MILFORD PLANNING

MP ref: M2059
DA ref: MCU23/0128
QA: lp.ms.ap

15 March 2024

Assessment Manager
Townsville City Council
PO Box 1268
TOWNSVILLE QLD 4810
Via: *TOLS*

Attention: Jake Kidner – Planning and Development

Dear Jake,

Re: Response to Information Request
Development Application seeking a Development Permit for Material Change of Use – Place of Worship (Extension to Church) on land described as Lot 29 on SP181745 and located at 13 Mount Kulburn Drive, Jensen

On behalf of the Applicant, Milford Planning refer to the abovementioned development application and to correspondence dated **12 January 2024**, being the formal Information Request issued by Townsville City Council (Council) (refer **Attachment 1**).

In response to Council's Information Request, and in accordance with Section 13.2 of the Development Assessment Rules, we hereby provide a response to all of the information requested as detailed in **Table 1** below.

Table 1 – Response to Information Request

Item	Response
Item 1 Compatibility with Scale and Amenity of Area	This item requested further justification for the proposed scale of the operation and its compatibility with the locality, in addition to the information provided in the development applications to date. As previously detailed, the area of influence that Beaches Church services includes suburbs such as Jensen, Mount Low, Bushland Beach, Deeragun, Burdell, and Bohle Plains, all of which continue to experience residential growth as land supply continues to become available. The abovementioned

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Townsville City Q 4810
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Table 1 – Response to Information Request	
Item	**Response**
	suburbs ongoing growth has resulted in growth in demand which is to be met by the proposed development. A congregation analysis is provided below to demonstrate the need for the proposed scale of operation in this location to meet the day to day needs of the local community. Beaches Church have provided congregational data that is as follows: ▪ 138 regular adult attendees and 40 children; ▪ Sunday Service attendance varies between 80-120 total attendees (this is a 100 % growth rate over the last two years); and ▪ congregation numbers are primarily made up of families and include a range of nationalities. The closest Australian Christian Church from Beaches Church is Calvary, located in Mount Louisa, whereby the three service times can generate between 1,500 – 2,000 patrons. Therefore, demand for the proposed development is demonstrated in the subject locality. The scale of the subject site allows for appropriate separation from neighbouring uses, as well as the opportunity for future growth (beyond this development application) as growth in the area of influence continues. Given the above, the scale of the proposed development on the subject site is consistent with both meeting the demand generated by the local congregation and supporting the day-to-day needs of the local community.
Item 2 Bushfire Management Plan	This item requested the provision of a Bushfire Management Plan to address the bushfire hazard identified on the site by its overlay mapping. In response to this item, it is confirmed that the proposed development has obtained a Relevant Purpose Determination under the *Vegetation Management Act 1999* to clear vegetation and an appropriate buffer around the proposed infrastructure and site access. The clearing of vegetation to this effect will facilitate the protection of people and property from bushfire hazard. In addition, engineering work associated with the proposed development has determined a strategy to ensure sufficient reticulated water supply will be provided on site for fire fighting purposes. The development is therefore capable of maintaining the safety of people and property in the context of the bushfire hazard on site, which will be largely removed with the relevant clearing work. It is suggested that Council condition the requirement for a Bushfire Management Plan if deemed necessary for the nature of the development.
Item 3 Set-down and Pick-up Facilities	This item requested further detail of the proposed set-down and pick-up facilities are provided to ensure suitable accessibility. In response to this item, Counterpoint Architecture have included detail of the line marking/ traffic arrangement proposed at the renovated building entrance in the amended set of plans provided at **Attachment 2**.
Item 4 Refuse Collection Area	This item requested further detail of the proposed servicing and refuse areas associated with the development. In response to this item, Counterpoint Architecture have included detail the proposed refuse storage area in the amended set of plans provided at

Table 1 – Response to Information Request	
Item	**Response**
	Attachment 2. The refuse storage area is proposed adjacent the car parking area and will be in an appropriately screened enclosure to ensure the amenity of the site is maintained.
Item 5 Amended Plans for Masterplan	This item requested amended plans clearly showing the staging of the development. We understand there was uncertainty regarding the proposed staging arrangement, including the extent of works in Stage 1 and Stage 2, as well as the future development on site. In response to this item, Counterpoint Architecture have simplified the staging arrangement in the amended set of plans, particularly drawing A-110 – Staging Diagrams – Revision C provided at **Attachment 2**. It has also been clarified that the remainder of the subject site is allocated for future development and is not subject to this development application.
Item 6 Water Main Pressure Test	This item requested that a water pressure test is performed to confirm the supply main will have appropriate pressure to service the proposed development. In response to this item, reference is made to the updated Engineering Service Report (Revision C) prepared by Langtree Consulting Engineers (refer **Attachment 3**). This report includes an assessment of the existing water network which has analysed the network parameters and identified upgrade options to achieve appropriate water pressure for the proposed development. The two upgrade options identified will ensure development has appropriate water pressure for the proposed use, with a second option provided with capacity beyond the requirements of this proposal to facilitate further development on the site in the future.
Item 7 Sewer Demand	This item requested a plan that clearly identifies the ultimate development requiring connection to the proposed sewer arrangement. In response to this item, the updated staging plan provided in response to Item 5 clarifies the extent of development subject to this development application. The Engineering Service Report (Revision C) prepared by Langtree Consulting Engineers (refer **Attachment 3**) includes a proposed sewer alignment to service the demand generated by the proposed development. The alignment of the proposed sewer has been designed in a manner that is likely to be compatible with future development on the remainder of the subject site, with the nature and detail of future development to reflect future demand. It is confirmed that the future development area does not form part of this development application.
Item 8 Soil Erosion and Sediment Control	This item requested that a soil erosion and sediment control plan is prepared for the proposed works. In response to this item, given the development application is seeking approval for a Material Change of Use and not Operational Work, soil erosion and sediment control measures will be relevant at the time detail of any future works is determined and the relevant approvals are obtained. As such, the detail provided in future works approvals will ensure any future works on the site appropriately deploy soil erosion and sediment control measures.

Table 1 – Response to Information Request	
Item	**Response**
Item 9 Traffic Impact Assessment	This item requested clarification regarding the parameters of the Traffic Impact Assessment prepared by Langtree Consulting Engineers. In particular, clarification was requested as to whether the Traffic Impact Assessment was prepared for the church expansion subject to this development application, or the proposed church expansion and future development on the land. In response to this item, it is confirmed that the Traffic Impact Assessment has been prepared for the proposed church expansion as per the data included in the reporting. The Traffic Impact Assessment does not include traffic associated with future development given the particulars of further development are yet to be determined and will be subject to future development approval.
Item 10 Dust Management Plan	This item requested that a dust management plan is prepared for the proposed works. In response to this item, as per the response to Item 8 above, a dust management plan will be relevant at the time detail of any future works is determined and the relevant approvals are obtained. As such, the detail provided in future works approvals will ensure any future works incorporate appropriate dust management measures.

Proceeding

We trust the above and attached information is sufficient to allow Council to assess the development application. If Council is of the view that the response does not appropriately address the Information Request, we request the opportunity to meet to discuss further.

We confirm the Applicant will now proceed with preparation for the necessary public notification actions, and will issue relevant correspondence to Council in due course.

If you have any questions regarding this correspondence, please contact the undersigned or Lachlan Pether on TEL: (07) 4724 0095.

Yours sincerely,

MILFORD PLANNING

Matteo Sandona

SENIOR TOWN PLANNER

Encl: Attachment 1 – Council Information Request
Attachment 2 – Amended development plans prepared by Counterpoint Architecture
Attachment 3 – Engineering Service Report (Revision C) prepared by Langtree Consulting Engineers

MILFORD PLANNING

Attachment 1

Date >> 12 January 2024

PO BOX 1268, Townsville
Queensland 4810

13 48 10

enquiries@townsville.qld.gov.au
townsville.qld.gov.au

ABN: 44 741 992 072

RECEIVED BY MILFORD PLANNING 12.01.24

Beaches Church
C/- Milford Planning
PO Box 5463
TOWNSVILLE CITY QLD 4810

Email >> info@milfordplanning.com.au

Dear Sir/Madam

Information Request
Planning Act 2016

As per our telephone conversation on *12 January 2024* please be advised that, upon review of the below mentioned development application, further information is required to undertake a comprehensive assessment. In accordance with section 12 of Development Assessment Rules under the *Planning Act 2016* the following information is requested.

Application Details

Application no:	MCU23/0128
Assessment no:	12109051
Proposal:	Place of Worship - Extension to Church
Street address:	13 Mount Kulburn Drive JENSEN QLD 4818
Real property description:	Lot 29 SP 181745
Applicant's reference:	M2059

The information requested is set out below >>

Request Item 1 – Demonstration of Compatibility with Scale and Amenity of Area

The applicant is requested to further demonstrate that the proposed development is compatible with the local character and amenity of the area, is limited in scale and supports the day-to-day needs of the local community.

Reason

To demonstrate compliance with Performance Outcomes PO7, PO9 and PO10 of the Rural residential zone code of the Townsville City Plan.

Request Item 2 – Bushfire Management Plan

The applicant is requested to provide a Bushfire Management Plan to address the identified medium to high bushfire risks mapped on the subject site.

Reason

To demonstrate compliance with Performance Outcome PO1 and PO2 of the Bushfire hazard overlay code of the Townsville City Plan and Element 3.5.5.1 (1) of the Strategic Framework.

Request Item 3 – Set-down and Pick-up Facilities

The applicant is requested to provide amended plans detailing line marked set-down and pick-up facilities for the development.

Reason

To demonstrate compliance with Performance Outcome PO19 of the Transport impact, access and parking code of the Townsville City Plan.

Advice

The applicant is advised that Council is of the position that this development is of a nature that would require set-down and pick-up facilities and such facilities would provide a greater accessibility for the proposed increase in congregation numbers.

Request Item 4 – Refuse Collection Area

The applicant is requested to provide amended plans detailing on-site loading, unloading and refuse collection areas for the development.

Reason

To demonstrate compliance with Performance Outcomes PO26 and PO27 of the Transport impact, access and parking code of the Townsville City Plan.

Advice

The applicant is advised that the subject site is within the serviced area for weekly refuse collection.

Request Item 5 – Amended Plans for Masterplan

The applicant is requested to provide amended plans clearly showing each stage of the development including proposed amenities as well as the master plan including all stages associated with this application.

Reason

A clear scope of works is required to enable a comprehensive assessment.

Advice

The Site Plan – Stage 1 to 4 is missing Stage 3 and does not include the proposed works and the Site Plan – Master Plan does not show the stages or proposed works.

Request Item 6 – Water Main Pressure Test

The applicant is requested to perform a pressure test at the supply main to demonstrate the development will have the appropriate pressure for its proposed and ultimate use.

Reason

To demonstrate compliance with Performance Outcome PO6 and PO11 of the Works code of the Townsville City Plan.

Request Item 7 – Sewer Demand

The applicant is requested to provide a plan that clearly identifies the ultimate development that will require sewer connection to the proposed 150 diameter sewer line.

Reason

To demonstrate compliance with Performance Outcome PO7 and PO12 of the Works code of the Townsville City Plan.

Advice

The applicant is advised that the Master plan will enable Council to confirm the loading expected for the proposed development aligns with the Engineering Services Report.

Request Item 8 - Soil Erosion and Sediment Control

The applicant is requested to provide a plan that identifies Soil Erosion and Sediment control measures for the proposed works, as part of this application an Erosion Hazard Assessment (EHA) must be submitted to determine the risk associated with the proposed earthworks.

Reason

To demonstrate compliance with Performance Outcome PO28 of the Works code of the Townsville City Plan.

Advice

The applicant is advised that Council prefers the SESC risk assessment to be known prior to OPW stage. While performing an ERH, a soil loss calculation can determine and therefore the construction period may be limited, removing the requirement for Type 1 SESC controls.

Council's expectation is that the applicant will ensure that SESC controls are in place and maintained in accordance with IECA best Practice.

Request Item 9 - Traffic Impact Assessment

The applicant is requested to confirm the submitted Traffic Impact Assessment (TIA) is modelled on the ultimate development with associated amenities.

Reason

To demonstrate compliance with Performance Outcome PO1, PO2 and PO3 of the Transport impact, access and parking code of the Townsville City Plan.

Advice

The applicant is advised that the submitted TIA states the development is based on increasing the church capacity to 300 people. The master plan discusses other amenities planned for the ultimate development which would infer an increase in vehicle trips. As such, Council requests confirmation to eliminate any confusion.

Request Item 10 - Dust Management Plan

The applicant is requested to provide a dust management plan for the development.

Reason

To demonstrate compliance with Performance Outcome PO34, PO35 and PO39 of the Works code of the Townsville City Plan.

End of Information Request >>

Further information

Advice Item 1 - Firefighting

The applicant is requested to provide balance tanks on site for the purpose of firefighting.

Reason

Council does not permit direct draw from Council water mains for firefighting purposes.

Advice Item 2 - Landscape Concept Plan

The applicant is requested to provide a more detailed landscape concept plan that identifies any existing trees to be retained, new shade trees to be planted (particularly in the car park) and an indication of the proposed species around the extension and car park.

Reason

The submission of a more detailed landscape concept will avoid a future operational works application for landscape.

Under the provisions of the Development Assessment Rules under the *Planning Act 2016*, you have three options available in response to this Information Request. You may give the assessment manager (in this instance Council):

(a) all of the information requested; **or**
(b) part of the information requested; **or**
(c) a notice that none of the information will be provided.

For any response given in accordance with items (b) and (c) above, you may also advise Council that it must proceed with its assessment of the development application.

Please be aware that under the Development Assessment Rules under the *Planning Act 2016*, the applicant is to respond to any Information Request within **3 months** of the request. If you do not respond to the Information Request within this time period, or, within a further period agreed between the applicant and Council, it will be taken that you have decided not to provide a response. In the event of no response being received, Council will continue with the assessment of the application without the information requested.

Council prefers that all of the information requested be submitted as one package. If any additional matters arise as a result of the information submitted, or, as a result of public notification (where applicable), you will be advised accordingly.

Should any referral agency make an information request, you are reminded of your obligation to provide council with a copy of the information response provided to that referral agency.

You may wish to follow the progress of this application using PD Online on Council's website www.townsville.qld.gov.au

If you have any further queries in relation to the above, please do not hesitate to contact Jake Kidner on telephone 07 4417 5240, or email developmentassessment@townsville.qld.gov.au.

Yours faithfully

For Assessment Manager
Planning and Development

MILFORD PLANNING

Attachment 2

COUNTERPOINT

BEACHES CHURCH - ALTERATIONS & ADDITIONS

13 MT KULBURN DRIVE
JENSEN, QLD

A-000	COVER PAGE	B
A-001	LOCATION PLAN	C
A-002	CONTEXT PLAN	C
A-011	SITE PLAN - PROPOSED	D
A-101	FLOOR PLAN - PROPOSED	B
A-110	STAGING DIAGRAMS	C
A-200	ELEVATIONS	C
A-201	ELEVATIONS	C
A-400	CONCEPT IMAGERY	B
A-401	CONCEPT IMAGERY	B
A-402	CONCEPT IMAGERY	B
A-403	CONCEPT IMAGERY	C
A-404	CONCEPT IMAGERY	B
A-405	CONCEPT IMAGERY	B
A-406	CONCEPT IMAGERY	B
A-407	CONCEPT IMAGERY	B

PLANNING INFORMATION

LOT NO:

PROPOSED AREA:

PARKING:

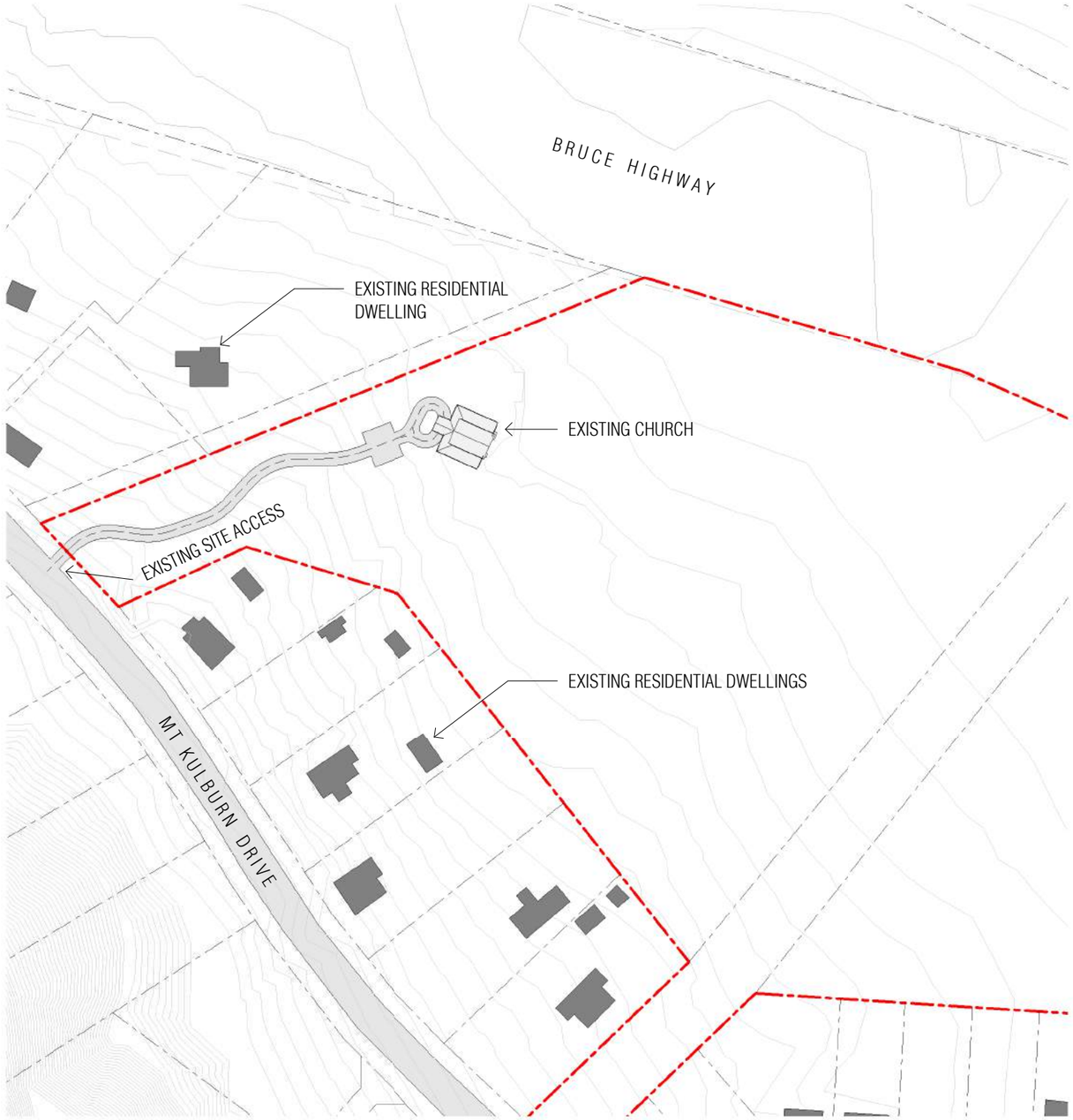
COUNTERPOINT ARCHITECTURE 487 FLINDERS STREET, TOWNSVILLE PO BOX 1604 Townsville QLD 4810 P: (07) 4724 0990 E: ADMIN@CPOINT.COM.AU

1 A-200 **LOCATION PLAN**
SCALE 1 : 2500

PROJECT BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	CLIENT DETAILS BEACHES CHURCH	N	TITLE LOCATION PLAN	PROJECT NO. 32728	DATE 02.06.23	DRAWING No. A-001	ISSUE C

COUNTERPOINT

28/02/2024 3:53:45 PM



2 **EXISTING CONTEXT PLAN**
A-200 SCALE 1 : 2500

1 **PROPOSED CONTEXT PLAN**
A-200 SCALE 1 : 2500

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

N

TITLE
CONTEXT PLAN

PROJECT NO.
32728

DATE
02.06.23

DRAWING No.
A-002

ISSUE
C

COUNTERPOINT

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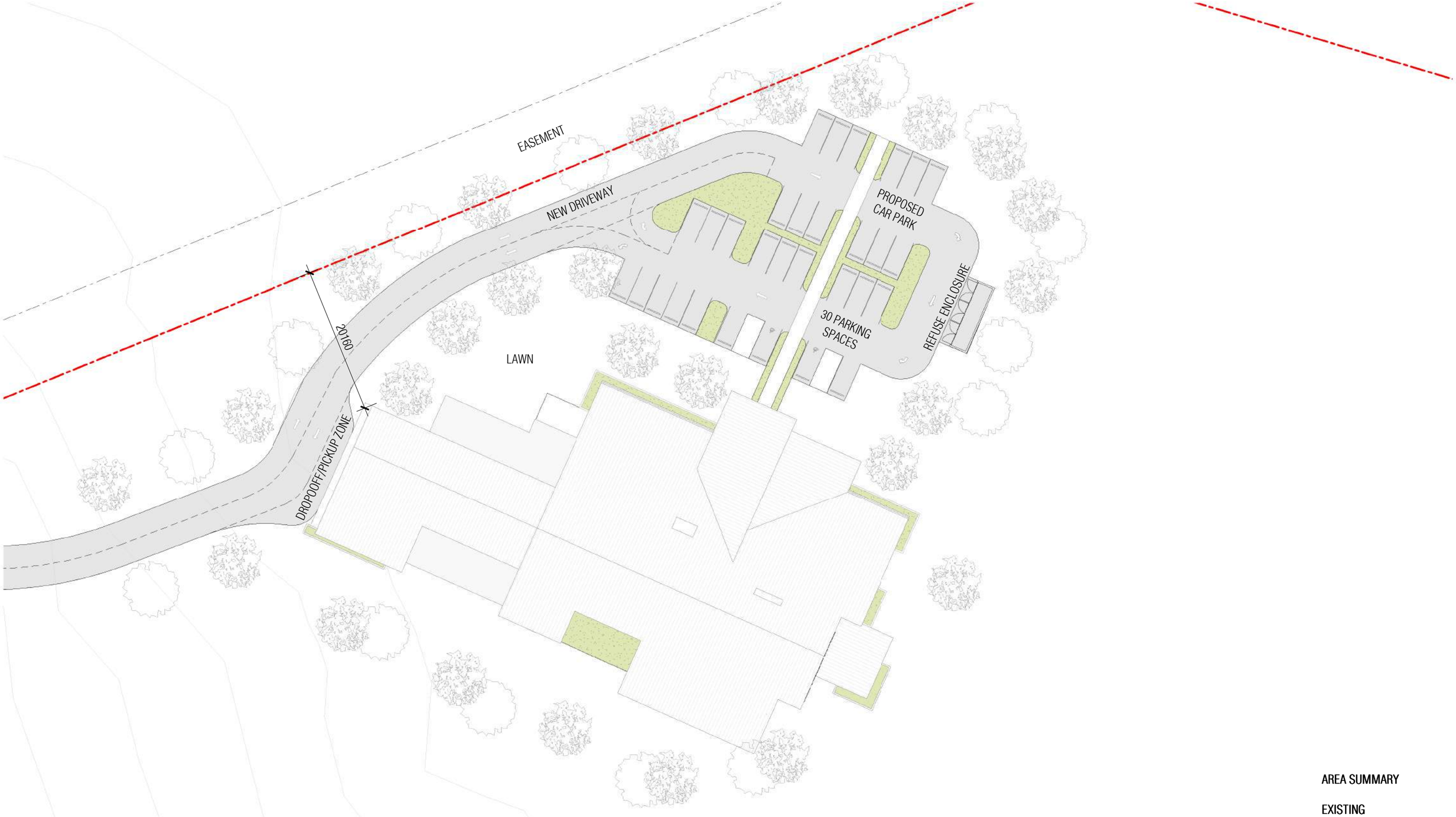

1 PROPOSED SITE PLAN 1-500
A-200 SCALE 1 : 500

PARKING SUMMARY

TOTAL: 30 CAR PARKS
2 NO. ACCESSIBLE SPACES

AREA SUMMARY

EXISTING
INTERNAL: 430m²
EXTERNAL: 35m²

PROPOSED
INTERNAL: 1680m²
EXTERNAL: 786m²

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

N

TITLE
SITE PLAN - PROPOSED

PROJECT NO.
32728

DATE
28.02.24

DRAWING No.
A-011

ISSUE
D

COUNTERPOINT

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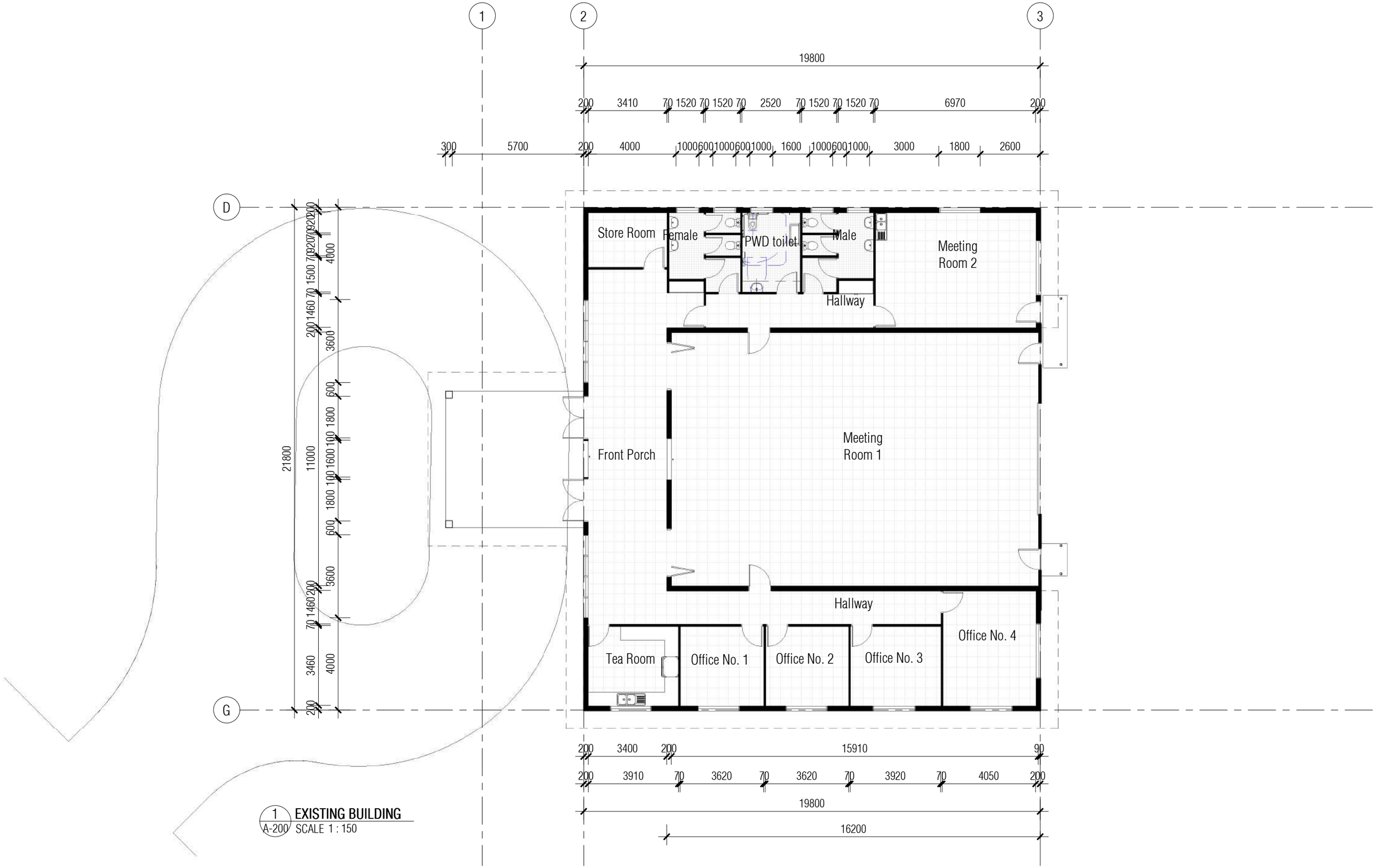
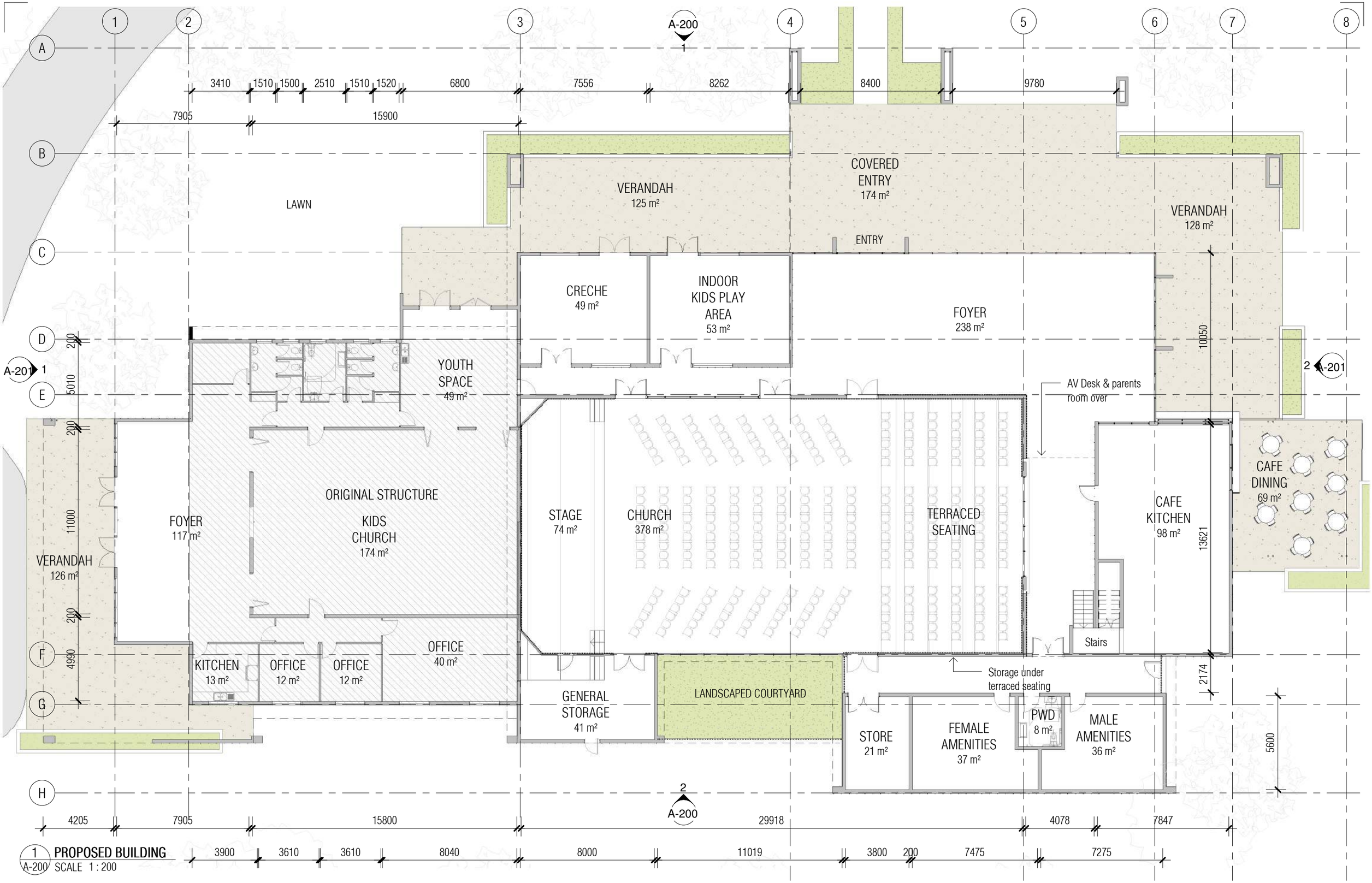


1 A-200 **EXISTING BUILDING**
SCALE 1 : 150

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	FLOOR PLAN - EXISTING	32728	17.04.23	A-100	A

COUNTERPOINT

28/02/2024 3:53:46 PM



1 A-200 **PROPOSED BUILDING**
SCALE 1 : 200

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	FLOOR PLAN - PROPOSED	32728	04.05.23	A-101	B

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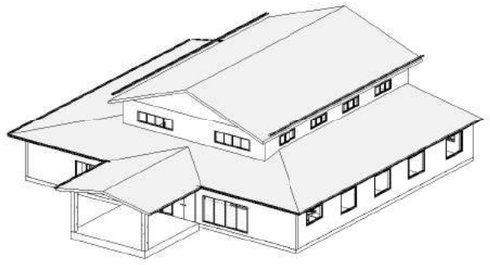
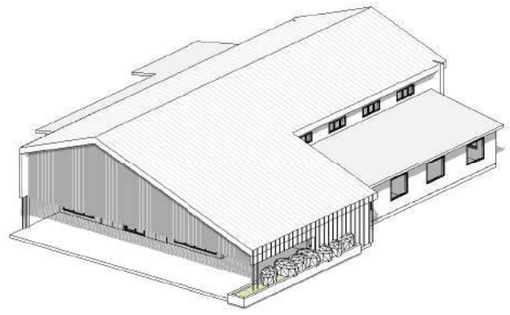
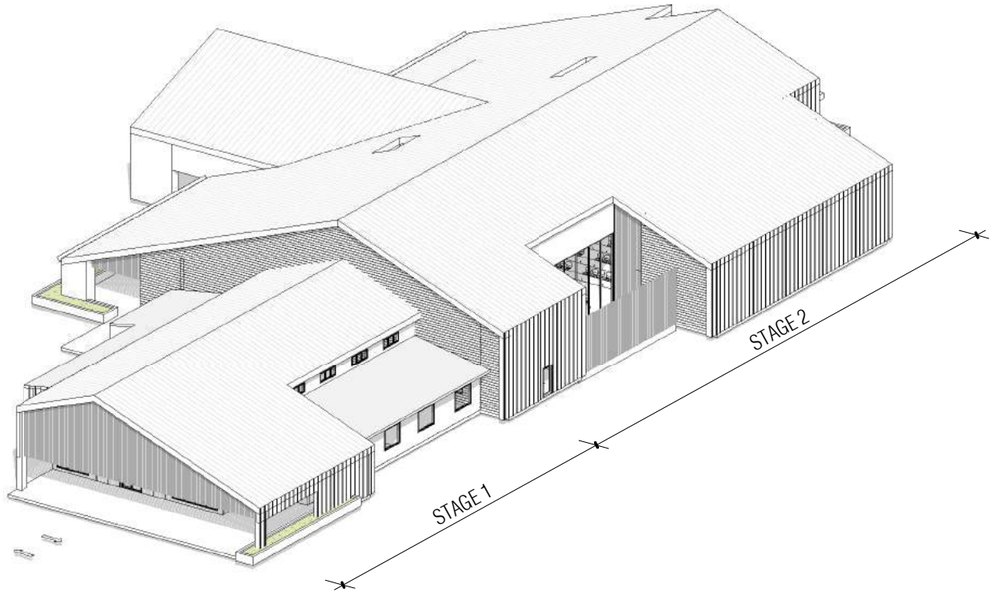


1 **EXISTING BUILDING**
SCALE



2 **PROPOSED BUILDING STAGE 1**
SCALE

ALTERATIONS AND ADDITIONS TO
EXISTING CHURCH BUILDING



3 **PROPOSED BUILDING STAGE 2**
SCALE

EXTENSION AND ADDITIONAL PARKING
TO CHURCH FACILITY

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
STAGING DIAGRAMS

PROJECT NO.
32728

DATE
28.02.24

DRAWING No.
A-110

ISSUE
C

COUNTERPOINT

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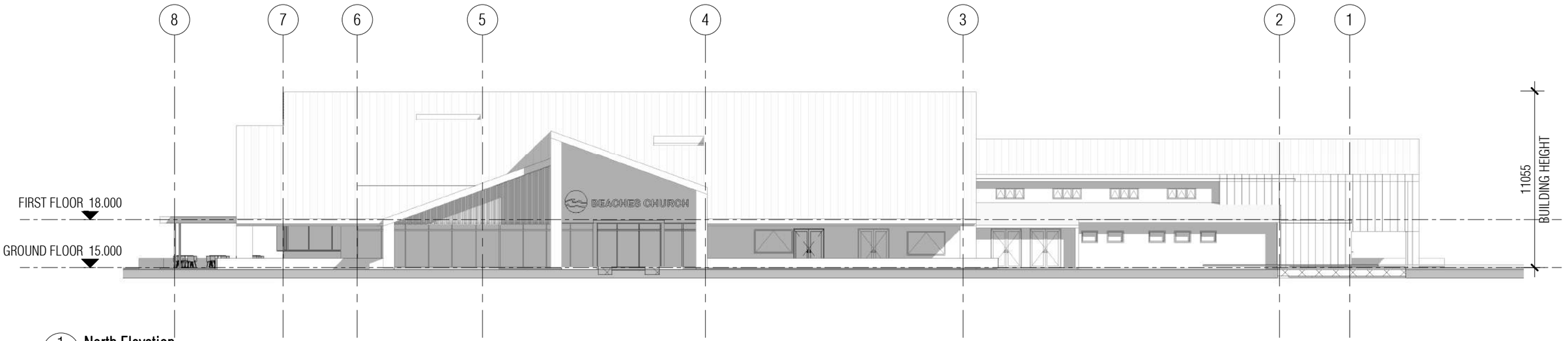
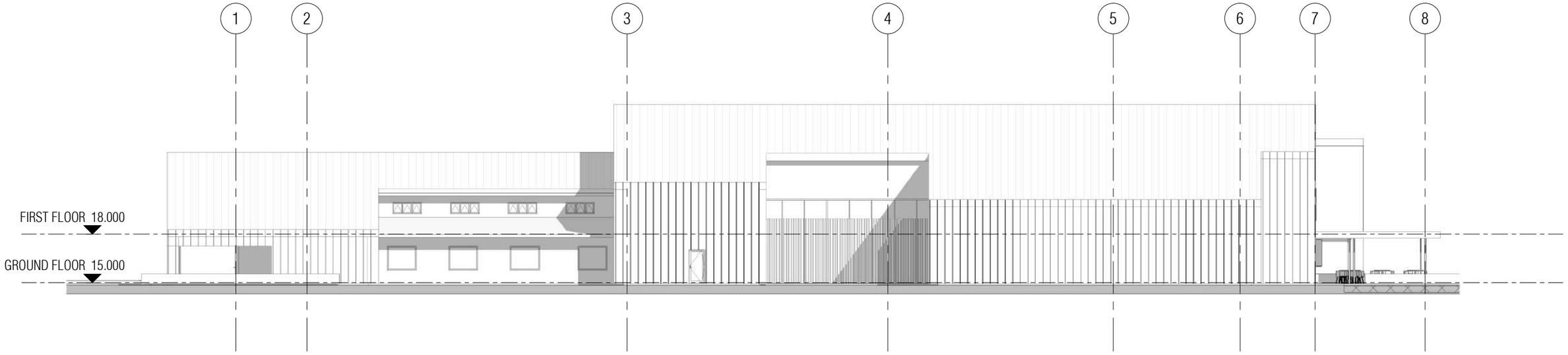


1 A-101 **North Elevation**
SCALE 1 : 250



2 A-101 **South Elevation**
SCALE 1 : 250

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	ELEVATIONS	32728	02.06.23	A-200	C

COUNTERPOINT

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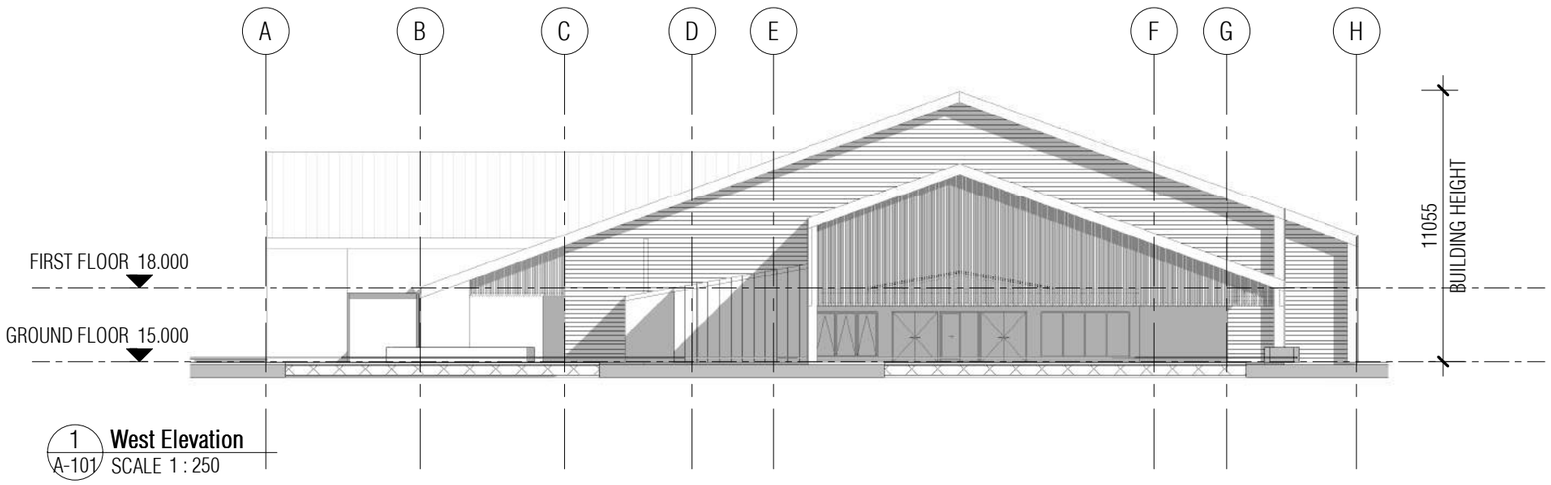
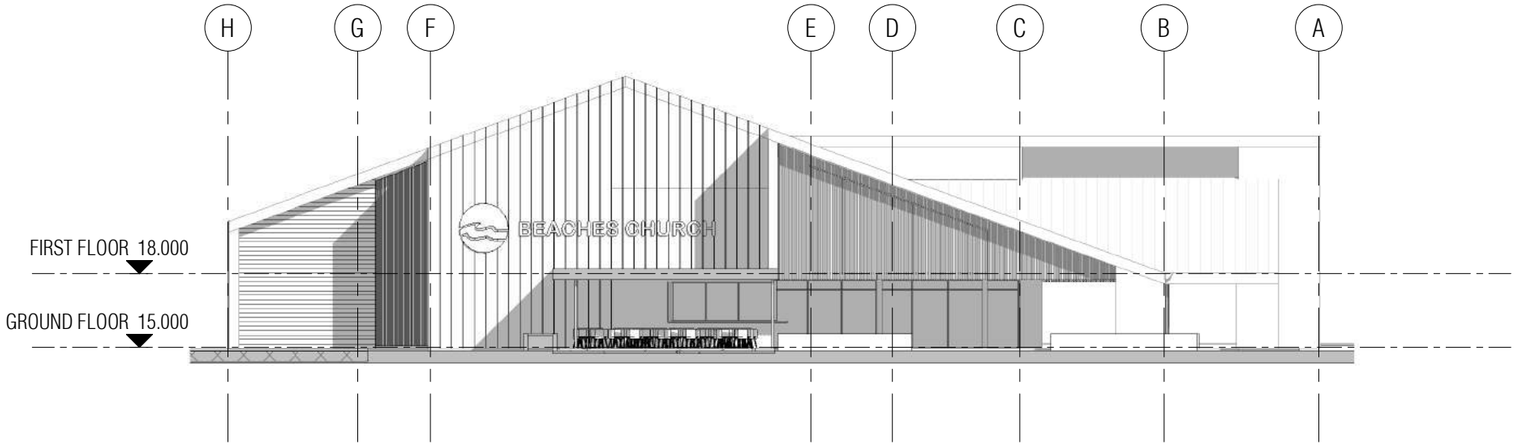


1 A-101 **West Elevation**
SCALE 1 : 250



2 A-101 **East Elevation**
SCALE 1 : 250

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	ELEVATIONS	32728	02.06.23	A-201	C

COUNTERPOINT

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PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-400

ISSUE
B

COUNTERPOINT

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PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	CONCEPT IMAGERY	32728	04.05.23	A-401	B

COUNTERPOINT

28/02/2024 3:53:55 PM

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-402

ISSUE
B

COUNTERPOINT

28/02/2024 3:53:55 PM

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	CONCEPT IMAGERY	32728	02.06.23	A-403	C

COUNTERPOINT

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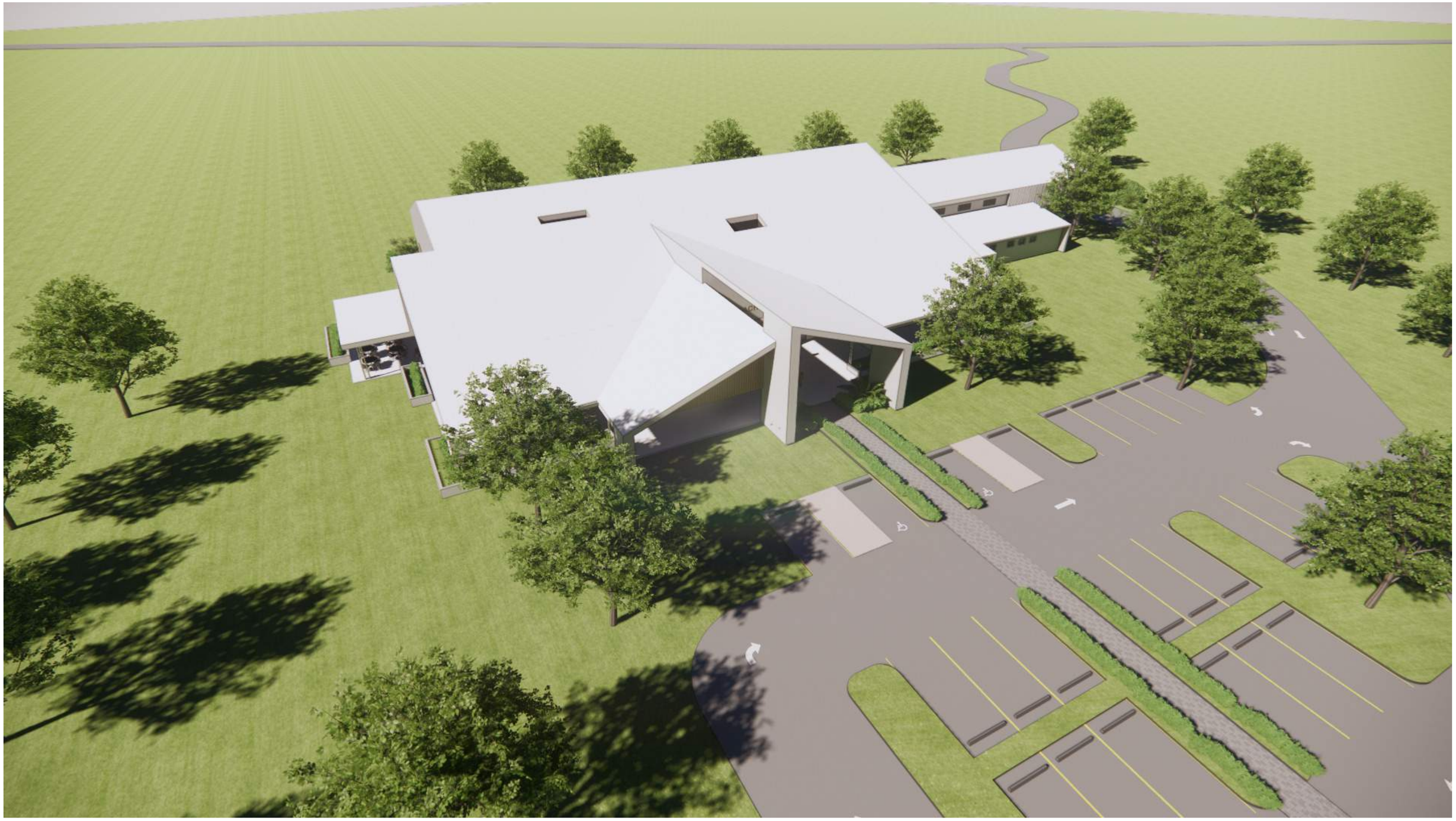

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-404

ISSUE
B

COUNTERPOINT

28/02/2024 3:53:55 PM

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-405

ISSUE
B

COUNTERPOINT

28/02/2024 3:53:55 PM

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	CONCEPT IMAGERY	32728	04.05.23	A-406	B

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-407

ISSUE
B

COUNTERPOINT

28/02/2024 3:53:56 PM

MILFORD PLANNING

Attachment 3

LANGTREE
Consulting Engineers

13 MT KULBURN DRIVE, JENSEN

ENGINEERING SERVICES REPORT

BEACHES CHURCH

LANGTREE CONSULTING

Project No.: 0954

Reference No.: R-AR0174

Date: 29/02/2024

Document Set ID: 23004657
Version: 1, Version Date: 15/03/2024

Controlled Copy No.: 1

Revisions: C

Revision Record:

Rev	Review Date	Description	Prepared	Checked	Approved
A	2/06/2023	Issued for Client Comment	Aidan Reinaudo	Geoffrey Smart	Brett Langtree
B	13/12/2023	Response to RFI	Aidan Reinaudo	Geoffrey Smart	Brett Langtree
C	29/02/2024	Response to SARA Advice	Aidan Reinaudo	Geoffrey Smart	Brett Langtree

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1.0 INTRODUCTION

Langtree Consulting has been engaged by Milford Planning on behalf of Beaches Church to undertake an engineering services report for the proposed extension of the existing Beaches Church building. The development is located at 13 Mt Kulburn Drive, Jensen on land described as Lot 29 on SP181745.

This report outlines the following processes undertaken to identify suitable engineering solutions for the proposed development:

- Assessment of the external civil infrastructure services and proposed connection points for the development (potable water main, sewer, stormwater, drainage infrastructure);
- Assessment of stormwater related overlays affected by the site including flood hazard overly, storm surge potential overly and coastal hazard overlay; and
- Assessment of stormwater quality and quantity impacts of the development.

2.0 EXISTING CONDITIONS

The proposed development is located to the north of Townsville within Jensen. The development is located at 13 Mt Kulburn Drive, Jensen on land described as Lot 29 on SP181745.

Hereon in, the above-described lands shall be referred to as the subject site.

The subject site has a total area of 94,960m^2 and is bound by Mt Kulburn Drive to the west and south, residential properties to the east and the Bruce Highway to the north. The lot currently consists of the existing church building on the northwest side of the lot and the remaining of the lot consists of bushland.

Refer to Figure 1 below in red for development site locality.

Figure 1. *Site Locality (Source: Queensland Globe)*

2.1 SITE ZONING AND FLOOD HAZARD OVERLAY

The existing site is currently zoned rural residential. Refer to **Figure 2** for the current site zoning.

As seen in **Figure 3**, the site is located in a medium flood hazard area.

Figure 2. *Site Zoning (Source: TCC Mapping)*

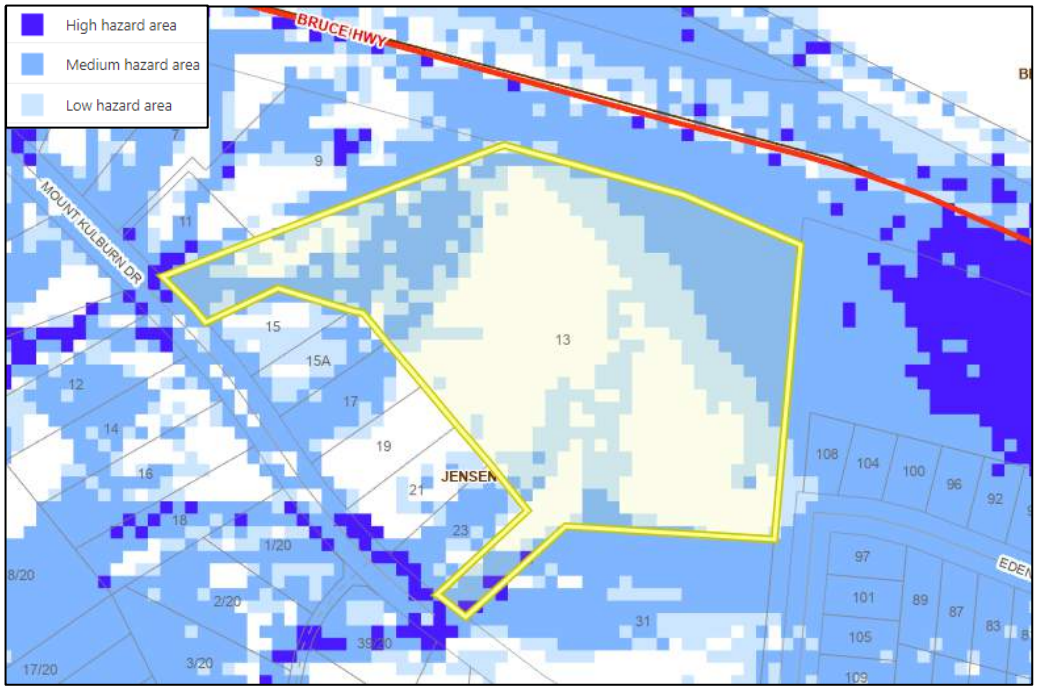

Figure 3. *Flood Hazard Overlay (Source: TCC Mapping)*

2.2 EXISTING INFRASTRUCTURE

The existing infrastructure services were gathered using TCC's mapping system. Refer to **Figure 4** for the existing services.

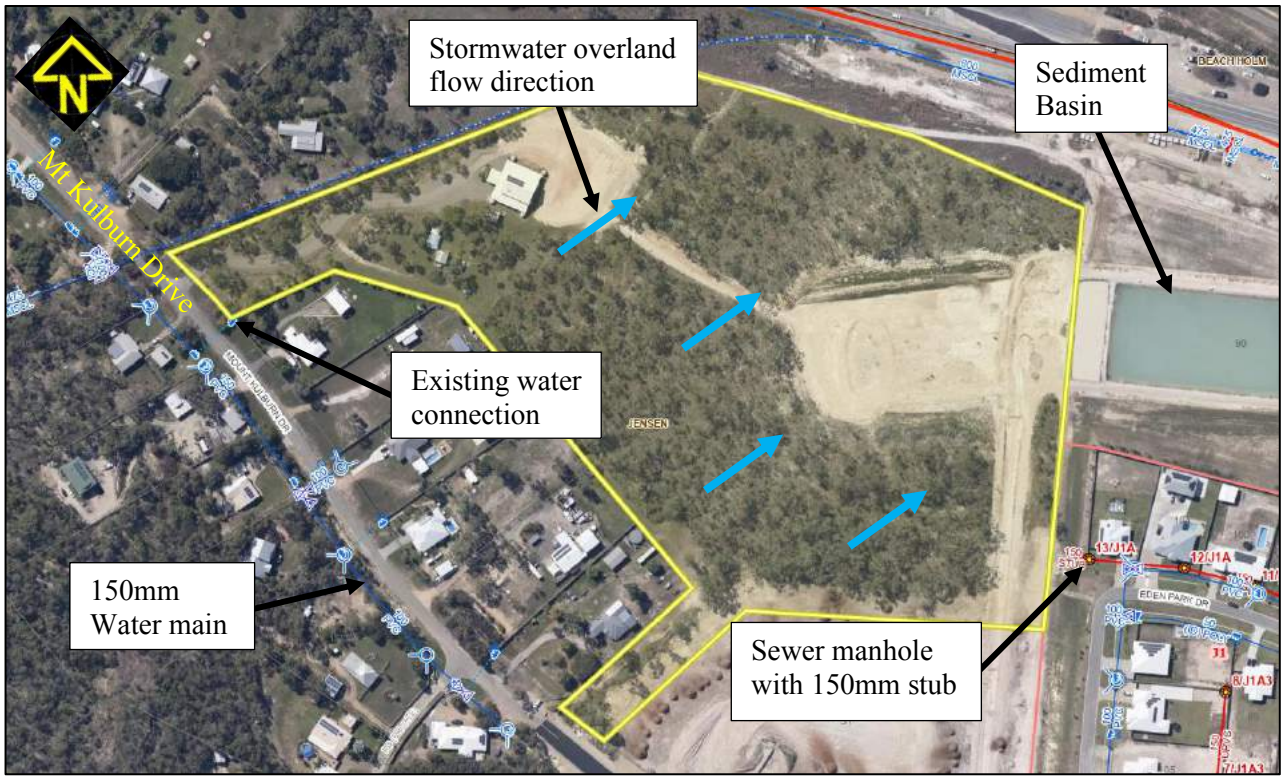

Figure 4. *Existing Infrastructure Services (Source: TCC Mapping)*

2.2.1 Existing Water

As shown in **Figure 4**, there is a 150mm PVC water main running along Mt Kulburn Drive on the opposite side of the subject site. The water main has fire hydrants located along the water main. The property connection is a dual connection with the neighbouring lot. The connection consists of a 32mm outside diameter (OD) road crossing with two (2) 25mm OD pipes going into the subject site and the neighbouring property.

2.2.2 Existing Sewer

The existing site currently uses an onsite sewerage system. A new residential estate (Eden Park Stage 4) has recently been constructed which has a sewerage manhole which is located on the eastern side of the subject site. The manhole has a 150mm uPVC stub which is capped just before it enters the subject site and has an invert level of 11.35m. It is proposed for the site to connect to the gravity sewerage system at the 150mm stub.

2.2.3 *Existing Stormwater*

The site currently has no stormwater infrastructure. The site falls to the northeast towards an existing sediment basin that was constructed during Eden Park Stage 4.

3.0 PROPOSED DEVELOPMENT

Beaches Church are seeking to extend the existing church to increase its capacity to 300 people. Refer to Figure 5 and Appendix A for the proposed layout plan.

The facility will be predominantly used on Sundays for Sunday Church.

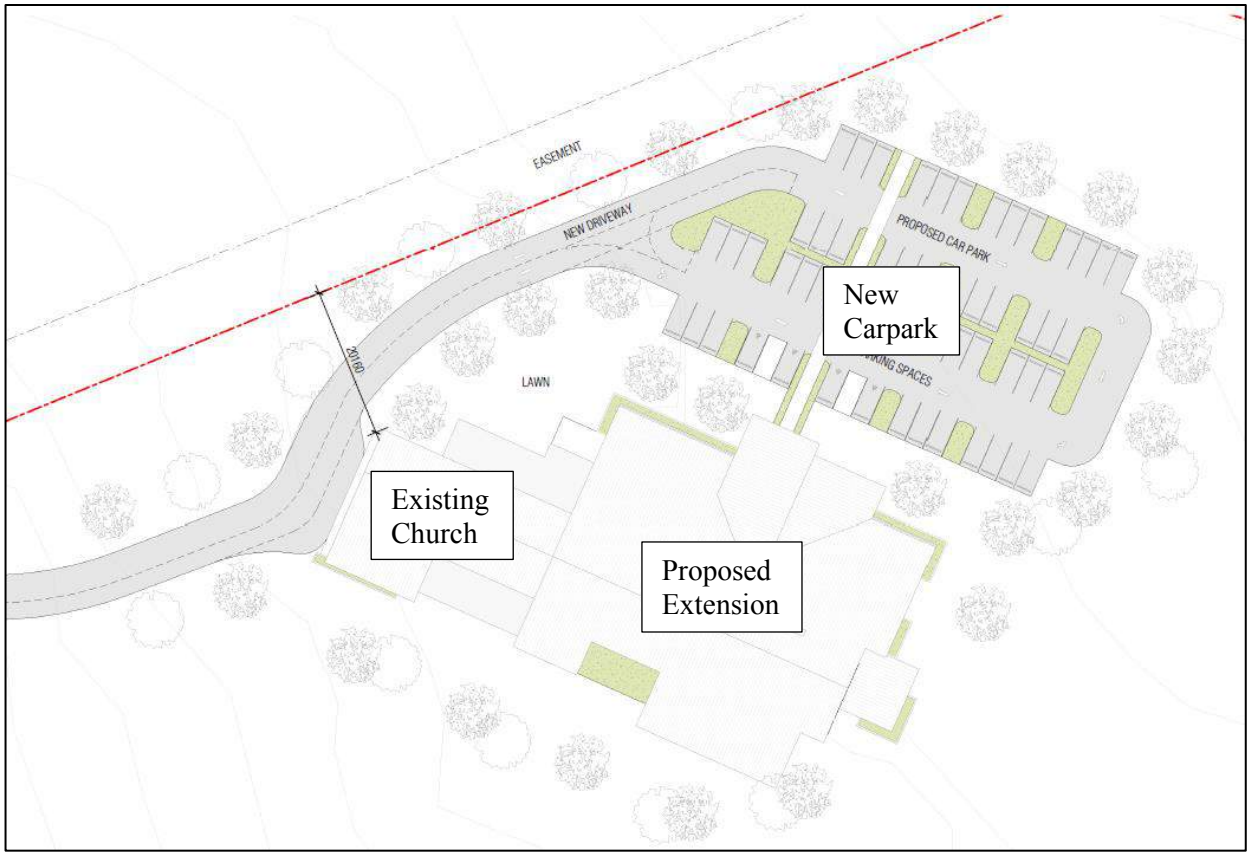

Figure 5. *Proposed Site Layout (Source: Counterpoint)*

The site will have a carpark to the northeast of the existing church which will utilise the existing access which are both proposed to be sealed. As future works are proposed the sewerage and water design will be based on the overall master plan. As seen in Figure 6, Stage 1 is outline in red and the remaining area of the site is for future works. The development is not anticipated to be subdivided in the future.

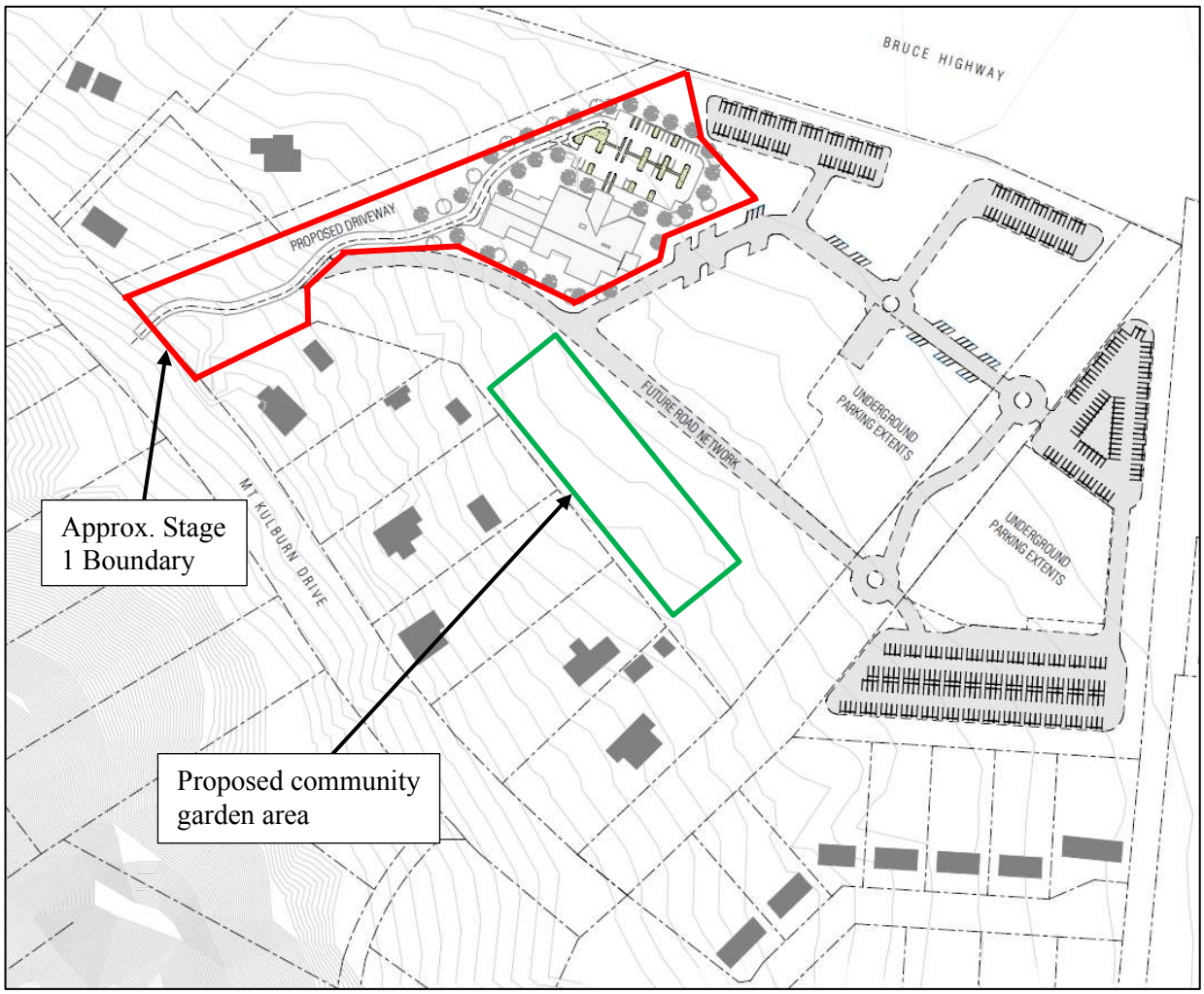

Figure 6: *Proposed Master Plan (Source: Counterpoint)*

3.1 PROPOSED WATER

Using the Queensland Government Planning Guidelines for Water Supply and Sewerage (2010) the average demand flows for the development were found. Refer to **Table 1** for the development generated L/day.

Table 1. *Peak Water Demand Summary*

Development	GFA (m^2)	Water Demand (L/day/100m^2 GFA)	L/day
Existing Church	525	300	1575
Proposed Extension	730	300	2190
		Total	3765

As seen in **Table 1**, the proposed extension will generate an additional water demand of about 2190 L/day. (Total estimated daily demand is 3765L/day.) The existing water connection is located approximately 380m from the water reservoir on top of the hill west of the site. The water reservoir is approximately 78.5m above the property connection point. The trunk main from the reservoir is a DN475mm pipe. The DN150 reticulation mains connect to the trunk main near Mt Kilburn Dr. It is expected that a pressure reducing valve is located on the DN150 to DN475 connection point so it is assumed that the residual head at the property connection is 40m (The hydraulic grade level of the water pressure being 61.5m.)

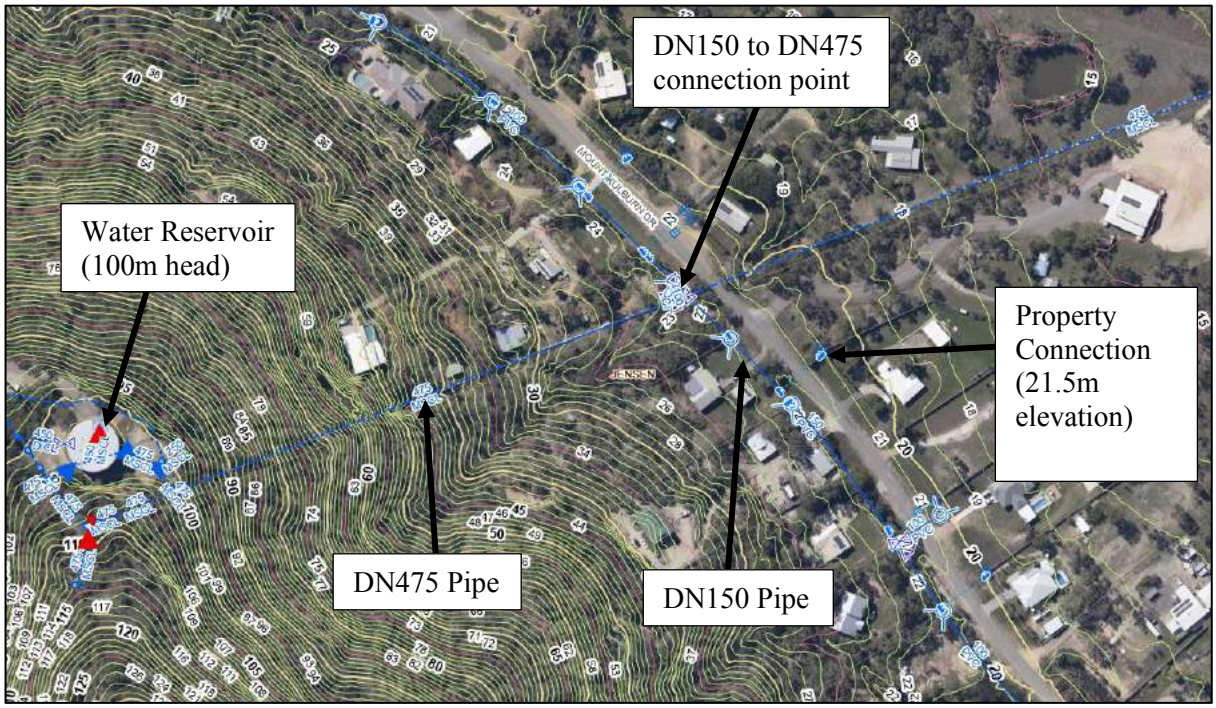

Figure 7: *Existing Water Network*

The site is currently serviced by an OD 25 pipe (20mm internal diameter) which should be upsized to a minimum 25mm internal diameter (DN32). This increase in sizing better suits the increased demand and allows for connection to a fire hose reel. A new DN32 service crossing line and meter would need to be provided for this upgraded service.

As the ultimate development proposal includes multiple detached buildings it is likely an internal 100mm main will be required to follow the internal road network with fire hydrants. Therefore, two options are proposed for the interim service connection:

- Option 1: Construct new OD 32 connection off the existing DN150 main and wait for future stages to construct DN100 main.
- Option 2: Construct new DN100 main off the existing DN150 and run across road. This 100mm main could be terminated at the access entry and the proposed interim 32mm service be connected off the 100mm main. Alternatively the 100mm main could be continued into the property and capped near the church. In this latter scenario, at the entrance to the site, the connection would require 100mm gate valves, either side of a 100mm check valve. A 25mm ID bypass meter would be provided to the check valve.

Option 1 is the least expensive option and is recommended in this instance if the timing of the future works is some years off.

Refer to Figure 8 for the water connection options.

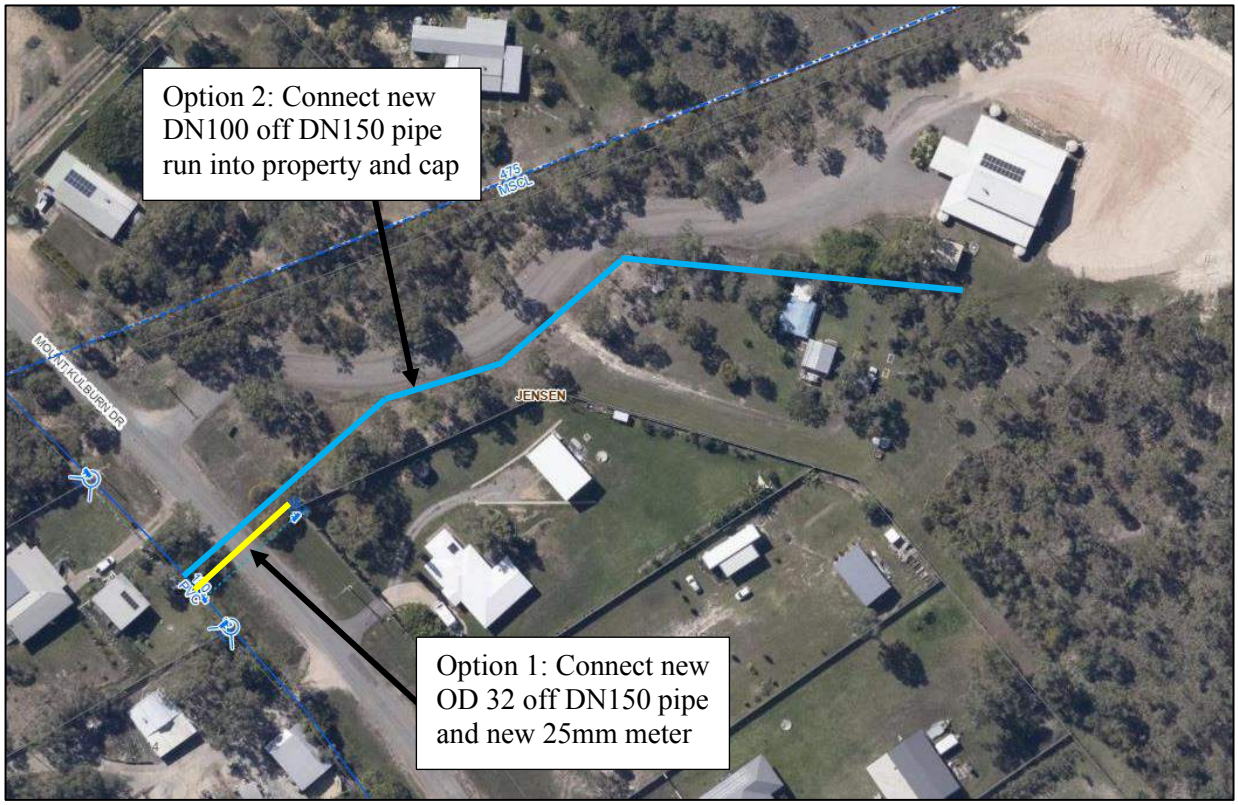

Figure 8: *Proposed Water Connection Options*

3.2 PROPOSED SEWER

The site is proposed to be connected to the existing manhole in the eastern corner of the lot. Using the Queensland Government Planning Guidelines for Water Supply and Sewerage (2010) the average demand flows for the development were found. Refer to Table 2 for the development generated L/day.

Table 2. *Average Sewerage Demand Summary*

Development	GFA (m^2)	Water Demand (L/day/100m^2 GFA)	L/day	L/s
Whole development	11,811	150	17,717	0.21

The sewerage system will have the following properties:

- DN150 PVC pipe;
- Start invert level = 13.88m (approx.)
- End invert level = 11.35m
- Length = 402m (approx.)
- MH 1 to MH 2 Grade = 1.0%, MH 2 to Existing MH Grade = 0.5%

A pipe of the above properties will have a capacity of 5 L/s. As seen above the development will have an average dry weather flow (ADWF) of 0.21 L/s. The peak dry weather flow (PDWF) is calculated by multiplying the ADWF by a factor 'd'. Using Figure C1 from Appendix C of Water Services Australia (WSA) Gravity Sewerage Code the factor 'd' was found to be 4.2. Therefore, the PDWF is equal to 4.2 x 0.21 = 0.88 L/s which is approximately 18% of the full pipe capacity.

Refer to Figure 9 for the proposed sewer alignment. The proposed sewer line follows the proposed future internal road network and should allow future adjoining buildings to be connected.

The sewer will be able to take the extension amenities and kitchen however the existing kitchen and amenities do not meet the minimum fall outlined in the plumbing code. This is to be confirmed during the detailed design phase.

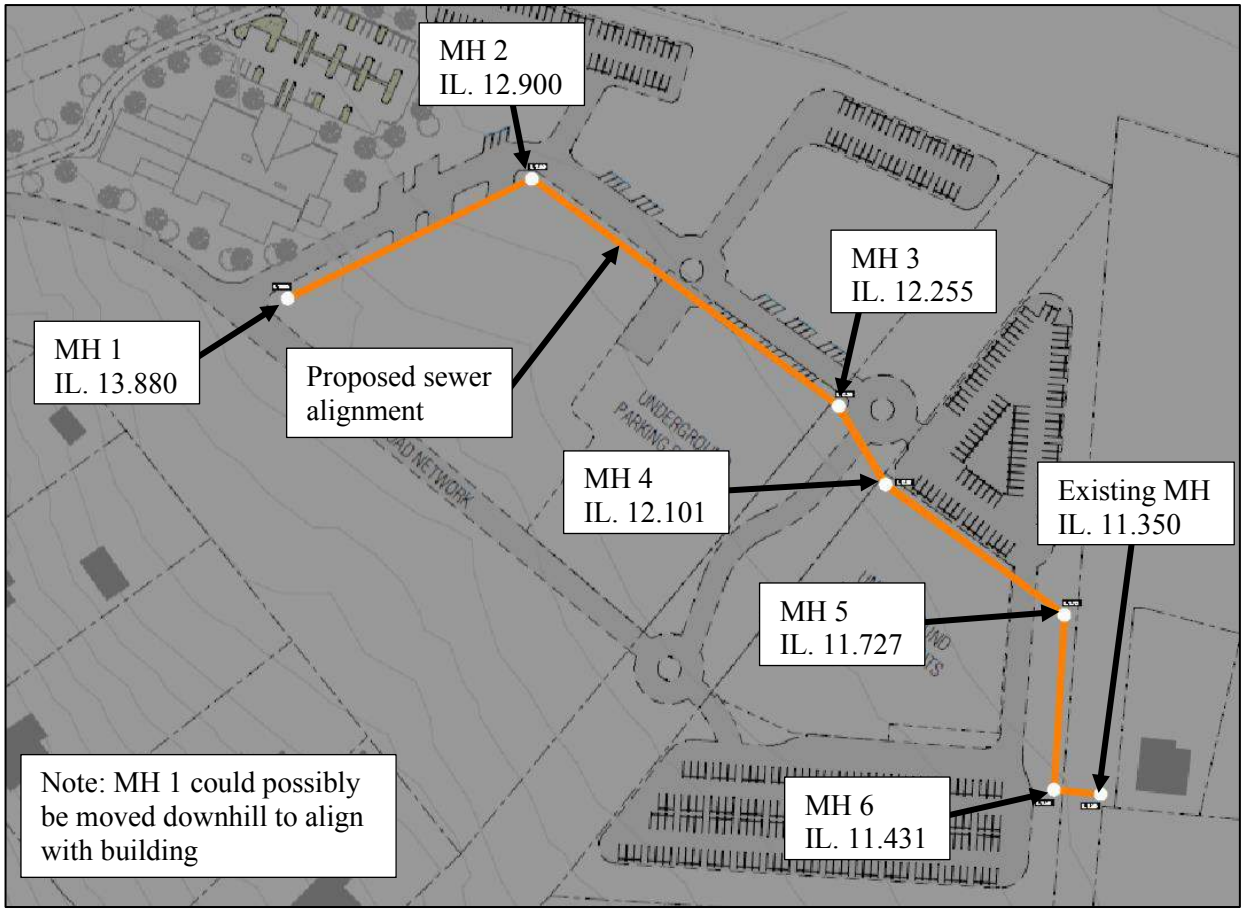

Figure 9: *Proposed Sewer Alignment with Approximate Invert Levels*

3.2.1 Capacity Check

As part of the RFI, Council has requested that the capacity of the downstream sewer reticulation connecting to the pump station be checked. The capacity of the pipe between MH 1/J1A and MH 0/J1 will be check. This pipe is a DN150 at 0.58% grade. The catchment area of the connection to the pump stations is shown in Figure 10.

Figure 10. *Pumpstation Connection Catchment*

The pipe capacity will be checked using the following parameters:

- Total house in catchment area = 159
- 3.5 EP/dwelling
- 230L/EP/day

The ADWF entering the pipe from the dwellings was calculated to be 1.48L/s. The new flow entering the pipe including the 0.21L/s from the development is 1.69L/s. The PWWF is calculated by multiplying 5 or C1 (larger of the two) by the ADWF. C1 is calculated using the following equation:

$$C1 = 15 \times EP^{-0.1587} = 15 \times 556.5^{-0.1587} = 5.5$$

The PWWF is equal to 5.5 x 1.69 = 9.3L/s.

A DN150 pipe at 0.58% grade has a capacity (Qf) of 11L/s. Using the pipes flowing partially full table, it was found that the pipe will flow at 71% capacity which is below the maximum pipe flow of 75% capacity. As such the sewerage pipe connection to the pump station has sufficient capacity to take the development sewerage flows.

4.0 STORMWATER MANAGEMENT

LIDAR contours of the subject site indicate that the existing topology falls north east towards the Bruce Highway. The site has three (3) catchment areas which are for Culvert 1, Culvert 2 and the sediment basin. Refer to **Figure 11** for the existing site contours.

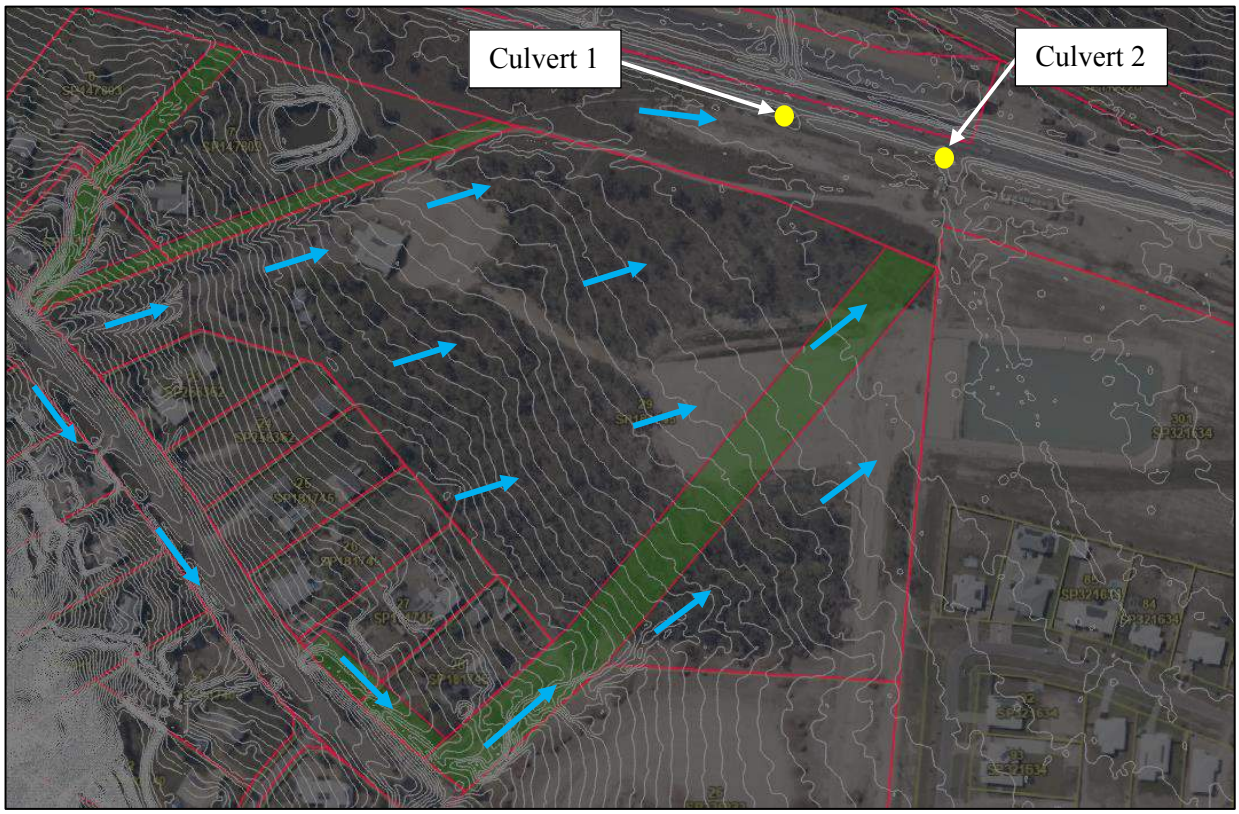

Figure 11. *Existing Site Contours*

4.1 HYDRAULIC ASSESSMENT

Hydraulic assessment of the site has been undertaken in accordance with the Queensland Urban Drainage Manual (QUDM) 2017. The rational method equations have been adopted:

$$Q_y = (C_y \,.\, {}^{t}I_y \,.\, A) / 360$$

Where:

Q_y = peak flow rate (m3/s) for average recurrence interval (ARI) of ''y' years

C_y = coefficient of discharge (dimensionless) for ARI of 'y' years

A = area of catchment (Hectares)

${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an ARI of 'y' years

t = the nominal design storm duration as defined by the time of concentration

4.1.1 *Pre-Development Stormwater*

The catchment areas (green) and the longest flow path (blue line) are shown in **Figure 12** below. Culvert 1 has a catchment area of 5.89ha, Culvert 2 has a catchment area of 5.54ha and Catchment 3 has a catchment area of 16.97ha

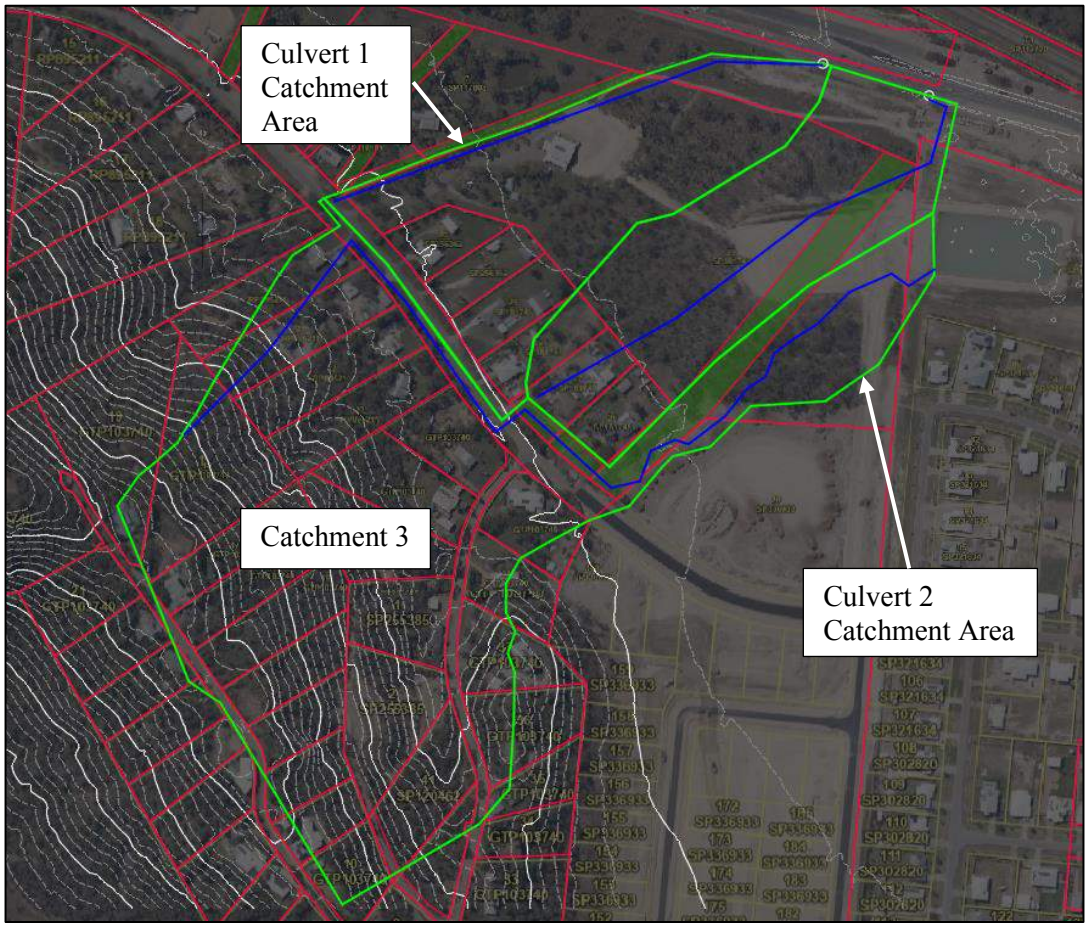

Figure 12: *Pre Development Catchment Area*

The pre-development catchments flow rates for a 1%, 2%, 5%, 10%, 20% and 50% AEP event are summarised in **Table 3** below.

Table 3. *Pre Development Flow Rates*

Catchment	AEP Event (m^3/s)					
	1% AEP	2% AEP	5% AEP	10% AEP	20% AEP	50% AEP
Culvert 1	2.74	2.34	1.81	1.48	1.24	0.85
Culvert 2	1.86	1.59	1.22	1.00	0.84	0.57
Catchment 3	5.82	4.98	3.84	3.15	2.62	1.79

Refer to **Appendix B** for the calculations.

4.1.2 *Post Development Stormwater*

Please note that as is only located within the Culvert 1 catchment. Therefore, the post development flow rates for Culvert 2 and Catchment 3 will remain unchanged due to the development.

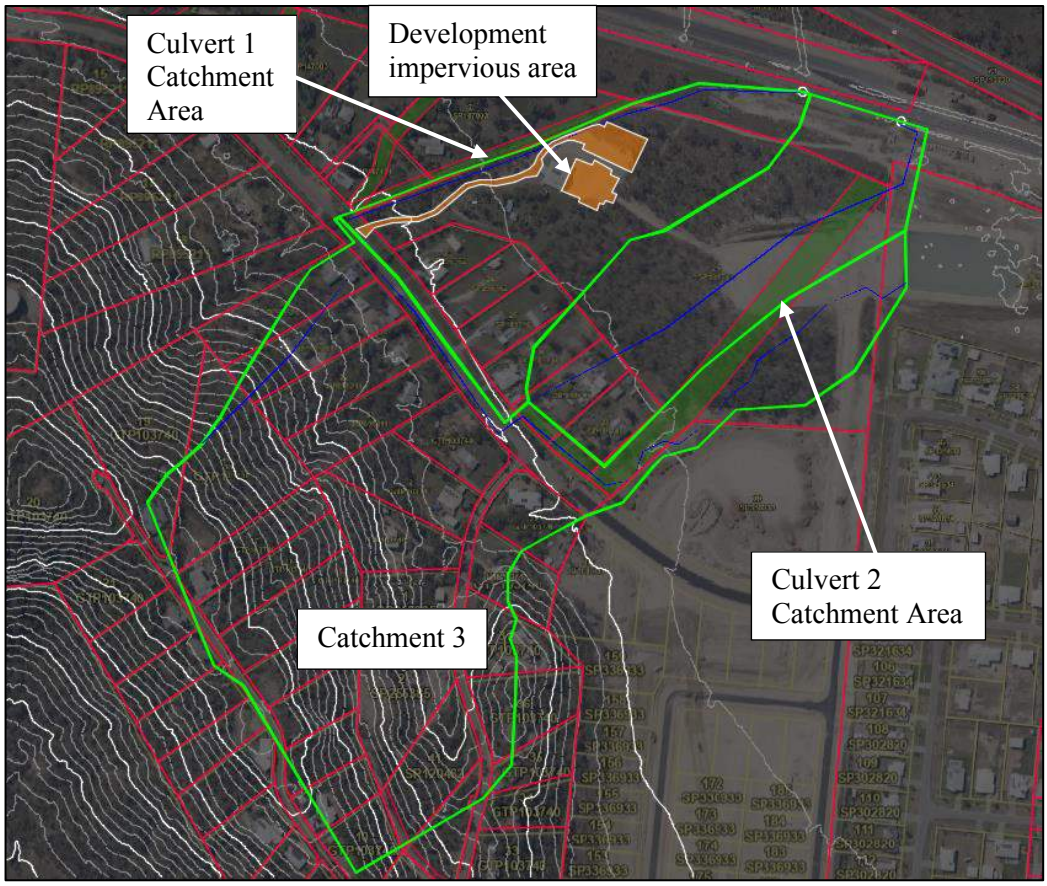

Figure 13: *Post Development Catchment Area*

The impervious area in the Culvert 1 catchment area has increased by 4,979m^2 due to the development. Refer to **Table 4** for the Culvert 1 post development flow rates.

Table 4. *Culvert 1 Post Development Flow Rates*

Catchment	AEP Event (m^3/s)					
	1% AEP	2% AEP	5% AEP	10% AEP	20% AEP	50% AEP
Culvert 1	2.80	2.40	1.85	1.52	1.27	0.87

Refer to **Appendix C** for the calculations.

4.1.3 *Stormwater Summary*

The development is not located within the Culvert 2 catchment area or the Catchment 3 area and therefore the flow rates for these catchments will remain unchanged due to the development. The flow rate in the Culvert 2 catchment has a maximum increase of 0.06m^3/s for a 1% and 2% AEP. This increase is insignificant and therefore the development will have an insignificant impact of the Culvert 1 catchment flow rate.

	AEP Event (m^3/s)					
	1% AEP	2% AEP	5% AEP	10% AEP	20% AEP	50% AEP
Pre	2.74	2.34	1.81	1.48	1.24	0.85
Post	2.80	2.40	1.85	1.52	1.27	0.87
Increase	0.06	0.06	0.04	0.04	0.03	0.02

5.0 STORMWATER QUALITY

From State Planning Policy (SPP), 2017, Assessment benchmarks - Water Quality and Table B, Post construction phase – Stormwater management design objectives, performance outcomes apply only to development applications for a "material change of use for an urban purpose that involves premises 2,500m2 or greater in size will result in an impervious area greater than 25% of the net developable area".

The subject site has an increase in impervious area of 5% and thus, no does not trigger assessment against SPP Water Quality Objectives.

6.0 SUMMARY

This report has assessed the suitability of the proposed development and impacts associated with respect to water reticulation, sewerage reticulation and stormwater.

The report has found the following:

<u>Water</u>

- The building extension will generate an additional 2,190 L/day demand;
- The site is located in close proximity to the water reservoir so water pressure is expected to be adequate.

- It is envisaged that ultimately a 100mm service line will be need for the long term development of the site. The timing of the future development of the site is unclear and 32mm water service is adequate for the church and extensions associated with this application.
- Two options are proposed to service the building extension and future development:
    - Option 1: Construct new OD 32 connection off the existing DN150 main and wait for future stages to construct DN100 main.
    - Option 2: Construct new DN100 main off the existing DN150 and run across road and stop at either after it crosses the road and use OD 32 for remaining pipe or run DN100 into property and cap near existing building.
    - Option 1 is the least cost and is recommended unless the additional development of the site is programmed for the near future.

Sewer

- The site sewerage will connect into the existing manhole in the eastern corner of the lot;
- An internal sewer reticulation layout is proposed following the future internal road layout at minimum grades.
- The proposed DN 150 sewer line has adequate capacity for the projected loadings from the site.
- The sewer will be able to take the extension amenities and kitchen however the existing kitchen and amenities do not meet the minimum fall outlined in the plumbing code. This is to be confirmed during the detailed design phase.
- The sewerage pipe connection to the pump station capacity was checked and was found to be sufficient to take the development sewerage flows.

Stormwater Assessment

- The development is only located within the Culvert 1 catchment area;
- The development is not located within the Culvert 2 catchment area or the Catchment 3 area and therefore the flow rates for these catchments will remain unchanged due to the development;
- The pre and post development peak flow rates for Culvert 1 are as follows:

Scenario	1% AEP (ARI 100)
Pre-development	2.74 m^3/s
Post-development	2.80 m^3/s

- This increase of 0.06m^3/s is insignificant and therefore the development will have an insignificant impact of the Culvert 1 catchment flow rate.

APPENDIX A

DEVELOPMENT PLANS

COUNTERPOINT

BEACHES CHURCH - ALTERATIONS & ADDITIONS

13 MT KULBURN DRIVE
JENSEN, QLD

A-000	COVER PAGE	B
A-001	LOCATION PLAN	C
A-002	CONTEXT PLAN	C
A-011	SITE PLAN - PROPOSED	D
A-101	FLOOR PLAN - PROPOSED	B
A-110	STAGING DIAGRAMS	C
A-200	ELEVATIONS	C
A-201	ELEVATIONS	C
A-400	CONCEPT IMAGERY	B
A-401	CONCEPT IMAGERY	B
A-402	CONCEPT IMAGERY	B
A-403	CONCEPT IMAGERY	C
A-404	CONCEPT IMAGERY	B
A-405	CONCEPT IMAGERY	B
A-406	CONCEPT IMAGERY	B
A-407	CONCEPT IMAGERY	B

PLANNING INFORMATION

LOT NO:

PROPOSED AREA:

PARKING:

COUNTERPOINT ARCHITECTURE 487 FLINDERS STREET, TOWNSVILLE PO BOX 1604 Townsville QLD 4810 P: (07) 4724 0990 E: ADMIN@CPOINT.COM.AU

1 A-200 **LOCATION PLAN**
SCALE 1 : 2500

PROJECT BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	CLIENT DETAILS BEACHES CHURCH	N	TITLE LOCATION PLAN	PROJECT NO. 32728	DATE 02.06.23	DRAWING No. A-001	ISSUE C

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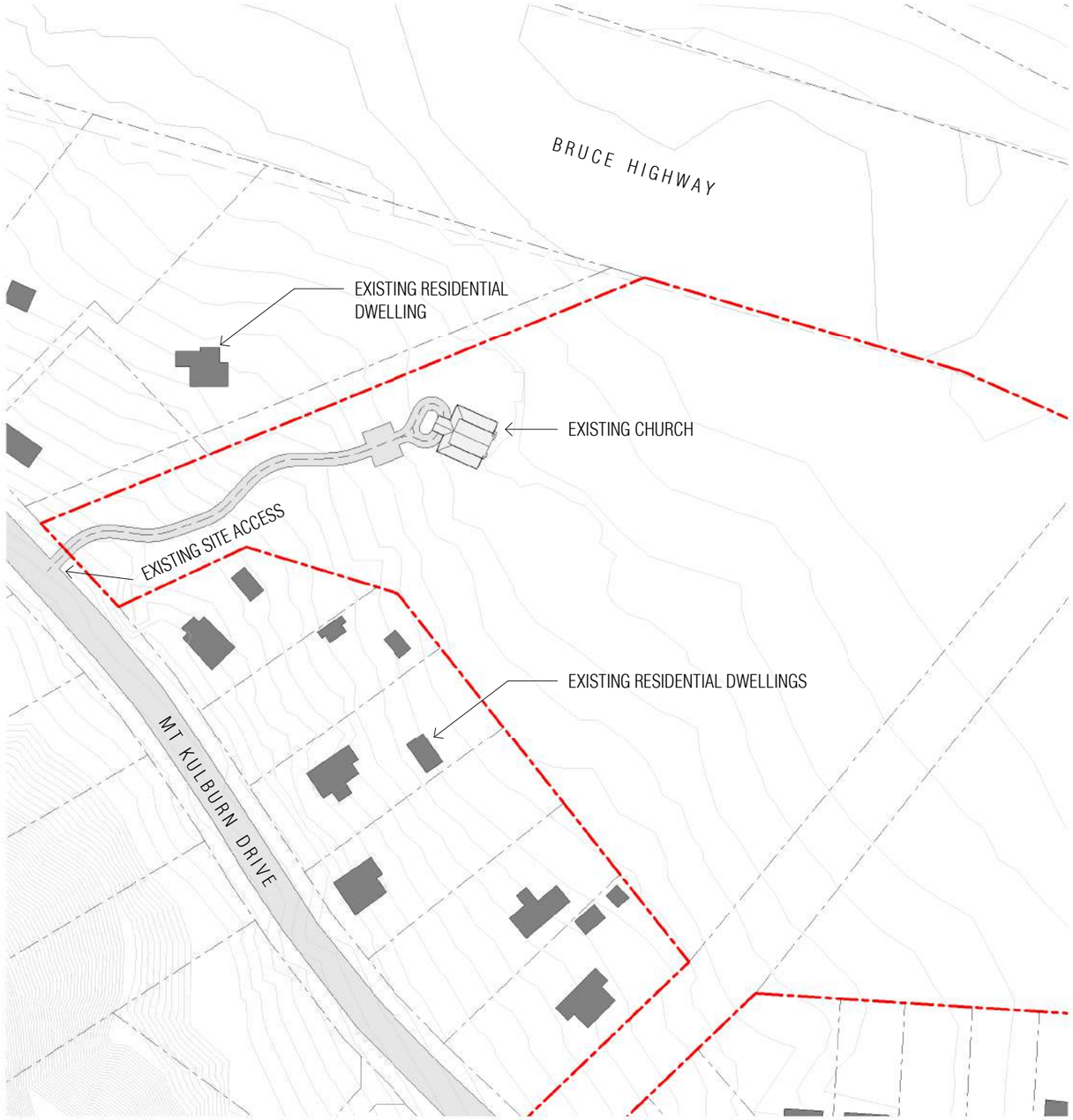

2 **EXISTING CONTEXT PLAN**
A-200 SCALE 1 : 2500

1 **PROPOSED CONTEXT PLAN**
A-200 SCALE 1 : 2500

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

N

TITLE
CONTEXT PLAN

PROJECT NO.
32728

DATE
02.06.23

DRAWING No.
A-002

ISSUE
C

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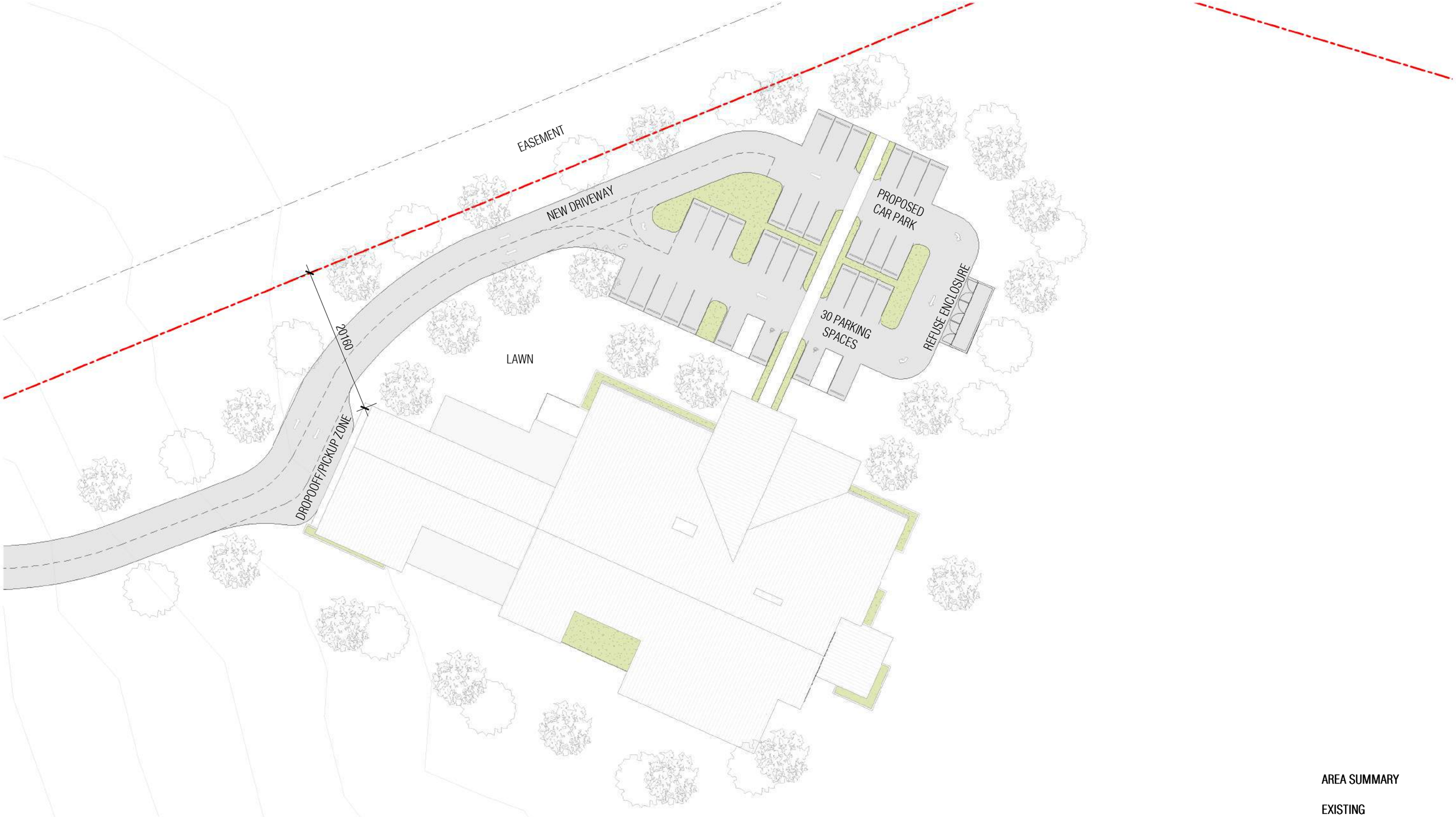

1 PROPOSED SITE PLAN 1-500
A-200 SCALE 1 : 500

PARKING SUMMARY

TOTAL: 30 CAR PARKS
2 NO. ACCESSIBLE SPACES

AREA SUMMARY

EXISTING
INTERNAL: 430m²
EXTERNAL: 35m²

PROPOSED
INTERNAL: 1680m²
EXTERNAL: 786m²

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

N

TITLE
SITE PLAN - PROPOSED

PROJECT NO.
32728

DATE
28.02.24

DRAWING No.
A-011

ISSUE
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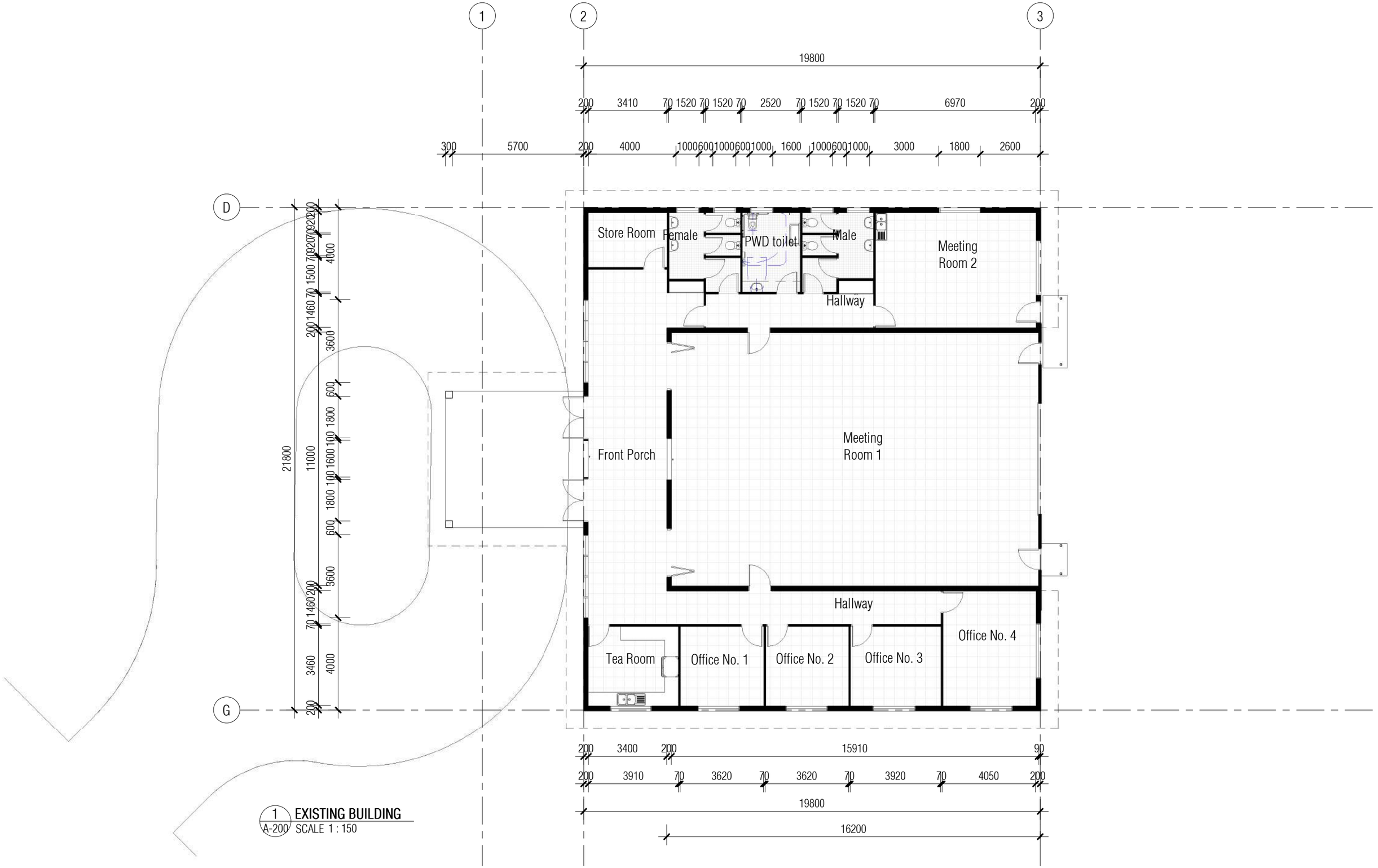

1 A-200 **EXISTING BUILDING**
SCALE 1 : 150

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COUNTERPOINT

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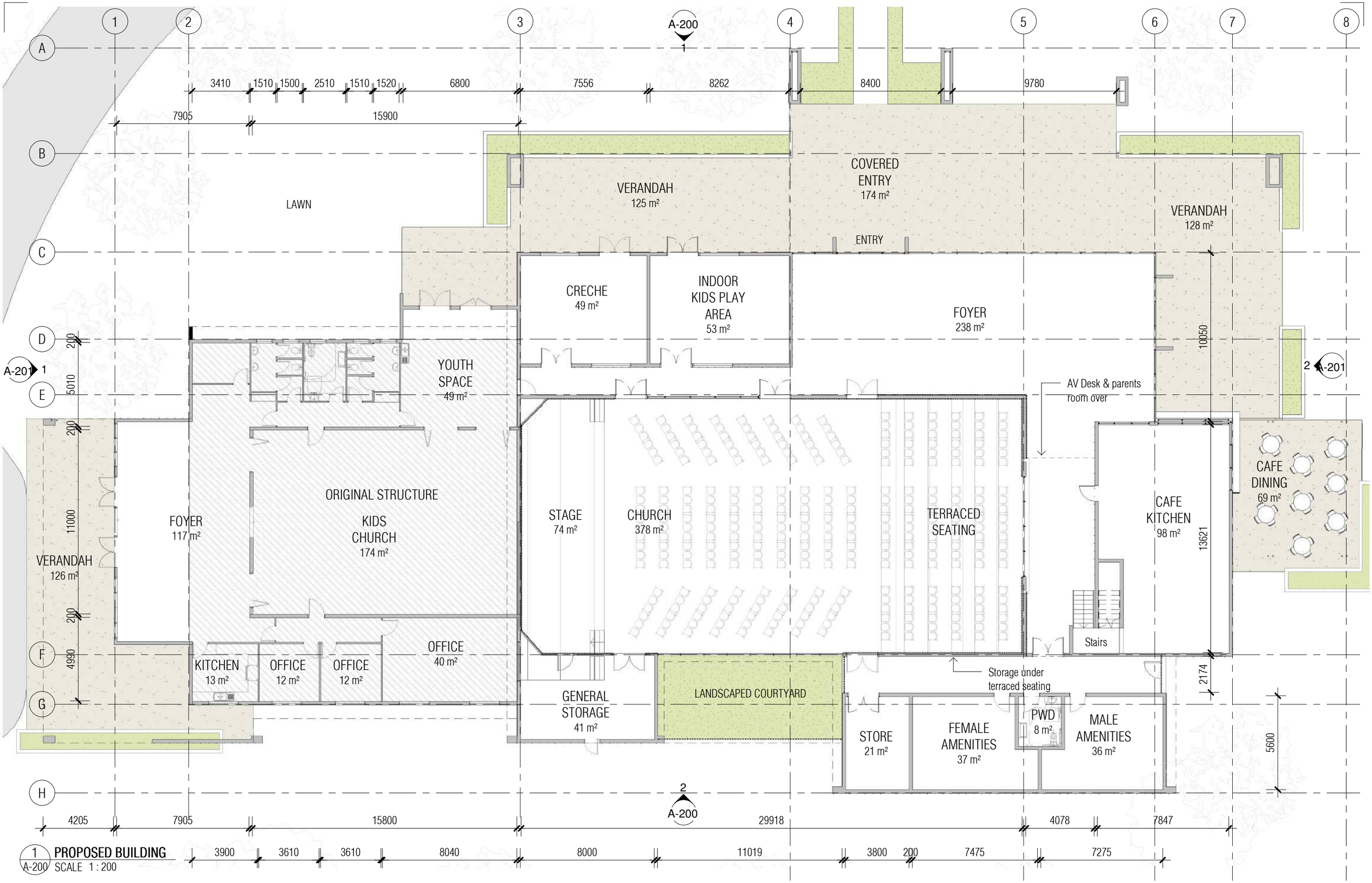

1 A-200 **PROPOSED BUILDING**
SCALE 1 : 200

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	FLOOR PLAN - PROPOSED	32728	04.05.23	A-101	B

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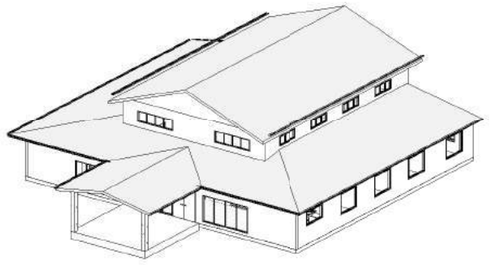
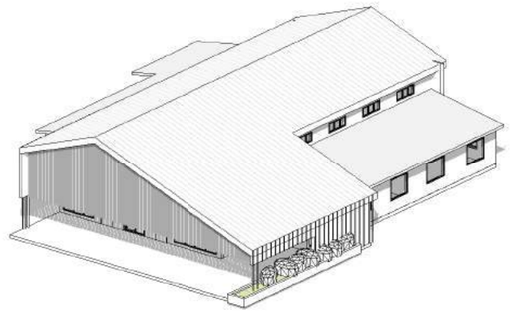
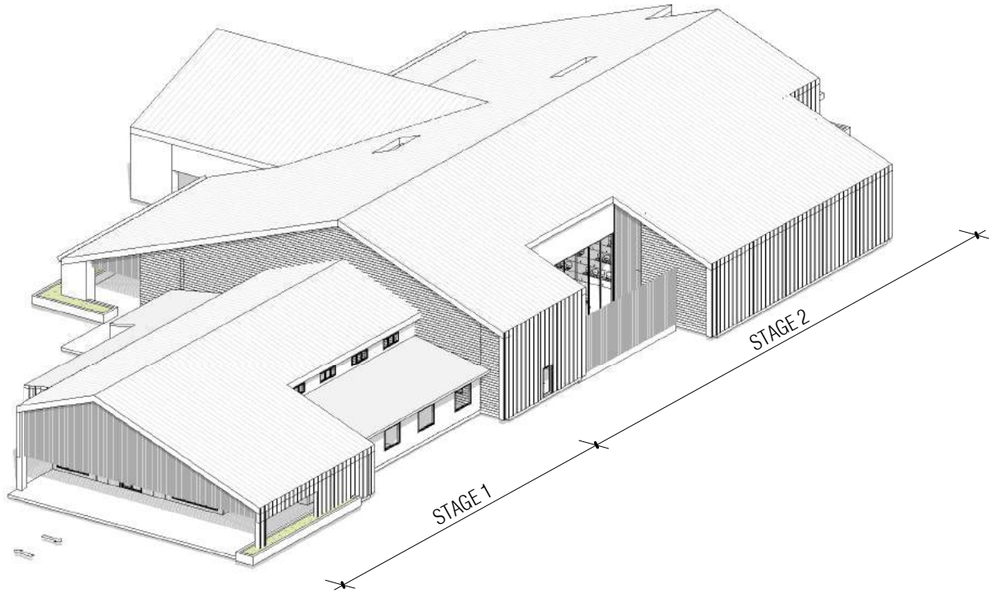


1 **EXISTING BUILDING**
SCALE



2 **PROPOSED BUILDING STAGE 1**
SCALE

ALTERATIONS AND ADDITIONS TO
EXISTING CHURCH BUILDING



3 **PROPOSED BUILDING STAGE 2**
SCALE

EXTENSION AND ADDITIONAL PARKING
TO CHURCH FACILITY

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
STAGING DIAGRAMS

PROJECT NO.
32728

DATE
28.02.24

DRAWING No.
A-110

ISSUE
C

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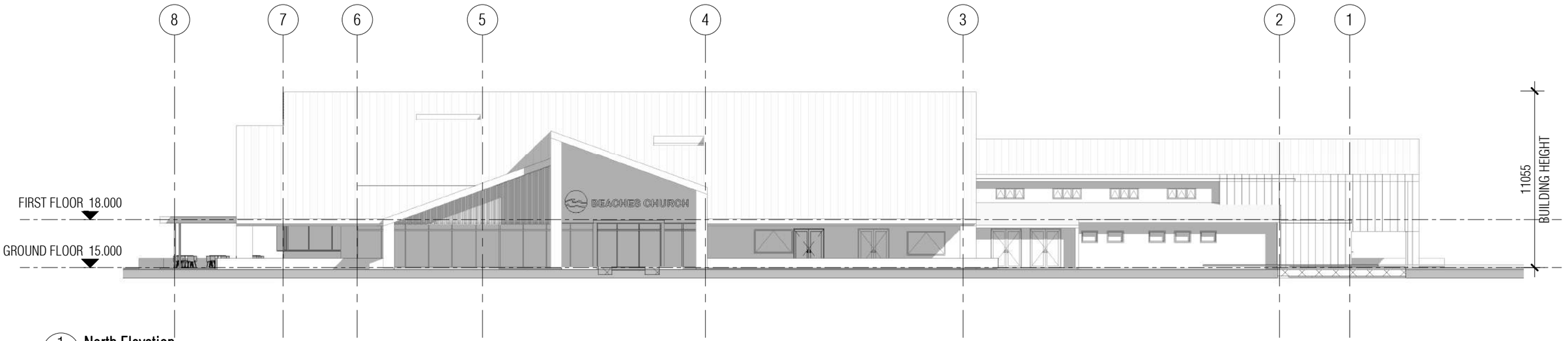
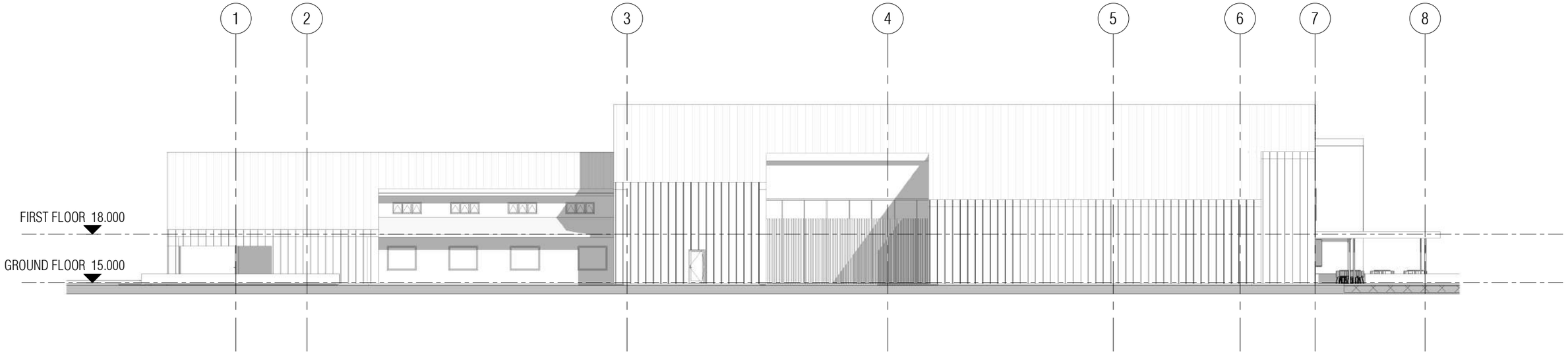


1 A-101 **North Elevation**
SCALE 1 : 250



2 A-101 **South Elevation**
SCALE 1 : 250

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COUNTERPOINT

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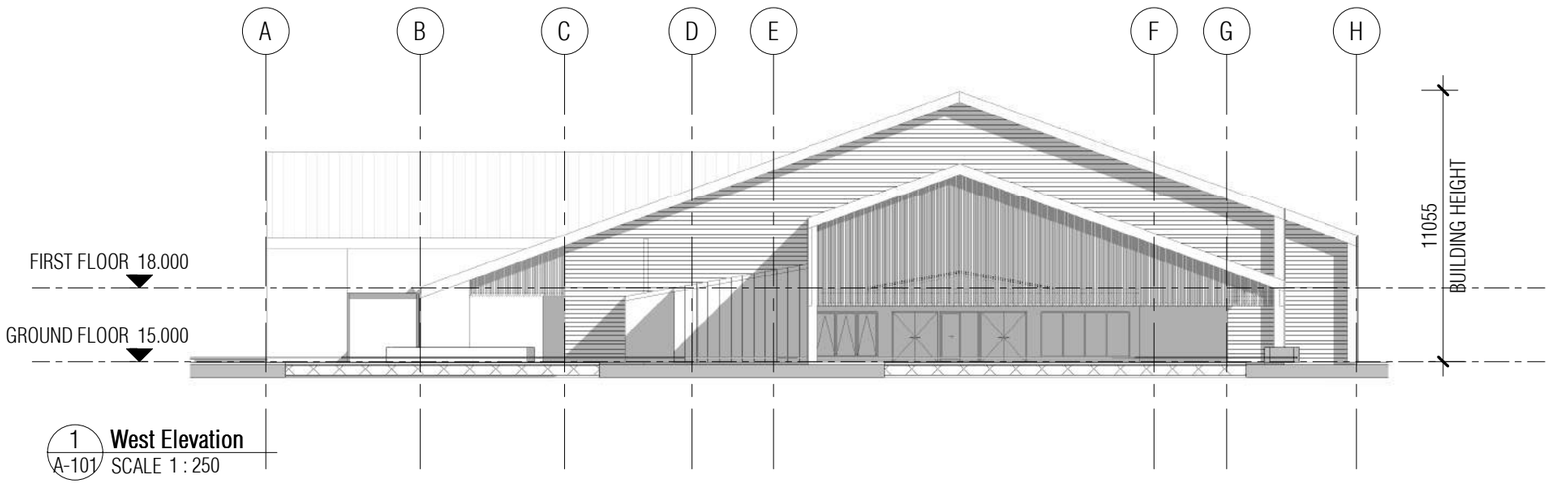
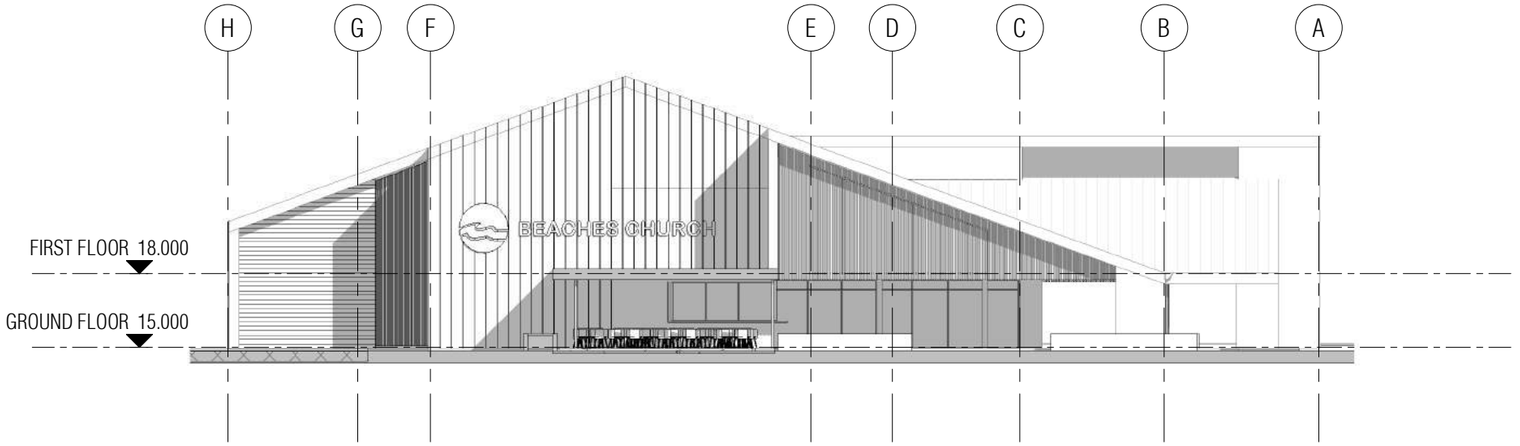


1 A-101 **West Elevation**
SCALE 1 : 250



2 A-101 **East Elevation**
SCALE 1 : 250

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	ELEVATIONS	32728	02.06.23	A-201	C

COUNTERPOINT

28/02/2024 3:53:54 PM

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-400

ISSUE
B

COUNTERPOINT

28/02/2024 3:53:55 PM

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	CONCEPT IMAGERY	32728	04.05.23	A-401	B

COUNTERPOINT

28/02/2024 3:53:55 PM

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-402

ISSUE
B

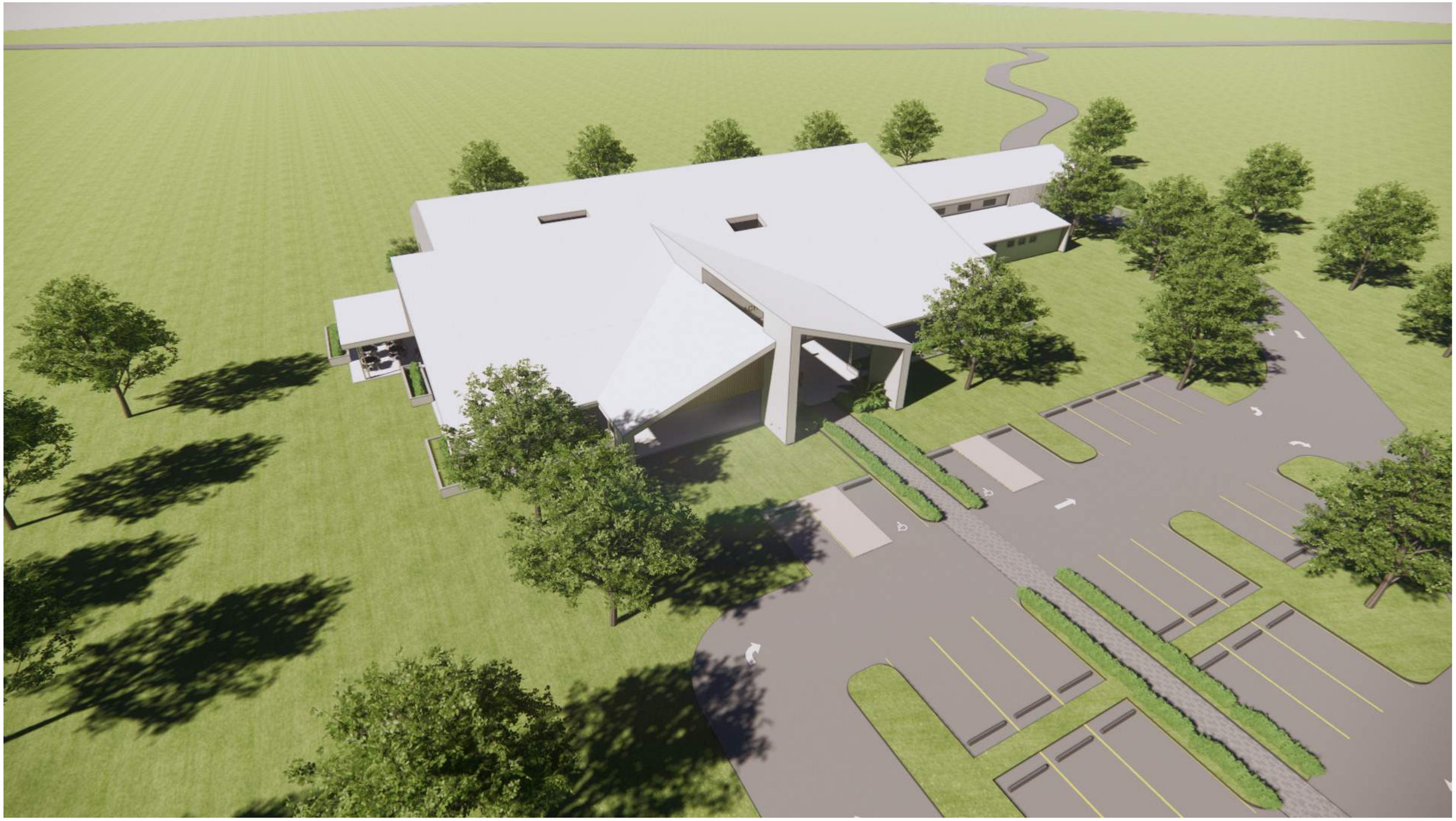
COUNTERPOINT

28/02/2024 3:53:55 PM

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	CONCEPT IMAGERY	32728	02.06.23	A-403	C

COUNTERPOINT

28/02/2024 3:53:55 PM



PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-404

ISSUE
B

COUNTERPOINT

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PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-405

ISSUE
B

COUNTERPOINT

28/02/2024 3:53:55 PM

PROJECT	CLIENT DETAILS	TITLE	PROJECT NO.	DATE	DRAWING No.	ISSUE
BEACHES CHURCH - ALTERATIONS & ADDITIONS 13 MT KULBURN DRIVE JENSEN QLD	BEACHES CHURCH	CONCEPT IMAGERY	32728	04.05.23	A-406	B

PROJECT
BEACHES CHURCH - ALTERATIONS & ADDITIONS
13 MT KULBURN DRIVE
JENSEN QLD

CLIENT DETAILS
BEACHES CHURCH

TITLE
CONCEPT IMAGERY

PROJECT NO.
32728

DATE
04.05.23

DRAWING No.
A-407

ISSUE
B

COUNTERPOINT

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APPENDIX B

PRE DEVELOPMENT STORMWATER ASSESSMENT

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 1% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	16.3

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	6.3

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	100				
A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	196.4			Impervious Area (m2) =	2943.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05		*- refer QUDM 2017, Table 4.5.1*		
Frequency Factor, F =	1.20		*- refer QUDM 2017, Table 4.5.2*		
C_{10} =	0.71		*- refer QUDM 2017, Table 4.5.3 & 4.5.4*		
C_y =	0.85				
Q (m^3/s) =	**2.738**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 2% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	16.3

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	6.3

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	50				
A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	175.4			Impervious Area (m2) =	2943.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05	*- refer QUDM 2017, Table 4.5.1*			
Frequency Factor, F =	1.15	*- refer QUDM 2017, Table 4.5.2*			
C_{10} =	0.71	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*			
C_y =	0.82				
Q (m^3/s) =	**2.343**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 5% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	16.3

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	6.3

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	20				
A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	148.2			Impervious Area (m2) =	2943.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05		*- refer QUDM 2017, Table 4.5.1*		
Frequency Factor, F =	1.05		*- refer QUDM 2017, Table 4.5.2*		
C_{10} =	0.71		*- refer QUDM 2017, Table 4.5.3 & 4.5.4*		
C_y =	0.75				
Q (m^3/s) =	**1.808**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PRE DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 10% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: *Beaches Church*

Project Location:

Input
Output

(1) Guidelines
- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)
a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:
- t = overland sheet flow travel time (min)
- L = overland sheet flow path length (m)
- n = Horton's surface roughness factor
- S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045
t (mins) =	16.3

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3
t_c (mins) =	6.3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)
$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:
- Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
- C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
- A = area of catchment (ha)
- ${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
- t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	10		
A (ha) =	5.887	= 58870 m2	
t_c (mins) =	22.6	Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	127.6	Impervious Area (m2) =	2943.5
${}^{1}I_{10}$ (mm/hr) =	79.2	Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05	*- refer QUDM 2017, Table 4.5.1*	
Frequency Factor, F =	1.00	*- refer QUDM 2017, Table 4.5.2*	
C_{10} =	0.71	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*	
C_y =	0.71		
Q (m^3/s) =	**1.483**		

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 20% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	16.3

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	6.3

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	5				
A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	112.1			Impervious Area (m2) =	2943.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05		*- refer QUDM 2017, Table 4.5.1*		
Frequency Factor, F =	0.95		*- refer QUDM 2017, Table 4.5.2*		
C_{10} =	0.71		*- refer QUDM 2017, Table 4.5.3 & 4.5.4*		
C_y =	0.67				
Q (m^3/s) =	**1.237**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 50% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) = 16.3

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) = 6.3

d) Total tc

t_c (mins) = 22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 2

A (ha) =	5.887	=	58870 m2
t_c (mins) =	22.6		
Rainfall intensity, I (mm/hr) =	85.8		
${}^{1}I_{10}$ (mm/hr) =	79.2		

Catchment Area (m2) =	58870
Impervious Area (m2) =	2943.5
Fraction Impervious =	0.05

Fraction impervious, f_i =	0.05	*- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F =	0.85	*- refer QUDM 2017, Table 4.5.2*
C_{10} =	0.71	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*
C_y =	0.60	

Q (m^3/s) = **0.848**

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 2 CATCHMENT AREA - 1% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUDM 2017, Section 4.6.6*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	200.0
U/S RL (m) =	19.10
D/S RL (m) =	13.70
S (%) =	2.70
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	23.0

b) Channel flow

Flow distance (m) =	289
Upstream level (m) =	13.7
Downstrem level (m) =	12.6
Fall of channel (m) =	1.1
Flow time in channel (min) =	7.5
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	22.5

d) Total tc

t_c (mins) =	45.5

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	100				
A (ha) =	5.5434	=	55434	m2	
t_c (mins) =	45.5			Catchment Area (m2) =	55434
Rainfall intensity, I (mm/hr) =	141.4			Impervious Area (m2) =	2771.7
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05	*- refer QUDM 2017, Table 4.5.1*			
Frequency Factor, F =	1.20	*- refer QUDM 2017, Table 4.5.2*			
C_{10} =	0.71	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*			
C_y =	0.85				
Q (m^3/s) =	**1.857**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 2 CATCHMENT AREA - 2% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUDM 2017, Section 4.6.6*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	200.0
U/S RL (m) =	19.10
D/S RL (m) =	13.70
S (%) =	2.70
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) = 23.0

b) Channel flow

Flow distance (m) =	289
Upstream level (m) =	13.7
Downstrem level (m) =	12.6
Fall of channel (m) =	1.1
Flow time in channel (min) =	7.5
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) = 22.5

d) Total tc

t_c (mins) = 45.5

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 50

A (ha) =	5.5434	=	55434 m2		
t_c (mins) =	45.5			Catchment Area (m2) =	55434
Rainfall intensity, I (mm/hr) =	126.2			Impervious Area (m2) =	2771.7
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05

Fraction impervious, f_i =	0.05	*- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F =	1.15	*- refer QUDM 2017, Table 4.5.2*
C_{10} =	0.71	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*
C_y =	0.82	

Q (m^3/s) = 1.588

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 2 CATCHMENT AREA - 5% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUDM 2017, Section 4.6.6*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	200.0
U/S RL (m) =	19.10
D/S RL (m) =	13.70
S (%) =	2.70
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	23.0

b) Channel flow

Flow distance (m) =	289
Upstream level (m) =	13.7
Downstrem level (m) =	12.6
Fall of channel (m) =	1.1
Flow time in channel (min) =	7.5
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	22.5

d) Total tc

t_c (mins) =	45.5

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	20				
A (ha) =	5.5434	=	55434	m2	
t_c (mins) =	45.5			Catchment Area (m2) =	55434
Rainfall intensity, I (mm/hr) =	106.5			Impervious Area (m2) =	2771.7
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05	*- refer QUDM 2017, Table 4.5.1*			
Frequency Factor, F =	1.05	*- refer QUDM 2017, Table 4.5.2*			
C_{10} =	0.71	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*			
C_y =	0.75				
Q (m^3/s) =	**1.224**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PRE DEVELOPMENT - CULVERT 2 CATCHMENT AREA - 10% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: *Beaches Church*

Project Location:

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

Input
Output

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUDM 2017, Section 4.6.6*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	200.0
U/S RL (m) =	19.10
D/S RL (m) =	13.70
S (%) =	2.70
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) = 23.0

b) Channel flow

Flow distance (m) =	289
Upstream level (m) =	13.7
Downstrem level (m) =	12.6
Fall of channel (m) =	1.1
Flow time in channel (min) =	7.5
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) = 22.5

d) Total tc

t_c (mins) = 45.5

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 10

A (ha) =	5.5434	=	55434 m2		
t_c (mins) =	45.5			Catchment Area (m2) =	55434
Rainfall intensity, I (mm/hr) =	91.7			Impervious Area (m2) =	2771.7
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05

Fraction impervious, f_i =	0.05	*- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F =	1.00	*- refer QUDM 2017, Table 4.5.2*
C_{10} =	0.71	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*
C_y =	0.71	

Q (m^3/s) = 1.003

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PRE DEVELOPMENT - CULVERT 2 CATCHMENT AREA - 20% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: *Beaches Church*

Project Location:

Input
Output

(1) Guidelines
- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)
a) Overland Flow (Friend's equation) *- refer QUDM 2017, Section 4.6.6*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	200.0
U/S RL (m) =	19.10
D/S RL (m) =	13.70
S (%) =	2.70
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) = 23.0

b) Channel flow

Flow distance (m) =	289
Upstream level (m) =	13.7
Downstrem level (m) =	12.6
Fall of channel (m) =	1.1
Flow time in channel (min) =	7.5
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) = 22.5

d) Total tc

t_c (mins) = 45.5

(3) Design Flow (Q)
$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	5		
A (ha) =	5.5434	= 55434 m2	
t_c (mins) =	45.5	Catchment Area (m2) =	55434
Rainfall intensity, I (mm/hr) =	80.4	Impervious Area (m2) =	2771.7
${}^{1}I_{10}$ (mm/hr) =	79.2	Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05	*- refer QUDM 2017, Table 4.5.1*	
Frequency Factor, F =	0.95	*- refer QUDM 2017, Table 4.5.2*	
C_{10} =	0.71	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*	
C_y =	0.67		

Q (m^3/s) = **0.835**

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

PRE DEVELOPMENT - CULVERT 2 CATCHMENT AREA - 50% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUDM 2017, Section 4.6.6*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	200.0
U/S RL (m) =	19.10
D/S RL (m) =	13.70
S (%) =	2.70
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	23.0

b) Channel flow

Flow distance (m) =	289
Upstream level (m) =	13.7
Downstrem level (m) =	12.6
Fall of channel (m) =	1.1
Flow time in channel (min) =	7.5
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	22.5

d) Total tc

t_c (mins) =	45.5

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	2				
A (ha) =	5.5434	=	55434	m2	
t_c (mins) =	45.5			Catchment Area (m2) =	55434
Rainfall intensity, I (mm/hr) =	61.4			Impervious Area (m2) =	2771.7
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.05
Fraction impervious, f_i =	0.05		*- refer QUDM 2017, Table 4.5.1*		
Frequency Factor, F =	0.85		*- refer QUDM 2017, Table 4.5.2*		
C_{10} =	0.71		*- refer QUDM 2017, Table 4.5.3 & 4.5.4*		
C_y =	0.60				
Q (m^3/s) =	**0.571**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

POST DEVELOPMENT - CATCHMENT 3 - 1% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: ***Beaches Church***

Project Location:

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

Input
Output

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QU$_i$ - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	50.0
U/S RL (m) =	86.40
D/S RL (m) =	68.80
S (%) =	35.20
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	8.7

b) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	189
v (m/s) =	1.500
t (mins) =	2.1

c) Channel flow

Flow distance (m) =	243.7
Upstream level (m) =	22.2
Downstrem level (m) =	18.4
Fall of channel (m) =	3.8
Flow time in channel (min) =	3.5
Multiplier, Δ =	2

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	7.0

d) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	484
v (m/s) =	0.300
t (mins) =	26.9

d) Total tc

t_c (mins) =	44.7

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	100
A (ha) =	16.9709
t_c (mins) =	44.7
Rainfall intensity, I (mm/hr) =	142.8
${}^{1}I_{10}$ (mm/hr) =	79.2

= 169709 m2

Catchment Area (m2) =	169709
Impervious Area (m2) =	16970.9
Fraction Impervious =	0.10

Fraction impervious, f_i =	0.10
Frequency Factor, F =	1.20

- refer QUDM 2017, Table 4.5.1
- refer QUDM 2017, Table 4.5.2

C_{10} =	0.72
C_y =	0.86

- refer QUDM 2017, Table 4.5.3 & 4.5.4

Q (m^3/s) =	**5.822**

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

POST DEVELOPMENT - CATCHMENT 3 - 2% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: ***Beaches Church***

Project Location:

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

Input
Output

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QU$_i$ - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	50.0
U/S RL (m) =	86.40
D/S RL (m) =	68.80
S (%) =	35.20
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) = 8.7

b) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	189
v (m/s) =	1.500

t (mins) = 2.1

c) Channel flow

Flow distance (m) =	243.7
Upstream level (m) =	22.2
Downstrem level (m) =	18.4
Fall of channel (m) =	3.8
Flow time in channel (min) =	3.5
Multiplier, Δ =	2

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) = 7.0

d) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	484
v (m/s) =	0.300

t (mins) = 26.9

d) Total tc

t_c (mins) = 44.7

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 50

A (ha) =	16.9709	=	169709 m2
t_c (mins) =	44.7		
Rainfall intensity, I (mm/hr) =	127.5		
${}^{1}I_{10}$ (mm/hr) =	79.2		

Catchment Area (m2) =	169709
Impervious Area (m2) =	16970.9
Fraction Impervious =	0.10

Fraction impervious, f_i =	0.10	*- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F =	1.15	*- refer QUDM 2017, Table 4.5.2*
C_{10} =	0.72	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*
C_y =	0.83	

Q (m^3/s) = **4.979**

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

POST DEVELOPMENT - CATCHMENT 3 - 5% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QU$_i$ - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	50.0
U/S RL (m) =	86.40
D/S RL (m) =	68.80
S (%) =	35.20
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) = 8.7

b) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	189
v (m/s) =	1.500

t (mins) = 2.1

c) Channel flow

Flow distance (m) =	243.7
Upstream level (m) =	22.2
Downstrem level (m) =	18.4
Fall of channel (m) =	3.8
Flow time in channel (min) =	3.5
Multiplier, Δ =	2

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) = 7.0

d) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	484
v (m/s) =	0.300

t (mins) = 26.9

d) Total tc

t_c (mins) = 44.7

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 20

A (ha) = 16.9709 = 169709 m2

t_c (mins) = 44.7

Rainfall intensity, I (mm/hr) = 107.6

$^{1}I_{10}$ (mm/hr) = 79.2

Catchment Area (m2) =	169709
Impervious Area (m2) =	16970.9
Fraction Impervious =	0.10

Fraction impervious, f_i = 0.10 *- refer QUDM 2017, Table 4.5.1*

Frequency Factor, F = 1.05 *- refer QUDM 2017, Table 4.5.2*

C_{10} = 0.72 *- refer QUDM 2017, Table 4.5.3 & 4.5.4*

C_y = 0.76

Q (m^3/s) = 3.837

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

POST DEVELOPMENT - CATCHMENT 3 - 10% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: ***Beaches Church***

Project Location:

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

Input
Output

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QU$_i$ - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	50.0
U/S RL (m) =	86.40
D/S RL (m) =	68.80
S (%) =	35.20
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) = 8.7

b) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	189
v (m/s) =	1.500

t (mins) = 2.1

c) Channel flow

Flow distance (m) =	243.7
Upstream level (m) =	22.2
Downstrem level (m) =	18.4
Fall of channel (m) =	3.8
Flow time in channel (min) =	3.5
Multiplier, Δ =	2

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) = 7.0

d) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	484
v (m/s) =	0.300

t (mins) = 26.9

d) Total tc

t_c (mins) = 44.7

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 10

A (ha) =	16.9709	=	169709 m2
t_c (mins) =	44.7		
Rainfall intensity, I (mm/hr) =	92.6		
${}^{1}I_{10}$ (mm/hr) =	79.2		

Catchment Area (m2) =	169709
Impervious Area (m2) =	16970.9
Fraction Impervious =	0.10

Fraction impervious, f_i =	0.10	*- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F =	1.00	*- refer QUDM 2017, Table 4.5.2*
C_{10} =	0.72	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*
C_y =	0.72	

Q (m^3/s) = 3.145

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

POST DEVELOPMENT - CATCHMENT 3 - 20% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: ***Beaches Church***

Project Location:

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

Input
Output

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QU$_i$ - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	50.0
U/S RL (m) =	86.40
D/S RL (m) =	68.80
S (%) =	35.20
n =	0.045
t (mins) =	8.7

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

b) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	189
v (m/s) =	1.500
t (mins) =	2.1

c) Channel flow

Flow distance (m) =	243.7
Upstream level (m) =	22.2
Downstrem level (m) =	18.4
Fall of channel (m) =	3.8
Flow time in channel (min) =	3.5
Multiplier, Δ =	2
t_c (mins) =	7.0

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

d) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	484
v (m/s) =	0.300
t (mins) =	26.9

d) Total tc

t_c (mins) =	44.7

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	5		
A (ha) =	16.9709	= 169709 m2	
t_c (mins) =	44.7	Catchment Area (m2) =	169709
Rainfall intensity, I (mm/hr) =	81.2	Impervious Area (m2) =	16970.9
${}^{1}I_{10}$ (mm/hr) =	79.2	Fraction Impervious =	0.10
Fraction impervious, f_i =	0.10	*- refer QUDM 2017, Table 4.5.1*	
Frequency Factor, F =	0.95	*- refer QUDM 2017, Table 4.5.2*	
C_{10} =	0.72	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*	
C_y =	0.68		
Q (m^3/s) =	**2.620**		

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

POST DEVELOPMENT - CATCHMENT 3 - 50% AEP

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QU$_i$ - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	50.0
U/S RL (m) =	86.40
D/S RL (m) =	68.80
S (%) =	35.20
n =	0.045
t (mins) =	8.7

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

b) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	189
v (m/s) =	1.500
t (mins) =	2.1

c) Channel flow

Flow distance (m) =	243.7
Upstream level (m) =	22.2
Downstrem level (m) =	18.4
Fall of channel (m) =	3.8
Flow time in channel (min) =	3.5
Multiplier, Δ =	2
t_c (mins) =	7.0

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

d) Stream Velocity Method - Steep Country (8 to 1.5%)

L (m) =	484
v (m/s) =	0.300
t (mins) =	26.9

d) Total tc

t_c (mins) =	44.7

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	2		
A (ha) =	16.9709	= 169709 m2	
t_c (mins) =	44.7	Catchment Area (m2) =	169709
Rainfall intensity, I (mm/hr) =	62.1	Impervious Area (m2) =	16970.9
${}^{1}I_{10}$ (mm/hr) =	79.2	Fraction Impervious =	0.10
Fraction impervious, f_i =	0.10	*- refer QUDM 2017, Table 4.5.1*	
Frequency Factor, F =	0.85	*- refer QUDM 2017, Table 4.5.2*	
C_{10} =	0.72	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*	
C_y =	0.61		
Q (m^3/s) =	**1.792**		

APPENDIX C

POST DEVELOPMENT STORMWATER ASSESSMENT

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

POST DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 1% AEP

PROJECT No.	0954			
CALCULATION BY	AR	DATE	1/06/23	
CHECKED BY	GS	DATE	1/06/23	
SHEET		OF		

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	16.3

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	6.3

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	100				
A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	196.4			Impervious Area (m2) =	7922.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.13
Fraction impervious, f_i =	0.13		*- refer QUDM 2017, Table 4.5.1*		
Frequency Factor, F =	1.20		*- refer QUDM 2017, Table 4.5.2*		
C_{10} =	0.73		*- refer QUDM 2017, Table 4.5.3 & 4.5.4*		
C_y =	0.87				
Q (m^3/s) =	**2.803**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

POST DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 2% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045
t (mins) =	16.3

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3
t_c (mins) =	6.3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	50				
A (ha) =	5.887	=	58870 m2		
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	175.4			Impervious Area (m2) =	7922.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.13
Fraction impervious, f_i =	0.13		*- refer QUDM 2017, Table 4.5.1*		
Frequency Factor, F =	1.15		*- refer QUDM 2017, Table 4.5.2*		
C_{10} =	0.73		*- refer QUDM 2017, Table 4.5.3 & 4.5.4*		
C_y =	0.84				
Q (m^3/s) =	**2.399**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

POST DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 5% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045
t (mins) =	16.3

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3
t_c (mins) =	6.3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	20				
A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	148.2			Impervious Area (m2) =	7922.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.13
Fraction impervious, f_i =	0.13	*- refer QUDM 2017, Table 4.5.1*			
Frequency Factor, F =	1.05	*- refer QUDM 2017, Table 4.5.2*			
C_{10} =	0.73	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*			
C_y =	0.76				
Q (m^3/s) =	**1.851**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

POST DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 10% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) = 16.3

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) = 6.3

d) Total tc

t_c (mins) = 22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 10

A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	127.6			Impervious Area (m2) =	7922.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.13

Fraction impervious, f_i =	0.13	*- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F =	1.00	*- refer QUDM 2017, Table 4.5.2*
C_{10} =	0.73	*- refer QUDM 2017, Table 4.5.3 & 4.5.4*
C_y =	0.73	

Q (m^3/s) = **1.518**

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

POST DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 20% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045
t (mins) =	16.3

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3
t_c (mins) =	6.3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	5				
A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	112.1			Impervious Area (m2) =	7922.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.13
Fraction impervious, f_i =	0.13		*- refer QUDM 2017, Table 4.5.1*		
Frequency Factor, F =	0.95		*- refer QUDM 2017, Table 4.5.2*		
C_{10} =	0.73		*- refer QUDM 2017, Table 4.5.3 & 4.5.4*		
C_y =	0.69				
Q (m^3/s) =	**1.267**				

CATCHMENT HYDROLOGY
(RATIONAL METHOD)

PROJECT No.	0954		
CALCULATION BY	AR	DATE	1/06/23
CHECKED BY	GS	DATE	1/06/23
SHEET		OF	

POST DEVELOPMENT - CULVERT 1 CATCHMENT AREA - 20% AEP

Project Name: ***Beaches Church***

Project Location:

Input
Output

(1) Guidelines

- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Overland Flow (Friend's equation) *- refer QUI - refer QUDM 2017, Section 4.6.8*

$t = (107\ n\ L^{0.333}) / S^{0.2}$

where:

t = overland sheet flow travel time (min)
L = overland sheet flow path length (m)
n = Horton's surface roughness factor
S = slope of surface (%)

L (m) =	100.0
U/S RL (m) =	22.60
D/S RL (m) =	17.80
S (%) =	4.80
n =	0.045

- refer QUDM 2017, Figure 4.4, assumed average grassed surface

t (mins) =	16.3

b) Channel flow

Flow distance (m) =	146
Upstream level (m) =	17.8
Downstrem level (m) =	12.2
Fall of channel (m) =	5.6
Flow time in channel (min) =	2.1
Multiplier, Δ =	3

- refer QUDM 2017, Figure 4.5

- refer QUDM 2017, Technical notes for Figure 4.5

t_c (mins) =	6.3

d) Total tc

t_c (mins) =	22.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	2				
A (ha) =	5.887	=	58870	m2	
t_c (mins) =	22.6			Catchment Area (m2) =	58870
Rainfall intensity, I (mm/hr) =	85.8			Impervious Area (m2) =	7922.5
${}^{1}I_{10}$ (mm/hr) =	79.2			Fraction Impervious =	0.13
Fraction impervious, f_i =	0.13		*- refer QUDM 2017, Table 4.5.1*		
Frequency Factor, F =	0.85		*- refer QUDM 2017, Table 4.5.2*		
C_{10} =	0.73		*- refer QUDM 2017, Table 4.5.3 & 4.5.4*		
C_y =	0.62				
Q (m^3/s) =	**0.868**				