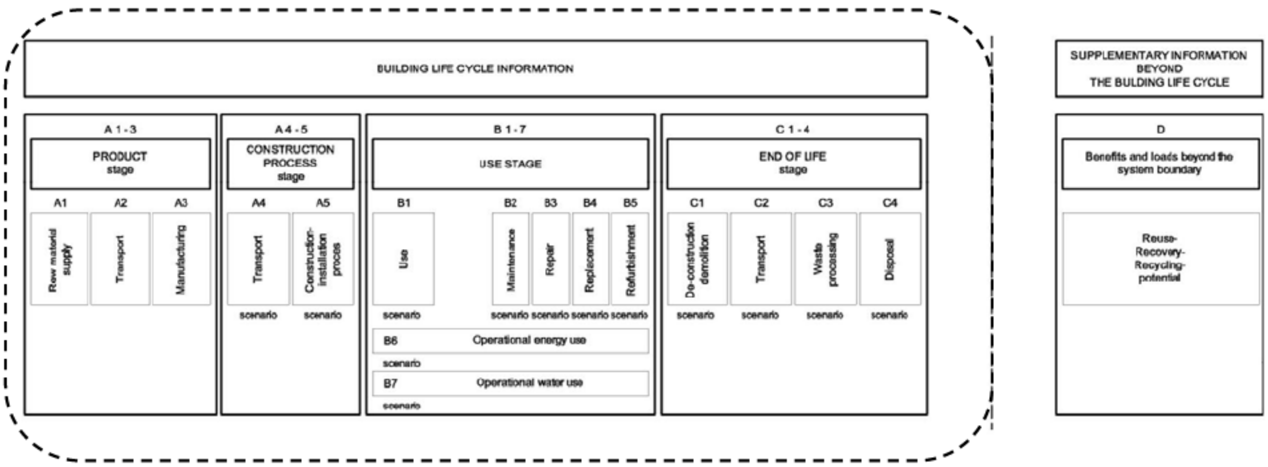
Comparisons between systems shall be done on the basis of the same function, measured by the same functional unit in the form of equivalent reference flows..

Table.2 Functional Equivalent Definition

Aspect of Object of Assessment	Description
Building Type	A space for multidisciplinary education and research
Technical and functional requirements	LEED (Leadership in Energy and Environmental Design) Green Building Rating System™ and The Living Building Challenge (LBC). The Science and Technology Commons, Sustainability Education Resource Centre, **BC** Hydro Theatre, Policy Lab, Building Simulation Software Lab, Solar Simulation Daylighting Lab, Building Monitoring and Assessment Lab, CIRS Lecture Hall (Modern Green Auditorium), CIRS Inhabitants' space
Pattern of use	Monday to Friday (0800-1730), Sat/Sun/Holidays closed
Required service life	60 years or longer.

2.2 Reference Study Period

According to EN 15978, the default value for the reference study period shall be the required service life of the building. The full Life Cycle Assessment for the CIRS building from resource extraction (cradle) to use phase and disposal phase (grave). However, In order to fully study the whole process of building cycle, use of service life as study period is required, the “cradle to gate” method is used to develop the LCA study. thus it can be seen that The reason to use service life as study period is LCA highlight the life cycle of the CIRS building from material production to construction process in this particular study developed for the table blow.



system boundary

Figure 3 Building LCA System Boundaries According to EN 15804/15978

2.3 Object of Assessment Scope

The product system being studied in this LCA are the structure and envelope of the CIRS building on a square foot finished floor area of academic building basis. In order to focus on design related impacts, this CIRS building LCA study encompasses a cradle-to-gate scope that includes the raw material extraction, manufacturing of construction materials, and construction of the structure and envelope of the CIRS Building, as well as associated transportation effects throughout.

According to EN15978, the object of assessment should include the building, from its foundations to the external works enclosed within the area of the building’s site, over the reference study period. Any deviations from this scope need to be clearly made from EN 15978. This bill of materiel utilizes the Athena Life Cycle Inventory (LCI) Database, in order to generate a cradle-to-grave LCI profile for the building. In this study, LCI profile results focus on the manufacturing (inclusive of raw material extraction), transportation of construction materials to site and their installation as structure and envelope assemblies of the Angus Building. As the CIRS building of LCA study, is a cradle-to-gate assessment, the expected service life of the CIRS Building is set to 1 year, which results in the maintenance, operating energy and end-of-life stages of the building's life cycle being left outside the scope of assessment.

According to the Canadian Institution of Quantity Surveyors (CIQS), the IE input document was sorted by using of level 3 elements with some adjustment to suit the scope of CIRS building assessment. The assemblies of the CIRS building that are modeled include footings, slab on grade, column and beams, floors, stairs, walls, roofs, interior doors and windows opening and their associated envelope. Some of the components in CIQS level 3 elements such as shoring, finishes, exterior doors and screens, and interior door frame and hardware were omitted in the object of assessment because of limitations of available data and the IE software, as well as to minimize the uncertainty of the model.

The quantity takeoffs for each element were calculated using combination of CIRS building architectural drawings and OnScreen TakeOff file provided from 2012 study. Table 3 below summarize the information for CIQS level 3 elements. Obviously, the measurement for both A21 foundation and A22 lowest floor construction are the sum of total area of the slab-on-grade. A22 upper floor construction is measured using the sum of the total area of all upper floors. Sum of total area of the roofs measured from outside face of exterior wall was used for A23 roof construction quantity measurement. A31 walls below grade and A32 walls above grade were calculated using the sum of total surface area of exterior wall above and below grade. Finally, B11 partition section is measurement of sum of the total surface area of interior walls.

Table 3 Building Definition for the sorted level 3 elements

CIVIL 498C Level 3 Elements	Description	Quantity (Amount)	Units
A11 Foundation	Wall and column footings.	1309	M^2
A21 Lowest Floor Construction	The slab-on-grade.	1439.8	M^2
A22 Upper Floor Construction	All upper floor(s) measured from the outside face of the exterior walls.	3635	M^2
A23 Roof Construction	The roof(s) measured from the outside face of the exterior walls.	1854	M^2
A31 Walls Below Grade	The exterior walls above grade.	1877.4	M^2
A32 Walls Above Grade	The exterior walls below grade that include curtain walls, walls cast in place and concrete block.	6900.5	M^2
B11 Partitions	The interior walls, door opening, window opening and envelope.	2543.9	M^2

3.0 Statement of Boundaries and Scenarios Used in the Assessment

3.1 System Boundary

System Boundary-Details the extent of the product system to be studied in terms of product components, life cycle stages, and unit processes.

The ISO standards indicate that inputs to a product or process do not need to be included in an LCI if they do not represent a significant fraction of the total mass of processed materials or product, they do not contribute significantly to a toxic emission, and they do not represent a significant amount of energy.

The selection of the system boundary shall be consistent with the goal of the study (ISO 14044); for the LCA study of the CIRS building, we are only modeling processes from construction product manufacturing till building construction process. Any processes beyond and after our system boundary, is not part of this study and such should be well understood prior to any comparative assertions with other products with varied boundary conditions, for example, existing building/site preparation. Figure 3 inserted in the previous give a general perspective of modular information for the different stages of the building assessment based on default EN 15798 LCA standard.

For building life cycle and its' sub stages, they both have their own upstream and downstream. Upstream is towards energy and resource extraction as well as downstream is towards use and waste handling. For building life cycle, module A is upstream and modules B, C are downstream. Each module also has its upstream and downstream, like for production stage, the upstream is: raw material supply, and downstream is manufacturing. For construction process stage, the upstream is transport and the downstream are construction insulation process.

3.2 Product Stage

The product stage is also known as "cradle to gate" for the building products. Cradle-to-gate is an assessment of a partial product life cycle from resource extraction (cradle) to the factory gate. The use phase and disposal phase of the product are omitted in the whole building LCA. [1] The product stage includes three sub process: raw material supply, transport and manufacturing modules. The LCA models developed to describe the impacts were created in the Impact Estimator software “Athena EI” using the unit processes, within the main processes, illustrated previously in Figure 4.

The energy use in raw material supply include all the active in order to extract the raw resources. The development of life cycle inventory data starts here, by tracking energy use and emissions to air, water and land per unit of resource. The transportation of raw resources

For the concrete construction product of CIRS building After the raw material acquisition completed, the material will be either delivered to a concrete mixing plant to produce concrete for construction and then concrete will be ship to construction site to cast in place, or concrete block would be form at manufacture and concrete block will be shipped to construction site for installation.

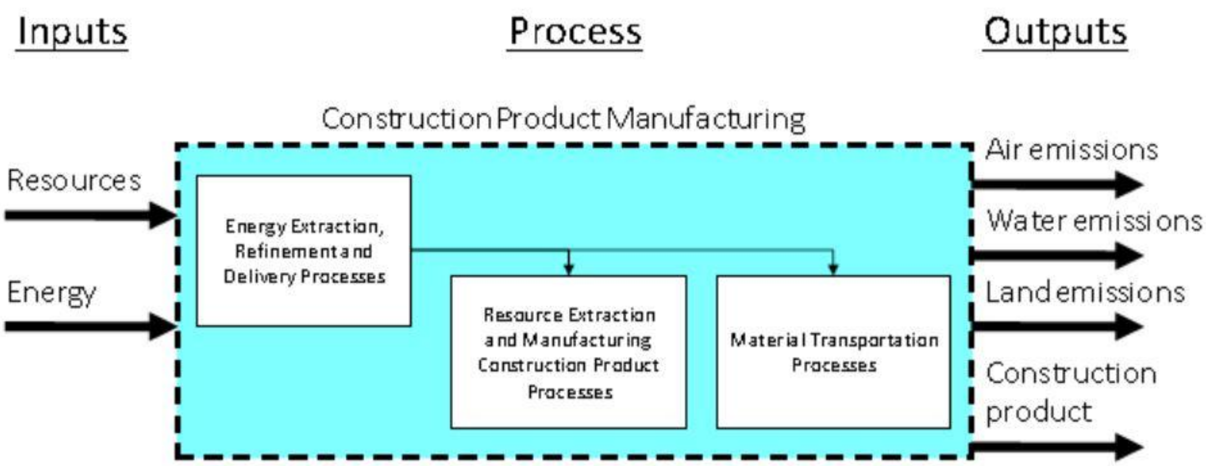


Figure 4 - Manufacturing Construction materials by Impact Estimator software.

3.3 Construction Stage

For the construction stage of CIRS building, the construction material from upstream process (construction product) to construction site, and on-site construction. Athena building impact estimator evaluate the construction stage for the CIRS building and the process of the construction stage is shown blow see figure 5.

The transport distance should be considered from material/ component manufacture place to construction site in term of the transportation of construction stage. The construction process stage divide the stage into two process module: transport and construction installation. Onsite construction could be considered as an additional step for manufacture that individual components are installed according to form the building structure. The individual assemblies was transported from manufactory location at the stage starts. In order to account for transport distance, an average of the transportation distance site are applied for some major cities. This is an important life cycle stages that is often omitted in LCA for the product. In addition to building product transportation, waste generation, and the energy use of machines like cranes and mixers, the on-site construction activity stage includes such items as the transportation of equipment to and from the site, concrete form-work, and temporary heating and ventilation.[2]

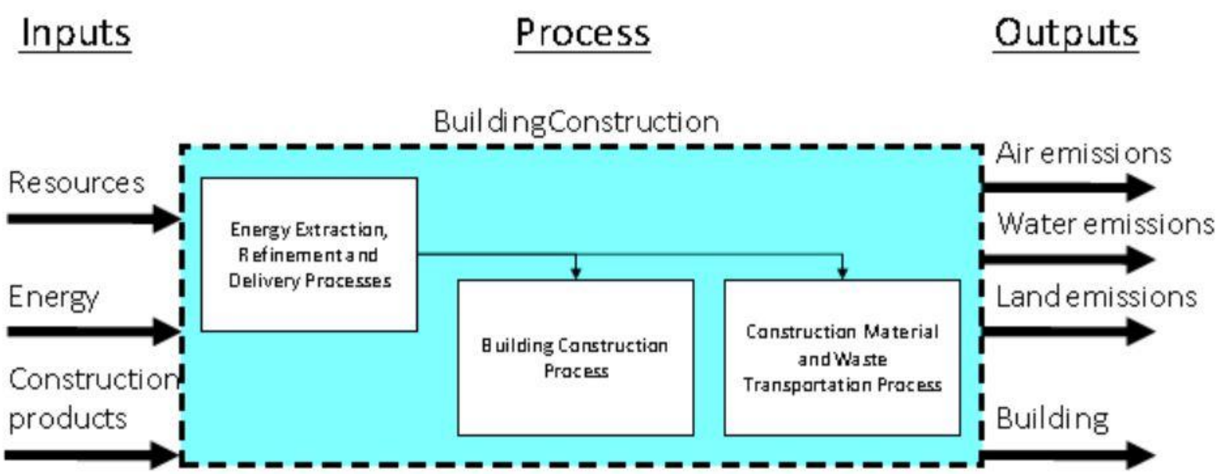


Figure 5 - Building Construction by Impact Estimator software

4. Environmental Data

4.1 Data Sources

4.1.1 Athena LCI Database

Athena research teams follow common building materials from cradle-to-grave to calculate the environmental effects at each stage in the product's life cycle.

From the beginning, the Athena Institute has been conducting life cycle research, developing an ever-growing set of comprehensive, comparable life cycle inventory (LCI) databases for building materials and products. In fact, most of the research at Athena goes into developing, verifying and updating the databases that form the basis of the Athena software tools.

Athena experts conduct research independently to accomplish core program objectives, and work with industry to conduct thorough life cycle inventories. For example, in its original gypsum wallboard study, Athena studied not only regular gypsum board, but also the related finishing tapes and muds as well as fire resistant, moisture resistant, shaft-liner, mobile home and gypsum fiberboard. As a result, Athena provides users of its software tools with an unparalleled level of detail and specificity.

The Athena Institute has developed data not only for building materials and products but also for energy use, transportation, construction and demolition processes including on-site construction of a building's assemblies, maintenance, repair and replacement effects through the operating life, and demolition and disposal. [3]

Athena's databases are regionally sensitive, taking into consideration manufacturing technology, transportation and electricity grid differences as well as recycled content differences for products produced in various regions. Athena databases are built from the ground up using actual mill or engineered process models and are not reliant on trade or government data sources. [3]

Maintenance of Athena materials databases is often supported by research contracts from industry. However, updating the life cycle inventory data for construction systems and processes, for demolition and end-of-life processes, for missing materials and systems not otherwise funded, and for improvements in the software tools themselves requires support from Athena membership fees and from research grants. This core support enables Athena to move its data and tools to the next generation of construction sector demands.[3]

4.1.2 US LCI Database

NREL and its partners created the U.S. Life Cycle Inventory (LCI) Database to help Life Cycle Assessment (LCA) experts answer their questions about environmental impacts.

This database provides a cradle-to-grave accounting of the energy and material flows into and out of the environment that are associated with producing a material, component, or assembly. The critically reviewed LCI data are consistent with a common research protocol and with international standards. The LCI data support efforts to develop product LCAs, support systems, and LCA tools.

NREL's U.S. LCI Database is a collection of unit processes. PE INTERNATIONAL has integrated this database into GaBi format. The result: the NREL U.S. LCI Integrated - available to all GaBi software users free of charge upon request. [4]

When you're used to working with cradle-to-gate datasets, the US LCI Database's unit processes may present a challenge and for many they are not directly applicable in practical LCA studies. PE INTERNATIONAL has taken these unit processes and modelled them back to the cradle using the U.S. boundary conditions for energy, upstream processes and resources, thereby adding value to the U.S. LCI Database for GaBi users. [4]

4.2 Data Adjustments and Substitutions

Table 4 Material Types and Property Inaccuracies Table

Level 3 Element	Geometry Measurement (ex. height, length, thickness takeoffs for wall or material, door/window counts)		Type and Property Selection (ex. concrete strength, rebar size, roof/floor loading, etc.)	
	Description of Inaccuracy (ies)	IE Input(s) Effected	Description of Inaccuracy (ies)	IE Input(s) Effected
A11 Foundations	N/A	N/A	Unknown % flyash, thickness, and concrete, assumption must be made	Concrete SoG_Mech Mat_150mm
A21 Lowest Floor Construction	Inconsistent area measurement for Athena and on-screen take off	Floor_F10_SLAB-ON-GRADE	Unknown % concrete flyash, thickness, and material, assumption must be made	Floor_F10_SLAB-ON-GRADE
A22 Upper Floor Construction	Unknown area measurement for Athena and on-screen take off	LAMINATED WOOD	Unknown Category and Material, assumption must be made	LAMINATED WOOD
A23 Roof Construction	Unknown area measurement for Athena and on-screen take off	Green roof, Roof_R2_LAMINATED-WOOD-PAVING-STONE	The TPO was used but IE model is EPDM white.	The EPDM white is basically same as TPO
A31 Walls Below Grade	Inconsistent inputs of Length between excel and Athena for Wall of the basement	Wall_Cast-in-place_E1-SW5_Basement	Inconsistent material of the basement wall, assumption must be made	Wall_Cast-in-place_E1-SW5_Basement
A32 Walls Above Grade	N/A	N/A	Unknown Category and Material, assumption must be made	Wall Steel Stud

B11 Partitions	N/A	N/A	Unknown the Sheathing Type, Stud Spacing, Stud Weight, and Stud Thickness of Steel Stud	Wall_Wood stud_Steel stud_WA7.3_

According to the information of CIRS building LCA study from table 4. it can be obtain that the improvement strategies were applied to improve the data accuracy. For example, the construction area was recalculated for inconsistent measurement on excel input and Athena IE input, and inaccurate measurement input was corrected; Inconsistent material for wall and roof was input and in order to improve the data accuracy to replace with similar material; Some of the material data accuracy improvement strategies are suggested such as improvement on Athena LCI database and site visit to collect information. After the above improvement is completed, nevertheless, There are a number of the inaccuracy for the CIRS building and they need to be improved.

4.3 Data Quality

Data quality describes the characteristics of the data. The five types of uncertainties in LCA study were described in the section, which are database, model, temporal, spatial and variability between sources respectively. According to the collection/allocation method used to generate data, availability or accuracy of the LCI database, uncertainty of service life of product, and differences in transport potential, the data uncertainty could be produced by the reason of above. Data uncertainty also could impact LCI and LCA study.

Modeling uncertainty could be inputted in difference between linear and nonlinear modeling, For example, the length of a specific component (wall length) for the linear assessment. it result could affect by unknown potential effect of characterization factor. Some of the simplified model could be generated by the characteristic of model uncertainty, because there may be unknown interaction between building parameters.

Temporal uncertainty is occurred due to time difference such as waste emission rate varies in different year, or data vintage. The impact result could be affected because of different interpretation over time..

Spatial uncertainty is due to difference in regions. According to the production standard for material were generated in factories, so the factories located at different regions. Also, different region could potentially have varied sensitivity towards different environmental impact. the Athena LCI and US LCI database adapt North American standard for the its development of . Thus, the uncertainty in CIRS building LCI data source is mitigated.

Variability between data sources is due to difference in technologies that the product is produced. Also, it could be caused by different human exposure pattern. (eg, high population density vs. low population density of the area.

Overall, OnScreenTakeOff software were used for quantity take off to reduce the potential uncertainty in LCI data source. Also, the software used in for assessment, Athena building impact estimator is used to suit North America standard and the database include the Vancouver region. Thus, other uncertainties are decreased such as temporal, spatial and variability between sources. However, some uncertainty could be introduced because of choices. If the building modeling is simplified, the exact cause-effect mechanism may be not captured.

5.0 List of Indicators Used for Assessment and Expression of Results

LCIA methodology and types of impacts- State the methodology used to characterize the LCI results and the impact categories that will address the environmental and other issues of concern.

In a Life Cycle Impact Assessment (LCIA), essentially two methods are followed: problem-oriented methods (mid points) and damage-oriented methods (end points). For the purpose of our study we used problem oriented (mid-point) methodology through "Tool for the Reduction and Assessment of Chemical and other environmental Impacts (TRACI)", which was developed by the US Environmental Protection Agency (US EPA). In the problem-oriented approaches, flows are classified into environmental themes (impact categories) to which they contribute.

The impact categories selected and the units used to express them (i.e. category indicators) are listed below.

Table 5 The Indicators Used forThe impact categories

Characterized by	**Impact category**	**Category indicator**
US EPA-TRACI	Global warming potential	Kg CO_2 equivalents
US EPA-TRACI	Ozone depletion potential	Kg CFC^{-11} equivalents
US EPA-TRACI	Eutrophication potential	Kg N equivalents
US EPA-TRACI	Acidification potential	Kg SO_2 equivalents
US EPA-TRACI	Smog formation potential	Kg O3 equivalents
US EPA-TRACI	Human health respiratory effects potential	Kg $PM_{2.5}$ equivalents
Athena Institute	Fossil Fuel Consumption	MJ
Athena Institute	Weighted raw resource	Kg

Each the cause effect chain of Impact category is following.

Figure 6 GWP – Cause Effect Chain

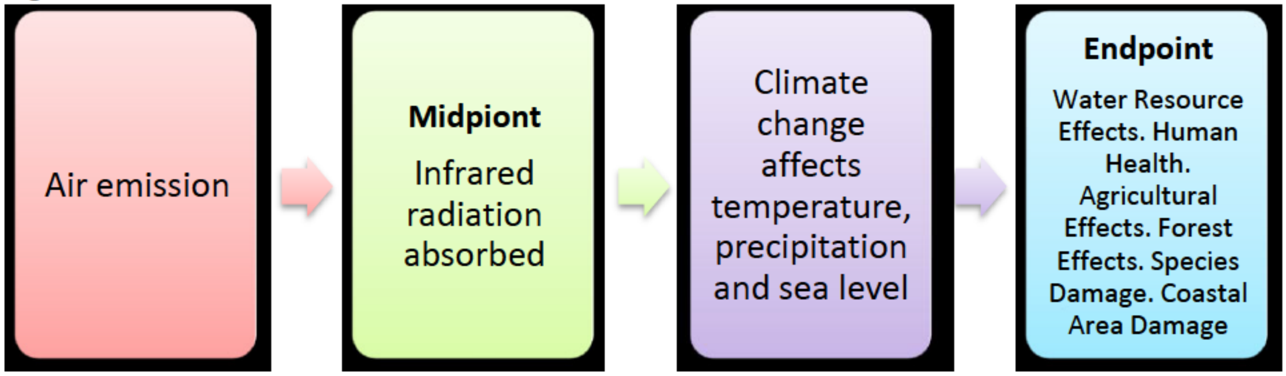


Figure 7 ODP – Cause Effect Chain

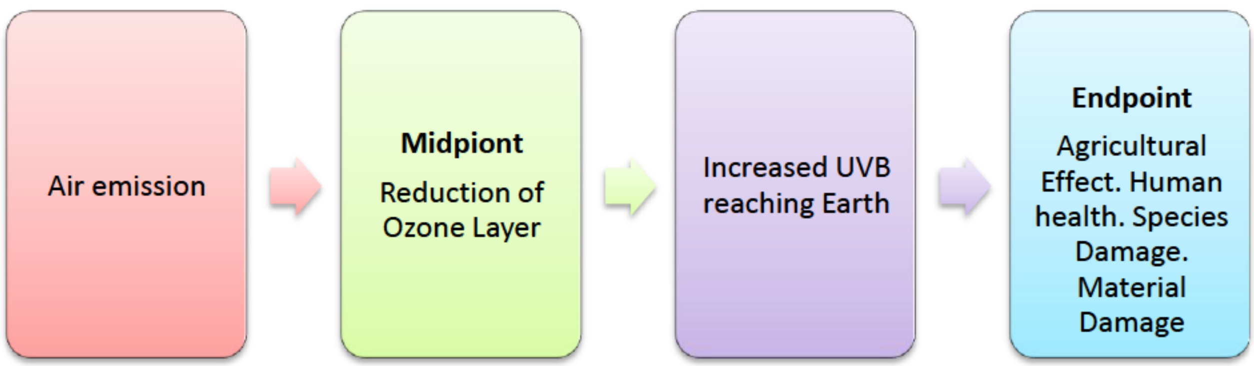


Figure 8 EP – Cause Effect Chain

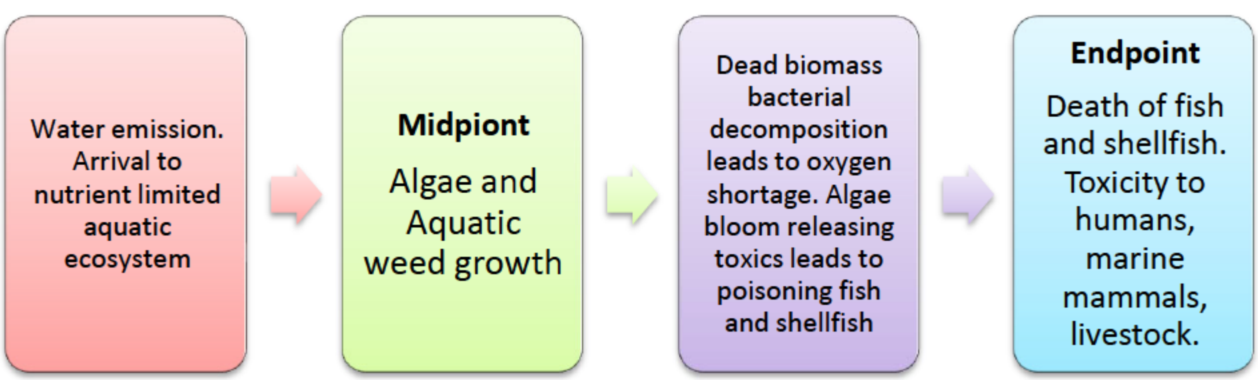


Figure 9 AP – Cause Effect Chain

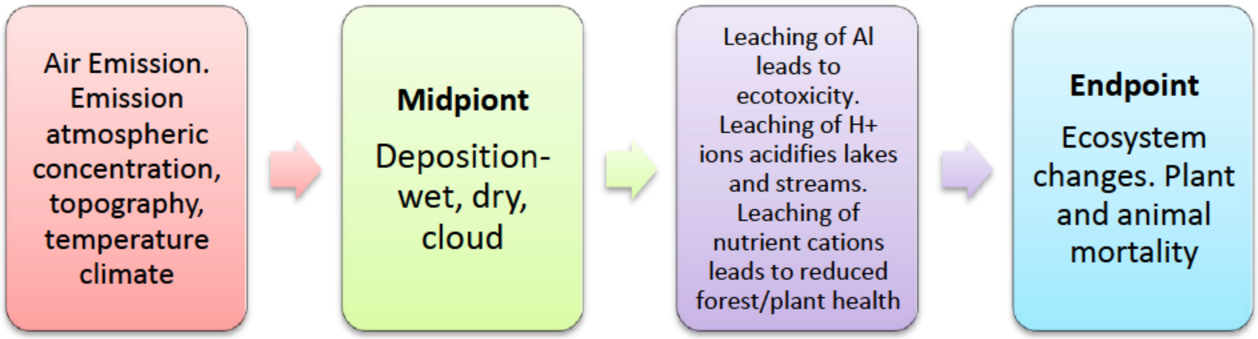


Figure 10 SP – Cause Effect Chain

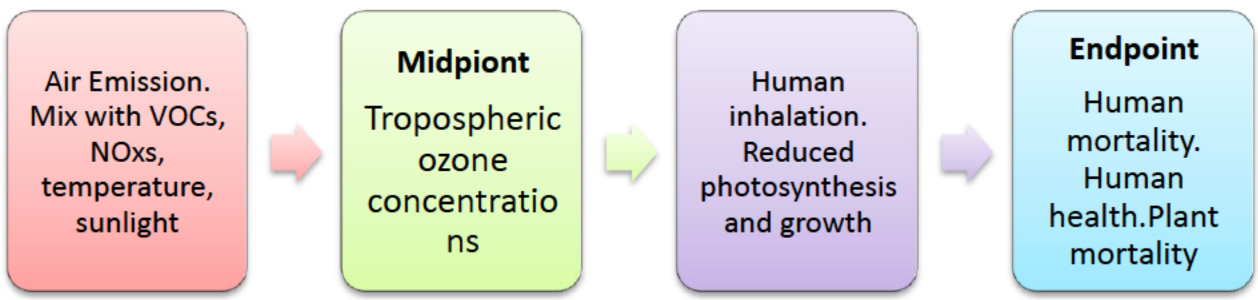
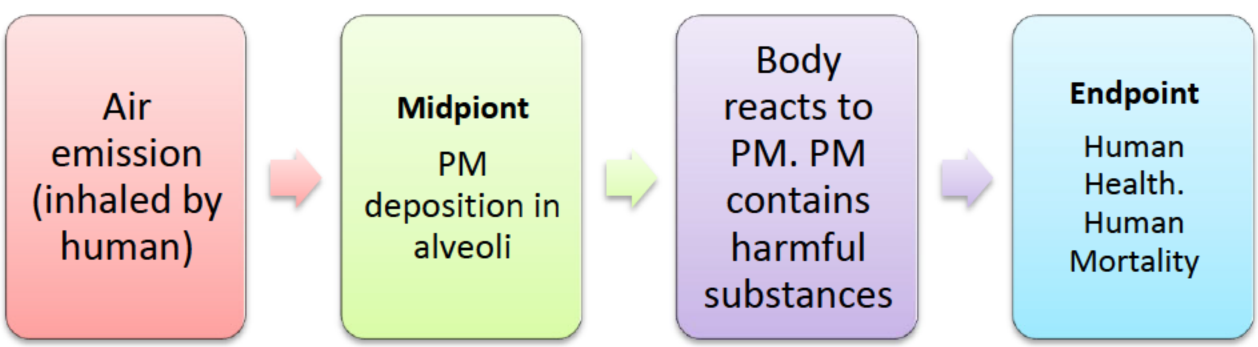


Figure 11 Human health-Air – Cause Effect Chain



6.0 Model Development

CIRS building modeling information for this project is sorted based on Canadian Institute of Quantity Surveyors (CIQS) level 3 elements for input information to Athena impact estimator. The elements is reorganized from previous model as following: foundations, lowest floor construction, upper floor construction, roof construction, walls below grade and walls above grade. The above table 3 in section 2.3 provides a summary of level 3 elements and general description of each component.

The sorting of the data are emphasized by the stage 3 of model improvement, and the stage 3 of model improvement fit CIQS level 3 elements requirement as well as possible improvements to the accuracy of previous model. For the table 4 in section 4.2 that summarized in previous section, some inconsistency in data entries were found from previous model and adjustment, which were made correct errors. Moreover, some uncertainties were created, which due to lack of information. Therefore, from the site visits to collection of the information, and further research and LCA study to expend the LCI database, which is recommended to improve the accuracy of inventory data.

Following table summarize the bill of material generated by Athena IE software. This is an estimation of all the types of materials used for building and their corresponding values is produced. The quantities were not taken from the quantity take off documents, as they were measures of the assemblies of building products not the constituent materials. Athena IE breaks down all the building assemblies into their respective quantities through complex back ground calculation algorithms and data manipulation from its data inventory. Bill of materials for CIRS as retrieved from Athena IE is shown below:

Table 6 The bill of material for CIRS

Material	Quantity	Unit
1/2" Gypsum Fibre Gypsum Board	36.96	m2
1/2" Moisture Resistant Gypsum Board	348.0	m2
1/2" Regular Gypsum Board	821.915	m2
12 Ga. Steel Roof	3131.0	m2
3 mil Polyethylene	44.123	m2
5/8" Regular Gypsum Board	7016.725	m2
6 mil Polyethylene	7442.743	m2

Aluminum	35.913	Tonnes
Blown Cellulose	576.063	m2 (25mm)
Cold Rolled Sheet	0.207	Tonnes
Concrete 30 MPa (flyash 25%)	719.929	m3
Concrete 30 MPa (flyash 35%)	89.78	m3
Concrete 30 MPa (flyash av)	1066.79	m3
Concrete 60 MPa (flyash av)	526.686	m3
Concrete Blocks	5387.92	Blocks
Concrete Brick	1079.217	m2
Concrete Tile	107.085	m2
Double Glazed Hard Coated Argon	361.16	m2
EPDM membrane (black, 60 mil)	1784.762	kg
EPDM membrane (white, 60 mil)	12060.414	kg
Expanded Polystyrene	13255.059	m2 (25mm)
FG Batt R11-15	10099.976	m2 (25mm)
Galvanized Sheet	6.052	Tonnes
Galvanized Studs	6.625	Tonnes
Glazing Panel	165.666	Tonnes
GluLam Sections	464.662	m3
Hollow Structural Steel	121.16	Tonnes
Joint Compound	8.015	Tonnes
Large Dimension Softwood Lumber, Green	359.727	m3
Large Dimension Softwood Lumber, kiln-	4.768	m3
MDI resin	44.186	kg
Mortar	20.038	m3
MW Batt R11-15	8151.977	m2 (25mm)
Nails	1.473	Tonnes
Oriented Strand Board	237.051	m2 (9mm)
Paper Tape	0.092	Tonnes
Polyiso Foam Board (unfaced)	662.598	m2 (25mm)
PVC Membrane 48 mil	00	kg
Rebar, Rod, Light Sections	98.728	Tonnes
Screws Nuts & Bolts	1.731	Tonnes
Small Dimension Softwood Lumber, kiln-	65.729	m3
Softwood Plywood	3899.281	m2 (9mm)
Solvent Based Alkyd Paint	21.2242	L
Solvent Based Varnish	21.2242	L
Water Based Latex Paint	21.2242	L
Welded Wire Mesh / Ladder Wire	**2.6389**	Tonnes

7.0 Communication of Assessment Results

Life Cycle Results

According to the bill of material and summary measure table of each level 3 element, which of their performance should be compared. The output data of product stage and construction process stage of CIRS building and each level 3 element are list below.

Table 7 Summary Measure Table By Life Cycle Stages

	PRODUCT			CONSTRUCTION PROCESS		
Summary Measures	Manufacturing	Transport	**Total**	Construction-installation Process	Transport	**Total**
Fossil Fuel Consumption (MJ)	19207080.95	629796.67	**19836878**	1391990.11	979026.62	**2371016.7**
Global Warming Potential (kg CO2 eq)	1753506.52	36516.92	**1790023.4**	118611.90	58615.45	**177227.36**
Acidification Potential (kg SO2 eq)	14009.36	226.86	**14236.23**	879.32	345.22	**1224.55**
HH Particulate (kg PM2.5 eq)	7066.1	6.36	**7072.46**	137.96	9.83	**147.79**
Eutrophication Potential (kg N eq)	770.7507519	15.86	**786.62**	53.52	24.25	**77.782**
Ozone Depletion Potential (kg CFC-11 eq)	0.01370285	1.4865E-06	**0.0137043**	0.000987127	2.3515E-06	**0.0009895**
Smog Potential (kg O3 eq)	180581.7613	8031.16	**188612.92**	19310.27	12205.90	**31516.18**

Table 8 Summary Measure for Fossil Fuel Consumption By two life cycle stages

Life cycle stage	Comparison of Fossil Fuel Consumption (MJ) by Life Cycle Stages						
	CIRS A11 Foundations	CIRS A21 Lowest Floor Construction	CIRS A22 Upper Floor Construction	CIRS A23 Roof Construction	CIRS A31 Walls Below Grade	CIRS A32 Walls Above Grade	CIRS B11 Partitions
Product	1175471.32	45450.93	3059901	3035336.72	2132658.13	6163668.53	413921.94
Construction process	204423.97	6165.65	282188.52	352234.49	326575.04	495785.22	70097.44

According to the summary measure table by the two life cycle stages, the figure 12 is obtained blow. The production stage and construction of the walls above grade element require most of fossil fuel consumption by the figure 12

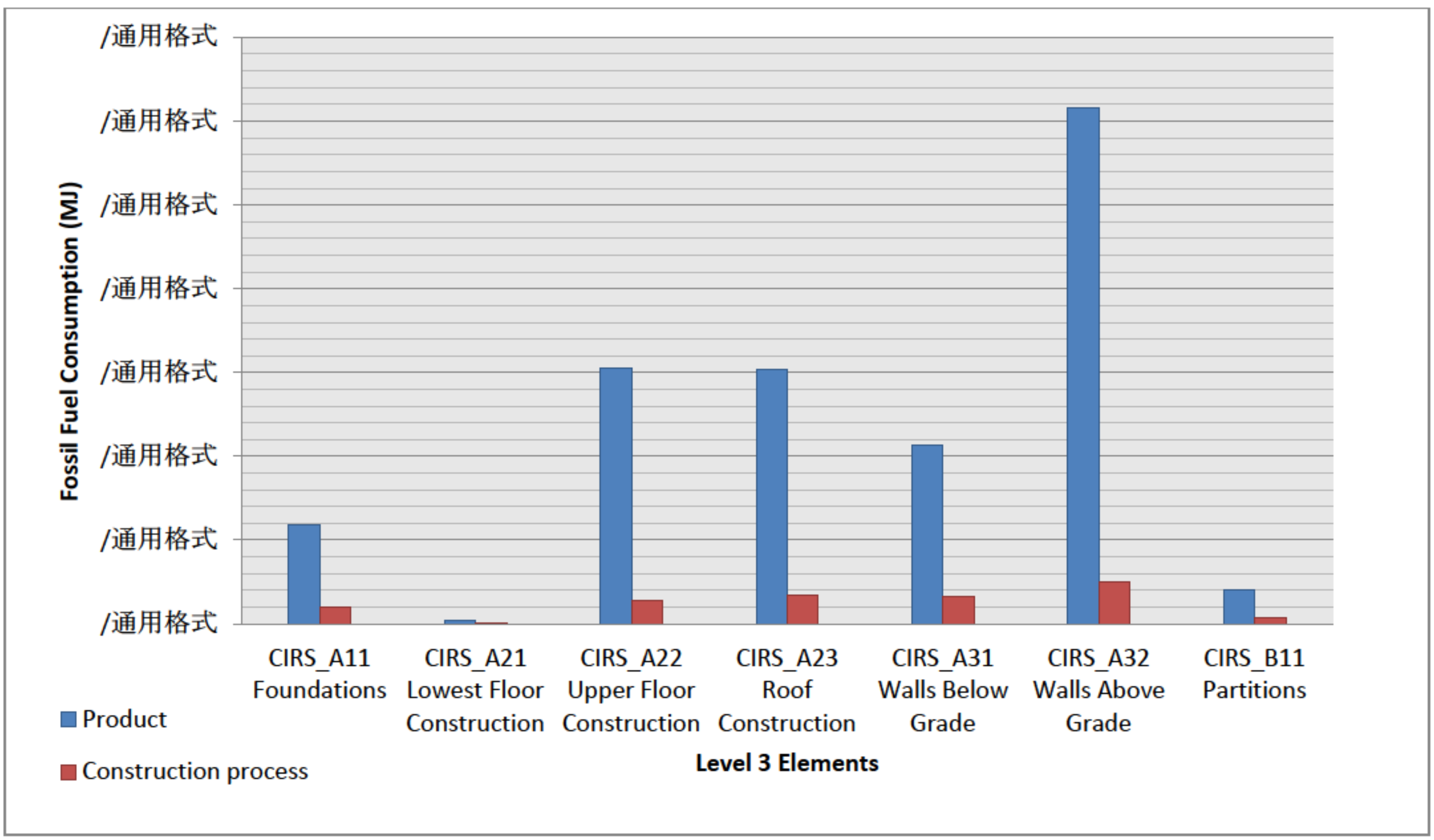


Figure 12 CIRS Building Fossil Fuel Consumption by life cycle stage

Table 9 Summary Measure for Global Warming Potential By two life cycle stages

Life cycle stage	Comparison of Global Warming Potential (kg CO^2 eq) by Life Cycle Stages						
	CIRS A11 Foundations	CIRS A21 Lowest Floor Construction	CIRS A22 Upper Floor Construction	CIRS A23 Roof Construction	CIRS A31 Walls Below Grade	CIRS A32 Walls Above Grade	CIRS B11 Partitions
Product	148468.96	4939.15	229128.53	313941.91	255904.12	687905.5	28953
Construction process	17730.36	539.82	23876.41	30898.292	28954.74	41944.48	5418.54

According to the summary measure table by the two life cycle stages, the figure 13 is obtained blow. The production stage has more contribution to GWP, and the walls above grade has more impact compare with other elements that is indicated.

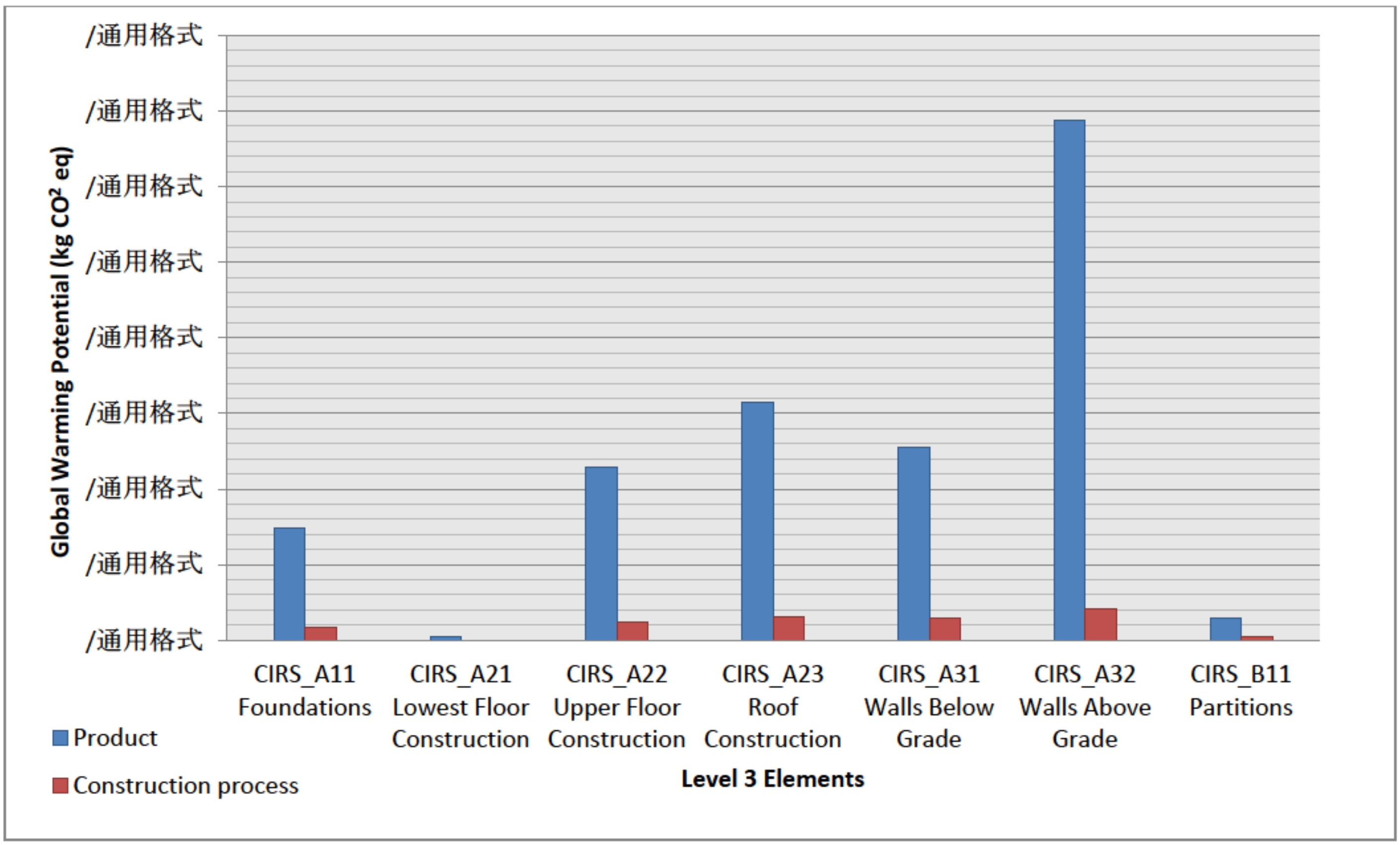


Figure 13 CIRS Building Global Warming Potential by life cycle stage

Table 10 Summary Measure for Acidification Potential By two life cycle stages

Life cycle stage	Comparison of Acidification Potential (kg SO^2 eq) by Life Cycle Stages						
	CIRS A11 Foundations	CIRS_A21 Lowest Floor Construction	CIRS_A22 Upper Floor Construction	CIRS_A23 Roof Construction	CIRS_A31 Walls Below Grade	CIRS_A32 Walls Above Grade	CIRS B11 Partitions
Product	722.16	25.47	1568.99	1684.44	1232.54	6180.31	185.46
Construction process	97.61	3.11	141.22	165.32	169.10	245.39	31.87

According to the summary measure table by the two life cycle stages, the figure 14 is obtained blow. Excessive amount of H+ ions could introduce potential environmental problems to soil and water problem. Figure above indicate the hotspots for acidification potential are production of assemblies and the walls above grade.

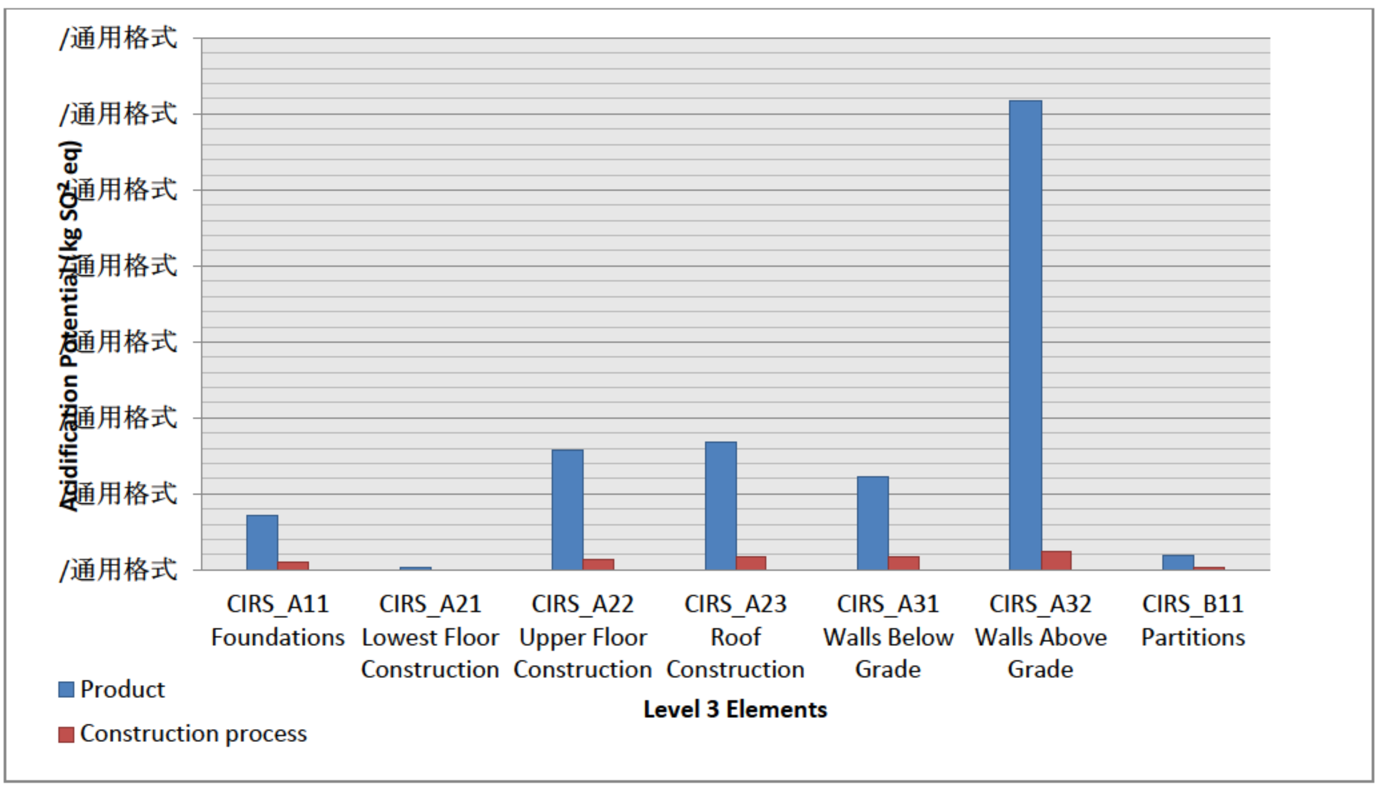


Figure 14 CIRS Building Acidification Potential by life cycle stage

Table 11 Summary Measure for HH Particulate By two life cycle stages

Life cycle stage	Comparison of HH Particulate (kg PM2.5 eq) by Life Cycle Stages						
	CIRS_A11 Foundations	CIRS_A21 Lowest Floor Construction	CIRS_A22 Upper Floor Construction	CIRS_A23 Roof Construction	CIRS_A31 Walls Below Grade	CIRS_A32 Walls Above Grade	CIRS_B11 Partitions
Product	305.19	25.47	649.79	1684.44	1232.54	6180.31	185.46
Construction process	16.275	3.11	20.01	165.32	169.10	245.39	31.87

According to the summary measure table 11 by the two life cycle stages, the figure is obtained blow. Human hearth respiratory effect is only impact category that emphasizes human health issue in this study. The Figure indicates the potential risk of HH Particulate that could caused by the product stage of CIRS building and the production of material used to walls above grade construction has highest impact on HH particulate.

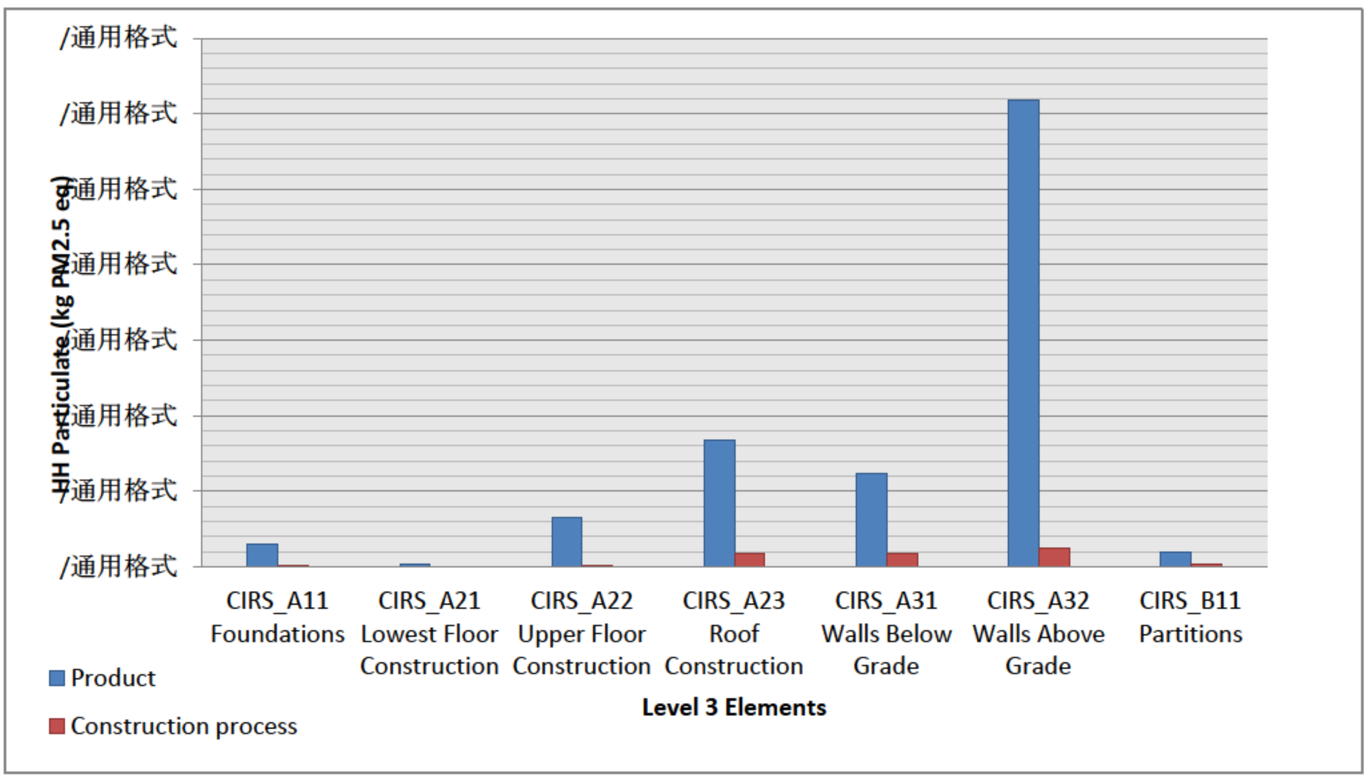


Figure 15 CIRS Building HH Particulate by life cycle stage

Table 12 Summary Measure for Eutrophication Potential By two life cycle stages

Life cycle stage	Comparison of Eutrophication Potential (kg N eq) by Life Cycle Stages						
	CIRS A11 Foundations	CIRS A21 Lowest Floor Construction	CIRS A22 Upper Floor Construction	CIRS A23 Roof Construction	CIRS_A31 Walls Below Grade	CIRS_A32 Walls Above Grade	CIRS B11 Partitions
Product	22.21	1.44	114.20	79.60	47.66	170.65	1253.7
Construction process	5.12	0.17	7.055785	8.73	9.01	14.08	575.57

According to the summary measure table 12 by the two life cycle stages, the figure is obtained blow. Excessive amount of nutrients discharged into water or terrestrial landscape could lead to Eutrophication of the area. Figure 10 represent this result that the Eutrophication potential because of material production and construction are minimal except the stage for partitions material production.

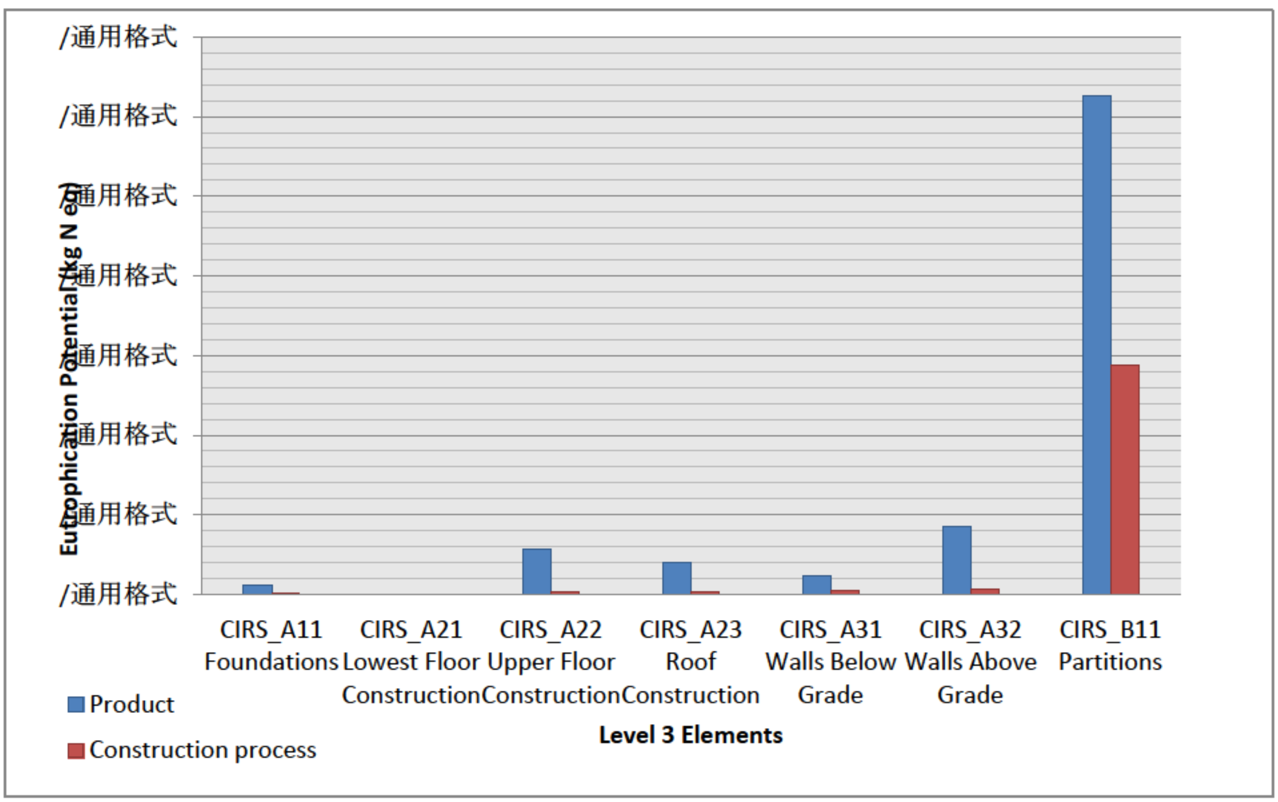


Figure 16 CIRS Building Eutrophication Potential by life cycle stage

Table 13 Summary Measure for Smog Potential By two life cycle stages

Life cycle stage	Comparison of Smog Potential (kg O3 eq) by Life Cycle Stages						
	CIRS_A11 Foundations	CIRS_A21 Lowest Floor Construction	CIRS_A22 Upper Floor Construction	CIRS_A23 Roof Construction	CIRS_A31 Walls Below Grade	CIRS_A32 Walls Above Grade	CIRS_B11 Partitions
Product	8848.55	293.91	16722.71	19242.32	15151.31	62976.67	1253.70
Construction process	2688.58	86.53	3192.69	4305.99	4716.59	6611.08	575.57

According to the summary measure table 13 by the two life cycle stages, the figure 10 is obtained blow. Smog potential could cause serious concerns to human and vegetable health by blocking sunlight and creating hazardous concentration of ozone. Figure represent this result that the production stage and walls above grade has more impact on smog simulation.

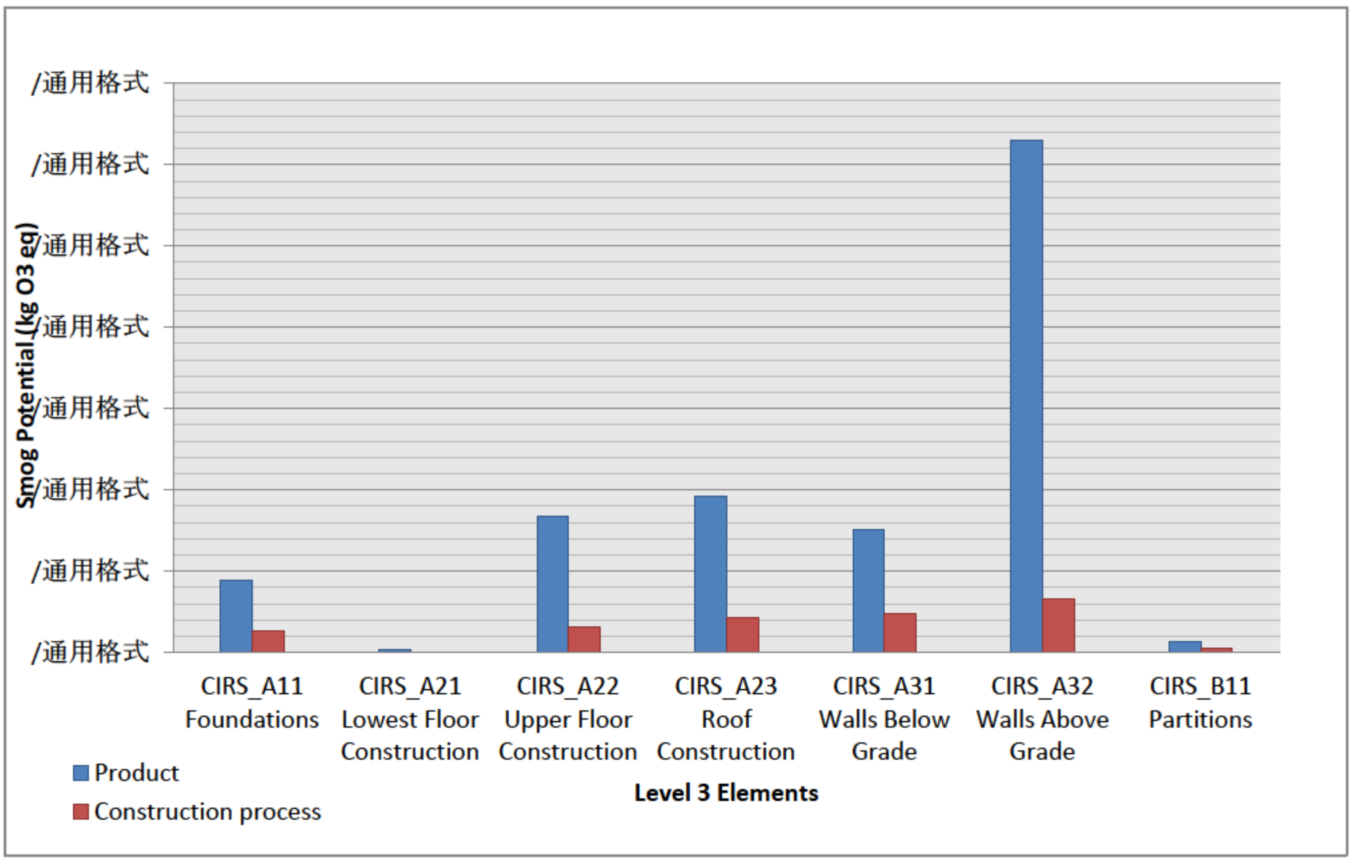


Figure 17 CIRS Building Smog Potential by life cycle stage

Table 14 Summary Measure for Ozone Depletion Potential By two life cycle stages

Life cycle stage	Comparison of Ozone Depletion Potential (kg CFC-11 eq) by Life Cycle Stages						
	CIRS_A11 Foundations	CIRS_A21 Lowest Floor Construction	CIRS_A22 Upper Floor Construction	CIRS_A23 Roof Construction	CIRS_A31 Walls Below Grade	CIRS_A32 Walls Above Grade	CIRS_B11 Partitions
Product	0.0014354	4.245E-05	0.000824	0.00263	0.002329	0.00381	0.0001378
Construction process	7.197E-05	2.129E-06	4.166E-05	0.000129	0.0001168	0.00013	8.209E-06

The table shows Ozone Depletion Potential by life cycle stages of CIRS building. Figure 18 indicates that the value of Ozone Depletion Potential is relatively small; walls below grade and walls above grade and roof construction have more contribution to ozone depletion potential.

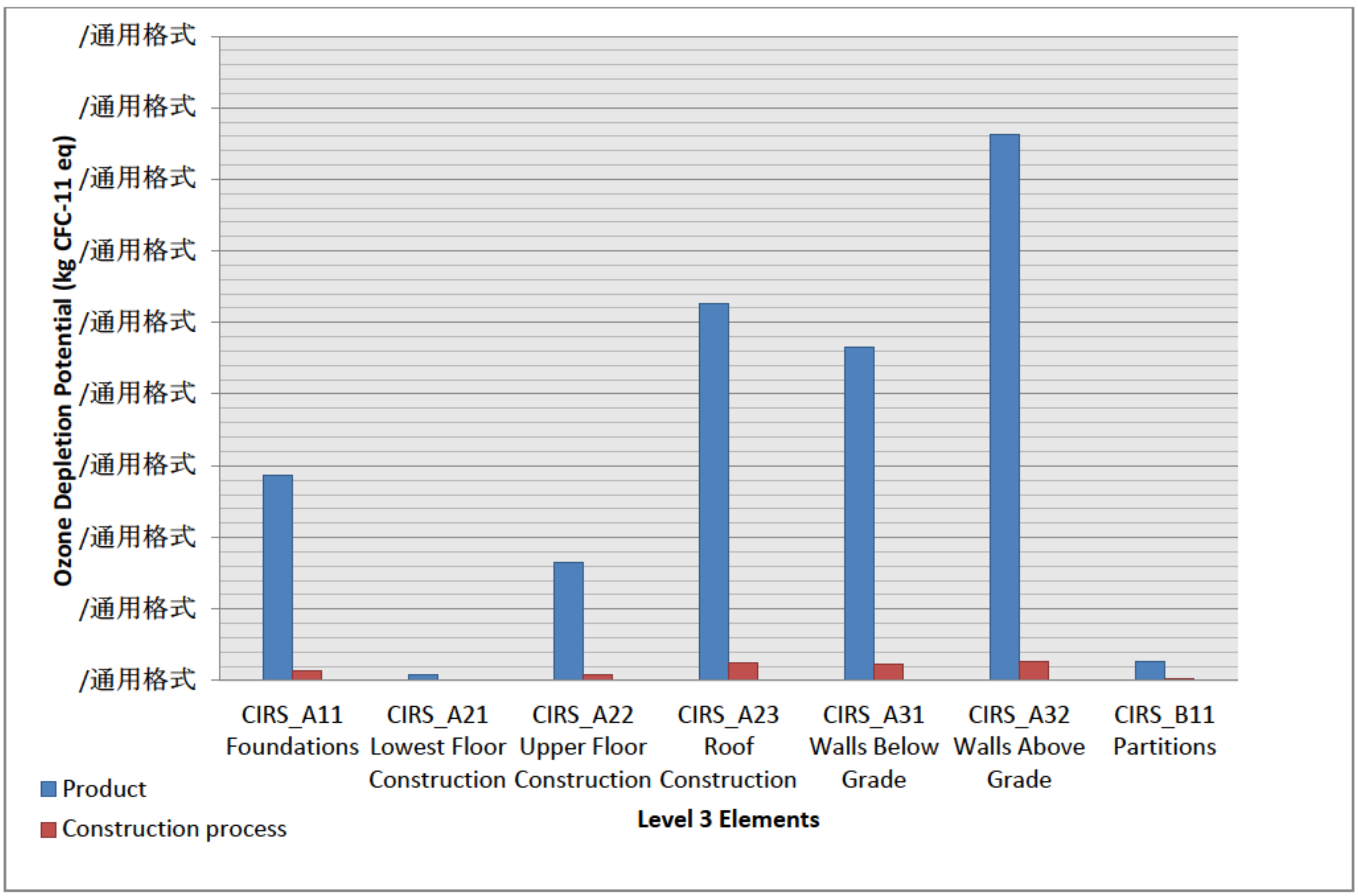


Figure 18 CIRS Building Smog Potential by life cycle stage

reference

1. Jump up Franklin Associates, A Division of Eastern Research Group. "Cradle-to-gate Life Cycle Inventory of Nine Plastic Resins and Four Polyurethane Precursors". The Plastics Division of the American Chemistry Council. Retrieved 2012-10-31.
2. Athena Sustainable Material Institute, 2013. http://www.athenasmi.org/
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4. National Renewable Energy Laboratory (NREL), 2009. http://www.gabi-software.com/
5. Canadian Standards Association. (2006). CSA Standard CAN/CSA-ISO 14040:06. International Organization for Standardization (ISO).
6. Athena Sustainable Materials Institute, “Life Cycle inventory of ICI roofing systems: Onsite construction effects”, Ottawa 2001

Annex A -Interpretation of Assessment Results

Benchmark Development

Benchmark development is intended aim for this project for the LCA , and will help intended audience to make decision with the benchmark result. There are the flowing added benefit to LCA study for the Benchmark: Development of benchmark allowing intended audience to better interoperate LCA based information. Benchmark development utilize the application of LCA study incorporate to design decision-making, which before further suitable application could be formed. For the applied the benchmark to LCA study, benchmark development should be made upon same functional unit and same goal and scope for comparative assertion to make the comparison valid. Conclusion cannot be drawn based on different scope and functional unit. According to goal and scope and modeling method. So the result comparison of the study of UBC building life cycle assessment is valid.

UBC Academic Building Benchmark

The following graph was developed based on October 21, 2013 benchmark result. An average of all the buildings GWP impact was calculated use as benchmark reference. Table 15 introduces the comparison to class benchmark for the building GWP.

Table 15 Comparison to class benchmark for the building GWP.

GMP Impact			
	CIRS	**Benchmark**	**% Difference**
A11 Foundations	134.03	333.04	60%
A21 Lowest Floor Construction	34.24	143.1	76%
A22 Upper Floor Construction	69.79	532.25	87%
A23 Roof Construction	186	594.47	69%
A31 Walls Below Grade	151.73	790.19	80%
A32 Walls Above Grade	105.77	159.54	34%
B11 Partitions	13.51	125.23	89%

According to the difference of between the assessment value of GMP and benchmark in table 15, the figure 10 is obtained blow. It is obvious that the percentage of difference between the assessment value of GMP and benchmark, which have an considerable impact for the upper floor construction and the walls below grade.

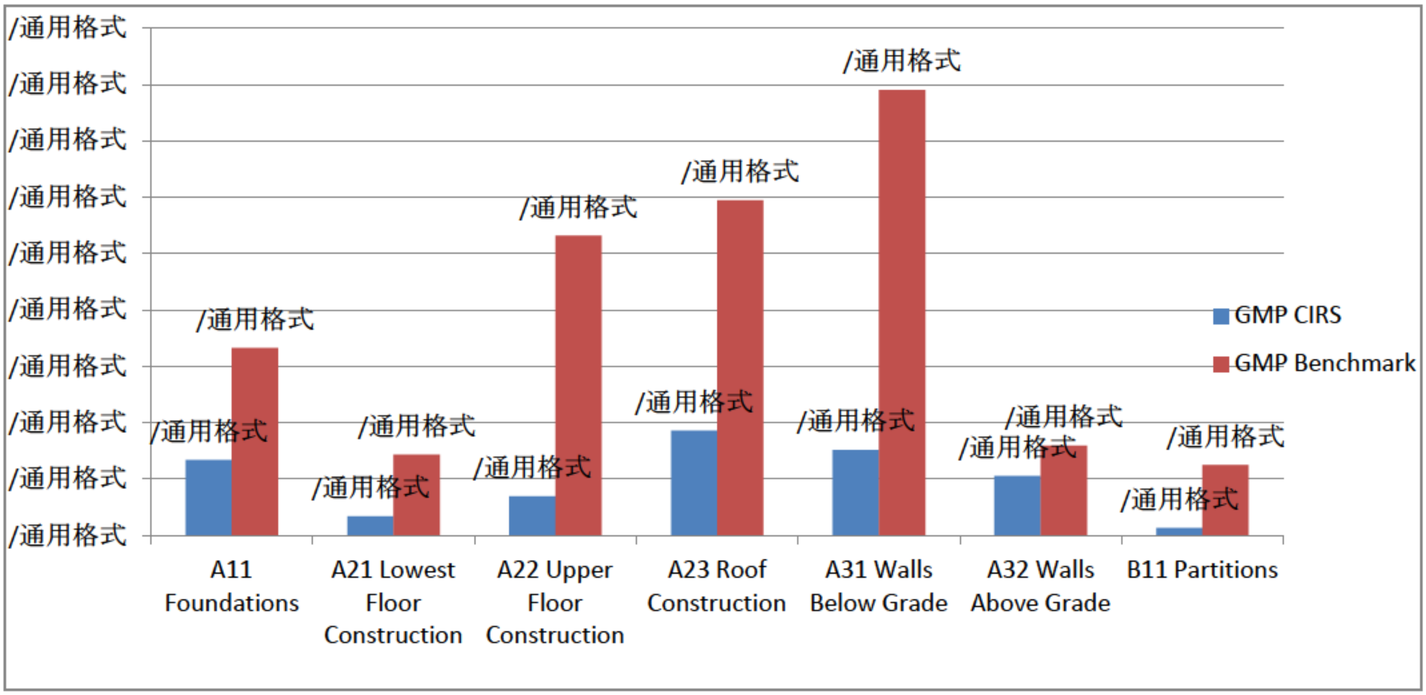

Figure 19 Comparison to class benchmark for the building GWP

Annex B -Recommendations for LCA Use

Life cycle assessment is a technique developed to evaluate potential environmental impact account for all the product life cycle from manufacturing to end of life disposal. For the purpose of this project, only part of building life was evaluated in the study. Production stage and manufacturing stage are the only two components for evaluation. Usage stage includes use, maintenance, repair, replacement, refurbishment, operational energy use and operational water use are eliminated from the analysis. Also, end of life stage include demolition, transportation, waste processing and disposal were left out of the scope. However, it is essential to include all of the life stages into studies in order to draw valid conclusion for building performance, and make the recommendation to UBC stakeholder. Some of the material in construction stage could potentially have higher cost energy consumption; however, it could save reduce amount of energy required in long run. Therefore, only partial of the stage is not valid to provide conclusive result, further development on modules beyond product and construction is recommended.

After a valid result is found based on LCA study, engineers, LCA practitioners and UBC stakeholders could use the impact to result to utilize the design to minimize the potential negative environmental impact not only in short period time but also take into the consideration of building operation and disposal for its expected service life. At this stage, some of the recommendation could be used based on difference in construction method and material selection to mitigate some of the potential impact.

The structural and architectural drawing digitalized and most of the details are legible for the purpose of the quantity takeoff. Previous student did thorough job on tracing of the structural drawing onto OnScreen TakeOff software, very minor mistakes were existed and they are within tolerance range. However, there some lack of data issues when transferring input to Athena IE software due to availability of LCI database. Therefore some assumption must be made such as concrete capacity and flyash percentage.

One of the issues associated with LCA study application is prioritizing impact categories. Some of the mitigation factors to certain impact categories might cause more serious problem to other one. For example, in CIRS building study result, choose the material that has lot eutrophication potential might increase other environmental impact such as GWP, and acidification potential.

Since some of the problems are regional sensitive and problems scales are also different, it is important to prioritizing when making design decision.

A continuing development involve life cycle module beyond the production and construction is recommend to better assist decision-making. To improve data quality, all of the building drawing should be unified, digitalized, and imported to Onscreen TakeOff software for consistence, and this will also reduce temporal uncertainty. Periodical checking and updating of the database is also suggestion to improve the accuracy and availability of the data source. With the more valid result that include entire building cycle analysis, UBC could reference the result when doing further construction, and find the most utilized material selection, construction method, structural design component, and demolition and disposal method to minimize the potential impacts.

Annex C -Author Reflection

	Name	Description	Select the content code most appropriate for each attribute from the dropdown menu	Comments on which of the CEAB graduate attributes you believe you had to demonstrate during your final project experience.
1	Knowledge Base	Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.	IA = introduced & applied	LCA knowledge was introduced and applied to the final project
2	Problem Analysis	An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.	DA = developed & applied	The analytical skill was further developed and applied in to completion of final project
3	Investigation	An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.	DA = developed & applied	Some of the final report component required research to obtain information
4	Design	An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.	A = applied	This skill was applied to complete outline steps to operationalize LCA method
5	Use for Engineering Tools	An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.	IDA = introduced, developed & applied	Athena IE software and Onscreen TakeOff were introduced and applied for the final program, the skill was developed
6	Individual and Team Work	An ability to work effectively as a member and leader in teams, preferably in a multi-	DA = developed & applied	Team work mostly completed during class discussion, and completion

		disciplinary setting.		of benchmark
7	Communication	An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.	A = applied	Written communication skill was applied to complete final report
8	Professionalism	An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.	A = applied	N/A
9	Impact of Engineering on Society and the Environment	An ability to analyze social and environmental aspects of engineering activities. Such ability includes an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society, the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship.	A = applied	LCA study is analyzing the environmental impact of the product life cycle and associated with society aspect
10	Ethics and Equity	An ability to apply professional ethics, accountability, and equity.	A = applied	N/A
11	Economics and Project Management	An ability to appropriately incorporate economics and business practices including project, risk, and change management into the practice of engineering and to understand their limitations.	IA = introduced & applied	Building Cost estimate
12	Life-long Learning	An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge.	IDA = introduced, developed & applied	N/A

Annex D – Impact Estimator Inputs and Assumption

Element	Quantity	Units	Assembly Type	Assembly Name	Input Fields	Known/Measured Information	IE Inputs
A11 Foundations		1309			m²		
			1.1.1 Concrete SoG	1.1.1.1 SoG_Mech Mat_150mm	Length (ft)	73.79672	90.42
					Width (ft)	73.79672	90.42
					Thickness (in)	6	4
					Concrete (psi)	4350	4000
					Concrete flyash %	30	25
					Rebar	10M	10M
				1.1.1.2 SoG_Mat_1_150mm_Auditorium	Length (ft)	10.8	13.24
					Width (ft)	10.8	13.24
					Thickness (in)	6	4
					Concrete (psi)	4350	4000
					Concrete flyash %	30	25
					Rebar		
				1.1.1.3 SoG_Mat_2_150mm_Auditorium	Length (ft)	16.2	19.86
					Width (ft)	16.2	19.86
					Thickness (in)	6	4
					Concrete (psi)	4350	4000
					Concrete flyash %	30	25
					Rebarr		
			1.1.2 Concrete Footing	1.1.2.1 Elevator_Footing_NorthWest	Length (ft)	4.27	4.27
					Width (ft)	4.27	4.27
					Thickness (in)	12	12
					Concrete (psi)	4350	4000
					Concrete flyash %	50	35
					Rebar	15M	15M
				1.1.2.1 Elevator_Footing_NorthEast	Length (ft)	4.1	4.1
					Width (ft)	4.1	4.1
					Thickness (in)	12	12
					Concrete (psi)	4350	4000
					Concrete flyash %	50	35
					Rebar	15M	15M
				1.1.2.2 PullPit_Footing_200mm	Length (ft)	3.34	3.34
					Width (ft)	1.8	1.8
					Thickness (in)	8	8
					Concrete (psi)	4350	4000

					Concrete flyash %	50	35
					Rebar	15M	15M
				1.1.2.3 Footing_F1 (Strip)	Length (ft)	77.75	77.75
					Width (ft)	4	4
					Thickness (in)	10	10
					Concrete (psi)	4350	4000
					Concrete flyash %	50	35
					Rebar	20M	20M
				1.1.2.4 Footing_F2 (Strip)	Length (ft)	212.082	212.082
					Width (ft)	4.333	4.333
					Thickness (in)	10	10
					Concrete (psi)	4350	4000
					Concrete flyash %	50	35
					Rebar	20M	20M
				1.1.2.5 Footing_F3 (Strip)	Length (ft)	104.21	104.21
					Width (ft)	2.1667	2.1667
					Thickness (in)	8	8
					Concrete (psi)	4350	4000
					Concrete flyash %	50	35
					Rebar	15M	15M
				1.1.2.6 Footing_F4	Length (ft)	40.002	40.002
					Width (ft)	40.002	40.002
					Thickness (in)	12	12
					Concrete (psi)	4350	4000
					Concrete flyash %	50	35
					Rebar	25M	20M
				1.1.2.7 Footing_F5	Length (ft)	12	12
					Width (ft)	12	12
					Thickness (in)	14	14
					Concrete (psi)	4350	4000
					Concrete flyash %	50	35
					Rebar	25M	20M
	A21 Lowest Floor Construction	1439.8	m^2				
				Concrete Slab on Grade	Floor_F10_SLAB-ON-GRADE	Area (m^2)	1179	1179
					Span (m)	9.8	12.2
					Width (m)	120.3061224	145.15
					Live load (kPa)	4.8	4.8

					Category	Concrete	Concrete
					Material	Concrete slab	Concrete slab
					Thickness (mm)	150	100
					Concrete flyash %	0.3	0.25
					Concrete (mPa)	30	30
					Category	Vapour barrier	Vapour barrier
					Material	-	Poly
					Thickness (mm)	-	6
				Floor_F11_SLAB-ON-GRADE-RAISED-FLOOR	Area (m^2)	260.8	260.8
					Span (m)	9.8	12.2
					Width (m)	26.6122449	32.1
					Live load (kPa)	4.8	4.8
					Category	Concrete	Concrete
					Material	Concrete slab	Concrete slab
					Thickness (mm)	150	100
					Concrete flyash %	0.3	0.25
					Concrete (mPa)	30	30
					Category	Vapour barrier	Vapour barrier
					Material	-	Poly
					Thickness (mm)	-	6
A22 Upper Floor Constructi on	3635	m^2					
			2.2.1 Concrete Columns	2.2.1.1 Column_Concrete_C1 & C4_Beam_N/A_Basement	Number of Beams	0	0
					Number of Columns	5	5
					Floor to floor height (ft)	11.5	11.5
					Bay sizes (ft)	24.75	24.75
					Supported span (ft)	22.65	22.65
					Live load (psf)	100	100
				2.2.1.1.2 Column_Concrete_C2_Beam_N/A_Basement	Number of Beams	0	0
					Number of Columns	4	4
					Floor to floor height (ft)	13.75	13.75
					Bay sizes (ft)	45.25	45.25

					Supported span (ft)	20	20
					Live load (psf)	100	100
				2.2.1.2 Column_Concrete_C2_Beam_N/A_GroundLevel	Number of Beams	0	0
					Number of Columns	2	2
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	45.25	45.25
					Supported span (ft)	20	20
					Live load (psf)	100	100
				2.2.1.3 Column_N/A_Beam_Glulam_GroundLevel_Hor (Auditorium)	Number of Beams	2	2
					Number of Columns	0	0
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	71	71
					Supported span (ft)	11	11
					Live load (psf)	100	100
			2.2.2 Wooden Columns & Beams	2.2.2.1 Column_Beam_Glulam_GroundLevel_Vert (Wings)	Number of Beams	23	23
					Number of Columns	45	45
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	32	32
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.1.1Column_Beam_Glulam_GroundLevel_Horizontal (Wings)	Number of Beams	37	37
					Number of Columns	40	40
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	10	10
					Supported span (ft)	8	8

						Live load (psf)	100	100
					2.2.2.1.2 Column_N/A_Beam_Glulam_GroundLevel_Vert (Auditorium)	Number of Beams	7	7
						Number of Columns	2	2
						Floor to floor height (ft)	13	13
						Bay sizes (ft)	45.25	45.25
						Supported span (ft)	10	10
						Live load (psf)	100	100
					2.2.2.1.3 Column_Beam_Glulam_GroundLevel_Atrium	Number of Beams	1	1
						Number of Columns	2	2
						Floor to floor height (ft)	13	13
						Bay sizes (ft)	45	45
						Supported span (ft)	4	4
						Live load (psf)	100	100
					2.2.2.1.4 Column_Beam_Glulam_GroundLevel_Connecting lobby_Hor	Number of Beams	6	6
						Number of Columns	6	6
						Floor to floor height (ft)	13	13
						Bay sizes (ft)	18.85	18.85
						Supported span (ft)	10	10
						Live load (psf)	100	100
					2.2.2.2.1 Column_Glulam_Beam_N/A_GroundLevel_Stairs	Number of Beams	0	0
						Number of Columns	4	4
						Floor to floor height (ft)	13	13

					Bay sizes (ft)	32	32
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.2 Column_Glulam_Beam_N/A_GroundLevel_Elev shaft	Number of Beams	0	0
					Number of Columns	4	4
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	9	9
					Supported span (ft)	5.25	5.25
					Live load (psf)	100	100
				2.2.2.2.3 Column_Beam_Glulam_Level2_Vert (Wings)	Number of Beams	23	23
					Number of Columns	45	45
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	32	32
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.4 Column_Beam_Glulam_Level2_Horizontal (Wings)	Number of Beams	37	37
					Number of Columns	40	40
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	10	10
					Supported span (ft)	8	8
					Live load (psf)	100	100
				2.2.2.2.5 Column_Beam_Glulam_Level2_Atrium	Number of Beams	1	1
					Number of Columns	2	2

					Floor to floor height (ft)	13	13
					Bay sizes (ft)	45	45
					Supported span (ft)	4	4
					Live load (psf)	100	100
				2.2.2.2.5 Column_Beam_Glulam_Level2_Connecting lobby_Hor	Number of Beams	6	6
					Number of Columns	6	6
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	18.85	18.85
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.1 Column_Glulam_Beam_N/A_Level2_Stairs	Number of Beams	0	0
					Number of Columns	4	4
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	32	32
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.2 Column_Glulam_Beam_N/A_Level2_Elev shaft	Number of Beams	0	0
					Number of Columns	4	4
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	9	9
					Supported span (ft)	5.25	5.25
					Live load (psf)	100	100
				2.2.2.2.3 Column_Beam_Glulam_Level3_Vert (Wings)	Number of Beams	23	23
					Number of Columns	45	45

					Floor to floor height (ft)	13	13
					Bay sizes (ft)	32	32
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.4 Column_Beam_Glulam_Level3_Horizontal (Wings)	Number of Beams	37	37
					Number of Columns	40	40
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	10	10
					Supported span (ft)	8	8
					Live load (psf)	100	100
				2.2.2.2.5 Column_Beam_Glulam_Level3_Atrium	Number of Beams	1	1
					Number of Columns	2	2
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	45	45
					Supported span (ft)	4	4
					Live load (psf)	100	100
				2.2.2.2.5 Column_Beam_Glulam_Level3_Connecting lobby_Hor	Number of Beams	6	6
					Number of Columns	6	6
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	18.85	18.85
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.1 Column_Glulam_Beam_N/A_Level3_Stairs	Number of Beams	0	0
					Number of Columns	4	4

					Floor to floor height (ft)	13	13
					Bay sizes (ft)	32	32
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.2 Column_Glulam_Beam_N/A_Level 3_Elev shaft	Number of Beams	0	0
					Number of Columns	4	4
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	9	9
					Supported span (ft)	5.25	5.25
					Live load (psf)	100	100
				2.2.2.2.3 Column_Beam_Glulam_Roof_Vert (Wings)	Number of Beams	23	23
					Number of Columns	45	45
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	32	32
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.4 Column_Beam_Glulam_Roof_Horizontal (Wings)	Number of Beams		
					Number of Columns	37	37
					Floor to floor height (ft)	40	40
					Bay sizes (ft)	13	13
					Supported span (ft)	10	10
					Live load (psf)	8	8
				2.2.2.2.1 Column_Glulam_Beam_N/A_Roof_Stairs	Number of Beams	0	0
					Number of Columns	4	4

					Floor to floor height (ft)	13	13
					Bay sizes (ft)	32	32
					Supported span (ft)	10	10
					Live load (psf)	100	100
				2.2.2.2.2 Column_Glulam_Beam_N/A_Roof_ Elev shaft	Number of Beams	0	0
					Number of Columns	4	4
					Floor to floor height (ft)	13	13
					Bay sizes (ft)	9	9
					Supported span (ft)	5.25	5.25
					Live load (psf)	100	100
			2.2.3 Steel Beams	2.2.3.1 Column_N/A_Beam_HSS_Penthous e_Hor	Number of Beams	12	12
					Number of Columns	24	24
					Floor to floor height (ft)	5	5
					Bay sizes (ft)	11.75	11.75
					Supported span (ft)	5	5
					Live load (psf)	40	40
				2.2.3.2 Column_N/A_Beam_HSS_Penthous e_Vert	Number of Beams	26	26
					Number of Columns	24	24
					Floor to floor height (ft)	5	5
					Bay sizes (ft)	5	5
					Supported span (ft)	5	5
					Live load (psf)	40	40
			2.2.4 SUSPENDED CONCRETE SLAB	Floor_F20_SUSPENDED-CONCRETE-SLAB	Area (m^2)	14.6	14.6
					Span (m)	1.75	1.75

					Width (m)	8.342857143	8.342857143
					Live load (kPa)	4.8	4.8
					Category	Concrete	Concrete
					Material 1	Concrete slab	Concrete slab
					Thickness (mm)	200	200
					Concrete flyash %	0.3	0.25
					Concrete (mPa)	30	30
				Floor_F21_SUSPENDED-CONCRETE-SLAB-EPOXY	Area (m^2)	33.3	33.3
					Span (m)	3.5	3.5
					Width (m)	9.514285714	9.514285714
					Live load (kPa)	4.8	4.8
					Category	Concrete	Concrete
					Material	Concrete slab	Concrete slab
					Thickness (mm)	300	300
					Concrete flyash %	0.3	0.25
					Concrete (mPa)	30	30
				Floor_F23_SUSPENDED-CONCRETE-SLAB-TERRAZZO	Area (m^2)	580.6	580.6
					Span (m)	9.8	9.8
					Width (m)	59.24489796	59.24489796
					Live load (kPa)	4.8	4.8
					Category	Concrete	Concrete
					Material	Concrete slab	Concrete slab
					Thickness (mm)	250	250
					Concrete flyash %	0.3	0.25
					Concrete (mPa)	30	30
				Floor_F30_SUSPENDED-CONCRETE-SLAB-RAISED-TECRETE	Area (m^2)	435.5	435.5
					Span (m)	9.8	9.8
					Width (m)	44.43877551	44.43877551
					Live load (kPa)	4.8	4.8
					Category	Concrete	Concrete
					Material	Concrete slab	Concrete slab
					Thickness (mm)	250	250
					Concrete flyash %	0.3	Average
					Concrete (mPa)	30	30
			2.2.5LAMINATED WOOD	Floor_F40_LAMINATED-WOOD-RAISED-TECRETE	Area (m^2)	1778.3	

					Span (m)	9.8	
					Width (m)	181.4591837	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	89	
					Decking	Plywood	
					Thickness (mm)	16	
					Category	Underlay	Steel roof system
					Material	Sheet metal	Galvanized sheet
					Thickness (mm)	-	12 GA
				Floor_F41_LAMINATED-WOOD-RAISED-TECRETE-SLOPED-TILE	Area (m^2)	45.9	
					Span (m)	9.8	
					Width (m)	4.683673469	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	89	
					Decking	Plywood	
					Thickness (mm)	16	
					Category	Underlay	Steel roof system
					Material	Sheet metal	Galvanized sheet
					Thickness (mm)	-	12 GA
					Category	-	
					Material	Concrete topping	
					Thickness (mm)	25	
				Floor_F42_LAMINATED-WOOD-RAISED-TECRETE-SOFFIT	Area (m^2)	288.2	
					Span (m)	9.8	
					Width (m)	29.40816327	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	89	
					Decking	Plywood	
					Thickness (mm)	16	
					Category	Underlay	Steel roof system
					Material	Sheet metal	Galvanized sheet
					Thickness (mm)	-	12 GA

					Category	Vapour barrier	Vapour barrier
					Material	-	Poly
					Thickness (mm)	-	6
					Category	Insulation	Insulation
					Material	Insulation	Polystyrene Expanded
					Thickness (mm)	150	150
				Floor_F43_LAMINATED-WOOD-RAISED-TECRETE-SLOPED-TILE-SOFFIT	Area (m^2)	22.4	
					Span (m)	9.8	
					Width (m)	2.285714286	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	89	
					Decking	Plywood	
					Thickness (mm)	16	
					Category	Underlay	Steel roof system
					Material	Sheet metal	Galvanized sheet
					Thickness (mm)	-	12 GA
					Category	-	
					Material	Concrete topping	
					Thickness (mm)	25	
					Category	Vapour barrier	Vapour barrier
					Material	-	Poly
					Thickness (mm)	-	6
					Category	Insulation	Insulation
					Material	Insulation	Polystyrene Expanded
					Thickness (mm)	150	150
				Floor_F50_LAMINATED-WOOD-CONCRETE-TOPPING	Area (m^2)	141.9	
					Span (m)	9.8	
					Width (m)	14.47959184	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	184	
					Decking	Plywood	
					Thickness (mm)	16	

					Category	-	
					Material	Concrete topping	
					Thickness (mm)	50	
				Floor_F51_LAMINATED-WOOD-CONCRETE-TOPPING-SOFFIT	Area (m^2)	120	
					Span (m)	9.8	
					Width (m)	12.24489796	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	184	
					Decking	Plywood	
					Thickness (mm)	16	
					Category	-	
					Material	Concrete topping	
					Thickness (mm)	50	
					Category	Vapour barrier	Vapour barrier
					Material	-	Poly
					Thickness (mm)	-	6
					Category	Insulation	Insulation
					Material	Insulation	Polystyrene Expanded
					Thickness (mm)	150	150
				Floor_F52_LAMINATED-WOOD-CONCRETE-TOPPING-GWB-CEILING	Area (m^2)	85.4	
					Span (m)	9.8	
					Width (m)	8.714285714	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	184	
					Decking	Plywood	
					Thickness (mm)	16	
					Category	-	
					Material	Concrete topping	
					Thickness (mm)	50	
					Category	GWB	Gypsum Board
					Material	Insulation	Gypsum Board
					Thickness (mm)	13	1/2"
			2.2.6 WOOD	Floor_F53_WOOD-FLOOR-JOISTS	Area (m^2)	89.25	89.25

			JOIST				
					Span (m)	9.8	9.8
					Width (m)	9.107142857	3.65
							3.65
							1.8
					Live load (kPa)	4.8	4.8
					Category	Wood joist	Wood joist
					Material	Wood joist	Wood joist
					Thickness (mm)	184	-
					Decking	Plywood	Plywood
					Thickness (mm)	19	19
					Category	GWB	Gypsum Board
					Material	Insulation	Gypsum Board
					Thickness (mm)	13	1/2"
			2.2.7.1 Glulam Beams	Column_N/A_ Beams_ Glulam_Ground Level_38 x 286	Volume of Glulam lumber m^3		28.606
				Column_N/A_ Beams_ Glulam_Level 2_38 x 286	Volume of Glulam lumber m^3		18.905
				Column_N/A_ Beams_ Glulam_Level 3_38 x 286	Volume of Glulam lumber m^3		16.903
				Column_N/A_ Beams_ Glulam_Level 3_38 x 286	Volume of Glulam lumber m^3		25.892
				Column_N/A_ Beams_ Glulam_Penthouse_38 x 286	Volume of Glulam lumber m^3		5.317
			2.2.7.2 Stairs	Stairs_ Glulam Wooden Stingers_ all floors	Volume of Glulam lumber m^3		40.74
				Stairs_Concrete_GroundLevel_Entrance	Volume of Concrete m^3		1.717

					Concrete (psi)	4350	4000
					Concrete flyash %	30	25
					Rebar	20M	20M
			2.2.7.3 Hollow Structural steel (HSS)	HSS 102x76x8.5 _ Penthouse_Skylight	Volume of Steel Tonnes		87.82
			2.2.7.3 Skylight Glazing	Skylight glazing	Area m^2		149.57
A23 Roof Construction	1854	m^2					
			2.3.1 Green roof	Roof_R1_LAMINATED-WOOD-GREEN-ROOF	Area (m^2)	372.5	
					Span (m)	9.8	
					Width (m)	38.01020408	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	184	
					Decking	Plywood	
					Thickness (mm)	16	
					Category	Vapour retarder	Vapour retarder
					Material	-	Poly
					Thickness (mm)	-	6
					Category	Insulation	Insulation
					Material	Insulation	EPDM white
					Thickness (mm)	100	100
					Category	Roof envelope	Roof envelope
					Material	TPO	PVC membrane
					Thickness (mm)	60	-
			2.3.2 LAMINATED WOOD	2.3.2.1 Roof_R2_LAMINATED-WOOD-PAVING-STONE	Area (m^2)	83.4	
					Span (m)	9.8	
					Width (m)	8.510204082	
					Live load (kPa)	4.8	
					Category	-	

					Material	Laminated wood	
					Thickness (mm)	184	
					Decking	Plywood	
					Thickness (mm)	19	
					Category	Vapour retarder	Vapour retarder
					Material	-	Poly
					Thickness (mm)	-	6
					Category	Insulation	Insulation
					Material	Insulation	Polystyrene Expanded
					Thickness (mm)	100	100
					Category	Roof envelope	Roof envelope
					Material	TPO	EPDM white
					Thickness (mil)	60	-
					Category	Roof envelope	Roof envelope
					Material	Concrete pavers	Concrete tile
					Thickness (mm)	50	-
				2.3.2.2 Roof_R3_LAMINATED-WOOD-SLOPED-INSULATION	Area (m^2)	996.4	
					Span (m)	9.8	
					Width (m)	101.6734694	
					Live load (kPa)	4.8	
					Category	-	
					Material	Laminated wood	
					Thickness (mm)	89	
					Decking	Plywood	
					Thickness (mm)	19	
					Category	Vapour retarder	Vapour retarder
					Material	-	Poly
					Thickness (mm)	-	6
					Category	Insulation	Insulation
					Material	Insulation	Polystyrene Expanded
					Thickness (mm)	100	100
					Category	Roof envelope	Roof envelope
					Material	TPO	EPDM white
					Thickness (mil)	60	-
			2.3.3 WOOD JOIST	Roof_R4_WOOD-JOISTS	Area (m^2)	34.6	34.6
					Span (m)	9.8	9.8

					Width (m)	3.530612245	3.530612245
					Live load (kPa)	4.8	4.8
					Category	Wood joist	Wood joist
					Material	Wood joist	Wood joist
					Thickness (mm)	184	-
					Decking	Plywood	Plywood
					Thickness (mm)	16	15
					Category	Vapour retarder	Vapour retarder
					Material	-	Poly
					Thickness (mm)	-	6
					Category	Insulation	Insulation
					Material	Insulation	Polystyrene Expanded
					Thickness (mm)	100	100
					Category	Roof envelope	Roof envelope
					Material	TPO	EPDM white
					Thickness (mil)	60	-
			2.3.4 Curtain Wall	Wall_Curtain wall_E5.1/2_Roof	Length (m)	46	46
					Height (m)	1.6	1.6
					Percent Viewable Glazing	-	-
					Percent Spandrel Panel	-	-
					Thickness of Insulation (mm)	-	-
					Spandrel Type (Metal/Glass)	Glass	Glass
			2.3.5 Steel Stud	Wall_Steel stud_WA7_Roof	Length (ft)	7	7
					Height (ft)	3.5	3.5
					Sheathing Type	None	None
					Stud Spacing	600oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	39 x 152	38 x 152
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"

						Thickness	-	-
				2.3.6 Wood Stud	2.3.6.1 Wall_Wood stud_E3.2-SW8_Roof	Length (m)	40	40
						Height (m)	3.5	3.5
					Wood Stud	Wall Type	Loadbearing	Loadbeari ng
						Sheathing Type	6mm Plywood	Plywood
						Study Spacing	300oc	400oc
						Stud Type	Kiln dried	Kiln dried
						Stud Thickness	38 x 184	38 x 184
					Envelope	Category	Cladding	Cladding
						Material	90 sawn face concrete masonry	Brick - concrete
						Thickness (mm)	-	-
						Category	Insulation	Insulation
						Material	R20 Mineral wool	Rockwool Batt
						Thickness (mm)	-	119
						Category	Vapour Barrier	Vapour Barrier
						Material	air, vapour 7 moisture barrier	6 mil poly
						Thickness	-	-
						Category	Gypsum Board	Gypsum Board
						Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
						Thickness (mm)	-	-
					Window Opening	Number of Windows	8	8
						Total Window Area (ft2)	5.2	5.2
						Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
						Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
					Door Opening	Number of Doors	4	4
						Door Type	Hollow Steel	Steel Exterior Door
					2.3.6.2 Wall_Wood stud_E11_Roof	Length (m)	26	26
						Height (m)	2	2
					Wood Stud	Wall Type	Non loadbearing	Non loadbearin g
						Sheathing Type	13mm Plywood	Plywood
						Study Spacing	-	400oc

					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 140	38 x 140
				Envelope	Category	Insulation	Insulation
					Material	R20 Mineral wool	Rockwool Batt
					Thickness (mm)	-	119
					Category	Vapour Barrier	Vapour Barrier
					Material	vapour permeable membrane	3 mil poly
					Thickness	-	-
					Category	15 ext grade sheathing	-
					Material	-	-
					Thickness (mm)	-	-
				Door Opening	Number of Doors	6	6
					Door Type	Hollow Steel	Steel Exterior Door
				2.3.6.3 Wall_Wood stud_E3.2-W6_Roof	Length (m)	22	22
					Height (m)	3.5	3.5
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Envelope	Category	Cladding	Cladding
					Material	90 sawn face concrete masonry	Brick - concrete
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 Mineral wool	Rockwool Batt
					Thickness (mm)	-	119
					Category	Vapour Barrier	Vapour Barrier
					Material	air, vapour 7 moisture barrier	6 mil poly
					Thickness	-	-
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Window Opening	Number of Windows	1.3	1.3
					Total Window Area (ft2)	2	2
					Frame Type	Fixed,	Fixed,

					Glazing Type	Aluminum Frame Low E Argon Filled Glazing	Aluminum Frame Low E Tin Argon Filled Glazing
A31 Walls Below Grade	1877.4	m^2					
			3.1.1 Cast In Place	3.1.1.1 Wall_Cast-in-place_W1-W2_Basement	Length (m)	127	127
					Height (m)	4.2	4.2
					Thickness (mm)	300	-
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	15M	15M
				Door Opening	Number of Doors	16	16
					Door Type	Steel Interior Door	Steel Interior Door
				3.1.1.2 Wall_Cast-in-place_E1-W1_Basement	Length (m)	93	93
					Height (m)	4.2	4.2
					Thickness (mm)	300	-
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	15M & 20M	15M
				Envelope	Category	Insulation	Insulation
					Material	R20 CT Insultation	Expanded Plystyrene
					Thickness (mm)	-	100
					Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly
					Thickness (mm)	-	-
				3.1.1.3 Wall_Cast-in-place_E1-SW5_Basement	Length (m)	70	81.667
					Height (m)	4.2	4.2
					Thickness (mm)	350	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	20M	20M
				Envelope	Category	Insulation	Insulation
					Material	R20 CT Insultation	Expanded Plystyrene
					Thickness (mm)	-	100
					Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly

					Thickness (mm)	-	-
				Door Opening	Number of Doors	4	4
					Door Type	Steel Interior Door	Steel Interior Door
				3.1.1.4 Wall_Cast-in-place_E1-SW4_Basement	Length (m)	36	36
					Height (m)	4.2	4.2
					Thickness (mm)	300	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	20M	20M
				Envelope	Category	Insulation	Insulation
					Material	R20 CT Insultation	Expanded Plystyrene
					Thickness (mm)	-	100
					Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly
					Thickness (mm)	-	-
				3.1.1.5 Wall_Cast-in-place_W1-W3_Basement	Length (m)	25	25
					Height (m)	4.2	4.2
					Thickness (mm)	300	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	15M	15M
				Door Opening	Number of Doors	4	4
					Door Type	Steel Interior Door	Steel Interior Door
				3.1.1.6 Wall_Cast-in-place_W1-SW1_Basement	Length (m)	24	24
					Height (m)	4.2	4.2
					Thickness (mm)	300	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	20M	20M
				Door Opening	Number of Doors	2	2
					Door Type	Steel Interior Door	Steel Interior Door
				3.1.1.7 Wall_Cast-in-place_E1-SW3_Basement	Length (m)	14	14
					Height (m)	4.2	4.2
					Thickness (mm)	300	300
					Concrete (MPa)	30	30

					Concrete flyash %	-	average
					Rebar	15M & 20M	15M
				Envelope	Category	Insulation	Insulation
					Material	R20 CT Insultation	Polystyrene Expanded
					Thickness (mm)	-	100
					Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly
					Thickness (mm)	-	-
				3.1.1.8 Wall_Cast-in-place_W1-SW2_Basement	Length (m)	13	26
					Height (m)	4.2	4.2
					Thickness (mm)	600	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	20M	20M
			3.1.2 Steel Stud	Wall_Steel stud_WA7_Basement	Length (ft)	45	45
					Height (ft)	4.2	4.2
					Sheathing Type	None	None
					Stud Spacing	600oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	152	152
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
				Door Opening	Number of Doors	2	2
					Door Type	Solid Wood	Solid Wood Door
A32 Walls Above Grade	6900.5	m^2					
			3.2.1 Cast In Place	3.2.1.1 Wall_Cast-in-place_W1-SW1_Ground	Length (m)	63	63
					Height (m)	6.5	6.5
					Thickness (mm)	300	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average

					Rebar	20M	20M
				Door Opening	Number of Doors	5	5
					Door Type	Solid Wood	Solid Wood Door
				3.2.1.2 Wall_Cast-in-place_E1-SW4_Ground	Length (m)	43	43
					Height (m)	4.2	4.2
					Thickness (mm)	300	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	20M	20M
				Envelope	Category	Insulation	Insulation
					Material	R20 CT Insultation	Polystyren e Expanded
					Thickness (mm)	-	100
					Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly
					Thickness (mm)	-	-
				Window Opening	Number of Windows	8	8
					Total Window Area (ft2)	4.9	4.9
					Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
					Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
				Door Opening	Number of Doors	1	1
					Door Type	Solid Wood	Solid Wood Door
				3.2.1.3 Wall_Cast-in-place_E3.1-SW4_Ground	Length (m)	42	42
					Height (m)	4.2	4.2
					Thickness (mm)	300	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	20M	20M
				Steel Stud	Sheathing Type	-	None
					Stud Spacing	400oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	-	38 x 92
				Envelope	Category	Cladding	Cladding
					Material	90 sawn face concrete masonry	Brick - concrete

						Thickness (mm)	-	-
						Category	Paint	Paint
						Material	Elastomeric paint	Varnish solvent based
						Thickness (mm)	-	-
						Category	Vapour Barrier	Vapour Barrier
						Material	Dampproofing	6 mil poly
						Thickness (mm)	-	-
						Category	Insulation	Insulation
						Material	R20 Mineral wool	Rockwool Batt
						Thickness (mm)	119	140
						Category	Gypsum Board	Gypsum Board
						Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
						Thickness (mm)	-	-
					Door Opening	Number of Doors	2	2
						Door Type	Glass Panel	Aluminum Exteror Door, 80% glazing
					3.2.1.4 Wall_Cast-in-place_Wood studs_E2_Ground	Length (m)	33	33
						Height (m)	4.2	4.2
						Thickness (mm)	300	300
						Concrete (MPa)	30	30
						Concrete flyash %	-	average
						Rebar	15M & 20M	20M
					Wood Stud	Wall Type	Non leadbearing	Non leadbearin g
						Sheathing Type	19 solid wood slats	Plywood
						Study Spacing	600oc	600oc
						Stud Type	Kiln dried	Kiln dried
						Stud Thickness	38 x 89	38 x 89
					Steel Stud	Sheathing Type	-	None
						Stud Spacing	600oc	600oc
						Stud Weight	-	Light (25Ga)
						Stud Thickness	-	38 x 92
					Envelope	Category	Vapour Barrier	Vapour Barrier
						Material	Dampproofing	6 mil poly
						Thickness (mm)	-	-
						Category	Insulation	Insulation
						Material	R20 CT Insultation	Polystyren e Expanded

					Thickness (mm)	-	100
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
					Category	Black out fabric	-
					Material	-	-
					Thickness (mm)	-	-
				3.2.1.5 Wall_Cast-in-place_E1-W1_Ground	Length (m)	33	33
					Height (m)	5	5
					Thickness (mm)	300	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	15M & 20M	20M
				Envelope	Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 CT Insultation	Polystyrene Expanded
					Thickness (mm)	-	100
				Window Opening	Number of Windows	5	5
					Total Window Area (ft2)	3.1	3.1
					Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
					Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
				Door Opening	Number of Doors	1	1
					Door Type	Glass Panel	Aluminum Exteror Door, 80% glazing
				3.2.1.6 Wall_Cast-in-place_W1-W2_Ground	Length (m)	27	27
					Height (m)	2.5	2.5
					Thickness (mm)	200	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	15M	15M

				3.2.1.7 Wall_Cast-in-place_Theatre roundback_Ground	Length (m)	17	17
					Height (m)	4.2	4.2
					Thickness (mm)	250	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	15M	15M
				Envelope	Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 CT Insultation	Polystyrene Expanded
					Thickness (mm)	-	100
				3.2.1.8 Wall_Cast-in-place_Retaining_Ground	Length (m)	15	12.5
					Height (m)	1.5	1.5
					Thickness (mm)	250	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	-	15M
				3.2.1.9 Wall_Cast-in-place_E1-SW5_Ground	Length (m)	16	18.66666667
					Height (m)	5.3	5.3
					Thickness (mm)	350	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	20M	20M
				Envelope	Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 CT Insultation	Polystyrene Expanded
					Thickness (mm)	-	100
				Door Opening	Number of Doors	1	1
					Door Type	Glass Panel	Aluminum Exteror Door, 80% glazing
				3.2.1.10 Wall_Cast-in-place_W1-SW2_Ground	Length (m)	13	26
					Height (m)	4.2	4.2
					Thickness (mm)	600	300

					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	20M	20M
				3.2.1.11 Wall_Cast-in-place_E1-W1_Level 02	Length (m)	18	18
					Height (m)	5.3	5.3
					Thickness (mm)	300	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	15M & 20M	20M
				Envelope	Category	Vapour Barrier	Vapour Barrier
					Material	Dampproofing	6 mil poly
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 CT Insultation	Polystyrene Expanded
					Thickness (mm)	-	100
				Window Opening	Number of Windows	5	5
					Total Window Area (ft2)	3.1	3.1
					Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
					Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
				3.2.1.12 Wall_Cast-in-place_W1-W2_Level 02	Length (m)	6	6
					Height (m)	5.3	5.3
					Thickness (mm)	200	300
					Concrete (MPa)	30	30
					Concrete flyash %	-	average
					Rebar	15M	15M
			3.2.2 Steel Stud	3.2.2.1 Wall_Steel stud_W14_Ground	Length (ft)	14	14
					Height (ft)	5.3	5.3
					Sheathing Type	-	None
					Stud Spacing	610oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	39 x 64	38 x 92
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	1" GWB X-TYP	Gypsum Moisture Resistant

							1/2"
					Thickness	-	-
					Category	-	Gypsum Board
					Material	-	Gypsum Moisture Resistant 1/2"
					Thickness	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	64
				3.2.2.2 Wall_Steel stud_W14_Level 02	Length (ft)	8	8
					Height (ft)	4.2	4.2
					Sheathing Type	-	None
					Stud Spacing	610oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	39 x 64	38 x 92
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	1" GWB X-TYP	Gypsum Moisture Resistant 1/2"
					Thickness	-	-
					Category	-	Gypsum Board
					Material	-	Gypsum Moisture Resistant 1/2"
					Thickness	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	64
				3.2.2.3 Wall_Steel stud_W14_Level 03	Length (ft)	8	8
					Height (ft)	4.2	4.2
					Sheathing Type	-	None
					Stud Spacing	610oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	39 x 64	38 x 92
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	1" GWB X-TYP	Gypsum Moisture Resistant 1/2"
					Thickness	-	-

					Category	-	Gypsum Board
					Material	-	Gypsum Moisture Resistant 1/2"
					Thickness	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	64
				3.2.2.4 Wall_Steel stud_W14_Level 04	Length (ft)	8	8
					Height (ft)	4.2	4.2
					Sheathing Type	-	None
					Stud Spacing	610oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	39 x 64	38 x 92
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	1" GWB X-TYP	Gypsum Moisture Resistant 1/2"
					Thickness	-	-
					Category	-	Gypsum Board
					Material	-	Gypsum Moisture Resistant 1/2"
					Thickness	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	64
			3.2.3 Wood Stud	3.2.3.1 Wall_Wood stud_E4_Level ALL	Length (m)	880	880
					Height (m)	0.7	0.7
					Wall Type	Non leadbearing	Non leadbearin g
					Sheathing Type	25 ply mulple ply cedar panel	Plywood
					Study Spacing	-	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	-	38x89
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-

					Category	Vapour Barrier	Vapour Barrier
					Material	air, vapour 7 moisture barrier	6 mil poly
					Thickness	-	-
					Category	Insulation	Insulation
					Material	R20 Mineral wool	Rockwool Batt
					Thickness (mm)	-	119
				3.2.3.2 Wall_Wood stud_E3.2-W6_Level 02	Length (m)	43	43
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	6mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Envelope	Category	Cladding	Cladding
					Material	90 sawn face concrete masonry	Brick - concrete
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 Mineral wool	Rockwool Batt
					Thickness (mm)	-	119
					Category	Vapour Barrier	Vapour Barrier
					Material	air, vapour 7 moisture barrier	6 mil poly
					Thickness	-	-
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Window Opening	Number of Windows	9	9
					Total Window Area (ft2)	6	6
					Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
					Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
				Door Opening	Number of Doors	2	2
					Door Type	Glass Panel	Aluminum Exteror Door, 80%

							glazing
				3.2.3.3 Wall_Wood stud_Wood stud_Level 02	Length (m)	20	20
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbearing
					Sheathing Type	13 Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 140	38 x 140
				Wood Stud	Wall Type	Loadbearing	Loadbearing
					Sheathing Type	13 Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 140	38 x 140
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 1/2"	Gypsum Regular 1/2"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	140
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 1/2"	Gypsum Regular 1/2"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	140
				Door Opening	Number of Doors	2	2
					Door Type	Solid Wood	Solid Wood Door
				3.2.3.4 Wall_Wood stud_W12-SW7_Level 02	Length (m)	19	19
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbearing
					Sheathing Type	both sides 16mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184

				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	184
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Door Opening	Number of Doors	2	2
					Door Type	Glass Panel	Aluminum Exteror Door, 80% glazing
				3.2.3.5 Wall_Wood stud_Steel stud_E3.1-W6_Level 02	Length (m)	6	6
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	6mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Steel Stud	Sheathing Type	-	None
					Stud Spacing	-	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	-	38 x 92
				Envelope	Category	Cladding	Cladding
					Material	90 sawn face concrete masonry	Brick - concrete
					Thickness (mm)	-	-
					Category	Vapour Barrier	Vapour Barrier
					Material	air, vapour 7 moisture barrier	6 mil poly
					Thickness	-	-
					Category	Paint	Paint
					Material	Elastomeric paint	Varnish solvent based
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 Mineral wool	Rockwool Batt
					Thickness (mm)	-	119

					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Window Opening	Number of Windows	1	1
					Total Window Area (ft2)	0.7	0.7
					Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
					Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
				3.2.3.6 Wall_Wood stud_E3.2-W6_Level 03	Length (m)	51	51
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	6mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Envelope	Category	Cladding	Cladding
					Material	90 sawn face concrete masonry	Brick - concrete
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 Mineral wool	Rockwool Batt
					Thickness (mm)	-	119
					Category	Vapour Barrier	Vapour Barrier
					Material	air, vapour 7 moisture barrier	6 mil poly
					Thickness	-	-
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Window Opening	Number of Windows	14	14
					Total Window Area (ft2)	10.5	10.5
					Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
					Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon

							Filled Glazing
				3.2.3.7 Wall_Wood stud_Wood stud_Level 03	Length (m)	20	20
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	13 Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 140	38 x 140
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	13 Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 140	38 x 140
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 1/2"	Gypsum Regular 1/2"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	140
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 1/2"	Gypsum Regular 1/2"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	140
				Door Opening	Number of Doors	2	2
					Door Type	Solid Wood	Solid Wood Door
				3.2.3.8 Wall_Wood stud_W12-SW7_Level 03	Length (m)	19	19
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	both sides 16mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184

				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	184
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Door Opening	Number of Doors	4	4
					Door Type	Glass Panel	Aluminum Exteror Door, 80% glazing
				3.2.3.9 Wall_Wood stud_Steel stud_E3.1-W6_Level 03	Length (m)	6	6
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	6mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Steel Stud	Sheathing Type	-	None
					Stud Spacing	-	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	-	38 x 92
				Envelope	Category	Cladding	Cladding
					Material	90 sawn face concrete masonry	Brick - concrete
					Thickness (mm)	-	-
					Category	Vapour Barrier	Vapour Barrier
					Material	air, vapour 7 moisture barrier	6 mil poly
					Thickness	-	-
					Category	Paint	Paint
					Material	Elastomeric paint	Varnish solvent based
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 Mineral wool	Rockwool Batt
					Thickness (mm)	-	119

					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Window Opening	Number of Windows	1	1
					Total Window Area (ft2)	0.7	0.7
					Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
					Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
				3.2.3.10 Wall_Wood stud_WA7.1-SW8_Level 03	Length (m)	10	10
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Non leadbearing	Non leadbearing
					Sheathing Type	13 Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	64
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				3.2.3.11 Wall_Wood stud_E3.2-W6_Level 04	Length (m)	51	51
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbearing
					Sheathing Type	6mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Envelope	Category	Cladding	Cladding

						Material	90 sawn face concrete masonry	Brick - concrete
						Thickness (mm)	-	-
						Category	Insulation	Insulation
						Material	R20 Mineral wool	Rockwool Batt
						Thickness (mm)	-	119
						Category	Vapour Barrier	Vapour Barrier
						Material	air, vapour 7 moisture barrier	6 mil poly
						Thickness	-	-
						Category	Gypsum Board	Gypsum Board
						Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
						Thickness (mm)	-	-
					Window Opening	Number of Windows	14	14
						Total Window Area (ft2)	10.5	10.5
						Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
						Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
					3.2.3.12 Wall_Wood stud_Wood stud_Level 04	Length (m)	20	20
						Height (m)	4.2	4.2
					Wood Stud	Wall Type	Loadbearing	Loadbeari ng
						Sheathing Type	13 Plywood	Plywood
						Study Spacing	300oc	400oc
						Stud Type	Kiln dried	Kiln dried
						Stud Thickness	38 x 140	38 x 140
					Wood Stud	Wall Type	Loadbearing	Loadbeari ng
						Sheathing Type	13 Plywood	Plywood
						Study Spacing	300oc	400oc
						Stud Type	Kiln dried	Kiln dried
						Stud Thickness	38 x 140	38 x 140
					Envelope	Category	Gypsum Board	Gypsum Board
						Material	Gypsum Regular 1/2"	Gypsum Regular 1/2"
						Thickness (mm)	-	-
						Category	Insulation	Insulation
						Material	Acoustic	Fiberglass Batt

					Thickness (mm)	-	140
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 1/2"	Gypsum Regular 1/2"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	140
				Door Opening	Number of Doors	2	2
					Door Type	Solid Wood	Solid Wood Door
				3.2.3.13 Wall_Wood stud_W12-SW7_Level 04	Length (m)	19	19
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	both sides 16mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	184
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Door Opening	Number of Doors	4	4
					Door Type	Glass Panel	Aluminum Exteror Door, 80% glazing
				3.2.3.14 Wall_Wood stud_WA7.1-SW8_Level 04	Length (m)	10	10
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Non leadbearing	Non leadbearin g
					Sheathing Type	13 Plywood	Plywood

					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	64
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				3.2.3.15 Wall_Wood stud_Steel stud_E3.1-W6_Level 04	Length (m)	6	6
					Height (m)	4.2	4.2
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	6mm Plywood	Plywood
					Study Spacing	300oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 184	38 x 184
				Steel Stud	Sheathing Type	-	None
					Stud Spacing	-	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	-	38 x 92
				Envelope	Category	Cladding	Cladding
					Material	90 sawn face concrete masonry	Brick - concrete
					Thickness (mm)	-	-
					Category	Vapour Barrier	Vapour Barrier
					Material	air, vapour 7 moisture barrier	6 mil poly
					Thickness	-	-
					Category	Paint	Paint
					Material	Elastomeric paint	Varnish solvent based
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	R20 Mineral wool	Rockwool Batt
					Thickness (mm)	-	119
					Category	Gypsum Board	Gypsum

							Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
				Window Opening	Number of Windows	1	1
					Total Window Area (ft2)	0.7	0.7
					Frame Type	Fixed, Aluminum Frame	Fixed, Aluminum Frame
					Glazing Type	Low E Argon Filled Glazing	Low E Tin Argon Filled Glazing
			3.2.4 Curtain Wall	3.2.4.1 Wall_Curtain wall_E7.2_Ground	Length (m)	93	93
					Height (m)	5.3	5.3
					Percent Viewable Glazing	-	-
					Percent Spandrel Panel	-	-
					Thickness of Insulation (mm)	-	-
					Spandrel Type (Metal/Glass)	Glass	Glass
				Door Opening	Number of Doors	10	10
					Door Type	Glass Panel Pair	Aluminum Exterior Door, 80% glazing
				3.2.4.2 Wall_Curtain wall_W11_Ground	Length (m)	10	10
					Height (m)	5.3	5.3
					Percent Viewable Glazing	-	-
					Percent Spandrel Panel	-	-
					Thickness of Insulation (mm)	-	-
					Spandrel Type (Metal/Glass)	Glass	Glass
				Door Opening	Number of Doors	2	2
					Door Type	Solid Wood	Solid Wood Door
				3.2.4.3 Wall_Curtain wall_E5.1/5.2/6/7_Level 02	Length (m)	155	155
					Height (m)	4.2	4.2
					Percent Viewable Glazing	0.82	0.82

					Percent Spandrel Panel	0.18	0.18
					Thickness of Insulation (mm)	-	25mm
					Spandrel Type (Metal/Glass)	Glass	Glass
				Door Opening	Number of Doors	2	2
					Door Type	-	Aluminum Exterior Door, 80% glazing
				3.2.4.4 Wall_Curtain wall_W11_Level 02	Length (m)	10	10
					Height (m)	4.2	4.2
					Percent Viewable Glazing	-	-
					Percent Spandrel Panel	-	-
					Thickness of Insulation (mm)	-	-
					Spandrel Type (Metal/Glass)	Glass	Glass
				Door Opening	Number of Doors	5	5
					Door Type	Solid Wood	Solid Wood Door
				3.2.4.5 Wall_Curtain wall_E5.1/5.2/6/7_Level 03	Length (m)	155	155
					Height (m)	4.2	4.2
					Percent Viewable Glazing	0.82	0.82
					Percent Spandrel Panel	0.18	0.18
					Thickness of Insulation (mm)	-	25mm
					Spandrel Type (Metal/Glass)	Glass	Glass
				3.2.4.6 Wall_Curtain wall_W11_Level 03	Length (m)	10	10
					Height (m)	4.2	4.2
					Percent Viewable Glazing	-	-
					Percent Spandrel Panel	-	-
					Thickness of Insulation (mm)	-	-
					Spandrel Type (Metal/Glass)	Glass	Glass
				Door Opening	Number of Doors	5	5

					Door Type	Solid Wood	Solid Wood Door
				3.2.4.7 Wall_Curtain wall_E5.1/5.2/6/7_Level 04	Length (m)	155	155
					Height (m)	4.2	4.2
					Percent Viewable Glazing	0.82	0.82
					Percent Spandrel Panel	0.18	0.18
					Thickness of Insulation (mm)	-	25mm
					Spandrel Type (Metal/Glass)	Glass	Glass
				3.2.4.8 Wall_Curtain wall_W11_Level 04	Length (m)	10	10
					Height (m)	4.2	4.2
					Percent Viewable Glazing	-	-
					Percent Spandrel Panel	-	-
					Thickness of Insulation (mm)	-	-
					Spandrel Type (Metal/Glass)	Glass	Glass
				Door Opening	Number of Doors	5	5
					Door Type	Solid Wood	Solid Wood Door
B11 Partitions	2543.9	m^2					
			1.1.1Wood Stud	1.1.1.1 Wall_Wood stud_Steel stud_WA7.3_Ground	Length (m)	76	76
					Height (m)	5.3	5.3
				Wood Stud	Wall Type	Loadbearing	Loadbeari ng
					Sheathing Type	19mm wood panels	Plywood
					Study Spacing	600oc	600oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	-	38x89
				Steel Stud	Sheathing Type	-	None
					Stud Spacing	-	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	-	38 x 92
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"

					Thickness	-	-
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
				1.1.1.2 Wall_Wood stud_Wood stud_WA7.1_Ground	Length (m)	6	6
					Height (m)	2.6	2.6
				Wood Stud	Wall Type	Non leadbearing	Non leadbearing
					Sheathing Type	13 Plywood	Plywood
					Study Spacing	400oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 64	38 x 64
				Wood Stud	Wall Type	Non leadbearing	Non leadbearing
					Sheathing Type	-	-
					Study Spacing	400oc	400oc
					Stud Type	Kiln dried	Kiln dried
					Stud Thickness	38 x 64	38 x 64
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
					Category	Insulation	Insulation
					Material	Acoustic	Fiberglass Batt
					Thickness (mm)	-	64
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness (mm)	-	-
			1.1.2 Steel Stud	1.1.2.1 Wall_Steel stud_WA7/7.2_Ground	Length (ft)	136	136
					Height (ft)	6.5	6.5
					Sheathing Type	None	None
					Stud Spacing	600oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	152	152
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"

						Thickness	-	-
						Category	Gypsum Board	Gypsum Board
						Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
						Thickness	-	-
						Category	Insulation	Insulation
						Material	Acoustic	Fiberglass Batt
						Thickness (mm)	-	152
					Door Opening	Number of Doors	17	17
						Door Type	Solid Wood	Solid Wood Door
					1.1.2.2 Wall_Steel stud_bathroom_Ground	Length (ft)	43	43
						Height (ft)	2.5	2.5
						Sheathing Type	-	None
						Stud Spacing	-	600oc
						Stud Weight	-	Light (25Ga)
						Stud Thickness	-	152
					Envelope	Category	Gypsum Board	Gypsum Board
						Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
						Thickness	-	-
						Category	Ceramic wall tiles (CT-3 to 10)	-
						Material	-	-
						Thickness	-	-
					Door Opening	Number of Doors	2	2
						Door Type	Solid Wood	Solid Wood Door
					1.1.2.3 Wall_Steel stud_WA7_Level 02	Length (ft)	44	44
						Height (ft)	4.2	4.2
						Sheathing Type	None	None
						Stud Spacing	600oc	600oc
						Stud Weight	-	Light (25Ga)
						Stud Thickness	39 x 152	38 x 152
					Envelope	Category	Gypsum Board	Gypsum Board
						Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
						Thickness	-	-
						Category	Gypsum Board	Gypsum Board

					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
				Door Opening	Number of Doors	5	5
					Door Type	Solid Wood	Solid Wood Door
				1.1.2.4 Wall_Steel stud_bathroom_Level 02	Length (ft)	10	10
					Height (ft)	4.2	4.2
					Sheathing Type	-	None
					Stud Spacing	-	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	-	152
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
					Category	Ceramic wall tiles (CT-3 to 10)	-
					Material	-	-
					Thickness	-	-
				1.1.2.5 Wall_Steel stud_WA7_Level 03	Length (ft)	44	44
					Height (ft)	4.2	4.2
					Sheathing Type	None	None
					Stud Spacing	600oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	39 x 152	38 x 152
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
				Door Opening	Number of Doors	3	3
					Door Type	Solid Wood	Solid Wood Door
				1.1.2.6 Wall_Steel stud_bathroom_Level 03	Length (ft)	10	10

					Height (ft)	4.2	4.2
					Sheathing Type	-	None
					Stud Spacing	-	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	-	152
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
					Category	Ceramic wall tiles (CT-3 to 10)	-
					Material	-	-
					Thickness	-	-
				1.1.2.7 Wall_Steel stud_WA7_Level 04	Length (ft)	44	44
					Height (ft)	4.2	4.2
					Sheathing Type	None	None
					Stud Spacing	600oc	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	39 x 152	38 x 152
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
					Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"
					Thickness	-	-
				Door Opening	Number of Doors	3	3
					Door Type	Solid Wood	Solid Wood Door
				1.1.2.8 Wall_Steel stud_bathroom_Level 04	Length (ft)	10	10
					Height (ft)	4.2	4.2
					Sheathing Type	-	None
					Stud Spacing	-	600oc
					Stud Weight	-	Light (25Ga)
					Stud Thickness	-	152
				Envelope	Category	Gypsum Board	Gypsum Board
					Material	Gypsum Regular 5/8"	Gypsum Regular 5/8"

					Thickness	-	-
					Category	Ceramic wall tiles (CT-3 to 10)	-
					Material	-	-
					Thickness	-	-

<table>
<tr><th>Assembly Group</th><th>Assembly Type and Name</th><th>Specific Assumptions</th></tr>
<tr><td rowspan="2">A11 Foundations</td><td colspan="2">The Impact Estimator, SOG inputs are limited to being either a 4” or 8” thickness. Some of the mechanical room padding is considered in Sog as it is on top of the basement SoG slab, the actual SOG thicknesses for the CIRS building were not exactly 4” or 8” thick but 6", the areas measured in Autodesk QTO required calculations to adjust the areas to accommodate this limitation.</td></tr>
<tr><td colspan="2">The Impact Estimator limits the Concrete strength to 3000, 4000 & 9000psi, we had to limit the actual strength of concrete for footings as per the Athena input i.e. 4000psi. Some of the mat footings were missing depth, e.g. MAT 1 & 2, drawing S201. Typical mat foundation thickness was considered from other mat foundations.</td></tr>
<tr><td rowspan="3">A21 Lowest Floor Construction</td><td colspan="2">Concrete Slab on-Grade</td></tr>
<tr><td>SoG_Mech Mat_150mm</td><td>The area of this slab had to be adjusted so that the thickness fit into the 4" thickness specified in the Impact Estimator. The following calculation was done in order to determine appropriate Length and Width (in feet) inputs for this slab.</td></tr>
<tr><td>SoG_Mat_1_150mm_Auditorium</td><td>The area of this slab had to be adjusted so that the thickness fit into the 4" thickness specified in the Impact Estimator. The following calculation was done in order to determine appropriate Length and Width (in feet) inputs for this slab</td></tr>
<tr><td rowspan="2">A22 Upper Floor Construction</td><td colspan="2">Suspended slab</td></tr>
<tr><td>Floor_F30_SUSPENDED-CONCRETE-SLAB-RAISED-TECRETE</td><td>All concrete was calculated as concrete masonry in the extra base materials due to Athena's limitation to model any such material</td></tr>
<tr><td rowspan="5">A23 Roof Construction</td><td colspan="2">Several roof components were excluded in the model due to modeling limitations and uncertainty. The components not included were, plant and growing medium, green roof root barrier and protection board.</td></tr>
<tr><td colspan="2">Green Roof</td></tr>
<tr><td>Roof_R1_LAMINATED-WOOD-GREEN-ROOF</td><td>The details of TPO were not found in Athena IE, so we used EPDM white, which is basically same as TPO</td></tr>
<tr><td colspan="2">Laminated wood</td></tr>
<tr><td>Roof_R2_LAMINATED-WOOD-PAVING-STONE</td><td>Roof widths were determined by dividing the total floor area of each condition by the span of that condition</td></tr>
</table>