2024

DEVELOPMENT APPLICATION

LOTS 8 & 4 (NO.293 & 295) OXFORD STREET, LEEDERVILLE

PROPOSED SIX (6) GROUPED DWELLINGS

CITY OF VINCENT

CF Town Planning & Development

Prepared for

Daniel Cassettai Design and Siamos Development for the construction of six (6) new grouped dwellings (two storey) on Lots8 & 4 (No.293 & 295) Oxford Street, Leederville.

Prepared by

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Planning & Development Consultants

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Name	Position	Document Revision	Date
Mr Carlo Famiano	Town Planner	Planning Report	4 March 2024

CF Town Planning & Development

4 March 2024

Chief Executive Officer
City of Vincent
PO Box 82
LEEDERVILLE WA 6902

Dear Sir/Madam

APPLICATION FOR DEVELOPMENT APPROVAL
PROPOSED SIX (6) GROUPED DWELLING (TWO STOREY)
LOTS 8 & 4 (No.293 & 295) OXFORD STREET, LEEDERVILLE
CITY OF VINCENT

We act on behalf of Daniel Cassettai Design and Siamos Developments as their consultant town planners and refer to the Application for Development Approval lodged with the City of Vincent seeking the City's approval for the construction of six (6) new grouped dwellings on Lots 8 & 4 (No.293 & 295) Oxford Street, Leederville to provide much needed housing within the Leederville & Mount Hawthorn localities in close proximity various Activity Centres.

In assessing this application, it is requested that the City of Vincent give due consideration to the following information prepared in support of the proposed development on the land:

LOCATION & PROPERTY DETAILS

Location

Lots 8 & 4 are located within the northern part of the Leederville locally, approximately 750 metres north of the Leederville Activity Centre (core area) and approximately 800 metres south of the Mount Hawthorn Activity Centre (see Figure 1 – Location Plan).

A review of the immediate locality has identified that the subject land is located within a well-established and well serviced part of Leederville, with convenient access to the following key nodes:

i) Various public open space reserves, including access to Britannia Reserve and Loftus Recreation Centre;

ii) High frequency public transport networks (i.e. bus routes). This include bus services along Oxford Street and easy access to the Leederville Train Station (see Figure 5 – Public Transport Network);

iii) A comprehensive regional road network (i.e. Oxford Street, Vincent Street, Scarborough Beach Road with easy access to the Mitchell Freeway);

iv) Access to a regional pedestrian/cycle network along the existing road network and along the Mitchell Freeway reserve, with a comprehensive pedestrian path network along the local street network;

v) Access to various schools (both private and public schools); and

vi) Mount Hawthorn and Leederville Activity Centres, which includes a variety of facilities such as medical, retail, entertainment, service commercial use and employment opportunities. The subject land also enjoys good access to the Perth Central Business District (CBD).

Given the above, this application seeks the relevant development approval for the construction of six (6) new grouped dwellings on the subject land to provide much needed housing and housing diversity within the Leederville locality, in close proximity to a key activity centres, a variety of amenities and to public transport.

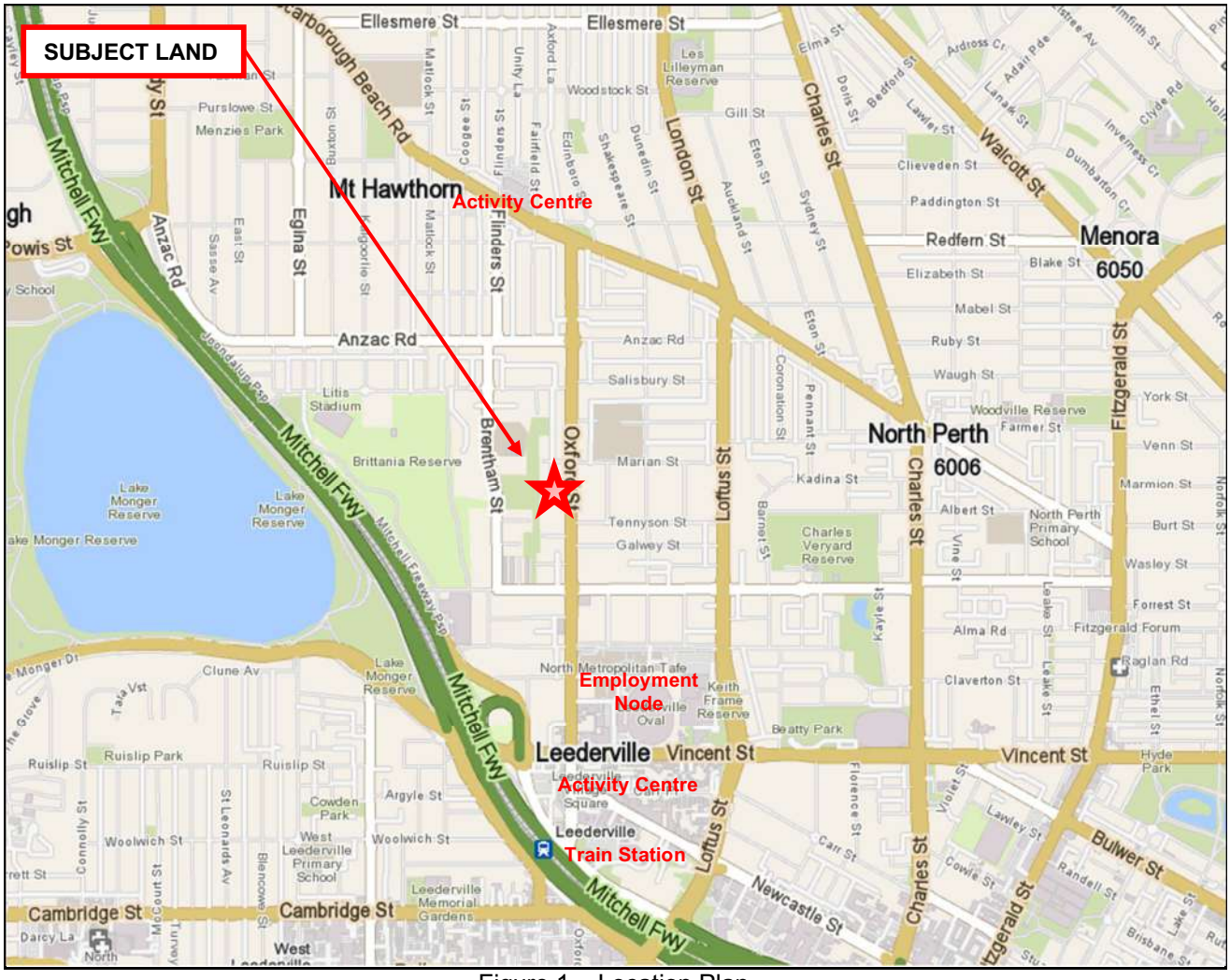

Figure 1 – Location Plan

Property Details

Lots 8 & 4 are rectangular in shape, comprise a total combined area of 1,024m^2 and contains an excessive fall in natural ground levels (NGL) from 10.08 metres along the land's front boundary to 8.39 metres along the land's rear boundary, which equates to a fall in NGL down/across the site of 1.69 metres (see site feature survey).

The subject land comprises a number of physical improvements including a single detached dwelling on each lot, sealed driveways and boundary fencing (see Figure 2 – Aerial Site Plan & Figure 3). This application proposes that all physical improvements on both Lots 8 & 4 will be removed to accommodate the new grouped dwelling development.

The existing dwellings and associated structures on the subject land is not identified on the City of Vincent's Municipal Heritage Inventory (MHI) and can therefore be removed subject to the issuance of a demolition permit by the City.

Figure 2 – Aerial Site Plan

Figure 3 – Existing dwellings on the subject land.

The verge area abutting the subject land contains one (1) street trees, which will be retained as part of this application (see Figure 2 – Aerial Site Plan). It is also observed that this part of the Oxford Street road reserve comprises extensive on-street car parking that could be used by visitors attending the subject land.

ESSENTIAL SERVICES

Lots 8 & 4 are served by an extensive range of essential service infrastructure including power, water, reticulated sewerage, stormwater drainage, gas and telecommunications (see Figure 4).

Figure 4 – The subject land is well serviced (MNG Mapping)

The subject land is also served by an efficient local and district road network with convenient access to Scarborough Beach Road, Oxford Street, Vincent Street and the Mitchell Freeway. Public transport is available along various nearby roads, including a service along Oxford Strreet and easy access to the Leederville Train Station (see Figure 5 – Public Transport Network).

The subject land is also well served by a pedestrian path network, including a regional cycle network along the Mitchell Freeway. It is contended that the subject land's good access to public transport and a pedestrian path network will provide an alternative form of transport for the future occupants and visitors to the development.

Figure 5 – Public Transport (bus routes shown in pink, with stops shown as orange dots - MNG Mapping)

PROPOSED DEVELOPMENT

This application proposes the demolition of all existing physical improvements on the subject land and the construction of six (6) new grouped dwellings of a two (2) storey nature. The key details of the proposed development include the following:

i) Each dwelling will comprise three (3) bedrooms and two (2) bathrooms;

ii) Each dwelling will comprise a double (two car) garage and a storeroom. It should be noted that all vehicular access for development will be from one (1) central common driveway along the land's Oxford Street frontage;

iii) Constructions of a visually permeable fence along the land's front boundary with Oxford Street to provide an element of security for the future occupants of the development;

iv) Installation of landscaping throughout the site; and

v) The dwelling will include the use of varying materials, a varying pallet of colours and varying setbacks/articulation to enhance the appearance of the development when viewed from the public realm (see Figure 6).

The lots will be amalgamated as part of the future development on the land.

Figure 6 – The front elevation of the proposed development.

STATUTORY REQUIREMENTS

Metropolitan Region Scheme

Lot 8 & 4 are currently classified 'Urban' zone under the Metropolitan Region Scheme (MRS). It should be noted that the zones and reservations prescribed by the MRS are broad categories only that are intentionally not precisely defined or limited in order to enable a flexible approach to town planning. The following definition is provided as a guide to its stated purpose/s in the MRS:

*"**Urban Zone** - Areas in which a range of activities are undertaken, including residential, commercial recreational and light industry."*

The proposed development and use of the land for grouped dwelling purposes is considered to be consistent with the defined intent of its current 'Urban' zoning classification under the MRS and has scope to be approved.

City of Vincent Local Planning Scheme No.2

Lots 8 & 4 are classified 'Mixed Use' zone under the City of Vincent's current operative Local Planning Scheme No.2 (LPS No.2) with a residential density coding of R100. In addition, the subject land is located within the 'Leederville Precinct'.

Under the terms of the City's LPS No.2 the development and use of any land classified 'Residential' zone for 'Grouped Dwelling' purposes is listed as a permitted ("P") use.

According to the City of Vincent's Local Planning Policy No.7.1.1 entitled 'Built Form', the subject land is identified as being within the 'Activity Corridor' built form area and comprises an allowable building height of four (4) storeys. Furthermore, LPP No.7.1.1 allows for a nil primary and secondary street setback.

Following discussions with the City of Vincent, it was advised that the required lot boundary setbacks calculations will be as per the R-Codes (i.e. Table 2A & 2B of Volume 1) and that the provision prescribed within Clause 1.2 of the City's LPP No.7.1.1 are only due regard and not required to be addressed.

Council's stated objectives for all land classified 'Mixed Use' zone under LPS No.2 are as follows:

- *To provide for a wide variety of active uses on street level which are compatible with residential and other non-active uses on upper levels.*
- *To allow for the development of a mix of varied but compatible land uses such as housing, offices, showrooms, amusement centres, eating establishments and appropriate industrial activities which do not generate nuisances detrimental to the amenity of the district or to the health, welfare and safety of its residents.*
- *To provide for a compatible mix of high density residential and commercial development.*
- *To promote residential use as a vital and integral component of these mixed use zones.*
- *To ensure development design incorporates sustainability principles, with particular regard to waste management and recycling and including, but not limited to, solar passive design, energy efficiency and water conservation.*
- *To ensure the provision of a wide range of different types of residential accommodation, including affordable, social and special needs, to meet the diverse needs of the community.*

It is contended that the future grouped dwelling development of the subject land is consistent with the stated objectives for the 'Mixed Use' zone prescribed in LPS No.2 for the following reasons:

- It will provide for a range of housing choice/diversity and allows for an increase in density to service the needs of the community;
- It will contribute to providing a range of different land uses along Oxford Street, by allowing an element of residential land use that will support the commercial/other mixed use developments within the precinct;
- It will provide a use that is compatible with other surrounding uses and will not be a nuisance to the area or have a detrimental impact on the amenity of the locality in terms of health, welfare and safety;
- It will assist with providing a wide range of housing types and densities within the immediate locality, which will cater for varying household structures and demographics;

- It will foster the re-development of the land to provide for significant improvements to the current levels of passive surveillance of the local streetscape, will add to the diversity of housing stock within the immediate locality and provide a development that will include good connectivity between both the public and private realms;
- It will provide for increased usage of the nearby public transport network and support the nearby activity centres;
- It will provide a design that incorporates sustainability principles, including access to natural light, cross ventilation and water conservation;
- It will provide an attractive and safe residential environment comprising affordable, modern and high quality housing within a well-established urban area.

Department of Fire and Emergency Services (DFES)

The subject land has not been identified by the Department of Fire and Emergency Services (DFES) as being located within a bushfire prone area (see Figure 7 – DFES Mapping).

Figure 7 – DFES bushfire mapping

State Planning Policy No.5.4 – 'Road & Rail Noise'

The subject land is not located within close proximity to any regional roads and/or railway network (see Figure 8). As such, this application is not required to address the requirements of State Planning Policy No.5.4 entitled 'Road and Rail Noise' in regard to noise.

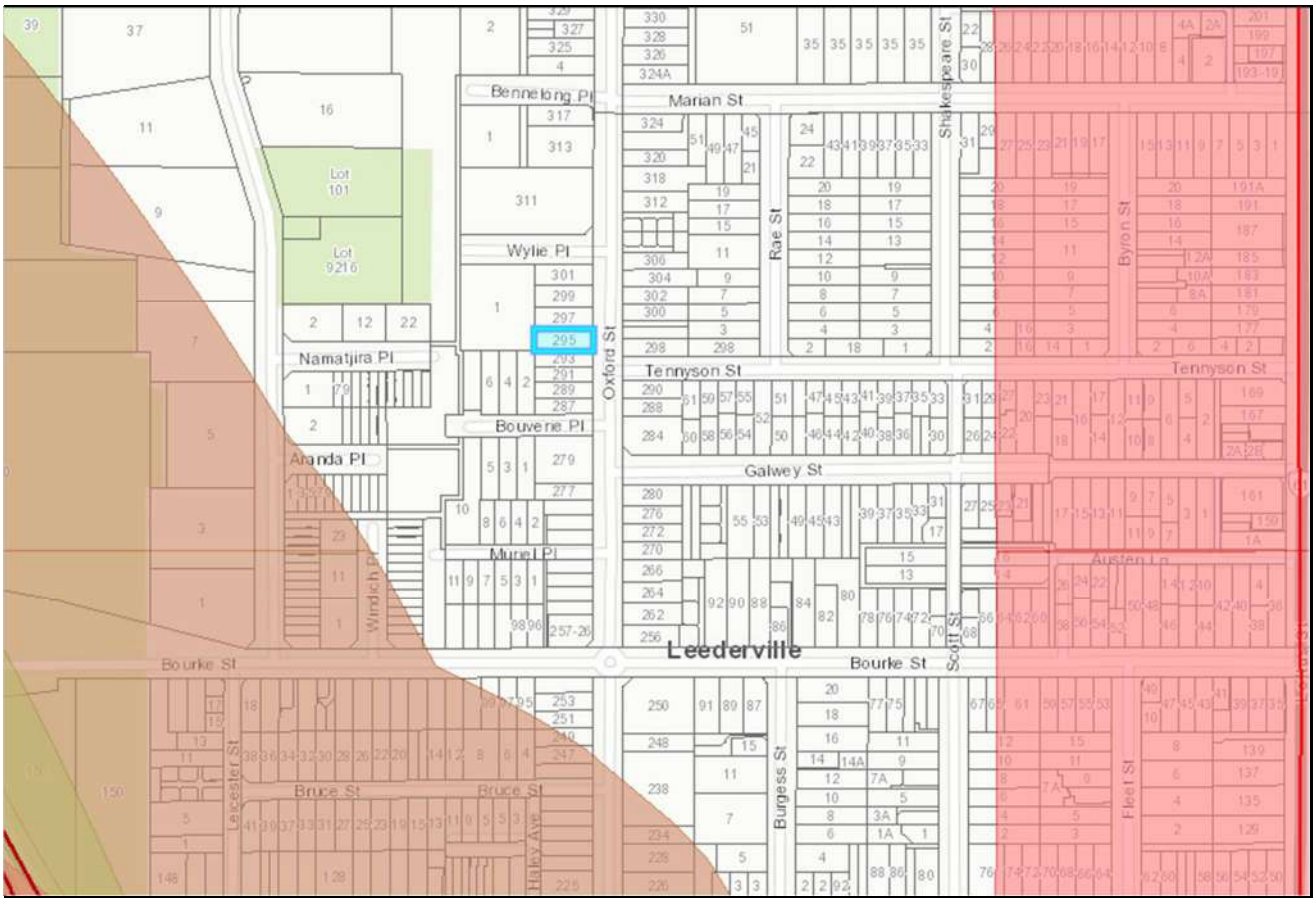

Figure 8 – SPP No.5.4 mapping

URBAN DESIGN STUDY

Lots 8 & 4 have historically been developed and used for 'Single House' purposes, with all physical improvements on the land to be removed. As previously mentioned, the verge area abutting the subject comprises one (1) mature street trees, which is in good condition and will need to be retained as part of the proposed development on the land.

A review of the existing and future character of the immediate locality has concluded that there is no defined or heritage character worthy of retention within this part of the Leederville locality, with a wide range of land uses and development styles/configuration being evident (i.e. range from single dwellings to grouped/multiple dwellings and commercial developments). Given this, it is considered reasonable to conclude that the character of the locality and the local streetscapes is not uniform, is varied in terms of the current built form, does not reflect any specific character or form and is undergoing continued re-development that reflects the varying zonings along Oxford Street. As such, it is contended that the development will provide a positive contribution to the immediate locality, whilst providing a diversity of housing types within close proximity to the Leederville and Mount Hawthorn Activity Centres.

Figures 9 & 10 below illustrate examples of the varying developments/land uses along this part of Oxford Street.

Figure 9 – Examples of Residential developments along Oxford Street in close proximity to the subject land.

Figure 10 – Examples of existing commercial developments along Oxford Street close to the subject land.

It should be noted that the designer/applicant has provided a response to the those matters prescribed within the City of Vincent's 'Development Application – Urban Design Study' form.

DEVELOPMENT STANDARDS

The design of the proposed new grouped dwelling development on the subject land has been formulated with due regard for the relevant 'deemed to comply requirements' of the Residential Design Codes Volume 1 (R-Codes) and the City of Vincent's current operative Local Planning Scheme No.2 (LPS No.2) including any relevant Local Planning Policies (including the City's LPP No.7.1.1 entitled 'Built Form') with the exception of the following:

a) R-Code Element 5.1.3 C3.1 - 'Lot boundary setback';

b) R-Code Element 5.1.3 C3.2 – 'Lot boundary setback' (buildings on boundary);

c) R-Code Element 5.3.1 C1.1 - 'Outdoor living area';

d) R-Code Element 5.3.3 C3.2 - 'Parking';

e) R-Code Element 5.3.7 C7.2 & C7.3 - 'Site works'; and

f) City of Vincent Local Planning Policy 7.1.1, Clause 1.4 - 'Landscaping'.

The following table provides justification for those aspects of the proposed new grouped dwelling development on the subject land seeking a variation to the 'deemed to comply requirements' of the relevant planning framework.

Table 1 – Justification

DEVELOPMENT STANDARD & 'DESIGN PRINCIPLES' OR 'LOCAL HOUSING OBJECTIVES'	PROPOSED VARIATION TO 'DEEMED TO COMPLY REQUIRMENTS'	JUSTIFICATION
R-Code Element 5.1.3 C3.1 – 'Lot boundary setback' *P3.1 Buildings set back from lot boundaries or adjacent buildings on the same lot so as to:* • *reduce impacts of building bulk on adjoining properties;* • *provide adequate direct sun and ventilation to the building and open spaces on the site and adjoining properties; and* • *minimise the extent of overlooking and resultant loss of privacy on adjoining properties.*	The application proposes the following aspects of the new development on the subject land do not meet the 'deemed to comply requirements' of Element 5.1.3 C3.1 of the R-Codes: i) Unit 3 & 4 ground floor will comprise a 1.258 metre setback from the western rear boundary in lieu of 1.5 metres; ii) Unit 3 ensuite/bath wall (upper floor) will comprise a 1.235 metre setback from the southern side boundary in lieu of 1.5 metres; and iii) Unit 4 ensuite/bath wall (upper floor) will comprise a 1.235 metre setback from the northern side boundary in lieu of 1.5 metres.	1. The proposed lot boundary variations for each dwelling (i.e. max 265mm) as considered to be minor and will not have an adverse impact on the adjoining properties and/or the streetscape in terms of bulk and scale. Furthermore, the variations can be attributed to the excessive fall in natural ground levels down the site which has resulted in higher wall height calculations. 2. The proposed development of the subject land complies with the visual privacy provisions of the R-Codes. 3. The offending walls comprise sufficient setback from the street to limit any impact on the streetscape in terms of bulk and scale. In fact, the parapet walls proposed as part of each dwelling will assist with screening some of the lot boundary setbacks from being visible from the street. 4. Each dwelling has been designed to provide adequate separation with the existing dwellings on the adjoining properties. 5. The proposed development on the subject land will comprise large separation between the upper floor of each dwelling to reduce the overall bulk and scale of the development when viewed from the adjoining properties. In addition, the separation provides an element of articulation. 6. The shadow cast by the proposed development over the adjoining northern property is considered to be acceptable within the 'Mixed Use' zone and will not adversely impact access to natural light and ventilation for the existing dwellings on the adjoining parties. 7. The proposed development has been designed to meet the needs of the future occupants of each dwelling and provide adequate space/outdoor living area. 8. Those portions of the development on the subject land comprising reduced setbacks from the western rear boundary will abut the side setback for the existing grouped dwelling on adjoining Lot 9 (No.2) Bouverie Place and the rear yard area of the existing grouped dwelling on adjoining Lot 44 (No.1) Wylie Place (see Figure 2 – Aerial Site Plan).Given the minor nature of the variations (i.e. less than 300mm), it is contended that the proposed new development will not have an adverse impact on any sensitive habitable spaces associated with existing

		dwellings on adjoining Lots 9 & 44. 9. Those portions of the proposed development comprising a reduced setback from the southern side boundary will abut the front setback, side setback and extensive rear yard area of the existing single detached dwelling on adjoining Lot 7 (No.291) Oxford Street (see Figure 2 – Aerial Site Plan). As previously mentioned, the setback variation is minor (i.e. 265mm) and that the adjoining property is likely to be re-developed in the future given its location within the 'Mixed Use' zone. As such, it is contended that the proposed development on the subject land will not have an adverse impact on the key outdoor living area associated with the existing dwelling on adjoining Lot 7 and it will not impede and restrict any future development on the adjoining lots. 10. Those portions of the proposed development comprising a reduced setback from the northern side boundary will abut the side setback area of the existing single detached dwelling on adjoining Lot 3 (No.297) Oxford Street which contains extensive vegetation along the boundary with the subject land that will screen the new development from being clearly visible (see Figure 2 – Aerial Site Plan). Furthermore. the proposed development on the subject land will not cast a shadow over the adjoining northern property at 12 noon on 21 June (i.e. winter solstice). As such, it is contended that the proposed development on the subject land will not have an adverse impact on any key habitable spaces associated with the existing dwelling on adjoining Lot 3. Like the adjoining southern lot, adjoining Lot 3 is likely to be re-developed in the future to accommodate a large scale development given the 'Mixed Use' zoning. As such, the proposed setback variation for the proposed development from the northern side boundary will not impede or restrict any further development on adjoining Lot 3. Having regard for the above it is contended that those portions of the proposed new grouped dwelling development on the subject land comprising reduced setbacks from the side and rear lot boundaries satisfy the 'design principles criteria' of Element 5.1.3 of the R-Codes, will not have a negative impact on the adjoining properties or the streetscape and may therefore be approved by the City.
5.1.3 C3.2 - Lot boundary setback (building on boundary) P3.2 Buildings built up to boundaries (other than the street boundary) where this: • makes more effective use of space for enhanced privacy for	The application proposes that the following aspects of the proposed grouped dwelling development on the subject land do not meet the 'deemed to comply requirements' of Element 5.1.3 C3.2 of the R-Codes: i) Those portions of the proposed	1. The variation to the wall length (i.e. an additional length of 800mm) along the side boundaries are considered to be minor. In addition, the part of the parapet walls comprising a height greater than 3.5 metres can be attributed to the excessive fall in natural ground levels down the site resulting in only part of the wall containing a maximum height of 4.1 metres and the balance portion comprising a lesser height. 2. In addition to the above point, the parapet walls are setback from the street, in lieu of an allowable nil front setback. As such, the extent of variations to the parapet wall length and height will not have an adverse impact on the streetscape and/or the adjoining properties in terms of bulk and scale.

the occupant/s or outdoor living areas; • does not compromise the design principle contained in clause 5.1.3 P3.1; • does not have any adverse impact on the amenity of the adjoining property; • ensures direct sun to major openings to habitable rooms and outdoor living areas for adjoining properties is not restricted; and • positively contributes to the prevailing development context and streetscape.	development to be built up to the northern and southern lot boundaries will comprise an overall length of 27.6 metres in lieu of 26.8 metres; and ii) Those portion of the proposed development to be built up to the side boundaries will comprise a maximum height of 4.1 metres in lieu of 3.5 metres.	3. It should be noted that the development has been designed to bench each dwelling down the slope of the land to limit any impact on the adjoining properties. 4. The use of a parapet wall for the new development on the subject land allows for improved use of the land and provides for greater internal/external living areas. 5. In addition to the above point, the use of parapet walls for the development has allowed for the provisions of much needed housing within the Leederville area. 6. The parapet wall will assist with providing improved privacy for each dwelling. In fact, the proposed development on the subject land complies with the visual privacy provisions of the R-Codes. 7. Given the minor variations being sought for the parapet walls along the lot boundaries, it is contended that the proposed development on the subject land will not adversely impact any key habitable spaces on the adjoining properties (see Figure 2 – Aerial Site Plan) and will not impede or restrict any future development on the adjoining properties given the 'Mised Use' zoning of the land. Having regard for the above it is contended that the portion of the proposed grouped dwelling development on the subject land to be built up to the side boundaries satisfy the 'design principles criteria' of Element 5.1.3 of the R-Codes, will not have an adverse impact on the adjoining properties or the local streetscape and may therefore be approved by the City.
R-Code Element 5.3.1 C1.1 – 'Outdoor living area' *"P1.1 Outdoor living areas which provide spaces:* • *capable of use in conjunction with a habitable room of the dwelling;* • *open to winter sun and ventilation; and* • *optimise use of the northern aspect of the site."*	The application proposes that the following aspects of the proposed development on the subject land do not meet the 'deemed to comply requirements' of Element 5.3.1 C1.1 of the R-Codes: i) The outdoor living area for Units 1 & 6 will be located within the front setback area in lieu of being located behind the front setback line; and ii) The outdoor living areas for each dwelling will comprise a minimum dimension of less than 4 metres.	1. The outdoor living area for each dwelling has been designed to be used in conjunction with a habitable room (i.e. dining room), providing a functional/usable entertaining area for the future occupants. 2. The location of the outdoor living area for Units 1 & 6 within the front setback area will provide for activation of the street and foster an element of social interaction between both the public and private realms. This is a good planning outcome. 3. In addition to the above point, the outdoor living area for each dwelling will be located along the common driveway, which will provide an element of interaction and passive surveillance for the occupants of the development. 4. It is noted that the new Medium Density Codes being re-introduced by the State Government in April 2024 will allow for a minimum dimension of 3 metres. Given this, it should be acknowledged that the planning framework has recognized that a minimum dimension of 3 metres is acceptable and results in a usable space. 5. Despite the variation to the minimum required dimension of the outdoor living area for each dwelling, the area is usable and will allow for the planting of a mature tree in each outdoor living area to enhance the amenity of the area. In fact, the area of the outdoor living area for each dwelling complies with the R-Codes.

		6. A number of dwellings within the development will provide some coverage of the outdoor living area to provide protection from the elements/weather for the occupants of each dwelling, therefore allowing the area to be used all year round. 7. Sufficient open space is provided for each dwelling to meet the needs of the future occupants and allow for adequate separation between the proposed development on the subject land and the existing dwellings on the adjoining lots. 8. Each dwelling will be provided with a drying court area separate to the dedicated outdoor living area. The separation of these areas will improve the amenity and functionality of each dwelling and minimizes potential constraints to the use of the dedicated outdoor living area. 9. The proposed outdoor living areas for four of the six dwellings will be located to capture the northern winter sun. 10. It is also noted that the City of Vincent, along with other local authorities, have approved variations to the minimum required dimension and the location of an outdoor living area within the front setback area in the past where the development has merit. In light of the justification above, it is viewed that the proposed development on the subject land has merit and that the variations could be granted in this instance. Having regard for the above it is contended that the location of the outdoor living area for Units 1 & 6 within the front setback area and the variation to the minimum dimension for the outdoor living area for each dwelling satisfies the 'design principles criteria' of Element 5.3.1 of the R-Codes, will be usable for to the future occupants of each dwelling and may therefore be approved by the City.
R-Code Element 5.3.3 C3.2 - 'Parking' *P3.1 Adequate car parking is to be provided on-site in accordance with projected need related to:* • *the type, number and size of dwellings;* • *the availability of on-street and other off-street parking; and* • *the proximity of the proposed development to public transport and other facilities.* *P3.2 Consideration may be given to a*	The application proposes that the grouped dwelling development on the subject land does not include the provision of any visitor parking bays in lieu of two (2) visitor bays required by the 'deemed to comply requirements' of Element 5.3.3 C3.2 of the R-Codes (for between 5 & 8 dwellings).	1. It should be noted that the subject land is located in close proximity to public transport and a comprehensive pedestrian path network. 2. The proposed development meets the 'deemed to comply requirements' of Element 5.3.3 C3.1 ('Parking') of the R-Codes in terms of residents parking bays (i.e. two bays per dwelling). 3. The proposed dwellings within the development are relatively small compared to the existing single dwelling type developments within the immediate locality. Given this, it is anticipated that the dwellings will not generate the need for greater on-site parking that reflects a single dwelling, as the dwellings are unlikely to accommodate large families that would typically generate greater traffic movements and parking demand. 4. In addition to the above point, it is anticipated that the dwellings will tend to cater for couples or small families only. Therefore, reducing the parking demand for the site and potentially allowing a visitor to park within the garage of the dwelling. 5. The Oxford Street road reserve contains on-street car parking on both sides of the road which is more than capable of catering for any visitor parking demand generated by the development

reduction in the minimum number of on-site car parking spaces for grouped and multiple dwellings provided: • *available street parking in the vicinity is controlled by the local government; and* • *the decision-maker is of the opinion that a sufficient equivalent number of on-street spaces are available near the development* *P3.3 Some or all of the required car parking spaces located off-site, provided that these spaces will meet the following:* *i. the off-site car parking area is sufficiently close to the development and convenient for use by residents and/or visitors;* *ii. any increase in the number of dwellings or possible plot ratio being matched by a corresponding increase in the aggregate number of car parking spaces;* *iii. permanent legal right of access being established for all users and occupiers of dwellings for which the respective car parking space is to be provided; and* *iv. where off-site car parking is shared*		on the subject land. Figures 11 & 12 below illustrates the existing on-street parking adjacent the subject land. 6. The use of the on-street parking for visitor needs generated by the development on the subject land will assist with providing less traffic movements on-site (i.e. provide improved safety of the occupants of the development) and will facilitate improved security for the development. 7. There are amble public transports services within close proximity to the subject land (including along Oxford Street). Access to the public transport network provides occupants and visitors to the proposed development with an alternative mode of transportation. 8. The subject land is well connected with pedestrian foot paths and a dedicated cycle lane along Oxford Street that provide safe access to and from the site for pedestrians and cyclists. 9. It should be noted that the new Medium Density R-Codes that are due to be re-introduced will only require one (1) resident parking bay per dwelling and one (1) visitor bay. This will result in the proposed development providing greater than the required on-site car parking for the residents. The additional resident on-site car parking will provide an opportunity for visitor parking for each individual dwelling.  Figure 11 – The existing on-street parking along both sides of Oxford Street.  Figure 12 – Oxford Street contains on-street parking, a pedestrian path network and bicycle land.

with other uses, the total aggregate parking requirement for all such uses, as required by the R-Codes and the scheme being provided. The number of required spaces may only be reduced by up to 15 per cent where the non-residential parking occurs substantially between 9 am and 5 pm on weekdays.		Having regard for the above it is contended that the absence of an on-site visitor car parking bays for the proposed grouped dwelling development on the subject land satisfies the 'design principles criteria' of Element 5.3.3 of the R-Codes and may therefore be approved.
R-Code Element 5.3.7 C7.2 & C7.3 – 'Site works' *P7.1 Development considers and respond natural features of the requires minimal excava* *P7.2 Where excavation/fill is necessary, all finished levels respecting the natural ground level at the lot boundary of the site and as viewed from the street.* *7.3 Retaining walls that result in land which can be effectively used for the benefit of residents and do not detrimentally affect adjoining properties and are designed, engineered and landscaped having due regard to clauses 5.3.7 and 5.4.1*	The application proposes the following variations to the 'deemed to comply requirements' of Element 5.3.7 C7.2 & C7.3 of the R-Codes: i) Retaining wall/fill along the southern side boundary will comprise a maximum height of 857mm above natural ground level (NGL) in lieu of an allowable height of 500mm above NGL; ii) Retaining wall/fill along the northern side boundary will comprise a maximum height of 847mm above natural ground level (NGL) in lieu of an allowable height of 500mm above NGL; and iii) Retaining wall built up to the lot boundaries in lieu of 1 metre setback.	1. The variations to the site works (i.e. 357mm maximum) are generally to the rear portion of the land and are relatively minor in nature. In addition, the variation can be attributed to the excessive fall in levels across/down the site of 1.69 metres. Given this variation in the natural ground level across the site, the new development has been designed to bench the dwellings down the site to address the fall of the land. This has resulted in minimizing any adverse impact on the adjoining properties. 2. The extent of fill above natural ground level will not impact any existing and developments on the adjoining properties. Detailed engineering drawings will be provided to the City at the building permit stage. 3. Despite the variation to the fill levels along the northern and southern lot boundaries, it is contended that the retaining walls will not have any adverse impacts on the streetscape in terms of bulk and scale. 4. The retaining walls will not be clearly visible from Oxford Street. 5. The location of the retaining wall along the lot boundaries provide for the effective use of all available space and the creation of adequate/usable external yard area to benefit the future occupants of the dwellings. 6. The proposed development on the subject land will not adversely impact access to light and ventilation for the existing dwellings on the adjoining properties. 7. A 1.8 metre high dividing fence will be constructed on top of the retaining wall along the side boundaries to ensure that each dwelling on the subject land do not result in any overlooking of the adjoining residential properties from the external yard areas. 8. Given the extent of fall in natural ground levels across the land, it could be expected that new development within the R100 areas will require large retaining walls/fill to address the undulating topography and excessive fall in levels. 9. Despite the extent of retaining walls and fill, the proposed

		development on the subject land complies with the maximum building height prescribed within the R-Codes and the City's Local Planning Policy. In fact, the maximum height of the proposed development is 8.8 metres, whereas the City's Policy allows a building height of 13.3 metres along Oxford Street. 10. Those portions of the site works for the new grouped dwelling development on the subject land to be built up to the southern side boundary will the abut the side setback area and extensive rear yard area of the existing single detached dwelling on adjoining Lot 7 (No.291) Oxford Street (see Figure 2 – Aerial Site Plan). Given the minor nature of the variations and the excessive fall in natural ground level down the site, it is contended that the proposed development on the subject land will not have an adverse impact on the existing dwelling on adjoining Lot 7. 11. Those portions of the site works for the development on the subject land to be built up to the northern side boundary will abut the side setback area and extensive rear yard area of the existing single detached dwelling on adjoining Lot 3 (No.297) Oxford Street, which comprises vegetation along the boundary (see Figure 2 – Aerial Site Plan). As such, it is contended that the proposed site works (retaining wall/fill) will not have any adverse impact on the sensitive areas associated with the existing dwelling on adjoining Lot 3. 12. In addition to the above two points, it is contended that the adjoining properties currently comprise older developments and that these sites are likely to be redeveloped in the future to reflect the R100 density coding (i.e. could be developed to accommodate a mixed use development or a large multiple dwelling development). Given this, the impact of the proposed development on the subject land is unlikely to impact the future development of these lots. Having regard for the above it is contended that the proposed retaining wall and fill to be built up to the side boundaries of the subject land satisfies the 'design principles criteria' of Element 3.3.7 of the R-Codes, is a result of the constraints of the land, will assist with providing a level/usable site, will not have a detrimental impact on the adjoining properties or local streetscape and may therefore be approved.
Local Planning Policy No.7.1.1 Clause 1.4 – 'Landscaping' P1.4.1 Landscaping is to be designed to reduce the impact of development on adjoining residential zones and public spaces. P1.4.2 Landscaping should provide	The application proposes that the proposed development does not comprise 80% canopy coverage along the side boundaries as required by the 'deemed to comply requirements' of Clause 1.4 of the City's Policy.	1. The proposed variation to the extent of 'Canopy Cover' along the side boundaries is unlikely to have a detrimental impact on the amenity of the local streetscape or any adjoining properties, as the new development has been designed to include the planting of a mature trees throughout the site and the front setback area to enhance the appearance of all dwellings when viewed from the street. 2. The City's Policy allows for parapet walls to be built up to the side boundaries in accordance with the R-Codes, which is two thirds of the boundary length and does not allow for extensive planting along the side boundaries. As such, the landscaping provision of the City's Policy does not take into account the allowable extent of parapet walls.

increased urban air quality, tree and vegetation coverage and a sense of open space between buildings. P1.4.3 The integration of sustainable landscape design with the building creating a greater landscaping amenity for residents and occupants and the community. P1.4.4 The provision of landscaping that will make an effective and demonstrated contribution to the City's green canopy to reduce the impact of the urban heat island effect. P1.4.5 Development that prioritises the retention of mature and healthy trees. P1.4.6 Landscaping at the rear of the property should not negatively impact on the use and activation of a right of way. P1.4.7 Open air car parks should be appropriately landscaped to provide adequate shading and reduce the impact on adjoining properties. P1.4.8 The provision of a combination of evergreen and deciduous plant species which would improve the thermal performance of the development.		3. The extent of landscaping for the proposed development on the subject land will achieve the objectives set by the City to provide adequate coverage of the land to satisfy the City's goal to provide more environmentally sensitive urban area (given the constraints of the land). 4. The Oxford Street verge area abutting the subject land contains a street tree which is being preserved. The street tree will assist with providing screening and soften the overall appearance of the development when viewed from the street. In addition, the front setback of the development and verge area will be comprehensively landscaped and maintained to help soften any potential impact the development may have on the local streetscape. 5. The proposed development will include the planting of some ten (10) trees to assist with improving the overall appearance and amenity of the development for its future occupants. 6. The proposed development is located within a Mixed Use or town centre environment, which is charactersised by having large, dense developments with little space to accommodate comprehensive landscaping area. The proposed development has been designed to include a good spread of landscaping whilst still accommodating a built form to provide for additional housing in close proximity of an Activity Centre and along an Activity Corridor. 7. The extent of tree canopy provided in support of the new development will assist with the City's vision of creating a green canopy and achieve the Vincent City Council's ambition of reducing urban heat. This is evident when viewing the development from the street. 8. The adjoining properties comprise large trees which projects a canopy over the subject land. All efforts will be made during the construction phase on the subject land to retain this canopy coverage. 9. Clause 5.9 of the City's Policy No.7.1.1 does not take into consideration lots with a relativity small area and with a high density coding (in particular within a town centre environment). Given these constraints and the vision to intensify development within town centre area/activity corridor, it should be recognised and acknowledged that there is a predisposition to greater variations to the landscaping requirements to assist with the development of the land. It is contended that the requirement to accommodate the area of 'Canopy Cover' on these small lots are excessive and that the provision may compromise the development potential of the land and the design layout of the dwellings to the detriment of the future occupants. Having regard for all of the above it is contended that the extent of landscaping provided in support of the new grouped dwelling development on the subject land in conjunction with the street tree along Oxford Street, satisfies the 'local housing objective' of Clause 5.9 of the City's Policy, will not compromise the objectives of the

		City's policy and may therefore be supported and approved by the City.

CONCLUSION

This portion of Oxford Street in Leederville is currently experiencing a transitional phase, wherein the older low density housing stock is being replaced by new higher density developments to reflect the 'Mixed Use' zoning and R100 density coding of the area. In addition, the development activity will assist with providing for additional housing in close proximity to public transport and the nearby Activity Centres.

The proposed development has been designed to reflect the changing nature, built form and character within the immediate locality, which includes a number of grouped and multiple dwelling developments to achieve the implied objectives of the density coding imposed by the City of Vincent and to reflect the strategic planning framework set by the State Government to provide much needed housing and housing diversity within a well service and established areas.

In light of the above information and justification, we respectfully request the City's favorable consideration and approval of the Application for Development Approval for the construction of a new grouped dwelling on Lots 8 & 4 (Nos.293 & 295) Oxford Street, Leederville in accordance with the pans prepared in support of the application.

Should you have any queries or require any additional information regarding any of the matters raised above please do not hesitate to contact me on 0407384140 or carlof@people.net.au.

CF Town Planning & Development
Planning & Development Consultants

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Life Cycle Assessment Report

Residence
293 and 295 Oxford Street Leederville
Oxford Townhouses

Date: 5 March 2024
Author: Daniel Cassettai
Report Id: Uncontrolled Document

This LCA Study was conducted as part of the Oxford Townhouses project. The LCA modeling within eTool is being managed by RapidLCA. For more information see contact details below.

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eTool Disclaimer

The predictions of embodied and operational impacts (including costs) conducted in eTool software, by their very nature, cannot be exact. It is not possible to accurately track all the impacts associated with a product or service over the life of a building or structure. eTool software and the modelling workflow has been built and tested to enable informed decisions when comparing design options. Environmental impact coefficients and generic costs do not necessarily correspond to those of individual brands of the same product or service due to differences within industries in the way these products and services are delivered.

This LCA study has not been reviewed and as such does not meet the relevant section of the ISO14044 requirements. Caution should be taken when interpreting the LCA study report.

eTool PTY LTD cannot make assurances regarding the accuracy of these reports for the above reasons.

Executive Summary

This Life Cycle Assessment has been completed for the Residence, located at 293 and 295 Oxford Street Leederville. The has been conducted for RapidLCA, the lead author is Daniel Cassettai The goal of this study is to profile and improve the environmental performance of the construction works. The study has been conducted in accordance with ISO 14044 and EN15978 .

About the Design

The following designs were modelled in these reports:

- **Proposed Design**: The proposed design at the time the modelling occurred.
- **Benchmark**: An equivalent benchmark design (or weighted statistical mix of designs) with conventional products, construction methods and use patterns.

Results

The results of the study are shown in the table below with savings highlighted in green text and increased impacts highlighted in red.

Characterised Impacts per Occupant per Year		Benchmark	Proposed Design	Proposed Design Savings
Environmental Impacts				
Global Warming Potential Total, GWP	kg CO_2 eq	3.21E+3	1.47E+3	54.23%
Ozone Depletion Potential, ODP	kg CFC-11 eq	2.03E-4	2.38E-4	-17.47%
Acidification Potential for Soil and Water, AP	kg SO_2 eq.	7.34E0	5.12E0	30.2%
Eutrophication potential, EP	kg PO_4 eq	2.90E0	2.48E0	14.42%
Photochemical Ozone Creation Potential, POCP	kg ethylene	5.62E-1	3.74E-1	33.48%
Abiotic Depletion Potential - Elements, ADPE	kg antimony	6.39E-2	5.14E-2	19.67%
Abiotic Depletion Potential - Fossil Fuels, ADPF	MJ	3.94E+4	1.76E+4	55.23%
Global Warming Potential Biogenic, GWP B	kg CO_2 eq	-6.62E+1	-3.09E+1	53.29%

Analysis

The report shows that the Proposed Design has lower Global Warming Potential Total, GWP impact than the Benchmark Design. The **Non-integrated Energy (B6+)** GWP Impacts are the most dominant life cycle module in the Proposed Design Design followed by the **Product Stage (A1A3)** and then **Replacement (B4)**.

Further analysis reveals:

- The **Superstructure** is the highest impact construction category,
- **Domestic Water Heating** is the highest operational impact by demand category,
- The **Electricity** is this highest impact operational impact by supply source,
- **Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening** is the highest impact material category,
- **Electrical Equipment, Small with transport and tradestaff, Electricity** is the highest people and equipment impact

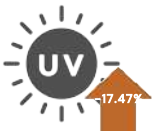
Two strategies were modelled in the Proposed Design, the **RIBA Phase 4 – Technical Design 1** strategy had the highest saving , followed by **RIBA Phase 4 – Technical Design 2** . See the below table for details.

	Scenario	GWP	ODP	AP	EP	POCP	ADPE	ADPF	GWP B
●	<Improved Design>								
●	RIBA Phase 4 – Technical Design 1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
●	RIBA Phase 4 – Technical Design 2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
●	<Proposed Design>								

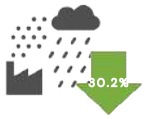
● Strategies included in Proposed Design ● Strategies not included in Proposed Design

Proposed Design Performance against Benchmark

Global Warming Potential Total, GWP



Ozone Depletion Potential, ODP



Acidification Potential for Soil and Water, AP

Eutrophication potential, EP

Photochemical Ozone Creation Potential, POCP

Abiotic Depletion Potential - Elements, ADPE

Abiotic Depletion Potential - Fossil Fuels, ADPF

Global Warming Potential Biogenic, GWP B

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Table Of Contents

1 Introduction

Managing the environmental impacts that arise from the construction and operation of buildings and infrastructure is of key importance in mitigating the damage caused directly and indirectly on the biosphere. Life Cycle Assessment (LCA) is the leading industry standard in clearly identifying optimum strategies for reducing environmental impacts. This report presents the results of the LCA completed for the Residence, 293 and 295 Oxford Street Leederville.

The study has been conducted in accordance with the following standards:

- International Standards 14040 and 14044.
- European Standard EN 15978: *Sustainability of Construction Works – Assessment of Environmental Performance of Buildings – Calculation Method*

The Author of the study is Daniel Cassettai of RapidLCA, and no independent review has yet been completed.

2 Goal of the Study

The goal of this study is to profile and improve the environmental performance of the construction works at 293 and 295 Oxford Street Leederville. The life cycle performance of the project is compared to other designs and as such this is a comparative study. The study has been conducted on assumption the results may be made public.

3 Scope of the Study

The LCA study has been conducted in accordance with the EN 15978 standard to assess the direct and indirect potential environmental impacts associated with the construction works at 293 and 295 Oxford Street Leederville as part of the Oxford Townhouses project.

3.1 Functional Unit

The function of the Building must reflect the core purpose of the asset such that it can be compared accurately to different designs. In this case, the functional focus is the Residence and the chosen functional unit is the provision of this function for one Occupant over one year.

The estimated design life of the design is 55 years which has been adopted for the LCA study period. This takes into consideration the structural service life limit (150 years), as well as redevelopment pressure on the asset such as surrounding density, asset ownership structures, and the architectural design quality.

Note that products with expected service lives of less than the life span of the project are assumed to be replaced at increments reflecting their service life.

3.2 System Boundary

The system boundary, shown in Figure 1, follows guidance given in EN15978.

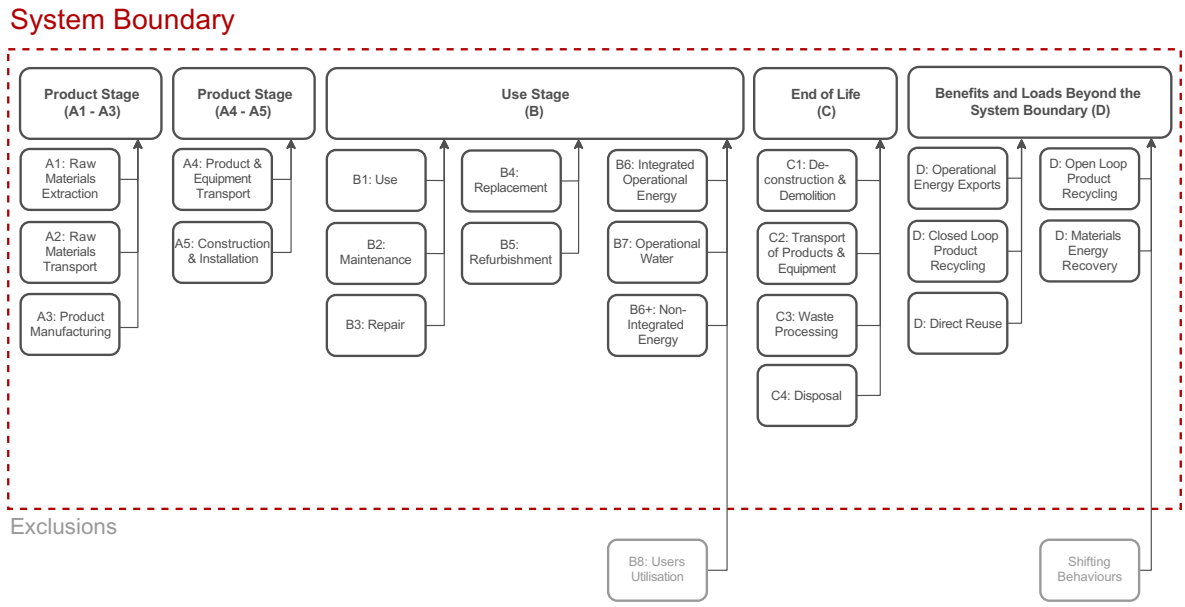


Figure 1: System Boundary Diagram

3.3 Environmental Indicators

The environmental indicators have been included in the study are detailed in Table 1. For further information regarding the environmental indicators please refer to Appendix A.

Environmental Indicator	Unit	Abbreviation	Characterisation Method
Environmental Impacts			
Global Warming Potential Total, GWP	kg CO_2 eq	GWP	CML-IA baseline V4.5
Ozone Depletion Potential, ODP	kg CFC-11 eq	ODP	CML-IA baseline V4.5
Acidification Potential for Soil and Water, AP	kg SO_2 eq.	AP	CML-IA baseline V4.5
Eutrophication potential, EP	kg PO_4 eq	EP	CML-IA baseline V4.5
Photochemical Ozone Creation Potential, POCP	kg ethylene	POCP	Institute of Environmental Sciences (CML)
Abiotic Depletion Potential - Elements, ADPE	kg antimony	ADPE	CML-IA baseline V4.5
Abiotic Depletion Potential - Fossil Fuels, ADPF	MJ	ADPF	CML-IA baseline V4.5
Global Warming Potential Biogenic, GWP B	kg CO_2 eq	GWP B	CML-IA baseline V4.5

Table 1: Environmental Indicators Included in LCA study.

3.4 Cutoff Criteria

The EN15978 cut-off criteria were used to ensure that all relevant potential environmental impacts were appropriately represented:

- Mass – if a flow is less than 1% of the mass at either a product-level or individual-process level, then it has been excluded, provided its environmental relevance is not of concern.
- Energy – if a flow is less than 1% of the energy at either a product-level or individual-process level, then it has been excluded, provided its environmental relevance is not a concern.
- The total of neglected input flows per module, e.g. per module A1-A3, A4-A5, B1-B5, B6-B7, C1-C4 and module D shall be a maximum of 5% of energy usage and mass.
- Environmental relevance – if a flow meets the above criteria for exclusion, but is considered to potentially have a significant environmental impact, it has been included. All material flows which leave the system (emissions) and whose environmental impact is higher than 1% of an impact category, have been included.

The Operational Guidance for Life Cycle Assessment Studies (Wittstock et al. 2012) states:

The apparent paradox is that one must know the final result of the LCA (so one can show that the omission of a certain process is insignificant for the overall results) to be able to know which processes, elementary flows etc. can be left out.

The approach taken in this study is to continue modelling smaller inputs until confidence is gained that the criteria is safely met.

3.5 Allocation

Allocation rules follow those of EN15804 as given below:

- Allocation will respect the main purpose of the studied processes. If the main purpose of combined processes cannot be defined (e.g. combined mining and extraction of nickel and precious metals), economic allocation may be used to divide resources and emissions between the products.
- The principle of modularity is maintained. Where processes influence the product's environmental performance during its life cycle, they will be assigned to the module where they occur.
- The sum of the allocated inputs and outputs of a unit process are equal to the inputs and outputs of the unit process before allocation. This means no double counting of inputs or outputs is permissible.

3.6 Independent Review

No independent review has been conducted of this study.

3.7 System Description Introduction

The object of the assessment is the Residence, located at 293 and 295 Oxford Street Leederville. The assessment includes all the upstream and downstream processes needed to provide the primary function of the structure from construction, maintenance, operation, and finally demolition and disposal. The inventory includes the extraction of raw materials or energy and the release of substances back to the environment or to the point where inventory items exit the system boundary either during or at the end of the project life cycle.

6 x Two storey Grouped dwellings

The project location is shown in figures 2 and 3.

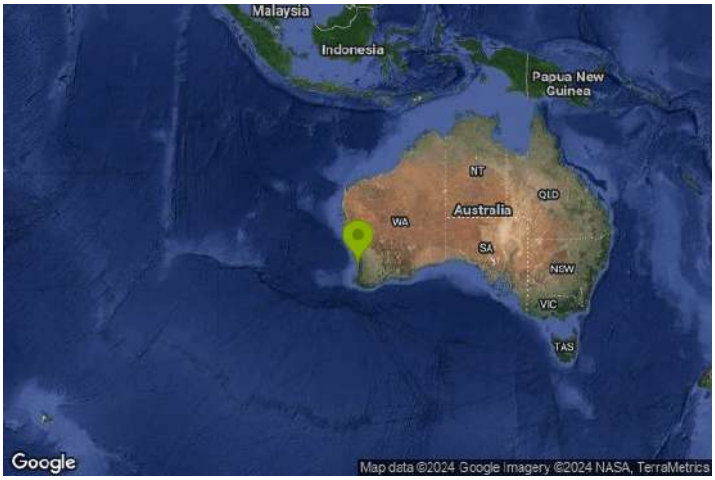


Figure 2: Location of the project - Global View.

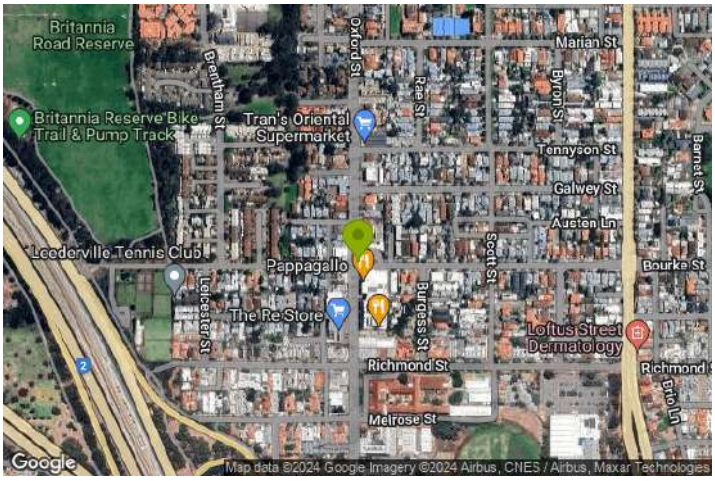


Figure 3: Location of the project - Locality View.

6 Two storey Grouped dwellings

3.8 Building Characteristics Table

Table 2 below shows the key characteristics of the design.

	Benchmark	Proposed Design

Design Details		
Design Name	CLCHC Baseline	293 and 295 Oxford Street Leederville
Stories (#)	2	2
Functional Focus	Residence	Residence
Structural Service Life Limit	150	150
Predicted Design Life	55	55
Functional Characteristics		
Dwellings	1	6
Bedrooms	4	18
Occupants	3	15
Total Floor Areas		
Usable Floor Area	214	816
Net Lettable Area	0	0
Fully Enclosed Covered Area	250	1,032
Unenclosed Covered Area	0	0
Gross Floor Area	250	1,032
Usable and Lettable Yield	86 %	79 %

Table 2 : Design Characteristics Compared

3.9 Structure Scope Table

Table 3 shows the structural scope of the inventory collection for the LCA. For further details on structure scope please refer to Appendix B.

Summary Structure Scope Diagram

Key: ✓ In Scope ✓ Partial ✗ Out of Scope

Category Name	Benchmark Design	Proposed Design
Substructure	✓	✓
Superstructure	✓	✓
Internal finishes	✓	✓
Fittings, furnishings and equipment	✓	✓
Services equipment	✓	✓
Prefabricated buildings and building units	✗	✗
Work to existing building	✗	✗
External works	✓	✓
Facilitating works	✓	✓
Project/design team	✓	✓
Undefined	✗	✗

Table 3 : Structural scope of LCI collection

3.10 Operational Scope Table

Table 4 shows the operational scope of the inventory collection for the LCA. For further details on structure scope please refer to Appendix B.

Operational Scope diagram

Key: ✓ In Scope ✗ Out of Scope

Category Name	Benchmark Design	Proposed Design
Appliances | Dishwashers	✓	✓
Appliances | Entertainment	✓	✓
Appliances | Laundry Appliances	✓	✓
Appliances | Office Workstations	✓	✓
Communications	✓	✓
Cooking and Food Preparation	✓	✓
Domestic Water Heating	✓	✓
Electrical Parasitic Loads	✓	✓
Fire Protection	✗	✓
HVAC	✓	✓
Industrial & Manufacturing Equipment	✗	✓
Lifts, Elevators and Conveying	✗	✓
Lighting	✓	✓
Miscellaneous	✗	✗
Monitoring, Control and Automation	✓	✓
Power Generation and Storage	✓	✓
Refrigeration	✓	✓
Safety and Security	✓	✓
Swimming Pools	✓	✓
Water Pumping	✓	✓
Water Removal and Treatment	✓	✓
Water Supply	✓	✓
Workshops, Garage & Misc	✓	✓

Table 4: Operational scope of LCI collection

4 Inventory Analysis

The design has been modelled using the available eToolLCD elements, templates and EPDs as shown in Table 5.

eToolLCD Item Type	Count in Design	
	Benchmark	Proposed Design
Design Templates	118	128
Equipment and People Elements	175	189
Material Elements	317	305
Energy Elements	31	29
Water Elements	13	13
EPDs	0	0

Table 5: Count of elements, templates and EPDs in the design

The eToolLCD library templates are customisable and users may submit templates for validation. The template validation process is undertaken by experienced LCA practitioners and is a process of checking the user inputs and ensuring the assumptions are adequately referenced. Table 6 shows the extent to which validated templates were used in the model.

eToolLCD Item Type	Validated (%)	
	Benchmark	Proposed Design
Total Design Templates	50.85	53.91
Equipment and People Elements	54.29	58.2
Material Elements	40.06	40.66
Energy Elements	0	0
Water Elements	0	0

Table 6: Use of validated templates

4.1 Templates Comparison

The eToolLCD templates found in each design are provided in Table 7.

Parent Template Name	Units	Quantity
		Proposed Design
Fittings, furnishings and equipment		
Appliances, Residential Average Op&Em	#	1
Cooking, Res Electric Oven Induction Stove	#	6
Kitchen Medium sized (incl Equipment)	#	6
Refrigeration, Residential Well Ventilated Fridge Recess	#	6
Standard 1st Bathroom - WC/Shower-bath/Basin/WallTiles	#	15
Facilitating works		
Demolition - Residential (End-of-Life)	#	6
Superstructure		
Door - HollowCoreTimber/SteelJam/Painted	#	42
Door - SolidCoreTimber/SteelJam/Painted (#)	#	12
Roof - TimberTruss/SteelSheeting/25°Pitch	m2	570
Staircase, Concrete, 40Mpa, 2% reo	#	6
Timber frame wall with exterior insulation finishing system (100mm EPS)	m2	1E-06
Upper Floors - Concrete Slab, 172mm, 40MPa, 3.8% reo (m2)	m2	480
Wall, External, Masonry, double brick 90-50-90 insulated with foundations and finishes	m2	402.66
Wall, Internal, Masonry, Single Brick Wall (90mm) uninsulated with foundations and finishes	m2	314.350001
Windows, Residential Aluminium Single Glaze, fly screen	m2	202.02
Services equipment		
Ducted System Air Source Heat Pump for Cooling, higher efficiency (COP/EER 3.8), R410a Refrigerant	#	6
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	#	6
Electric Instantaneous Hot Water System (HWS_App)	#	6
Electrical Fittings - sockets power points wiring embodied only (m2)	m2	1116
LED Outdoor Lighting (Residential - Ultra High Efficiency 150lm/watt), m2	m2	150
LED Residential Lighting (High Efficiency - 110lm/watt)	#	20
Solar PV System Residential - Zone 3 (Perth Sydney etc)	kW	18
Swimming Pool - Pumps and Filters Ultra Efficient	m2	1E-06
Utilities Connection to Site Residential	#	6
Water tank - steel (embodied)	L	2.4E-05
Water Use and Treatment (eTool Turbo)	#	6
Internal finishes		
Floor Covering - Carpet (glue down/Nylon)	m2	198
Floor Covering - Tiles (ceramic/10mm)	m2	95
Floor Covering - Tiles (ceramic/5mm)	m2	235
Substructure		
Lowest Floor - Concrete Slab, 100mm, 20MPa, 3.8% reo (m2)	m2	574
External works		
Pool Structure - Concrete	m2	1E-06
Swimming Pool Seasonal Temperature Control - No Pool Cover - Gas	m2	1E-06

Table 7: Templates Comparison (showing master templates only)

4.2 eTool software

eTool software was used to model life cycle impacts of the project. eToolLCD uses third party background processes aggregated as mid-point indicators and stored in a number of libraries within the software which are coupled with algorithms and user inputs to output the environmental impact assessment. A map of user inputs, data sources and algorithms (outputs) is given in Figure 4.

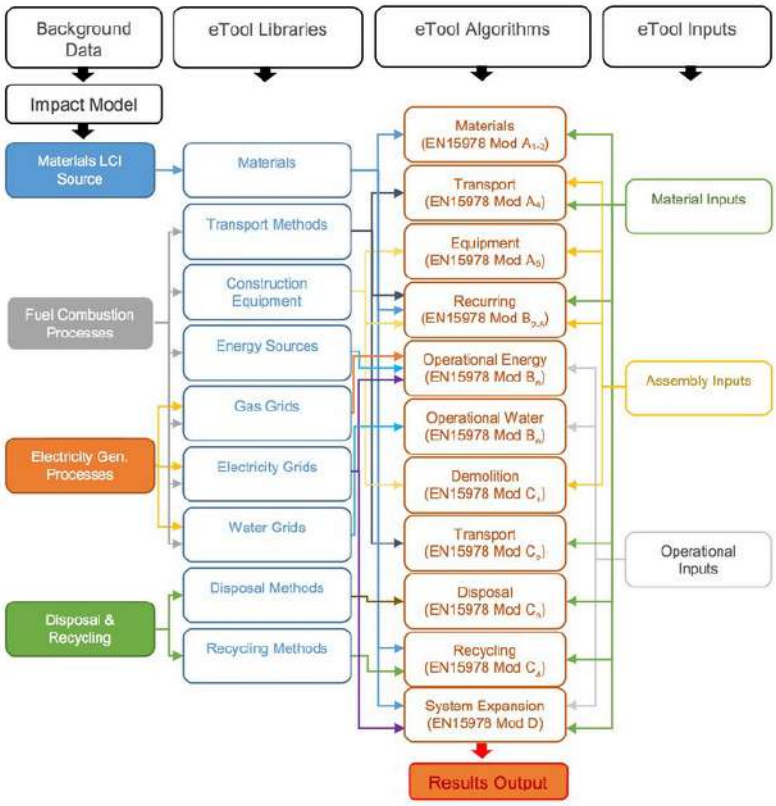


Figure 4: Relationship between LCI background data, eToolLCD software library, inputs and algorithms.

4.3 Data Quality

The data quality requirements for the background data are detailed in Table 8. Each of the criteria has been assessed for compliance and results presented below.

Criteria	Background Data Requirement	Compliance	
		Benchmark	Proposed Design
Temporal Relevancy	For annually fluctuating processes like Grid electricity fuel mixes the datasets must have been updated within the last 2 years. More static processes like materials production must have been updated within the last 10 years. Product specific EPDs must have been updated in the last 5 years.	Failed Grid Passed Materials	Failed Grid Passed Materials
Geographical Relevancy	The background data should be specifically compiled for the same country (preferable) or continent as the project location.	Passed(Same Country)	Passed(Same Country)
Precision	No requirement specified however a qualitative review undertaken to ensure no erroneous values.	Passed	Passed
Completeness	Qualitative assessment of the process to ensure no obvious exclusions.	Passed	Passed
Technological Relevancy	Ensure that technology assumptions are representative for the product or product group.	Passed	Passed
Consistency	The study methodology holds for the background data.	Passed	Passed
Reproducibility	The information available about the methodology and the data values reported should allow an independent practitioner to reproduce the results reported in the study.	Passed	Passed

Table 8: Summary of data quality requirements for the study.

Criteria	Inventory Collection Requirement (eToolLCD User Inputs)	Compliance	
		Benchmark	Proposed Design
Temporal Relevancy	All inputs into eToolLCD to be reflective of the project being assessed and if assumptions are made these are to be based on industry practices that are consistent with the project commissioning date.	Passed 0/5 Checks	Passed 0/1 Checks

Criteria	Inventory Collection Requirement (eToolLCD User Inputs)	Compliance	
		Benchmark	Proposed Design
Geographical Relevancy	All inputs into eToolLCD must be reflective of the project being assessed and if assumptions are made these are based on the current practices employed in the project country.	Passed 0/5 Checks	Passed 0/2 Checks
Precision	To avoid aggregated errors a high level of precision is expected inputs into eToolLCD software, being either to 3 significant figures or: • Two significant figures or nearest 10 hours for equipment run time • Two significant figures or nearest 10kg for material quantities • Two significant figures or nearest 100MJ / annum for operational energy • Two significant figures or nearest 100kL / annum for operational water use	Passed 0/4 Checks	Passed 0/1 Checks
Completeness	Inputs to cover all life cycle phases and elements identified in the system boundary. The link between background data, eToolLCD algorithms and subsequent LCA results is not to introduce significant gaps in the data.	Passed 0/10 Checks	Passed 0/2 Checks
Technological Relevancy	All inputs into eToolLCD must be reflective of the project being assessed and if assumptions are made these must be drawn from appropriate examples of like technology.	Passed 0/5 Checks	Passed 0/1 Checks
Consistency	All inputs into eToolLCD must be reflective of the project being assessed and if assumptions are made these are drawn from the same reference library.	Passed 0/10 Checks	Passed 0/0 Checks
Reproducibility	The information available about the methodology and the data values reported should allow an independent practitioner to reproduce the results reported in the study.	Passed 0/9 Checks	Passed 0/1 Checks

Table 9: Summary of data quality requirements for the study.

4.4 Completeness

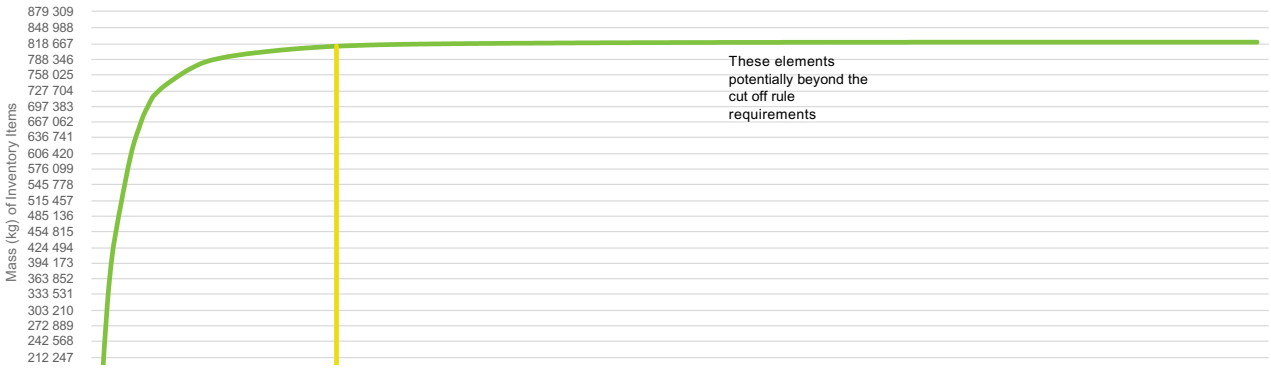
The study aims to follow EN15804 procedures for exclusion of inputs and outputs:

- All inputs and outputs to a (unit) process shall be included in the calculation, for which data are available.
- Data gaps may be filled by conservative assumptions with average or generic data. Any assumptions for such choices shall be documented.
- In case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1 % renewable and non-renewable primary energy usage and 1 % of the total mass input of that unit process.
- The total of neglected input flows per module, e.g. per module shall be a maximum of 5 % of energy usage and mass.
- Conservative assumptions in combination with plausibility considerations and expert judgement can be used to demonstrate compliance with these criteria.
- Particular care should be taken to include material and energy flows known to have the potential to cause significant emissions into air and water or soil related to the environmental indicators.

Two major tests were run to determine the compliance with the above cut-off rules.

4.4.1 Inventory Mass Quantities

The cumulative mass of inventory entries is shown in Figure 5. Given that 205 material elements within the LCA base design make up the last 1% of mass inventory entries a high level of confidence exists that the cut off rules have been upheld.



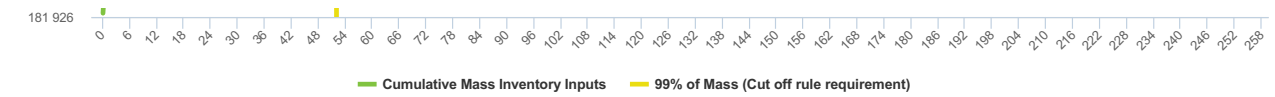


Figure 5: Cumulative Mass Inventory Entries. In this case 79.46% make up the last 5% of mass inventory entries.

4.4.2 Inventory Energy Analysis

The cumulative embodied energy of inventory entries is shown in Figure 6. Given that 364 elements within the LCA base design make up the last 1% of embodied energy inventory entries a high level of confidence exists that the cut off rules have been upheld.

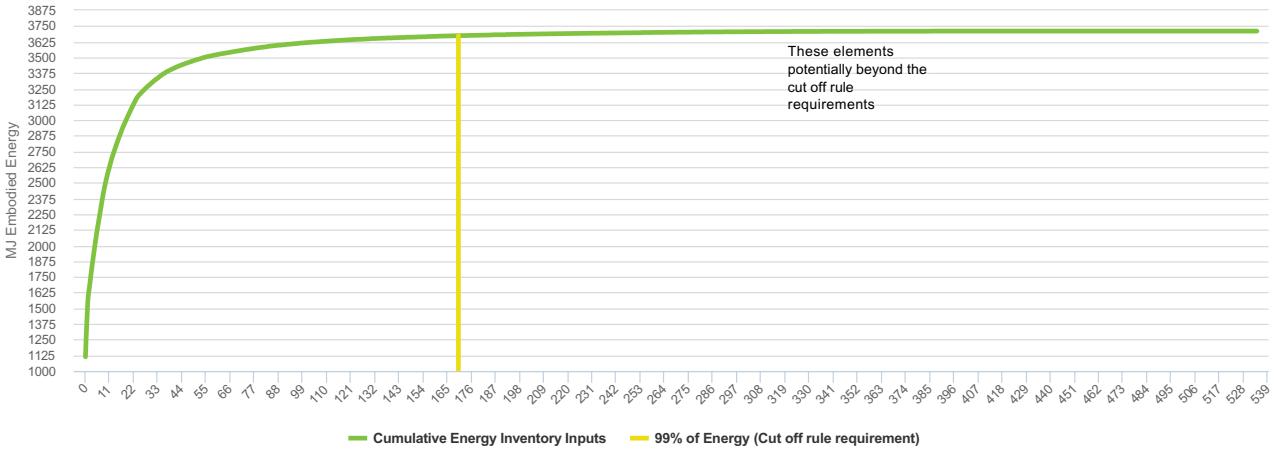


Figure 6 : Cumulative Energy Inventory Entries. In this case 68.04% make up the last 5% of energy inventory entries.

5 Life Cycle Impact Assessment

The Life Cycle Impact Assessment (LCIA) results are provided in Table 10 in the EN15978 reporting format. The red and orange figures within each row highlight the largest and second largest contributing life cycle modules for the indicator. Modules not assessed are abbreviated with "MNA".

The green figures in the comparison section highlight the most improved life cycle modules for the indicator.

5.1 Environmental Impacts

Table 10: Benchmark vs Proposed Design, Environmental Impacts of Each Life Cycle Phase.

Characterised Impacts Per Occupant Per Per Year		Construction Phases			Use Phases								End of Life Phases				Benefits and Loads Beyond the System Boundary	Total
		A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B6+	B7	C1	C2	C3	C4	D	
Benchmark																		
GWP	kg CO_2 eq	1.94E+2	9.23E+1	2.51E+1	0.00E0	2.51E+1	0.00E0	3.33E+2	0.00E0	1.40E+3	9.42E+2	1.02E+2	1.48E+1	1.93E+1	4.11E-4	8.03E+1	-2.09E+1	3.21E+3
ODP	kg CFC-11 eq	3.69E-5	1.19E-5	2.25E-6	0.00E0	6.71E-6	0.00E0	1.25E-4	0.00E0	6.26E-6	5.85E-6	1.62E-6	2.21E-6	2.57E-6	9.36E-11	1.42E-6	-3.70E-7	2.03E-4
AP	kg SO_2 eq.	1.92E0	4.35E-1	6.10E-2	0.00E0	6.47E-2	0.00E0	1.62E0	0.00E0	1.63E0	1.46E0	2.34E-1	5.25E-2	8.16E-2	1.86E-6	3.42E-2	-2.49E-1	7.34E0
EP	kg PO_4 eq	1.08E0	1.05E-1	9.82E-3	0.00E0	1.86E-2	0.00E0	7.69E-1	0.00E0	5.15E-1	4.66E-1	1.86E-1	1.26E-2	2.04E-2	6.14E-7	7.66E-3	-2.90E-1	2.90E0
POCP	kg ethylene	2.08E-1	4.80E-2	1.32E-2	0.00E0	1.21E-2	0.00E0	1.53E-1	0.00E0	7.26E-2	3.84E-2	1.07E-2	4.45E-3	5.04E-3	8.79E-8	1.21E-2	-1.61E-2	5.62E-1
ADPE	kg antimony	4.75E-3	2.05E-3	9.64E-5	0.00E0	2.59E-4	0.00E0	6.38E-3	0.00E0	2.40E-2	2.22E-2	4.14E-3	3.70E-4	9.00E-4	6.15E-10	4.46E-5	-1.28E-3	6.39E-2
ADPF	MJ	4.33E+3	1.28E+3	1.87E+2	0.00E0	2.27E+2	0.00E0	4.68E+3	0.00E0	1.72E+4	1.01E+4	1.00E+3	1.93E+2	2.71E+2	5.61E-3	1.37E+2	-3.17E+2	3.94E+4
GWP B	kg CO_2 eq	-1.37E+2	-1.91E-1	9.41E0	0.00E0	1.57E-2	0.00E0	-2.05E+1	0.00E0	1.06E0	9.81E-1	1.49E+1	2.34E-3	9.03E-4	-2.59E-6	5.76E+1	7.42E0	-6.62E+1
Proposed Design																		
GWP	kg CO_2 eq	3.56E+2	6.40E+1	2.79E+1	-6.23E-1	1.52E+1	0.00E0	3.23E+2	0.00E0	2.92E+2	7.85E+2	6.39E+1	1.26E+1	2.83E+1	1.61E0	5.90E+1	-5.58E+2	1.47E+3
ODP	kg CFC-11 eq	4.83E-5	8.40E-6	3.19E-6	0.00E0	6.86E-6	0.00E0	1.56E-4	0.00E0	2.24E-6	6.03E-6	1.34E-6	2.00E-6	3.76E-6	3.66E-7	1.93E-6	-2.40E-6	2.38E-4
AP	kg SO_2 eq.	2.18E0	3.09E-1	8.22E-2	0.00E0	1.48E-2	0.00E0	1.43E0	0.00E0	5.18E-1	1.39E0	1.48E-1	4.13E-2	1.20E-1	7.27E-3	4.53E-2	-1.16E0	5.12E0
EP	kg PO_4 eq	1.35E0	7.47E-2	1.26E-2	0.00E0	4.08E-3	0.00E0	8.06E-1	0.00E0	1.73E-1	4.65E-1	1.27E-1	9.33E-3	3.01E-2	2.40E-3	1.02E-2	-5.82E-1	2.48E0
POCP	kg ethylene	1.69E-1	3.07E-2	1.74E-2	0.00E0	2.75E-3	0.00E0	1.18E-1	0.00E0	1.44E-2	3.88E-2	7.43E-3	3.81E-3	7.31E-3	3.44E-4	7.09E-3	-4.30E-2	3.74E-1
ADPE	kg antimony	8.45E-3	1.33E-3	1.19E-4	0.00E0	5.65E-5	0.00E0	1.15E-2	0.00E0	1.31E-2	3.51E-2	3.34E-3	1.75E-4	1.24E-3	2.41E-6	6.32E-5	-2.31E-2	5.14E-2
ADPF	MJ	4.57E+3	8.67E+2	2.72E+2	0.00E0	5.05E+1	0.00E0	3.66E+3	0.00E0	3.75E+3	1.01E+4	7.52E+2	1.57E+2	3.93E+2	2.20E+1	1.87E+2	-7.16E+3	1.76E+4
GWP B	kg CO_2 eq	-6.42E+1	-7.41E-2	4.78E0	0.00E0	3.51E-3	0.00E0	-7.09E0	0.00E0	1.01E0	2.71E0	7.34E-1	2.26E-3	-3.95E-4	-1.01E-2	2.93E+1	1.95E0	-3.09E+1
Savings (Benchmark Compared to Proposed Design)																		
GWP	kg CO_2 eq	-1.62E+2	2.83E+1	-2.76E0	6.23E-1	9.91E0	0.00E0	1.08E+1	0.00E0	1.11E+3	1.57E+2	3.84E+1	2.20E0	-8.99E0	-1.61E0	2.13E+1	5.37E+2	**54.23%**
ODP	kg CFC-11 eq	-1.13E-5	3.53E-6	-9.44E-7	0.00E0	-1.51E-7	0.00E0	-3.08E-5	0.00E0	4.02E-6	-1.76E-7	2.72E-7	2.07E-7	-1.19E-6	-3.66E-7	-5.05E-7	2.03E-6	**-17.47%**
AP	kg SO_2 eq.	-2.54E-1	1.26E-1	-2.12E-2	0.00E0	4.99E-2	0.00E0	1.88E-1	0.00E0	1.11E0	6.17E-2	8.53E-2	1.11E-2	-3.83E-2	-7.27E-3	-1.12E-2	9.16E-1	**30.2%**
EP	kg PO_4 eq	-2.69E-1	3.03E-2	-2.81E-3	0.00E0	1.45E-2	0.00E0	-3.71E-2	0.00E0	3.42E-1	6.44E-4	5.88E-2	3.24E-3	-9.71E-3	-2.40E-3	-2.49E-3	2.92E-1	**14.42%**
POCP	kg ethylene	3.96E-2	1.72E-2	-4.28E-3	0.00E0	9.38E-3	0.00E0	3.52E-2	0.00E0	5.82E-2	-3.56E-4	3.31E-3	6.37E-4	-2.27E-3	-3.44E-4	4.99E-3	2.69E-2	**33.48%**
ADPE	kg antimony	-3.69E-3	7.22E-4	-2.21E-5	0.00E0	2.02E-4	0.00E0	-5.07E-3	0.00E0	1.09E-2	-1.29E-2	8.02E-4	1.94E-4	-3.45E-4	-2.41E-6	-1.86E-5	2.18E-2	**19.67%**
ADPF	MJ	-2.38E+2	4.09E+2	-8.56E+1	0.00E0	1.77E+2	0.00E0	1.02E+3	0.00E0	1.35E+4	1.79E+1	2.49E+2	3.61E+1	-1.23E+2	-2.20E+1	-4.96E+1	6.85E+3	**55.23%**
GWP B	kg CO_2 eq	-7.27E+1	-1.17E-1	4.63E0	0.00E0	1.22E-2	0.00E0	-1.34E+1	0.00E0	5.31E-2	-1.73E0	1.42E+1	8.62E-5	1.30E-3	1.01E-2	2.83E+1	5.47E0	**53.29%**

6 Detailed Analysis

This section provides a more detailed results of the life cycle impacts with the aim of identifying the hotspots by analysing temporal, spatial, functional, end-use demand and supply chain dimensions.

For each indicator being assessed the following charts are provided

The Time Series Charts articulate when impacts occur during the life of the design. This exposes insights such as the temporal hotspots signified by jumps in the plot during the life of the project (for example, relating to a large replacement item) and the payback period of design options

The Top Five Life Cycle Charts express impacts by different modules, categories and classes enabling a detailed understanding of what is responsible for the greatest impacts and also compares these impacts between designs . The pie chart within each bar chart shows the proportion of the life cycle impacts represented in the bar chart. A brief description of the categories is provided below:

- **LC Module Impacts:** The EN15978 Life Cycle Modules. Generally 100% building impacts will be included in the bar chart.
- **Construction Category:** The breakdown of the impacts by construction category. The bar chart will generally only part of the total building impacts.
- **Operational Demand:** The building end use demands that are driving environmental impacts.
- **Energy Supply:** The supply of fuels to the building, in effect the upstream fuel sources supplying energy for on site use during construction, operational and demolition.
- **Materials:** The materials (grouped into common categories) that are driving the environmental impacts.
- **Equipment and People:** The equipment and people required during construction, maintenance and demolition and all associated transport trips that are driving the environmental impacts

All impact figures are quoted per Occupant for the study.

6.1 Global Warming Potential Total, GWP (kg CO_2 eq)

Figure 7: Time series Global Warming Potential Total, GWP chart

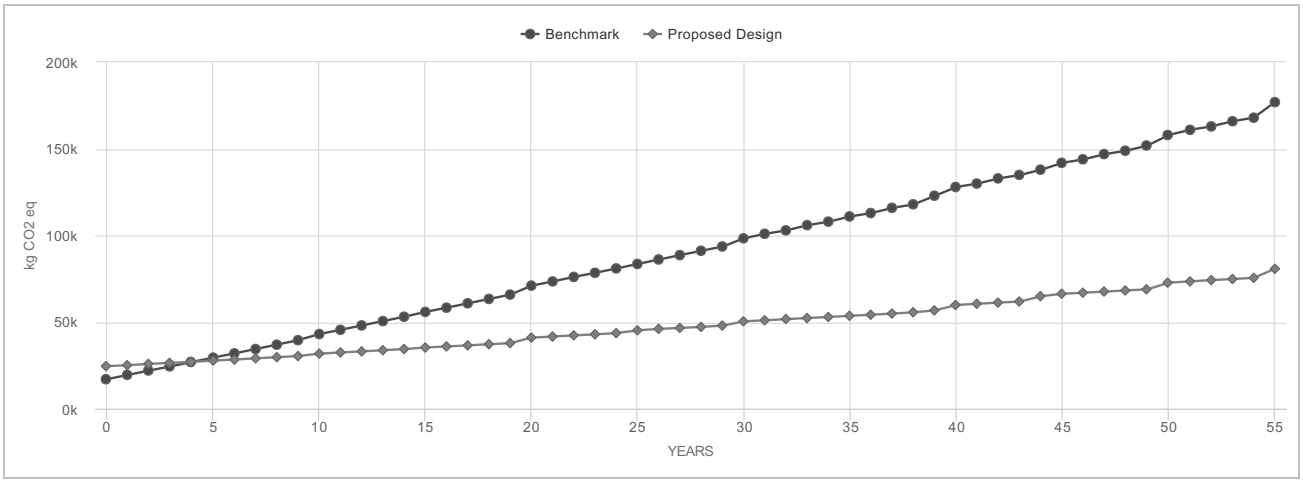
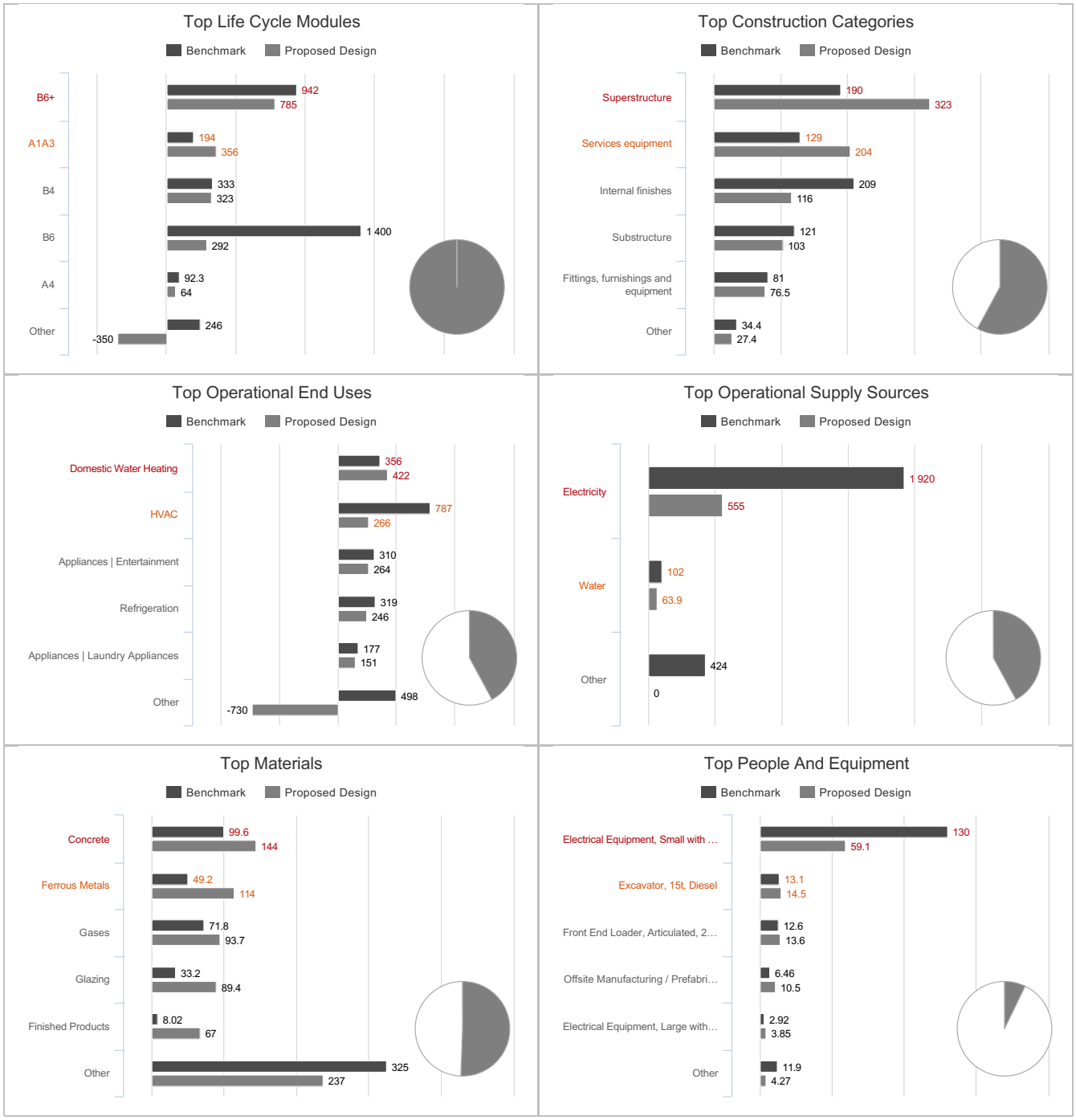


Figure 8: Top Five Global Warming Potential Total, GWP chart



Highest and Lowest Impact Materials (kg CO_2 eq)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	End of Life (C1-C4)	Recycling & Energy Export (D)	Biogenic	Total
Top 10 Impact Materials						
Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening	35750.7	35920.42	169.71	0	83.84	71924.67
Gases | Refrigerants | R-410A (Puron, AZ-20)	789.58	44380.98	16614.72	0	0.89	61786.17
Concrete | Unreinforced | Portland Cement Blends | 40 MPa	51878.63	0	8159.3	0	13.56	60051.49
Ferrous Metals | Steel | Reinforcement bar | Unspecified	58403.02	0	2667.3	-2929.14	-227.37	57913.81
Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	17658.24	33945.71	1367.58	-10149.16	164.43	42986.81
Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	36840.59	0	4814.07	0	-2342.94	39311.72
Concrete | Unreinforced | Portland Cement Blends | 20 MPa	24182.95	-514.32	4839.93	0	7.22	28515.78
Concrete | Reinforced | 1.0% Reinforcement | Portland Cement Blends | 30 MPa	23932.56	0	3517.68	0	-0.07	27450.17
Cementitious Binders | Mortars and Renders | 1 cement : 4 sand	18483.27	3435.09	1125.9	0	89.48	23133.73
Metals (Non-Ferous) | Aluminium Unspecified	12973.22	16492.7	184.21	-8297.29	26.67	21379.51
Bottom 5 Impact Materials						
Plant Based Products (non Timber) | Paper | General	45.75	183.01	0	0	-247.25	-18.48
Timber | Sustainably Sourced | General | Unspecified	290.59	267.43	23.51	-107.89	-929.28	-455.64
Timber | Sustainably Sourced | Softwood | Unspecified	495.98	456.45	40.13	-184.14	-1586.11	-777.69
Timber | Sustainably Sourced | Particle Board | Indoor	2572.89	2407.87	167.54	-768.7	-5557.45	-1177.85
Timber | Sustainably Sourced | Hardwood | Unspecified	7876.81	0	581.87	-1330.88	-10442.82	-3315.02

Highest and Lowest Impact Templates (kg CO_2 eq)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	Integrated Energy Use (B6)	Plug Load Energy Use (B6+)	Water Supply & Treatment (B7)	End of Life (C1-C4)	Recycling & Energy Export (D)	Biogenic	Total
Top 10 Impact Templates									
Appliances, Residential Average Op&Em	543.89	2927.39	0	443385.95	0	9.66	-503.02	1538.41	447902.28
Electric Instantaneous Hot Water System (HWS_App)	1125.91	4210.74	346906.84	0	0	27.98	-597.42	1223.41	352897.46
Refrigeration, Residential Well Ventilated Fridge Recess	3442.58	29129.66	0	202243.65	0	2408.59	-2824.01	766.24	235166.71
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	2230.27	28188.23	117857.83	0	0	8326.79	-380.7	413.09	156635.52
Ducted System Air Source Heat Pump for Cooling, higher efficiency (COP/EER 3.8), R410a Refrigerant	2230.27	28188.23	100790.99	0	0	8326.79	-380.7	354.03	139509.61
Cooking, Res Electric Oven Induction Stove	1697.54	6701.81	118975.17	0	0	19.83	144.62	187.62	127726.58
Upper Floors - Concrete Slab, 172mm, 40MPa, 3.8% reo (m2)	89490.18	0	0	0	0	8863.23	-8046.35	-2230.88	88076.17
Windows, Residential Aluminium Single Glaze, fly screen	38329.19	40747.22	0	0	0	186.69	-1227.06	85.86	78121.9
Wall, External, Masonry, double brick 90-50-90 insulated with foundations and finishes	61210.33	5577.3	0	0	0	6522.66	-95.03	-2225.97	70989.3
Lowest Floor - Concrete Slab, 100mm, 20MPa, 3.8% reo (m2)	45120.25	-514.32	0	0	0	5996.42	4098.53	-1552.1	53148.78
Bottom 5 Impact Templates									
Kitchen Medium sized (incl Equipment)	5505.11	6081.4	0	0	0	239.96	-1118.71	-5611.9	5095.86
LED Outdoor Lighting (Residential - Ultra High Efficiency 150lm/watt), m2	156.85	761.02	4093.88	0	0	0.69	-15.44	16	5013.01
Door - HollowCoreTimber/SteelJam/Painted	2324.63	2943.14	0	0	0	61.78	-824.89	-658.76	3845.91
Door - SolidCoreTimber/SteelJam/Painted (#)	713.84	656.23	0	0	0	18.71	-127.54	-281.97	979.27
Solar PV System Residential - Zone 3 (Perth Sydney etc)	29484.25	50514.68	-486363.75	0	0	1531.55	-445220.28	-2898.86	-852952.4

6.2 Ozone Depletion Potential, ODP (kg CFC-11 eq)

Figure 9: Time series Ozone Depletion Potential, ODP chart

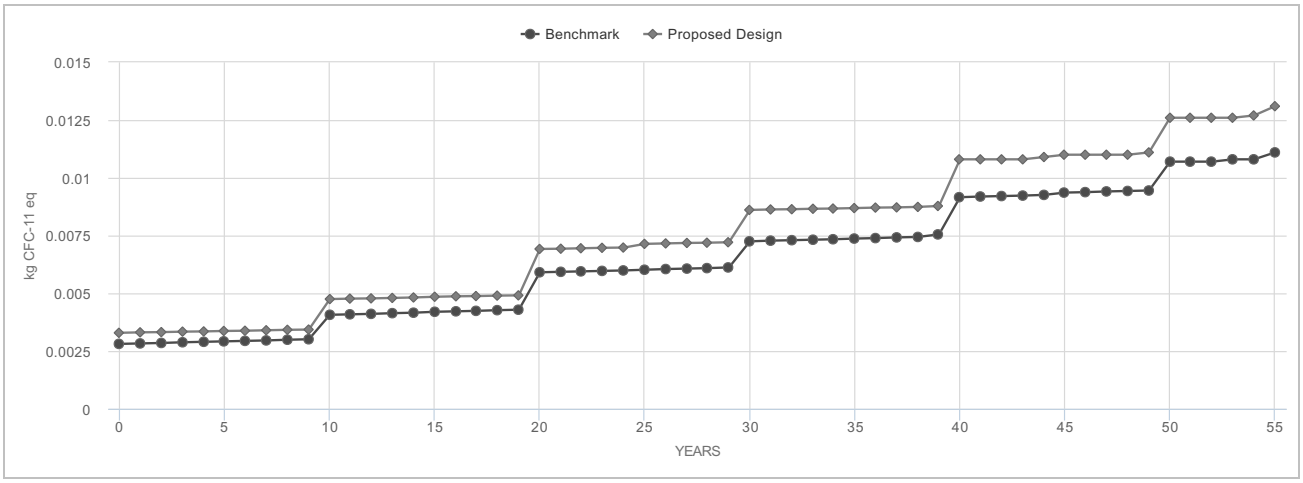
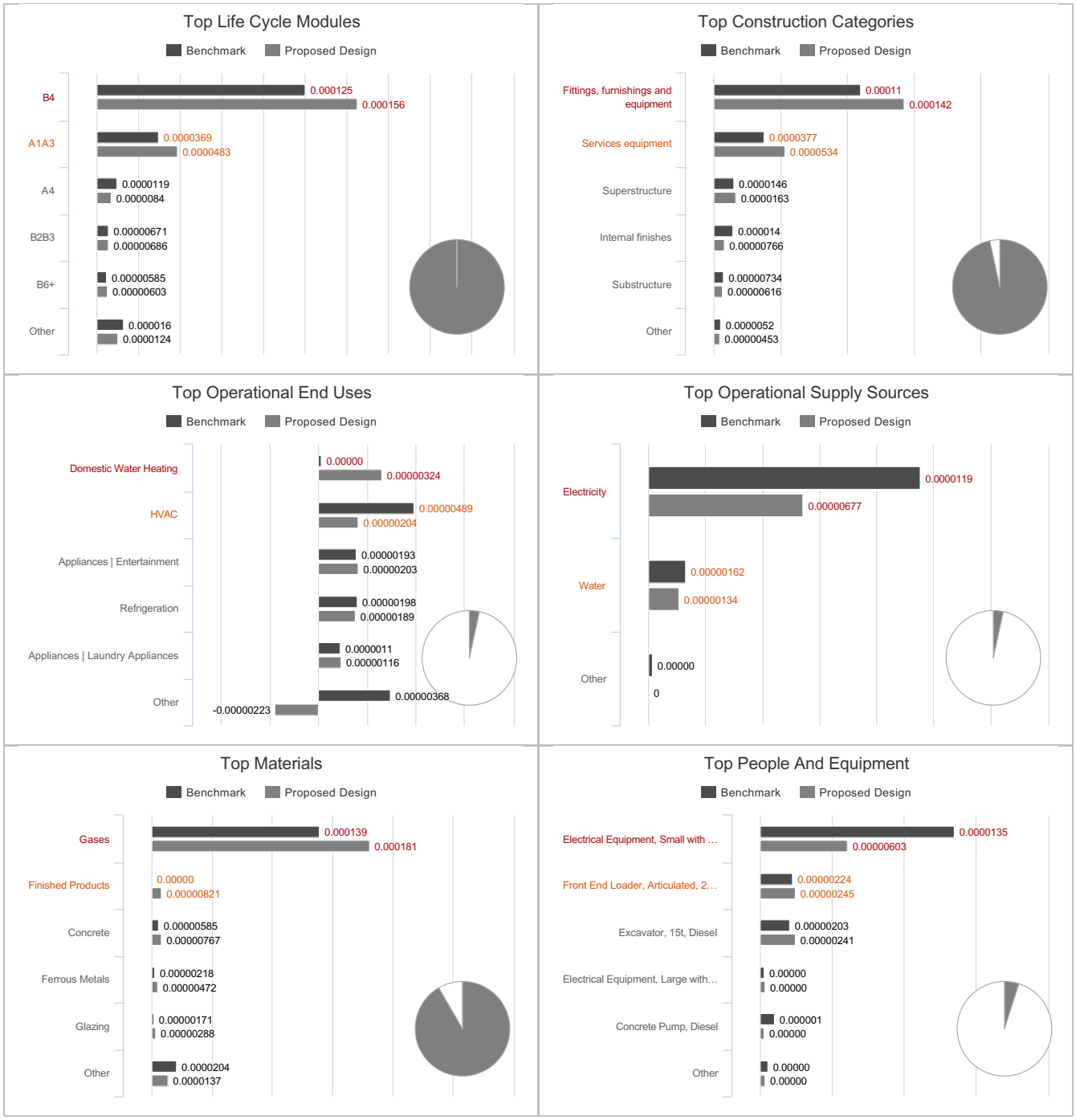


Figure 10: Top Five Ozone Depletion Potential, ODP chart



Highest and Lowest Impact Materials (kg CFC-11 eq)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Materials					
Gases | Refrigerants | R-134a (HFC-134a)	0.02	0.1	0	0	0.11
Gases | Refrigerants | R-410A (Puron, AZ-20)	0.01	0.02	0	0	0.03
Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	0	0	0	0	0.01
Concrete | Unreinforced | Portland Cement Blends | 40 MPa	0	0	0	0	0
Ferrous Metals | Steel | Reinforcement bar | Unspecified	0	0	0	0	0
Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening	0	0	0	0	0
Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	0	0	0	0	0
Concrete | Unreinforced | Portland Cement Blends | 20 MPa	0	0	0	0	0
Concrete | Reinforced | 1.0% Reinforcement | Portland Cement Blends | 30 MPa	0	0	0	0	0
Cementitious Binders | Mortars and Renders | 1 cement : 4 sand	0	0	0	0	0
Bottom 5 Impact Materials					
Plastics | Nylon | Unspecified	0	0	0	0	0
Metals (Non-Ferous) | Zinc	0	0	0	0	0
Ferrous Metals | Steel | Galvanised Structural | Unspecified	0	0	0	0	0
Ferrous Metals | Steel | Coated Sheet | Enamelled	0	0	0	0	0
Generic | Cost Adjustment Factors | Cost Only Factors (No Environmental Impacts Adjustment)	0	0	0	0	0

Highest and Lowest Impact Templates (kg CFC-11 eq)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	Integrated Energy Use (B6)	Plug Load Energy Use (B6+)	Water Supply & Treatment (B7)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Templates								
Refrigeration, Residential Well Ventilated Fridge Recess	0.02	0.1	0	0	0	0	0	0.12
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	0	0.01	0	0	0	0	0	0.02
Ducted System Air Source Heat Pump for Cooling, higher efficiency (COP/EER 3.8), R410a Refrigerant	0	0.01	0	0	0	0	0	0.02
Wall, External, Masonry, double brick 90-50-90 insulated with foundations and finishes	0	0	0	0	0	0	0	0
Upper Floors - Concrete Slab, 172mm, 40MPa, 3.8% reo (m2)	0	0	0	0	0	0	0	0
Wall, Internal, Masonry, Single Brick Wall (90mm) uninsulated with foundations and finishes	0	0	0	0	0	0	0	0
Appliances, Residential Average Op&Em	0	0	0	0	0	0	0	0
Roof - TimberTruss/SteelSheeting/25°Pitch	0	0	0	0	0	0	0	0
Electric Instantaneous Hot Water System (HWS_App)	0	0	0	0	0	0	0	0
Lowest Floor - Concrete Slab, 100mm, 20MPa, 3.8% reo (m2)	0	0	0	0	0	0	0	0
Bottom 5 Impact Templates								
LED Residential Lighting (High Efficiency - 110lm/watt)	0	0	0	0	0	0	0	0
Staircase, Concrete, 40Mpa, 2% reo	0	0	0	0	0	0	0	0
Door - HollowCoreTimber/SteelJam/Painted	0	0	0	0	0	0	0	0
Door - SolidCoreTimber/SteelJam/Painted (#)	0	0	0	0	0	0	0	0
LED Outdoor Lighting (Residential - Ultra High Efficiency 150lm/watt), m2	0	0	0	0	0	0	0	0

6.3 Acidification Potential for Soil and Water, AP (kg SO_2 eq.)

Figure 11: Time series Acidification Potential for Soil and Water, AP chart

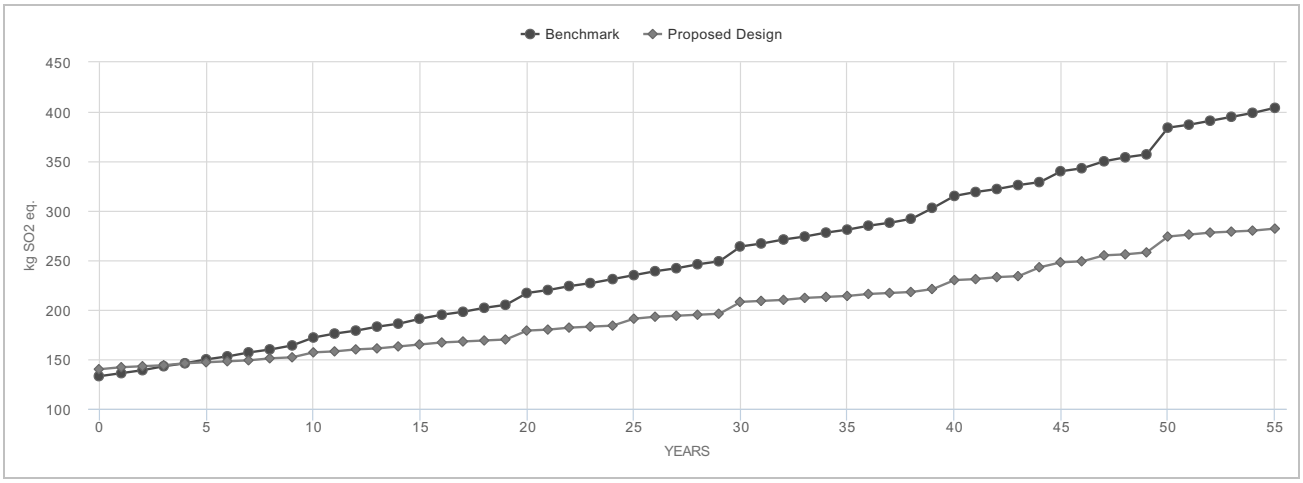
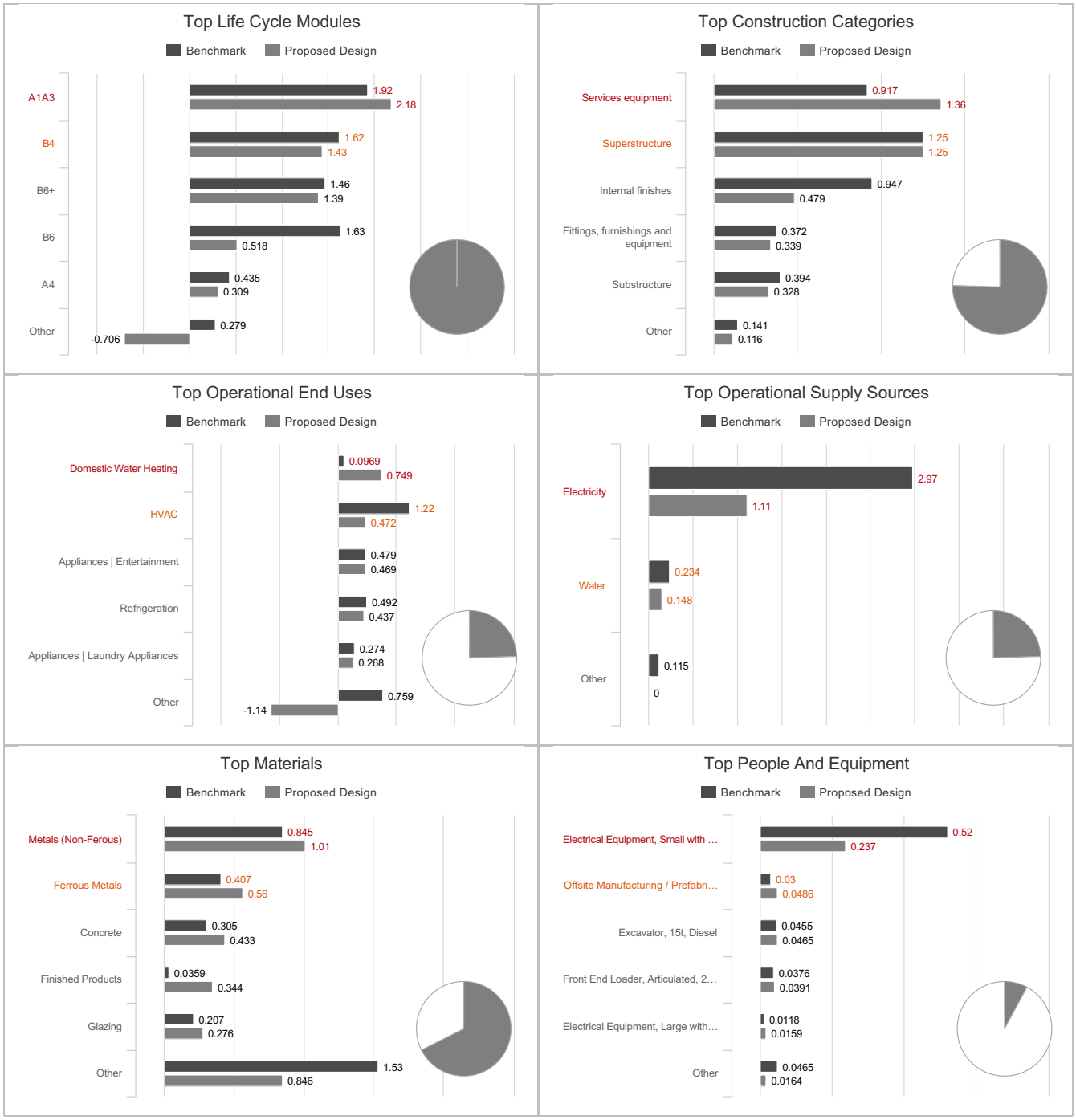


Figure 12: Top Five Acidification Potential for Soil and Water, AP chart



Highest and Lowest Impact Materials (kg SO_2 eq.)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Materials					
Metals (Non-Ferous) | Copper Unspecified	672.33	323.25	2.88	-227.89	770.57
Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	85.3	157.28	6.13	-27.35	221.35
Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening	106.2	106.98	0.78	0	213.96
Ferrous Metals | Steel | Coated Sheet | Zinc Coated & Coloured Sheet 0.43mm	202.02	9.33	0.91	-10.53	201.73
Ferrous Metals | Steel | Reinforcement bar | Unspecified	179.69	0	11.71	-12.42	178.98
Concrete | Unreinforced | Portland Cement Blends | 40 MPa	140.05	0	37.69	0	177.74
Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	71.61	0	22.14	0	93.74
Ceramics | Tiles | Ceramic Tiles	37.89	49.04	1.01	0	87.94
Concrete | Unreinforced | Portland Cement Blends | 20 MPa	65.48	0	22.36	0	87.84
Concrete | Reinforced | 1.0% Reinforcement | Portland Cement Blends | 30 MPa	67.8	0	16.25	0	84.05
Bottom 5 Impact Materials					
Ferrous Metals | Steel | Galvanised Structural | Unspecified	0.13	0	0	-0.02	0.12
Insulation | Rigid Foams and Boards | Polyethylene | Polyethylene	0.03	0.05	0	0	0.08
Asphalt and Bitumen | Asphalt hot mix | 5.50% primary bitumen, (0% RAP)	0	0.04	0	0	0.04
Ferrous Metals | Steel | Coated Sheet | Enamelled	0.01	0.01	0	-0.01	0.02
Generic | Cost Adjustment Factors | Cost Only Factors (No Environmental Impacts Adjustment)	0	0	0	0	0

Highest and Lowest Impact Templates (kg SO_2 eq.)

	Initial Materials & Construction (A1- A5)	Use Stage Materials & Construction (B1-B5)	Integrated Energy Use (B6)	Plug Load Energy Use (B6+)	Water Supply & Treatment (B7)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Templates								
Appliances, Residential Average Op&Em	2.88	15.56	0	789.62	0	0.05	-3.32	804.79
Electric Instantaneous Hot Water System (HWS_App)	55.87	109.37	617.8	0	0	0.26	-35.38	747.91
Refrigeration, Residential Well Ventilated Fridge Recess	22.31	113.28	0	360.17	0	0.44	-24.93	471.27
Roof - TimberTruss/SteelSheeting/25°Pitch	302.89	70.26	0	0	0	5.56	-1.37	377.34
Electrical Fittings - sockets power points wiring embodied only (m2)	322.98	26.36	0	0	0	1.47	-71.41	279.41
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	23.16	54.05	209.89	0	0	0.13	-11.06	276.17
Upper Floors - Concrete Slab, 172mm, 40MPa, 3.8% reo (m2)	265.57	0	0	0	0	40.61	-30.68	275.5
Cooking, Res Electric Oven Induction Stove	8.68	34.3	211.88	0	0	0.09	-1.19	253.77
Ducted System Air Source Heat Pump for Cooling, higher efficiency (COP/EER 3.8), R410a Refrigerant	23.16	54.05	179.5	0	0	0.13	-11.06	245.78
Windows, Residential Aluminium Single Glaze, fly screen	113.59	120.68	0	0	0	0.97	-2.71	232.54
Bottom 5 Impact Templates								
Demolition - Residential (End-of-Life)	0	0	0	0	0	34.1	0	34.1
Door - HollowCoreTimber/SteelJam/Painted	8.99	12.33	0	0	0	0.28	-2.37	19.23
LED Outdoor Lighting (Residential - Ultra High Efficiency 150lm/watt), m2	0.9	3.98	7.29	0	0	0	-0.07	12.1
Door - SolidCoreTimber/SteelJam/Painted (#)	2.84	3.11	0	0	0	0.08	-0.17	5.86
Solar PV System Residential - Zone 3 (Perth Sydney etc)	119.38	215.97	-866.15	0	0	8.11	-706.42	-1229.11

6.4 Eutrophication potential, EP (kg PO_4 eq)

Figure 13: Time series Eutrophication potential, EP chart

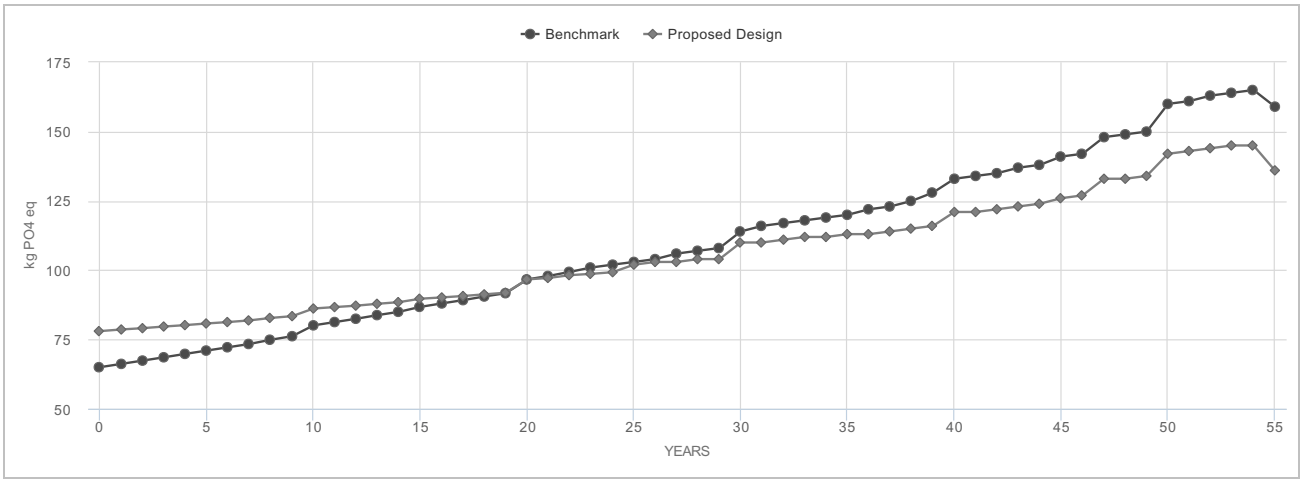
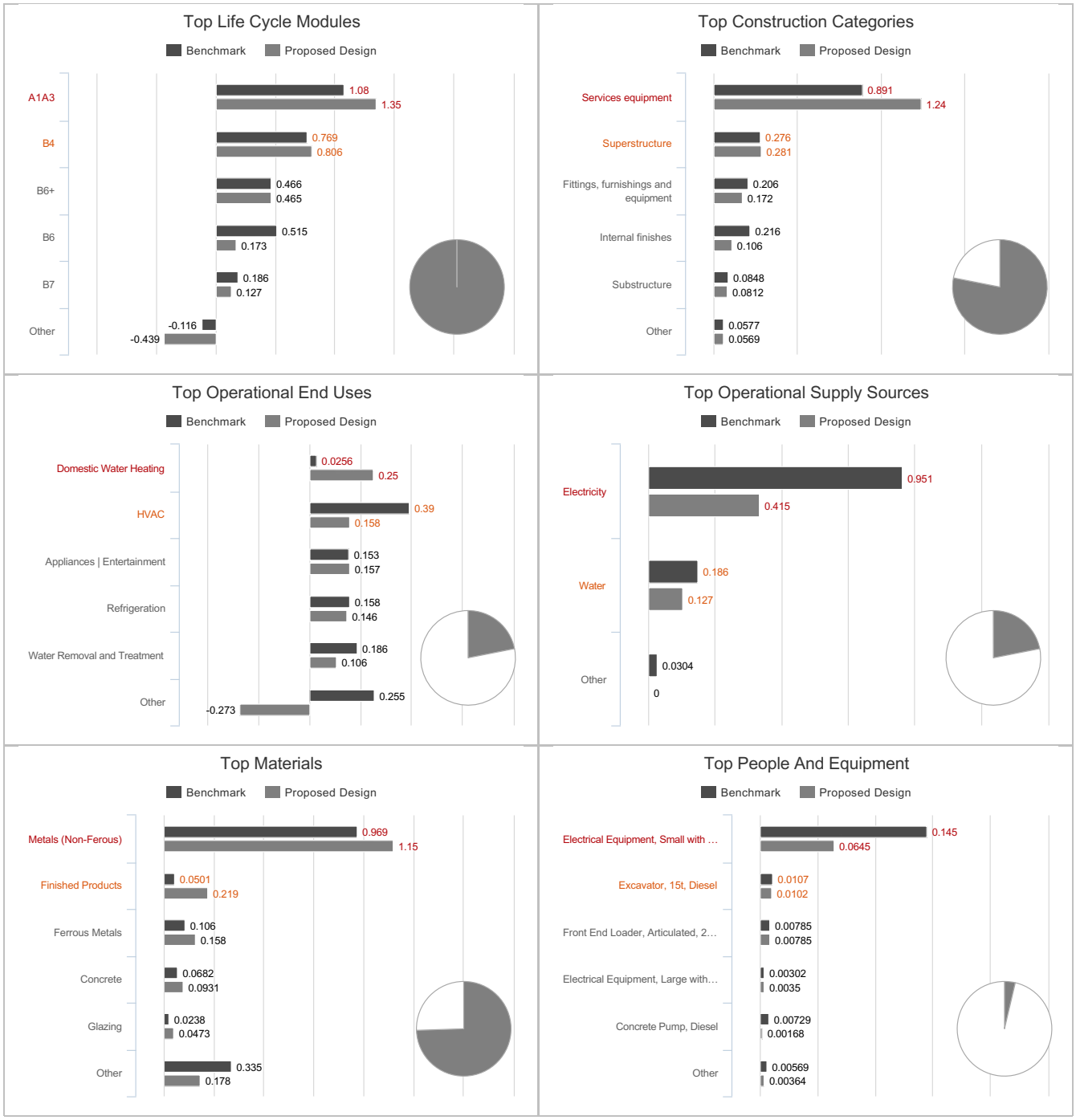


Figure 14: Top Five Eutrophication potential, EP chart



Highest and Lowest Impact Materials (kg PO_4 eq)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Materials					
Metals (Non-Ferous) | Copper Unspecified	823.51	394.41	0.35	-281.53	936.74
Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	37.48	69.5	2.01	-5.66	103.34
Ferrous Metals | Steel | Reinforcement bar | Unspecified	57.2	0	3.04	-3.29	56.95
Ferrous Metals | Steel | Coated Sheet | Zinc Coated & Coloured Sheet 0.43mm	51.78	2.39	0.24	-2.76	51.65
Finished Products | Electrical Goods | Electronics | Electronics For Control Unit	6.07	42.49	0	0	48.56
Concrete | Unreinforced | Portland Cement Blends | 40 MPa	28.3	0	9.33	0	37.62
Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening	18.61	18.8	0.19	0	37.6
Finished Products | Electrical Goods | Solar Inverters | Solar Inverter Generic	4.86	23.41	0	0	28.27
Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	14.03	0	5.49	0	19.51
Concrete | Reinforced | 1.0% Reinforcement | Portland Cement Blends | 30 MPa	14.81	0	4.02	0	18.83
Bottom 5 Impact Materials					
Ferrous Metals | Steel | Galvanised Structural | Unspecified	0.03	0	0	0	0.03
Insulation | Rigid Foams and Boards | Polyethylene | Polyethylene	0.01	0.01	0	0	0.02
Asphalt and Bitumen | Asphalt hot mix | 5.50% primary bitumen, (0% RAP)	0	0.01	0	0	0.01
Ferrous Metals | Steel | Coated Sheet | Enamelled	0	0	0	0	0.01
Generic | Cost Adjustment Factors | Cost Only Factors (No Environmental Impacts Adjustment)	0	0	0	0	0

Highest and Lowest Impact Templates (kg PO_4 eq)

	Initial Materials & Construction (A1- A5)	Use Stage Materials & Construction (B1-B5)	Integrated Energy Use (B6)	Plug Load Energy Use (B6+)	Water Supply & Treatment (B7)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Templates								
Electric Instantaneous Hot Water System (HWS_App)	66.26	122.59	206.33	0	0	0.04	-42.66	352.55
Electrical Fittings - sockets power points wiring embodied only (m2)	383.28	6.67	0	0	0	0.2	-87.99	302.16
Appliances, Residential Average Op&Em	1.86	9.88	0	263.71	0	0.01	-2.48	272.99
Utilities Connection to Site Residential	135.8	129.37	0	0	0	0.06	-58.73	206.5
Refrigeration, Residential Well Ventilated Fridge Recess	16.57	83.09	0	120.29	0	0.08	-22.13	197.9
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	21.27	47.9	70.1	0	0	0.02	-12.67	126.62
Ducted System Air Source Heat Pump for Cooling, higher efficiency (COP/EER 3.8), R410a Refrigerant	21.27	47.9	59.95	0	0	0.02	-12.67	116.47
Standard 1st Bathroom - WC/Shower-bath/Basin/WallTiles	128.49	7.82	0	0	0	0.22	-28	108.53
Water Use and Treatment (eTool Turbo)	0	0	0	0	104.94	0	0	104.94
Roof - TimberTruss/SteelSheeting/25°Pitch	75.95	15.44	0	0	0	1.39	-0.46	92.32
Bottom 5 Impact Templates								
Demolition - Residential (End-of-Life)	0	0	0	0	0	7.7	0	7.7
LED Outdoor Lighting (Residential - Ultra High Efficiency 150lm/watt), m2	0.6	3.62	2.43	0	0	0	-0.02	6.64
Door - HollowCoreTimber/SteelJam/Painted	2.53	3.38	0	0	0	0.07	-0.59	5.39
Door - SolidCoreTimber/SteelJam/Painted (#)	0.79	0.83	0	0	0	0.02	-0.04	1.6
Solar PV System Residential - Zone 3 (Perth Sydney etc)	49.98	99.97	-289.27	0	0	2.25	-193.23	-330.3

6.5 Photochemical Ozone Creation Potential, POCP (kg ethylene)

Figure 15: Time series Photochemical Ozone Creation Potential, POCP chart

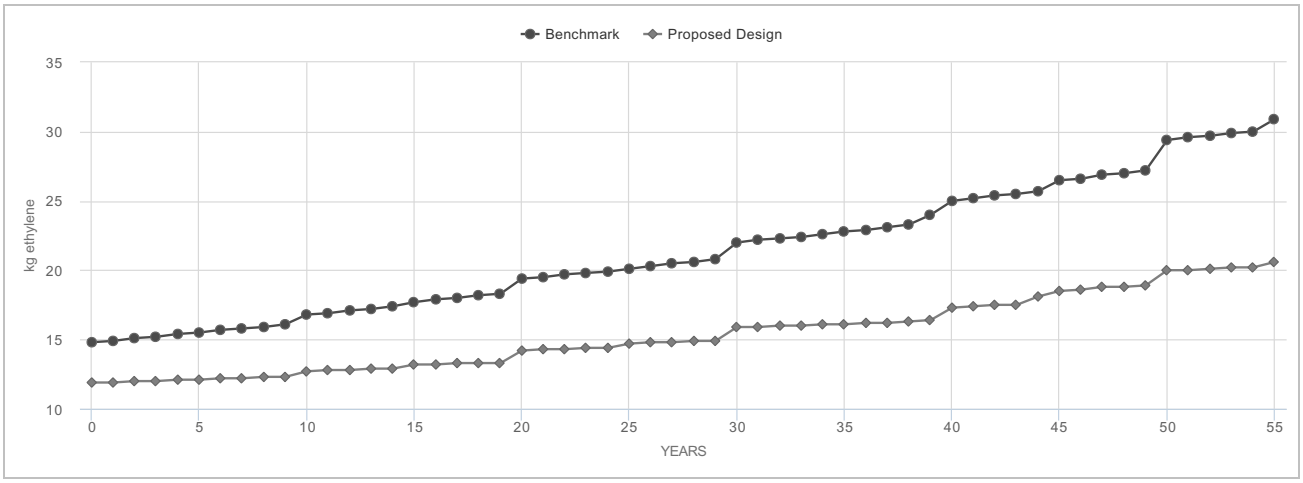


Figure 16: Top Five Photochemical Ozone Creation Potential, POCP chart

Highest and Lowest Impact Materials (kg ethylene)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Materials					
Timber | Sustainably Sourced | Hardwood | Unspecified	48.06	0	2.52	0.21	50.78
Metals (Non-Ferous) | Copper Unspecified	25.3	12.16	0.11	-8.58	28.99
Ferrous Metals | Steel | Reinforcement bar | Unspecified	20.88	0	0.62	-2.09	19.41
Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening	7.41	7.45	0.04	0	14.91
Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	3.93	6.51	0.29	-2.47	8.26
Concrete | Unreinforced | Portland Cement Blends | 40 MPa	4.88	0	2.05	0	6.93
Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	5.48	0	1.21	0	6.69
Timber | Sustainably Sourced | Plywood | Unspecified	3.24	0	1.2	0.1	4.53
Metals (Non-Ferous) | Aluminium Unspecified	2.62	3.37	0.08	-1.63	4.44
Concrete | Reinforced | 1.0% Reinforcement | Portland Cement Blends | 30 MPa	3.27	0	0.88	0	4.16
Bottom 5 Impact Materials					
Fibre Reinforced Plastics and Resins | Fibreglass Unspecified	0	0	0	0	0.01
Ferrous Metals | Steel | Galvanised Structural | Unspecified	0.01	0	0	0	0
Asphalt and Bitumen | Asphalt hot mix | 5.50% primary bitumen, (0% RAP)	0	0	0	0	0
Ferrous Metals | Steel | Coated Sheet | Enamelled	0	0	0	0	0
Generic | Cost Adjustment Factors | Cost Only Factors (No Environmental Impacts Adjustment)	0	0	0	0	0

Highest and Lowest Impact Templates (kg ethylene)

	Initial Materials & Construction (A1- A5)	Use Stage Materials & Construction (B1-B5)	Integrated Energy Use (B6)	Plug Load Energy Use (B6+)	Water Supply & Treatment (B7)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Templates								
Roof - TimberTruss/SteelSheeting/25°Pitch	57.65	5.9	0	0	0	2.83	-1.39	65
Electric Instantaneous Hot Water System (HWS_App)	2.41	5.65	17.2	0	0	0.01	-1.47	23.8
Appliances, Residential Average Op&Em	0.29	1.58	0	21.98	0	0	-0.31	23.55
Refrigeration, Residential Well Ventilated Fridge Recess	2.13	10.67	0	10.03	0	0.02	-1.93	20.92
Upper Floors - Concrete Slab, 172mm, 40MPa, 3.8% reo (m2)	23.28	0	0	0	0	2.82	-5.44	20.65
Windows, Residential Aluminium Single Glaze, fly screen	8.4	9.14	0	0	0	0.05	-0.24	17.35
Wall, External, Masonry, double brick 90-50-90 insulated with foundations and finishes	12.72	2.81	0	0	0	1.72	0.01	17.25
Electrical Fittings - sockets power points wiring embodied only (m2)	13.91	5.13	0	0	0	0.06	-2.72	16.38
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	2.73	6.67	5.84	0	0	0.01	-0.53	14.72
Wall, Internal, Masonry, Single Brick Wall (90mm) uninsulated with foundations and finishes	10.75	2.95	0	0	0	1.01	0.01	14.71
Bottom 5 Impact Templates								
Door - HollowCoreTimber/SteelJam/Painted	1.29	1.77	0	0	0	0.08	-0.45	2.69
Floor Covering - Tiles (ceramic/10mm)	1.15	1.27	0	0	0	0.03	0	2.45
Door - SolidCoreTimber/SteelJam/Painted (#)	0.43	0.55	0	0	0	0.03	-0.05	0.95
LED Outdoor Lighting (Residential - Ultra High Efficiency 150lm/watt), m2	0.07	0.29	0.2	0	0	0	-0.01	0.55
Solar PV System Residential - Zone 3 (Perth Sydney etc)	6.8	12.58	-24.11	0	0	0.36	-20.16	-24.53

6.6 Abiotic Depletion Potential - Elements, ADPE (kg antimony)

Figure 17: Time series Abiotic Depletion Potential - Elements, ADPE chart

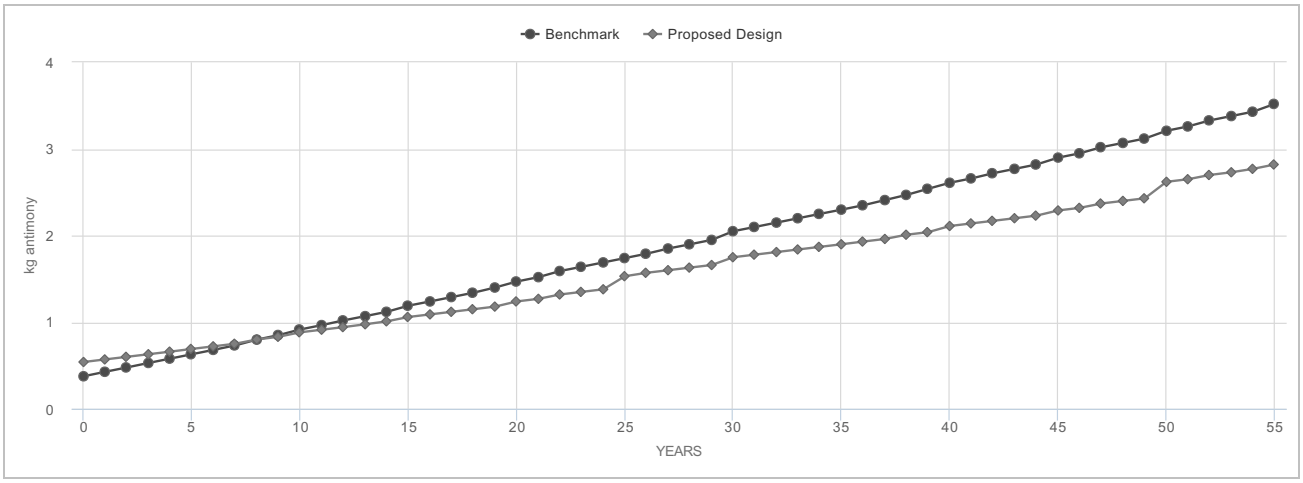
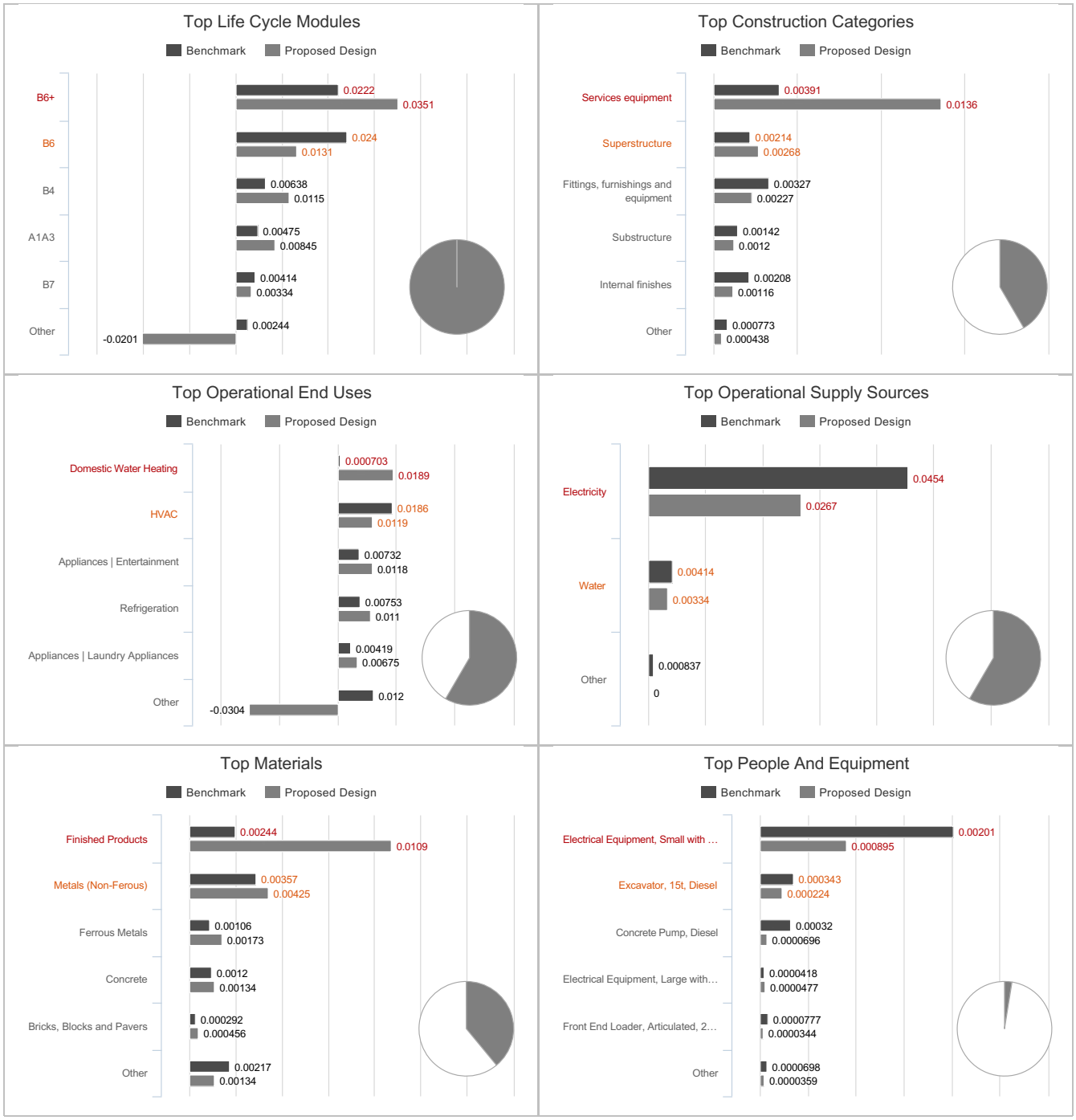


Figure 18: Top Five Abiotic Depletion Potential - Elements, ADPE chart



Highest and Lowest Impact Materials (kg antimony)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Materials					
Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	1.82	3.65	0	0	5.47
Metals (Non-Ferous) | Copper Unspecified	3.04	1.46	0	-1.04	3.47
Finished Products | Electrical Goods | Electronics | Electronics For Control Unit	0.29	2.05	0	0	2.35
Finished Products | Electrical Goods | Solar Inverters | Solar Inverter Generic	0.2	0.98	0	0	1.19
Ferrous Metals | Steel | Reinforcement bar | Unspecified	0.65	0	0.06	-0.06	0.64
Concrete | Unreinforced | Portland Cement Blends | 40 MPa	0.15	0	0.33	0	0.48
Ferrous Metals | Steel | Coated Sheet | Zinc Coated & Coloured Sheet 0.43mm	0.46	0.02	0	-0.05	0.43
Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	0.18	0	0.19	0	0.38
Concrete | Reinforced | 1.0% Reinforcement | Portland Cement Blends | 30 MPa	0.19	0	0.14	0	0.33
Ceramics | Tiles | Ceramic Tiles	0.12	0.16	0.01	0	0.29
Bottom 5 Impact Materials					
Asphalt and Bitumen | Asphalt hot mix | 5.50% primary bitumen, (0% RAP)	0	0	0	0	0
Fibre Reinforced Plastics and Resins | Fibreglass Unspecified	0	0	0	0	0
Insulation | Rigid Foams and Boards | Polyethylene | Polyethylene	0	0	0	0	0
Ferrous Metals | Steel | Coated Sheet | Enamelled	0	0	0	0	0
Generic | Cost Adjustment Factors | Cost Only Factors (No Environmental Impacts Adjustment)	0	0	0	0	0

Highest and Lowest Impact Templates (kg antimony)

	Initial Materials & Construction (A1- A5)	Use Stage Materials & Construction (B1-B5)	Integrated Energy Use (B6)	Plug Load Energy Use (B6+)	Water Supply & Treatment (B7)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Templates								
Appliances, Residential Average Op&Em	0.01	0.05	0	19.9	0	0	-0.01	19.95
Electric Instantaneous Hot Water System (HWS_App)	0.26	0.55	15.57	0	0	0	-0.16	16.22
Refrigeration, Residential Well Ventilated Fridge Recess	0.07	0.34	0	9.08	0	0	-0.11	9.38
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	0.15	0.65	5.29	0	0	0	-0.05	6.04
Cooking, Res Electric Oven Induction Stove	0.04	0.17	5.34	0	0	0	-0.02	5.54
Ducted System Air Source Heat Pump for Cooling, higher efficiency (COP/EER 3.8), R410a Refrigerant	0.15	0.65	4.52	0	0	0	-0.05	5.27
Water Use and Treatment (eTool Turbo)	0	0	0	0	2.75	0	0	2.75
LED Residential Lighting (High Efficiency - 110lm/watt)	0.13	0.86	1.69	0	0	0	0	2.67
Electrical Fittings - sockets power points wiring embodied only (m2)	1.43	0.08	0	0	0	0	-0.33	1.19
Utilities Connection to Site Residential	0.54	0.54	0	0	0	0	-0.22	0.86
Bottom 5 Impact Templates								
Windows, Residential Aluminium Single Glaze, fly screen	0.05	0.07	0	0	0	0.01	0	0.12
Floor Covering - Tiles (ceramic/10mm)	0.05	0.06	0	0	0	0	0	0.11
Door - HollowCoreTimber/SteelJam/Painted	0.03	0.04	0	0	0	0	-0.01	0.05
Door - SolidCoreTimber/SteelJam/Painted (#)	0.01	0.01	0	0	0	0	0	0.02
Solar PV System Residential - Zone 3 (Perth Sydney etc)	2.04	4.64	-21.83	0	0	0	-17.77	-32.92

6.7 Abiotic Depletion Potential - Fossil Fuels, ADPF (MJ)

Figure 19: Time series Abiotic Depletion Potential - Fossil Fuels, ADPF chart

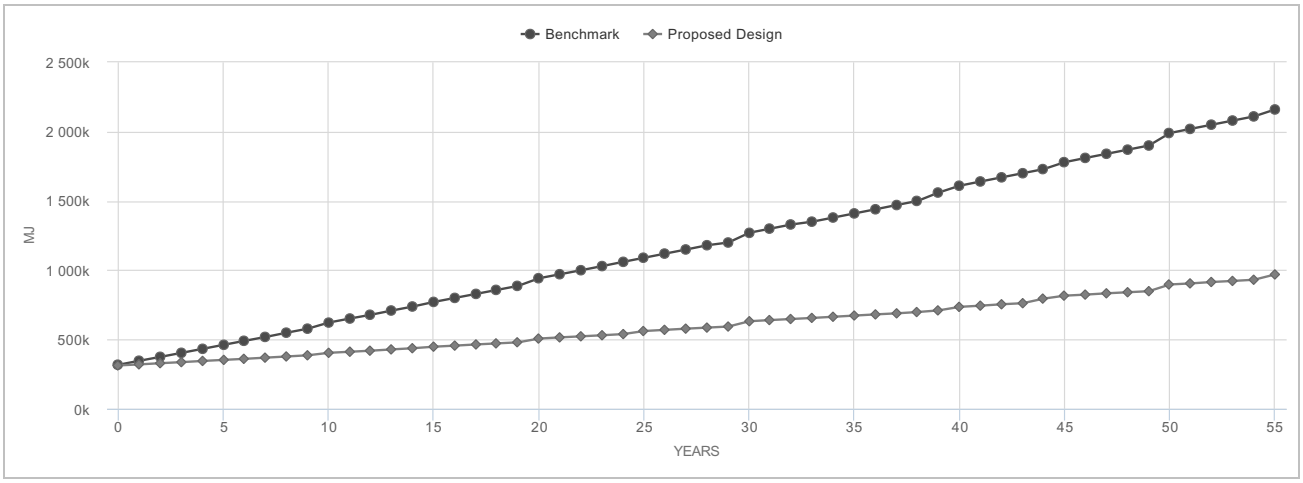
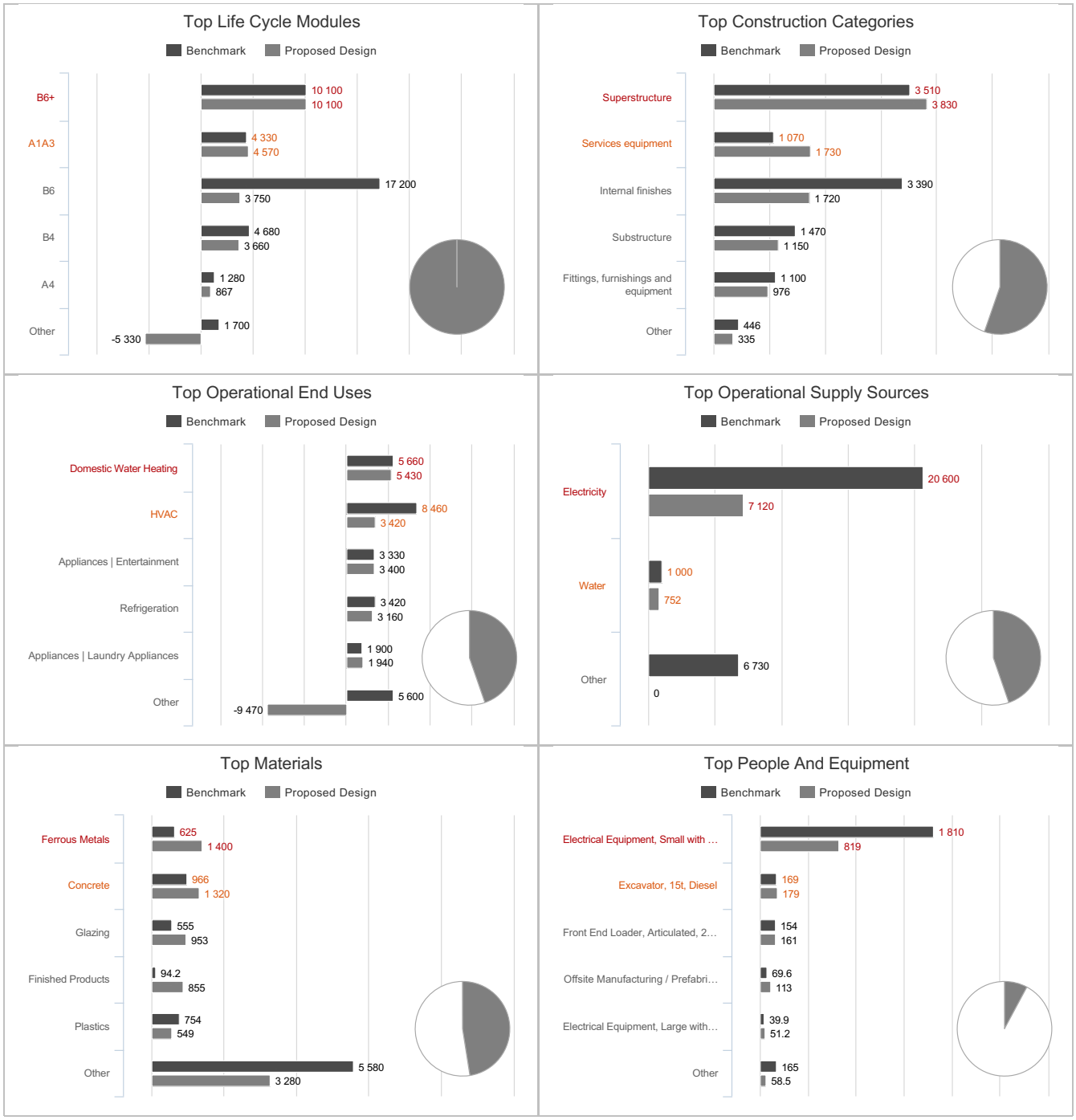


Figure 20: Top Five Abiotic Depletion Potential - Fossil Fuels, ADPF chart



Highest and Lowest Impact Materials (MJ)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Materials					
Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening	379540.57	382435.41	2894.84	0	764870.81
Ferrous Metals | Steel | Reinforcement bar | Unspecified	705575.64	0	35232.9	-32386.66	708421.87
Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	214409.76	432856.05	18569.93	-104018.73	561817.01
Concrete | Unreinforced | Portland Cement Blends | 40 MPa	391865.64	0	140056.44	0	531922.08
Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	369962.91	0	82113.94	0	452076.85
Concrete | Unreinforced | Portland Cement Blends | 20 MPa	186373.82	0	83078.58	0	269452.4
Concrete | Reinforced | 1.0% Reinforcement | Portland Cement Blends | 30 MPa	206386.38	0	60381.88	0	266768.26
Ceramics | Tiles | Ceramic Tiles	102581.87	134075.38	3753.05	0	240410.3
Metals (Non-Ferous) | Aluminium Unspecified	134484.57	171101.83	1993.42	-86033.56	221546.25
Cementitious Binders | Mortars and Renders | 1 cement : 4 sand	168624.75	32924.83	19326.35	0	220875.93
Bottom 5 Impact Materials					
Metals (Non-Ferous) | Brass	65.58	343.9	3.21	-82.82	329.87
Asphalt and Bitumen | Asphalt hot mix | 5.50% primary bitumen, (0% RAP)	39.79	275.25	6.09	0	321.12
Ferrous Metals | Steel | Galvanised Structural | Unspecified	155.95	0	4.69	-44.62	116.02
Ferrous Metals | Steel | Coated Sheet | Enamelled	57.61	58.34	0.73	-13.75	102.93
Generic | Cost Adjustment Factors | Cost Only Factors (No Environmental Impacts Adjustment)	0	0	0	0	0

Highest and Lowest Impact Templates (MJ)

	Initial Materials & Construction (A1- A5)	Use Stage Materials & Construction (B1-B5)	Integrated Energy Use (B6)	Plug Load Energy Use (B6+)	Water Supply & Treatment (B7)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Templates								
Appliances, Residential Average Op&Em	9063.67	48800.93	0	5722437.36	0	129.61	-5761.55	5774670.01
Electric Instantaneous Hot Water System (HWS_App)	15498.69	60958.06	4477256.58	0	0	341.28	-7048.3	4547006.32
Refrigeration, Residential Well Ventilated Fridge Recess	52047.09	262945.5	0	2610201.34	0	886.69	-32547.08	2893533.54
Cooking, Res Electric Oven Induction Stove	21627.01	85719.04	1535519.91	0	0	275.19	822.23	1643963.37
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	24945.96	80498.08	1521099.34	0	0	254.99	-4413.06	1622385.3
Ducted System Air Source Heat Pump for Cooling, higher efficiency (COP/EER 3.8), R410a Refrigerant	24945.96	80498.08	1300830.86	0	0	254.99	-4413.06	1402116.82
Upper Floors - Concrete Slab, 172mm, 40MPa, 3.8% reo (m2)	896854.38	0	0	0	0	145881.79	-89031.92	953704.24
Windows, Residential Aluminium Single Glaze, fly screen	415949.71	450592.62	0	0	0	3084.46	-12723.18	856903.6
Wall, External, Masonry, double brick 90-50-90 insulated with foundations and finishes	638285.14	86402.39	0	0	0	111484.03	-1074.05	835097.51
Roof - TimberTruss/SteelSheeting/25°Pitch	525548.96	255999.47	0	0	0	18670.7	-42958.04	757261.09
Bottom 5 Impact Templates								
Staircase, Concrete, 40Mpa, 2% reo	87633.03	6809.07	0	0	0	18217.79	4371.29	117031.18
Door - HollowCoreTimber/SteelJam/Painted	31727.34	43566.24	0	0	0	857.58	-9730.21	66420.95
LED Outdoor Lighting (Residential - Ultra High Efficiency 150lm/watt), m2	1995.77	9414.94	52836.56	0	0	9.97	-172.68	64084.57
Door - SolidCoreTimber/SteelJam/Painted (#)	9858.52	10722.77	0	0	0	264.28	-1492.81	19352.75
Solar PV System Residential - Zone 3 (Perth Sydney etc)	338645.96	616092.14	-6277118.31	0	0	20350.47	-5719648.86	-11021678.61

6.8 Global Warming Potential Biogenic, GWP B (kg CO_2 eq)

Figure 21: Time series Global Warming Potential Biogenic, GWP B chart

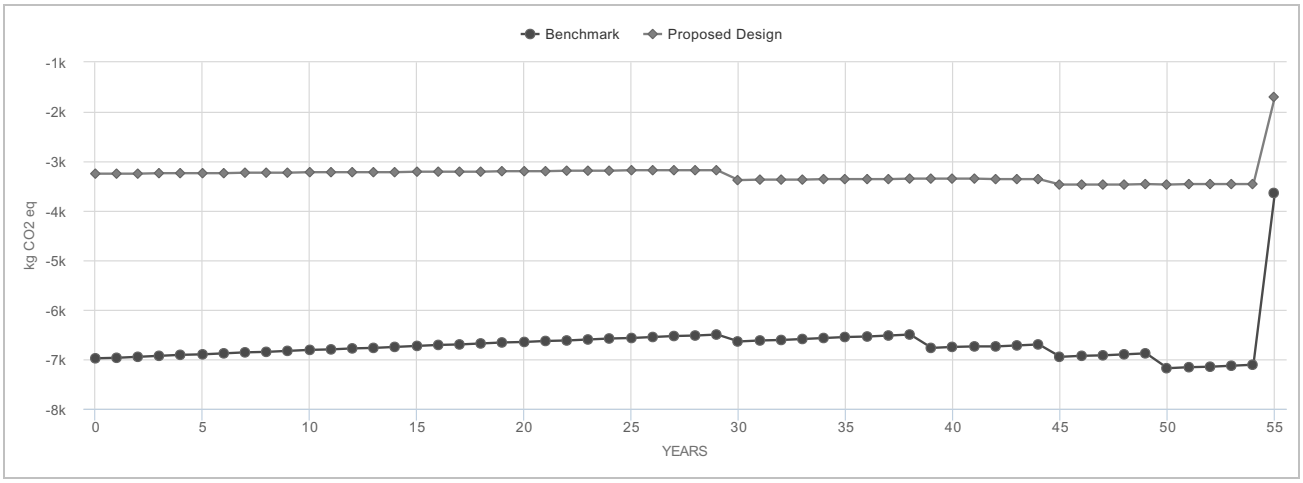
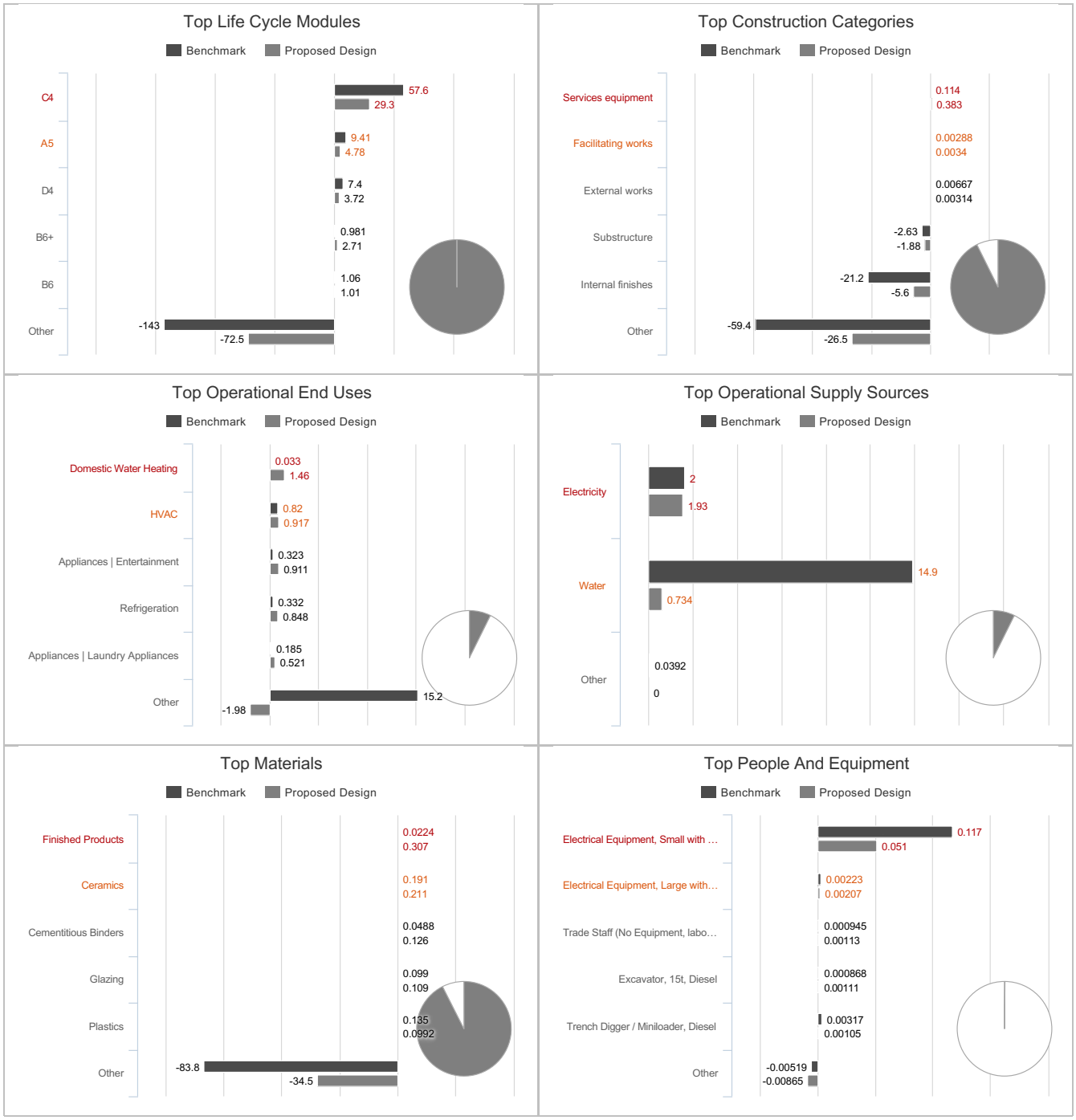


Figure 22: Top Five Global Warming Potential Biogenic, GWP B chart



Highest and Lowest Impact Materials (kg CO_2 eq)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Materials					
Finished Products | Electrical Goods | Solar PV Panels | Monocystalline	74.51	115.63	-8.35	-17.36	164.43
Cementitious Binders | Mortars and Renders | 1 cement : 4 sand	76.1	13.34	0.04	0	89.48
Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening	41.91	41.92	0.01	0	83.84
Ceramics | Tiles | Ceramic Tiles	33.97	42.84	0.01	0	76.82
Resins and Adhesives | Epoxy Resin	36.67	36.67	0	0	73.34
Plaster and Mineral Derived Products | 100% Primary Gypsum | Plaster | Unspecified	34.92	34.93	0.02	0	69.87
Finished Products | Electrical Goods | Solar Inverters | Solar Inverter Generic	11.77	56.7	0	0	68.47
Ferrous Metals | Steel | Stainless | Unspecified	7.03	19.89	-0.02	29.92	56.83
Ceramics | Porcelain Sanitary Products | Toilet	25.68	25.68	0	0	51.36
Ceramics | Porcelain Sanitary Products | Bath	33.39	0	0	0	33.4
Bottom 5 Impact Materials					
Plaster and Mineral Derived Products | 100% Primary Gypsum | Plasterboard | 12mm Sheets	-1085.26	-1085.25	0.01	0	-2170.5
Bricks, Blocks and Pavers | Clay Bricks and Pavers | Unspecified	-2343.13	0	0.19	0	-2342.94
Timber | Sustainably Sourced | Plywood | Unspecified	-10417.02	0	5944.87	610.12	-3862.03
Timber | Sustainably Sourced | Particle Board | Indoor	-6910.35	-2988.47	3602.03	739.34	-5557.45
Timber | Sustainably Sourced | Hardwood | Unspecified	-24232.85	0	12509.98	1280.06	-10442.82

Highest and Lowest Impact Templates (kg CO_2 eq)

	Initial Materials & Construction (A1-A5)	Use Stage Materials & Construction (B1-B5)	Integrated Energy Use (B6)	Plug Load Energy Use (B6+)	Water Supply & Treatment (B7)	End of Life (C1-C4)	Recycling & Energy Export (D)	Total
Top 10 Impact Templates								
Appliances, Residential Average Op&Em	0.48	2.69	0	1534.33	0	0	0.92	1538.41
Electric Instantaneous Hot Water System (HWS_App)	4.27	18.95	1200.46	0	0	0.01	-0.29	1223.41
Refrigeration, Residential Well Ventilated Fridge Recess	11	54.85	0	699.86	0	0	0.54	766.24
Water Use and Treatment (eTool Turbo)	0	0	0	0	605.45	0	0	605.45
Ducted System Air Source Heat Pump for Heating, Average Efficiency (COP/EER 3.27), R410a Refrigerant	0.37	4.9	407.84	0	0	0	-0.03	413.09
Ducted System Air Source Heat Pump for Cooling, higher efficiency (COP/EER 3.8), R410a Refrigerant	0.37	4.9	348.79	0	0	0	-0.03	354.03
Cooking, Res Electric Oven Induction Stove	-49.1	-196.32	411.71	0	0	-0.01	21.33	187.62
LED Residential Lighting (High Efficiency - 110lm/watt)	1.33	8.16	130.46	0	0	0	0.1	140.05
Standard 1st Bathroom - WC/Shower-bath/Basin/WallTiles	75.31	52.07	0	0	0	0.03	2.42	129.83
Windows, Residential Aluminium Single Glaze, fly screen	43.2	44.21	0	0	0	0.02	-1.56	85.86
Bottom 5 Impact Templates								
Wall, External, Masonry, double brick 90-50-90 insulated with foundations and finishes	-2386.48	-318.94	0	0	0	397.84	81.61	-2225.97
Upper Floors - Concrete Slab, 172mm, 40MPa, 3.8% reo (m2)	-5829.7	0	0	0	0	3255.04	343.78	-2230.88
Solar PV System Residential - Zone 3 (Perth Sydney etc)	99.81	186.43	-1683.05	0	0	-8.22	-1493.81	-2898.86
Kitchen Medium sized (incl Equipment)	-6973.71	-3035.73	0	0	0	3643.01	754.54	-5611.9
Roof - TimberTruss/SteelSheeting/25°Pitch	-27137.36	-1995.85	0	0	0	13372.76	1460.13	-14300.32

7 Scenarios Summary Tables

7.1 Proposed Design Scenarios Summary

Table 11: While modelling the Proposed Design the following scenarios were modelled.

	Scenario	GWP	ODP	AP	EP	POCP	ADPE	ADPF	GWP B
●	<Improved Design>								
●	RIBA Phase 4 – Technical Design 1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
●	RIBA Phase 4 – Technical Design 2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
●	<Proposed Design>								

● Strategies included in Proposed Design ● Strategies not included in Proposed Design

8 Low Impact Strategies

The following low impact design strategies were modelled in the LCA study to determine the relative benefits and aid the design decision making process.

The relative saving of each progressed recommendation against the Benchmark is provided in the following tables for each strategy. Further information regarding each strategy is also provided regarding motivation and logistical constraints.

8.1 Proposed Design Strategies

The following low impact strategies are included in the Proposed Design.

Design Strategy Performance	GWP	ODP	AP	EP	POCP	ADPE	ADPF	GWP B
<Improved Design>								
RIBA Phase 4 – Technical Design 1	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
RIBA Phase 4 – Technical Design 2	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
<Proposed Design>								

Table 12: Design Strategies in Proposed Design

8.1.1 RIBA Phase 4 – Technical Design 1

% Changes Against the Benchmark

Design Strategy Performance	GWP	ODP	AP	EP	POCP	ADPE	ADPF	GWP B
RIBA Phase 4 – Technical Design 1	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %

Table 13: Impact savings (or increases) associated with the RIBA Phase 4 – Technical Design 1 as a percentage of the Proposed Design.

RapidLCA automated phase

8.1.2 RIBA Phase 4 – Technical Design 2

% Changes Against the Benchmark

Design Strategy Performance	GWP	ODP	AP	EP	POCP	ADPE	ADPF	GWP B
RIBA Phase 4 – Technical Design 2	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %

Table 14: Impact savings (or increases) associated with the RIBA Phase 4 – Technical Design 2 as a percentage of the Proposed Design.

RapidLCA automated phase

9 Conclusion

The report shows that the Proposed Design has lower Global Warming Potential Total, GWP impact than the Benchmark Design. The **Non-integrated Energy (B6+)** GWP Impacts are the most dominant life cycle module in the Proposed Design Design followed by the **Product Stage (A1A3)** and then **Replacement (B4)**.

Further analysis reveals:

- The **Superstructure** is the highest impact construction category,
- **Domestic Water Heating** is the highest operational impact by demand category,
- The **Electricity** is this highest impact operational impact by supply source,
- **Glazing | Windows | Aluminium Framed | No Thermal Break | Single Glaze | Domestic 50% Opening** is the highest impact material category,
- **Electrical Equipment, Small with transport and tradestaff, Electricity** is the highest people and equipment impact

2 strategies were modelled in the Proposed Design, the **RIBA Phase 4 – Technical Design 1** strategy had the highest saving followed by **RIBA Phase 4 – Technical Design 2** . See full LCA report for details of other environmental strategies.

In addition to GWP, other indicators were included in the study, the results of which are summerised below.

The Proposed Design shows an expected performance improvement against the Benchmark Design for 6 indicators:

- 54.23% **saving** in GWP impacts
- NaN% **increase** in ODP impacts
- 30.2% **saving** in AP impacts
- 14.42% **saving** in EP impacts
- 33.45% **saving** in POCP impacts
- 20.31% **saving** in ADPE impacts
- 55.23% **saving** in ADPF impacts
- 53.29% **saving** in GWP B impacts

Appendix A: Environmental Indicators Description

Global Warming Potential Total, GWP

Anthropogenic global warming is caused by an increase of greenhouse gasses (GHG) in the earth's atmosphere. These gasses reflect some of the heat radiated from the earth's surface that would normally escape into space back to the surface of the earth. Overtime this warms the earth. Common GHGs include CO2, N2O, CH4 and volatile organic compounds (VOCs). Global Warming Potential Total (GWP) is expressed in equivalent GHGs released, usually in kgCO2e.
Global Warming Potential Total (GWP) = GWP Fossil + GWP Biogenic + GWP LULUC.

Ozone Depletion Potential, ODP

Ozone is formed and depleted naturally in the earth's stratosphere (between 15-40 km above the earth's surface). Halocarbon compounds are persistent synthetic halogen containing organic molecules that can reach the stratosphere leading to more rapid depletion of the ozone. As the ozone in the stratosphere is reduced more of the ultraviolet rays in sunlight can reach the earth's surface where they can cause skin cancer and reduced crop yields. Ozone Depletion Potential (ODP) is expressed in equivalent ozone depleting gasses (normally kgCFC11e).

Acidification Potential for Soil and Water, AP

Acidification is a consequence of acids (and other compounds which can be transformed into acids) being emitted to the atmosphere and subsequently deposited in surface soils and water. Increased acidity can result in negative consequences for flora and fauna in addition to increased corrosion of manmade structures (buildings vehicles etc.). Acidification Potential (AP) is an indicator of such damage and is usually measured in kgSO₂e

Eutrophication potential, EP

Over enrichment of aquatic ecosystems with nutrients leading to increased production of plankton, algae and higher aquatic plants leading to a deterioration of the water quality and a reduction in the value and/or the utilisation of the aquatic ecosystem. Eutrophication is primarily caused by surplus nitrogen and phosphorus. Sources of nutrients include agriculture (fertilisers and manure), aquaculture, municipal wastewater, and nitrogen oxide emissions from fossil fuel combustion.

Photochemical Ozone Creation Potential, POCP

Photochemical Ozone Creation Potential (POCP), commonly known as smog, is toxic to humans in high concentration. Although ozone is protective in the stratosphere at low levels it is problematic from both a health and nuisance perspective. Plant growth is also effected through damaged leaf surfaces and reduced photosynthesis. POCP is formed when sunlight and heat react with Volatile Organic Compounds (VOCs).

Abiotic Depletion Potential - Elements, ADPE

Abiotic Resource Depletion of energy (ADPM) is a measure of the extraction and consumption of primary resources from the earth. Such exploitation reduces resources available to future generations and as such must be managed.

Abiotic Depletion Potential - Fossil Fuels, ADPF

Abiotic Resource Depletion of energy (ARDE) is a measure of the extraction and consumption of non-renewable energy sources (primarily fossil fuels, but also inclusive of other energy sources such as uranium). Primary energy content of non-renewable energy sources including the embodied energy to extract, process and deliver the non renewable fuels, or manufacture, transport and install the renewable generator. Hence there is usually and non-renewable energy content associated with renewable fuels also.

Global Warming Potential Biogenic, GWP B

This indicator accounts for GWP from removals of CO2 into biomass from all sources except native forests, as transfer of carbon, sequestered by living biomass, from nature into the product system declared as GWP-biogenic. This indicator also accounts for GWP from transfer of any biogenic carbon from previous product systems into the product system under study. This indicator also covers biogenic emissions to air from biomass from all sources except native forests due to oxidation or degradation (e.g. combustion, solid waste disposal) as well as all transfer of biogenic carbon from biomass from all sources except native forests into subsequent product systems in the form of biogenic CO2.

APPLICATION FORM

CITY OF VINCENT
RECEIVED
8 March 2024

Development Application - Urban Design Study

As part of the accompanying material for an application for development approval pursuant to Schedule 2, Part 8, Clause 63 of the Planning and Development (Local Planning Schemes) Regulations 2015, an urban design study is required for all developments visible from the public realm.

The urban design study is to be provided as drawings, 3D studies, and diagrams that interpret the development site's context into opportunities and constraints to generate early design parameters. The elements of the urban design study are based on Appendix 1 – Design Principles of the Built Form Policy.

Applicant Details

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Suburb:	Mt Hawthorn	Postcode:	6016
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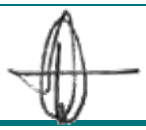
Applicant Signature			

Prepared by

Name:	Daniel Cassettai		
Address:	7/405 Oxford Street		
Suburb:	Mt Hawthorn	Postcode:	6016
Email Address:	dan@dcdesign.com.au		
Phone Number:	9201 9993		
Applicant Signature			

Property Details

Lot Number	4 & 8		
Address:	293 & 295 Oxford Street		
Suburb:	Leederville	Postcode:	6007

Urban Design Study:

Please outline how each of the following elements have been addressed and attach any relevant or supporting photos, images, diagrams or drawings where applicable.

Description	Applicant comment
Context & Character *Good design responds to and enhances the distinctive characteristics of a local area, contributing to a sense of place.*	
Demonstrate how you have reviewed the natural environment including topography, local flora and fauna.	The site has an approximate 2m slope running east to west (front to rear), over 40m. As a result, the development gradually steps down in response to the topography of the site. Existing vegetation on the lot consists of trees, light shrubs, and grass. Whilst the possibility of retaining the existing vegetation was not deemed viable, the design seeks to implement a landscaping strategy that reorientates and maximises its presentation towards the streetscape and internal driveway.
Demonstrate consideration of the site's streetscape character.	The Oxford Street Activity Corridor has a mixed and varied streetscape in terms of style and presentation. A range of single and double storey dwellings are present, alongside pockets of multi-dwelling developments ranging in height from 3 to 4 storeys. This mix of established and newer developments presents a unique streetscape character, whereby a 'commercial' feel is present towards the northern and southern extents of the activity corridor, whilst the central area has a distinct residential flavor. On-street parking is available along most of the street, alongside cycling lanes. Pedestrian footpaths are located on both sides of the street.
Demonstrate review of the built and natural environment of the local context to a radium of 400m – 1000m.	The established residential developments present on either side of the site have deeper setbacks from the street, and predominantly have front facing gardens with fences. Whilst these are typically single storey, there are also examples of double storey group-dwelling buildings along the street, particularly with newer developments. These newer developments include commercial, multi-dwelling and commercial premises with contemporary designs. There is a prevalence of small to medium sized trees along the streetscape, located on both public land and within the enclosed front gardens of established homes.
Demonstrate how the site's context and character influenced the development. Consider the following: • History of the local area; • Heritage listed buildings in the area; • High quality contemporary buildings in the area; • Materials, textures, patterns from high quality heritage / character as well as contemporary buildings in the area; and • Movement patterns / laneways.	Our design proposal seeks to balance the predominantly residential character of the street with the future aspirations of the Activity Corridor by presenting a contemporary design that takes material and built form cues from both. The contemporary design of the development along clean horizontal and vertical lines incorporates a dominant mix of rendered walls and large glass openings. Red brick, with a raw and rough finish, are used as feature elements that tie into the predominant material palette of established homes along the street. The development is also setback from the street to allow for front gardens with landscaping and small-medium sized trees. Consideration is also given to pedestrian and vehicle safety due to the adjacent footpath and on-street parking. The site has been amalgamated to ensure a single, central crossover, as opposed to two. This circulation spine allows vehicle and pedestrian access to the townhouses.
Landscape quality *Good design recognises that together landscape and buildings operate as an integrated and sustainable system, within a broader ecological context.*	
Demonstrate review of the existing landscaping of the site and the street including mature trees, species and natural features	Oxford Street is lined with mature trees, with single dwellings typically having street facing gardens enclosed by a front fence. These fences include a mix of low a high walls, both solid and permeable. Whilst established homes typically have trees visible from the street, newer commercial, grouped and mutli dwelling developments do not.
Demonstrate how the landscape quality of the streetscape and surrounding context has been incorporated into the building and landscape design.	Our design proposes lush gardens between the built form and Oxford Street, with small to medium trees. Planters have been used to create a layered, terrace, effect for visual interest along the street. In keeping with the some of the established homes along the street, portions of the gardens fronting Oxford Street are enclosed with fences – permeable and solid – to ensure an adequate level of privacy between the pedestrian side walk and on-street parking.

Description	Applicant comment
Built Form & Scale *Good design provides development with massing and height that is appropriate to its setting and successfully negotiates between existing built form and the intended future character of the local area.*	
What is the building massing and height of the streetscape? How has this been incorporated into the design?	Whilst there is a dominance of established residential dwellings along the street which are typically single storey, there are also examples of double storey grouped-dwellings, particularly with newer developments. Alongside these buildings are pockets of multi-dwelling developments ranging in height from 3 to 4 storeys.
How does the development respond and contribute to the built form and scale of the streetscape?	Our proposal is a two-storey development that is in keeping with predominantly single and double storey dwellings found along the immediate context of the site. This provides a transition between established homes and the future aspirations of the activity corridor. A generous setback to the street has also been provided to reduce the impact of bulk and scale to the street and in keeping with the residential built form in the area.
Demonstrate how the development encourages an activated and vibrant streetscape environment.	The central driveway acts a view corridor for the inner townhouses that gradually transitions from a public to semi-private space. As a result, all courtyards and gardens have been designed to internally face the central driveway to ensure direct views of the street. The front facing gardens have been designed with permeable and open fencing to promote passive surveillance. This creates interaction between public and private spaces that foster interaction between the street and active outdoor areas, whilst still maintaining privacy for residents. Landscaping and a mixed material palette also create visual interest and vibrancy to the building's façade.
Functionality & Build Quality *Good design meets the needs of users efficiently and effectively, balancing functional requirements to deliver optimum benefit and performing well over the full life-cycle.*	
Demonstrate how the proposed design complements the use of the building.	Generous ground floor living spaces have been designed to allow occupants to live with a strong visual connection between indoor and outdoor active spaces. Sleeping and living areas have been separated between floors to ensure privacy and so that they can be conditioned independently from each other. Bin and service courtyards have been separated from the main courtyards to maximise the amenity of outdoor living spaces.
Sustainability *Good design optimises the sustainability of the built environment, delivering positive environmental, social and economic outcomes.*	
Demonstrate how the building performance has been optimised using suitable orientation and layout of internal spaces.	Living spaces have been designed with openings spaced to ensure crossflow ventilation. Fans to bedrooms are also proposed, alongside solar PV systems, to minimise operational energy loads.
Amenity *Good design optimises internal and external amenity for occupants, visitors and neighbours, contributing to living and working environments that are comfortable and productive.*	
Demonstrate how the development optimises amenity for occupants, adjoining neighbours and onlookers	All townhouses are provided with sleeved, double parking, accessed from a central driveway. Ground floor living areas tie directly into the courtyards, which in turn benefit from views onto either the street or central mews driveway, which have been landscaped to provide a softer outlook. Openings are designed to ensure visual privacy of neighboring properties are maintained. Despite this, most bedrooms have been designed with clear, open views, overlooking courtyard tree canopies and green spaces.
Legibility *Good design results in buildings and places that are legible, with clear connections and memorable elements to help people find their way around.*	
Demonstrate how the design allow users and visitors to navigate through the development.	All entry's into the townhouses are visible from the central driveway and easily accessible from the street. Canopies ensure adequate cover and protection from the elements, and clearly define and identity the entry's for visitors. This is also aided by the change in floor material finishes.
Safety *Good design optimises safety and security, minimising the risk of personal harm and supporting safe behaviour and use.*	
Demonstrate how the layout of buildings on site provides safe and high level of amenity for residents.	Consideration is also given to pedestrian safety, with the site amalgamated to ensure a single, central crossover, as opposed to two. This circulation spine allows vehicle and pedestrian access to the townhouses. Street facing townhouses have been designed with a mix of solid and permeable materials to balance street surveillance and privacy from pedestrians and on-street parking. All courtyards and gardens to the remaining townhouses have been designed to internally face the central driveway, ensuring passive surveillance. This is further increased by the design of large openings to the upper floor bedrooms overlooking the driveways. Entries to the townhouses are visually open not concealed from view.

Description	Applicant comment
Community *Good design responds to local community needs as well as the wider social context, providing buildings and spaces that support a diverse range of people and facilitate social interaction.*	
Demonstrate how the development contributes to a sense of community, encouraging social engagement and enabling stronger communities.	The design benefits from a contemporary material palette with large expanses of glazing, combined with street level elements such as fencing, landscaping and planters. The layering of these forms and materials creates a visually engaging façade that ties into the existing streetscape. Orientating outdoor living areas externally towards the driveway and street allows for outside entertainment and socialising, whereby interaction with neighbouring residents are encouraged.
Aesthetics *Good design is the product of a skilled, judicious design process that results in attractive and inviting buildings and places that engage the senses.*	
Demonstrate how the surrounding context and character has been incorporated into the design of the development.	Our proposal is a two-storey development that is in keeping with predominantly single and double storey dwellings found along the immediate context of the site. Clean horizontal and vertical lines have been incorporated into the design, with mix of rendered walls and large glass openings. Red brick, with a raw and rough finish, are used as feature elements that tie into the predominant material palette of established homes along the street. In keeping with the some of the established homes along the street, portions of the gardens fronting Oxford Street are enclosed with fences.

Please complete all sections of this application and send to **mail@vincent.wa.gov.au** along with all relevant attachments. Alternatively, you can submit your application in person at our **Administration Centre (244 Vincent Street, Leederville)** or post to **PO Box 82, Leederville, 6902**.