Site-based Stormwater Management Plan (SSMP)

Capricorn Battery Energy Storage System (BESS)

Potentia Energy Pty Ltd

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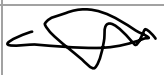
[Status code]	0	S. Seyed Ghasemi S. Terpstra	H. Chen M. Grim				
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1. Introduction

1.1 Purpose of this report

GHD Pty Ltd (GHD) has been engaged by Potentia Energy Pty Ltd for engineering services associated with the proposed development of the Capricorn Battery Energy Storage System (BESS) located on Lot 2 on RP613051 in Bouldercombe, Queensland. The proposed BESS will be connected to the Bouldercombe Substation.

GHD has been commissioned to prepare a Site-Based Stormwater Management Plan (SSMP) for the proposed BESS project area. The scope of work includes an assessment to provide support document for the development application approval, of stormwater quantity, through a hydrologic and hydraulic assessment, and stormwater quality, through MUSIC modelling of the proposed development.

1.2 Scope and limitations

This report: has been prepared by GHD for Potentia Energy Pty Ltd and may only be used and relied on by Potentia Energy Pty Ltd for the purpose agreed between GHD and Potentia Energy Pty Ltd as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Potentia Energy Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.3 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared the TUFLOW ("Model") for, and for the benefit and sole use of, Potentia Energy Pty Ltd to support hydraulic assessment and must not be used for any other purpose or by any other person.

The Model is a representation only and does not reflect reality in every aspect. The Model contains simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Model. Accordingly, the outputs of the Model cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.

The information, data and assumptions ("Inputs") used as inputs into the Model are from publicly available sources or provided by or on behalf of the Potentia Energy Pty Ltd, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Model as further Inputs becomes available.

The Model is limited by the mathematical rules and assumptions that are set out in the Report or included in the Model and by the software environment in which the Model is developed.

The Model is a customised model and not intended to be amended in any form or extracted to other software for amending. Any change made to the Model, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Model including any outputs.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.3 Assumptions

This assessment has been completed based on the following assumptions:

– Project hydrology has been undertaken in accordance with Australian Rainfall and Runoff (2019) guidelines.
– This study has assessed storm events of 50%, 20%, 10%, 5%, 2%, and 1% AEP based on the meeting held on 27/11 and the development application request (D/124-2024). No climate change assessment has been conducted at this stage (Concept Design).

- Hydraulic model extents need to be large enough, and the grid element sizes small enough, to capture the hydraulic characteristics of the overland flow. This is offset by the need to have a model able to run in an acceptable amount of time. For this assessment, the hydraulic model was run with a two (2) meter cell size with sub-grid sampling distance of one (1) meter for computational efficiency. It has been assumed that the adopted model resolution is adequate to identify relevant hydraulic features.
- Unless stated, flood grids presented in this report are based on estimated peak values of flow, depth, and velocity for each storm event, considering median temporal pattern for each duration of the design storm events. This means the value presented for each cell is based on the maximum computed value which has occurred over the durations of the simulated design events. Hence, a presentation of peak values does not represent an instantaneous point in time, but rather an envelope of maximum values.
- Hydrologic estimates have been validated against empirical estimates. Calibration of the hydrologic or hydraulic model was not conducted.
- Identifiable crossing structures (e.g. culverts) have been assumed based on visual observation of aerial imagery.
- Culvert length and width has been assumed based on the areal imagery, culvert height and invert levels are inferred from the provided 500 mm DEM. It is recommended to capture the culvert information via a detail survey or similar in the next stage of the project.
- Proposed design string provided for flood modelling in 2D DWG format. The proposed levels are initial and added to the flood model using TUFLOW layers (2d_zsh).
- For the design surface, it is assumed that:
  - Roads are sealed/ asphalt
  - Design surfaces (except the road) are compacted soil with gravel at the top
- Detailed design, drawings or costings of required stormwater infrastructure is outside the scope for the purposes of this study.
- Obtaining any approvals associated with the recommended works infrastructure is outside the scope for the purposes of this study

Additional and specific assumptions are provided in the relevant sections of this report.

2. Available data

2.1 Topography

– 0.5 m DTM undertaken by Aerometrex dated May 2024 provided to GHD by the client.
– 1-metre LiDAR dated 2015 extracted from ELVIS (Elevation and Depth - Foundation Spatial Data) website.

2.2 Imagery

Google Maps satellite aerial imagery was used throughout the assessment for both the hydrologic and hydraulic assessments.

2.3 Development layout

The design layout is based on the provided designed by Potentia Energy based on the Preliminary General BESS layout for Capricorn Creek BESS dated 28/11/2024 which included:

– BESS and on-site infrastructure.
– Sealed access roads within the BESS footprint.
– For more details refer to Appendix B.

2.4 Datum

The Australian Height Datum (AHD) was adopted for all hydraulic modelling levels cited in this report.

3. Site description

3.1 Existing site (Pre-development)

The Project Area consists of approximately 17 hectares and encompasses the entire area associated with the Project footprint which includes part of Lot 2 on RP613051. The Project area is located north of Bouldercombe within the Rockhampton Regional Council Local Government Area (LGA). The existing site is currently dominated by rural land and low density vegetation. The Bouldercombe Substation and Bouldercombe BESS are located directly south of the site. The topography of the site is relatively flat but grades to the north-west corner of the property. Four Mile Creek is located immediately west of the site and flow in northerly direction. The existing site locality is illustrated in Figure 1.

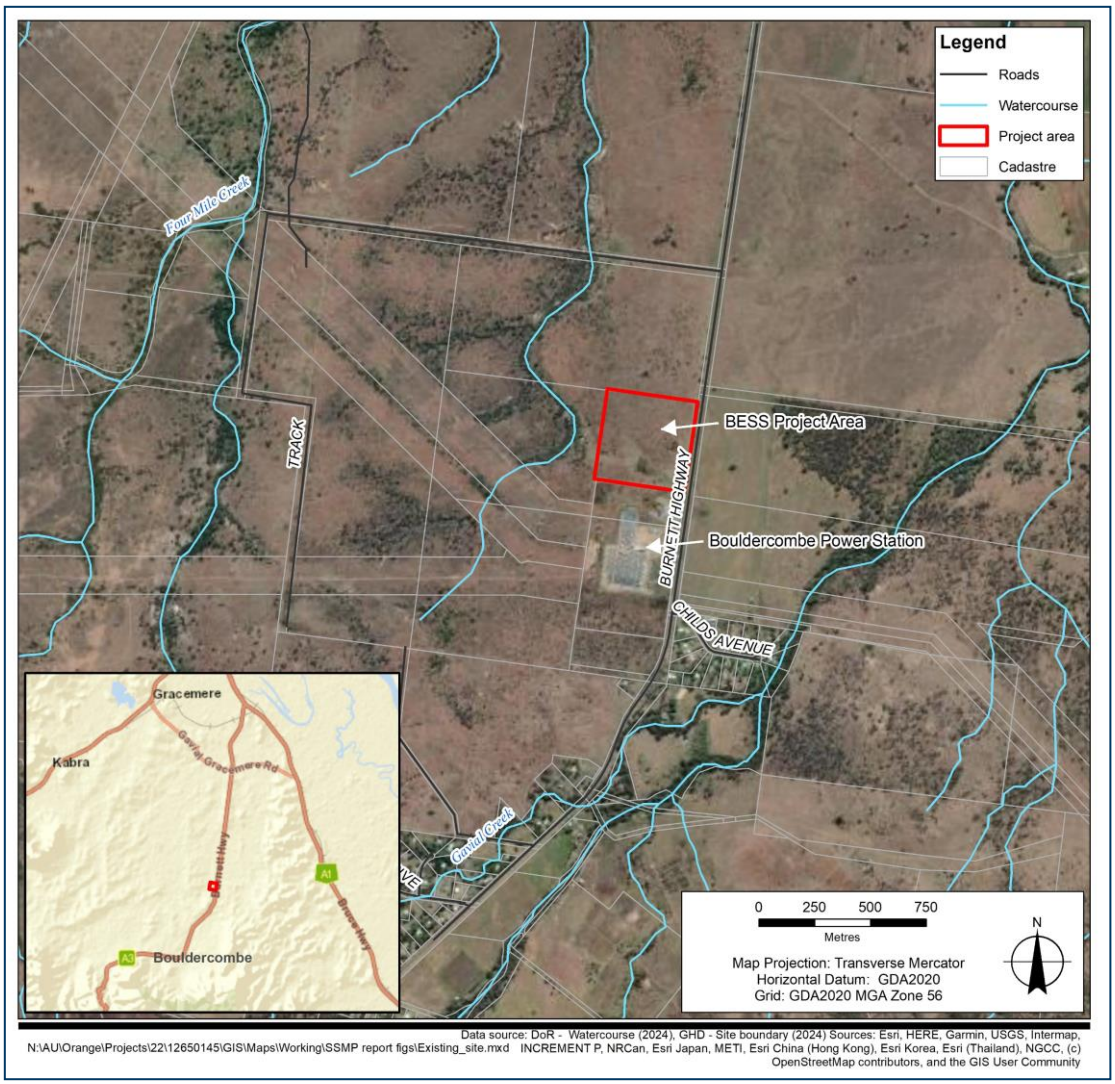


Figure 1 Existing site locality

3.2 Proposed site

The proposed development includes the following infrastructure:

– BESS and on-site infrastructure.
– Sealed access roads within the BESS footprint.
– Bioretention basin for water quality

Detailed plans of the Project area and proposed development infrastructure are provided in Appendix B.

4. Stormwater quantity

4.1 Hydrologic modelling

An XP-RAFTs (2018 version) hydrologic model was set-up and run in Storm Injector as part of the hydrologic assessment of the site. This section of the report presents the details of the hydrologic modelling undertaken.

4.1.1 Catchment hydrology

The subject site is located approximately 2.5 km from Bouldercombe in the Rockhampton Regional Council Local Government Area. The contributing catchment area to the local area near the site is approximately 384 ha. The terrain to the site is dominated by rural land and bushland.

A total of 26 sub-catchments were delineated using CatchmentSIM near the site. Figure 2 shows the catchment delineation undertaken for the local hydrologic model. Catchment parameters are summarised in Table 1.

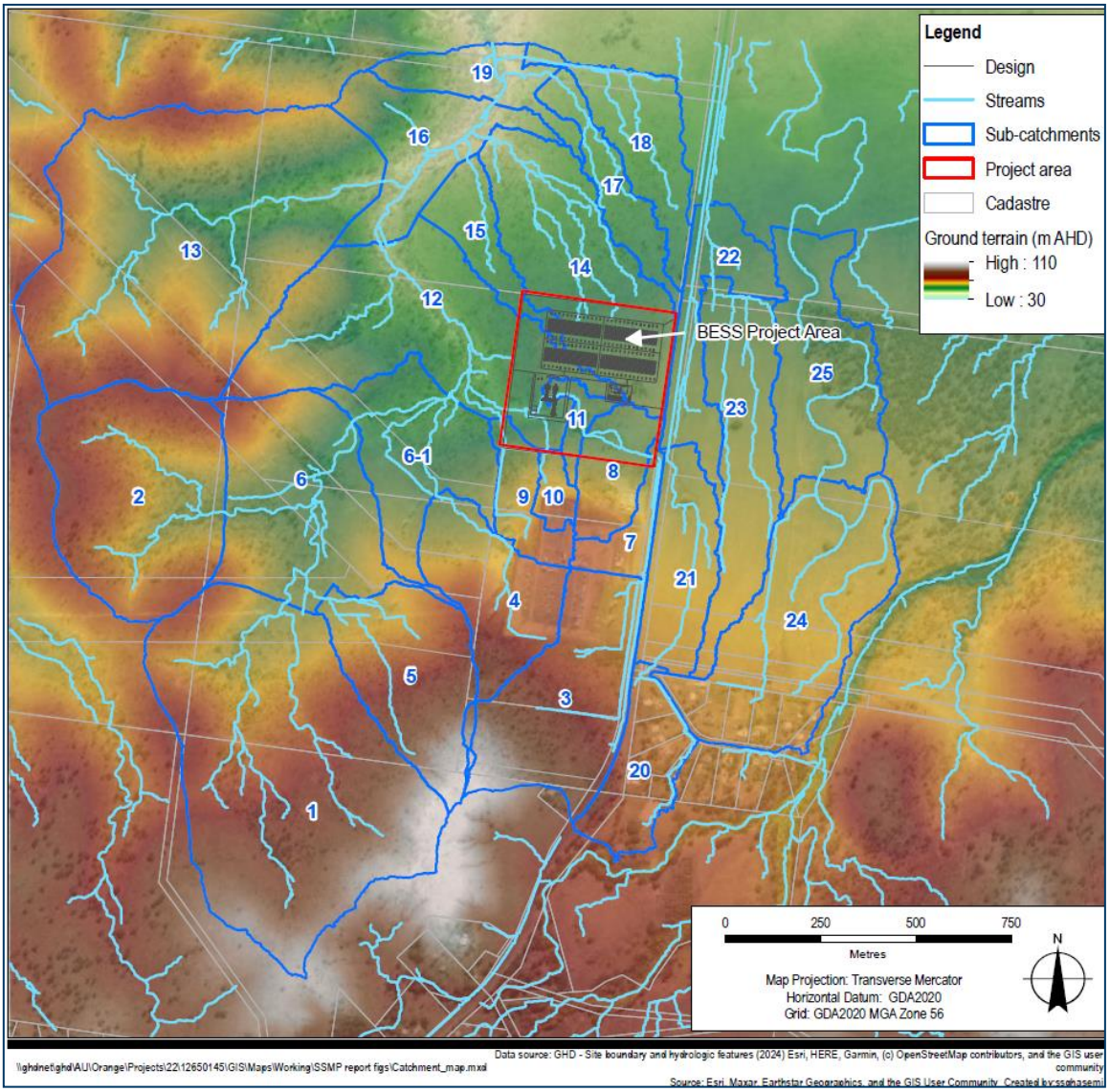


Figure 2 Catchment map

Table 1 Hydrology sub catchment parameters

ID	Area (ha)	Average Slope (%)	Impervious Percentage (%)
1	47.88478	1.95	0
2	24.45269	1.54	0
6-1	13.35944	1.15	0
3	17.62951	1.48	18
4	11.76855	2.37	21
5	14.57373	2.78	0
6	20.75634	1.19	0
7	3.237078	1.85	72
8	5.656706	1.97	23
9	4.411649	2.57	0
10	1.76114	3.74	0
11	1.85106	0.61	0
12	28.0546	0.98	0
13	52.53716	0.91	0
14	19.75952	1.38	0
15	5.307085	1.3	0
16	11.10127	0.91	0
17	5.6319	0.68	0
18	9.008311	0.73	0
19	5.920578	2.1	0
2	24.45269	1.54	0
20	7.925759	0.56	0
21	9.315272	1.02	0
22	8.774422	0.65	20
23	14.24854	0.63	0
24	23.75471	0.56	22
25	15.58462	0.46	0

4.1.2 Design rainfall, temporal patterns and losses

Rainfall Intensity-Frequency-Duration (IFD) data was obtained from the Bureau of Meteorology (BOM) (2016) and is presented in Figure 3 for the different Annual Exceedance Probability (AEP) events.

For the purposes of this assessment, design storms were simulated for the BOM IFD data using design storm durations of 10 minutes to 540 minutes for six (6) AEP events (50%, 20%, 10%, 5%, 2%, 1% AEPs).

The ten (10) standard Australian Rainfall and Runoff 2019 (ARR19) temporal patterns were applied in the hydrologic model.

The losses from the ARR19 Datahub were adopted for this assessment.

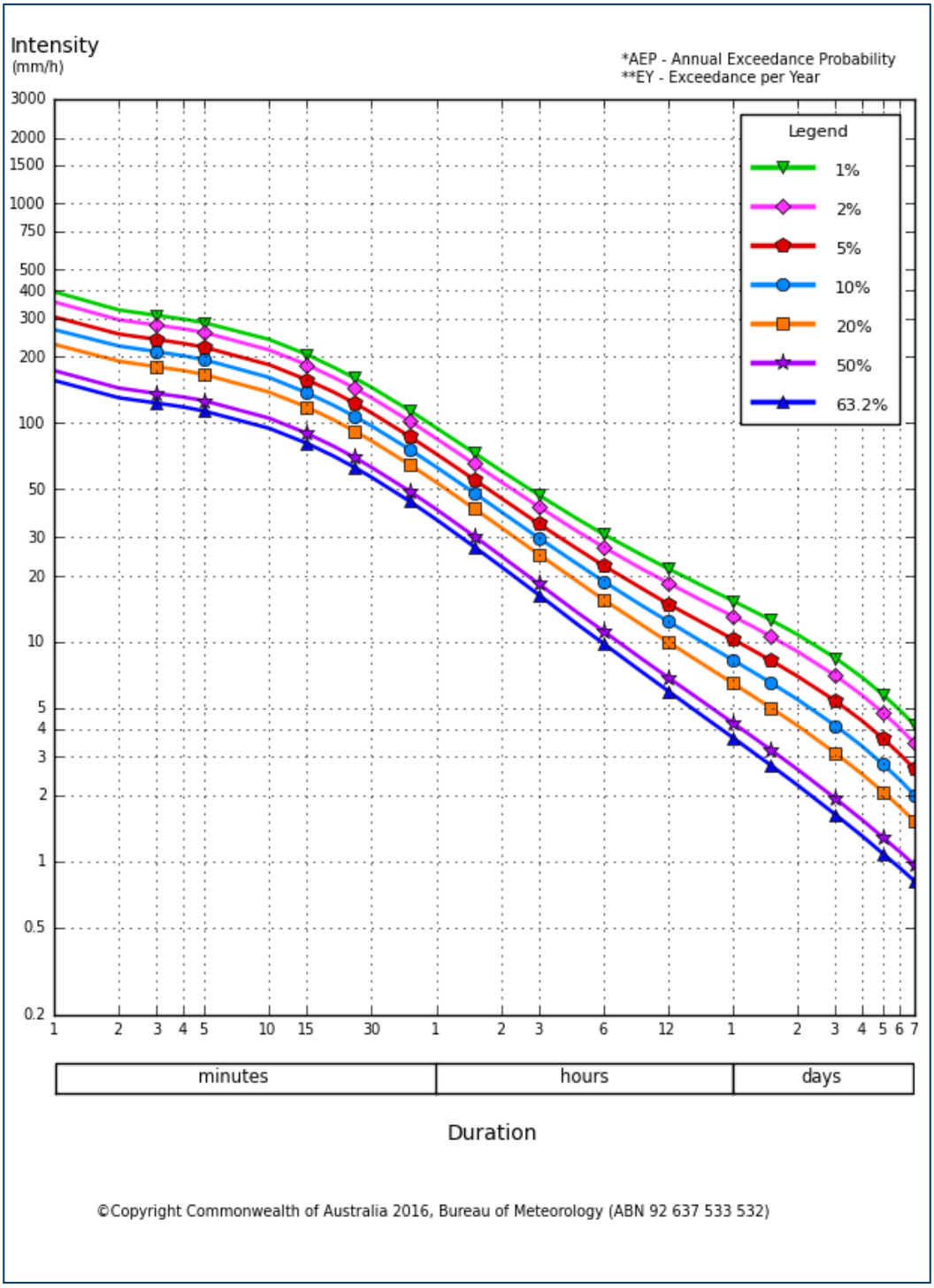


Figure 3 *Design rainfall intensity (Bureau of Meteorlogy, 2016, Extracted 11 December 2024).*

4.1.3 Results

Table 2 presents a summary of the hydrology model results for peak total flow rate for critical duration and median temporal pattern in accordance with AR&R 2019. to three likely outlet locations: Subcatchment 19, Subcatchment 22 and Subcatchment 25.

Table 2 Hydrology model peak flow summary

AEP	Subcatchment 19		Subcatchment 22		Subcatchment 25	
	Peak flow (m^3/s)	Critical storm duration	Peak flow (m^3/s)	Critical storm duration	Peak flow (m^3/s)	Critical storm duration
50%	8.9	9 hours	0.7	4.50 hours	1.2	4.50 hours
20%	16.3	9 hours	1.3	4.50 hours	2.2	4.50 hours
10%	21.9	3 hours	1.7	2 hours	2.8	3 hours
5%	28.0	3 hours	2.2	2 hours	3.5	4.50 hours
2%	30.7	6 hours	2.7	1.50 hour	4.2	1.50 hour
1%	38.2	2 hours	3.3	1.50 hour	5.0	1.50 hour

4.1.4 Validation

An empirical flow estimation using the Rational Method has been used to the validate the hydrologic model results at the following four locations within the catchment:

– Subcatchment 7
– Subcatchment 11
– Subcatchment 6-1
– Subcatchment 12

The Modified Friend's equation has been used to calculate the time of concentration at each of the four locations. This equation is appropriate as the catchment has an area less than 25 km^2.

Table 3 summarises the 1% AEP peak flows estimated from the hydrologic validation and the hydrologic model. The Rational Method results are generally within appropriate variance bounds for the 1% AEP event at the validation location. The hydrologic results are considered reasonable for applying as inflows to the hydraulic model.

Table 3 Summary of peak flow estimates from hydrologic validation

Validation location	1% AEP Peak Flow Rate (m^3/s)		
	XP-RAFTs	Rational Method	Difference (%)
Subcatchment 7	6.8	8.4	-19%
Subcatchment 11	7.4	9.1	-19%
Subcatchment 6-1	19.0	25.3	-25%
Subcatchment 12	29.2	39.3	-26%

4.2 Proposed hydraulic infrastructure

Diversion drains and culverts have been proposed to divert flow from upstream of the site to downstream to the unnamed creek, aiming for minimising flood impacts. Figure 4 showed the proposed hydraulic infrastructures locations.

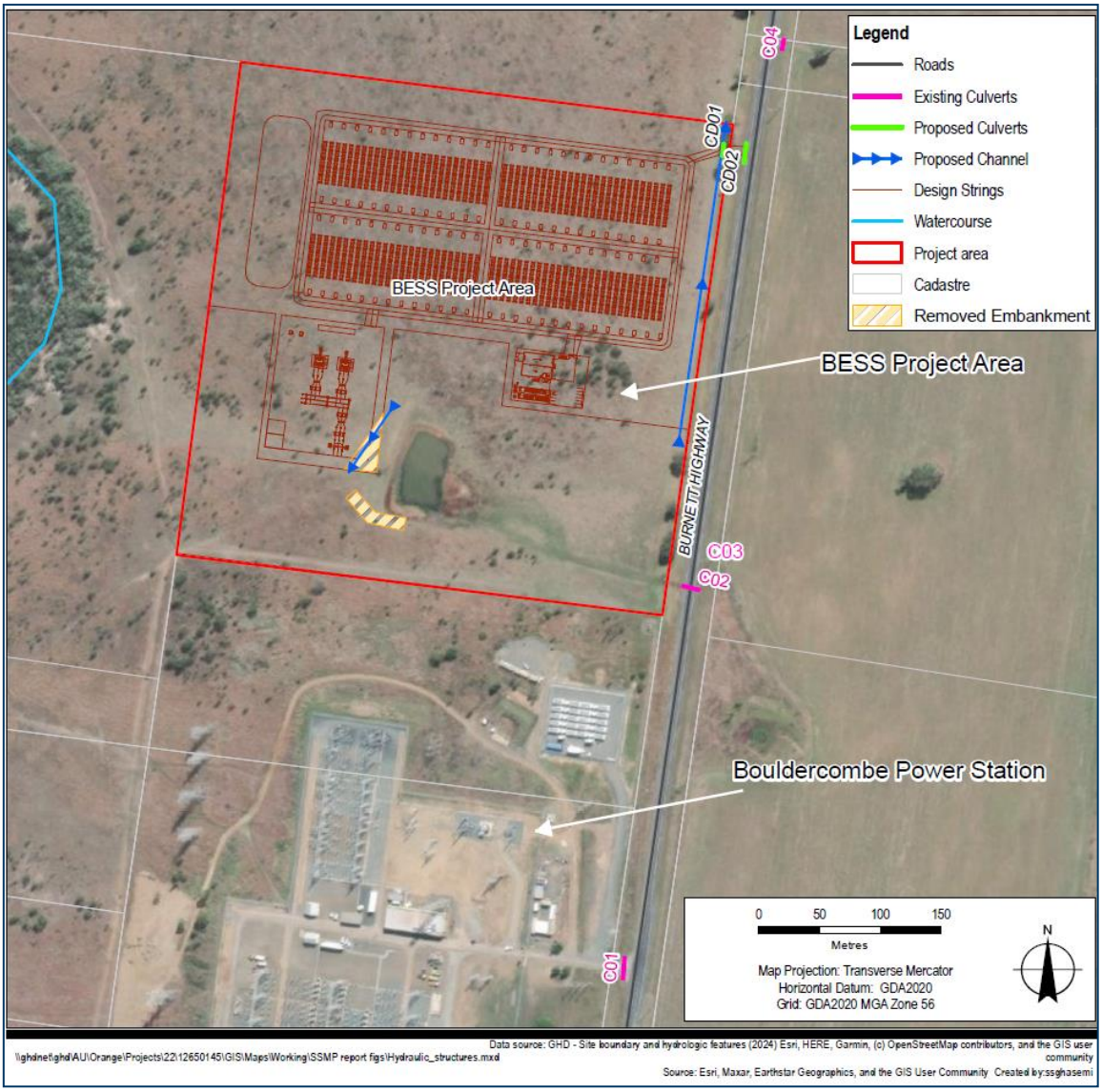


Figure 4 ***Proposed design drains and culvert***

Two (2) culverts proposed under the design access road and proposed tracks. Refer to Figure 4 for the locations of the proposed culverts. The geometry of these culverts were modelled in HY-8 software to determine the optimum size and number of culvert barrels to convey the required flow whilst maintaining a reasonable velocity. Design parameters for the modelling of the culverts are displayed in Table 4.

Table 4 ***Proposed design culverts sizes***

Culvert ID	Design storm event	Design Flow (m^3/s)	Geometry (No. x Width(m) x Height(m))	Type	Minimum road level (mAHD)
CD01[1]	1% AEP	0.5	2x1200x600	RCBC	45.9
CD02[2]	1% AEP	0.3	2x450	RCP	46.3

1- CD01 Culvert on the proposed drainage channel, under the proposed site access road

2- CD02 Culvert on the existing drainage channel at the western side of the Burnett Highway, under the proposed site access road connecting to the Burnett Highway

4.3 Hydraulic modelling

A TUFLOW hydraulic model (version 2023-03-AE-iSP-w64) using the HPC solution scheme was set-up to model the extent of local inundation and to estimate peak flood levels, depths and velocities affecting the BESS site.

TUFLOW HPC solves the Shallow Water Equations (SWE) using a finite volume numerical technique on the central nodes of a fixed grid, which is used to schematise the area of interest.

The hydraulic model set-up is illustrated in Figure 5.

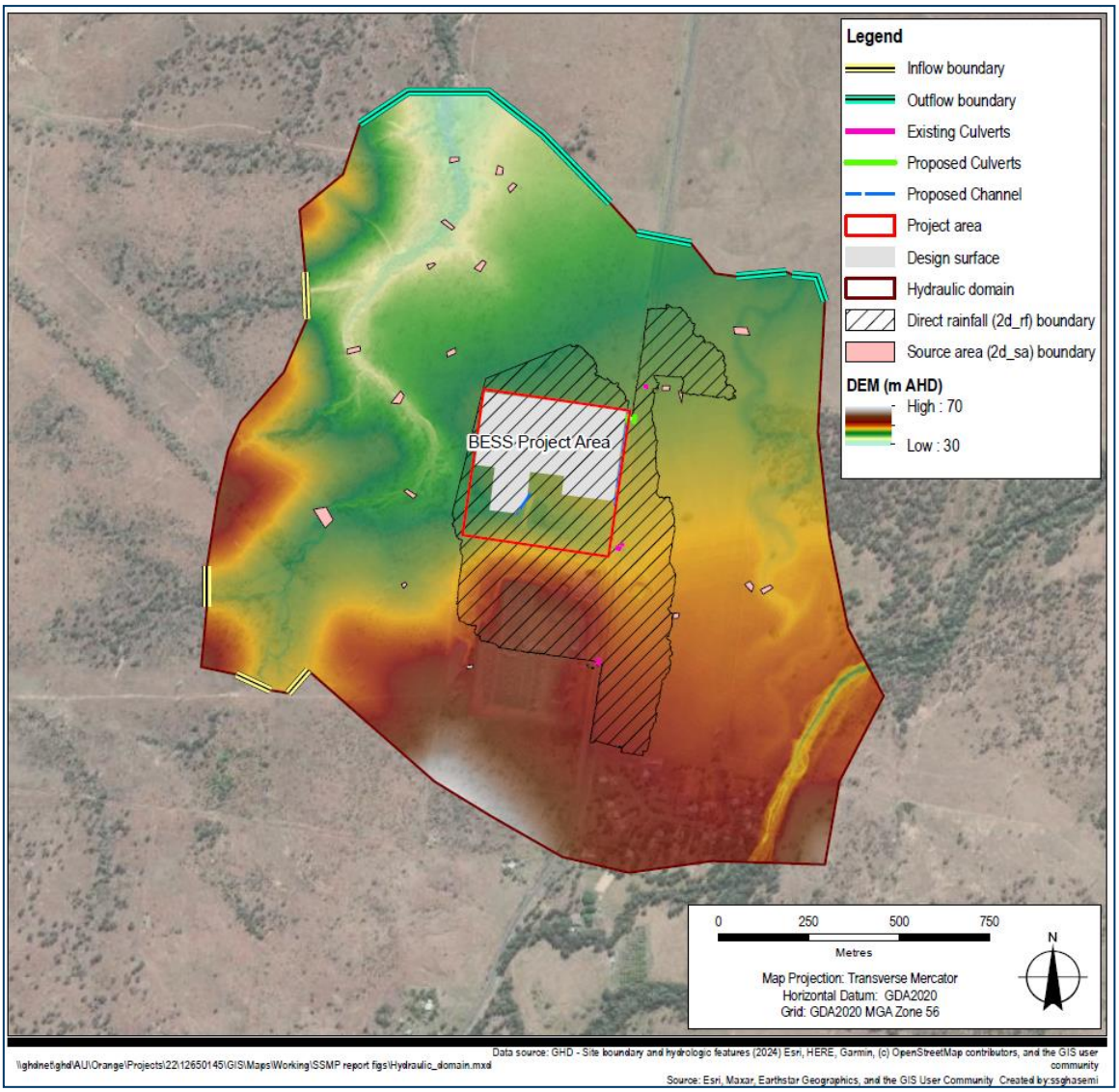


Figure 5 Hydraulic model domain

4.3.1 Model set-up

4.3.1.1 Geometry

The model was developed using a 2 m cell size with sub-grid (SGS) sampling to 1 m for computational efficiency. SGS functionality was enabled to more accurately represent the storage and conveyance in the hydraulic model. Rather than using a single elevation value for each model grid cell elevation, SGS uses the DEM elevations to determine a water surface elevation vs volume and wetted perimeter relationship for each model grid cell. This essentially allows the hydraulic model to sample the full resolution of the provided DEM regardless of the model grid cell size.

The 1 m LiDAR DEM (2015) and the 0.5 m survey DEM (05/2024), detailed in Section 2.1, were included in the hydraulic model to represent the existing ground terrain. No terrain modifications were undertaken.

4.3.1.1.1 Design Geometry

The proposed initial design provided for flood modelling using 2D-DWG format (refer to Section 2.3). The proposed design surface levels are initial and based on 0.5m freeboard for 1% AEP flood levels. The proposed design surface Manning's roughness is based on compacted soil with gravel on top, except for the proposed access road, which has been assumed to be sealed.

The proposed design surface and design drains have been added to the hydraulic model using the 2d zshape layers, it is acknowledged that these do not capture the exact geometric features due to the cell size in the model and are a simplified representation of the proposed design. Figure 6 shows proposed design features.

– Design surface has been added to the model using 2d zshape layers
– Location A: removal of the existing bund at southern side of the existing pond to divert flow toward unnamed creek
– Location B: create an opening at the edge of the proposed design extent to divert flow toward unnamed creek

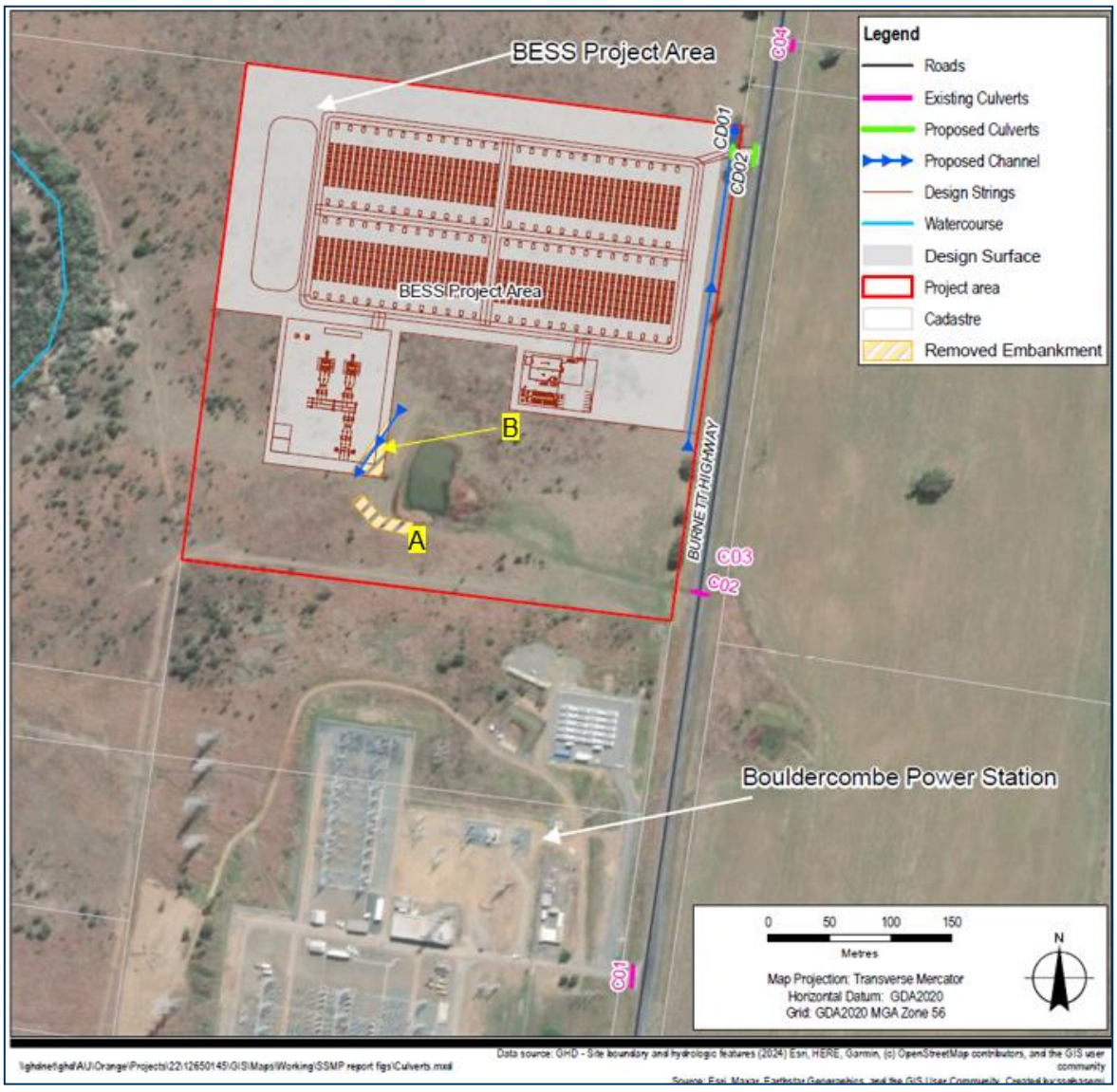


Figure 6 Post-developed site conditions

4.3.1.2 Boundary conditions sensitivity

A combination of boundary conditions was used in the model domain and are illustrated in Figure 5. These include:

– Four (4) flow-time (QT) boundaries for inflows.

– Four (4) normal-depth (HQ) boundaries for outflows with slopes ranging from 1 in 125 to 1 in 333 m/m.
– Twenty-three (23) source-area (SA) boundaries for local inflows near the site.
– One (1) direct gridded rainfall (RF) boundary for inflows on the site where no distinctive flow channels were observed. Rainfall losses have been applied for the direct rainfall section of the model in accordance with ARR19.

4.3.1.3 Hydraulic roughness

The Manning's 'n' coefficient for roughness was estimated from aerial imagery. The Manning's 'n' values for different surface types which were adopted in the hydraulic model are summarised in Table 5 and illustrated in Figure 7 and Figure 8 for pre- and post-development conditions of the site. It should be noted that the proposed design access road assumed sealed, and the proposed design surface has been assumed as compacted soil with a gravel top.

Table 5 Manning's 'n' roughness coefficients

Land Use	Manning's 'n' Roughness Value
Farm / low vegetation	0.045
Road	0.025
Dam / pond / waterway	0.035
Industrial	0.050
Buildings	0.100
Dense vegetation	0.080
Medium vegetation	0.060
Design pads- Compacted soils	0.040
Electricity facility with piles	0.090

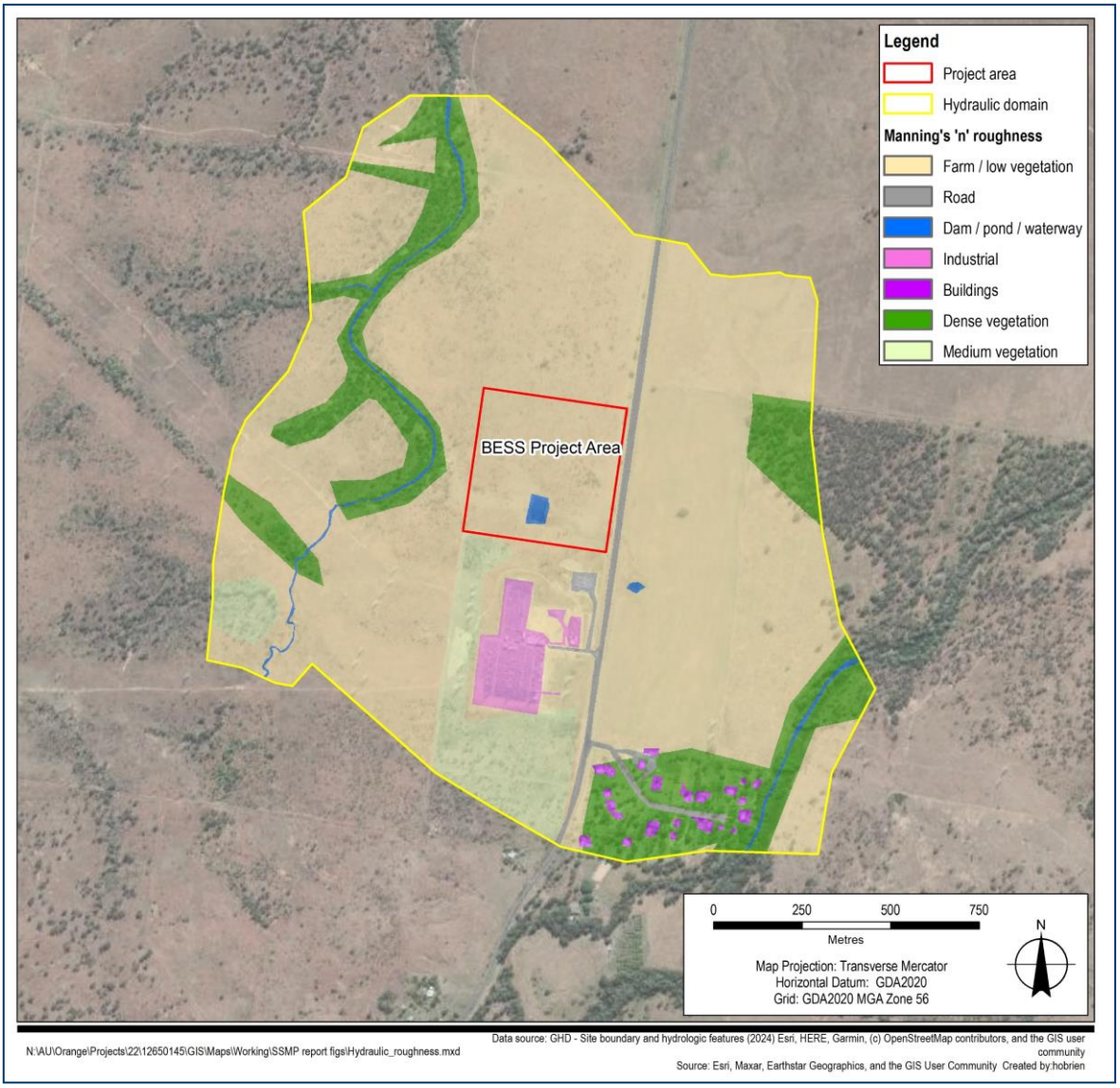


Figure 7 Hydraulic roughness – pre-developed condition

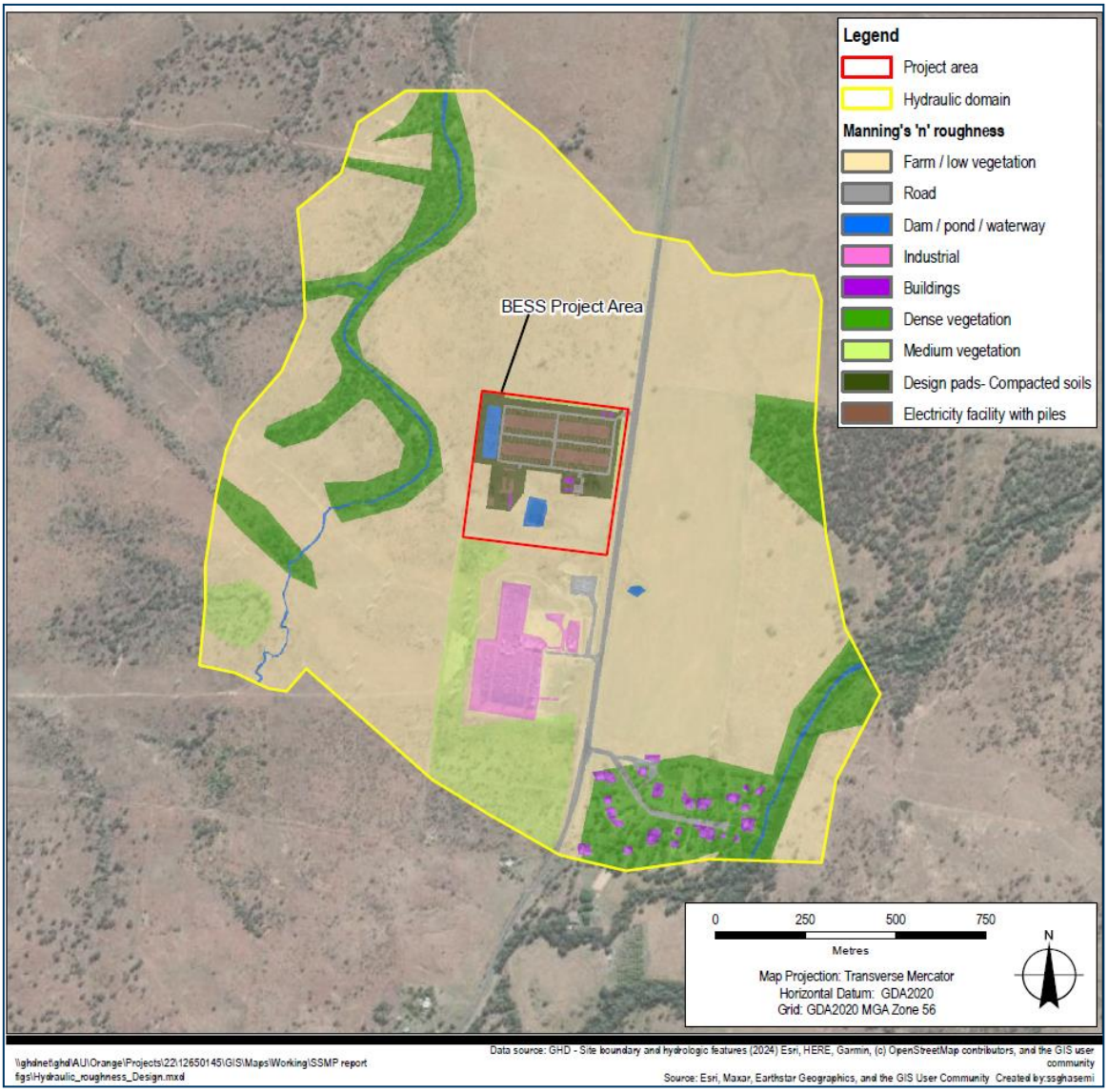


Figure 8 Hydraulic roughness – post-developed condition

4.3.1.4 Hydraulic structures

Hydraulic structures in the model domain were identified and estimated using aerial imagery. The structures were implemented in the model using 1D network (1d_nwk) pipe networks. Culvert length and width has been measured based on the areal imagery, culvert height and invert levels are extracted based on the provided 0.5m DEM. It is recommended to update the culvert information in the next stage of the project. Assumed hydraulic structure details used in the modelling are shown in Table 6 and illustrated in Figure 9.

Table 6 Hydraulic structure details

Culvert ID	Length (m)	Upstream invert (m AHD)	Downstream invert (m AHD)	Diameter (m)	Number of barrels	Existing / Proposed
C01	20	51.67	51.50	0.3	2	Existing
C02	16	46.85	46.56	1.2 x 0.6 (W x H)	2	Existing
C03	9.5	47.24	47.24	0.375	1	Existing
C04	11	44.77	44.52	0.3	1	Existing

For proposed design culverts and channel refer to Section, Figure 9 and Table 4.

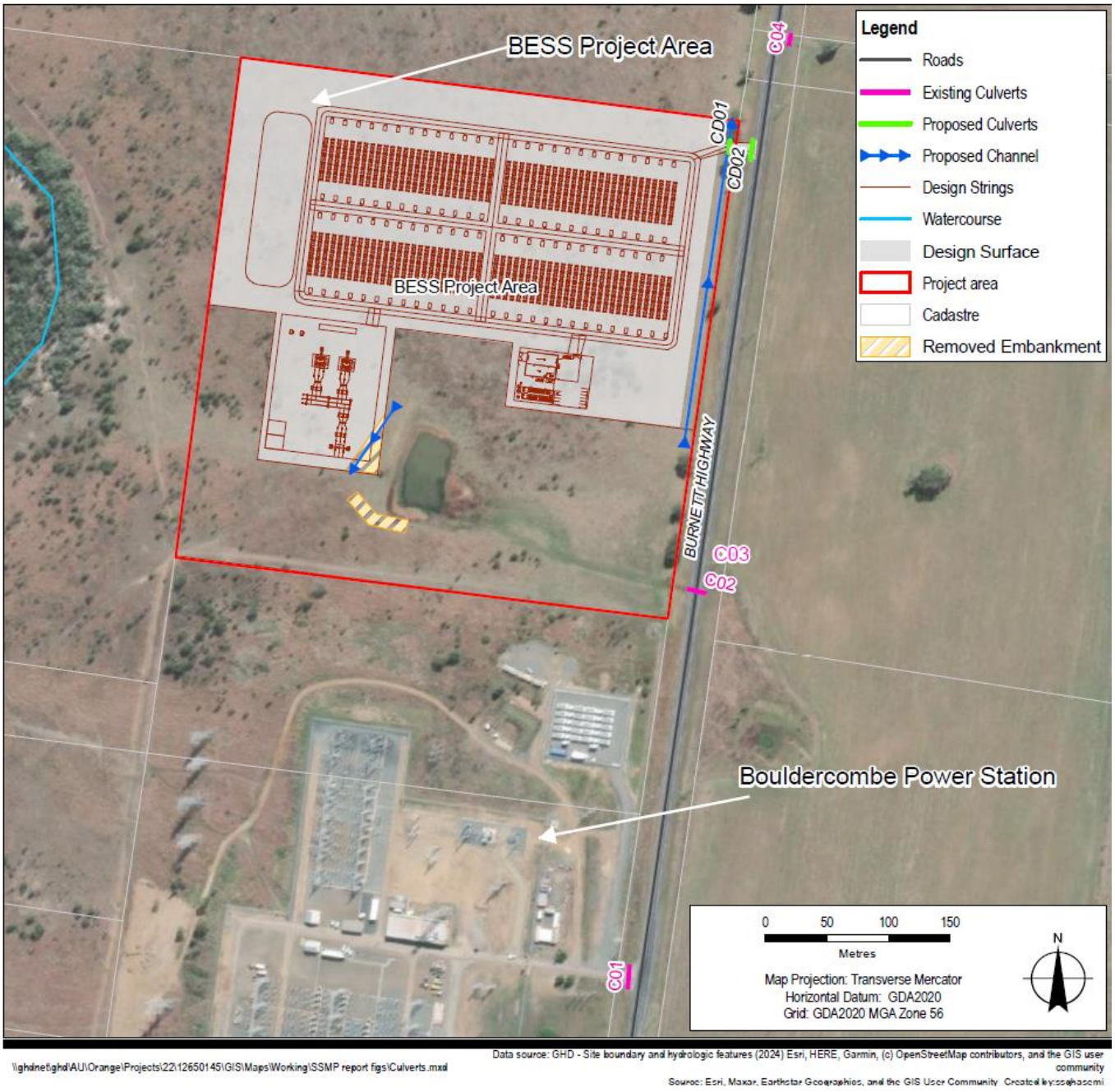


Figure 9 Existing and proposed hydraulic structure

4.3.2 Scenarios

The following six design events have been assessed (50%, 20%, 10%, 5%, 2%, 1% AEP) using storm durations ranging from 10 minutes to 540 minutes for the 10 standard temporal patterns. Modelling has been conducted for pre- and post-development site conditions.

4.3.2.1 Sensitivity scenarios

A sensitivity run involving a 10% variation in Manning's roughness coefficient (n) is conducted in hydraulic modelling to assess the impact of changes in surface roughness on flow characteristics. In these scenarios, the roughness coefficient is adjusted by 10% higher and lower its baseline value, scenario S01 and S02 respectively. This assessment allowing quantify the uncertainty for the evaluation of sensitivity of the flood results due to roughness parameters such as flood water level.

The sensitivity scenarios have been assessed for 1% AEP storm events for 10% increase (S01) and 10% decrease (S02) in adopted Mannings values. Refer to Table 7 for the manning's roughness value for sensitivity scenarios.

Table 7 Manning's roughness value for sensitivity scenarios

Land Use	10% increase – S01 Manning's 'n' Roughness Value	10% decrease – S02 Manning's 'n' Roughness Value
Farm / low vegetation	0.0405	0.0495
Road	0.0225	0.0275
Dam / pond / waterway	0.0315	0.0385
Industrial	0.045	0.055
Buildings	0.09	0.11
Dense vegetation	0.072	0.088
Medium vegetation	0.054	0.066
Design pads- Compacted soils	0.036	0.044
Electricity facility with piles	0.027	0.033

4.3.3 Results

The flood result maps (flood depth and velocity of flow) for the pre-development condition of the site are presented in Figures A1.1 to A2.6 in Appendix A. Below is a summary of the pre-development flood results:

– The pre-developed flood results show that the Burnett Highway has 10% AEP flood immunity. Flood results for 5% showed that the existing Highway is partially inundated. It should be noted that the highway levels are based on the provided 0.5m DEM, and the existing culvert information has been assumed from aerial imagery and the 0.5m DEM (refer to Section 1.3). To ensure a more accurate assessment of the road's flood immunity, it is recommended that this information be updated with a detailed survey in the next stage of the project.
– Flow depth across most of the project area is shallow, except for the existing pond, which has a flood depth of approximately 1.1 meters.
– Flood velocity across most of the site is less than 1.0 m/s, except for the existing flow path, where velocities range from 1.0 to 2.0 m/s in 1% AEP storm event.
– The flow rate estimated using the TUFLOW model has been validated against the hydrology model results for the outlets of Catchments 7 and 12. The 1% AEP flow rates at the catchment outlets are 6.5 m^3/s for Catchment 7 and 36.6 m^3/s for Catchment 12.

The pre- and post-development conditions have been assessed to identify any flood impacts on neighbouring properties, as well as changes to the immunity of the existing Burnett Highway To maintain flood immunity and minimize property impacts in the post-developed condition, the following measures have been implemented:

– The existing pond will be maintained to provide similar storage capacity in both pre- and post-development conditions, minimizing potential downstream impacts caused by changes in water storage volume.
– An opening in the embankment of the existing pond.
– An opening of the southeast corner of the design surface to create a diversion channel
– A bio-detention basin is proposed at the northwest corner of the site to manage water quality (refer to Section 5 for more details).

The post-developed condition flood maps results (flood depth and velocity) are presented in Figures A3.1 to A4.6 in Appendix A for the proposed design scenario (excluding temporary pad) unless otherwise specified. Flood level afflux mapping is provided in Figures A5.1 to A5.6. The following observations were made:

– The flood immunity for Burnett Highway remains the same.

- The velocity on the southern side of the existing pond increased (up to 1.5 m/s) due to the proposed embankment opening. It is recommended to install rock protection at this location to minimize the risk of erosion.
- Flood modelling results showed a velocity of approximately 2.0 m/s downstream of the existing pond on the southern side of the proposed design surface.
- No significant changes in flood velocity are observed on surrounding properties.
- The flow rate slightly increased towards the unnamed creek downstream of the proposed design surface. Specifically, the flow rate showed about a 15% increase (from approximately 10 m^3/s in the pre-developed condition to around 11 m^3/s in the post-developed condition), immediately downstream of the project boundary. This difference gradually decreased, reaching a 4% variation 200 meters downstream of the project boundary.
- The flood afflux results indicate that the increase in water level downstream of the project area is less than 50 mm for most surrounding areas, with the following exception.
    - Immediately downstream of the proposed culvert CD04, afflux reach up to 120 mm for 1% AEP storm event.
    - Upstream of culvert CD02, flood results showed an afflux of 170 mm in 1% AEP storm event at the culvert inlet due to the proposed access road in this location, However, the Burnett Highway remains un-overtopped.

Table 8 summarised flood level results for pre and post development condition of the site for nominated points. Refer to Figure 10 for the point locations.

Table 8 Water level results (mAHD) for nominated points. Refer to Figure 10 for point ID locations

ID	1% AEP		2% AEP		5% AEP		10% AEP		20% AEP		50% AEP	
	Pre-develop't	Post-develop't	Pre-develop't	Post-develop't	Pre-develop't	Post-develop't	Pre-develop't	Post-develop't	Pre-develop't	Post-develop't	Pre-develop't	Post-develop't
L1	47.71	47.71	47.67	47.67	47.63	47.63	47.55	47.55	47.43	47.43	47.31	47.31
L2	47.91	47.91	47.89	47.89	47.85	47.85	47.79	47.79	47.68	47.68	47.42	47.42
L3	47.79	47.79	47.78	47.78	47.75	47.75	-	-	-	-	-	-
L4	47.55	47.55	47.53	47.53	47.50	47.50	47.49	47.49	47.46	47.46	47.35	47.35
L5	47.14	47.14	47.13	47.13	47.12	47.12	47.11	47.11	47.09	47.09	47.03	47.03
L6	47.13	47.13	47.13	47.13	47.12	47.12	47.12	47.12	47.11	47.11	-	-
L7	47.13	47.13	47.12	47.12	47.12	47.12	47.12	47.12	47.11	47.11	47.11	47.11
L8	45.89	45.72	45.87	45.70	45.85	45.68	45.83	45.65	45.81	45.63	45.74	45.57
L9	45.89	45.69	45.87	45.66	45.85	45.63	45.83	45.59	45.80	45.56	45.73	45.46
L10	45.77	45.62	45.75	45.60	45.74	45.57	45.72	45.54	45.71	45.51	45.65	45.47
L11	43.31	43.34	43.30	43.33	43.28	43.31	43.27	43.29	43.25	43.27	43.20	43.21
L12	42.75	42.76	42.74	42.75	42.73	42.74	42.71	42.72	42.70	42.71	42.67	42.67
L13	41.78	41.79	41.69	41.70	41.61	41.62	41.52	41.53	41.43	41.44	41.25	41.26
L14	43.55	43.55	43.54	43.54	43.54	43.54	43.53	43.53	43.53	43.53	43.52	43.52
L15	45.86	45.86	45.83	45.83	45.80	45.80	45.72	45.72	45.65	45.65	45.55	45.55
L16	45.56	45.57	45.55	45.56	45.54	45.52	45.54	45.49	45.53	45.46	45.51	45.43
L17	45.51	45.51	45.50	45.50	45.49	45.48	45.48	45.47	45.46	45.46	45.44	45.44
L18	43.35	43.38	43.34	43.38	43.33	43.37	43.32	43.37	43.31	43.36	43.29	43.35

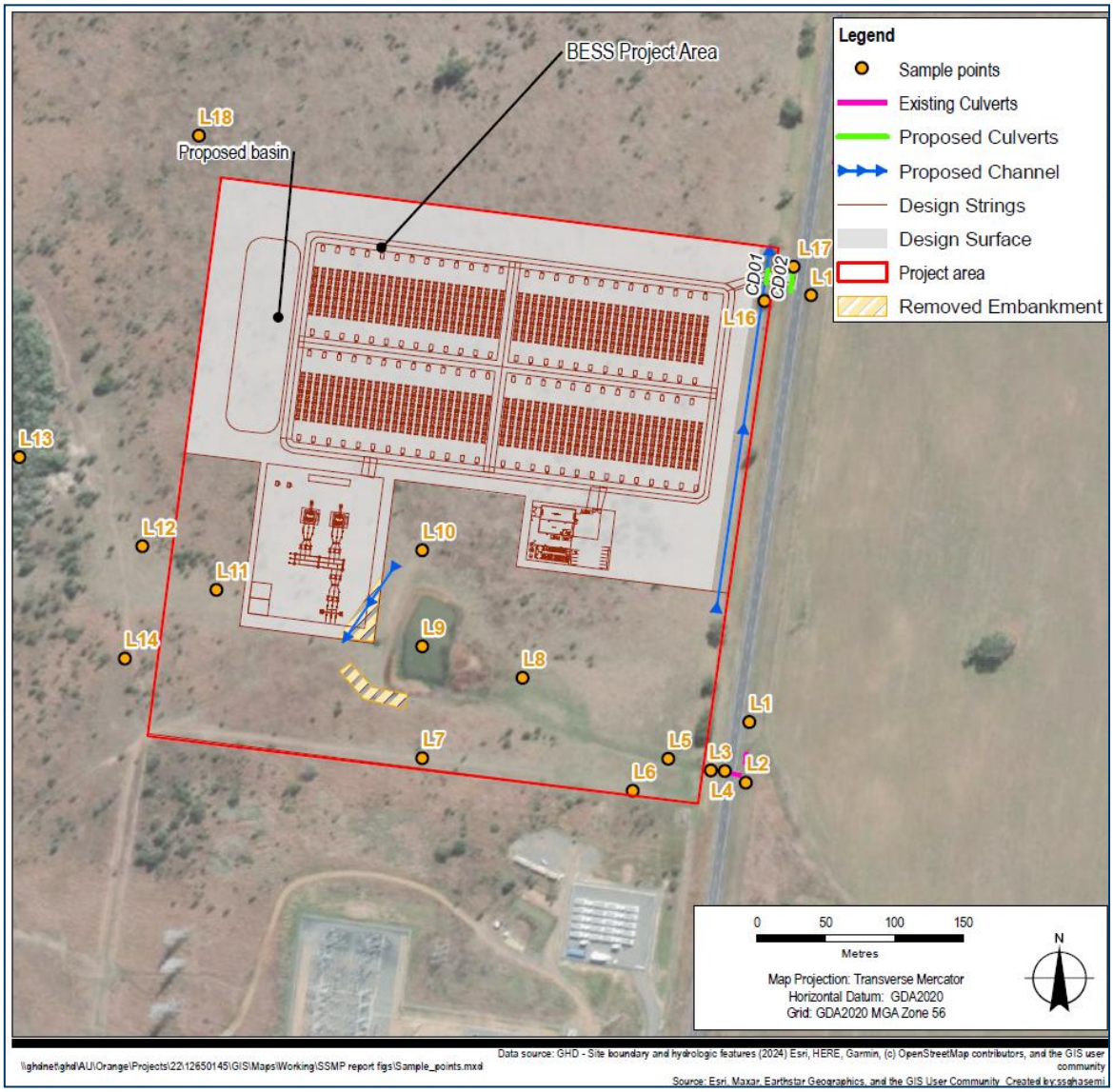


Figure 10 Hydraulic model results sample locations

4.3.3.1 Sensitivity Results

The results of the sensitivity analysis, with a 10% variation in Manning's roughness coefficient, showed minor changes. A 10% increase in roughness led to a slight decrease in flow velocity (~0.1 m/s) and a small rise in water level (~10 mm to ~40 mm) for 1% AEP storm event. In contrast, a 10% reduction in roughness resulted in a modest increase in flow velocity (~0.1 m/s) and decrease in water level (~10 mm to ~50 mm) for the 1% AEP event. However, the flood level impact on the surrounding area remained almost the same for both the sensitivity scenarios and the adopted Manning's roughness. Refer to Appendix C for the flood level afflux maps for sensitivity scenarios for 1% AEP storm event.

5. Stormwater quality

GHD has undertaken a stormwater quality assessment of the proposed development post construction. The following standards and guidance documentation has been adopted for the review:

– WaterByDesign MUSIC Modelling Guidelines (November 2018)
– Queensland State Planning Policy (July 2017)
– Queensland State Planning Policy Interactive Mapping System.

5.1 Water quality objectives (WQOs)

The ultimate development must achieve the relevant water quality objectives as given in the State Planning Policy (2017). This includes the following minimum reductions in mean annual loads compared with untreated stormwater runoff from the developed part of the site:

– Total Suspended Solids: 85% Reduction
– Total Phosphorous: 60% Reduction
– Total Nitrogen: 45% Reduction
– Gross Pollutants: 90% Reduction

These WQOs have been adopted for this design.

5.2 Water quality modelling

A MUSIC model has been prepared to determine the performance of the proposed treatment devices in achieving the required pollutant reduction loads. The software package MUSIC (Model for Urban Stormwater Improvement Conceptualisation) was used to model the pollutant exportation for the industrial allotment and associated roads in their mitigated and unmitigated post-development condition.

Pollutant export rates for Total Suspended Solids (TSS), Total Nitrogen (TN), Total Phosphorus (TP) and Gross Pollutants (GP) were available in MUSIC to model the water quality discharge from the site. Accordingly, these pollutants became the focus of the analysis to compare the unmitigated development discharge to the mitigated development discharge and the required percentage reduction of the median loads for the following indicators (WQOs):

– Suspended solids (SS);
– Total Nitrogen (TN); and
– Total Phosphorus (TP).
– Gross Pollutants (GP)

MUSIC was used to model the exportation rates of the relevant pollutants, and the effect that the selected treatment train had on the reduction of these pollutants from the site stormwater runoff.

5.2.1 MUSIC modelling

The parameters adopted for the MUSIC analysis of the site have been taken from the MUSIC Modelling Guidelines (November 2018). Table 9 lists the parameters of the adopted Land Use node in MUSIC.

Table 9 Land use parameters

Parameter		Land Use Value (Industrial)
Impervious Area Properties	Rainfall Threshold (mm/d)	1
Pervious Area Properties	Soil Storage Capacity (mm)	100
	Initial Storage (% Capacity)	30
	Field Capacity	100

Parameter		Land Use Value (Industrial)
	Infiltration Capacity Coefficient A	200
	Infiltration Capacity Coefficient B	1
Groundwater Properties	Initial Depth (mm)	10
	Daily Recharge Rate (%)	4
	Daily Baseflow rate (%)	2
	Daily Deep Seepage Rate (%)	0.4

5.2.2 Meteorological data

Rainfall data with a six-minute time step has been obtained from the Bureau of Meteorology (BOM) for the Rockhampton AERO Station 039083 from 31/03/2000 to 31/03/2010. The corresponding evapotranspiration rates for the various months were also obtained from BOM, utilising the average annual and monthly evapotranspiration maps.

Climate data, including rainfall intensity, duration, and frequency, is based on historical averages. Rainfall intensity is not assumed to increase.

5.2.3 Source Nodes

The Industrial source node in MUSIC has been modelled with a 'lumped catchment land use'. The pollutant export parameters for the industrial source node have been adopted in line with MUSIC Modelling Guidelines (2018).

Baseflow and stormflow pollutant export parameters used in the analysis are provided in Table 10.

Table 10 Pollutant generation parameter

Land Use (lumped)	TSS log^{10} Values		TP log^{10} Values		TN log^{10} Values	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev
Baseflow	0.78	0.45	-1.11	0.48	0.14	0.2
Stormflow	1.92	0.44	-0.59	0.36	0.25	0.32

Catchment details for source nodes are shown in Table 11 below. The impervious percentage was estimated based on the current site layout at the time of writing this report (refer to Figure 11). The nominated 90% impervious percentage falls within the recommended range of 70% to 95% for industrial sites, as per the MUSIC Modelling Guidelines (2018). This is in line with the guidelines, which account for the higher levels of imperviousness typically associated with industrial developments.

Table 11 Catchment Area

Catchment	Area (ha)	Surface Type	Impervious Percentage (%)
Total Site Area	10.198	Urban - Industrial	90

Please refer to Figure 11 for the assumed extents of the catchment. Please refer to Appendix B for site specific details.

Figure 11 Water quality catchment extent (in blue)

5.2.4 Stormwater Quality Treatment

To reduce the exportation of pollutants via stormwater from the site, some Stormwater Quality Improvement Devices (SQIDs) were integrated into the development. The selection process for the SQIDs considered the treatment efficiencies of the SQIDs in reducing TSS, TN and TP, effectiveness in peak flow attenuation, cost, site restrictions and footprint required.

A conventional bio-retention basin with a 600 mm filter depth has been modelled for pollutant reduction. It is assumed that all surface runoff within the assumed water quality catchment extent can be directed into this bio-retention basin. At this early stage of design, the bioretention basin is assumed to have a square shape (equal length and width) for the purpose of determining the surface area. This assumption simplifies calculations and provides a baseline for further refinement as the design progresses.

The parameters of the bio-retention basins modelled in MUSIC are shown below:

Table 12 Bio-retention basin details

Design Properties	Value
Extended Detention Depth	0.3 m
Surface Area	1826 m^2
Filter Area	1750 m^2
Saturated Hydraulic Conductivity	200 mm/h
Filter Depth	0.6 m
TN Content of Filter Media	400 mg/kg
Orthophosphate Content of Filter Media	30 mg/kg
Exfiltration Rate	0 mm/hr
High Flow Bypass	100 m^3/s

Design Properties	Value
Lining, Vegetation and Outlet Properties	Unlined basin, with an underdrain present and vegetation with effective nutrient removal plants.

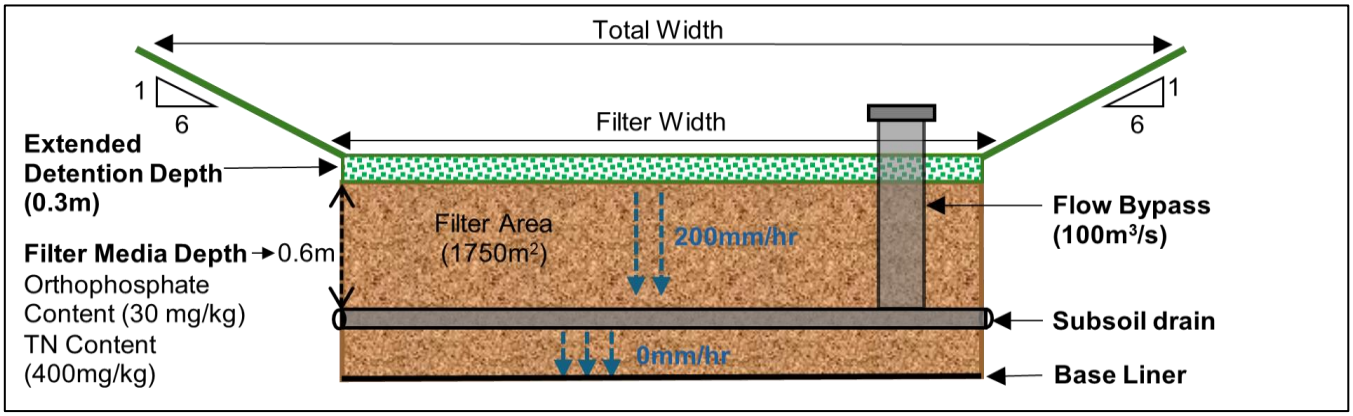


Figure 12 *Bio-retention basin typical layout*

5.2.5 Mitigated post development case

A MUSIC analysis has been undertaken with the incorporation of the bio-retention system discussed in Section 5.2.40. The MUSIC model layout is provided in Figure 13, while the resulting annual pollutant load reductions are provided in Table 13.

Figure 13 *MUSIC Model Layout*

Table 13 *Mitigated post development results*

Pollutant	Source Load	Residual Load	WQO	Achieved Reduction
Total Suspended Solid (kg/year)	7722	1091	>85%	85.87%
Total Phosphorous (kg/year)	20.16	7.989	>60%	60.37%

Pollutant	Source Load	Residual Load	WQO	Achieved Reduction
Total Nitrogen (kg/year)	131	54.85	>45%	58.14%
Gross Pollutants (kg/year)	1428	0	>90%	100.00%

The results in Table 13 indicate that through the incorporation of the bio-retention basin, the proposed development achieves the required WQO's.

5.2.6 Model Sensitivity to Bypass Flows

The bio-retention basin parameters proposed in Section 05.2.4 assumes that the site can convey all surface water to the bio-retention basin. It is expected that future design phases will develop the site earthwork and drainage models which would likely include an underground piped network and open channels. A sensitivity analysis was undertaken to determine the impact to the required bio-retention filter area sizes with increasing site bypass catchments. Table 14 indicates the minimum bio-retention basin filter area required with 5%, 10% and 20% site bypass catchments.

Table 14 Water quality sensitivity analysis

Site Bypass Catchment (%)	Bio-retention Filter Area (m^2)	TSS Reduction (%)	TP Reduction (%)	TN Reduction (%)	GP Reduction (%)
WQO	NA	>85	>60	>45	>90
0% Site bypass catchment	1 750	85.87	60.37	58.14	100.00
5% Site bypass catchment	2 250	86.74	61.2	59.37	95.00
10% Site bypass catchment	3 750	85.88	63.40	63.77	90.00
20% Site bypass catchment	10,000 m^2 bioretention did not achieve reduction targets. Consider alternative or additional SQIDs to achieve WQO's.				

The results in Table 14 indicated that increasing site bypass catchments resulted in exponentially larger bioretention filter areas to compensate and still meet the site WQO. It is recommended that future earthwork and drainage designs minimise the amount of site bypass catchment flows, by ensuring positive fall and grading to the proposed bioretention basin. This will minimise the required bioretention filter area and/or avoid the introduction of additional SQIDS to meet the target water quality objectives.

5.3 Maintenance

The ongoing maintenance, including but not limited to the maintenance of the bio-retention vegetation, will be the responsibility of the site owner/operators and should be undertake as outlined below. Due to the project's climatic region, it is recommended that the detailed design of the bio-retention basin utilises a submerged zone via an elevated underdrainage outlet. This will maintain more moisture within the bio-retention, improving vegetation health and minimising potable irrigation requirements.

A bio-retention filter should only be installed once the majority of the sediment producing activities for the proposed development has been completed. To minimise the accumulation of sediment within the vegetation and to improve maintenance, it is recommended that a sediment forebay is incorporated within the detailed design of the bio-retention basin.

The following sections provide expected maintenance requirements for the bio-retention basin.

5.3.1 Short term (weekly – monthly)

Short term maintenance of bio-retention systems shall be undertaken by the Proponent or its approved sub-contractor, and it should comprise mainly of:

– Weeding
– Watering
– Mowing (batters)

5.3.2 Medium term (half yearly/yearly)

To be completed by the Proponent or its approved sub-contractor on a biannual/annual or event-based trigger. Items to be checked and/or maintained include:

– Erosion
– Grass condition
– Flow conveyance/blockage
– Sedimentation
– Evidence of ponding
– Back-washing of filter material
– Cleanout of sediment forebay.

5.3.3 Long term (replacement)

Triggered by the results of medium-term assessment, the long-term replacement of bio-retention systems will occur from gross failure caused by large storm events or long-term use. Replacement and/or rectification works shall be completed by the Proponent or its approved sub-contractor. This work should generally include some or all of the following:

– Removal of accumulated sediment
– Replacement of underdrain system
– Replacement of filter material
– Grading of basin invert
– Replacement of surface vegetation.

6. Conclusion and recommendations

This report outlined the stormwater quantity and stormwater quality assessments undertaken by GHD for the proposed BESS project site. As part of the stormwater quantity assessment, existing site conditions (pre-development) were assessed to provide an understanding of the flood behaviour across the project site. Additionally, post-development conditions were assessed to evaluate potential flood impacts on neighbouring properties and immunity of the Burnett Highway.

6.1 Stormwater Quantity

The flood analysis for both pre- and post-development conditions at the project site indicates that the proposed design will effectively manage flood risks while minimising downstream impacts. The Burnett Highway will maintain flood immunity. It should be noted that the existing highway levels and existing culverts' invert levels extracted from provided 0.5 m DEM, it is recommended to update the levels and culverts details in the next stage of the project using detailed survey. The retention of the existing pond ensures similar storage capacity between pre- and post-development conditions, mitigating potential flood risks downstream.

Based on the flood velocity results appropriate measures such as rock protection at the culvert outlets and inlets have been recommended to reduce erosion risks. Additionally, the proposed access track adjustments and culvert placements will address local flood conditions without significantly impacting surrounding properties.

The proposed design effectively manages flood risks and minimises adverse effects on the surrounding areas. The flood afflux results indicate that the increase in water level downstream of the project area is less than 50 mm for most surrounding areas, except for upstream of proposed culvert CD02.

Overall, the assessment indicated that the proposed design would maintain the existing immunity of the Burnett Highway and no adverse impacts on surrounding properties.

6.2 Stormwater Quality

A stormwater quality analysis was undertaken in MUSIC for the proposed development.

The site was modelled with the inclusion of a bio-retention basin with a filter media area of 1750 m^2, to achieve the Water Quality Objectives (WQO) for the site. This assumes that all surface water is able to be directed to the basin and hence there is 0% site bypass catchments.

A sensitivity analysis was undertaken to investigate the effect of increasing site bypass catchments on the required bioretention filter area. This analysis indicated that if 5% of the site catchment bypasses the bioretention basin, the basin filter area would need to be increased to 2250 m^2 to still achieve the site's WQO. Similarly for a 10% site catchment bypass, the basin filter area would need to increase to 3750 m^2. When bypass catchments grew to 20% of the site, results indicated that the bioretention filter area would need to increase to greater than 10,000 m^2 to achieve the sites WQO, which was not considered to be practical.

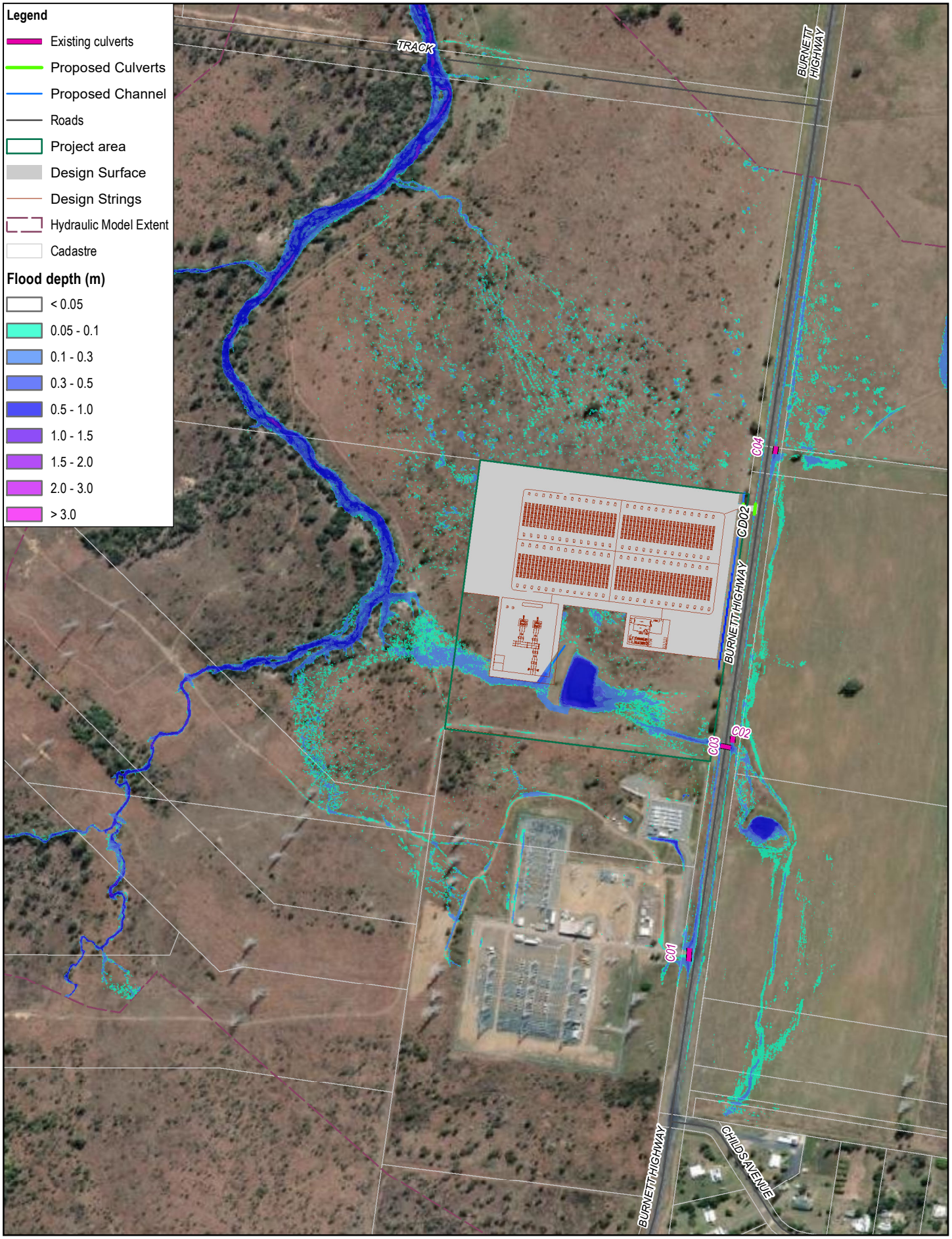
It is recommended that future earthwork and drainage designs minimise the amount of site bypass catchments, by ensuring positive fall and grading to the proposed bioretention basin. This will minimise the required bioretention filter area and avoid the introduction of additional SQIDS to meet the target water quality objectives.

It is recommended that once earthwork and pipe drainage designs are progressed, the MUSIC model is updated to incorporate the final design areas and bypass catchments to ensure that the bioretention basin still achieves the required site WQOs.

Appendices

Appendix A

Flood maps



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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
50% AEP storm event
Flood depth (m)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A3.1

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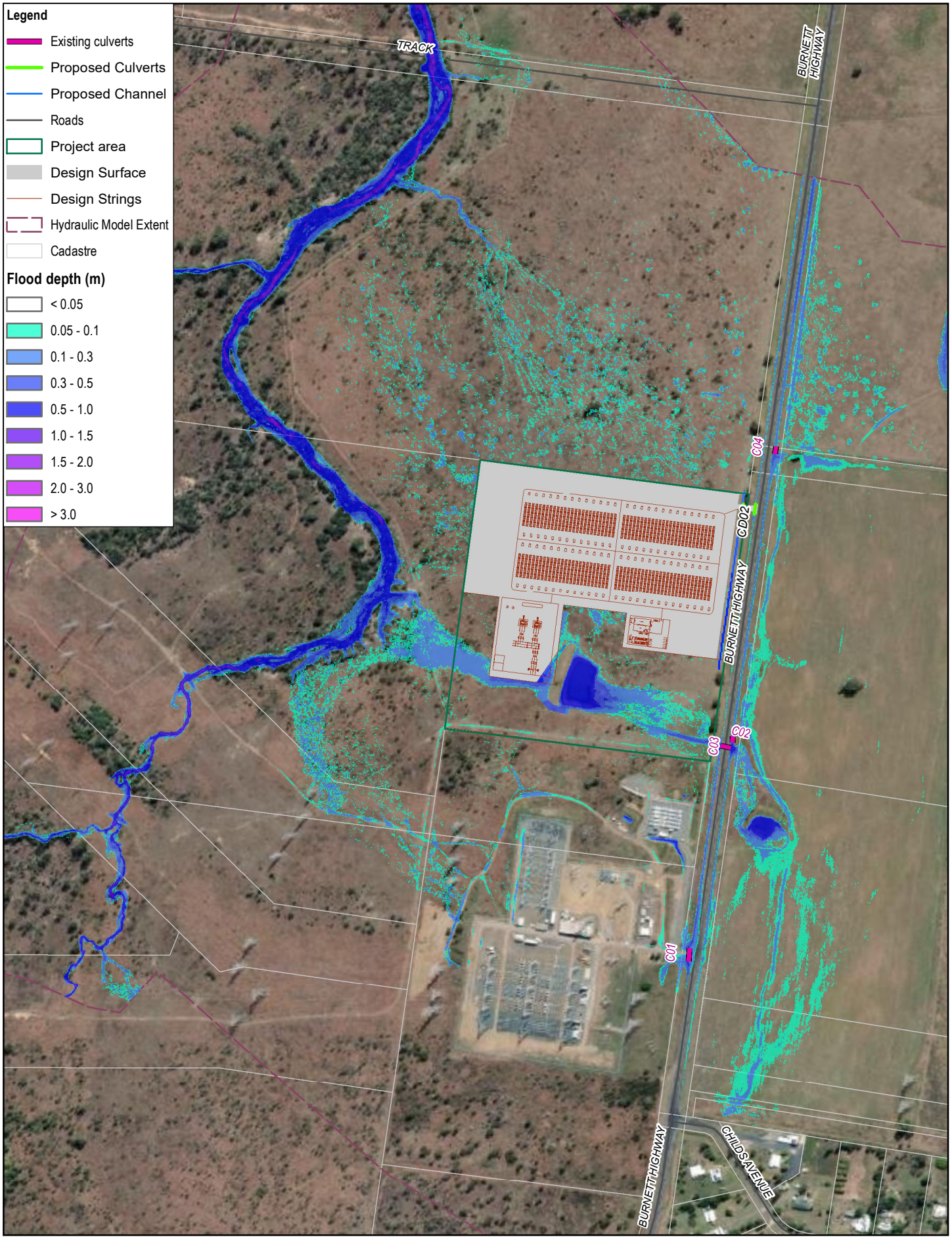

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GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
20% AEP storm event
Flood depth (m)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A3.2

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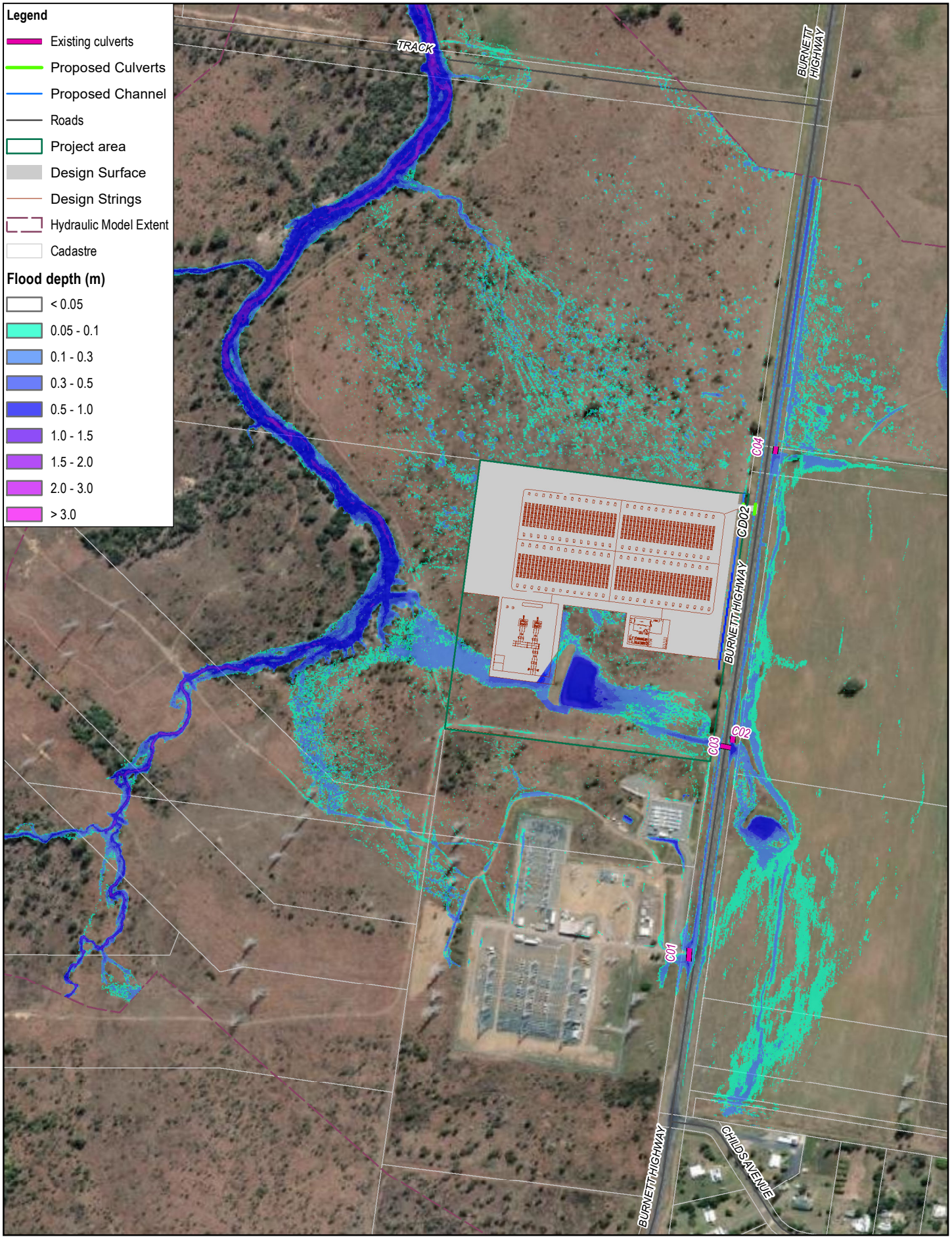

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
10% AEP storm event
Flood depth (m)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A3.3

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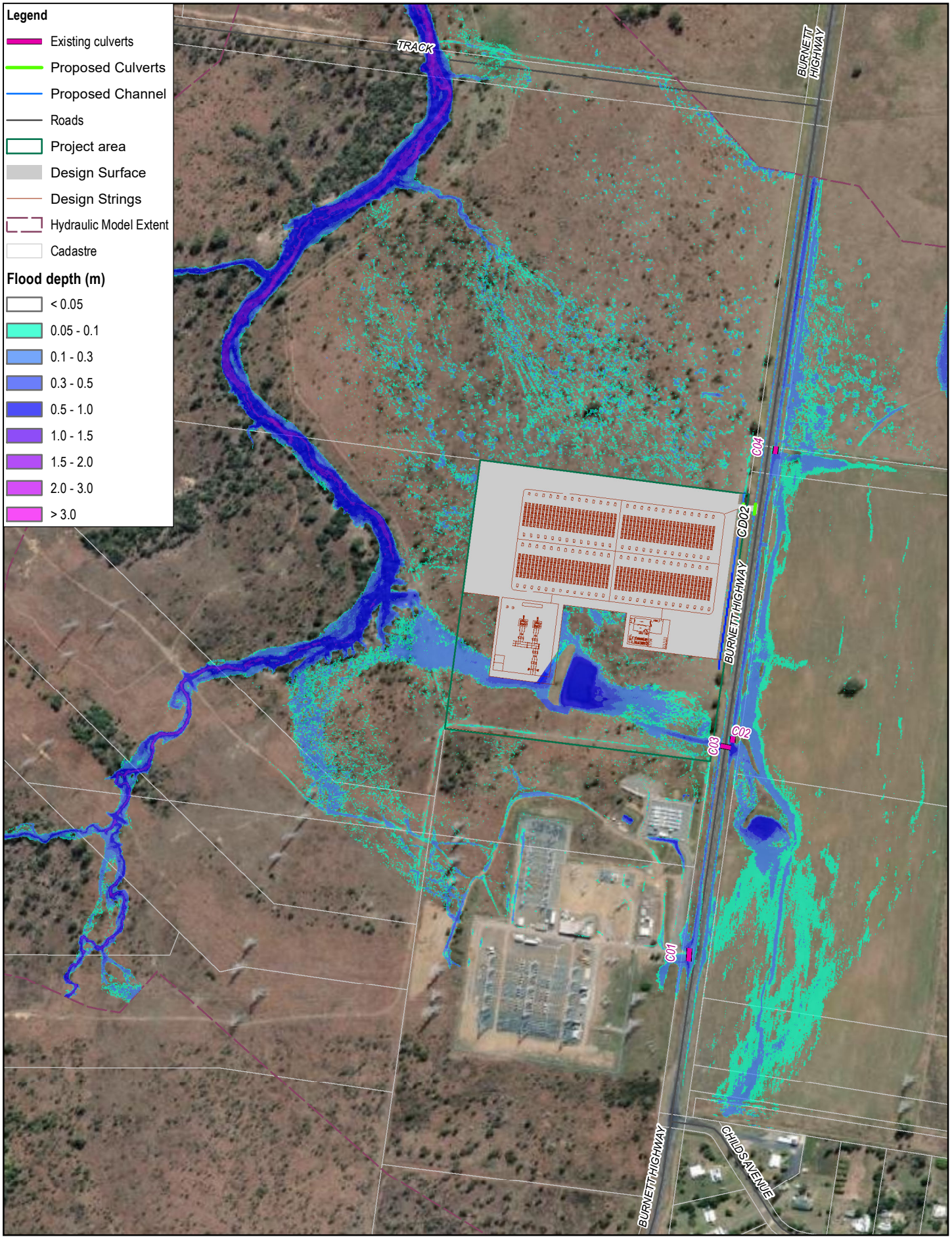

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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Capricorn BESS

Post_Developed site conditions
05% AEP storm event
Flood depth (m)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A3.4

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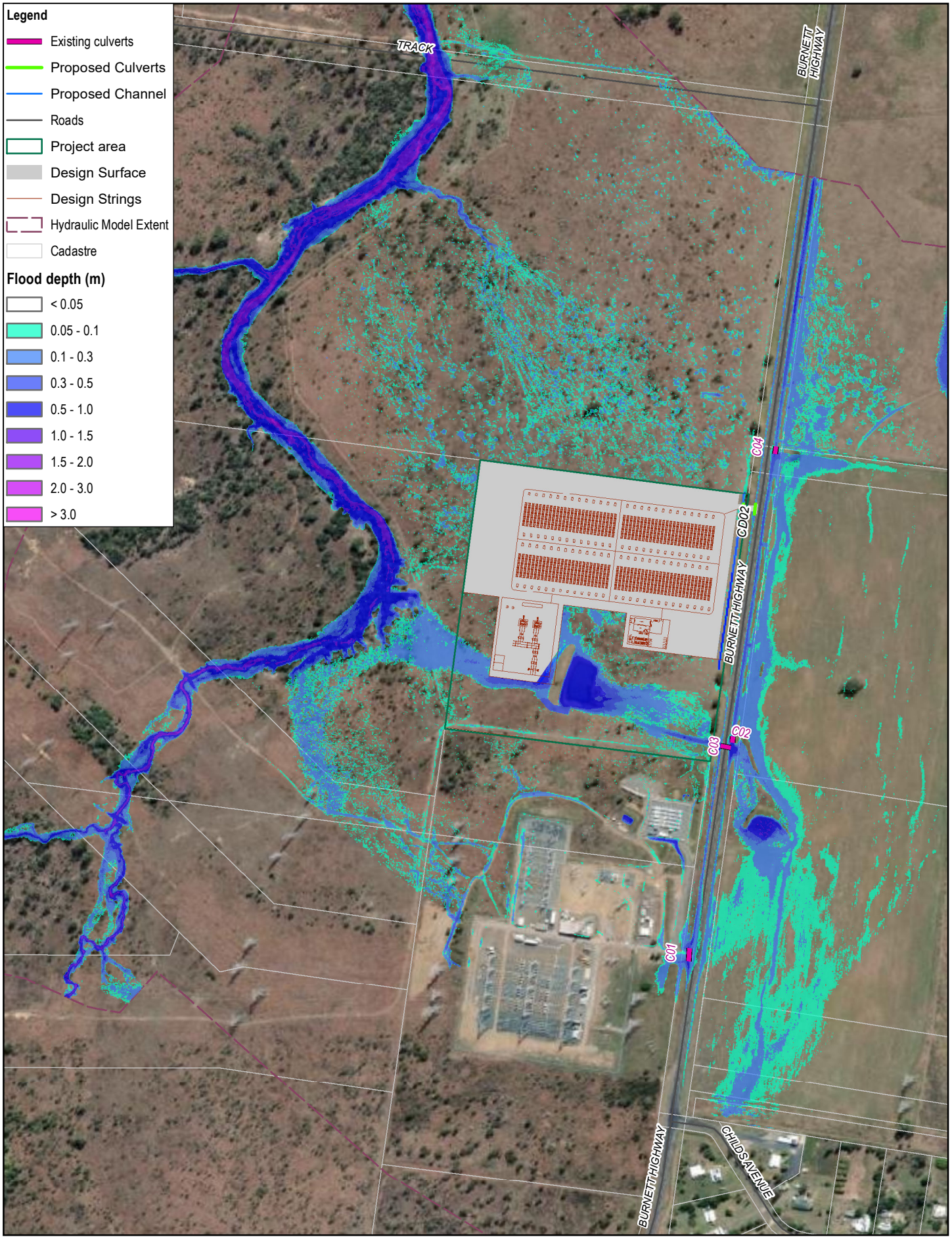

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
02% AEP storm event
Flood depth (m)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A3.5

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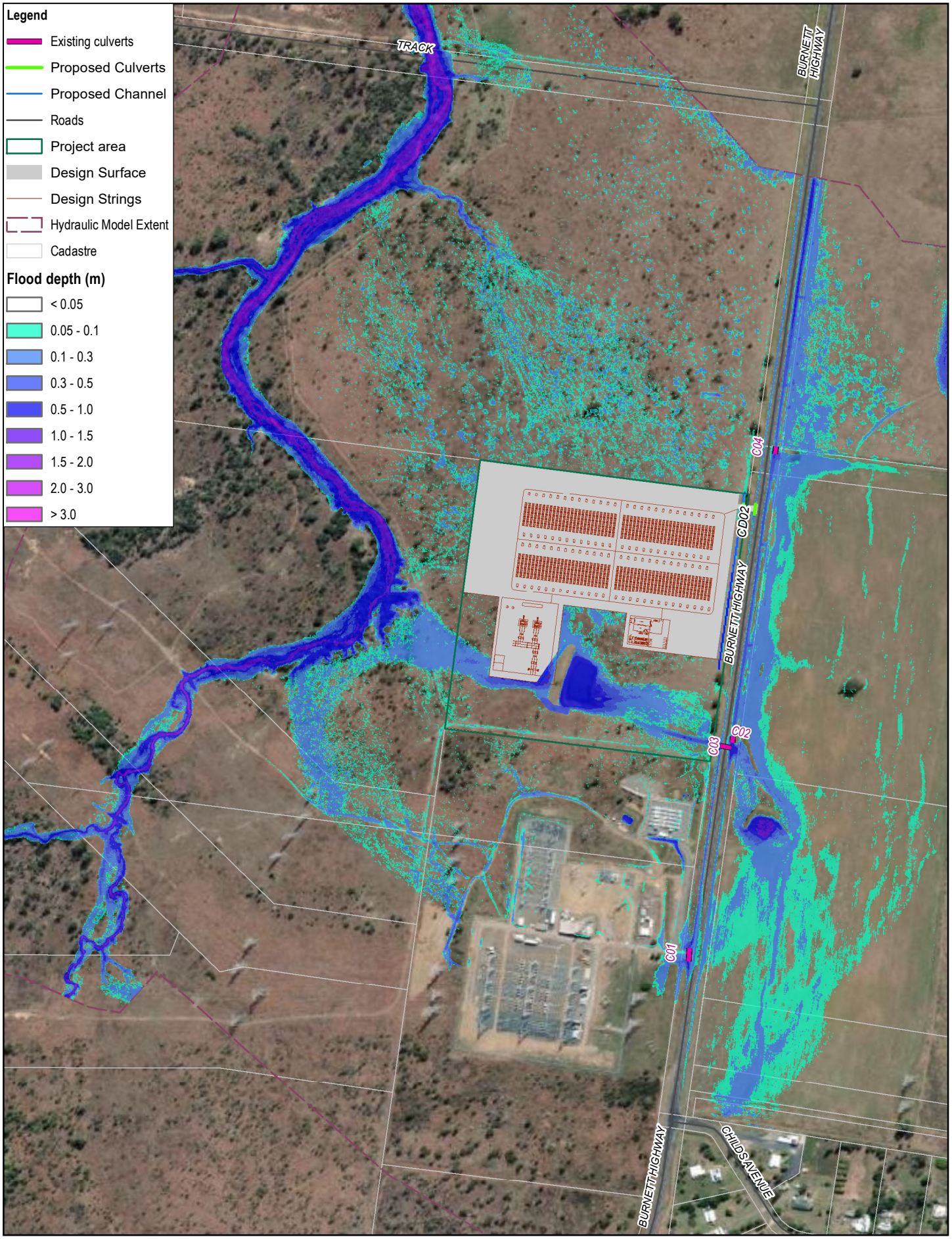

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
01% AEP storm event
Flood depth (m)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A3.6

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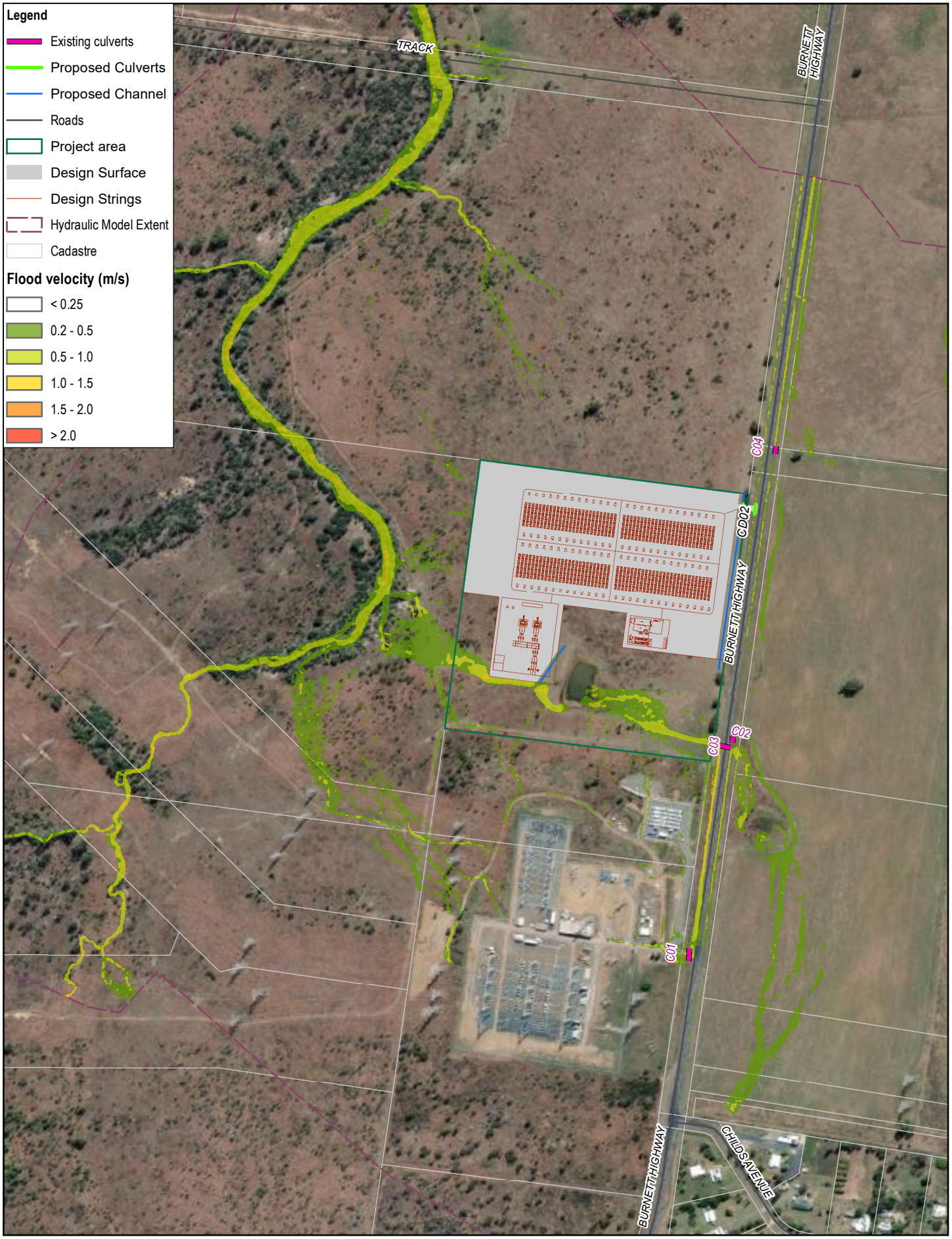

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
50% AEP storm event
Flood Velocity (m/s)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A4.1

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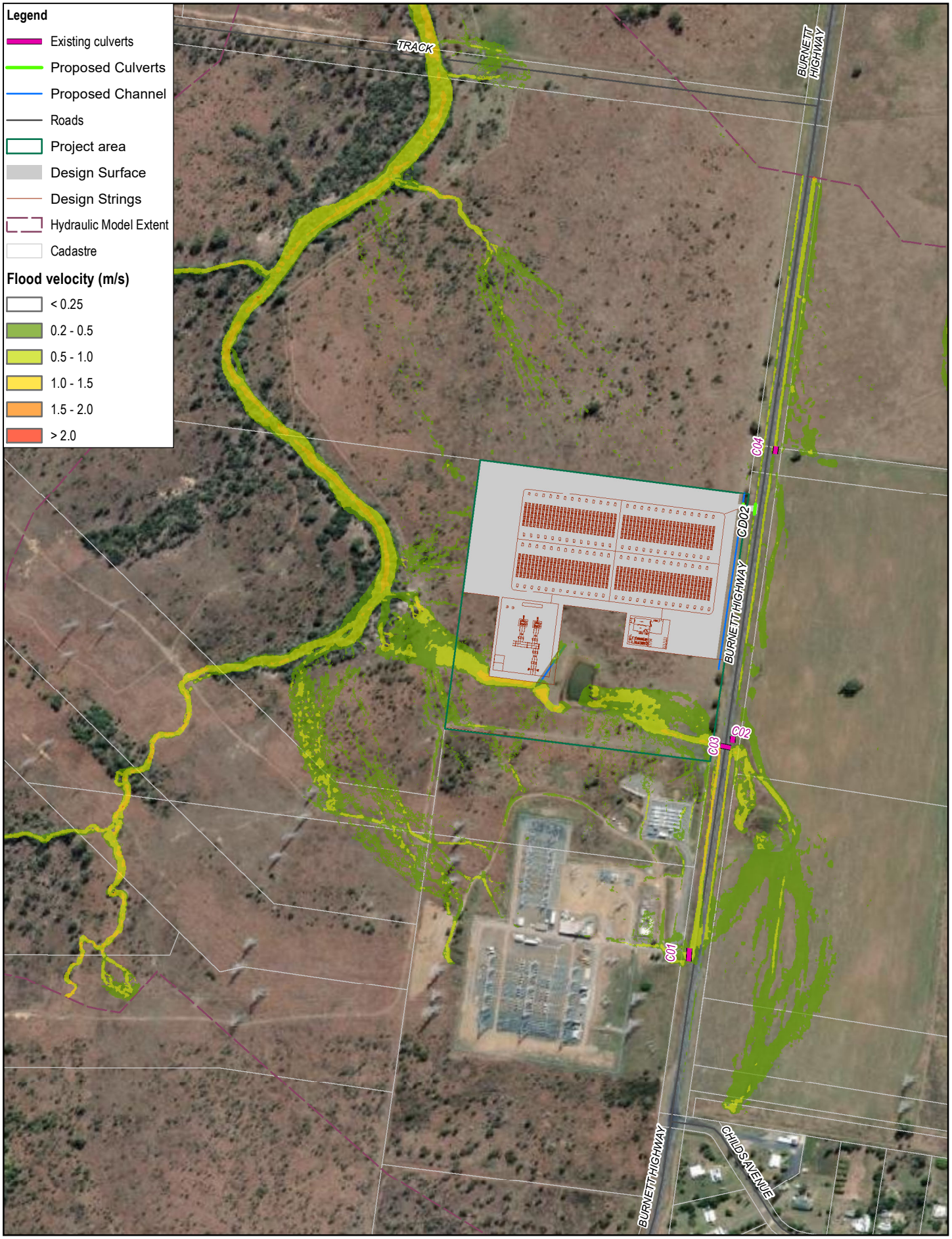

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
20% AEP storm event
Flood Velocity (m/s)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A4.2

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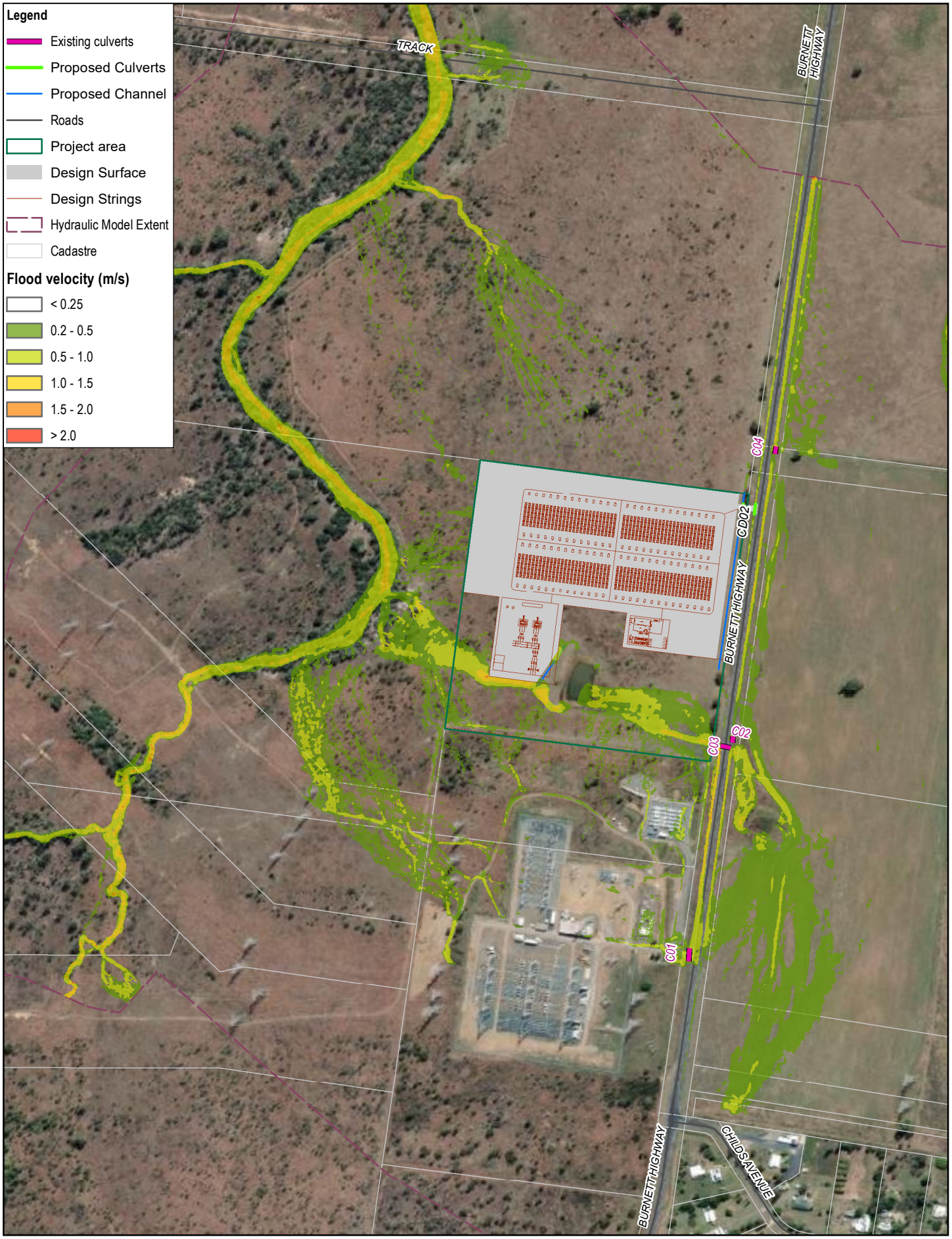

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
10% AEP storm event
Flood Velocity (m/s)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A4.3

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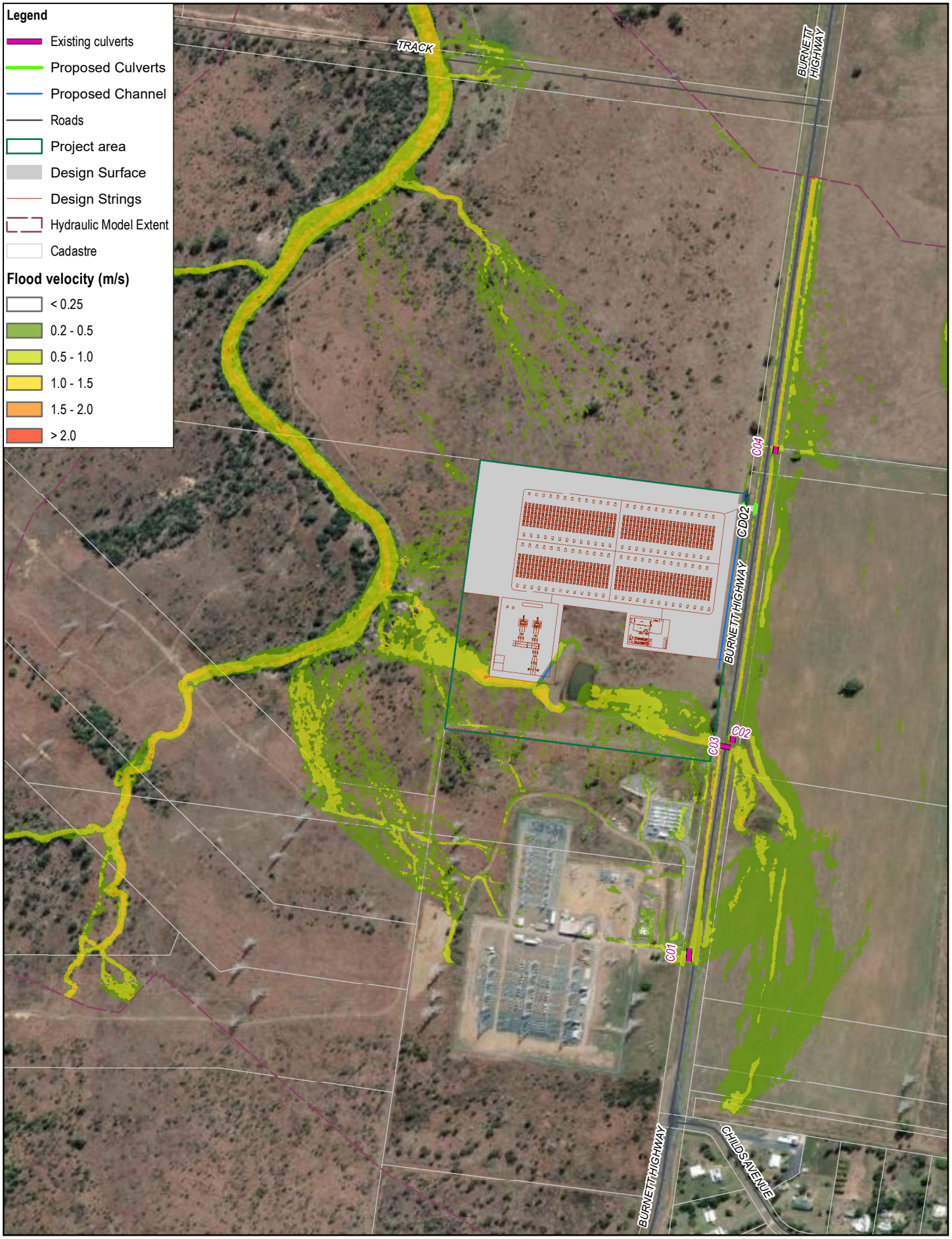

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
05% AEP storm event
Flood Velocity (m/s)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A4.4

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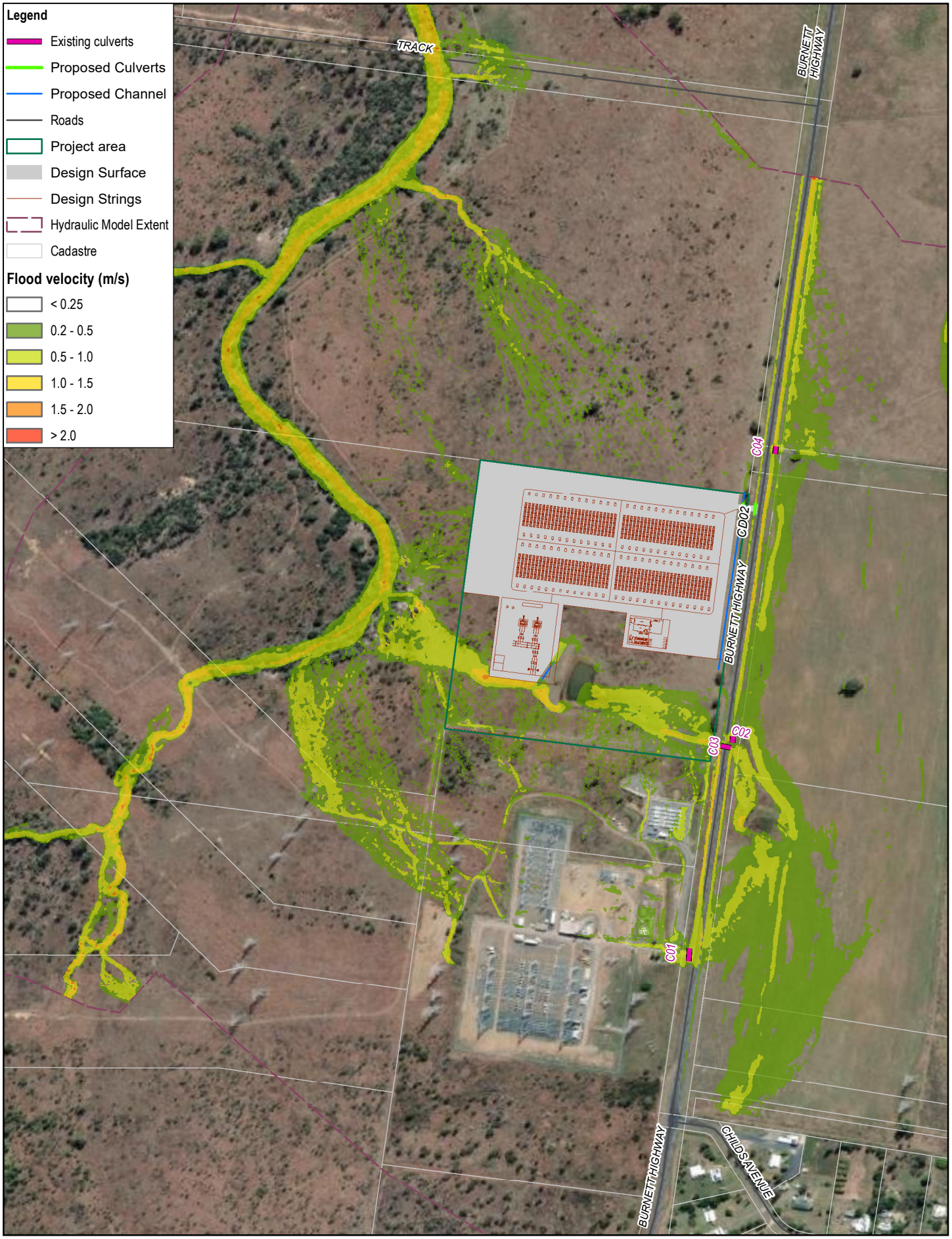

Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
02% AEP storm event
Flood Velocity (m/s)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A4.5

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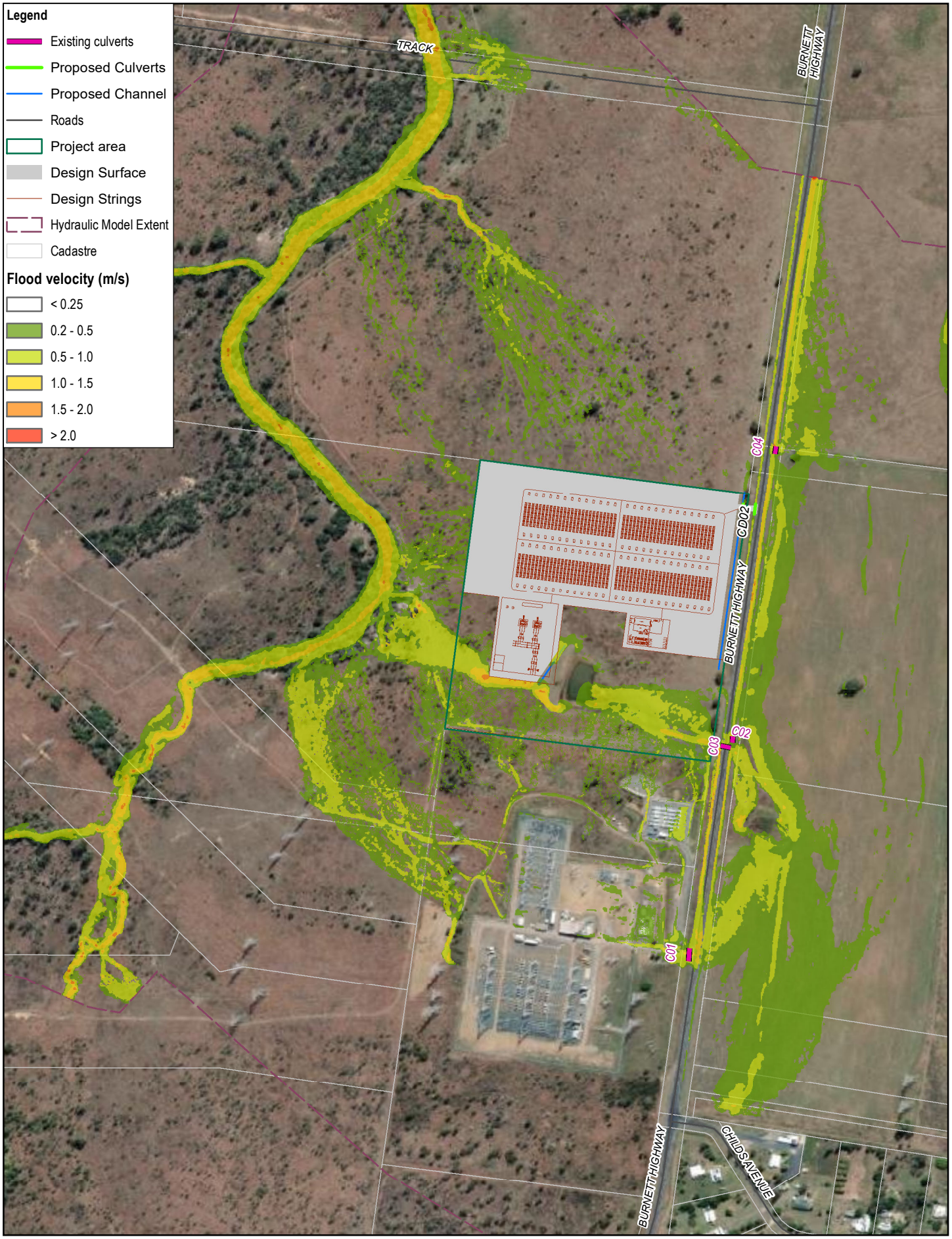

Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

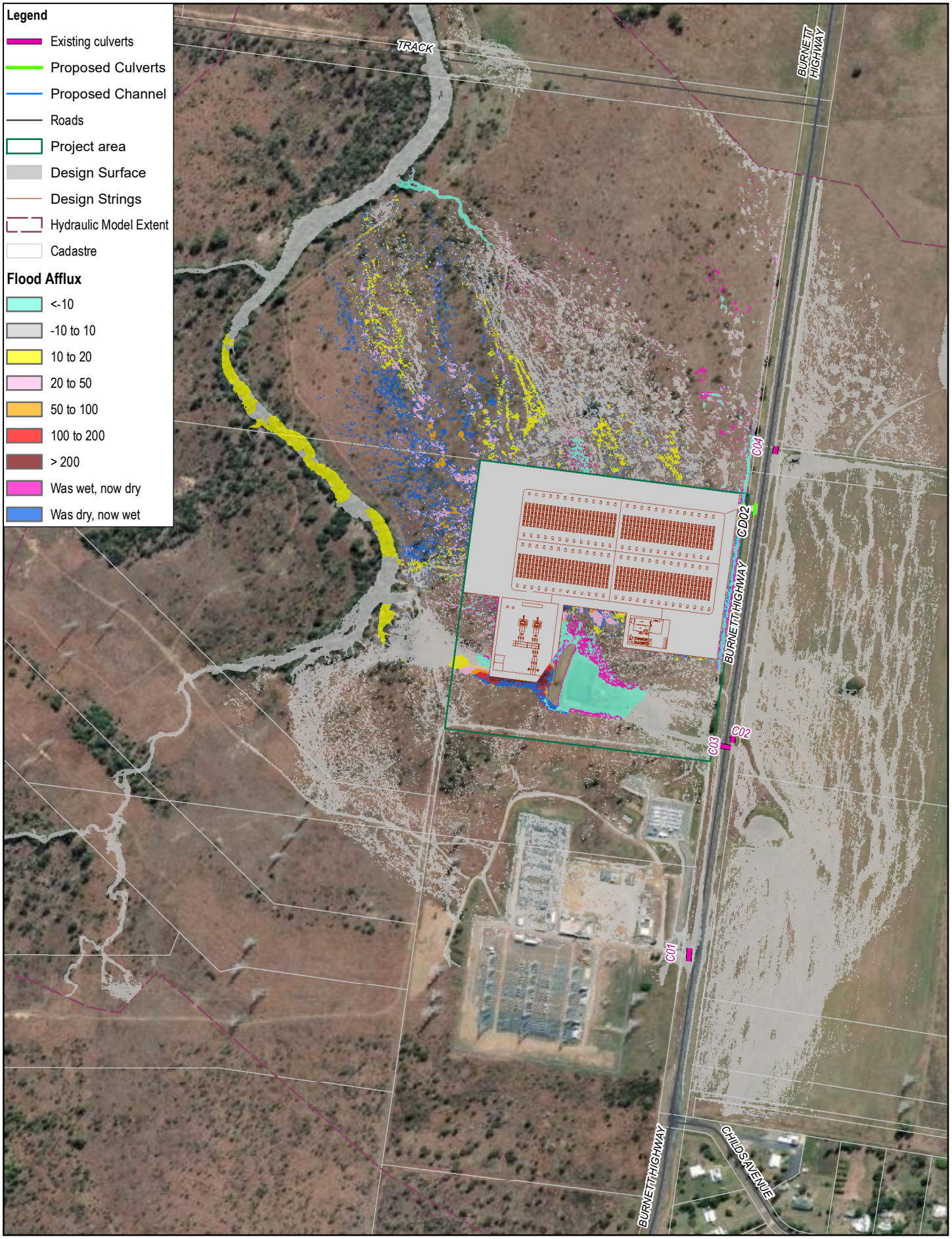
Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
01% AEP storm event
Flood Velocity (m/s)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A4.6

C:\Users\ssghasemi\Desktop\Capricorn\Fig_A4.6_D04_1p_Velocity_12650145.mxd



Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
50% AEP storm event
Flood Afflux (mm)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A5.1

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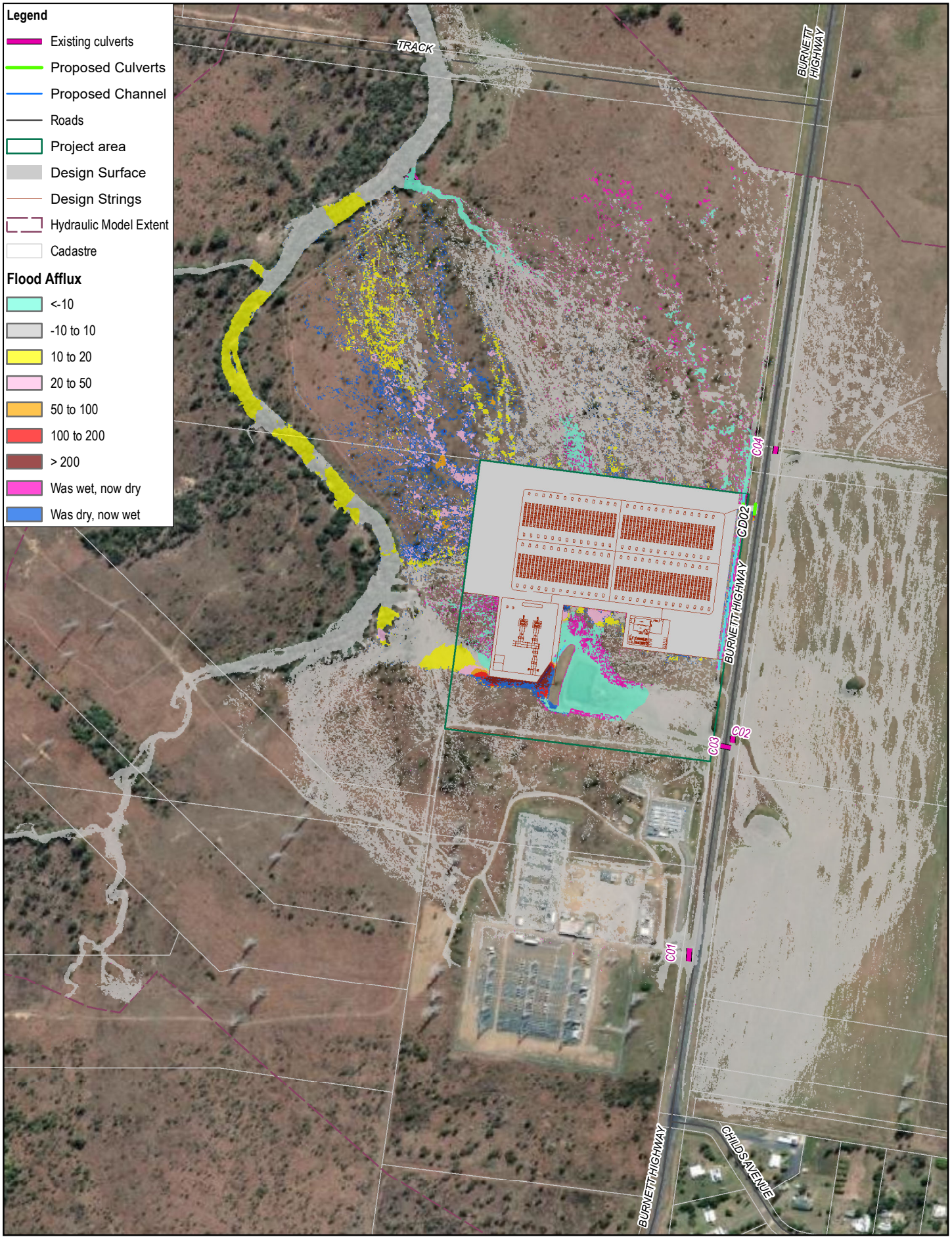

Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
20% AEP storm event
Flood Afflux (mm)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A5.2

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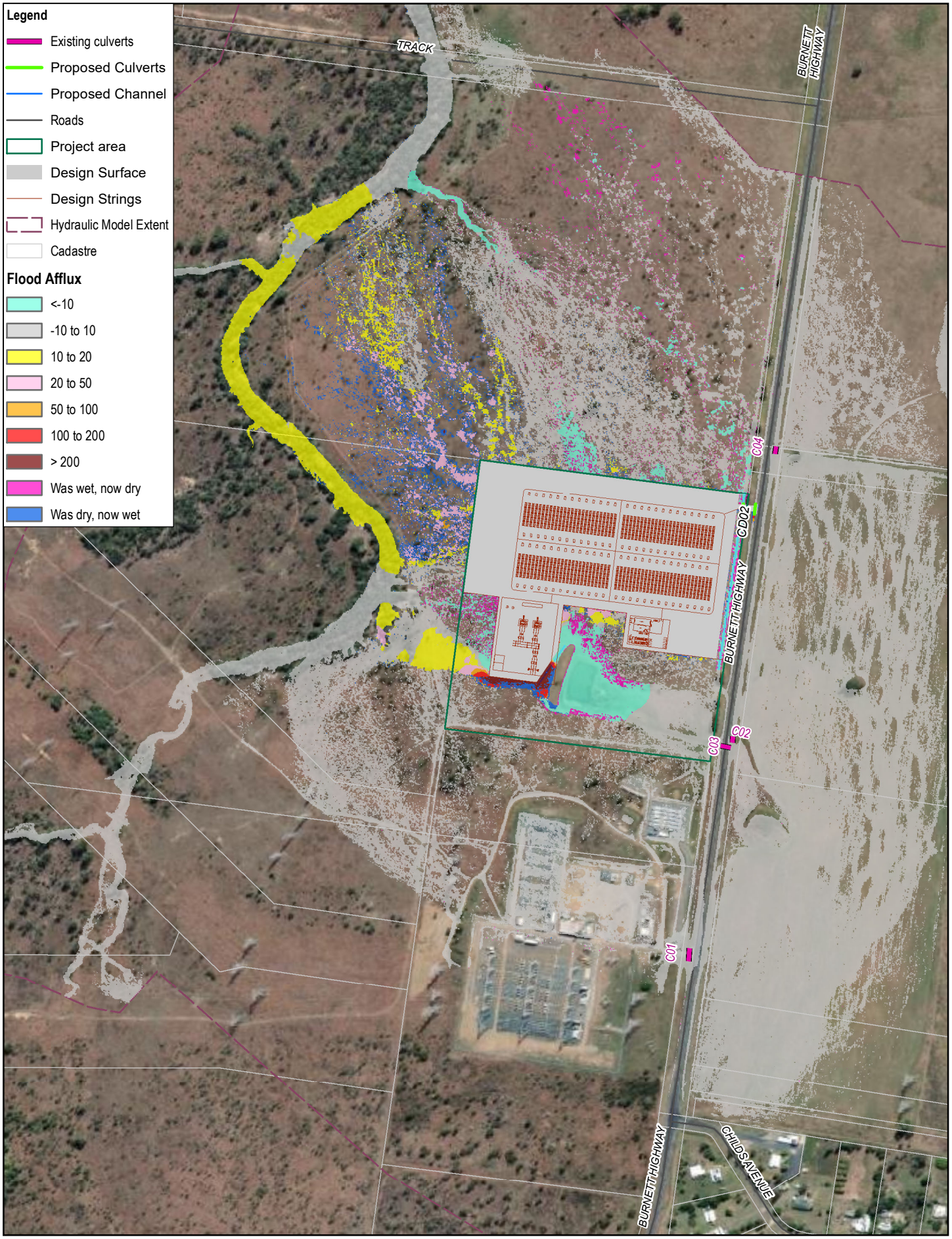

Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

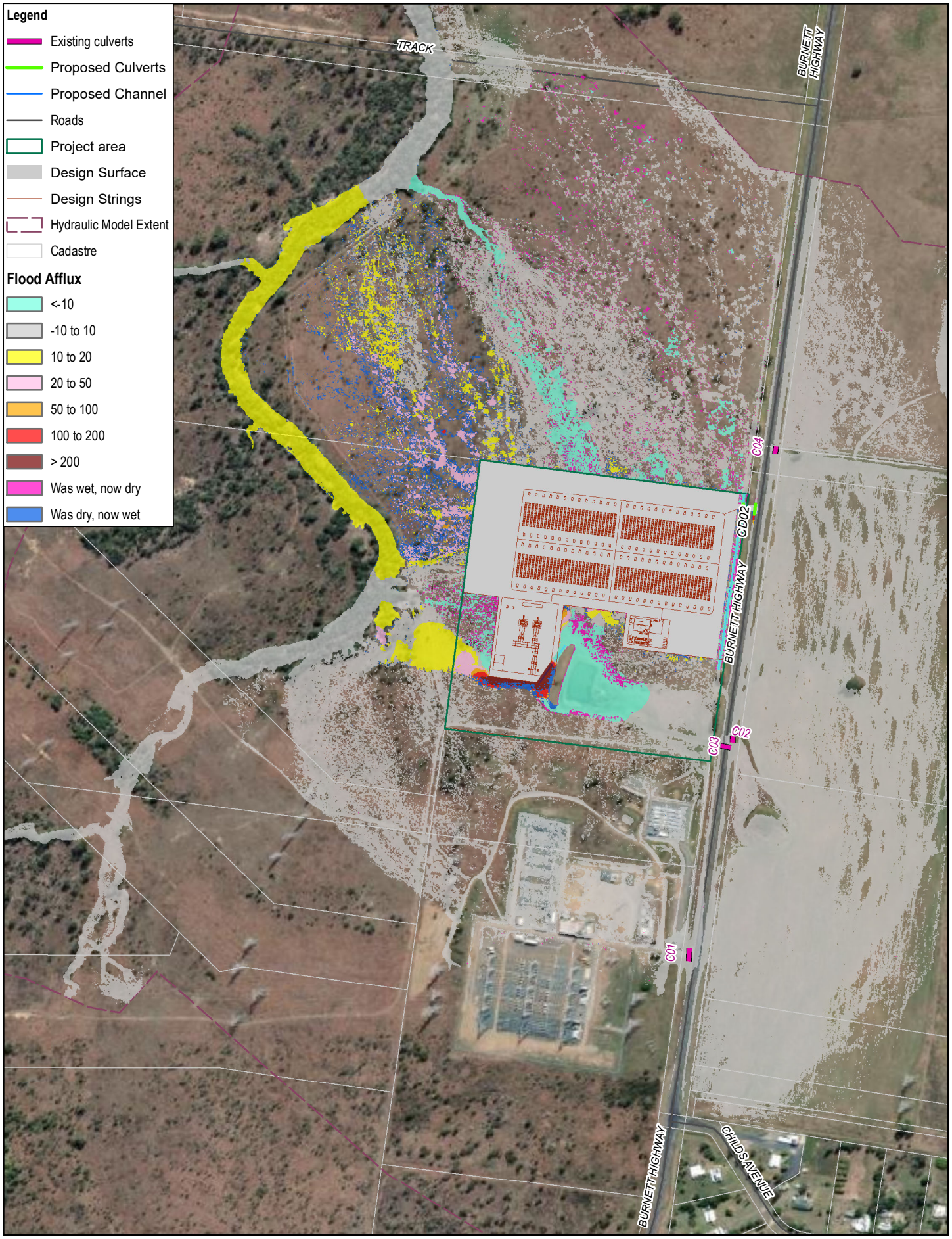
Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions 10% AEP storm event Flood Afflux (mm)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A5.3

C:\Users\ssghasemi\Desktop\Capricorn\Fig_A5.3_D04_10p_Afflux_WD_12650145.mxd



Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

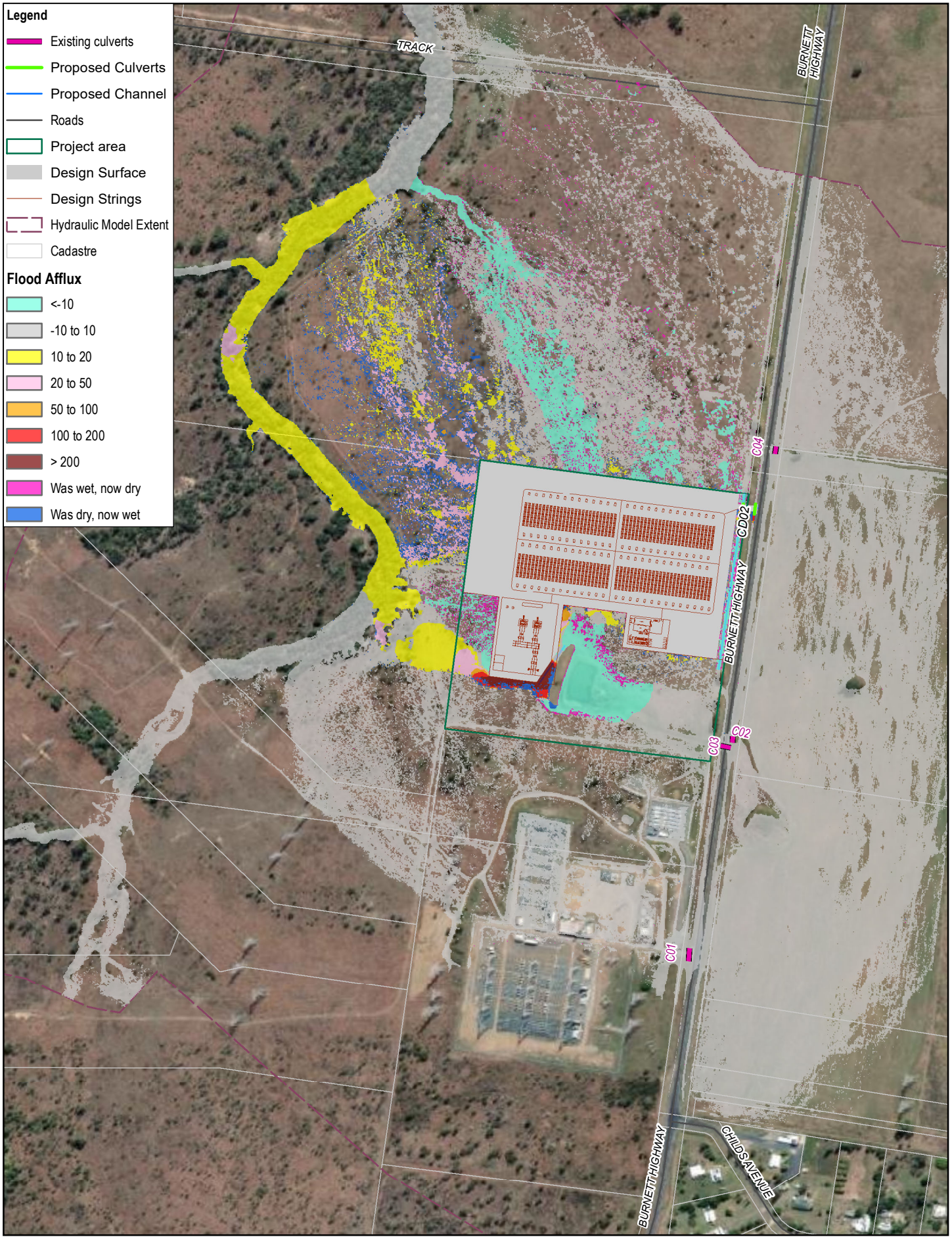
Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
05% AEP storm event
Flood Afflux (mm)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A5.4

C:\Users\ssghasemi\Desktop\Capricorn\Fig_A5.4_D04_5p_Afflux_WD_12650145.mxd



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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

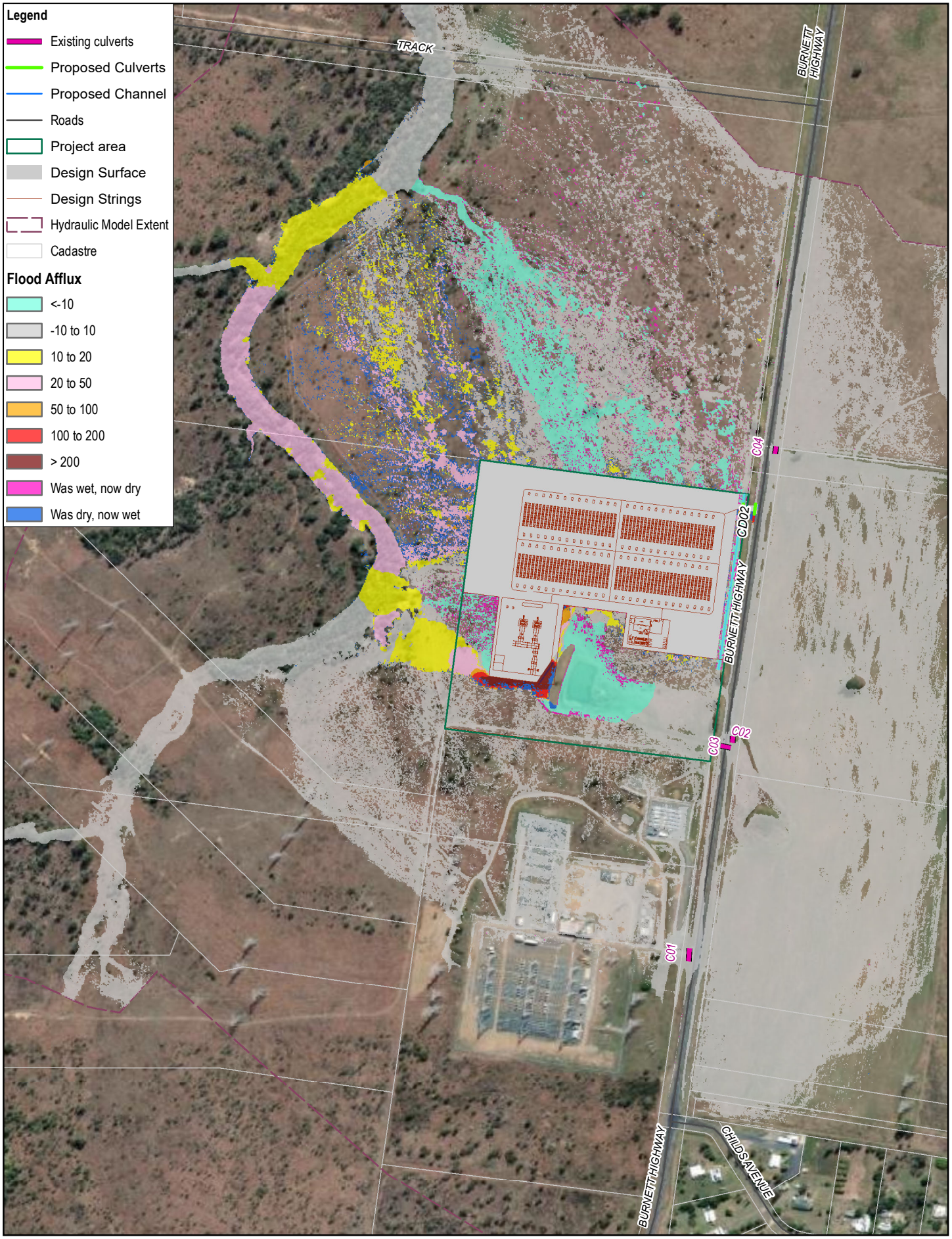
Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
02% AEP storm event
Flood Afflux (mm)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A5.5

C:\Users\ssghasemi\Desktop\Capricorn\Fig_A5.5_D04_2p_Afflux_WD_12650145.mxd



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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions
01% AEP storm event
Flood Afflux (mm)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure A5.6

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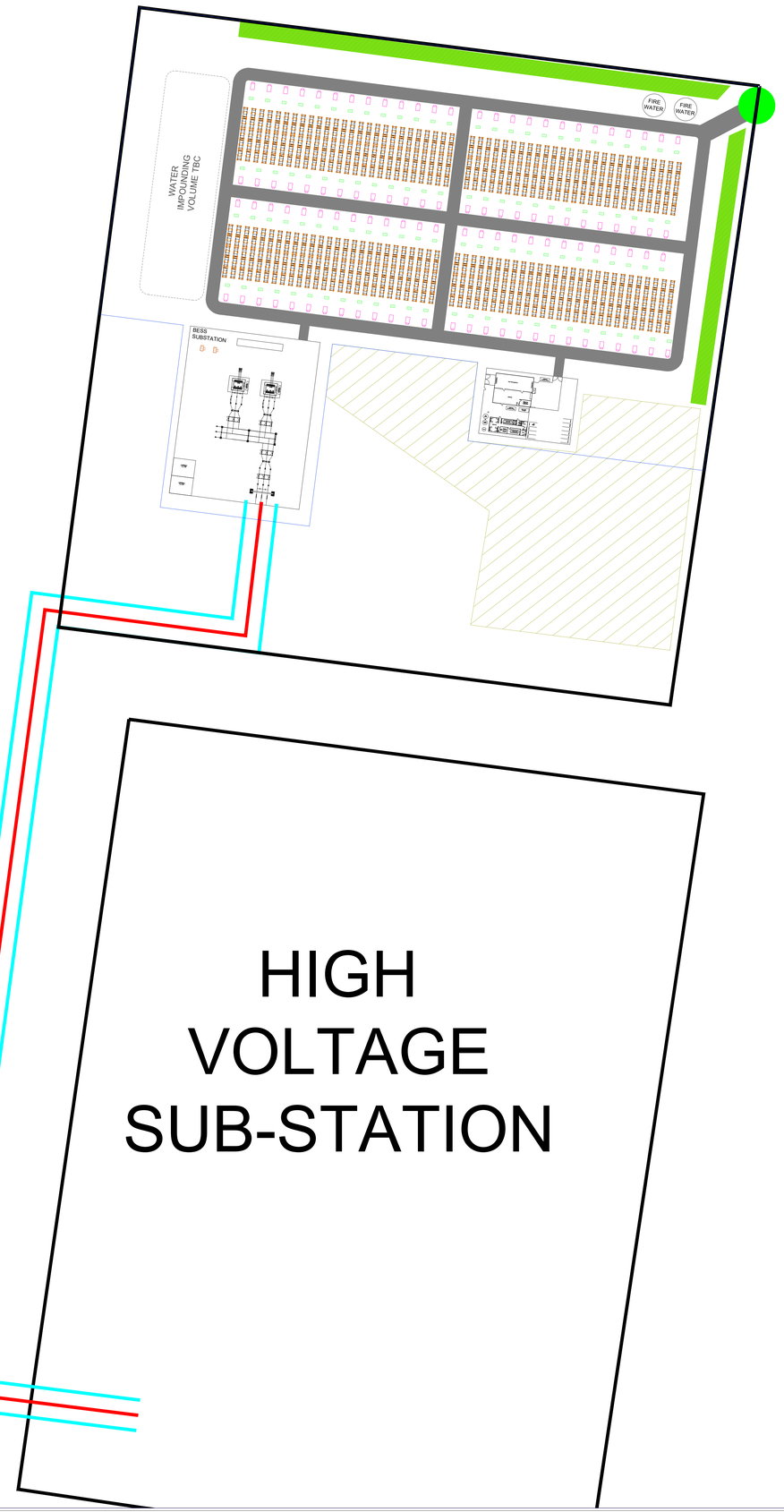
Appendix B

Development plans



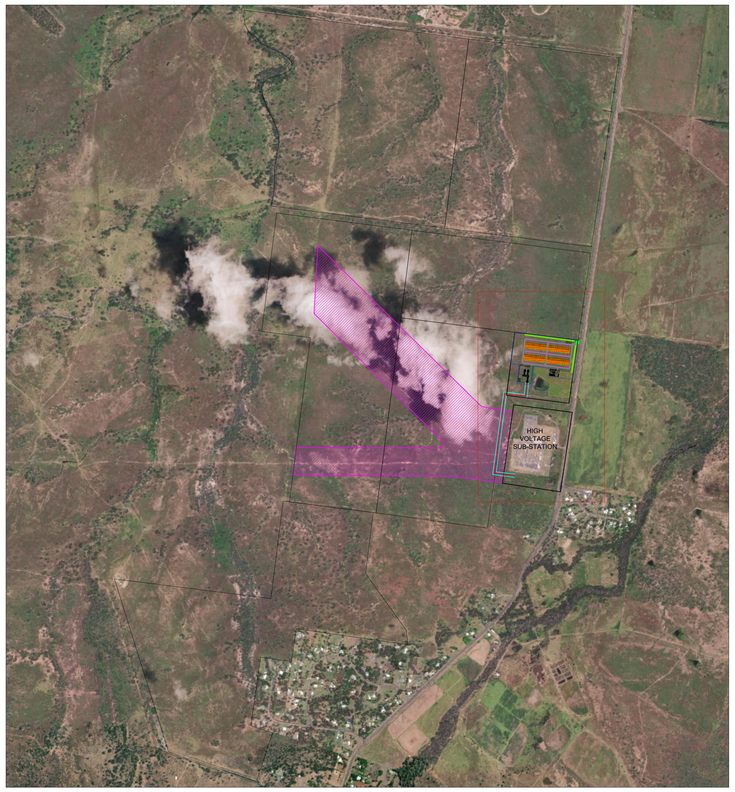
LEGEND

	ROAD
	BESS BOUNDARY
	SITE BOUNDARY
	POWER CABLE EASEMENT 20m
	POWERLINK CABLE
	POWER CONVERSION UNIT
	INVERTER BLOCK
	BATTERY BLOCK
	LAYDOWN AREA
	SITE PRIMARY ACCESS
	VEGETATION BUFFER

BESS SPECIFCATIONS

DESCRIPTION	QTY
RATED POWER (MW)	399
RATED ENERGY (MWh)	1575
USEFUL POWER (MW)	319.2
USEFUL ENERGY (MWh)	1354.5
BESS DURATION	4.24h
BESS CONTAINER MODULE	*SAFT I-Shift*
NUMBER OF BESS CONTAINERS	525
BESS CONTAINER CAPACITY (MWh)	3.0
POWER CONVERSION EQUIPMENT	SMA SCS 3800 UP-XT
NUMBER OF POWER CONVERSION EQUIPMENT	105
POWER CONVERSION EQUIPMENT POWER (MW)	3.8

SITE OVERVIEW



HIGH VOLTAGE SUB-STATION

REV:	DATE	DESCRIPTION	PREPARED BY	COLLABORATORS	VERIFIED BY	VALIDATED BY
10	28.11.2024	ADDED BESS POWER CABLE EASEMENT	Sola Elmir			
9	14.11.2024	Updated site access point and added landscape strip	Sola Elmir			
8	11.07.2024	Updated layout to allow for switchyard	Sola Elmir			
7	27.05.2024	Changed number of BESS containers/inverter from 6x2.6083MWh to 5x3MWh	Sola Elmir			

PROJECT: Capricon Creek BESS (Australia)

FILE NAME:

Engineering & Construction

CLASSIFICATION:

UTILIZATION SCOPE:

FORMAT: A0

SCALE: NTS

TITLE: PRELIMINARY GENERAL BESS LAYOUT

PLOT SCALE: NTS

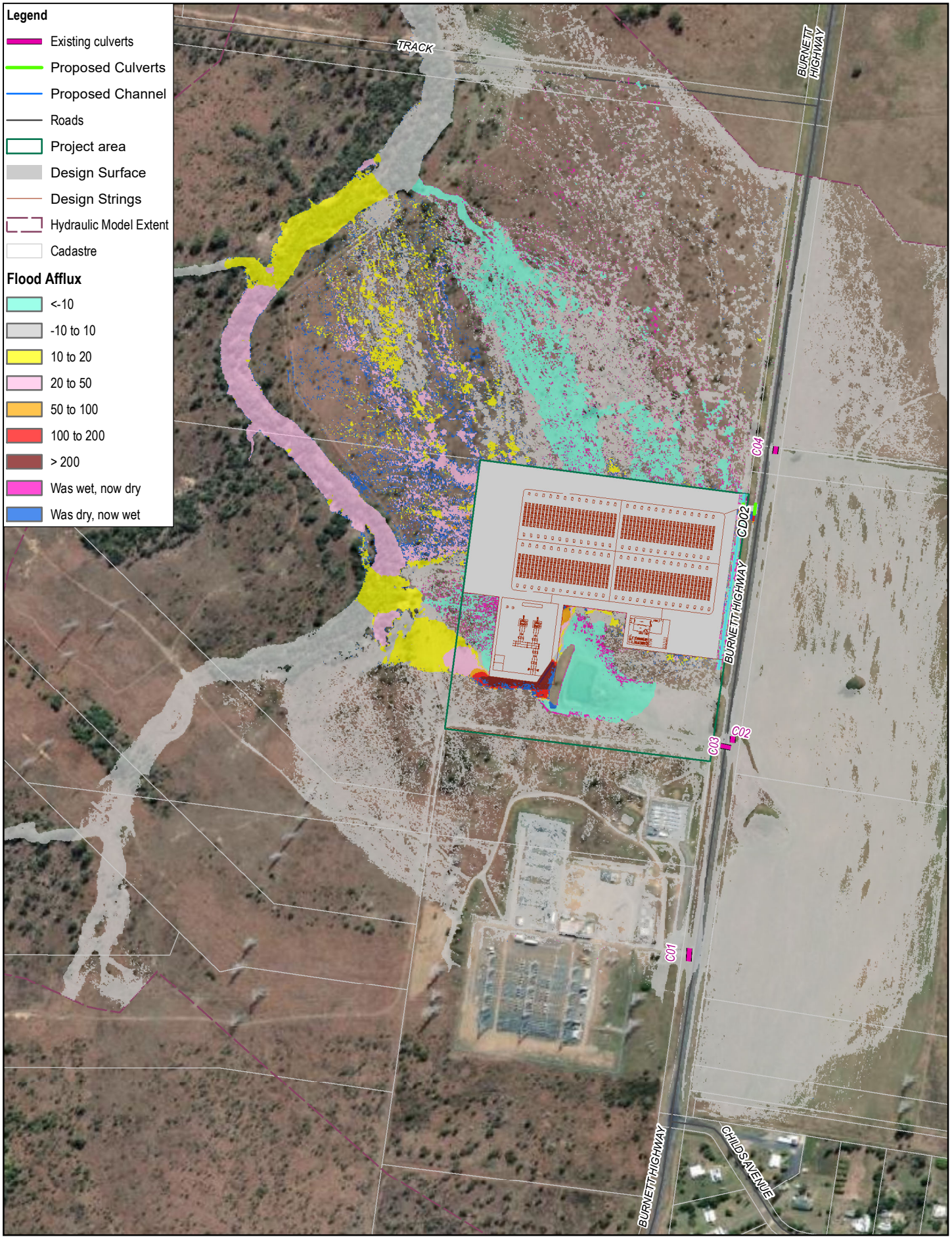
SHEET: 1 of 1

GRECODE

GROUP	FUNCTION	TYPE	ISSUER	COUNTRY	TEC	PLANT	SYSTEM	PROGESSIVE	REVISION
G R	E E C	D D	D A U	E	5 3	0 0	2 1	2 0 0 1	1 0

Appendix C

Flood Afflux Maps for Sensitivity Scenarios



Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

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Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions 1% AEP storm event Sensitivity (S01) Flood Afflux (mm)

Project No. **12650145**
Revision No.
Date **09/02/2025**

Figure C1.1

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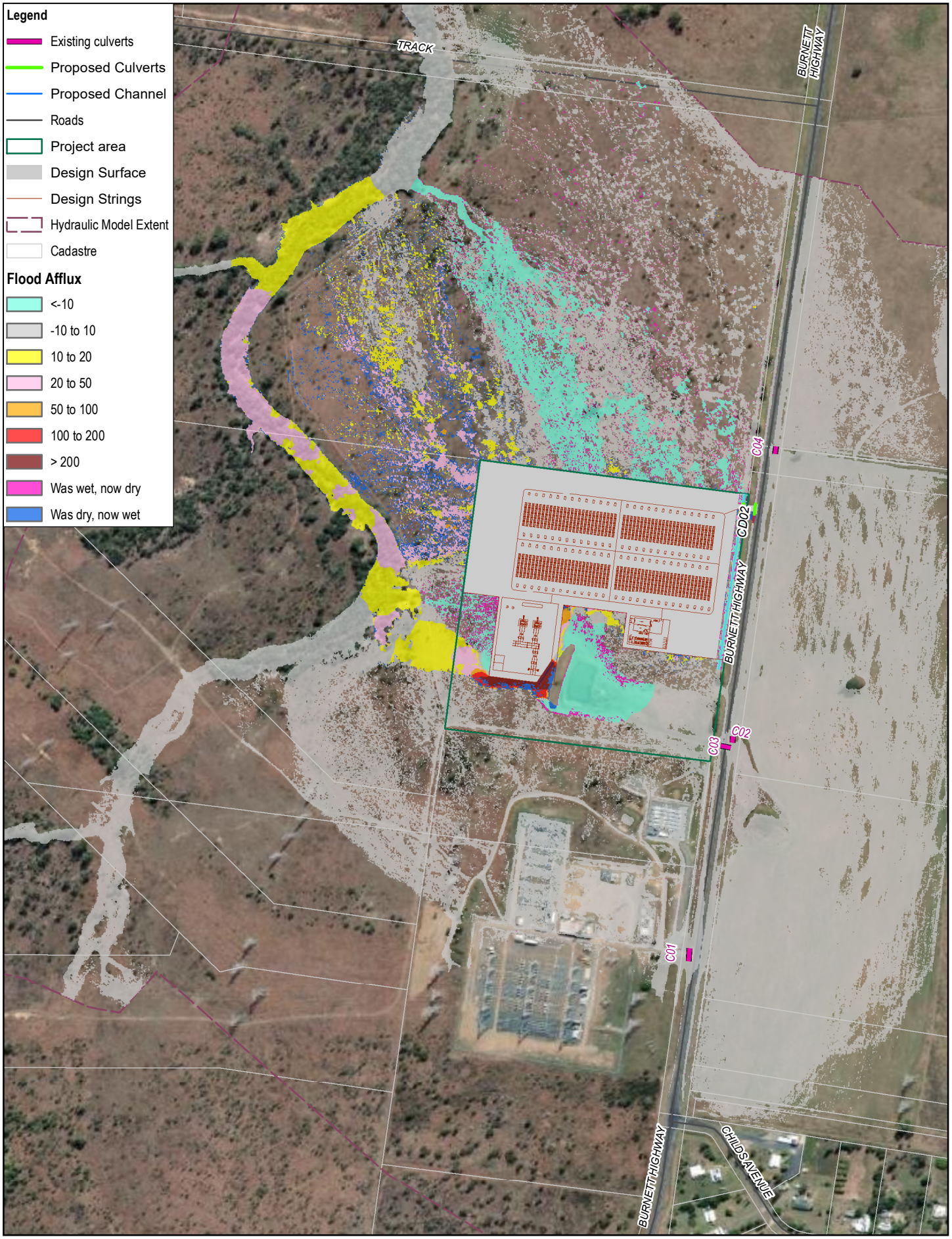

Paper Size ISO A4

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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GHD

Enel Green Power Australia Pty Ltd
Capricorn BESS

Post_Developed site conditions 1% AEP storm event Sensitivity (S02) Flood Afflux (mm)

Project No. **2650145**
Revision No. **B**
Date **09/02/2025**

Figure C2.1

C:\Users\ssghasemi\Desktop\Capricorn\Fig_C2.1_D04_1p_Afflux_WD_12650145.mxd

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The Power of Commitment