Appendix E Overland Flow Path Capacity Assessment, prepared by Stantec

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Approval no: DEV-2026-GCP-5471

Date: 11 November 2026

Queensland Government

Stantec

Overland Flow Path Capacity Assessment – 2 Village Boulevard Southport

Prepared for Economic Development Queensland

Reference no. 30470162 | 21 September 2026

Version	Date	Description	Authors	Quality Check	Independent Review
1	17/04/2026	Draft for Client Review	BW	CDB	MG
2	21/09/2026	Final	MG	CDB	NB

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Executive Summary

Economic Development Queensland (EDQ) has received a Further Issues Letter regarding its development application to subdivide Lot 1 into three allotments at 2 Village Boulevard, Southport. The site is flood-affected and contains an existing drainage easement. The Minster for Economic Development Queensland (MEDQ) has requested EDQ to demonstrate that the easement is sufficient to convey runoff exceeding the existing trunk drainage system capacity, accounting for climate change impacts in accordance with the latest guidance regarding rainfall scaling within Australian Rainfall and Runoff 2019 version 4.2 (ARR2019 v4.2).

A review of available hydrologic and hydraulic models identified the Water Technology (WT) Loders - Biggera Creek URBS hydrology model and associated TUFLOW hydraulic model developed for the Council of the City of Gold Coast (the City), as the most suitable basis for assessing flooding behaviour in the vicinity of the site. Stantec obtained these models from Council and further refined them for this assessment.

Because the WT model was developed to assess regional flooding characteristics, the subcatchments in the hydrology model were not sufficiently delineated to isolate flows contributing specifically to the existing trunk drainage system adjacent to the site. The subcatchment containing the subject site was therefore further delineated so only flows from contributing subcatchments were injected into the trunk drainage system and overland flow. The updated URBS model was run to identify the critical storm duration and temporal pattern that generated the maximum median peak flow at the site.

Hydraulic modelling using TUFLOW was undertaken for the storm event that generated the maximum median critical duration and temporal pattern, for both current (Year 2030) and future (Year 2100) design rainfall intensities under the 10% and 1% AEP events. Model runs were undertaken using DEM developed from (1) the existing site data and (2) the Cardno landform and overland flow channel design DEM developed as part of the Parklands GOLDOC Commonwealth Games overlay (2017) and Parklands Early Works package (2014). The WT model's trunk drainage network geometry data, including pipe sizes, invert levels, and lengths, was retained unchanged, and a 20% blockage factor was applied to pipes traversing the project site. A sensitivity assessment was also conducted applying a 50% and 100% blockage factors for the trunk drainage system provided through the project site.

Key Findings:

- With a blockage factor of 20% applied to the trunk drainage system provided through the project site, the model has indicated the trunk drainage provided within the drainage easement within the project site has the capacity to convey runoff generated from the 10% AEP and 1% AEP design storm events. No overtopping into the local overland flow channel occurs during the 10% or 1% AEP events for either the Year 2030 or Year 2100 design rainfall intensities for the currently existing scenario and/or for the 2014 design scenario. The modelling has indicated that the channel provided within the drainage easement does not convey runoff overtopping from the existing trunk drainage system during the 1% AEP storm event.

- With a blockage factor of 50% applied to the trunk drainage provided within the drainage easement within the project site has the capacity to convey runoff generated from the 10% AEP and 1% AEP design storm events. No overtopping into the local overland flow channel occurs during the 10% or 1% AEP events for either the Year 2030 or Year 2100 design rainfall intensities for the currently existing scenario and/or for the 2014 design scenario. The modelling has indicated that the channel provided within the drainage easement does not convey runoff overtopping from the existing trunk drainage system during the 1% AEP storm event.

- With a blockage factor of 100% applied to the trunk drainage system provided within the drainage easement during the 1% AEP storm event, runoff generated from the upstream catchments drains through the drainage easement provided with in the project site for the 1% AEP Year 2030 and Year 2100 design storm events. Runoff drains through the easement and outside of the easement when current ground DEM is utilised at the site or the 2014 Cardno design surface with a channel invert provided. The modelling has also indicated that runoff overtops Smith Motorway during the 1% AEP storm event. Flow hazard is higher on the Southport bound lane when the DEM developed from current site ground surface data was utilised.

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY ..... **II**

1 INTRODUCTION **1**

1.1 Purpose of this Report 1
1.2 Project Locality 2
1.3 Background on ARR2019 Version 4.2 3
1.3.1 Adopted Climate Sceanrios 3
1.3.2 Rainfall Scaling Factors 4
1.4 Terminology 5

2 PREVIOUS STUDIES **6**

3 HYDROLOGY **7**

3.1 Hydrology model update 7
3.1.1 Updated Sub-Catchment Discretisation 7
3.1.2 Updated Impervious Area Mapping 7
3.1.3 Design Rainfall Scaling 9
3.1.4 Hydrology Model Results 9

4 HYDRAULIC MODELLING **14**

4.1 Model Topography 14
4.2 2D Model Hydraulic Roughness 18
4.3 Boundary Conditions 20
4.3.1 Tailwater Conditions 20
4.3.2 Inflow Hydrograph 20
4.4 Structures 20

5 MODEL RESULTS **22**

5.1.1 Blockage Sensitivity Model Results 27

6 DISCUSSION **31**

6.1 EDQ Request for Information 31

7 CONCLUSION **33**

8 REFERENCES **34**

APPENDIX A TRUNK DRAINAGE 20%BLOCKAGE FACTOR SCENARIO FLOOD CHARACTERISTICS MAP **1**

APPENDIX B TRUNK DRAINAGE 50%BLOCKAGE FACTOR SCENARIO FLOOD CHARACTERISTICS MAP **1**

APPENDIX C TRUNK DRAINAGE 100%BLOCKAGE FACTOR SCENARIO FLOOD CHARACTERISTICS MAP **1**

APPENDIX D 2014 CARDNO TRUNK DRAINAGE DESIGN DOCUMENTATION **1**

APPENDIX E ARR2019 BLOCKAGE ASSESSMENT **1**

Tables

Table 1-1 ARR2019 Version 4.2 Rainfall Scaling Factors (SSP2-4.5) (Source: ARR Data Hub)

Table 3-1 Updated and Existing subcatchment ratio adopted in the URBS model

Table 4-1 Land Use Category Hydraulic Roughness

Table 5-1 Flood Level Result at the Trunk Drainage Headwall on Smith Street: With 20% Blockage Applied to Trunk Drainage

Table 5-2 Flood Level Result at the Trunk Drainage Headwall on Smith Street: With 50% Blockage Applied to Trunk Drainage

Table 5-3 Flood Level Result at the Trunk Drainage Headwall on Smith Street: With 100% Blockage Applied to Trunk Drainage

Figures

Figure 1-1 Project Locality Map

Figure 1-2 Projected Global Temperature Increases Above Pre-1990 Baseline Associated with SSPs

Figure 1-3 Australian Rainfall and Runoff Preferred Terminology

Figure 3-1 Existing and Updated Delineation of Subcatchment 4016.

Figure 3-2 Current land use pattern adopted in the Stantec URBS Model.

Figure 3-3 Year 2030 – 10%AEP Catchment 401606 Total Hydrograph Peak Flow Box Plot

Figure 3-4 Year 2030 – 10% AEP Catchment 401606 90 minutes storm duration Total Hydrograph for 10 Temporal Patterns

Figure 3-5 Year 2030 – 1% AEP Catchment 401606 Total Hydrograph Peak Flow Box Plot

Figure 3-6 Year 2030 – 1%AEP Catchment 401606 90 minutes storm duration Total Hydrograph for 10 Temporal Patterns

Figure 3-7 Year 2100 – 10%AEP Catchment 401606 Total Hydrograph Peak Flow Box Plot

Figure 3-8 Year 2100 – 10%AEP Catchment 401606 90 minutes storm duration Total Hydrograph for 10 Temporal Patterns

Figure 3-9 Year 2100 – 1%AEP Catchment 401606 Total Hydrograph Peak Flow Box Plot

Figure 3-10 Year 2100 – 1%AEP Catchment 401606 90 minutes storm duration Total Hydrograph for 10 Temporal Patterns

Figure 4-1 Model Extent, DEM and Boundaries

Figure 4-2 SITE DEM DEVELOPED FROM CURRENT SITE DATA

Figure 4-3 LOCALITY DEM DEVELOPED FROM CARDNO 2014 AND 2017 DESIGN SURFACE

Figure 4-4 Terrain Cross Section for Overland Flowpath Downstream of Culvert Inlets Including Existing (Red) and Proposed Surfaces (Green)

Figure 4-5 LAND USE MAP ADOPTED IN HYDRAULIC MODELLING

Figure 4-6 Trunk Drainage System Layout in the Project Site Locality

Figure 5-1 Year 2030 10% AEP Flood Depths and Levels for Existing Conditions

Figure 5-2 Year 2030 1% AEP Flood Depths and Levels for Existing Conditions

Figure 5-3 Year 2100 10% AEP Flood Depths and Levels for Existing Conditions

Figure 5-4 Year 2100 1% AEP Flood Depths and Levels Existing Condition

Figure 5-5 Year 2030 1% AEP Flow Hazard Category Based on Existing ground surface DEM

Figure 5-6 Year 2030 1% AEP Flow Hazard Category Based on 2014 and 2017 Design surface DEM

1 Introduction

1.1 Purpose of this Report

Economic Development Queensland (EDQ) has received a Further Issues Letter in relation to its development application to subdivide Lot 1 at 2 Village Boulevard, Southport (project site), into three allotments. The site is located within a flood-affected area. A piped drainage culvert that collects drainage from upstream catchments is provided within an existing drainage easement provided within the site. The Minister for Economic Development Queensland (MEDQ) has requested that EDQ demonstrate the adequacy of the drainage easement to convey runoff in excess of the existing trunk drainage system capacity, with due consideration of climate change impacts.

Stantec has reviewed flood models previously developed by various consultants for the surrounding locality and has concluded that the City-adopted Water Technology (WT) URBS hydrologic model and TUFLOW hydraulic model can be further developed to assess flood characteristics within the subject site under the current Year 2030 IFD and future Year 2100 IFD design scenarios.

Water Technology (WT) has developed hydrological (URBS) and hydraulic (TUFLOW) models for the Loders and Biggera Creek catchments for the City of Gold Coast. These models cover the project site and include representation of the major trunk drainage culvert located within the existing drainage easement, which conveys runoff from the upstream catchment, however, the hydrology model was developed to assess regional flooding characteristics and the subcatchments in the model covered a large area. As a result, they are not sufficientlydelineated to accurately apportion flows that traverse the development site. In addition, the revised site terrain information and the proposed overland flow path geometry are not captured within the WT hydraulic model.

To improve model resolution and ensure accurate representation of local drainage behaviour, Stantec have undertaken the following updates:

Hydrological Model Updates: The URBS model was modified to:

- Subdivide the existing lumped URBS subcatchment so that flows entering the trunk drainage system and the overland flow path are generated exclusively from the upstream contributing catchment that drains through the site.
- Update the hydrological model to generate revised flow hydrographs for the discretised project-locality subcatchments.
- Update design rainfall from the ARR2019 baseline conditions from Council's URBS model to Year 2030 SSP2-4.5 and Year 2100 SSP2-4.5 conditions in accordance with ARR2019 version 4.2.

Hydraulic Model Updates: The Council's TUFLOW hydraulic model has been modified to:

- Correctly apply inflows at appropriate locations on the trunk drainage system based on the discretised hydrology model outputs.
- Integrate revised existing ground levels by superimposing a DEM generated from updated site terrain data to develop the "existing conditions" scenario model.
- Incorporate the previously proposed overland flow path geometry from 2014 within the revised easement layout to create the "previously proposed conditions" scenario model.

This report documents:

- The updates made to Council's URBS hydrology model;
- The updates made to Council's TUFLOW hydraulic model to support the development application; and
- The outcomes of the hydraulic analysis, demonstrating whether the proposed overland flow path satisfies relevant design and performance requirements.

1.2 Project Locality

The site is located at # 2 Village Boulevard (Lot 8 on SP275512). It is bound by Village Boulevard in the north, Smith Street in the east, Knowledge Street in the west ad Parklands Drive in the south. The drainage easement is identified as EMT BB on SP275512. The Locality map is attached in Figure 1-1.

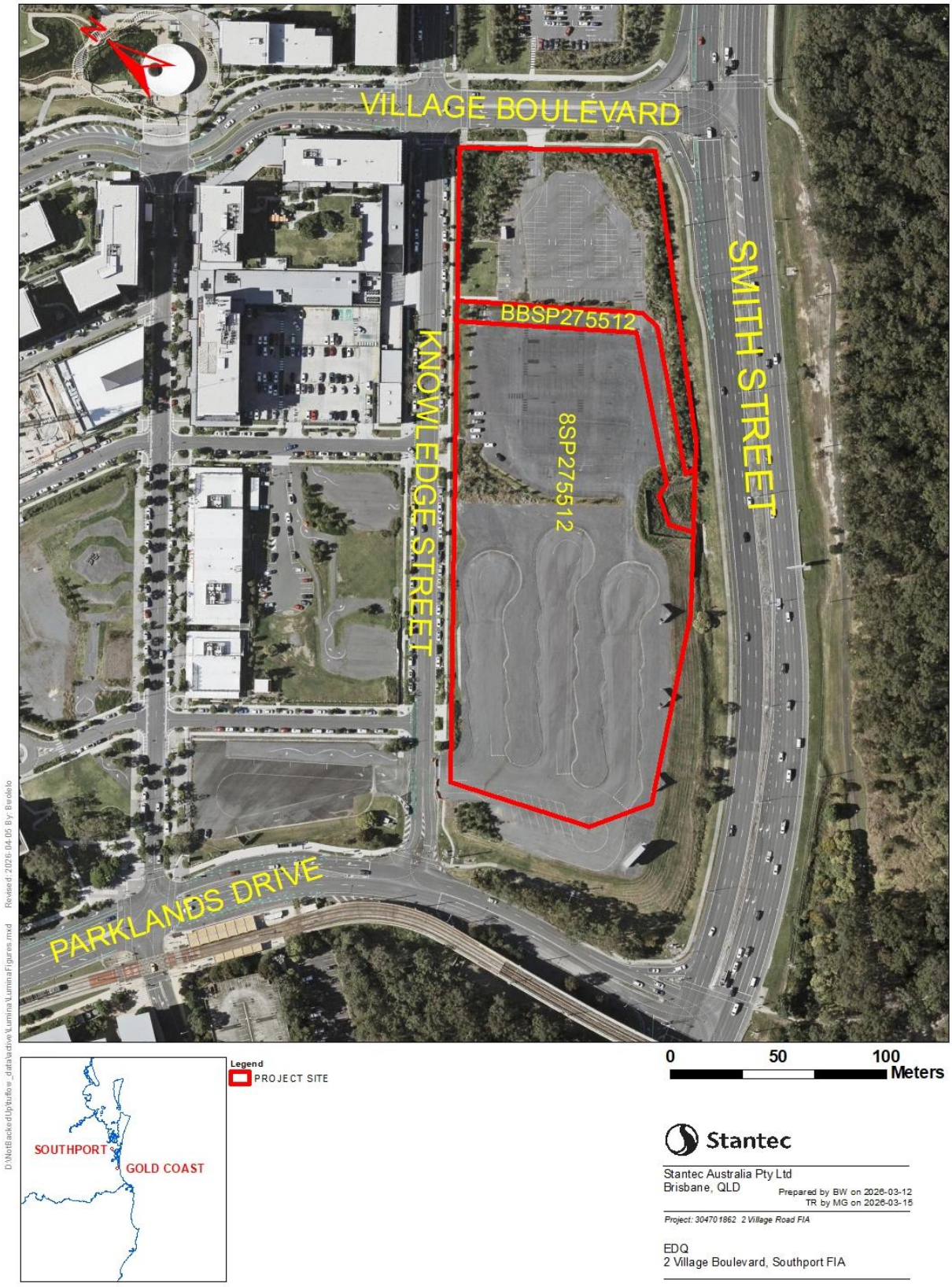


Figure 1-1 Project Locality Map

1.3 Background on ARR2019 Version 4.2

In late 2022, the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW), in partnership with Engineers Australia, commenced an 18-month project to update the climate change considerations within Australian Rainfall and Runoff: A Guide to Flood Estimation (ARR). This work replaced Chapter 6 of Book 1 in ARR with a revised version (Version 4.2, released August 2024).

The project drew on a rigorous literature review of hydroclimatology under climate change, peer-reviewed and published in international journals, and was informed by updated climate projections from the Intergovernmental Panel on Climate Change (IPCC). The review was followed by extensive industry consultation and testing to ensure the guidance provided practical, nationally consistent advice for design flood estimation under future climate conditions. The project was jointly funded through the National Emergency Management Agency under the Disaster Risk Reduction Package.

The ARR2019 version 4.2 guidance establishes nation-wide percentage increases in rainfall intensity above the ARR2019 baseline (1960–1990 climate) to account for the influence of climate change. Key features of the guidance are:

- Storm duration sensitivity – Shorter duration events (≤1 hour) are most sensitive to climate change, with recommended increases of approximately 15% per degree of global warming. For longer-duration events (≥24 hours), the recommended increase is lower, approximately 8% per degree.
- Planning horizons – Rainfall increase factors are provided for multiple timeframes:
    - Short-term (2021–2040) – The mid-point of this period is the year 2030.
    - Medium-term (2041–2060) – The mid-point of this period is the year 2050.
    - Long-term (2081–2100) – The mid-point of this period is the year 2090.
- Shared Socio-economic Pathways (SSPs) – The guidance aligns with the latest IPCC AR6 framework, allowing practitioners to select rainfall increase factors under different global emissions and adaptation scenarios. Four SSPs are defined:
    - SSP1 – sustainability pathway:
    - SSP2 – middle-of-the-road pathway:
    - SSP3 – fragmented world (high emissions, low adaptation):
    - SSP5 – fossil-fuel intensive growth pathway:

An illustration of projected global temperature changes for the current SSPs relative to the pre-1990 baseline is shown in Figure 1-2. This graph shows the recorded and projected global temperature changes to the year 2100.

1.3.1 Adopted Climate Sceanrios

Based on guidance from the client, Stantec has adopted ‘SSP2-4.5 – middle-of-the-road pathway’ as the basis for rainfall scaling for this assessment. The adoption of this SSP is consistent with guidance from the Draft National Climate Scenario Guidance (Federal DCCEEW, 2025) which recommends this SSP for adoption as it aligns with current global policy pledges.

Two time horizons have been adopted based on guidance from the client:

- Year 2030, representing a short-term planning horizon (4-years from the date of this study). This accounts for 1.2 degrees of expected global warming above pre-1990 baseline conditions, as per latest IPCC projections, with the majority of that temperature increase already having occurred

by the year 2026 as shown in Figure 1-2. This climate scenario has been adopted as the design scenario for this study.

- Year 2100, representing a long-term planning horizon (74-years from the date of this study) for SSP2. The projected global temperature increase above pre-1990 baseline conditions for this scenario is 2.5 degrees Celsius, and 1.3 degrees above the year 2030 design conditions. This scenario was modelled as a form of climate sensitivity to the projected impacts climate change in the long-term.

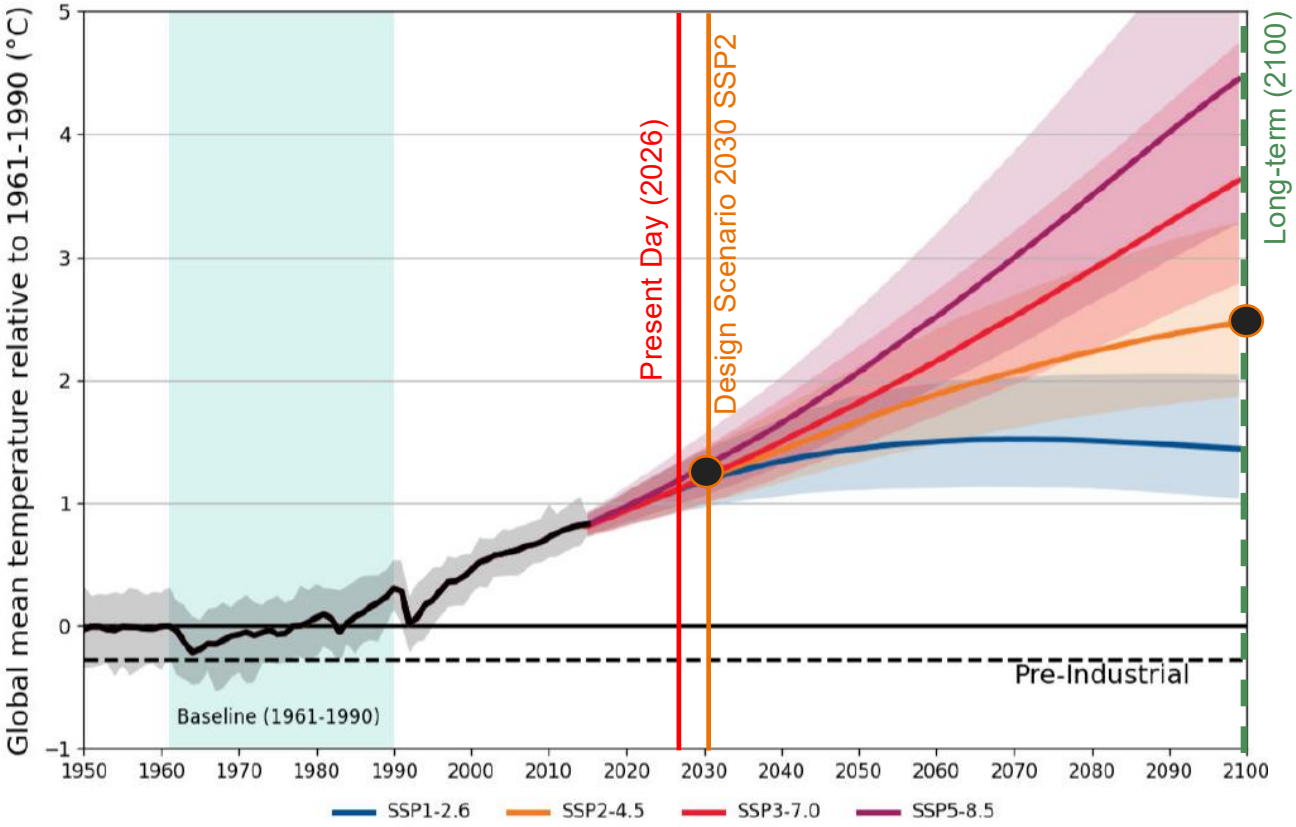


Figure 1-2 Projected Global Temperature Increases Above Pre-1990 Baseline Associated with SSPs (Source: ARR2019 Book 1 Chapter 6)- Indicative climate scenarios for the Cabramatta Creek (ARR2019 version 4.2)

1.3.2 Rainfall Scaling Factors

ARR2019 Version 4.2 guidance calculates rainfall scaling based on the global temperature increase from baseline (determined by the combination of year and SSP) and the storm duration. The rainfall scaling factors for SSP2-4.5 extracted from the ARR Data Hub for the two time horizons are summarised in Table 1-1.

Table 1-1 ARR2019 Version 4.2 Rainfall Scaling Factors (SSP2-4.5) (Source: ARR Data Hub)

Year	<1 hour	1.5 hours	2 hours	3 hours	4.5 hours	6 hours	9 hours	12 hours	18 hours	>24 hours
2030	1.18	1.17	1.16	1.14	1.13	1.12	1.12	1.11	1.10	1.10
2100	1.41	1.37	1.35	1.32	1.29	1.27	1.25	1.24	1.22	1.21

It is also noted that ARR2019 Version 4.2 provides guidance for rainfall loss scaling to increase losses. This change is intended to account for a potentially drier climate and therefore greater soil moisture capacity. These rainfall loss increases somewhat counter the rainfall increases, though they have generally been found in other study areas to be of relatively minor impact compared with the rainfall scaling itself.

For this assessment no rainfall loss scaling has been applied. This is considered a reasonable and conservative assumption, noting that the rainfall scaling itself is expected to be the dominant factor affecting climate change model sensitivity.

1.4 Terminology

Book 1, Chapter 2, Section 2.2.5 Adopted Terminology in Australian Rainfall & Runoff, 2019 describes the adopted terminology as shown in **Figure 1-3.** Modelling within this assessment was for the:

- 10% Annual Exceedance Probability (AEP), or 1 in 10 year event; and
- 1% AEP, or 1 in 100 year event.

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very Frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
	0.11	10	10	9.49
Rare	0.05	5	20	20
	0.02	2	50	50
	0.01	1	100	100
Very Rare	0.005	0.5	200	200
	0.002	0.2	500	500
	0.001	0.1	1000	1000
Extreme	0.0005	0.05	2000	2000
	0.0002	0.02	5000	5000
			↓	
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Figure 1-3 Australian Rainfall and Runoff Preferred Terminology

2 Previous Studies

Review of Council's flood risk awareness map has indicated that the subject site is affected by the maximum regional flood extent and that the site has a low flooding risk along the proposed easement.

Flooding and water quality management assessments for the locality have previously been undertaken as part of several technical studies, including:

- DesignFlow's Gold Coast Parklands Redevelopment (Commonwealth Games Village) Stormwater Management Plan;
- Hyder Consulting's Flooding and Hydraulics Report (F007-AA005621-AAR-03) dated 20/08/2013; and
- Water Technology's Loders and Biggera Creek Catchment Flood Study – Technical Report (2022).

Flooding and water quality management assessment for the locality were conducted as part DesignFlow's 'Gold Coast Parklands Redevelopment (Commonwealth Games Village) Stormwater Management Plan', Hyder Consulting's Flooding and Hydraulics report F007-AA005621-AAR-03' dated 20/08/13, and the Water Technology's Loders and Biggera Creek Catchment Flood Study – Technical report.

DesignFlow's report produced in 2014 addresses stormwater quality management and lake recirculation and treatment issues within the Parklands component of the Gold Coast Health and Knowledge Precinct.

The Hyder Consulting's Flooding and Hydraulics report provides flood assessment for the pre 2013 scenario catchment and post landform and provision of trunk drainage assets to support the Parklands development. The report was commissioned in 2014. The flow hydrograph utilised in the flood model was developed using the ARR87 procedures and does not address the current ARR2019 V4.2 requirements.

In August 2022, Water Technology prepared on behalf of the City the Loders and Biggera Creek flood study technical report. The Hydraulic modelling was conducted in TUFLOW and the hydrology model was developed in URBS. The model covered a catchment area of approximately 37km^2, with an average subcatchment area of 0.7km^2.

3 Hydrology

3.1 Hydrology model update

3.1.1 Updated Sub-Catchment Discretisation

Hydrological modelling of the Loders and Biggera Creek catchments was undertaken by Water Technology (WT) as part of the Loders - Biggera Catchments Flood Study. The hydrology models were developed using URBS and covered a total catchment area of approximately 37 km². The average subcatchment size in the WT model was approximately 70 ha. This level of discretisation was not sufficient to produce the detailed flow hydrographs required for assessing the performance of the existing trunk drainage system and the proposed overland flow channel within the drainage easement at 2 Village Boulevard, Southport. To provide the necessary level of detail for assessing trunk drainage and overland flow conveyance, subcatchment Big4016 was further subdivided into twelve smaller subcatchments in the Stantec-modified URBS model. This discretisation enabled the generation of local flow hydrographs suitable for evaluating the hydraulic capacity of both the trunk drainage system and the proposed overland flow channel within the drainage easement. The existing Big4016 subcatchment and the more discretised subcatchment layout is illustrated in Figure 3-1.

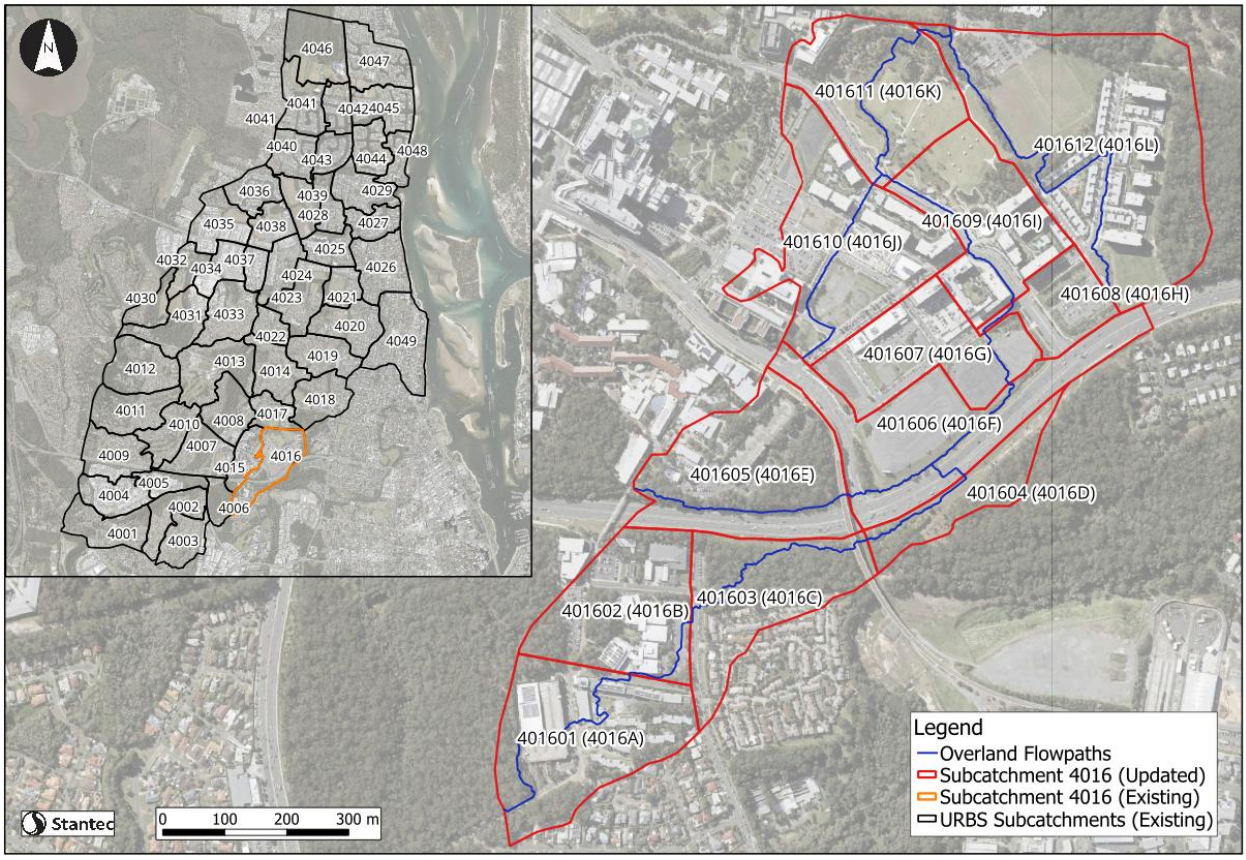


Figure 3-1: Existing and Updated Delineation of Subcatchment 4016.

3.1.2 Updated Impervious Area Mapping

It was also necessary to assign imperviousness ratios to each of the subdivided subcatchments to reflect changes in land use patterns since the original development of the WT model. This approach allows the spatial distribution of land uses within the smaller subcatchments to be represented more accurately, rather than applying a single average imperviousness value previously assigned to the larger

subcatchment 4016. The updated land use pattern, which is consistent with current catchment Google Maps aerial imagery and adopted in the Stantec URBS model, is shown in Figure 3-2. The adopted imperviousness ratio adopted in the WT and Stantec URBS models is captured in Table 3-1.

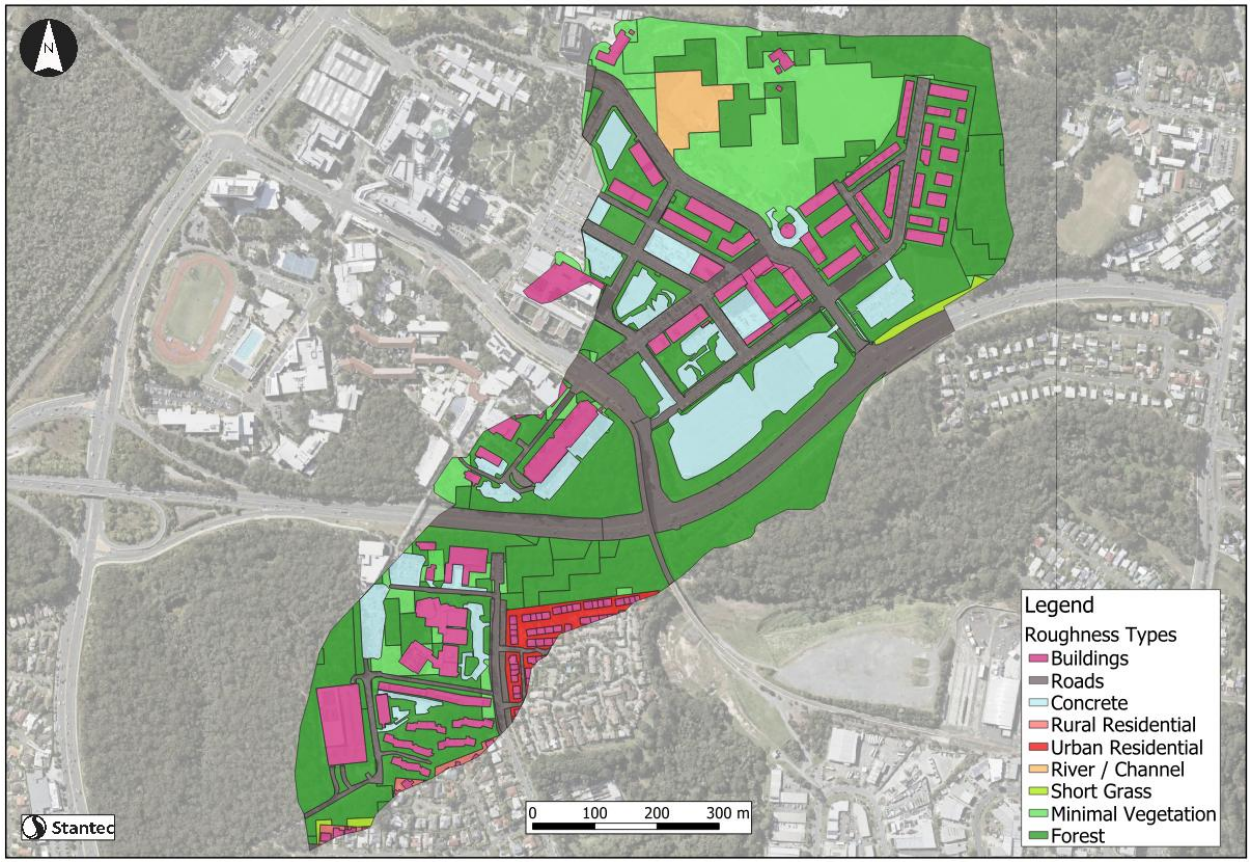


Figure 3-2: Current land use pattern adopted in the Stantec URBS Model.

Table 3-1 Updated and Existing subcatchment ratio adopted in the URBS model

Catchment ID	Area (km²)	UF	UH	UM	UL	UR
401601 (4016A)	0.06	0.54	0.38	0.03	0.00	0.03
401602 (4016B)	0.05	0.37	0.48	0.00	0.00	0.14
401603 (4016C)	0.05	0.53	0.45	0.00	0.00	0.02
401604 (4016D)	0.02	1.00	0.00	0.00	0.00	0.00
401605 (4016E)	0.07	0.42	0.52	0.00	0.00	0.06
401606 (4016F)	0.06	0.24	0.75	0.00	0.00	0.01
401607 (4016G)	0.04	0.26	0.74	0.00	0.00	0.00
401608 (4016H)	0.02	0.39	0.57	0.00	0.00	0.04
401609 (4016I)	0.05	0.21	0.43	0.00	0.00	0.36
401610 (4016J)	0.07	0.27	0.70	0.00	0.00	0.03
401611 (4016K)	0.05	0.18	0.16	0.00	0.00	0.66
401612 (4016L)	0.13	0.59	0.19	0.00	0.00	0.23
4016 (Existing)	0.66	0.13	0.53	0.00	0.00	0.33

**UF – Fraction of subcatchment forested, UH – High density urban fraction, UM – Medium density urban fraction, UL – Low density urban fraction, UR – Fraction of subcatchment with rural land (cleared but nor forested).*

3.1.3 Design Rainfall Scaling

The Bureau of Meteorology (2016) IFD data adopted in the WT model for the project site was adjusted to represent present-day conditions (Year 2030) and future climate change conditions (Year 2100), based on the SSP2-4.5 pathway. Further background on these design rainfall updates and ARR2019 version 4.2 is included in Section 1.3. The URBS hydrology model was then used to generate corresponding Year 2030 and Year 2100 flow hydrographs for the Biggera Creek catchment.

Given that the project site lies wholly within the Biggera Creek catchment, no hydrology model updates were undertaken to derive flow hydrographs for subcatchments associated with the Loders Creek catchment. Accordingly, outputs from the hydrology model are to be applied exclusively for assessing flood behaviour and hydraulic characteristics within the project site boundary.

3.1.4 Hydrology Model Results

The discretised subcatchments were incorporated within the URBS model to generated flow hydrographs for the current (Year 2030) climate and the future Year 2100 climate. Flow hydrographs were generated for these subcatchments for the 10% AEP storm event and the 1% AEP storm event. The flow hydrographs were incorporated as boundary conditions in the current study.

The Stantec hydrology model was run to determine the storm duration and storm temporal pattern that generated the maximum median peak flow at the inlet of the trunk drainage system (total flow hydrograph for catchment 401606) that drained through the site. The box plots showing the storm duration and temporal patterns that generated the peak maximum median flow at subcatchment 401606 for the 10% AEP and 1% AEP event during the current Year 2030 climate design rainfall intensities and the future 10% AEP and 1% AEP storm event during the future Year 2100 climate design rainfall intensities is captured in Figures 3.3 to Figure 3.10 Review of the box plots has indicated that the 90minute duration storm generated the maximum median peak flow for the Year 2030 and Year 2100 climate scenarios.

Review of the hydrographs generated for each of the temporal patterns has indicated that:

- For the 10%AEP, Year 2030 and Year 2100 design rainfall intensities EN06 generated the maximum median peak flow hydrograph.
- For the 1% AEP, Year 2030 and Year 2100 design rainfall intensities, EN03 generated the maximum median peak flow hydrograph

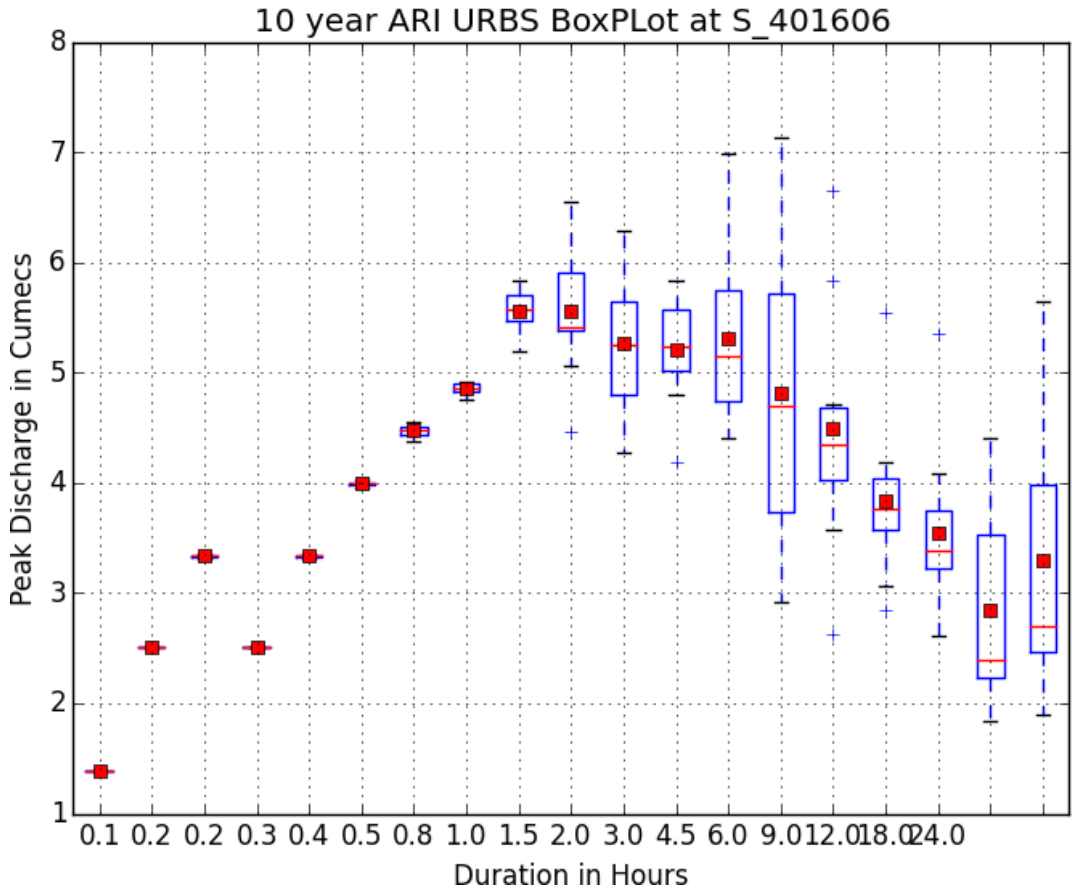


Figure 3-3 Year 2030 – 10%AEP Catchment 401606 Total Hydrograph Peak Flow Box Plot

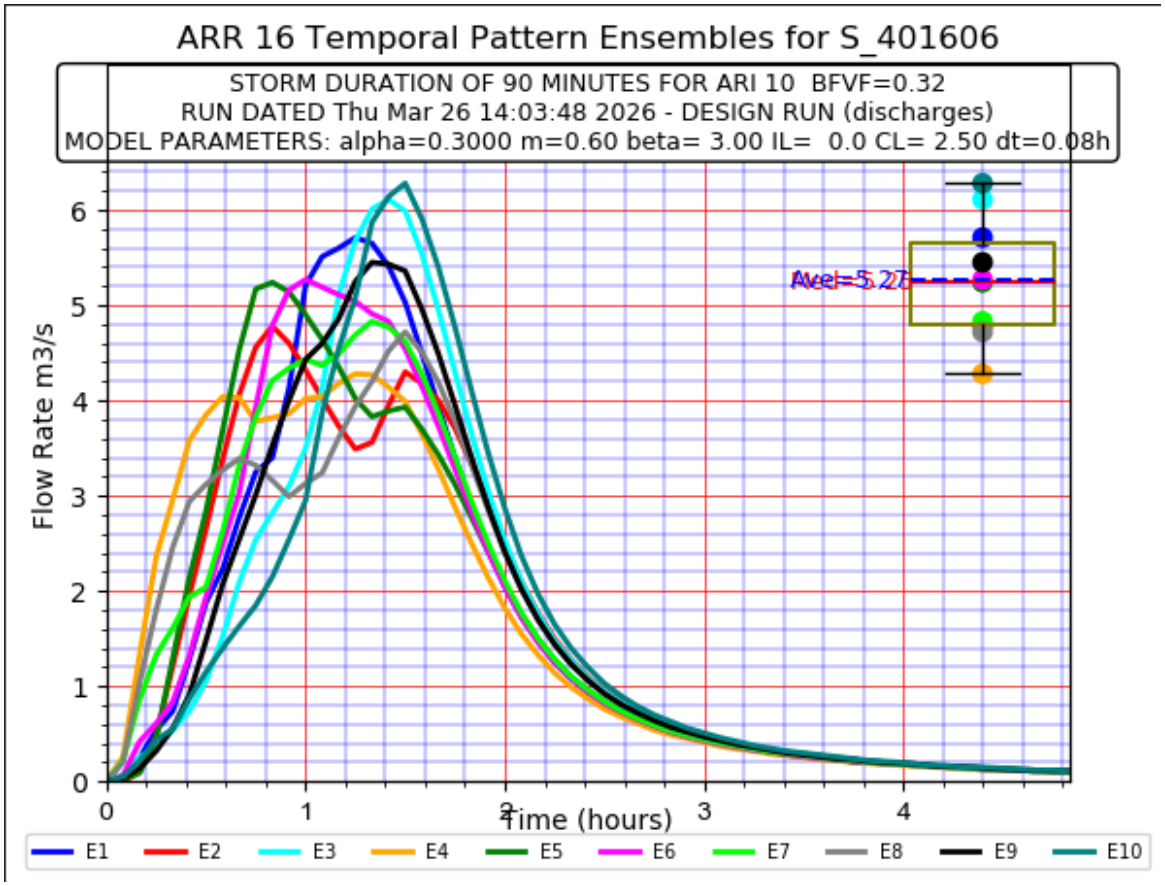


Figure 3-4 Year 2030 – 10% AEP Catchment 401606 90 minutes storm duration Total Hydrograph for 10 Temporal Patterns

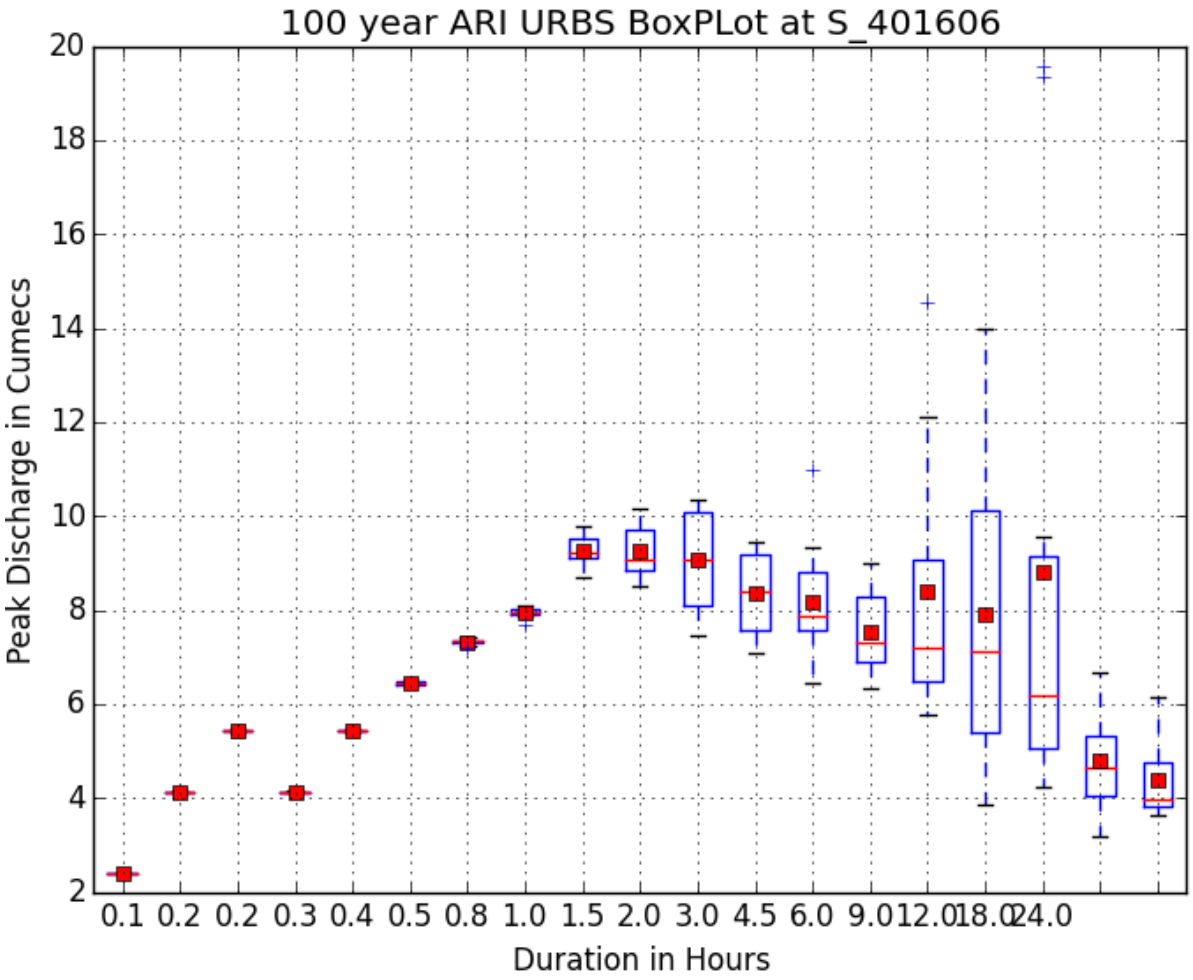


Figure 3-5 Year 2030 – 1% AEP Catchment 401606 Total Hydrograph Peak Flow Box Plot

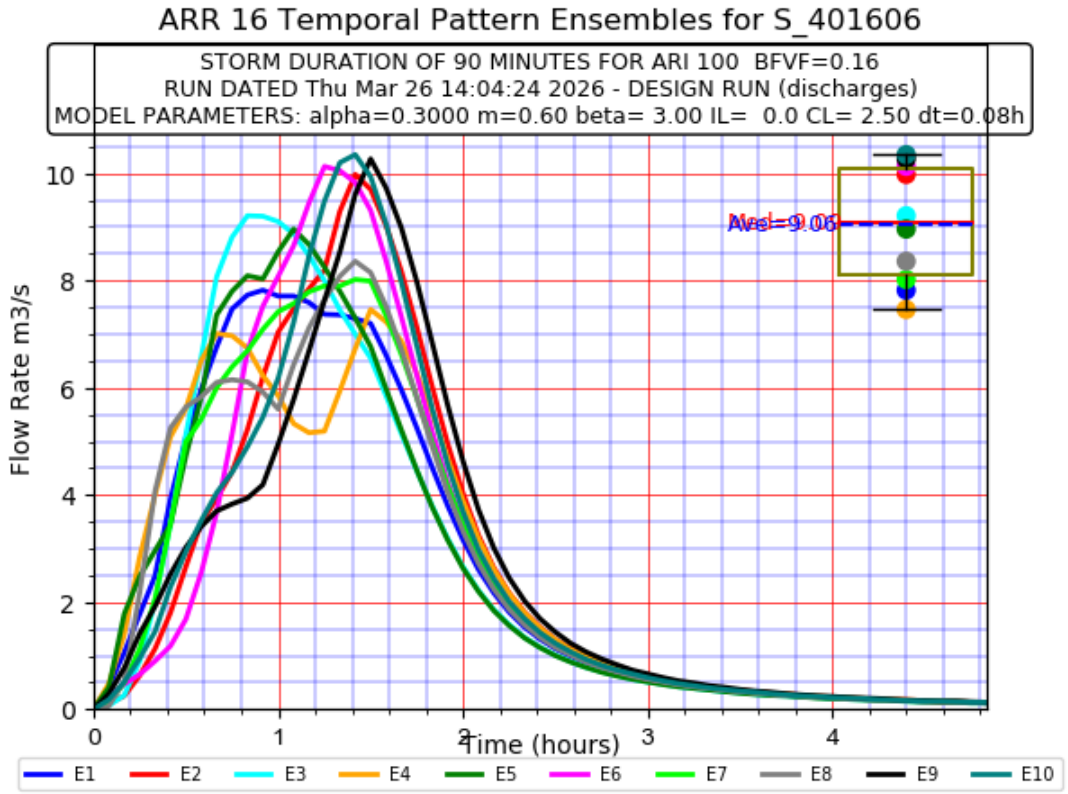


Figure 3-6 Year 2030 – 1%AEP Catchment 401606 90 minutes storm duration Total Hydrograph for 10 Temporal Patterns

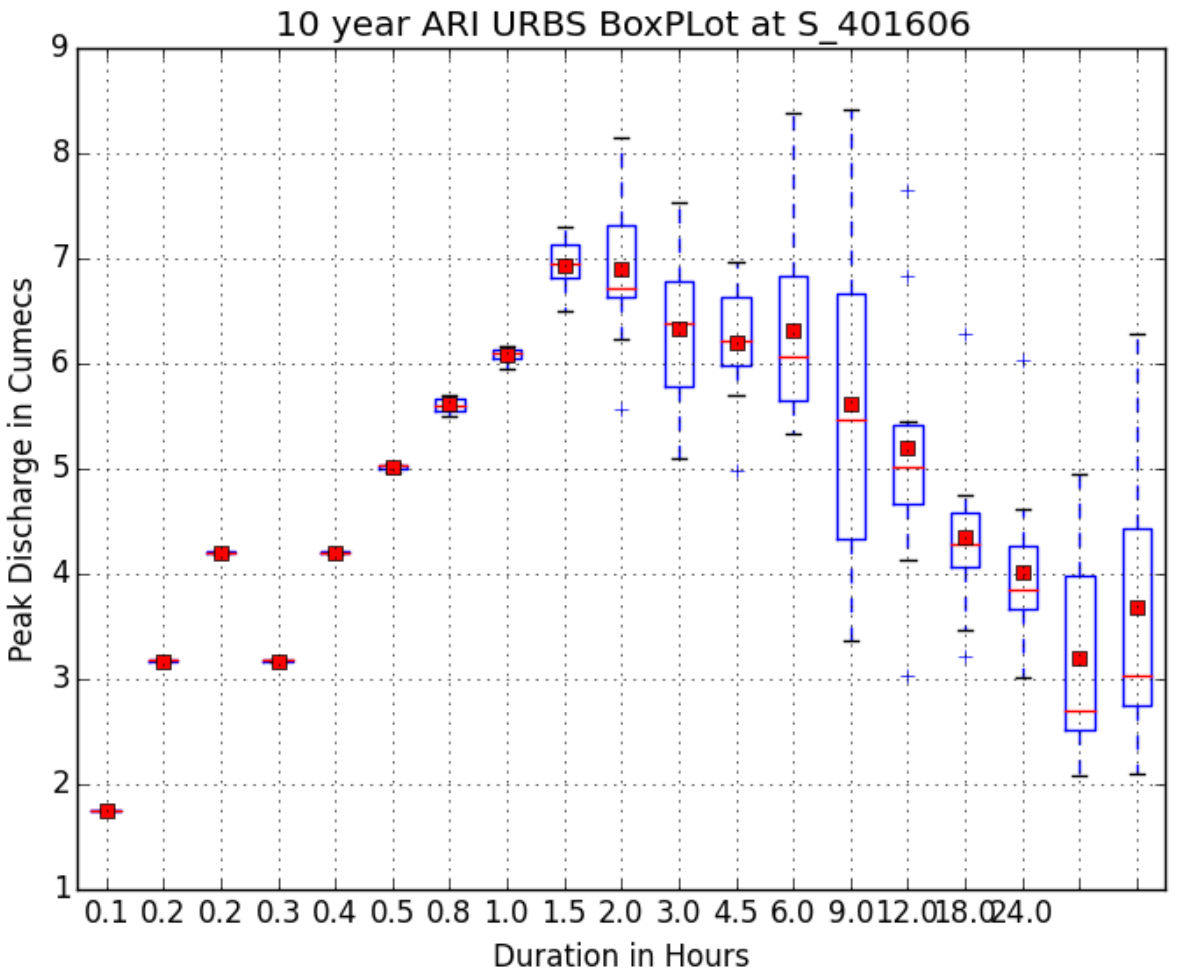


Figure 3-7 Year 2100 – 10%AEP Catchment 401606 Total Hydrograph Peak Flow Box Plot

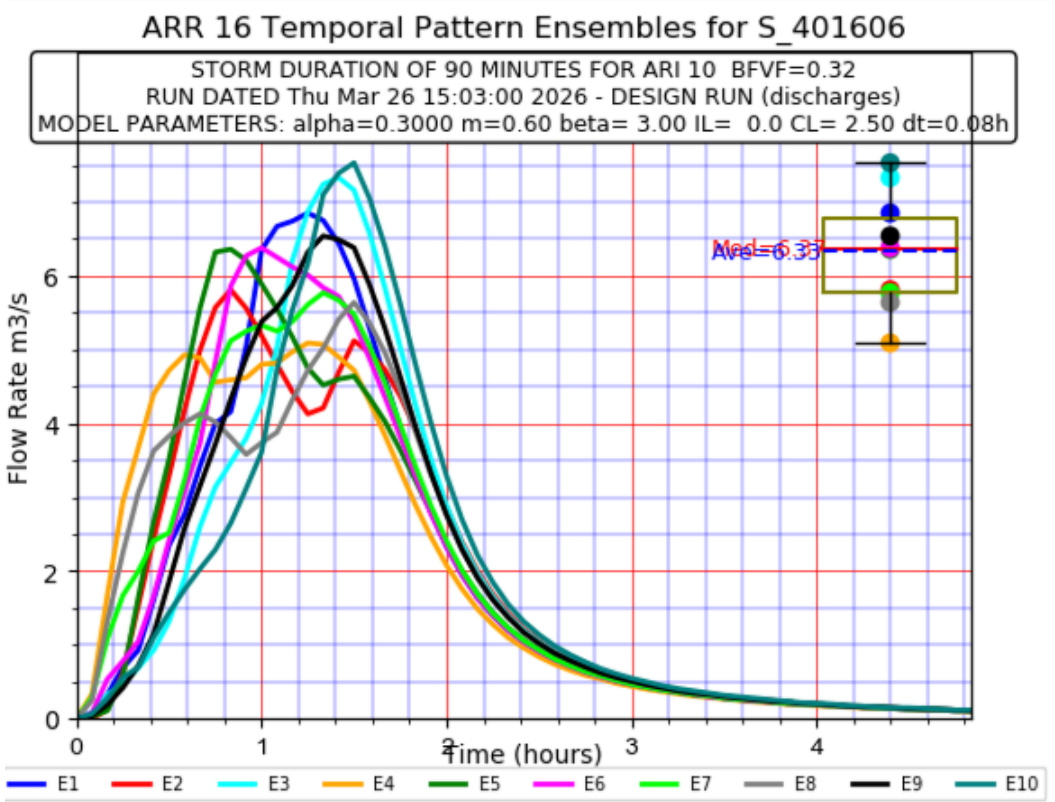


Figure 3-8 Year 2100 – 10%AEP Catchment 401606 90 minutes storm duration Total Hydrograph for 10 Temporal Patterns

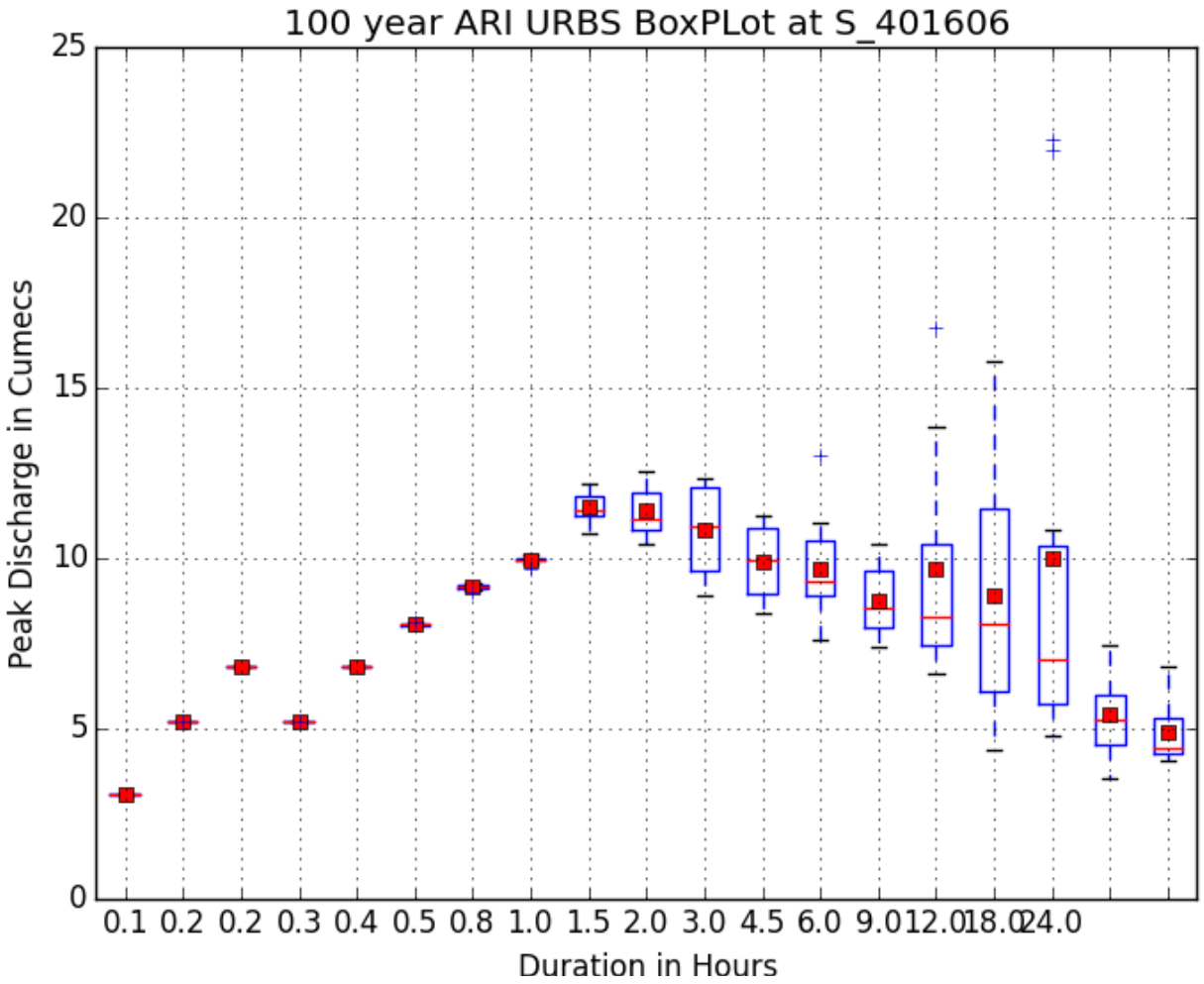


Figure 3-9 Year 2100 – 1%AEP Catchment 401606 Total Hydrograph Peak Flow Box Plot

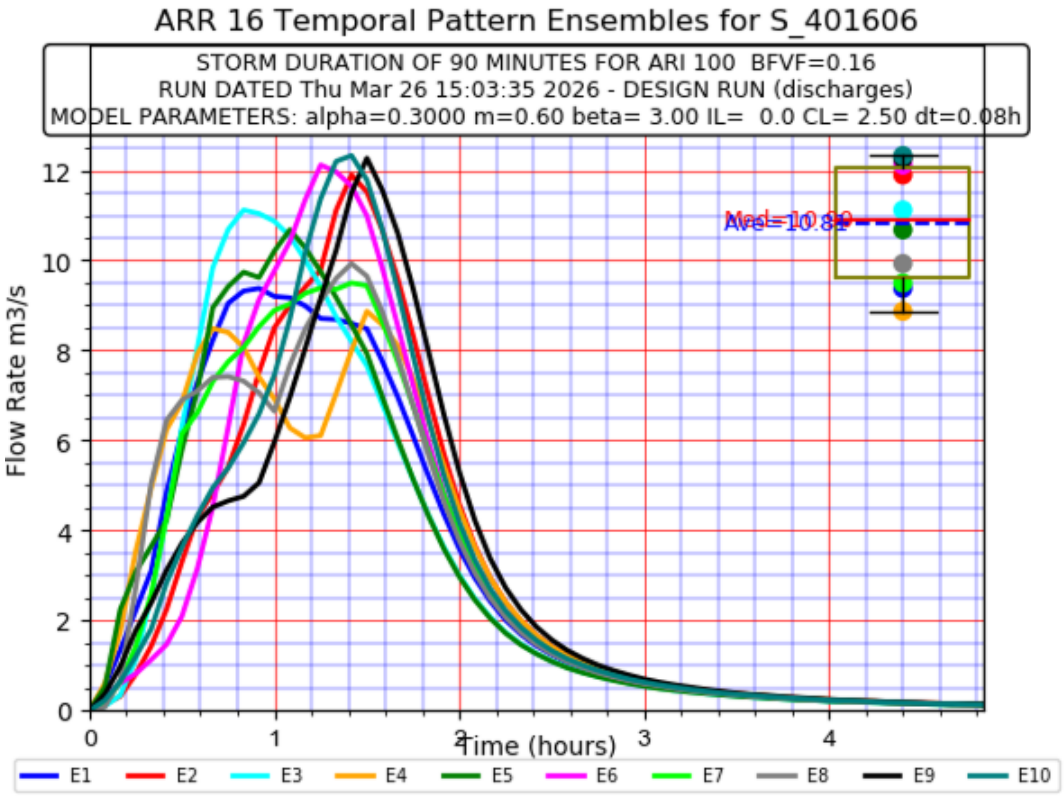


Figure 3-10 Year 2100 – 1%AEP Catchment 401606 90 minutes storm duration Total Hydrograph for 10 Temporal Patterns

4 Hydraulic Modelling

The hydraulic model developed by Water Technology (WT) was further refined to support the assessment of the existing trunk drainage system using updated site terrain data within the easement, as well as the channel design digital elevation model (DEM) prepared by Cardno for the 2017 Parklands GOLDOC Commonwealth Games overlay and 2014 Parklands trunk infrastructure early works package. The updated hydraulic modelling was undertaken using TUFLOW Build 2020-01-AA.

A 2 m grid cell size was adopted for the 2D domain in the updated model, consistent with the approach adopted in the WT model. No changes were made to the overall 2D model domain extent. The model covers approximately 38 km² of the Loders and Biggera Creek subcatchments. The updated model extent is shown in Figure 4-1.

4.1 Model Topography

The WT model topography was adopted in the Stantec model. The DEM in the WT model was developed from a 1m resolution digital elevation model (DEM) data set provided by the City of Gold Coast for the Loders and Biggera Creek catchments. The WT model terrain data is captured in Figure 4.1.

For the subject site, as no As Constructed survey data was available for the current site, a DEM developed from the Parklands GOLDOC Commonwealth Games overlay design landform developed by Cardno in 2017 was superimposed on the WT model DEM. This design overlay was adopted as it represented a landform surface similar to the existing surface levels within the site. The existing site data contours are captured in Figure 4.2.

For the previously proposed modelling scenario, similar to the existing scenario the DEM developed from the Parklands GOLDOC Commonwealth Games overlay design landform developed by Cardno in 2017 was superimposed on the WT model DEM. In addition, this design overlay also incorporated an overland flow channel profile that aligned with the drainage easement acquired over the site. This overland flow channel profile was originally developed as part of the Parklands Stage 1 Early Works in 2014. The Cardno (2017) overlay design landform with the 158m long overland flow path channel (2014) provided between Smith Street and Knowledge Street across the project site is captured in Figure 4.3.

A cross section comparison of the existing and previously proposed terrain immediately downstream of the culvert inlet is shown in Figure 4-4. It shows that the low point in terms of overland flowpaths for both conditions is the channel within the Smith Street road corridor with minimum elevation of 11.47m AHD. The secondary channel proposed within the subject site in the previously proposed scenario has a minimum invert of 11.97m AHD, however its expected this wider channel design would allow additional overland flows through the subject site relative to the existing terrain.

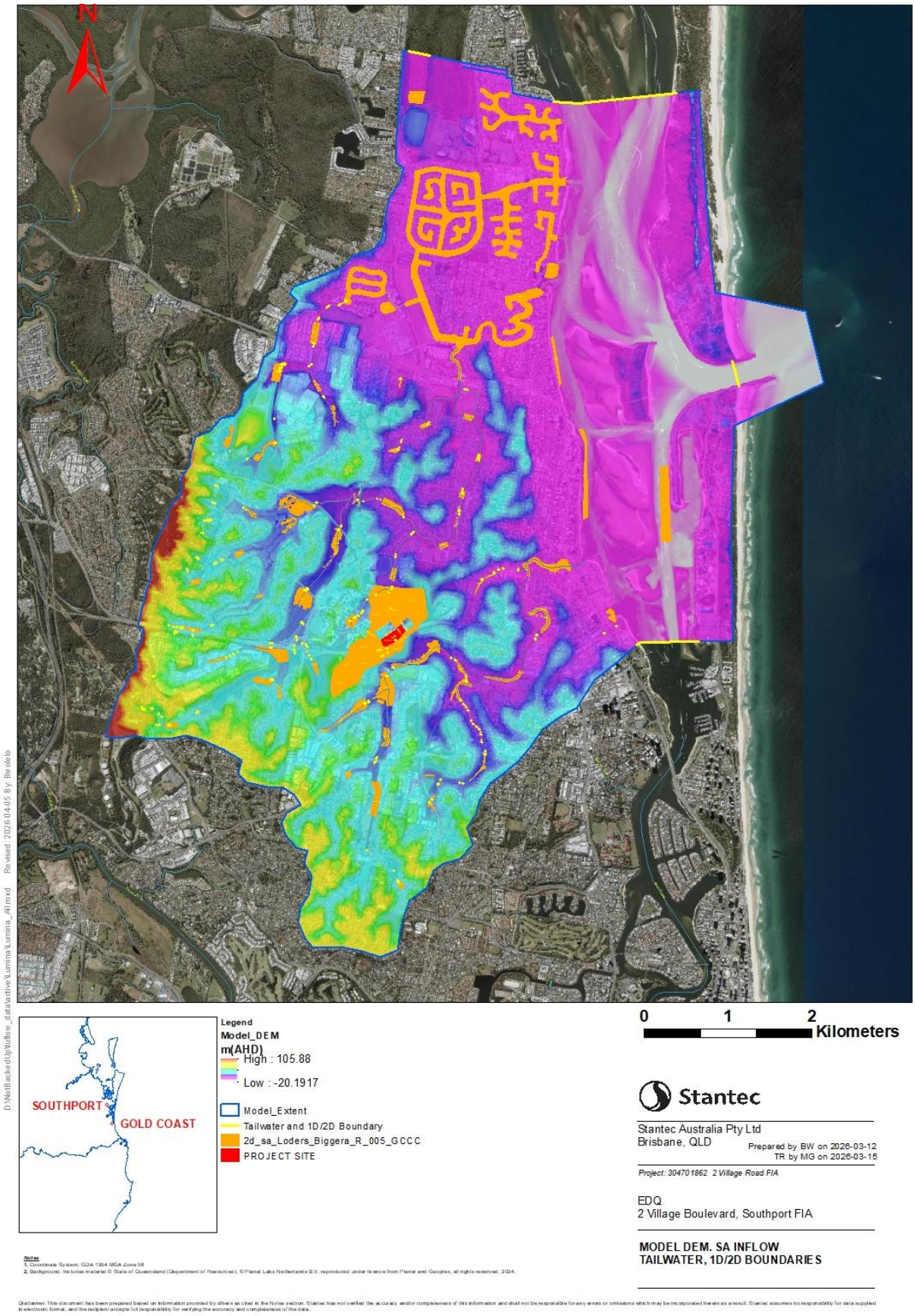


Figure 4-1 Model Extent, DEM and Boundaries

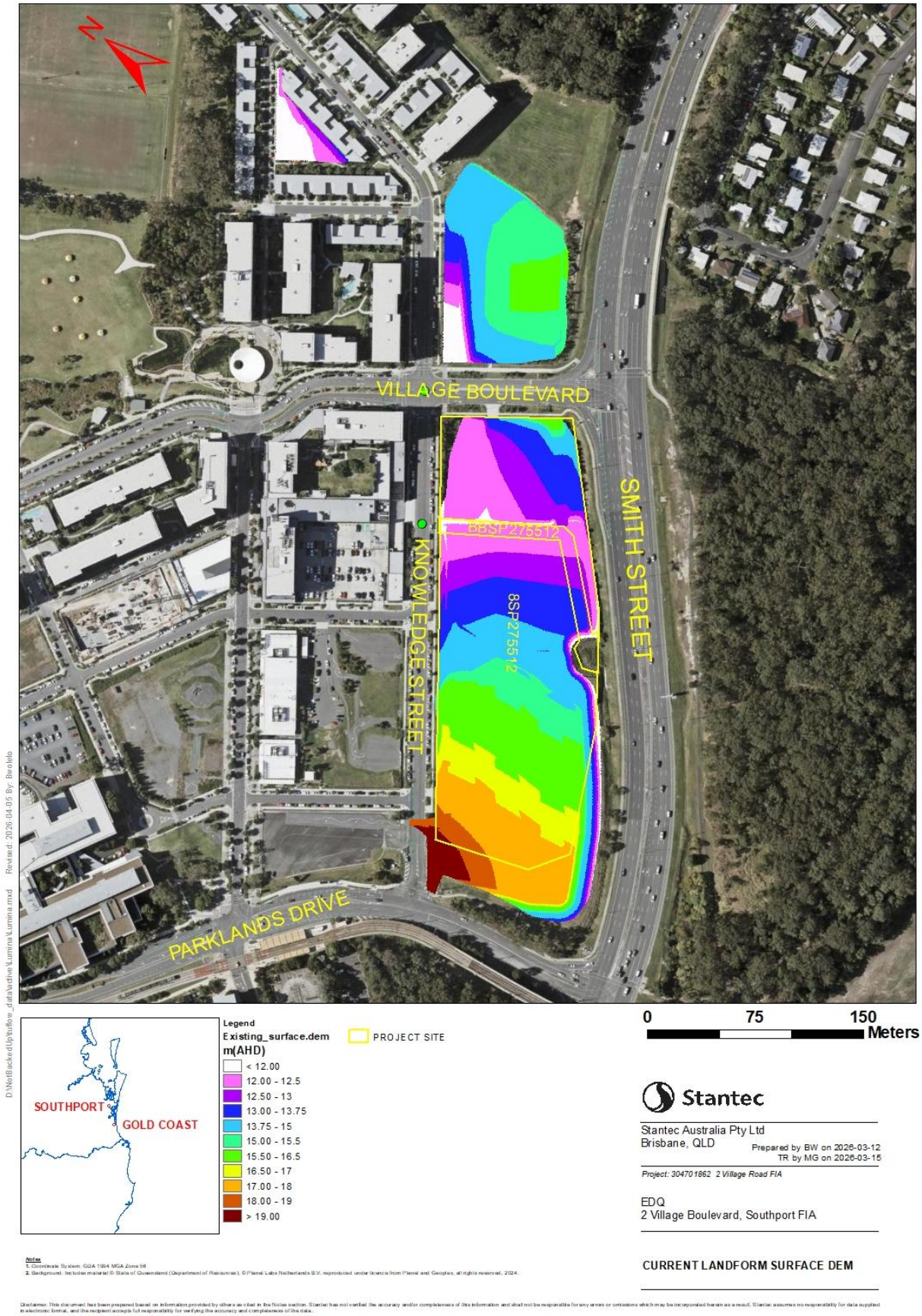


Figure 4-2 SITE DEM DEVELOPED FROM CURRENT SITE DATA

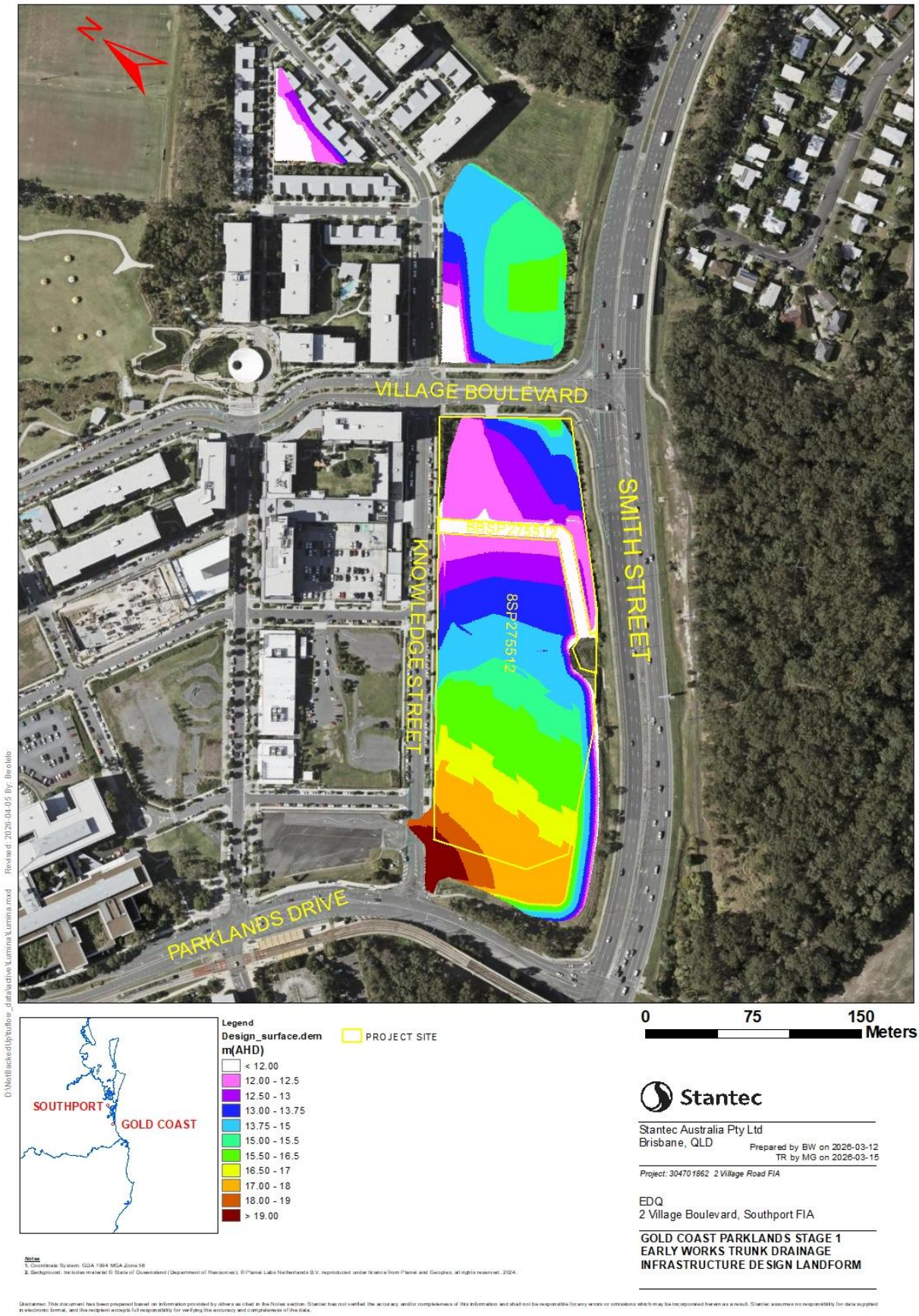


Figure 4-3 LOCALITY DEM DEVELOPED FROM CARDNO 2014 AND 2017 DESIGN SURFACE

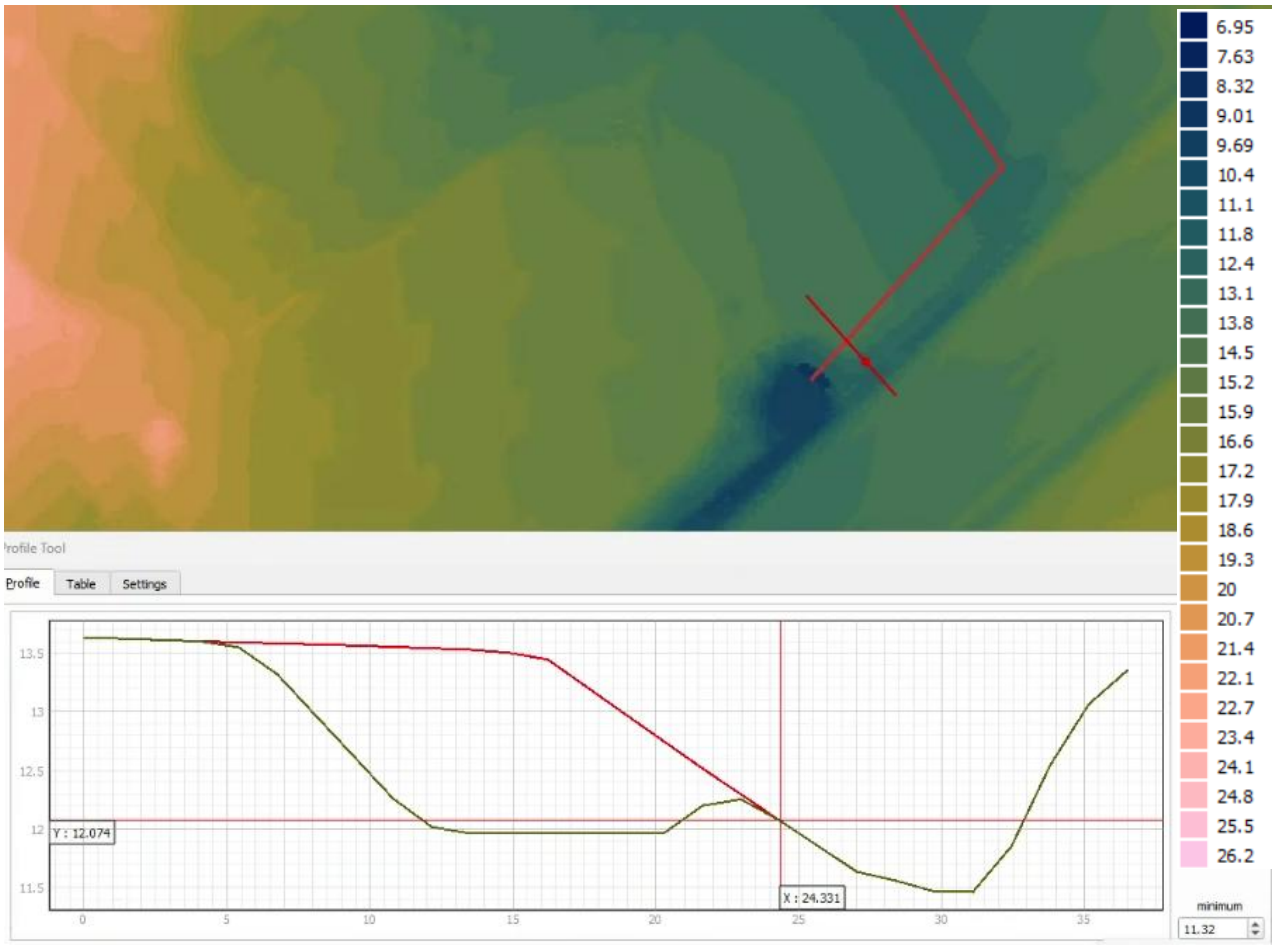


Figure 4-4 Terrain Cross Section for Overland Flowpath Downstream of Culvert Inlets Including Existing (Red) and Previously Proposed (2014) Surfaces (Green)

4.2 2D Model Hydraulic Roughness

The hydraulic roughness values applied in the 2D model, corresponding to the catchment land use patterns shown in Figure 4-2, are summarised in Table 4.1. These hydraulic roughness parameters were adopted directly from the WT hydraulic model, which utilised the values in Table 4.1 during model calibration.

For the Parklands Drive and Smith Street corridors including the vegetated open channel upstream of the trunk drainage inlets, a roughness value of 0.02 has been adopted (road corridor land use). For the culvert inlet area, the carpark areas, and the area downstream, a roughness value of 0.09 was adopted. Based on review of aerial imagery, the culvert inlet location does look densely vegetated, while the open channel upstream is generally maintained grass, meaning roughness mapping in the TUFLOW model may generally be suitable. In order to remain consistent with calibrated hydraulic model conditions, no changes to the hydraulic roughness values have been made by Stantec.

Table 4-1 Land Use Category Hydraulic Roughness

Land use Type	Manning's Roughness Coefficient
Short grass	0.035
Grass/Low density vegetation	0.060
River Channel	0.025
Concrete	0.013
Roads	0.020
Buildings	0.100
Urban Residential	0.100
Rural Residential	0.090
Forest	0.090

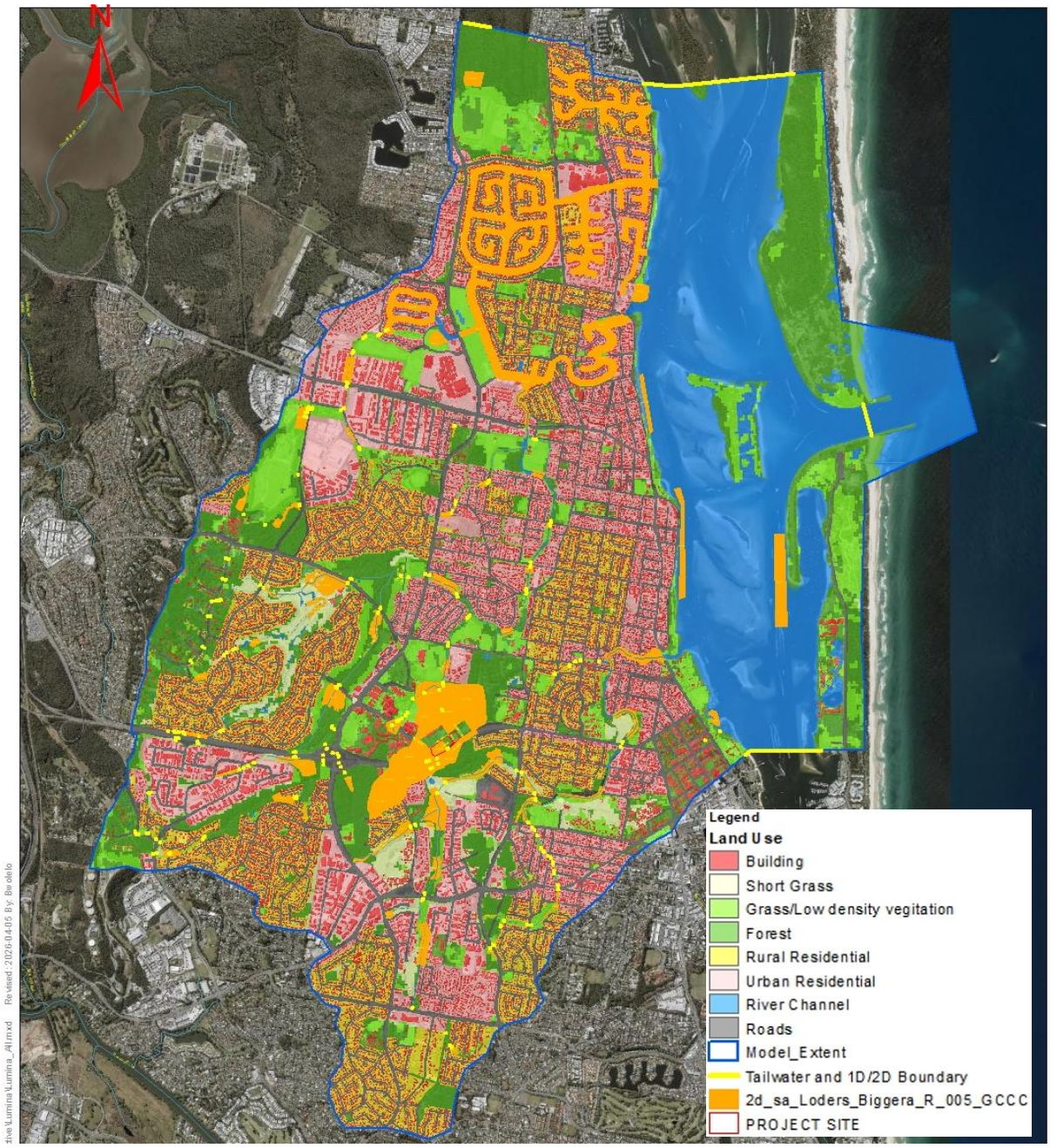


Figure 4-5 LAND USE MAP ADOPTED IN HYDRAULIC MODELLING

4.3 Boundary Conditions

4.3.1 Tailwater Conditions

The model is bound by the Coral Sea Tailwater conditions set within the model boundary are adopted in this study. With the site being located at an average elevation of 13mAHD, the adopted tailwater level will not affect flood characteristics at the site location. However, the model being bound by the southern sea, tailwater conditions set within the model boundary are adopted in this study. The WT model has adopted MHWS for the current 10% AEP event and Q20 storm surge for the current Year 2030 climate. The model adopted MHWS for the 10% AEP and Q20 storm surge event for the 1% AEP event for the future Year 2100 climate.

4.3.2 Inflow Hydrograph

The inflow hydrographs for the WT model were developed using the URBS software package. The hydraulic model was developed to assess regional flooding. The subcatchments in the hydrology model had an average area of about 70ha. The hydrographs were applied to the hydraulic model as a source area to facilitate flow within the creeks.

The project site is located within subcatchment Biggera4016. To facilitate the assessment of the trunk drainage system and performance of the overland flow path provided within the easement, Subcatchment Biggera4016 was further subdivided into ten subcatchments and a hydrograph was developed for each of the subcatchments in URBS. Within this subcatchment, the hydrographs were applied as a source area at the lowest point in the 2D model domain and within the pits in the 1D domain. No change to source area inflows and their location was made outside Biggera4016 catchment. With the site being located in an upstream reach, storm durations ranging from 15 minutes to 3 hours were tested in the URBS model and the storm duration that generated the maximum median peak hydrograph upstream of the trunk drainage system that was provided across the project site was selected. The storm duration and temporal pattern that generated the peak flow for the 10% and 1% current climate and 10% and 1% AEP for the year 2100 climate intensities was run through the hydraulic model.

4.4 Structures

Trunk drainage systems, culverts and bridges within the model domain were incorporated into the WT model. The trunk drainage system that runs through the project site was also captured in the in the WT model. No amendments were made to the existing structures' size, invert level or length data. Layout of trunk drainage system and culverts in the vicinity of the project are shown in Figure **4-6**. Due to required model discretisation, flow from Knowledge Street catchment and Village Boulevard were incorporated as a 1D-BC flow hodograph to the trunk drainage system.

The WT model has considered 20% blockage factor for drainage structures provided across the project site. QUDM suggests that a blockage of 20% be applied for culverts with height less than 3m and width less than 5m. A review of design blockage factors has also been conducted in Appendix E which confirms the adoption of a 20% blockage factor as being appropriate. 20% blockage figure was adopted in the study.

Sensitivity testing was conducted with 50% and 100% blockage applied to the culvert provided within the drainage easement at the project site to assess the culvert performance under high blockage scenarios, and to assess overland flowpath behaviour in the case of the 100% blockage scenario.

It is noted that there is a large grated inlet protection on the upstream side of the culverts. This grated inlet protection should suitably reduce the risk of blockage for the culverts, however it is understood that vegetation covers part of the grated inlet at the moment. It is important that this inlet be maintained and cleaned to ensure that the culverts are able to flow as designed without significant blockage.

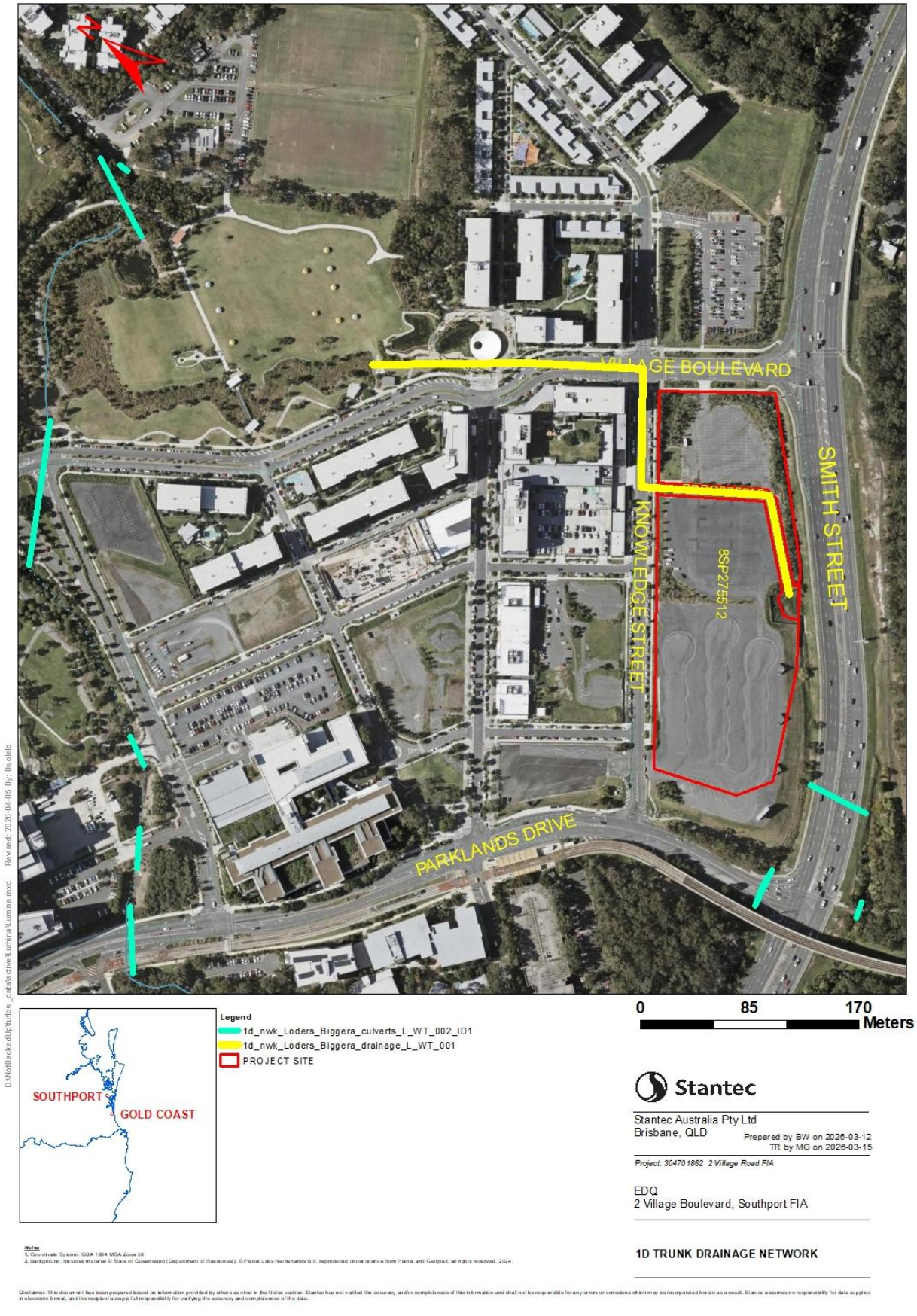


Figure 4-6 Trunk Drainage System Layout in the Project Site Locality

5 Model Results

Hydraulic modelling was undertaken to assess the flow characteristics within the subject site. The modelling was completed using the ARR2019 (Version 4.2) methodology for the Year 2030 and Year 2100 design horizons, for both the 10% AEP and 1% AEP storm events. Storm durations and temporal patterns that produced the peak median flows are discussed in Section 3. These hydrographs from the storms that generated the peak maximum median follows captured below were routed through the hydraulic model:

- 10% AEP, Year 2030 – 90-minute duration, TP06
- 1% AEP, Year 2030 – 90-minute duration, TP03
- 10% AEP, Year 2100 – 90-minute duration, TP06
- 1% AEP, Year 2100 – 90-minute duration, TP03

Two landform scenarios were modelled:

1. Existing: The existing natural surface levels based on current site data.
2. Proposed: The combined 2014 and 2017 design landform prepared by Cardno for the Gold Coast Parklands Commonwealth Games development.

The modelling results indicate that the existing trunk drainage culvert that is provided through the drainage easement within the subject site has the capacity to convey runoff generated from the upstream catchments under both the current (Year 2030) and future (Year 2100) 1% AEP design storm events.

A 20% blockage factor, consistent with Council's current Biggera and Loders Catchments flood modelling data, was applied. The results show no overtopping from the culvert inlet that would otherwise flow through the drainage easement within the site. The culvert inlet was originally designed in accordance with QUDM's blockage reduction requirements. However, site inspection photographs indicate that the area has not been well maintained, with significant vegetation growth around the inlet. It is recommended that Council undertake regular maintenance of this trunk drainage asset.

As no overtopping flows above the culvert capacity are directed through the local overland flow path within the site, only the existing scenario has been used to present the 10% and 1% AEP flood depths and flood level contours. Flood depth results for the 10% AEP and 1% AEP storm events for the Year 2030 and Year 2100 design storm events are captured in Figure 5-1, Figure 5-3, Figure 5-3 and Figure 5-4. The review of the 1% AEP event depth of flooding indicated that Smith Street upstream of the site overtops during the 1% AEP storm event during the Year 2030 and Year 2100 1% AEP storm events. The Flood Characteristics maps for the 20% blockage scenario adopted are provided in Appendix A.

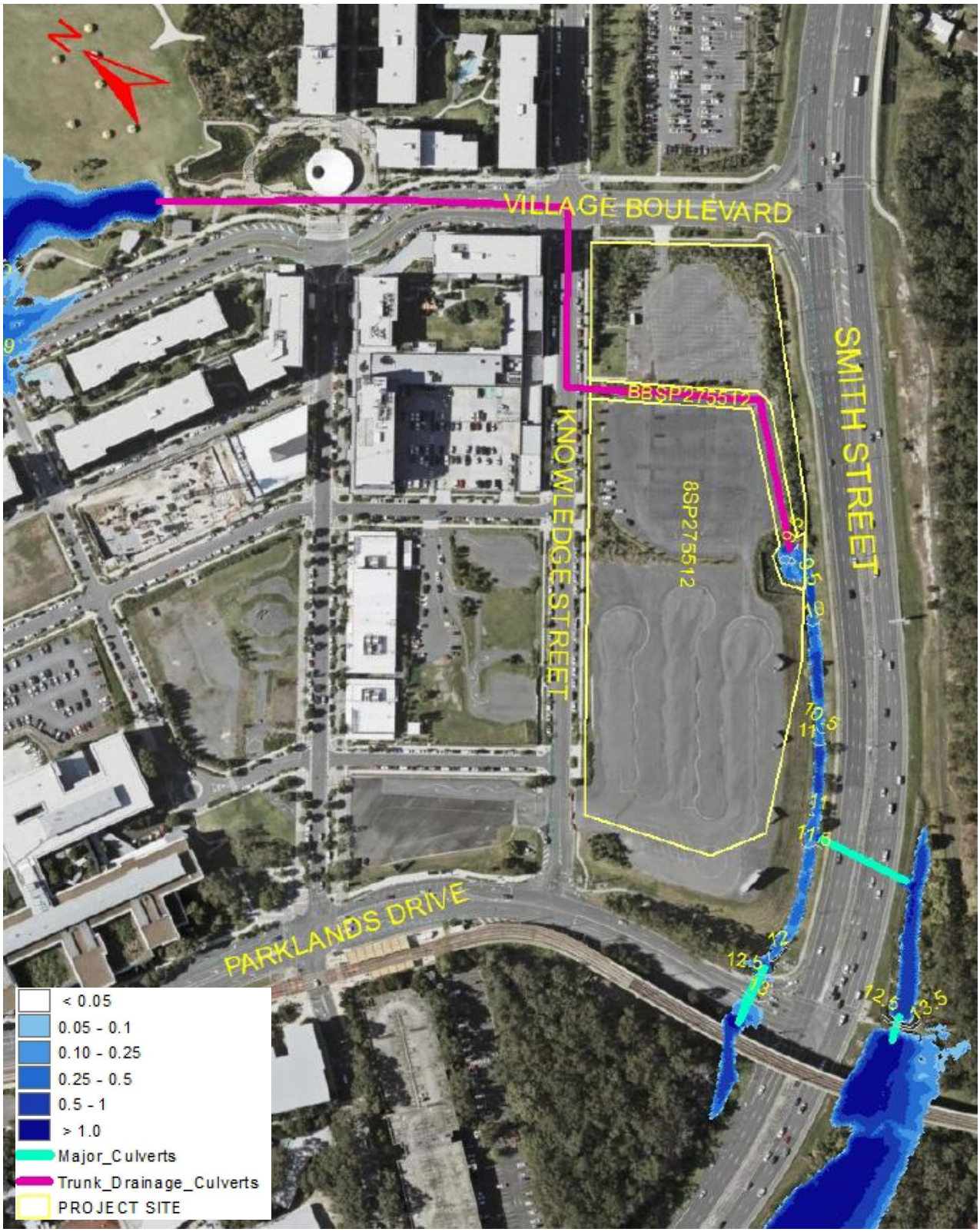


Figure 5-1 Year 2030 10% AEP Flood Depths and Levels for Existing Conditions

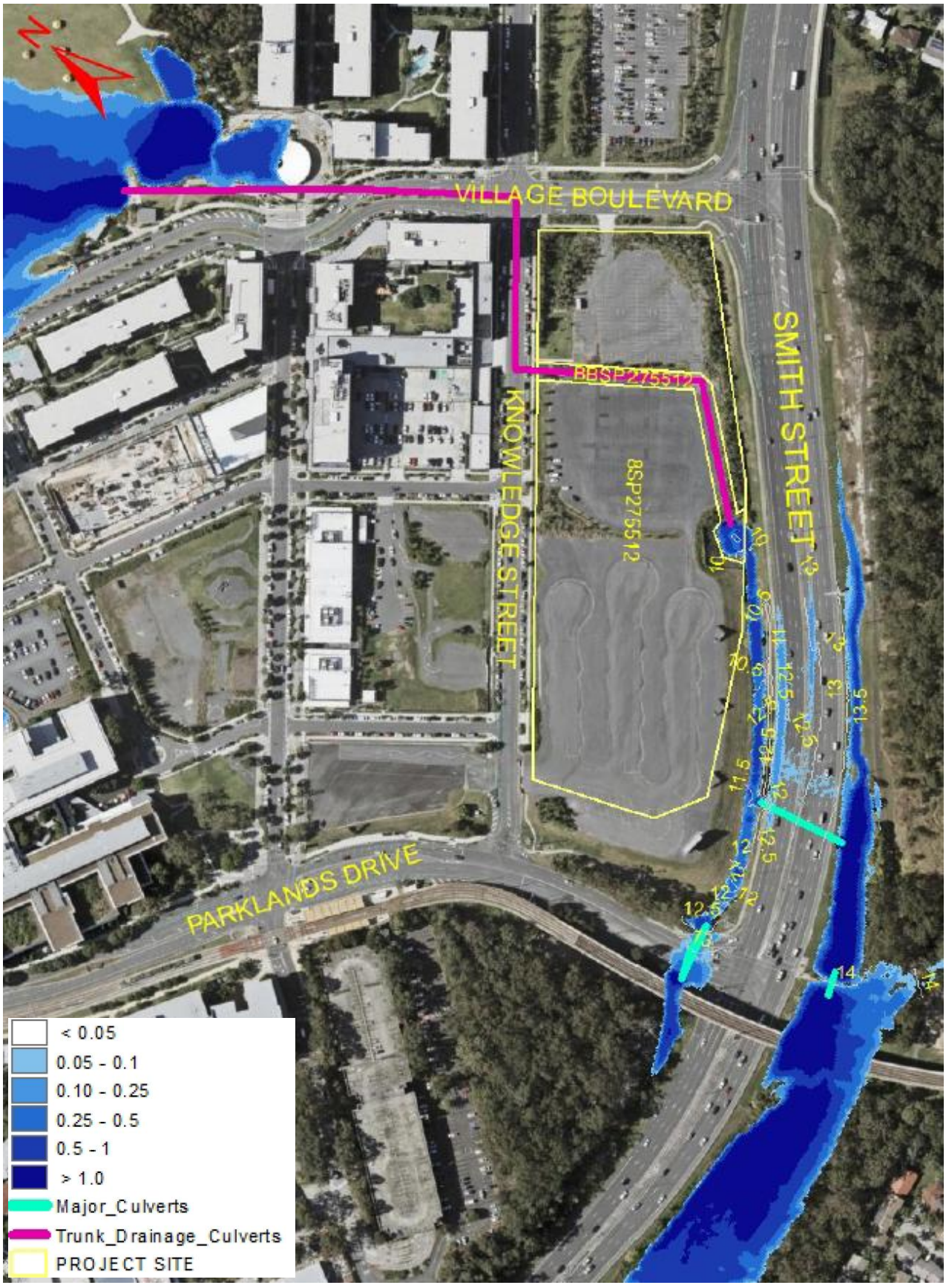


Figure 5-2 Year 2030 1% AEP Flood Depths and Levels for Existing Conditions

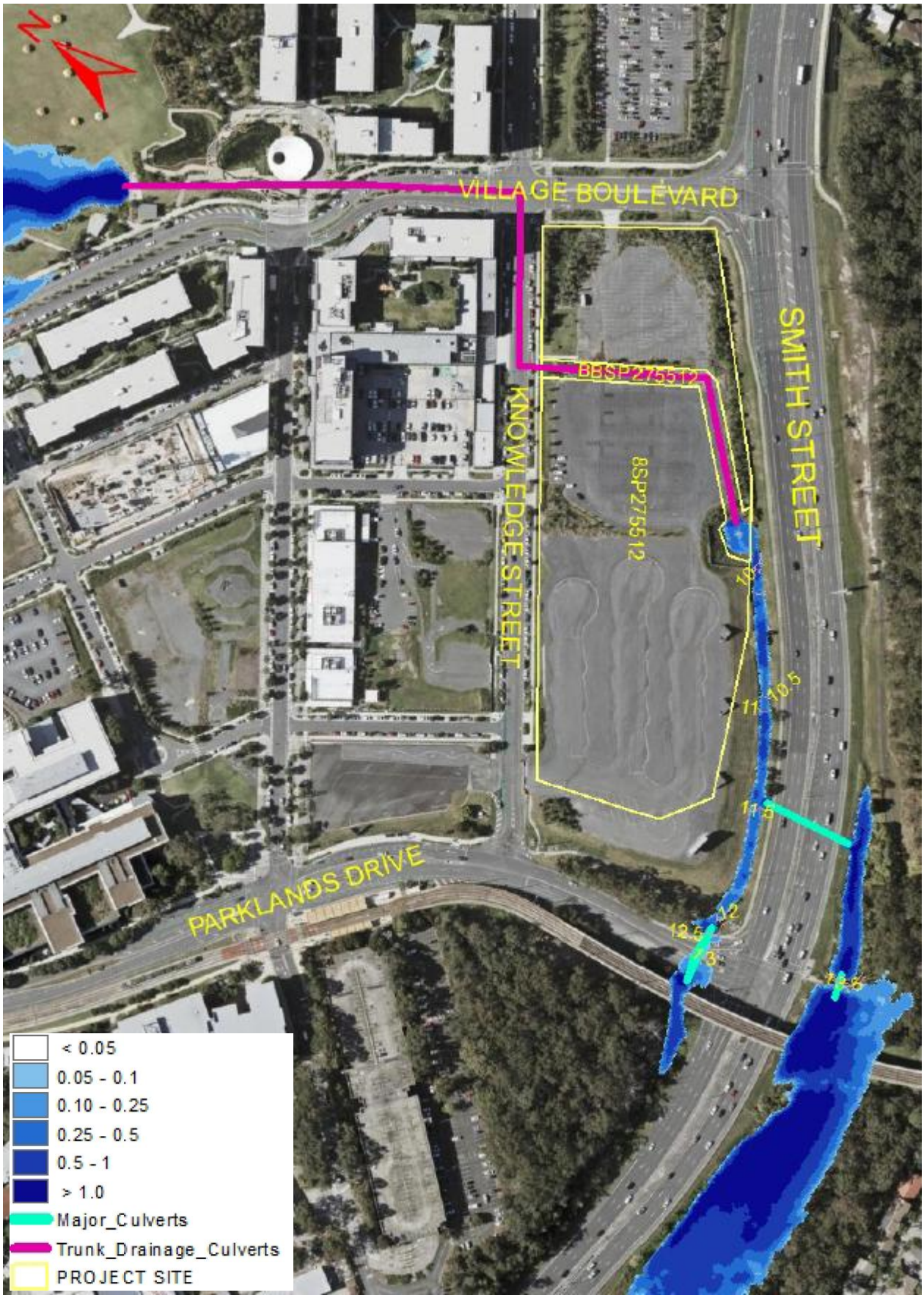


Figure 5-3 Year 2100 10% AEP Flood Depths and Levels for Existing Conditions

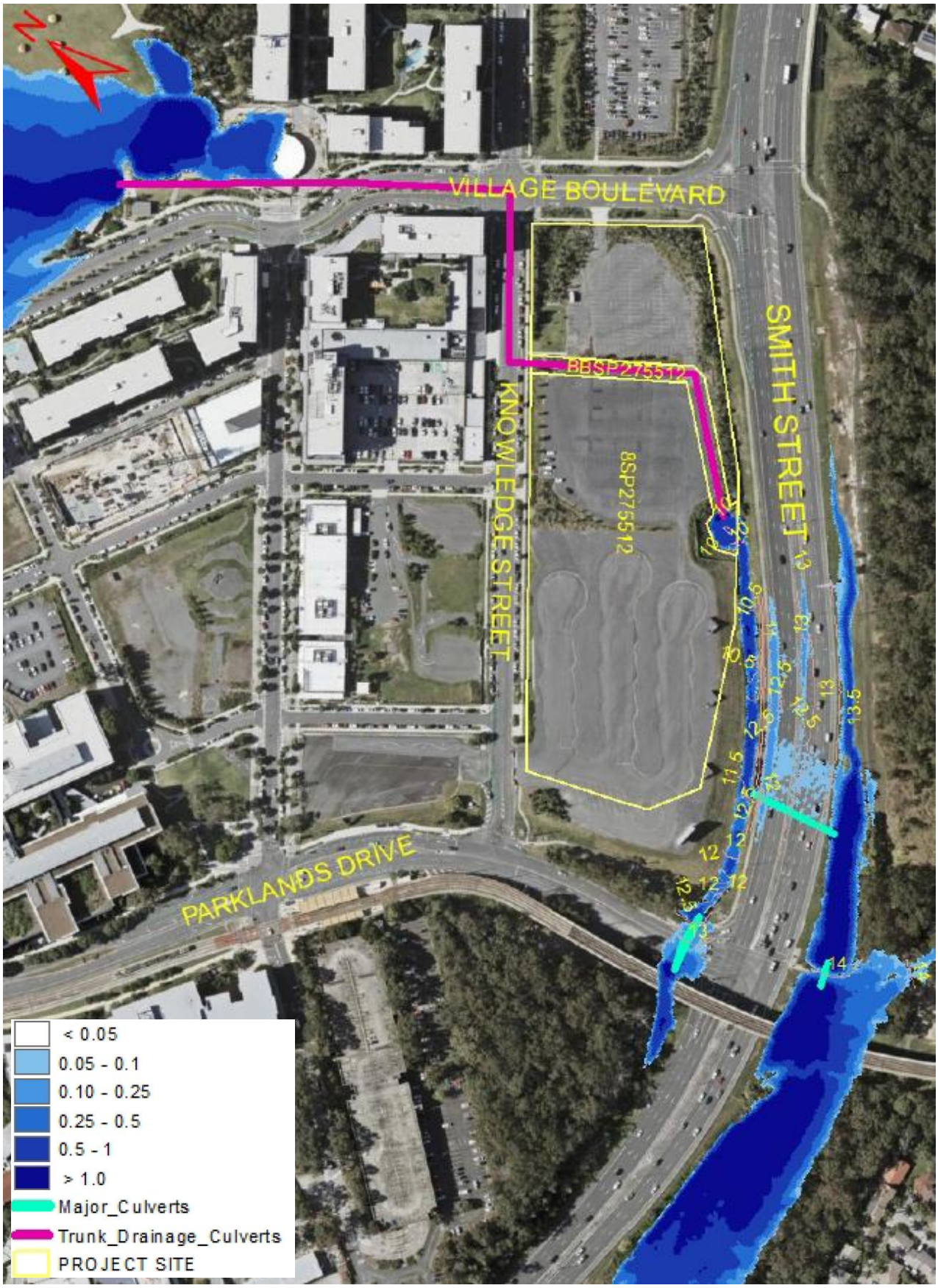


Figure 5-4 Year 2100 1% AEP Flood Depths and Levels Existing Condition

Peak flood level data was extracted at the inlet to the trunk drainage system located within the drainage easement at Smith Street. The modelling results presented in Table 5-1 indicate that a freeboard of approximately 1.5 m is provided during the Future Year 2100, 100-year ARI storm event.

Table 5-1 Flood Level Result at the Trunk Drainage Headwall on Smith Street: With 20% Blockage Applied to Trunk Drainage

Item #	ARI	Design Climate Year	Landform	Blockage %	Flood Level m(AHD)	Bypass Flow Overtop Level m(AHD)	Freeboard (m)
1	10	2030	Ground Survey Surface	20%	9.447	11.47	2.023
2	10	2030	2014 Design Surface	20%	9.447	11.97	2.523
3	10	2100	Ground Survey Surface	20%	9.545	11.47	1.925
4	10	2100	2014 Design Surface	20%	9.545	11.97	2.425
5	100	2030	Ground Survey Surface	20%	9.812	11.47	1.658
6	100	2030	2014 Design Surface	20%	9.812	11.97	2.158
7	100	2100	Ground Survey Surface	20%	9.979	11.47	1.491
8	100	2100	2014 Design Surface	20%	9.979	11.97	1.991

For 2014 design surface scenario, the minimum flowpath level in the road corridor is the same as the existing invert 11.47m AHD, however minimum levels reported in the above table have been modified to represent the minimum proposed flowpath level within the site.

With respect to maximum percentage flowing results (1d_ccA results from TUFLOW) indicating how close the culverts are to flowing at full capacity during the design flood events:

- 10% AEP, Year 2030 – 90-minute duration, TP06 – 22% full
- 1% AEP, Year 2030 – 90-minute duration, TP03 – 36% full
- 10% AEP, Year 2100 – 90-minute duration, TP06 – 26% full
- 1% AEP, Year 2100 – 90-minute duration, TP03 – 43% full

5.1.1 Blockage Sensitivity Model Results

Blockage assessment was conducting using ARR2019 procedures. The analysis has indicated that the 20% blockage could be adopted for the barrel and/or inlet blockage. The assessment results are captured in Appendix E.

Sensitivity run assessment with 100% blockage of the trunk drainage system has indicated that there could be a potential spill from the 1% AEP event outside the extent of the provided easement channel. Within the development site.

Flood characteristics maps for the 50% trunk drainage blockage scenario are provided in Appendix B.

Flood characteristics maps for the 100% trunk drainage blockage scenario modelling are provided in Appendix C.

H1-H6 hazard category mapping results for the existing and proposed conditions for the year 2030 1% AEP event are shown in Figure 5-5 and Figure 5-6 respectively. The results show the design surface that allows overtopping discharge early from the trunk drainage system upstream area performed better in relation to flow hazard on Smith Street. Two northbound lanes on Smith Street will have hazard category H1 in the 2014 Design surface case. Two lanes will have H2 hazard category and the outside lane will have Hazard Category H3 if the trunk drainage system is fully blocked and under the current locality ground surface is adopted in the modelling. Downstream on Knowledge Street there is negligible

difference in flood hazard, with H2 – H3 hazard affectation for both existing and proposed conditions.

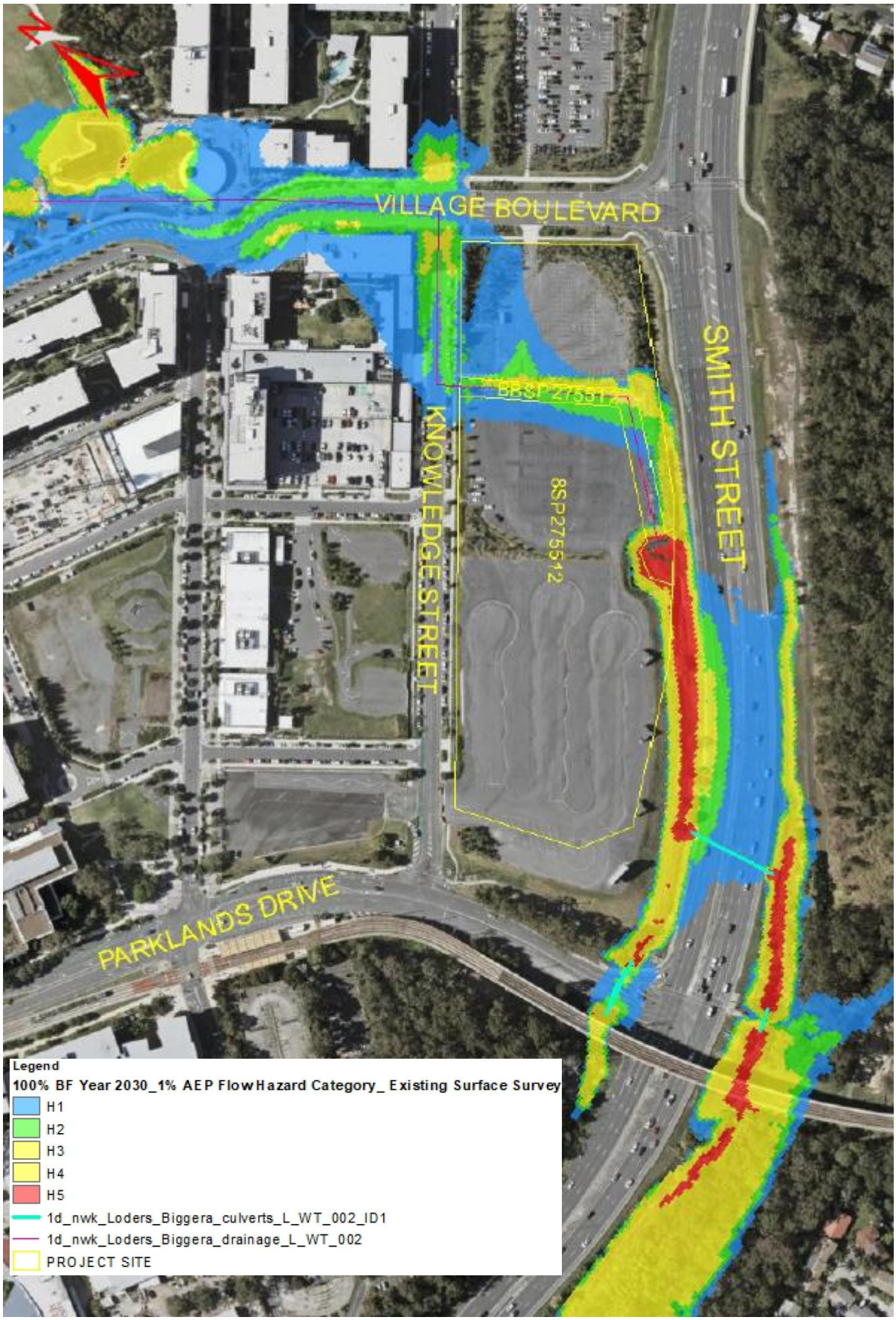


Figure 5-5 Year 2030 1% AEP Flow Hazard Category Based on Existing ground surface DEM



Figure 5-6 Year 2030 1% AEP Flow Hazard Category Based on 2014 and 2017 Design surface DEM

Review of the peak flood level results summarised in Table 5-2 indicates that, with a 50% blockage applied to the trunk drainage system, a freeboard of approximately 1.0 m is maintained. For the 50% blocked scenario, the maximum water level above the invert of the culvert in the 1% AEP year 2030 and year 2100 scenarios being 1.35m and 2.1m respectively. The maximum full percentage for the culvert in the 1% AEP year 2030 and year 2100 scenarios was 100%, with flow in the culvert pressurized during the 1% AEP year 2100 scenario.

Analysis of the model outputs in Table 5-3 shows that the trunk drainage system will be overtopped under conditions of complete blockage. Under this scenario, overtopping occurs via the proposed channel in the design surface when the 2014 Cardno design surface is adopted in the model. If the current existing surface data are superimposed on the model bathymetry, floodwaters are predicted to flow adjacent to Smith Street and extend to a location approximately 70 m downstream of the trunk drainage headwall. The modelling indicates that, in the event of complete blockage of the trunk drainage system, runoff depths could exceed 0.78 m above the design channel invert level.

Table 5-2 Flood Level Result at the Trunk Drainage Headwall on Smith Street: With 50% Blockage Applied to Trunk Drainage

Item #	ARI	Design Climate Year	Landform	Blockage %	Flood Level m(AHD)	Bypass Flow Overtop Level m(AHD)	Freeboard (m)
1	100	2030	Ground Survey Surface	50%	10.254	11.47	1.216
2	100	2030	2014 Design Surface	50%	10.254	11.97	1.716
3	100	2100	Ground Survey Surface	50%	10.999	11.47	0.471
4	100	2100	2014 Design Surface	50%	10.999	11.97	0.971

Table 5-3 Flood Level Result at the Trunk Drainage Headwall on Smith Street: With 100% Blockage Applied to Trunk Drainage

Item #	ARI	Design Climate Year	Landform	Blockage %	Flood Level m(AHD)	Bypass Flow Overtop Level m(AHD)	Freeboard (m)
1	100	2030	Ground Survey Surface	100%	12.89	11.47	-1.420
2	100	2030	2014 Design Surface	100%	12.707	11.97	-0.737
3	100	2100	Ground Survey Surface	100%	12.93	11.47	-1.460
4	100	2100	2014 Design Surface	100%	12.757	11.97	-0.787

6 Discussion

6.1 EDQ Request for Information

Stantec received a Request for Information (RFI) from EDQ in September 2026 with the following responses by Stantec to comments:

- *SDAP has been considered as part of the assessment. DTMR will assess the proposal against all relevant PO and AO in State code 1: Development in a state-controlled road environment. Stormwater and overland flow, Flooding, and Drainage Infrastructure provisions may be relevant to your reporting*

Stantec Response: As this is a review of existing drainage infrastructure, rather than an assessment to support development or drainage upgrades, assessment against State Development Assessment Provisions (SDAP) is not required. The assessment and modelling of the '2014 proposed' conditions is a sensitivity assessment against the previous alternate design that was not progressed, the focus of the review is on the 'existing' scenario results to assess the performance of the current site condition.

- *The 100% blockage scenario considers the continuous drainage flow due to the installation of the self-cleansing inlet grate as required by QUDM; and*

Stantec Response: There is an existing large inlet grate for the culvert inlet that was designed in 2014 (see Appendix D for design drawings). Upon high-level review it appears this inlet protection structure was designed to QUDM standards and should provide sufficient blockage protection for the existing culverts. With an approximate grated surface area 5 times greater than the culvert opening area (45m^2 compared to 9m^2) this exceeds QUDM minimum requirements of 3 times greater area.

Conservatively, the sensitivity modelling for high blockage scenarios (50% and 100% blockage) has not considered the existing blockage protection in assessing these blockage scenarios. This grate should further reduce the likelihood of culvert blockage meaning these sensitivity tests should be very unlikely.

- *To emphasize the importance of maintenance of the inlets of the trunk culverts so the blockage potential is reduced*

Stantec Response: As noted above, there is an existing culvert inlet grate that should ensure blockage risk is reduced. However it is understood that this inlet grate has been overgrown by minor vegetation, reducing the likely effectiveness of this blockage protection. A note has been added in Section 4.4 to note the importance of continued maintenance and cleaning of debris from this grate to ensure blockage risk is reduced.

- *Provide information on chance of blockage based on the Australian Rainfall & Runoff Ver 4.2, Book 6, Ch. 6 (Blockage of Hydraulic Structures)*

Stantec Response: A complete blockage assessment using the ARR2019 blockage assessment form has been re-assessed and included in Appendix E. Conservatively, the assessment has concluded that there is a 'high' design blockage risk. This is despite the existing inlet grate noted in the above response providing blockage protection when maintained. Based on the relative culvert opening width and design debris length, the resultant design blockage factor is 20%, consistent with the blockage factor adopted in the design event modelling for this assessment.

The 50% and 100% blockage factors adopted in sensitivity scenarios corresponds to medium and high debris potential where the opening width is less than the design debris length. Given the significant width of the culverts (3.0 metres), and the presence of an existing culvert inlet grate, the probability of these extreme blockage scenarios is very low. Nevertheless, these two scenarios have been included as a worst-case blockage scenario, particularly the 100% blockage scenario which allows an assessment of the existing and 2014 proposed overland flowpaths through the site if the culverts were unable to flow at all.

- *Provide further commentary on potential impact of the runoff beyond the easement extent and how to mitigate this impact on the current and future development on and off the site*

Stantec Response: The results show that in the design blockage scenario (20% blockage) and even in the 50% blockage sensitivity scenario the culvert have sufficient capacity to convey a 1% AEP year 2100 event with no overland flooding downstream. It is only in the extreme 100% blockage scenario that overland flows are conveyed through the site. Based on ARR guidance, the 20% blockage scenario is appropriate for design.

In the 100% blockage scenario, 1% AEP year 2100 flows are conveyed along the existing flowpath, and the Knowledge Street and Village Boulevard corridors before discharging back to the ponds and channel downstream. As shown in Appendix C Figure C.1 the flooding depths are greatest in the road reserve with only shallow (up to 0.25 metres) flooding of the northern carpark and properties on the corner of Knowledge St and Village Boulevard. Figure C.3 shows that these sites are all affected by H1 hazard, or low hazard safe for all pedestrians, vehicles and buildings.

- *Figure 4-4 of the report shows an existing and a proposed cross-sections of an overland flowpath. The report needs to elaborate if the proposed wider channel was included in the model along the current easement through the site*

Stantec Response: The assessment and modelling of the '2014 proposed' conditions is a sensitivity assessment against the previous alternate design that was not progressed. It is understood there is not a plan to modify the existing site at this stage. The focus of the review is on the 'existing' scenario results to assess the performance of the current site condition. This clarification has been added near Figure 4-4.

- *The report shows overtopping of Smith Street during the 1% AEP event for both the current (2030) and 2100 climate change scenarios. The report needs to provide clarification if any work adjacent to the current easement would exacerbate the flooding condition across the Smith Street corridor.*

Stantec Response: No work is proposed near the road corridor, this is an assessment of the existing conditions.

The assessment of Smith St flooding should not be based on 100% blockage scenario results as this is only a sensitivity assessment to extreme blockage conditions. For the design flood event (20% blockage), Figure 5-24 shows that in a year 2100 1% AEP there is minor overtopping of Smith St from the west with flooding not a result of channel capacity for the section of channel within the subject site. As shown in Appendix A Figure A.23 this flooding of the road surface is H1 hazard, or low hazard safe for all pedestrians, vehicles and buildings.

- *it is certified by a REPQ engineer.*

Stantec Response: Reviewed and signed off by RPEQ Nicole Bichel (22245).

7 Conclusion

EDQ has received a Further Issues Letter regarding its development application to subdivide Lot 1 into three allotments at 2 Village Boulevard, Southport. The site is flood affected and contains an existing drainage easement. The Minister for Economic Development Queensland (MEDQ) has requested that EDQ demonstrate the adequacy of the easement to convey runoff exceeding the capacity of the existing trunk drainage system, including consideration of future climate change impacts.

Stantec has undertaken flood modelling in accordance with ARR2019 (Version 4.2) to establish design rainfall intensities for the current (Year 2030) and future (Year 2100) climate conditions. Flow hydrographs representing the maximum median peak flows were developed using the SSP2-4.5 climate pathway for the Biggera Creek catchment, with particular focus on the discretised sub-catchment surrounding the site. The discretised subcatchments hydrographs were generated using the URBS software package for both Year 2030 and Year 2100 design rainfall events.

The City of Gold Coast's Biggera–Loders catchments TUFLOW hydraulic model was subsequently updated to incorporate the revised inflow hydrographs. These flows were then routed through the existing waterways and the current piped trunk drainage system. Review of the hydraulic model results indicates that the trunk drainage infrastructure constructed during the early works for the Gold Coast Parklands Stage 1 development (by Cardno) has sufficient capacity to convey runoff generated from the 1% AEP storm event under both current (Year 2030) and future (Year 2100) climate scenarios following the SSP2-4.5 pathway, even when applying a 50% blockage scenario.

.

8 References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), Version 4.2, 2019.

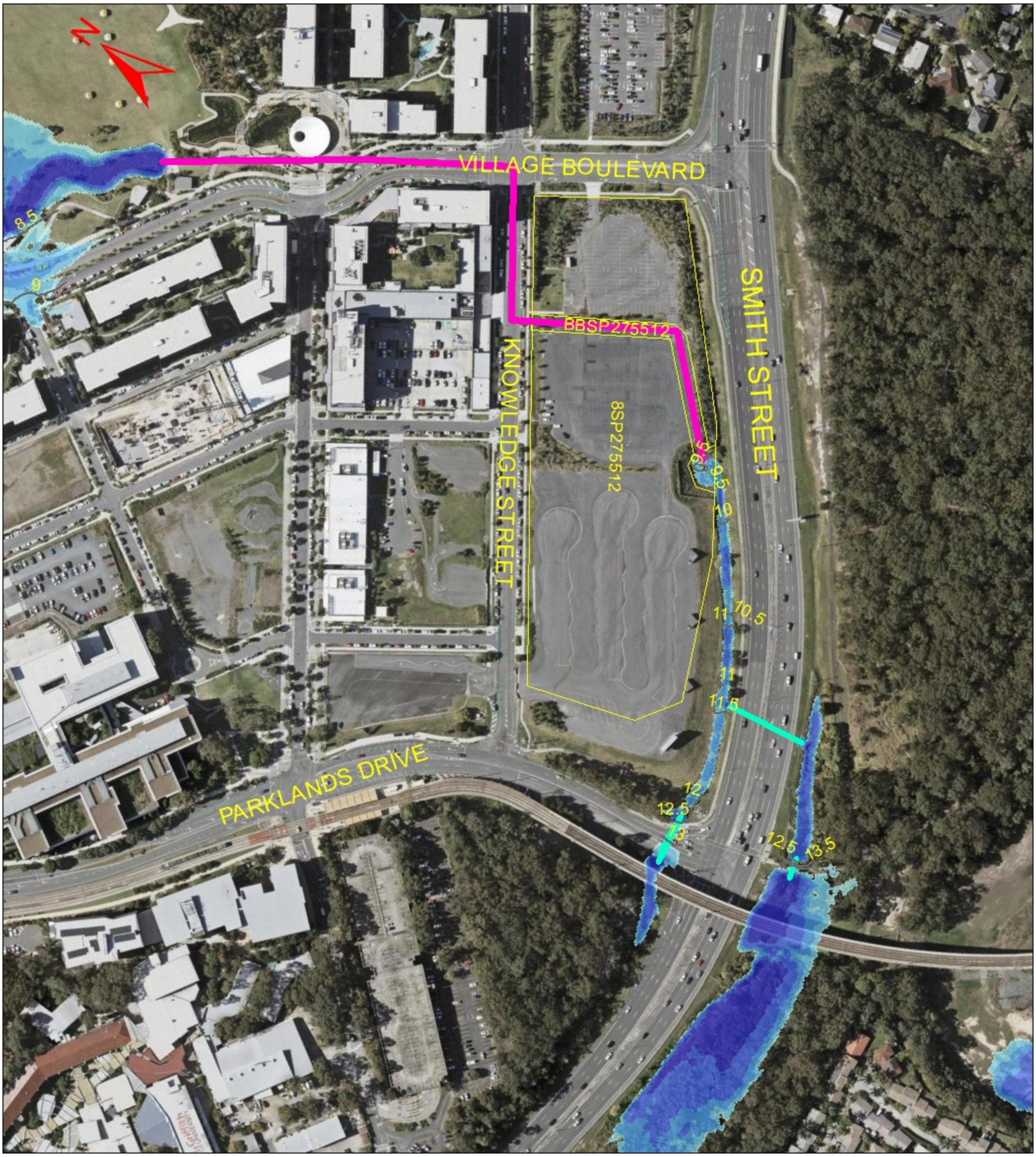
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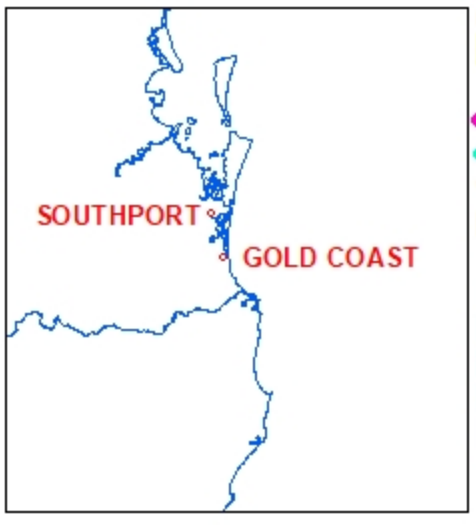
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Hyder (2013) “Early works & Trunk Drainage Infrastructure: Gold Coast Parklands”, Flooding and Hydraulic Report, prepared for Economic Development Queensland, August, 28 pp + Apps

Water Technology (2022) “Loders and Biggera Creek Catchment Flood Study”, Flooding Report, prepared for City of Gold Coast, Version 01, August, 41 pp + Maps + Apps

Appendix A Trunk Drainage 20%Blockage Factor Scenario Flood Characteristics Map





Legend

- PROJECT SITE
- Year_2030_Ex_10%_AEP_Flood_Level_Contour
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Ex_Surv_DEM_10%_AEP_Depth of Flooding (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

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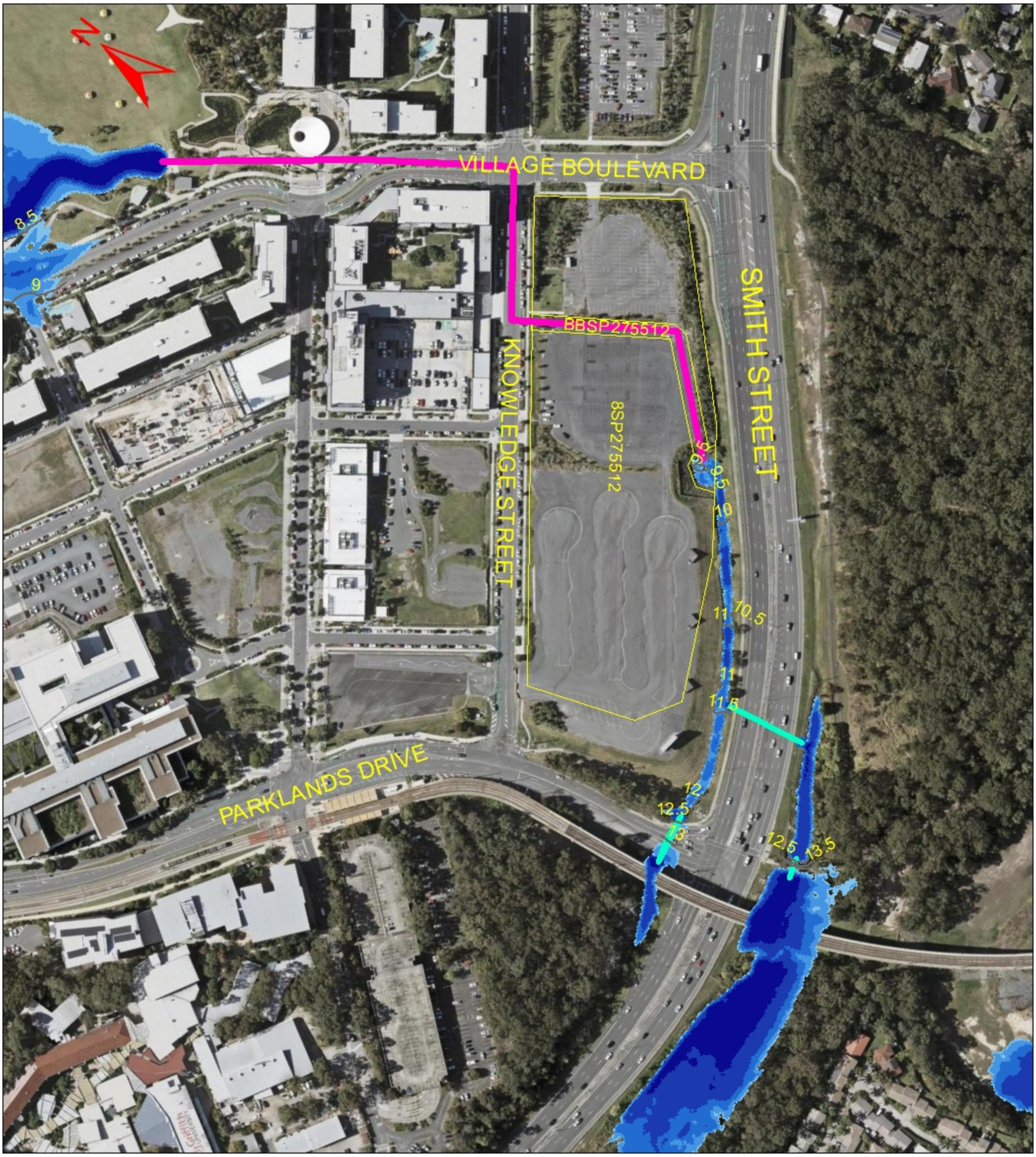
Project: 304701862 2 Village Road FIA

EDQ
2 Village Boulevard, Southport FIA

Appendix A.1 Year_2030_Ex_Surv_DEM_10%_AEP_Depth of Flooding and Flood Leve

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Legend

- PROJECT SITE
- Year_2030_Pr_10%_AEP_Flood_Level_Contour
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Pr_10%_AEP_Depth of Flooding (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

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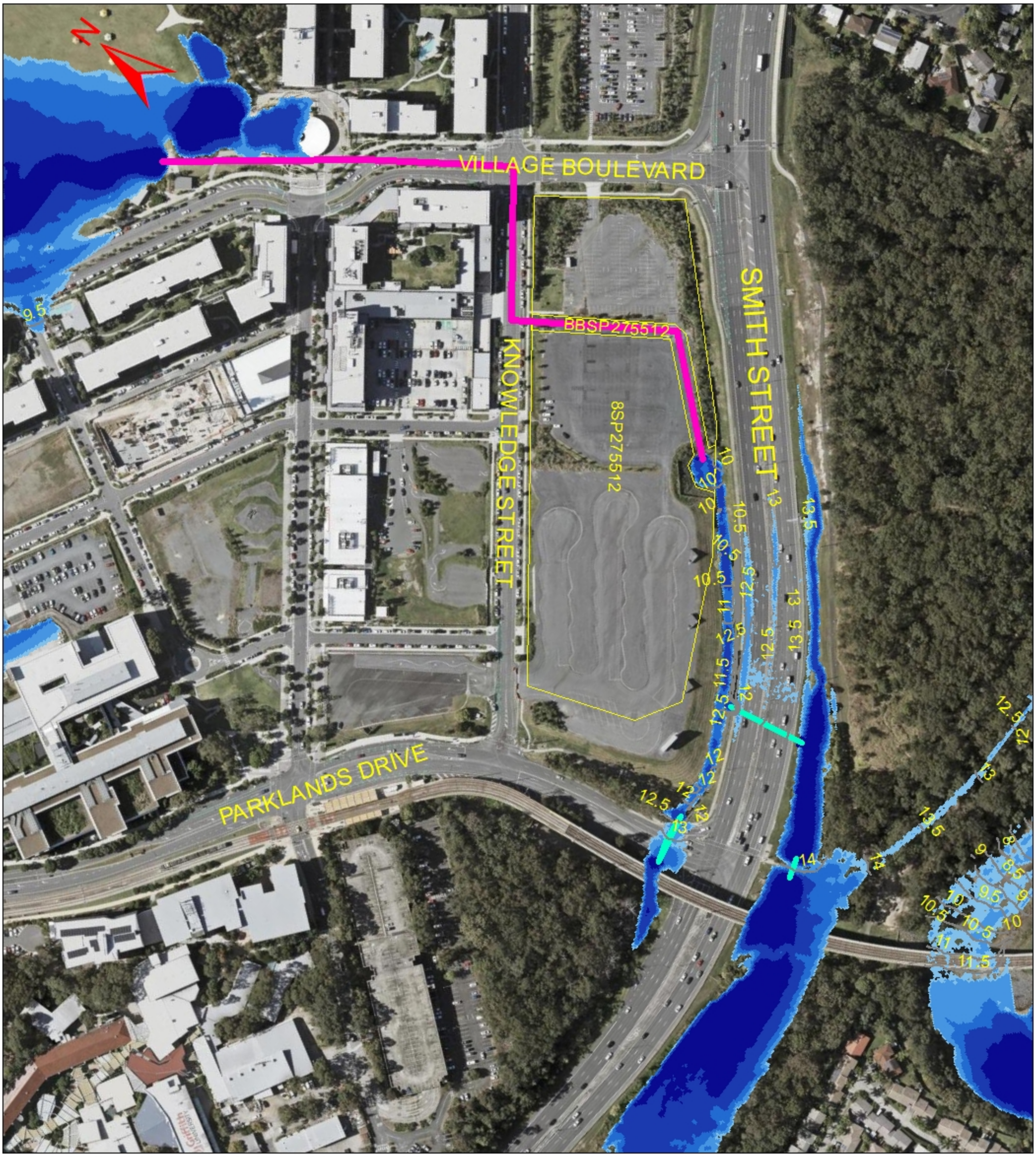
EDQ
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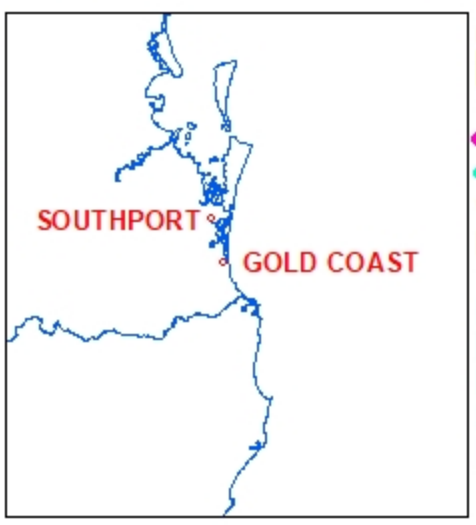
Appendix A.2 Year_2030_Pr_2014 Design_DEM_10%_AEP_Depth of Flooding and Flood Level

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Legend

- PROJECT SITE
- Year_2030_Ex_1%_AEP_Flood_Level_Contour
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Ex_1%_AEP_Depth of Flooding (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

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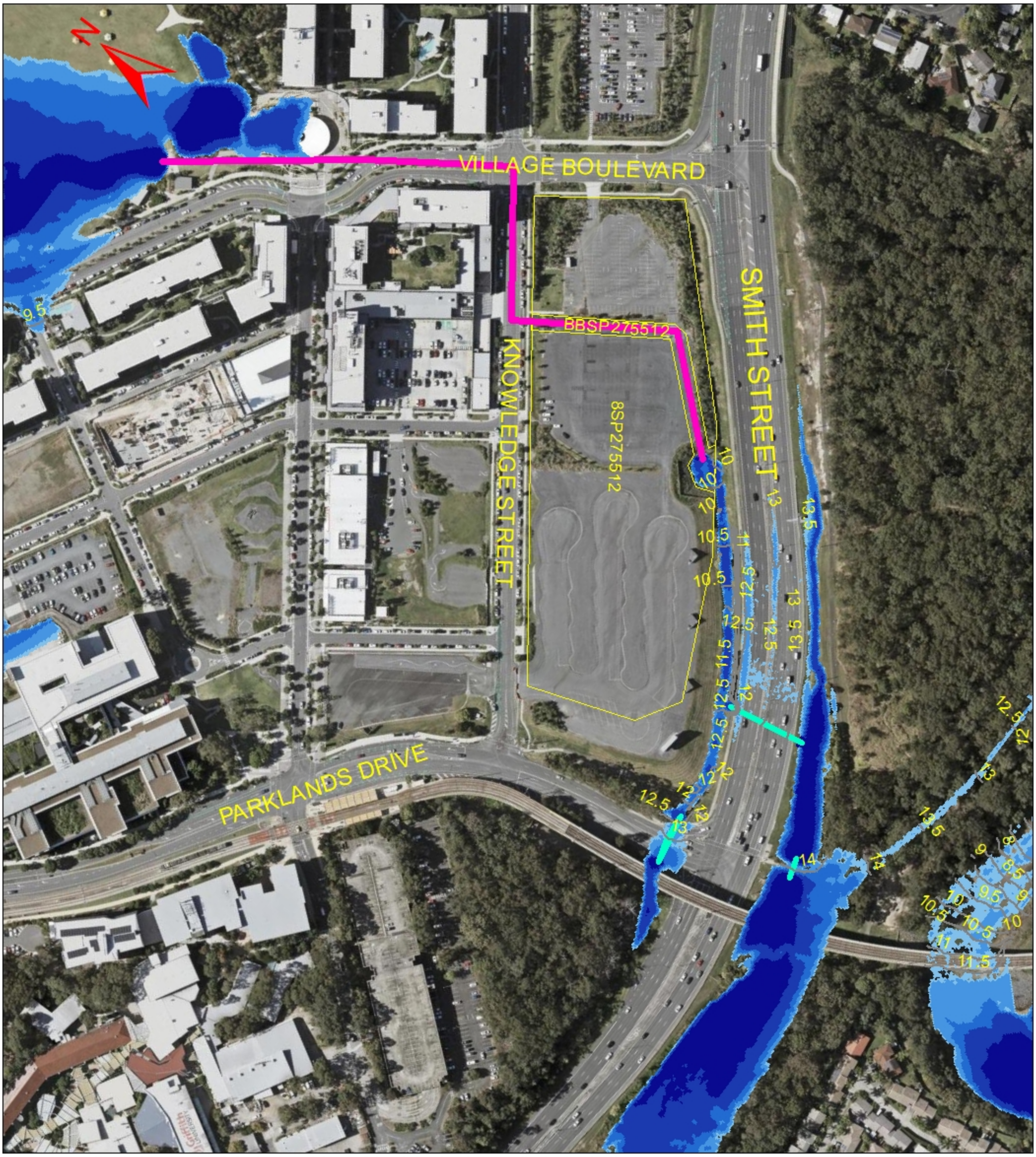
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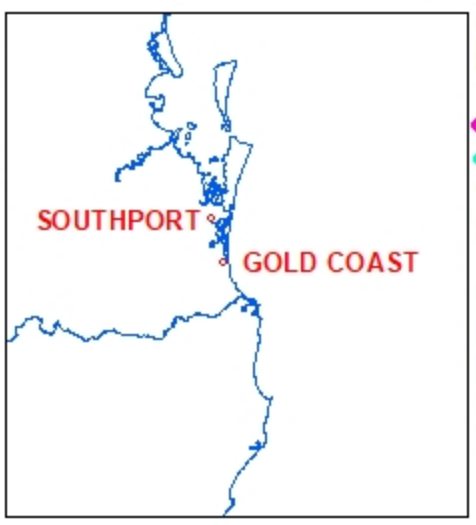
EDQ
2 Village Boulevard, Southport FIA

Appendix A.3 Year_2030_ Ex_Surv _DEM 1%_AEP_Depth of Flooding and Level

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Legend

- PROJECT SITE
- Year_2030_Pr_1%_AEP_Flood_Level_Contour
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Pr_1%_AEP_Depth of Flooding (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

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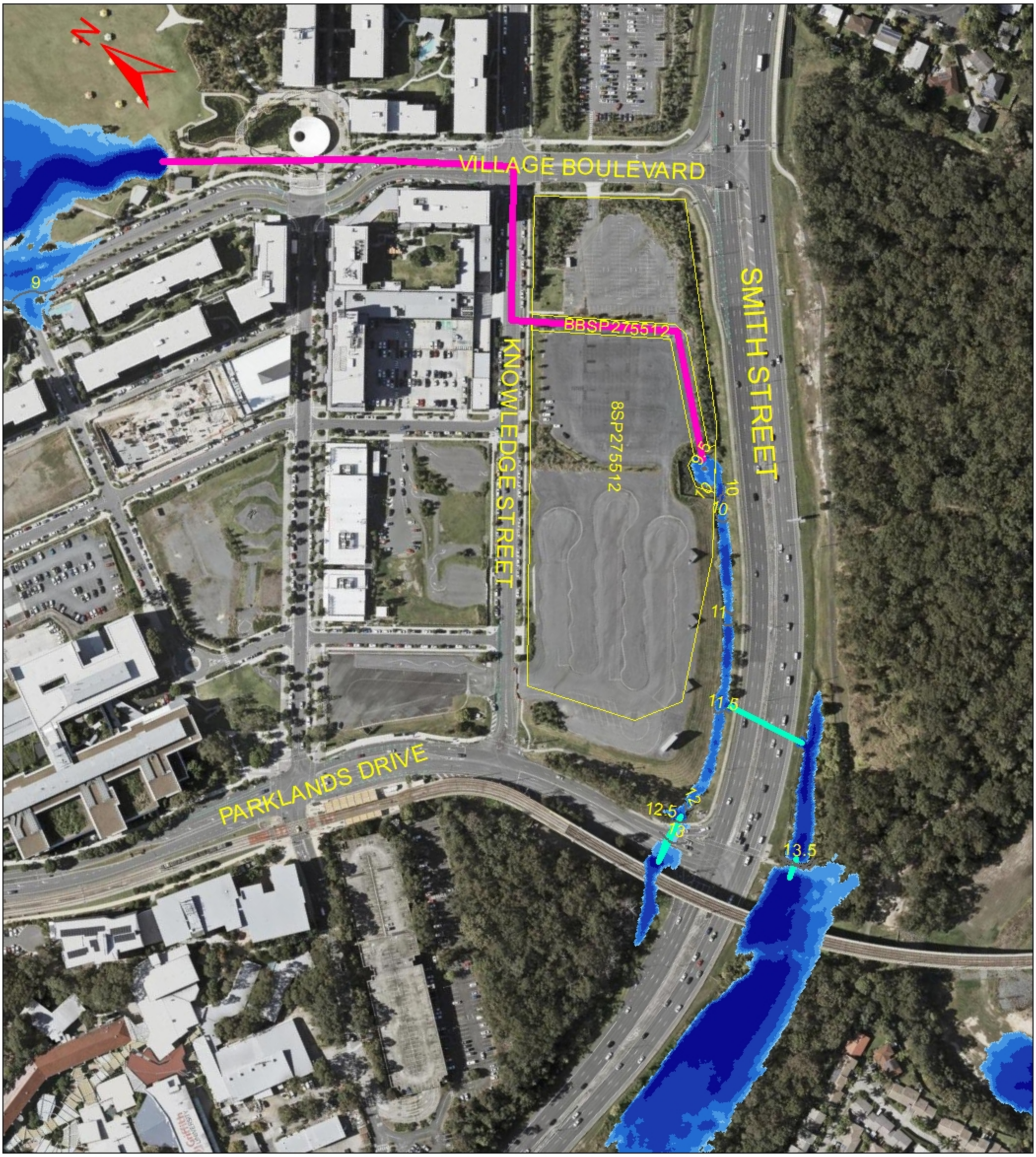
EDQ
2 Village Boulevard, Southport FIA

Appendix A.4 Year_2030_Pr_2014_Design_DEM 1%_AEP_Depth of Flooding and Flood Level

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Legend

- PROJECT SITE
- Year_2100_EX_10%_AEP_Flood_Level_Contour
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Ex_Surv_DEM_10%_AEP_Depth of Flooding (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

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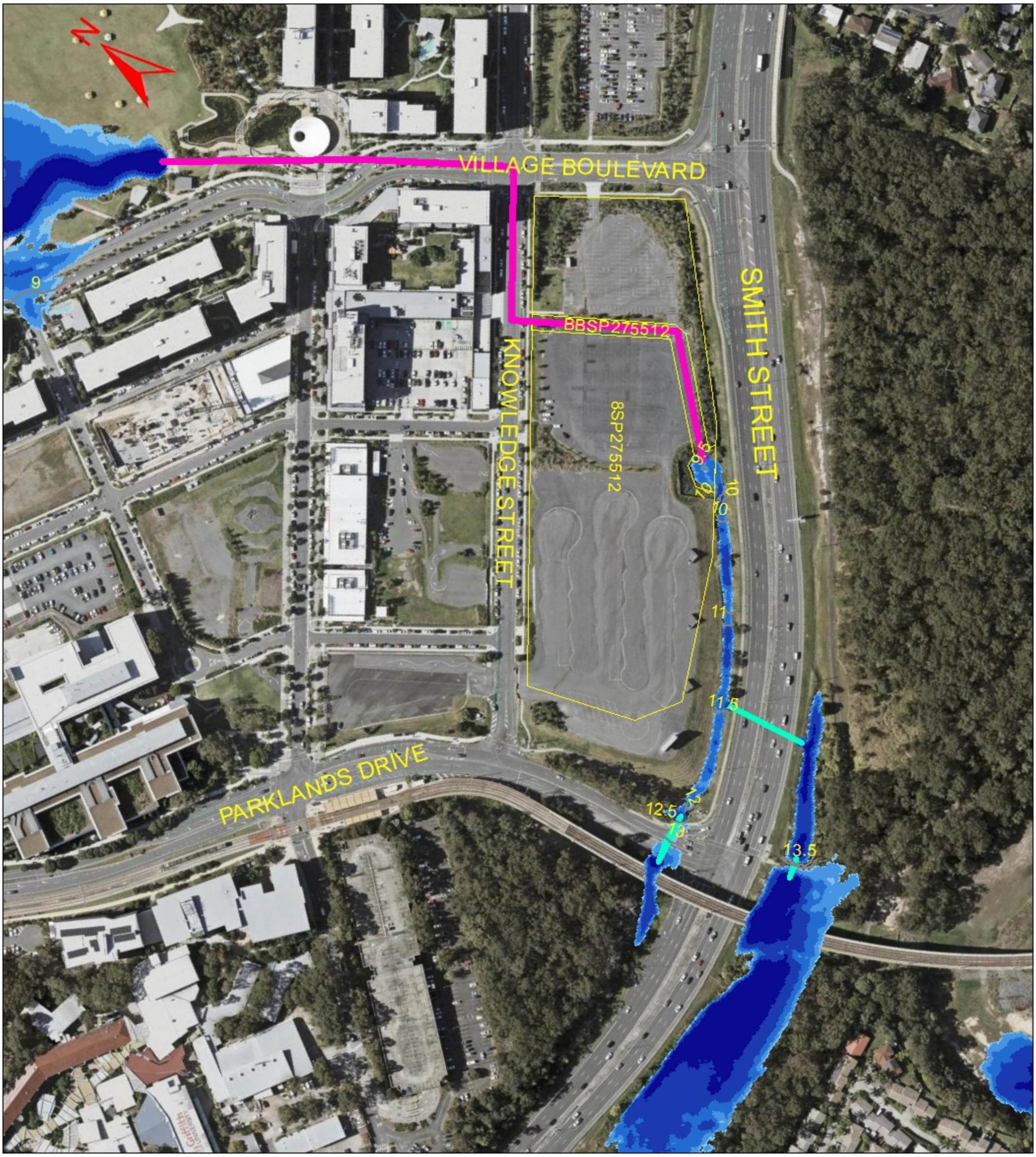
EDQ
2 Village Boulevard, Southport FIA

Appendix A.5 Year_2100_Ex_Surv_DEM 10%_AEP_Depth of Flooding and Flood Level

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Legend

- PROJECT SITE
- Year_2100_Pr_10%_AEP_Flood_Level_Contour
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Pr_10%_AEP_Depth of Flooding (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

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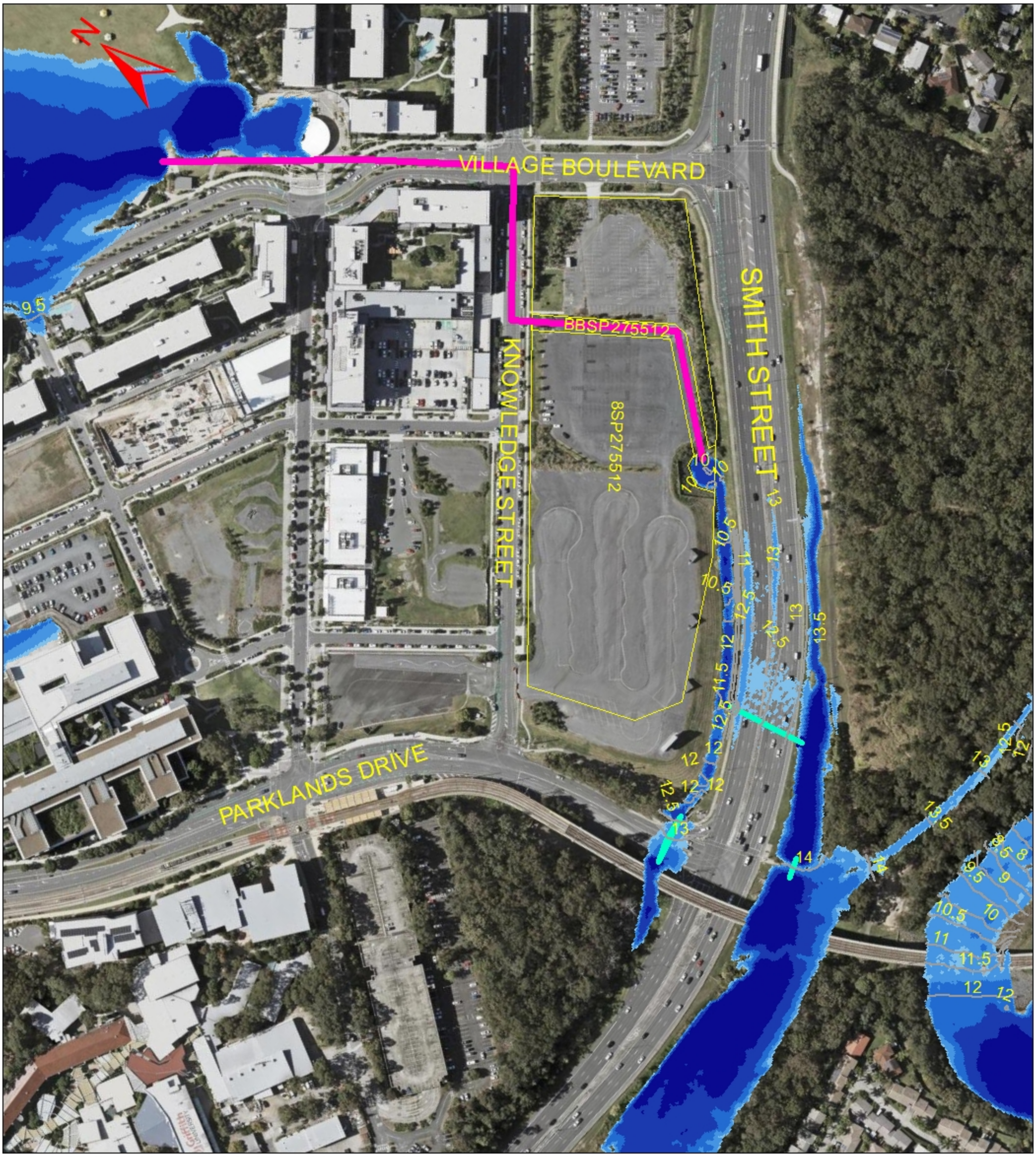
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Appendix A.6 Year_2100_Pr_2014_Design_DEM 10%_AEP_Depth of Flooding and Flood Level

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Legend

- PROJECT SITE
- Year_2100_Ex_1%_AEP_Flood_Level_Contour
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Ex_1%_AEP_Depth of Flooding (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

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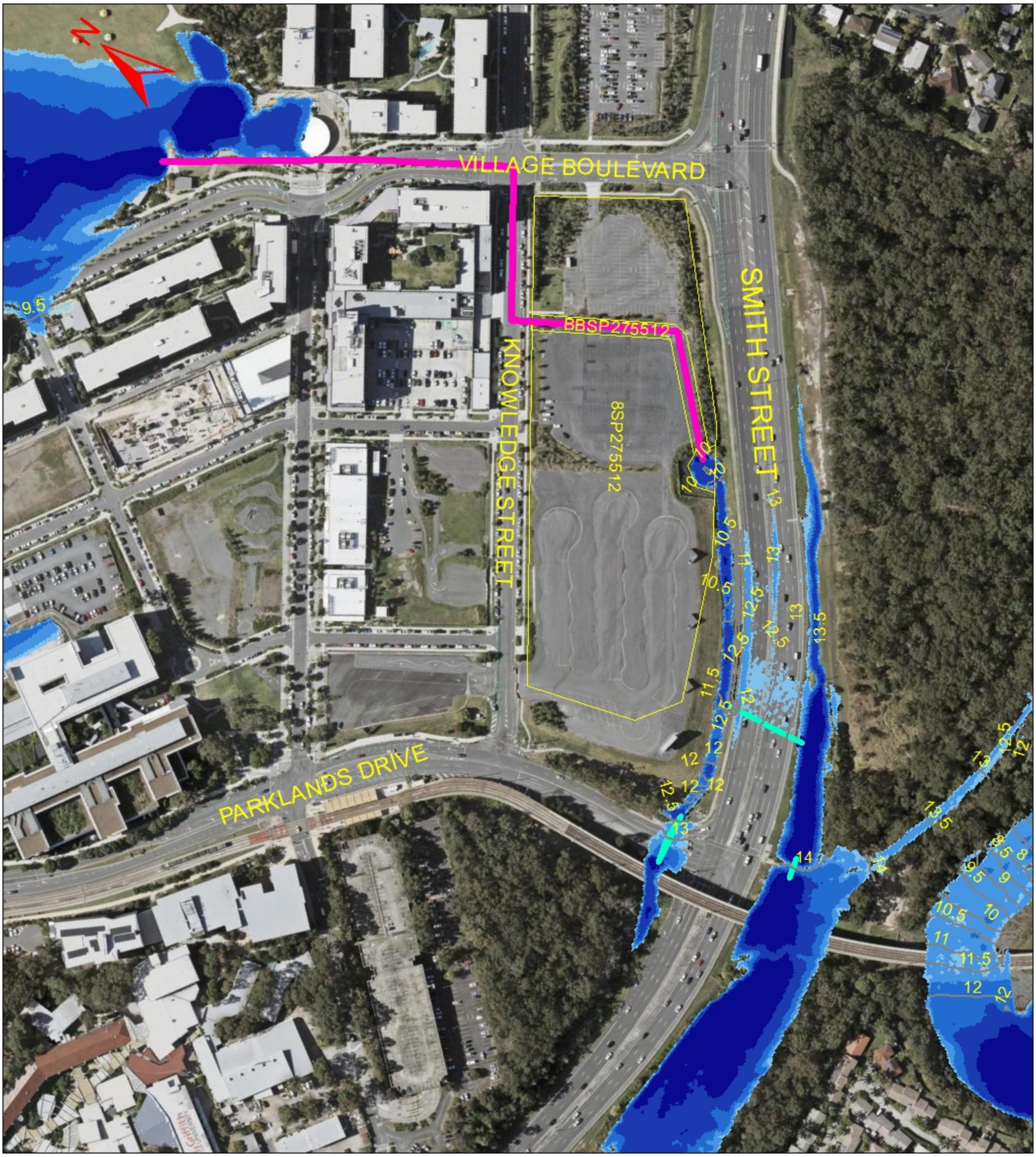
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Appendix A.7 Year_2100_Ex_Surv_DEM 1%_AEP_Depth of Flooding and Flood Level

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Legend

- PROJECT SITE
- Year_2100_Pr_1%_AEP_Flood_Level_Contour
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Pr_1%_AEP_Depth of Flooding (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

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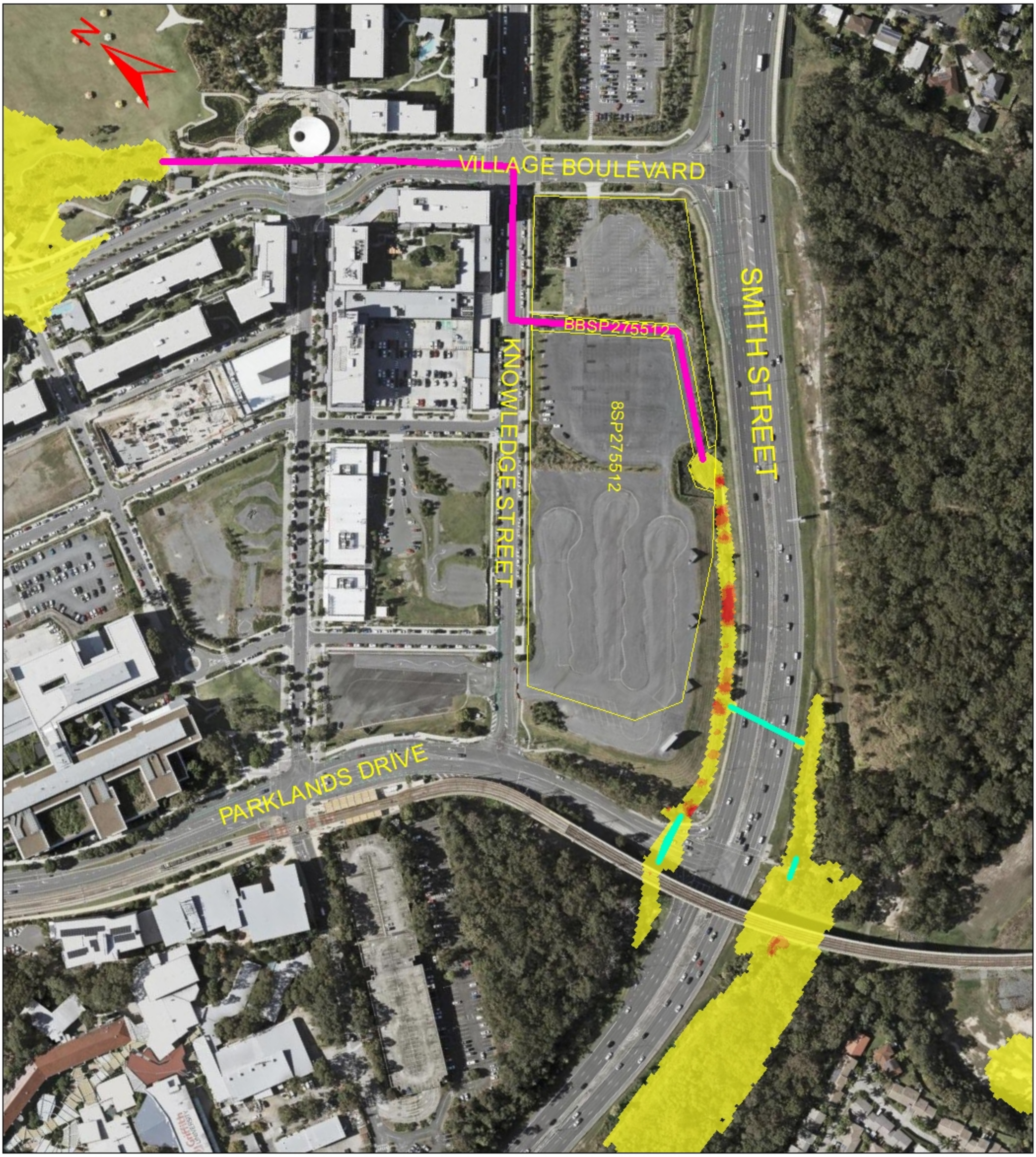
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Appendix A.8 Year_2100_ Pr_2014_Design _DEM 1%_AEP_Depth of Flooding and Level

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Ex_Surv_DEM_10%_AEP_Flow_Velocity (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

0 75 150 Meters

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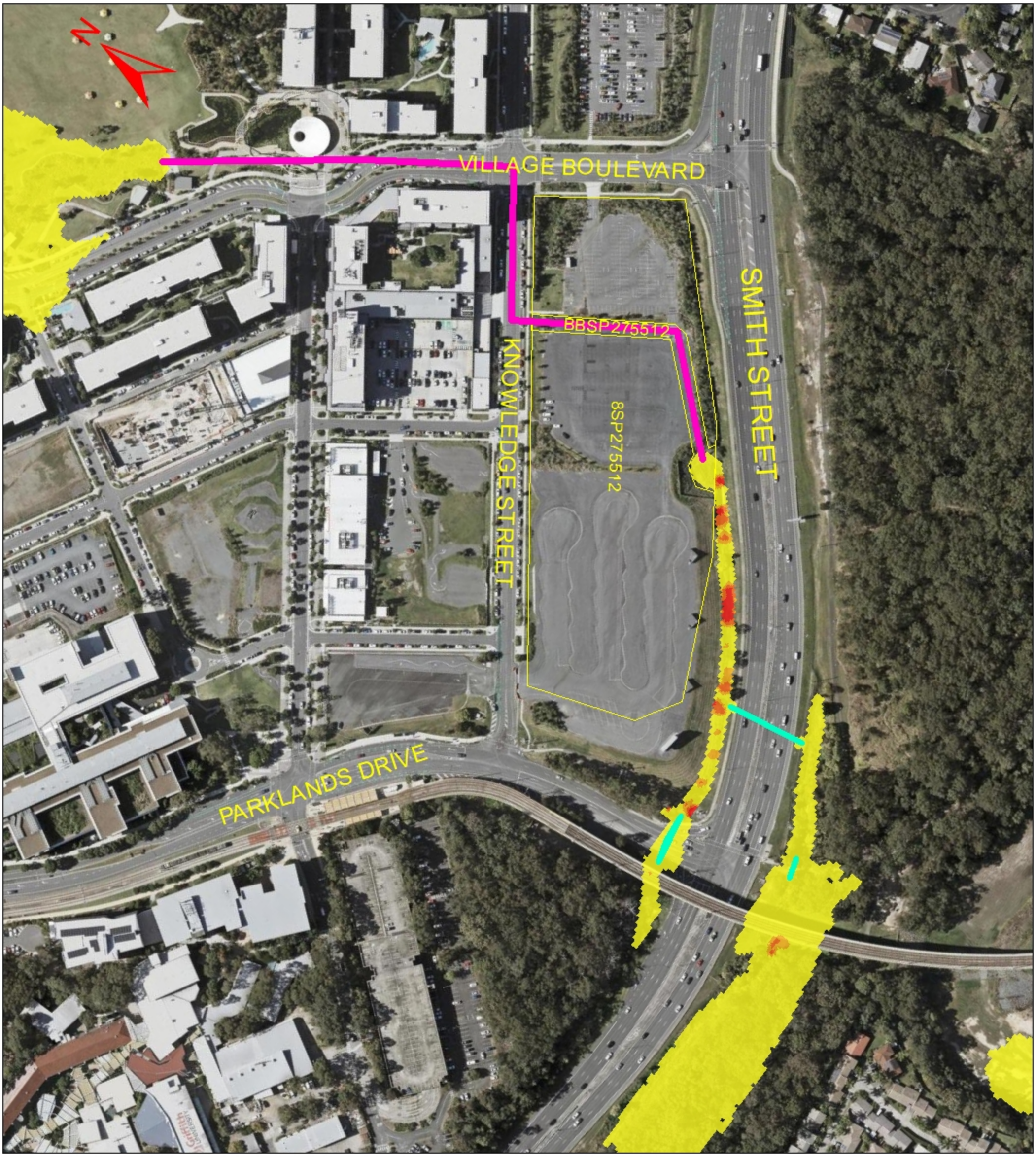
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Appendix A.9 Year_2030_Ex_Surv_DEM 10%_AEP_FLow_Velocityl

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Pr_2014_Design_DEM_10%_AEP_Flow_Velocity (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

0 75 150 Meters

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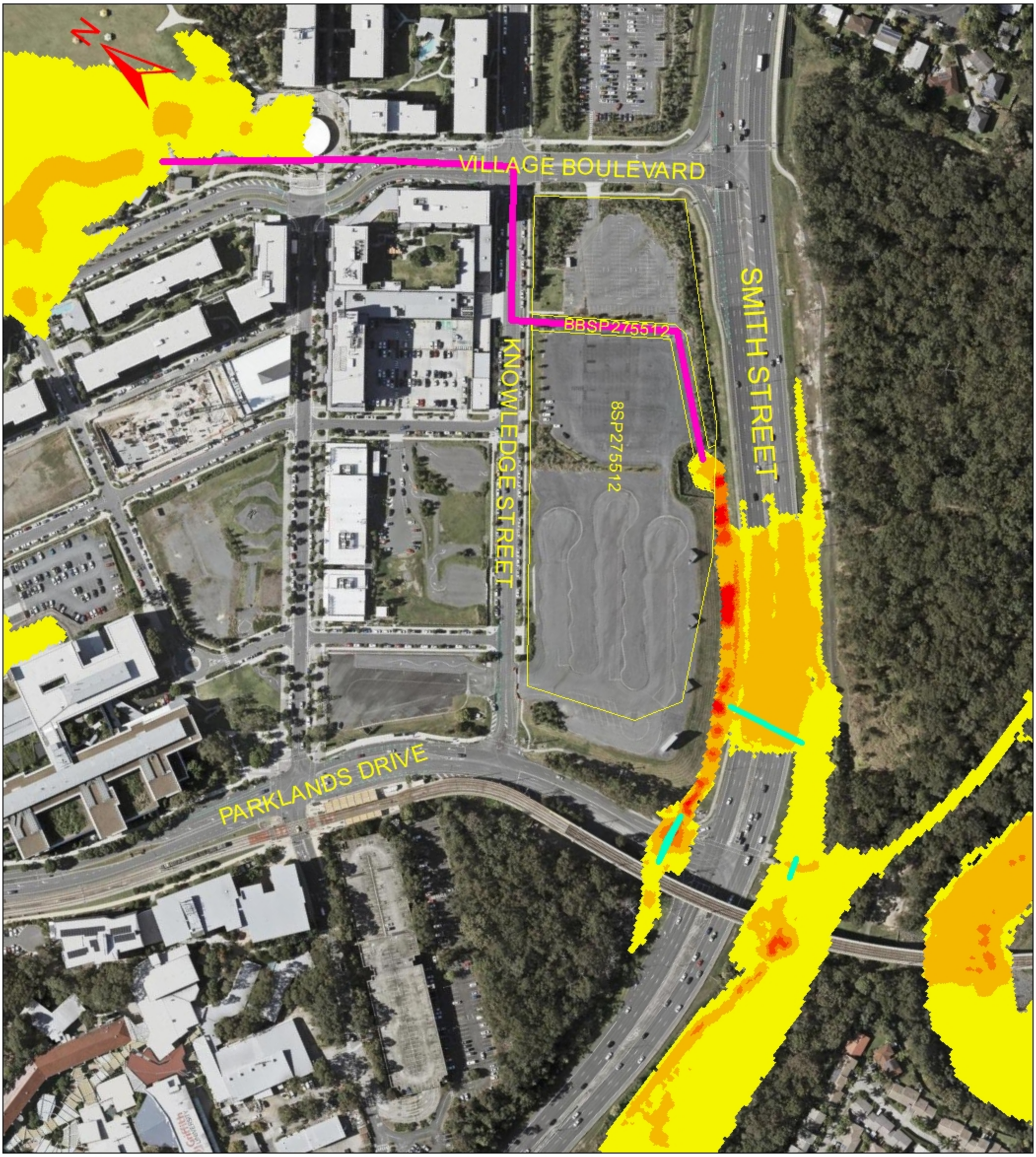
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Appendix A.10 Year_2030_2014_Design_DEM 10%_AEP_FLow_Velocityl

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Ex_Surv_DEM_1%_AEP_Flow_Velocity (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

0 75 150 Meters

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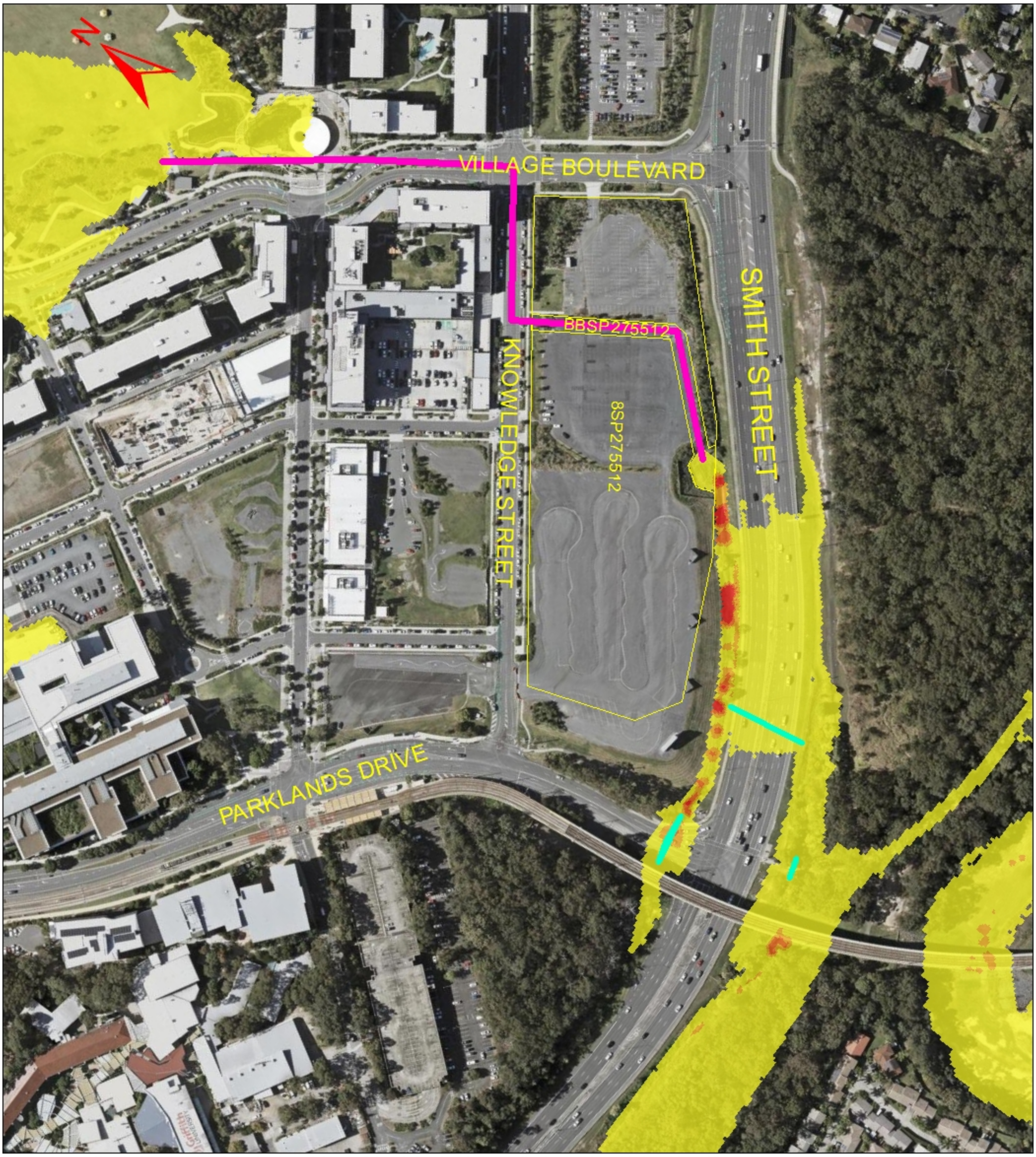
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Appendix A.11 Year_2030_Ex_Surv_DEM 1%_AEP_FLow_Velocityl

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Pr_2014_Design_DEM_1%_AEP_Flow_Velocity (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

0 75 150 Meters

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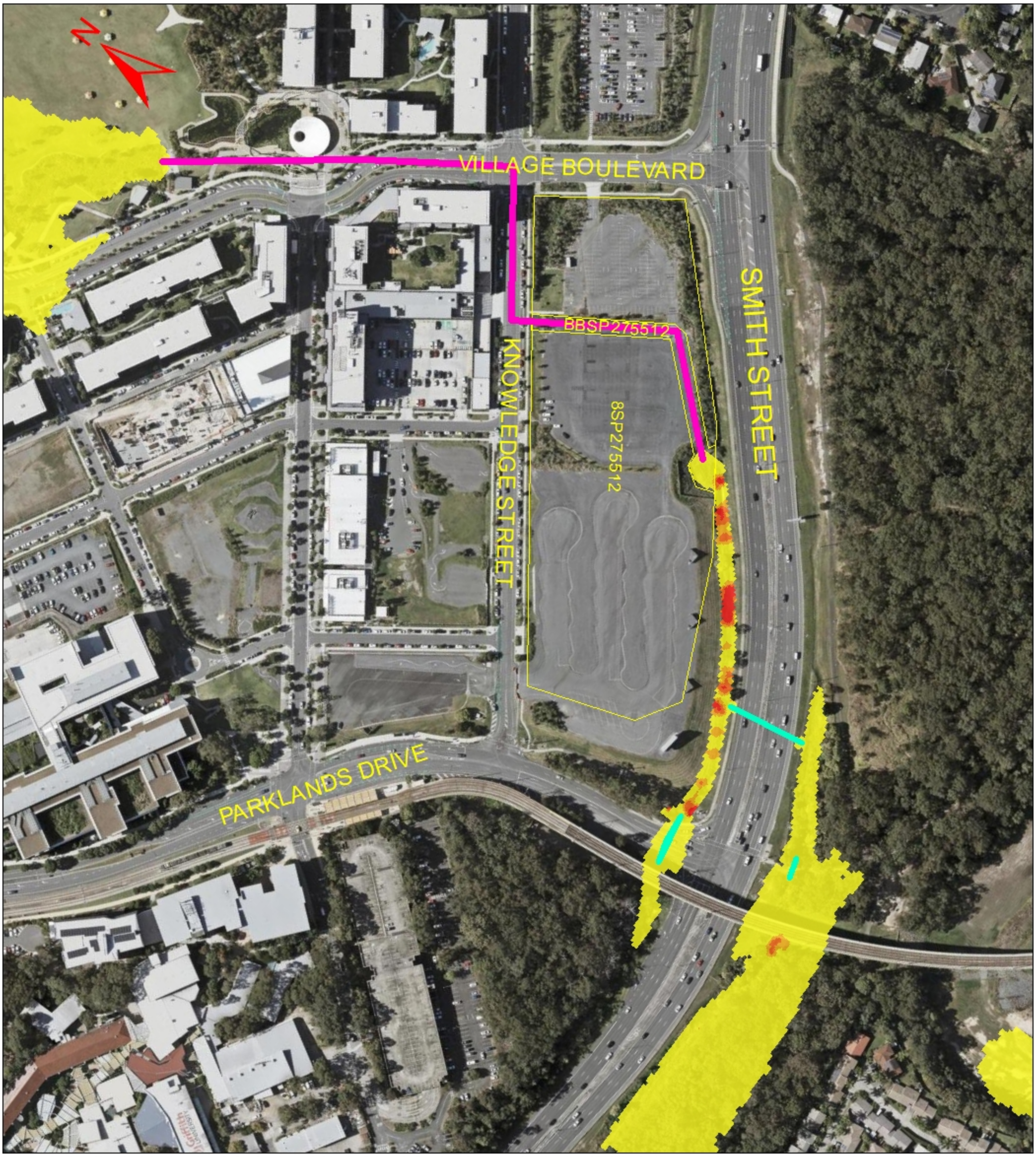
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Appendix A.12 Year_2030_2014_Design_DEM 1%_AEP_FLow_VelocityI

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Ex_Surv_DEM_10%_AEP_Flow_Velocity (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

0 75 150 Meters

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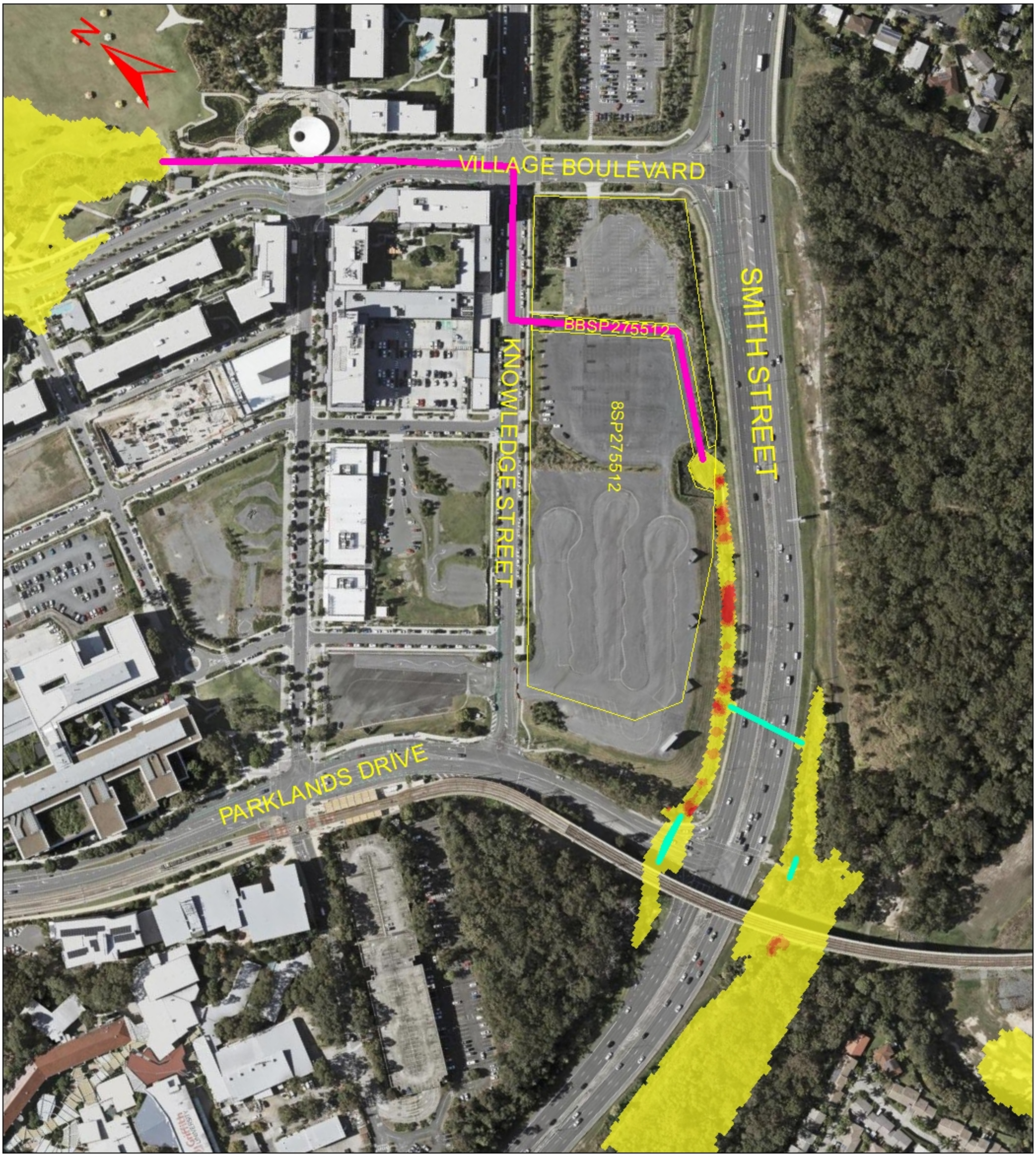
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Appendix A.13 Year_2100_Ex_Surv_DEM 10%_AEP_FLow_Velocity

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Pr_2014_Design_DEM_10%_AEP_Flow_Velocity (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

0 75 150 Meters

Stantec

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Brisbane, QLD

Prepared by BW on 2026-03-12
TR by MG on 2026-03-15

Project: 304701862 2 Village Road FIA

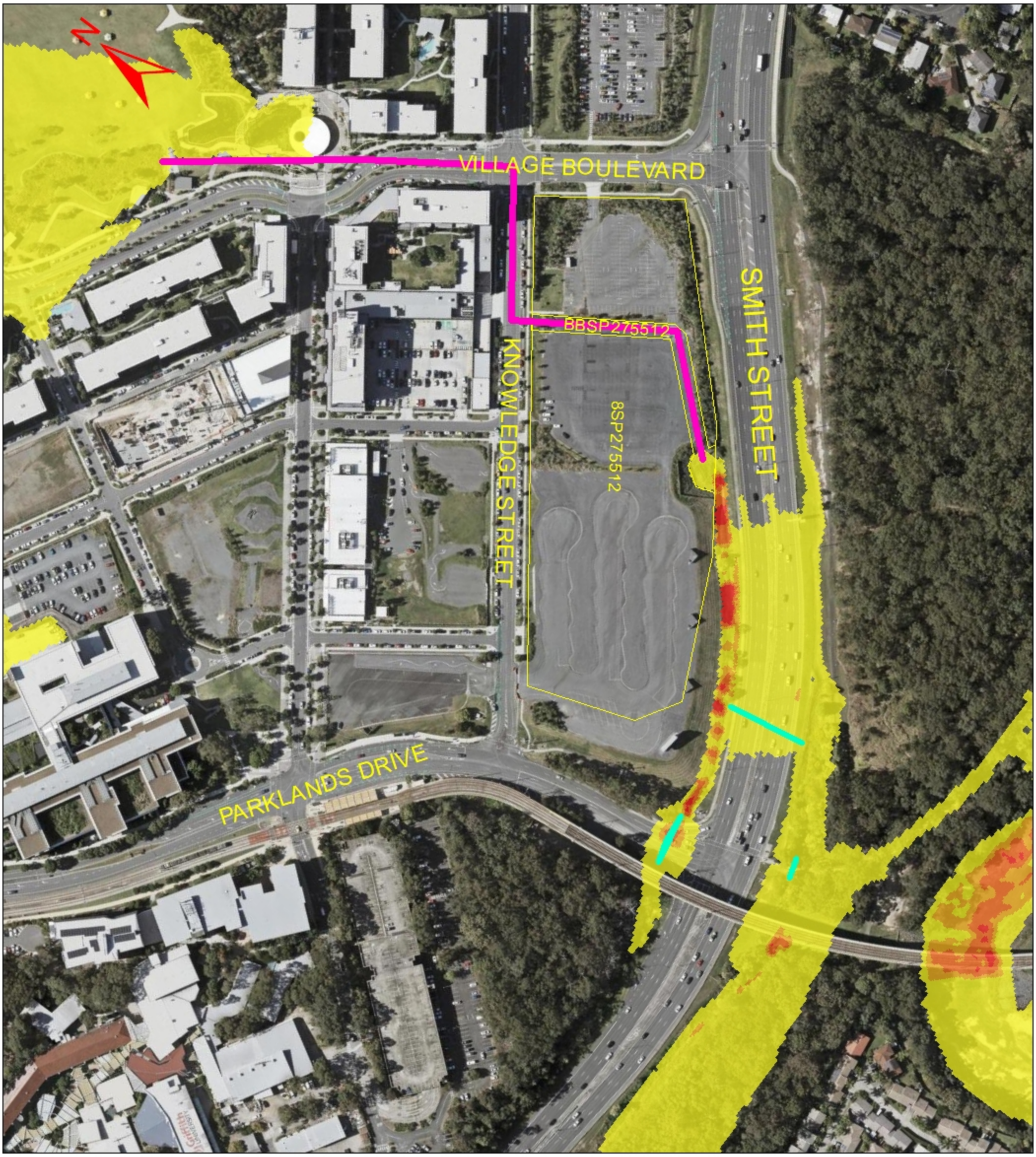
EDQ
2 Village Boulevard, Southport FIA

Appendix A.14 Year_2100_2014_DES_DEM 10%_AEP_FLow_Velocity

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Ex_Surv_DEM_1%_AEP_Flow_Velocity (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

0 75 150 Meters

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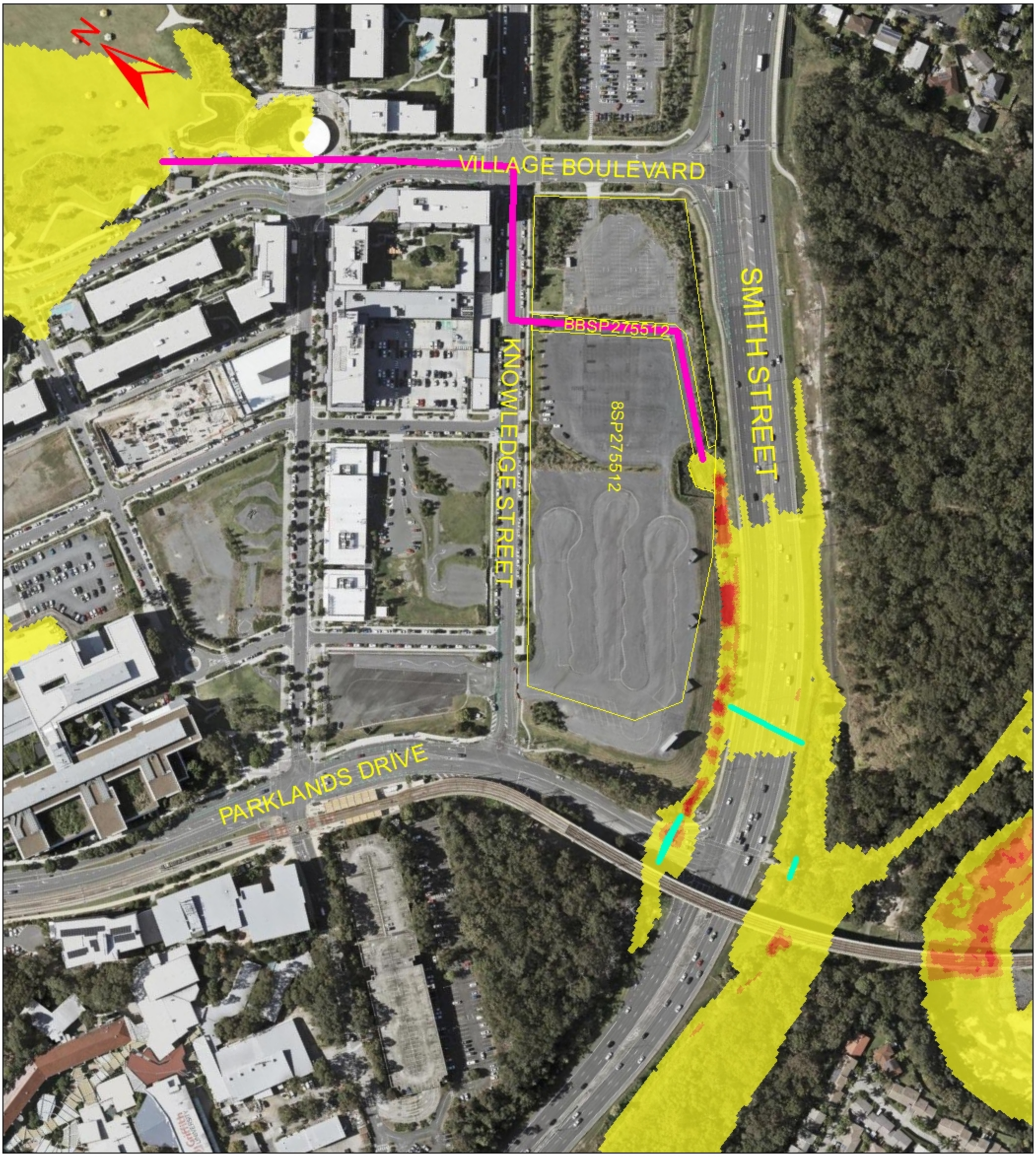
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Appendix A.15 Year_2100_Ex_Surv_DEM 1%_AEP_FLow_Velocity

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Pr_2014_Design_DEM_1%_AEP_Flow_Velocity (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

0 75 150 Meters

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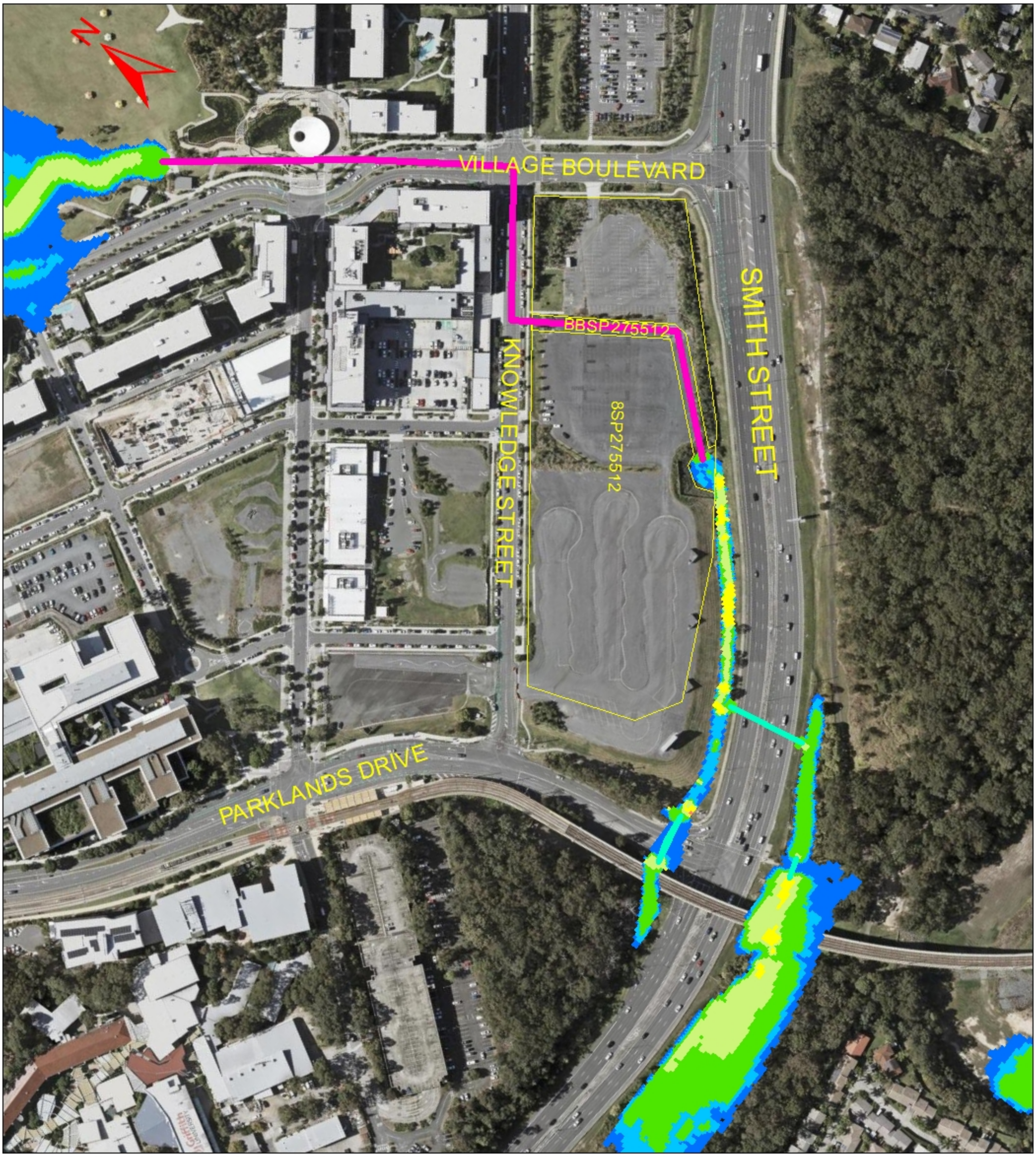
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2 Village Boulevard, Southport FIA

Appendix A.16 Year_2100_2014_Design_DEM 1%_AEP_FLow_Velocity

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Ex_Surv_DEM_10%_AEP_Flow_Hazard

- H1
- H2
- H3
- H4
- H5
- H6

0 75 150 Meters

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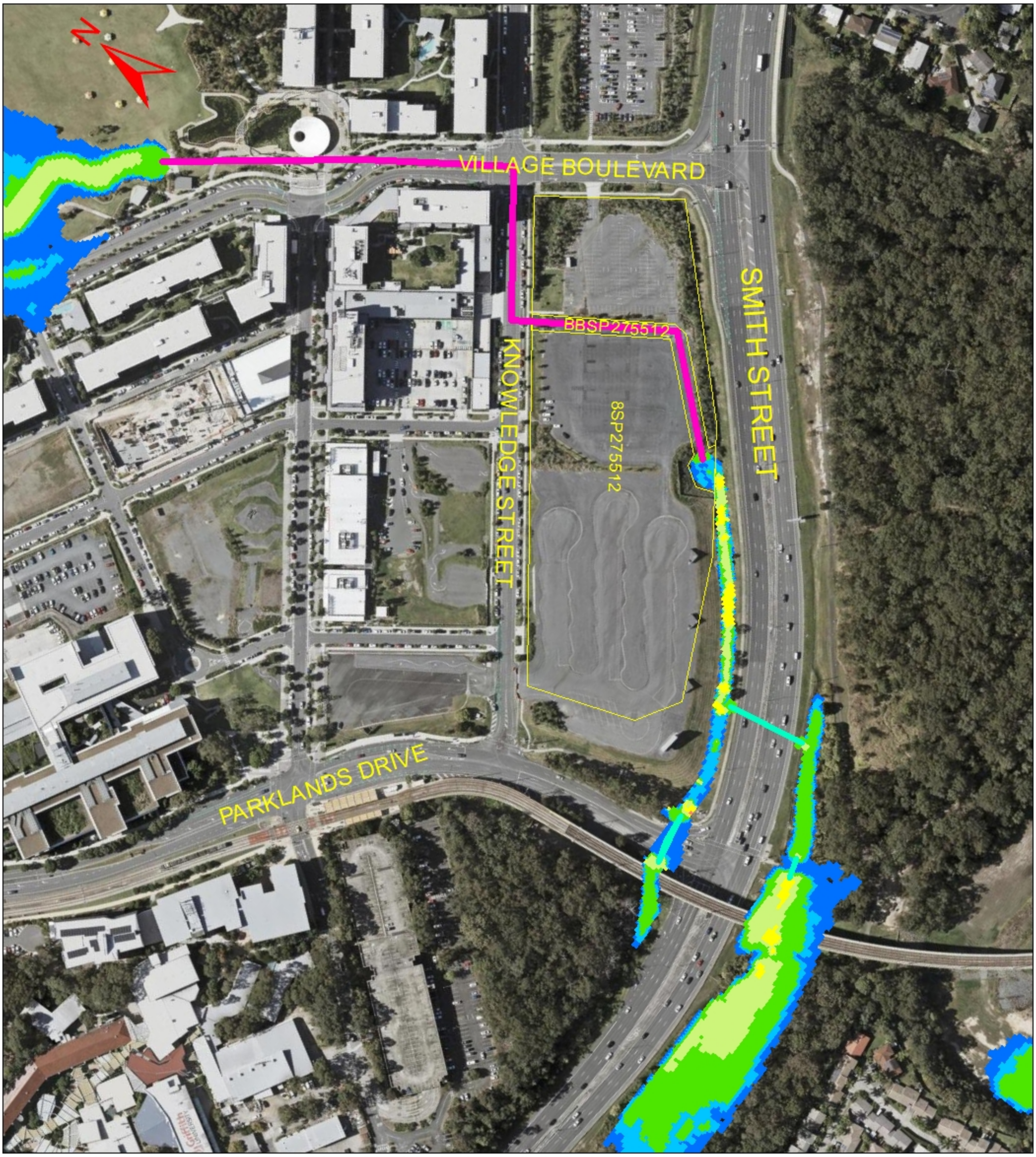
Appendix A.17 Year_2030_Ex-Surv_DEM 10%_AEP_FLow_Hazard

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Pr_2014_Design_DEM_10%_AEP_Flow_Hazard

- H1
- H2
- H3
- H4
- H5
- H6

0 75 150 Meters

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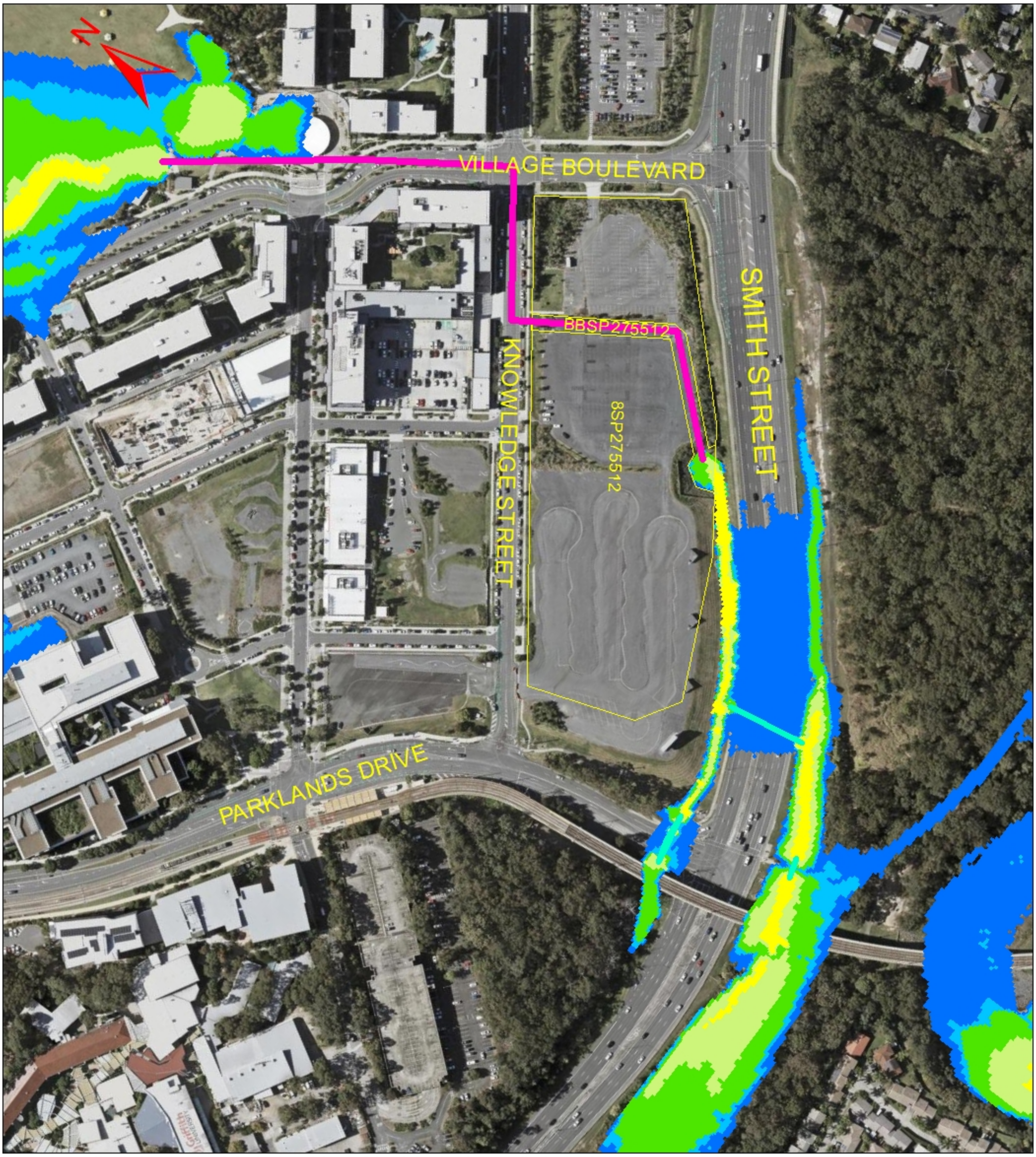
Appendix A.18 Year_2030_ Pr_2014_Design _DEM 10%_AEP_FLow_Hazard

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Ex_Surv_DEM_1%_AEP_Flow_Hazard

- H1
- H2
- H3
- H4
- H5
- H6

0 75 150 Meters

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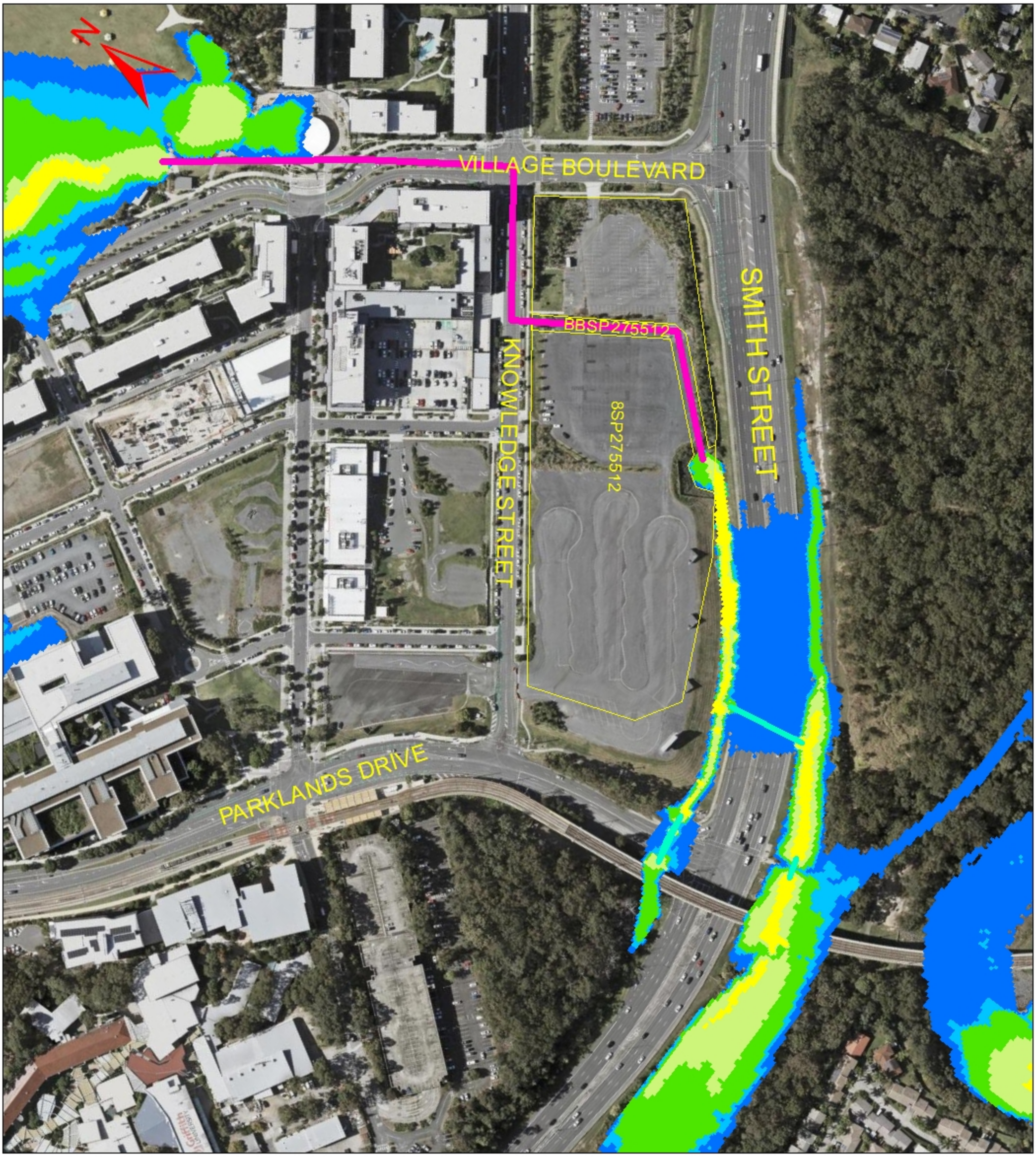
Appendix A.19 Year_2030_ Ex_Surv _DEM 1%_AEP_FLow_Hazard

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2030_Pr_2014_Design_DEM_1%_AEP_Flow_Hazard

- H1
- H2
- H3
- H4
- H5
- H6

0 75 150 Meters

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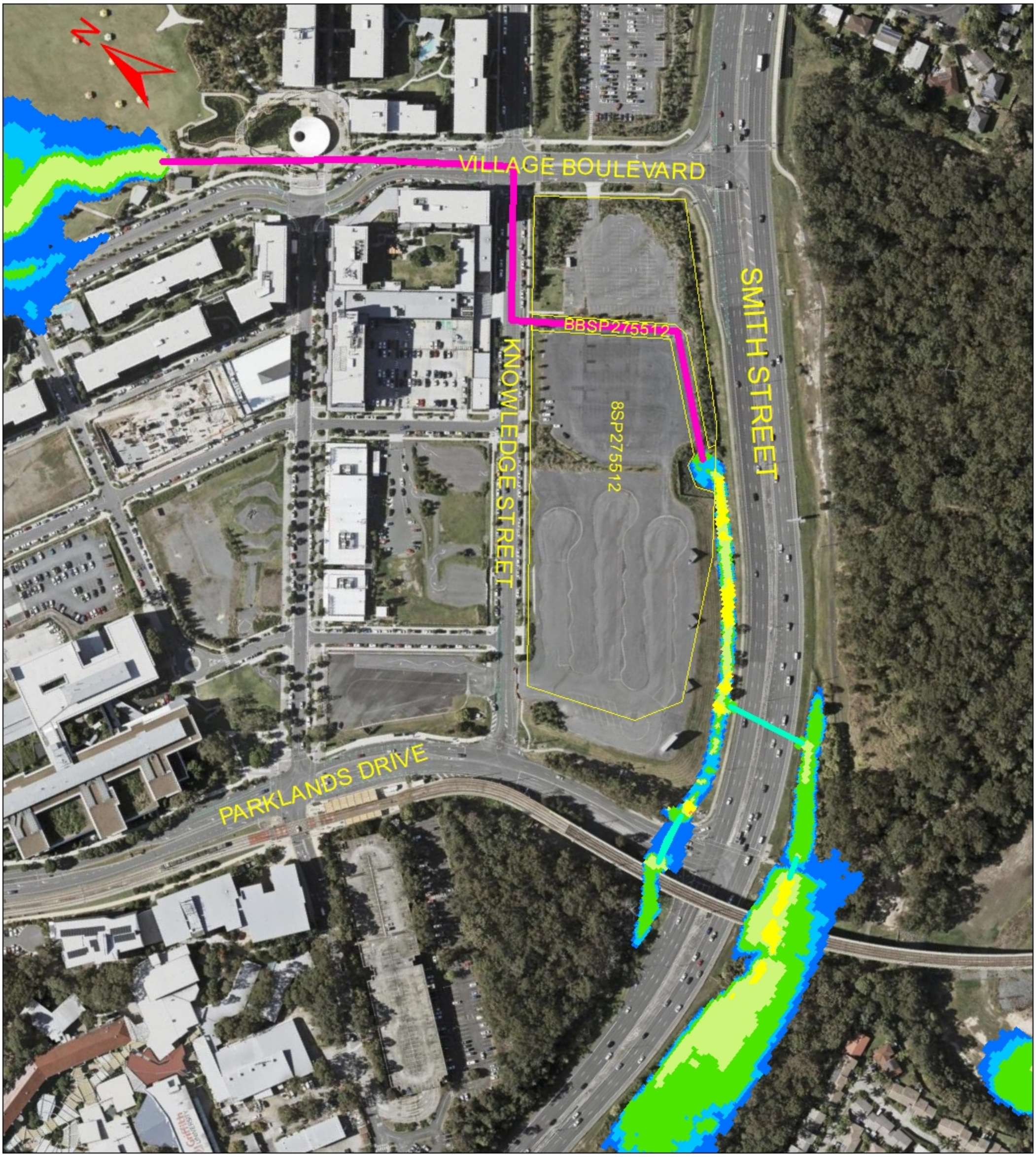
Appendix A.20 Year_2030_ Pr_2014_Design _DEM 1%_AEP_FLow_Hazard

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Ex_Surv_DEM_10%_AEP_Flow_Hazard

- H1
- H2
- H3
- H4
- H5
- H6

0 75 150 Meters

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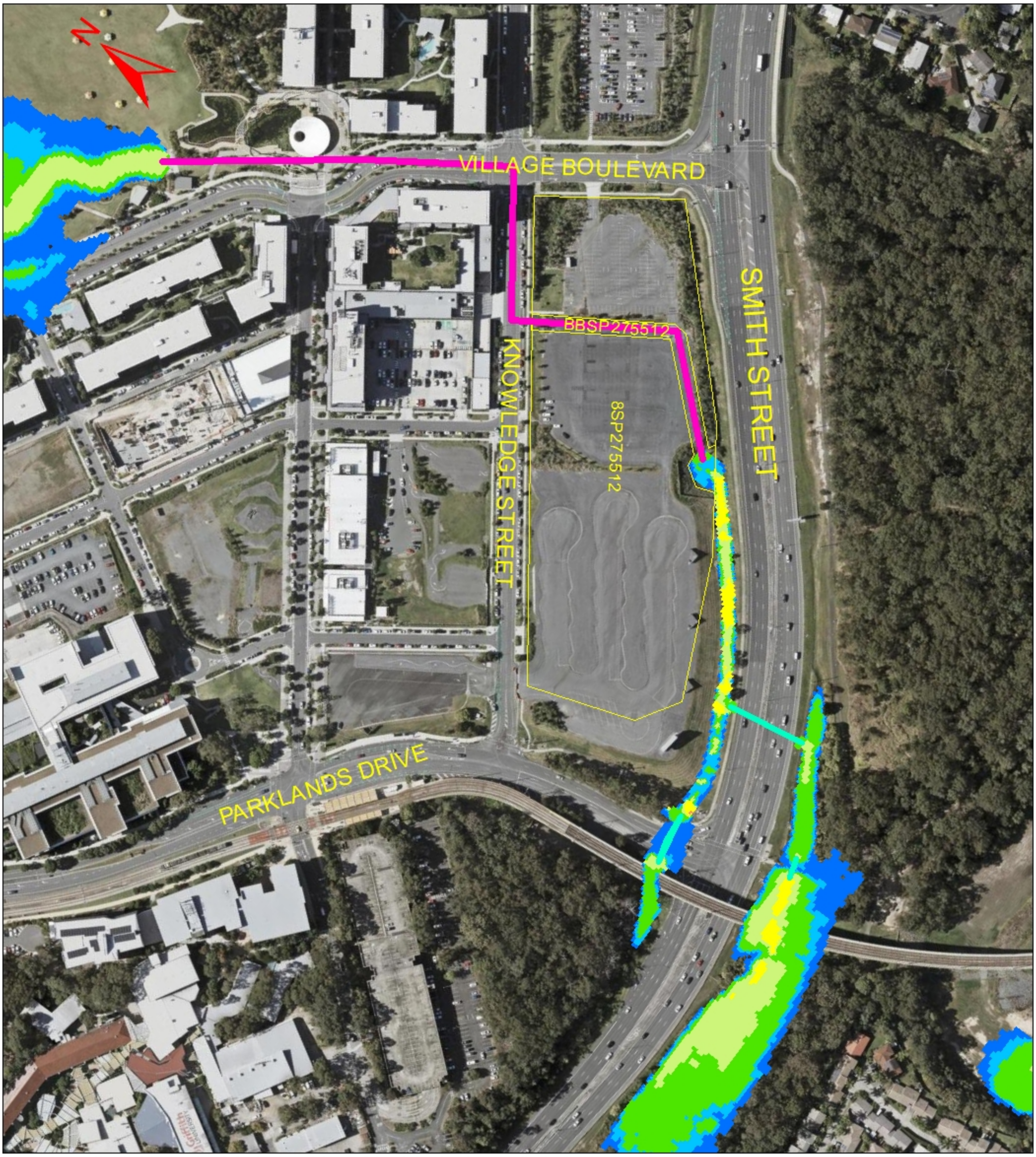
EDQ
2 Village Boulevard, Southport FIA

Appendix A.21 Year_2100_ Ex_Surv _DEM 10%_AEP_FLow_Hazard

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Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Pr_2014_Design_DEM_10%_AEP_Flow_Hazard

- H1
- H2
- H3
- H4
- H5
- H6

0 75 150 Meters

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EDQ
2 Village Boulevard, Southport FIA

Appendix A.22 Year_2100_ Pr_2014_Design _DEM 10%_AEP_FLow_Hazard

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VILLAGE BOULEVARD

BBSP275512

KNOWLEDGE STREET

8SP275512

SMITH STREET

PARKLANDS DRIVE

N



Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Ex_Surv_DEM_1%_AEP_Flow_Hazard

- H1
- H2
- H3
- H4
- H5
- H6

0 75 150 Meters

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EDQ
2 Village Boulevard, Southport FIA

Appendix A.23 Year_2100_ Ex_Surv _DEM 1%_AEP_Depth of Flow Hazard

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VILLAGE BOULEVARD

BBSP275512

KNOWLEDGE STREET

8SP275512

SMITH STREET

PARKLANDS DRIVE

N



Legend

- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

Year_2100_Pr_2014_Design_DEM_1%_AEP_Flow_Hazard

- H1
- H2
- H3
- H4
- H5
- H6

0 75 150 Meters

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EDQ
2 Village Boulevard, Southport FIA

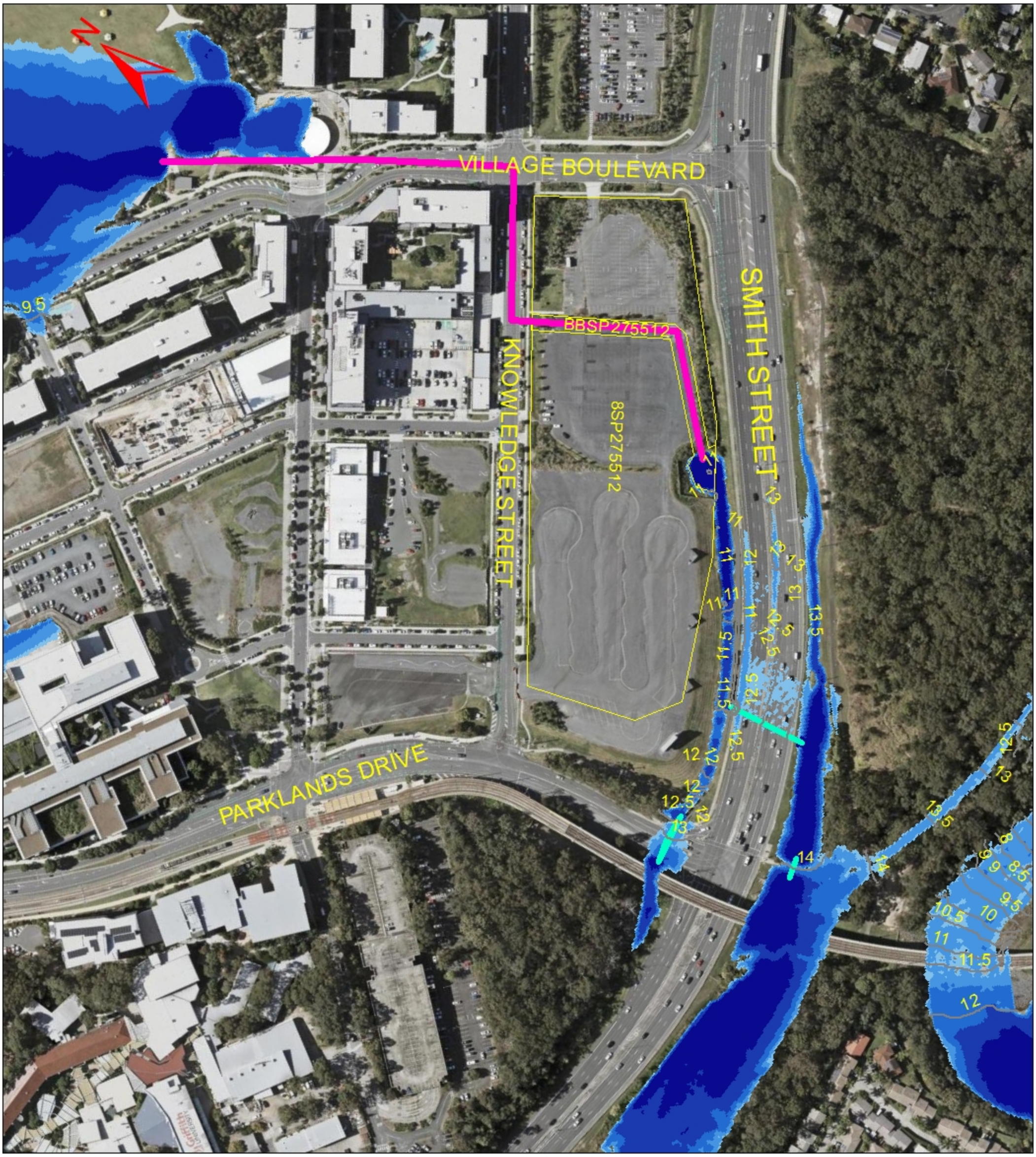
Appendix A.24 Year_2100_ Pr_2014_Design _DEM 1%_AEP_FLow_Hazard

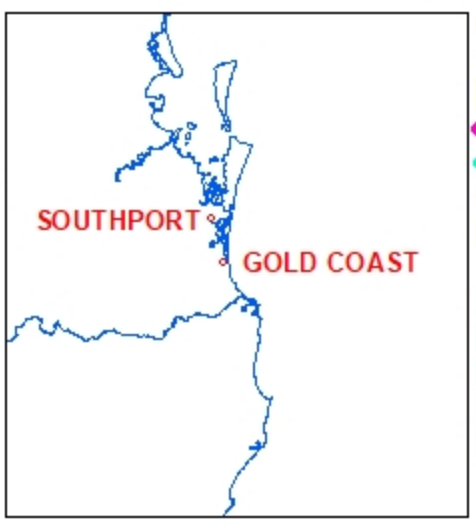
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Appendix B Trunk Drainage 50%Blockage Factor Scenario Flood Characteristics Map





Legend

- 50% BF Year 2100_1% AEP Flood Level Contour
- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

50% BF Year 2100_1%AEP Depth of Flooding_2014_Design Surface_DEM (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

Notes
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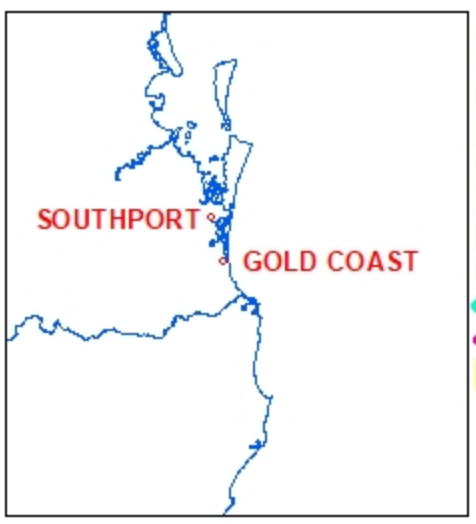
EDQ
2 Village Boulevard, Southport FIA

Appendix B.1 50% BF 2014 Design Surface _DEM Year 2100 1% _AEP_Depth of Flood and Level

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Legend

50% BF Y2100_1% AEP Flow Velocity_Project Site Design Surface DEM (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5
- Major_Culverts
- Trunk_Drainage_Culverts
- PROJECT SITE

0 75 150 Meters

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Appendix B.2 50% BFDesign Surface DEM
YEAR 2100 1% AEP Flow Velocity

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VILLAGE BOULEVARD

SMITH STREET

KNOWLEDGE STREET

BBSP275512

8SP275512

PARKLANDS DRIVE



Legend

50% BF Y2100_1% AEP Flow Hazard_Project Site Design Surface DEM

- H1
- H2
- H3
- H4
- H5
- Major_Culverts
- Trunk_Drainage_Culverts
- PROJECT SITE

0 75 150 Meters

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EDQ
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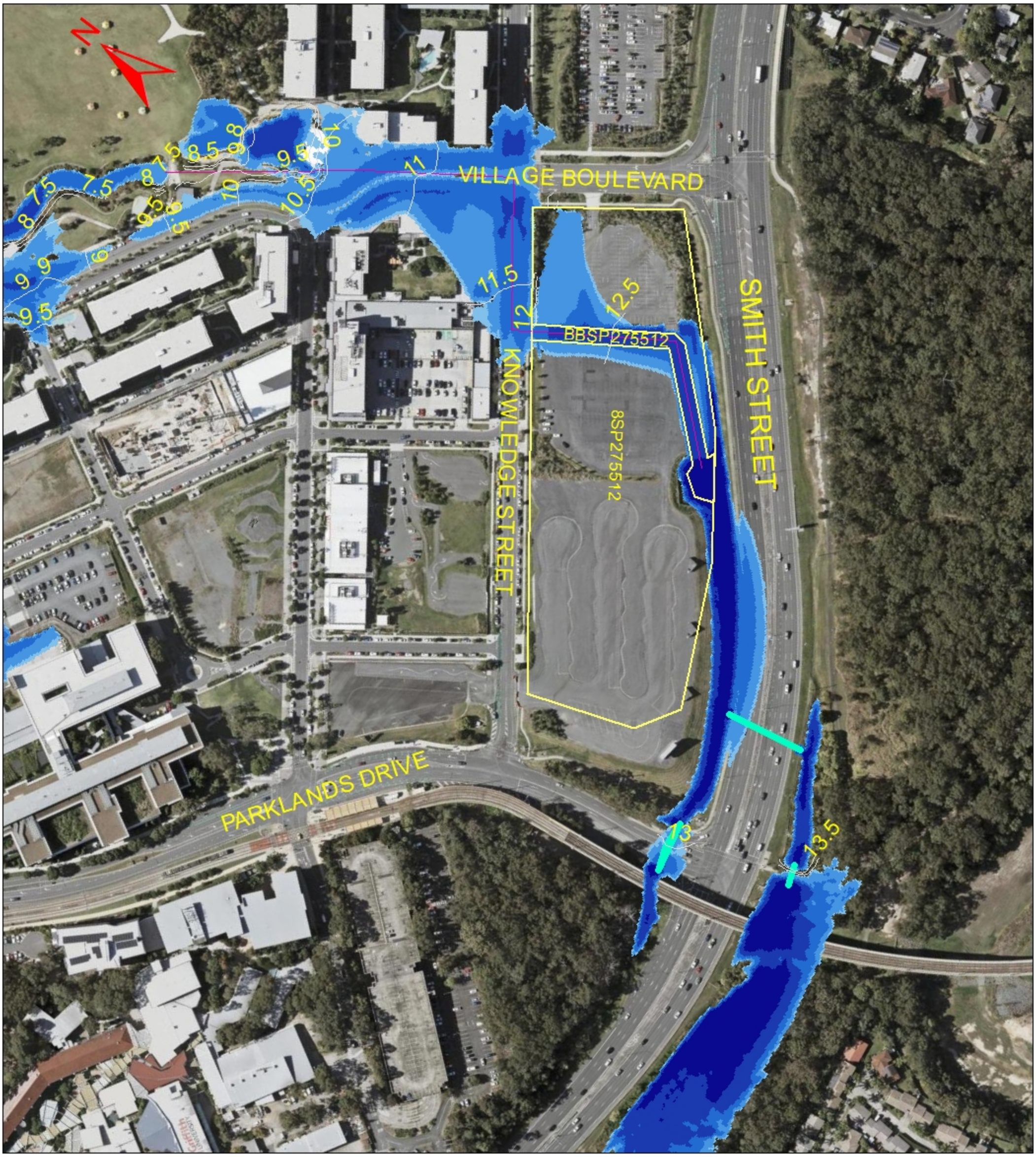
Appendix B.3 50% BF Design Surface DEM
YEAR 2100 1% Flow Hazard

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Appendix C Trunk Drainage 100%Blockage Factor Scenario Flood Characteristics Map





Legend

100% BF Year 2100_1% AEP Flood Level Contour Design Surface

100% BF Y2100_1% AEP Flood Level and Depth_Project Site Design Surface DEM (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

Major_Culverts

Trunk_Drainage_Culverts

PROJECT SITE

0 75 150 Meters

Notes
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2. Background: Esri, HERE, Garmin, (c) OpenStreetMap contributors
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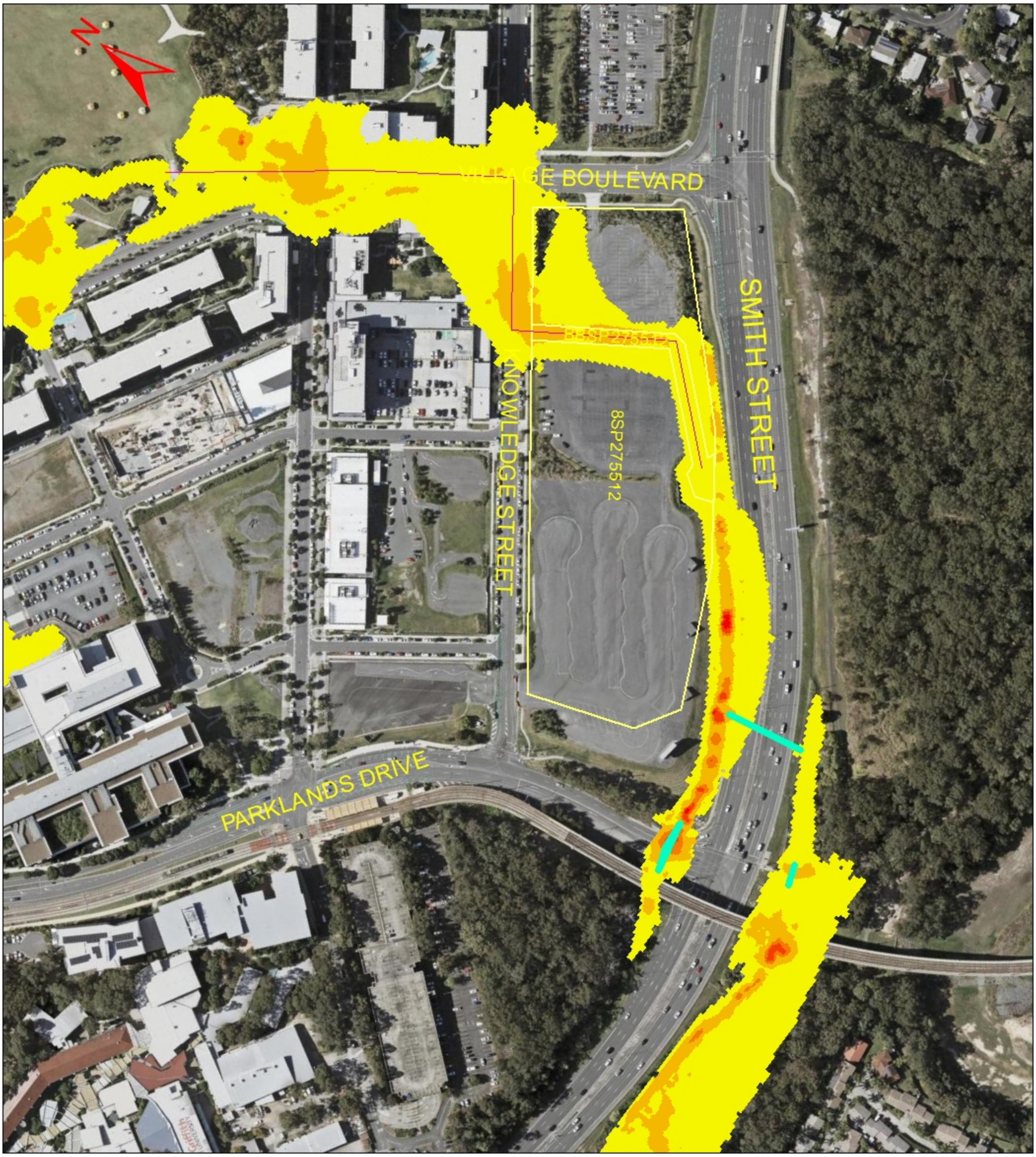
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EDQ
2 Village Boulevard, Southport FIA

Appendix C.1 100% BF Design Surface DEM YEAR 2100 1% Depth of Flood and Level

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Legend

100% BF Y2100_1% AEP Flow Velocity_Project Site Design Surface DEM (m/s)

- < 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5
- Major_Culverts
- Trunk_Drainage_Culverts
- PROJECT SITE

0 75 150 Meters

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TR by MG on 2026-03-31

Project: 304701862 2 Village Road FIA

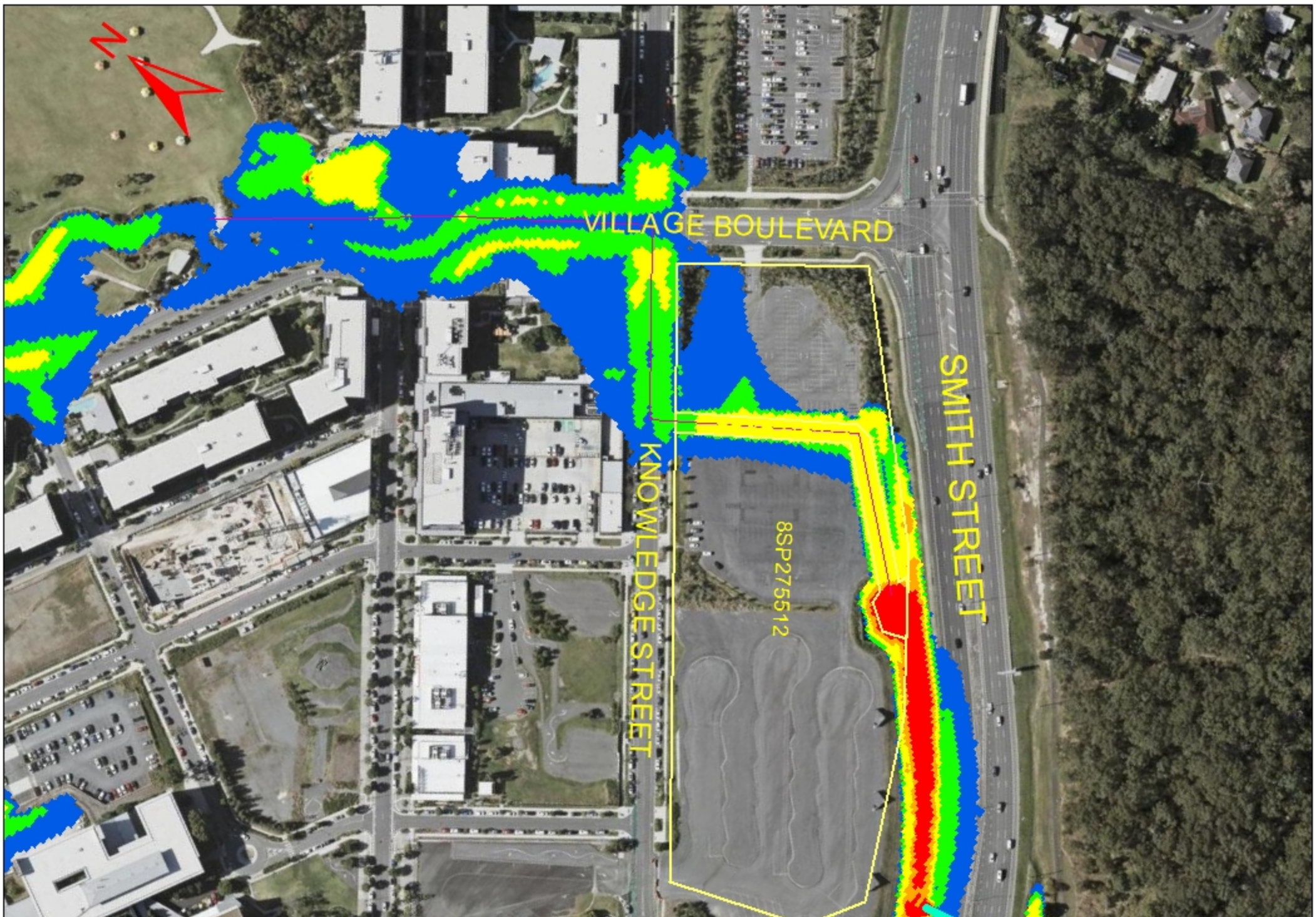
EDQ
2 Village Boulevard, Southport FIA

Appendix C.2 100% BF Design Surface DEM YEAR 2100 1% Flow Velocity

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Notes
1. Coordinate System: GDA 1994 MGA Zone 56
2. Background: Esri, HERE, Garmin, (c) OpenStreetMap contributors
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Legend

100% BF Y2100_1% AEP Flow Hazard_Project Site Design Surface DEM

- H1
- H2
- H3
- H4
- H5
- Major_Culverts
- Trunk_Drainage_Culverts
- PROJECT SITE

0 75 150 Meters

Stantec

Stantec Australia Pty Ltd
Brisbane, QLD

Prepared by BW on 2026-03-30
TR by MG on 2026-03-31

Project: 304701862 2 Village Road FIA

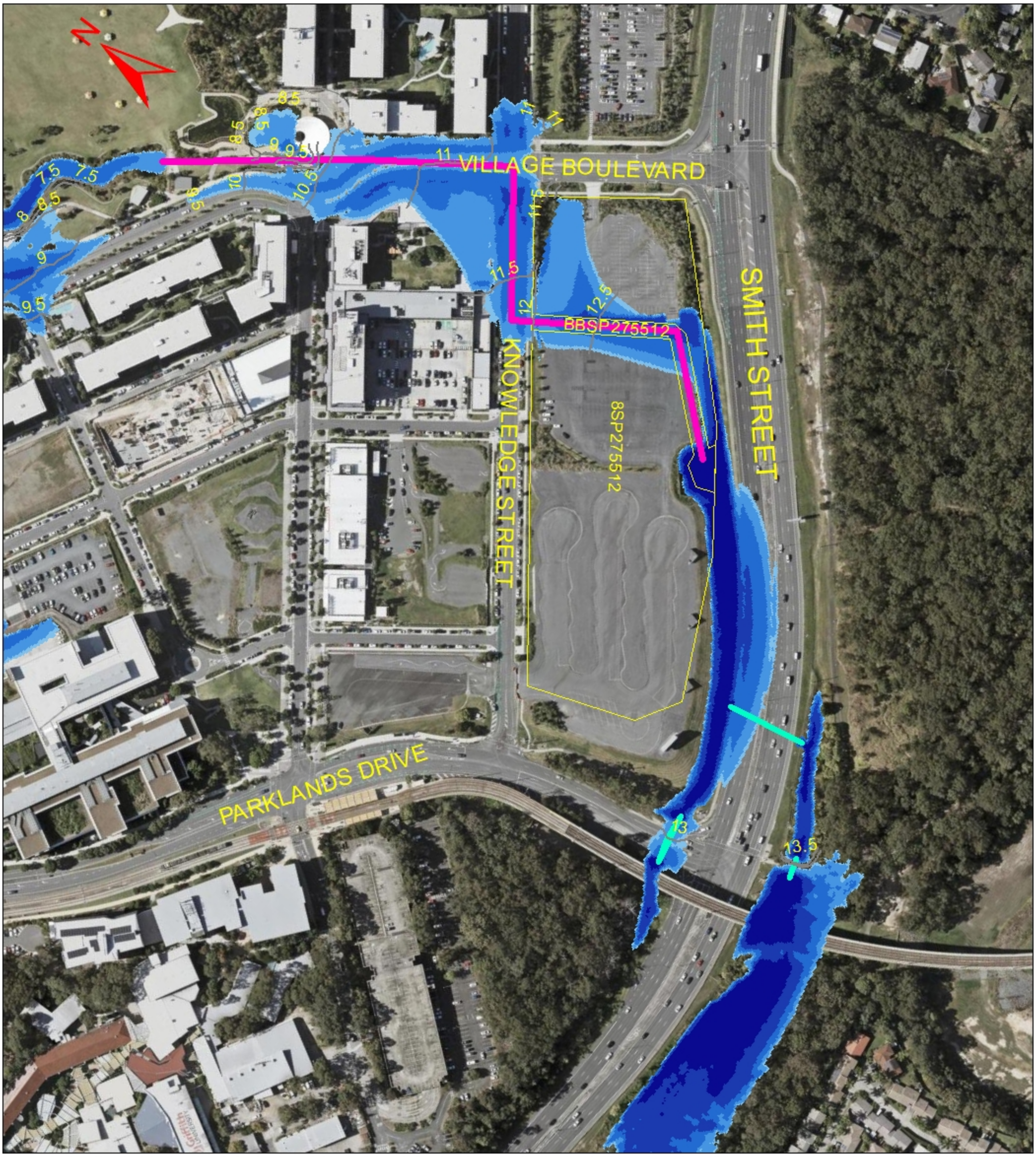
EDQ
2 Village Boulevard, Southport FIA

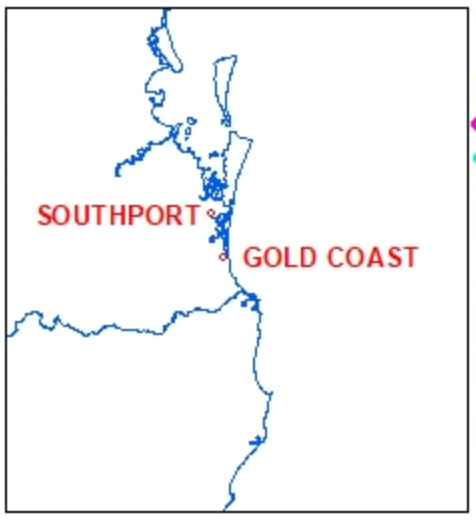
Appendix C.3 100% BF Design Surface DEM
YEAR 2100 1% Flow Hazard

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Legend

- 100% BF Year 2100_1% AEP Flood Level Contour Existing Surface
- PROJECT SITE
- TRUNK DRAINAGE CULVERTS
- MAJOR CULVERTS

100% BF Year 2100_1% AEP Depth of Flooding_Existing Surface Survey_DEM (m)

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- > 1.0

0 75 150 Meters

Notes
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Stantec

Stantec Australia Pty Ltd
Brisbane, QLD

Prepared by BW on 2026-03-12
TR by MG on 2026-03-15

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EDQ
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Appendix C.4 100% BF Existing Survey Surface _DEM Year 2100 1% _AEP_Depth of Flood and Level

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