Queensland Government

Department of
State Development, Manufacturing, Infrastructure and Planning

SARA reference: 1910-13906 SRA
Council reference: D/95-2019

12 February 2020

Chief Executive Officer
Rockhampton Regional Council
PO Box 1860
Rockhampton Qld 4700
enquiries@rrc.qld.gov.au

Attention: Amanda O'Mara

Dear Sir/Madam

SARA response—33-53 Knight Street, Park Avenue

(Referral agency response given under section 56 of the *Planning Act 2016*)

The development application described below was confirmed as properly referred by the Department of State Development, Manufacturing, Infrastructure and Planning on 31 October 2019.

Response

Outcome:	Referral agency response – with conditions.
Date of response:	12 February 2020
Conditions:	The conditions in **Attachment 1** must be attached to any development approval.
Advice:	Advice to the applicant is in **Attachment 2**.
Reasons:	The reasons for the referral agency response are in **Attachment 3**.

Development details

Description:	Development permit	Reconfiguring a lot for 3 lots into 13 lots
SARA role:	Referral Agency.	
SARA trigger:	Schedule 10, Part 9, Division 4, Subdivision 1, Table 1 (Planning Regulation 2017) Development which exceeds a threshold stated in Schedule 20 of the Planning Regulation 2017 Schedule 10, Part 9, Division 4, Subdivision 2, Table 1 (Planning	

Fitzroy/Central regional office
Level 2, 209 Bolsover Street,
Rockhampton
PO Box 113, Rockhampton QLD 4700

	Regulation 2017) Reconfiguring a lot near a State transport corridor Schedule 10, Part 9, Division 4, Subdivision 2, Table 3 (Planning Regulation 2017) Reconfiguring a lot near a State-controlled road intersection
SARA reference:	1910-13906 SRA
Assessment Manager:	Rockhampton Regional Council
Street address:	33-53 Knight Street, Park Avenue
Real property description:	2RP611882; 3RP611882; 4SP134379
Applicant name:	Aurizon Property Pty Ltd
Applicant contact details:	GPO Box 456 Brisbane QLD 4001 Andrew.Batts@aurizon.com.au

Representations

An applicant may make representations to a concurrence agency, at any time before the application is decided, about changing a matter in the referral agency response (s.30 Development Assessment Rules) Copies of the relevant provisions are in **Attachment 4**.

A copy of this response has been sent to the applicant for their information.

For further information please contact Carl Porter, Principal Planning Officer, on 07 4924 2918 or via email RockhamptonSARA@dsdmip.qld.gov.au who will be pleased to assist.

Yours sincerely

Anthony Walsh
Manager Planning

cc Aurizon Property Pty Ltd, Andrew.Batts@aurizon.com.au

enc Attachment 1 - Referral agency conditions
Attachment 2 - Advice to the applicant
Attachment 3 - Reasons for referral agency response
Attachment 4 - Representations provisions
Attachment 5 - Approved plans and specifications

Attachment 1—Referral agency conditions

(Under section 56(1)(b)(i) of the *Planning Act 2016* the following conditions must be attached to any development approval relating to this application) (Copies of the plans and specifications referenced below are found at Attachment 5)

No.	Conditions	Condition timing
Reconfiguring a lot		
Reconfiguring a lot near a State transport corridor— The chief executive administering the *Planning Act 2016* nominates the Director-General of Department of Transport and Main Roads to be the enforcement authority for the development to which this development approval relates for the administration and enforcement of any matter relating to the following condition(s):		
1.	The setback of the Horace Street vehicle crossover from railway level crossing ID: 06624 (Horace Street, Glenmore Junction) must be generally in accordance with the General Concept Lot Layout, prepared by McMurtrie Consulting Engineers, dated 24/01/2020, drawing number 0591819-SK-0003, revision C.	Prior to submitting the Plan of Survey to the local government for approval
2.	(a) The development must provide road/rail barriers in accordance with Queensland Rail Civil Engineering Technical Requirement CIVIL-SR-007 – *Design and Selection Criteria for Road/Rail Interface Barriers* generally in accordance with the Industrial Subdivision One (1) Lot into Thirteen (13) Lots over Lot 4 on SP134379, 33-53 Knight Street, Park Avenue, prepared by Veris Australia Pty Ltd, dated 24/01/2020, drawing number 400217-006-CP06 (Sheet 1 of 2), issue G, as amended in red. (b) RPEQ certification, with supporting documentation, must be provided to the Program Delivery and Operations Unit, Central Queensland Region (Central.Queensland.IDAS@tmr.qld.gov.au) within the Department of Transport and Main Roads, confirming that the development has been constructed in accordance with part (a) of this condition.	(a) & (b) Prior to submitting the Plan of Survey to the local government for approval
3.	(a) Any excavation, filling/backfilling/compaction, retaining structures, batters, stormwater management measures and other works involving ground disturbance must not encroach upon or de-stabilise the railway corridor, including all transport infrastructure or the land supporting this infrastructure, or cause similar adverse impacts. (b) RPEQ certification, with supporting documentation, must be provided to the Program Delivery and Operations Unit, Central Queensland Region (Central.Queensland.IDAS@tmr.qld.gov.au) within the Department of Transport and Main Roads, confirming that the development has been constructed in accordance with part (a) of this condition.	(a) At all times (b) Prior to submitting the Plan of Survey to the local government for approval
4.	Fencing must be provided along the site boundary with the railway corridor in accordance with Queensland Rail drawing number QR-C-S3230 – '1.8m High Chain Link Security Fence Without Rails Using 50mm Diamond Mesh General Arrangement'.	Prior to submitting the Plan of Survey to the local government for approval
5.	(a) A Traffic Management Plan must be prepared by a RPEQ and given to the Program Delivery and Operations Unit, Central Queensland Region (Central.Queensland.IDAS@tmr.qld.gov.au) within the Department of Transport and Main Roads. (b) The Traffic Management Plan must demonstrate that there will	(a) & (b) Prior to obtaining development approval for operational work

	be no disruption to the safety and operational integrity of railway level crossings during the course of construction and/or operation of the development. In particular, vehicle types and/or vehicle routes must not worsen short stacking issues over railway level crossings ID:05407, 06315 and 06624 at Glenmore Junction (Welch Street, Horace Street and Glenmore Road) and at railway level crossing ID:0548 of the North Coast Line (Main Street/White Street intersection). (c) The construction and operation of the development must be undertaken in accordance with the Traffic Management Plan.	(c) At all times
Reconfiguring a lot near a State-controlled road intersection & Reconfiguring a lot near a State transport corridor— The chief executive administering the *Planning Act 2016* nominates the Director-General of Department of Transport and Main Roads to be the enforcement authority for the development to which this development approval relates for the administration and enforcement of any matter relating to the following condition(s):		
6.	(a) The development must be carried out generally in accordance with sections 3.1 and 4.2, Table 6, and Appendices A and B of the Stormwater Management Plan, prepared by McMurtrie Consulting Engineers, dated 24 January 2020, Job number 059-18-19, revision C. (b) RPEQ certification, with supporting documentation, must be provided to the Program Delivery and Operations Unit, Central Queensland Region (Central.Queensland.IDAS@tmr.qld.gov.au) within the Department of Transport and Main Roads, confirming that the development has been constructed in accordance with part (a) of this condition.	(a) At all times (b) Prior to submitting the Plan of Survey to the local government for approval

Attachment 2—Advice to the applicant

General advice	
1.	Terms and phrases used in this document are defined in the *Planning Act 2016* its regulation or the State Development Assessment Provisions (SDAP) [v2.5]. If a word remains undefined it has its ordinary meaning.
2.	**Works on a railway corridor** Pursuant to section 255 of the *Transport Infrastructure Act 1994,* the railway manager's written approval is required to carry out works in or on a railway corridor or otherwise interfere with the railway or its operations. In particular, the following will require relevant approvals to be obtained from the railway manager (Queensland Rail) such as a licence to enter and construct and wayleave agreement, amongst other relevant approvals: • any proposed connections or modifications to services and utilities in the railway corridor. Service and utility connections must be in accordance with Queensland Rail technical requirement CIVIL-SR-016 – *Services Under Railway Property (Non-Queensland Rail) Services.* The applicant should also contact the railway manager prior to the installation of any fencing along the site boundary with the railway corridor. Please be advised that this concurrence agency response does not constitute an approval under section 255 of the *Transport Infrastructure Act 1994* and that such approvals need to be separately obtained from the relevant railway manager. The applicant should contact the Queensland Rail Property Team at developmentenquiries@qr.com.au or (07) 3072 2213 in relation to obtaining the necessary approvals.

Attachment 3—Reasons for referral agency response

(Given under section 56(7) of the *Planning Act 2016*)

The reasons for the department's decision are the development:

- is for a one into 13 lot industrial subdivision
- does not compromise the safety and efficiency of the State-controlled road intersection
- can be conditioned to protect the railway from adverse impacts
- the development complies with State Codes 1&2 with conditions applied
- the development complies with State Code 6: Protection of State Transport Network

Material used in the assessment of the application:

- The development application material and submitted plans
- *Planning Act 2016*
- Planning Regulation 2017
- The *State Development Assessment Provisions* (version [2.5]), as published by the department
- The Development Assessment Rules
- SARA DA Mapping system

Attachment 4—Change representation provisions

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Attachment 5—Approved plans and specifications

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Development Assessment Rules—Representations about a referral agency response

The following provisions are those set out in sections 28 and 30 of the Development Assessment Rules[1] regarding **representations about a referral agency response**

Part 6: Changes to the application and referral agency responses

28 Concurrence agency changes its response or gives a late response

28.1. Despite part 2, a concurrence agency may, after its referral agency assessment period and any further period agreed ends, change its referral agency response or give a late referral agency response before the application is decided, subject to section 28.2 and 28.3.

28.2. A concurrence agency may change its referral agency response at any time before the application is decided if—

(a) the change is in response to a change which the assessment manager is satisfied is a change under section 26.1; or

(b) the Minister has given the concurrence agency a direction under section 99 of the Act; or

(c) the applicant has given written agreement to the change to the referral agency response.[2]

28.3. A concurrence agency may give a late referral agency response before the application is decided, if the applicant has given written agreement to the late referral agency response.

28.4. If a concurrence agency proposes to change its referral agency response under section 28.2(a), the concurrence agency must—

(a) give notice of its intention to change its referral agency response to the assessment manager and a copy to the applicant within 5 days of receiving notice of the change under section 25.1; and

(b) the concurrence agency has 10 days from the day of giving notice under paragraph (a), or a further period agreed between the applicant and the concurrence agency, to give an amended referral agency response to the assessment manager and a copy to the applicant.

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1 Pursuant to Section 68 of the *Planning Act 2016*

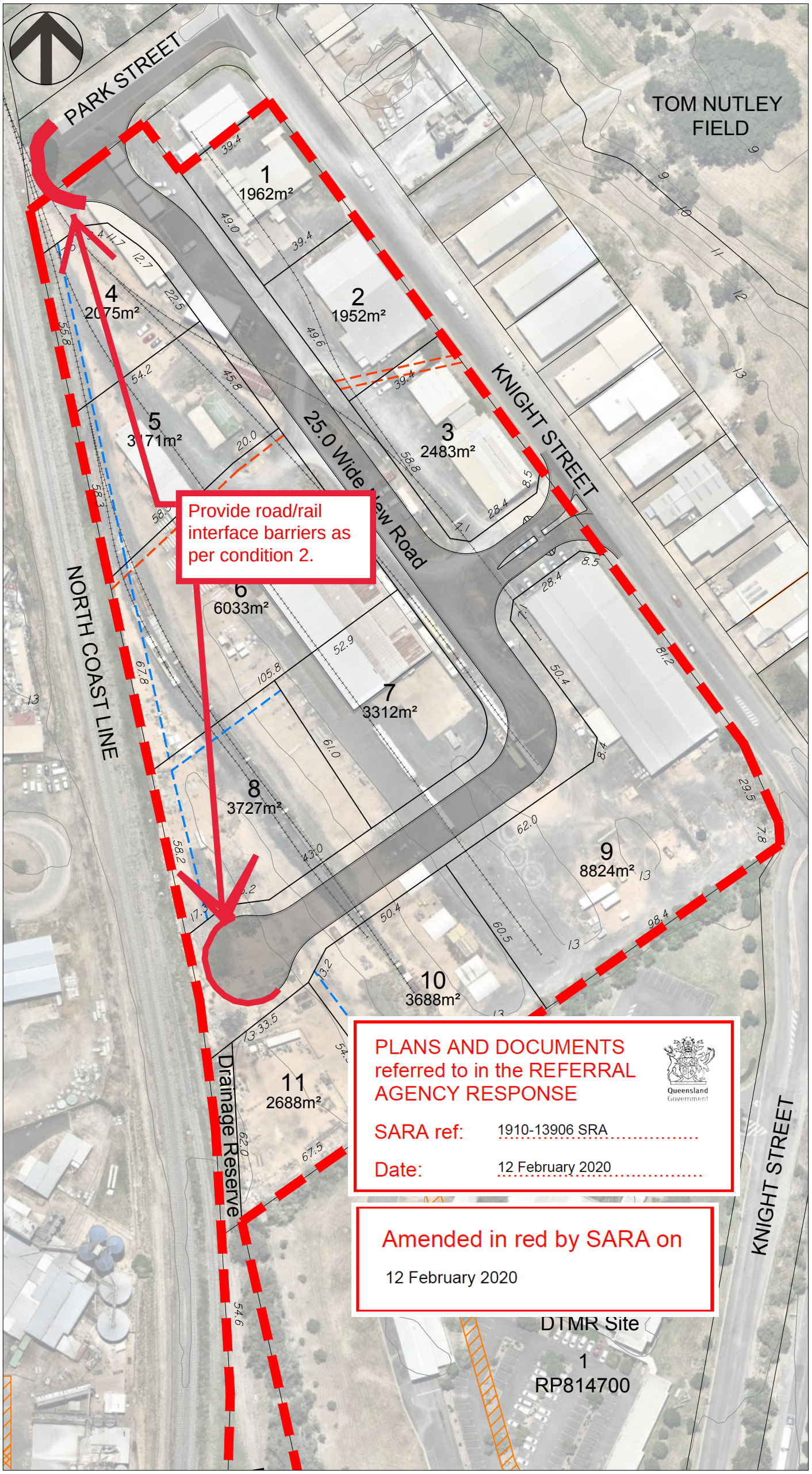
2 In the instance an applicant has made representations to the concurrence agency under section 30, and the concurrence agency agrees to make the change included in the representations, section 28.2(c) is taken to have been satisfied.

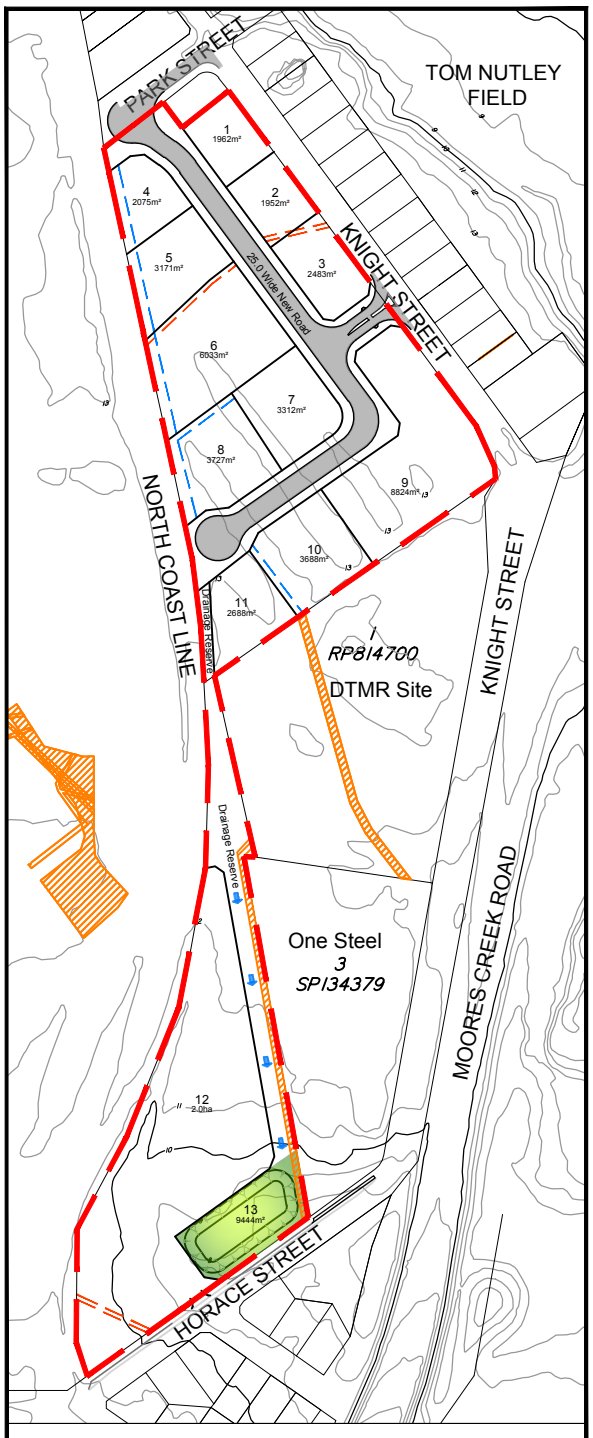
Part 7: Miscellaneous

30 Representations about a referral agency response

30.1. An applicant may make representations to a concurrence agency at any time before the application is decided, about changing a matter in the referral agency response.[3]

[3] An applicant may elect, under section 32, to stop the assessment manager's decision period in which to take this action. If a concurrence agency wishes to amend their response in relation to representations made under this section, they must do so in accordance with section 28.





SITE LOCATION SCALE 1:5,000@A3

LEGEND

Site Boundary	
Existing easement	
Proposed Stormwater basin. Size and location subject to engineering drawings.	
Traced existing rail	
Proposed stormwater easement subject to engineering drawings.	
Proposed sewer easement subject to engineering drawings.	
Proposed new road pavement	

DEVELOPMENT SUMMARY

Total Site Area	8.2ha
Area of Lots	5.9964ha
Total Number of Lots	12
Average Lot Area (excl. lot 12)	3,628m²
Stormwater basin area	3,625m²
Total Area of Road	1.23ha

DRAFT FOR DISCUSSION PURPOSES ONLY

Areas,dimensions and number of lots are approximate only and remain subject to final survey and Council Approval.

0 75m 150m 225m
50 100 150 mm SCALE BAR

IMPORTANT NOTES:

This plan was prepared for Preliminary evaluation of the land situated at Rockhampton. This plan is intended for discussion purposes only and should not be used for any other purposes. No investigations have been undertaken by Veris Australia Pty Ltd over this area of land other than to sight the registered plan and topographical map. The Contours, boundaries, creek line, flood lines, building locations have all been scaled and should not have any reliance based on them as they are only intended as a general guide. Any comments contained on this plan should be confirmed by the relevant authorities. The dimensions, areas and total number of lots shown hereon are subject to field survey and also to the requirements of Council and any other authority which may have requirements under any relevant legislation. In particular, no relevance should be placed on the information on this plan for any financial dealings involving the land.

Data Sources

Cadastral Boundaries	400217-006-CP06-D
Engineering Drawings by McMurtrie	0581819-SK-0001-B 0581819-SK-0002-B 0581819-SK-0003-B
Contours / Topographic	QSC
Aerial Images	Nearmap

Issue	Revisions	Date	Drawn
E	Show southern part of site in detail on sheet No 2	15.10.2019.	SI
D	Amend lot layout	11.10.2019.	SI
C	Add note	12.04.2019.	SI
B	Amend lot layout	08.04.2019.	SI
A	Original	28.03.2019.	SI

Locality: Rockhampton
Local Authority: RRC
Scale: 1:1,500@A3
Designed: SI
Drawn: SI
Checked: MF
Plot Date: 15 Jul, 2019
Computer File Ref: 400217-006-CP06-E.dwg

AURIZON

Industrial Subdivision
One (1) Lot into Twelve (12) Lots and One (1) Reserve Lot over Lot 4 on SP134379,
33-53 Knight Street, Park Avenue

veris
BRISBANE (07) 3666 4700
WHITSUNDAYS (07) 4945 1722
MACKAY (07) 4951 2911
CAIRNS (07) 4051 6722
veris.com.au
ACN 615 735 727
Veris Australia Pty Ltd

Drawing No 400217-006-CP06 (Sheet 1 of 2)
Issue E

QueenslandRail

PLANS AND DOCUMENTS referred to in the REFERRAL AGENCY RESPONSE

SARA ref: 1910-13906 SRA

Date: 12 February 2020

Queensland Government
Department of Main Roads

Civil Engineering Technical Requirement

CIVIL-SR-007

DESIGN AND SELECTION CRITERIA FOR ROAD/RAIL INTERFACE BARRIERS

Revision: B

Updated: 30/05/2011

Document Information	
Current Revision:	B
First Released:	15/06/2009
Last Updated:	30/05/2011
Review Before:	30/05/2014
Approved by:	Ian McColl
Authorised by:	Chris Keye

Document Amendment History

Revision	Date	Section(s) Amended	Summary of Amendment
Initial	15/06/2009		Initial (New Queensland Rail/Qld Main Roads document)
A	30/09/2010		Rebranded with new disclaimer.
B	30/05/2011		MCE Replaced with CIVIL

TABLE OF CONTENTS

1.0 INTRODUCTION

An intrusion into the railway corridor by an errant vehicle, loss of cargo onto the rail track or debris resulting from the event can cause a major incident and lead to extensive disruptions to railway and road operations.

A major incident could cause:

- Significant loss of life to rail passengers and the occupant(s) of the road vehicle(s);
- Damage to vehicle(s) and train(s);
- Derailed train being hit by a train on adjacent tracks;
- Track blockage;
- Damage to infrastructure; and
- Delays due to the time taken for debris removal.

In light of the increasing potential of incidents in shared corridors, Queensland Main Roads and QR Network collaborated to produce this specification for designers to determine the appropriate road and bridge barrier where the road and the rail are in close proximity without having to go back to first principles each time.

The current standards for road and bridge barriers AS 3845 and AS 5100 assume the main risk of an errant vehicle is to the occupants of the vehicle. In addition to this, Queensland Main Roads "Road Planning and Design Manual" Chapter 8, currently provides guidance on the treatment of roadside hazards but does not take into account adjacent third parties, such as railways.

This document sets out requirements for road and bridge barriers where the road and rail corridors are in close proximity and includes a road/rail barrier selection matrix developed using a risk assessment methodology. It has been further supplemented with a systematic procedure for barrier selection in parallel road and rail corridors and a document on road barrier selection for bridges over rail corridors.

NOTE

This document has been jointly developed by QR Network and Queensland Main Roads (Network Operations and Road Safety Division and Structures Division); any alterations must be jointly endorsed by both Authorities.

This document shall be subject to a review in 5 years from initial date of issue.

2.0 ASSUMPTIONS

- The errant vehicle is assumed to have 1 or 2 occupant(s); and
- Trucks are assumed to be a 36 tonne tanker semi-trailer for road barriers and a 44 tonne tanker semi-trailer for bridge barriers in accordance with AS 3845 and AS5100 respectively.

3.0 EXCLUSIONS

- Level crossings;
- “High centre of gravity” vehicles such as double-decker cattle trucks (Where these vehicles form part of the traffic stream, then the height of barriers needs to be re-evaluated);
- Length of barrier required on bridge approaches;
- At-grade and elevated roads with tight horizontal radius curves where the speed environment transitions between high and low speed; and
- Barriers adjacent to construction sites.

4.0 REFERENCE DOCUMENTS

- AS 3845
- AS 5100

- Queensland Main Roads: Road Planning and Design Manual
- QR Network documents: CIVIL-SR-001; CIVIL-SR-006; CIVIL-SR-014

- Barlow, S., Pritchard, R., Theodoropoulos, A., Troutbeck, R., 2009, "Barriers between road and rail: barriers adjacent to rail explained", 7th Austroads Bridge Conference, Auckland, New Zealand.

5.0 ROAD/RAIL INTERFACE BARRIER SELECTION PROCESS

Suitable reinforced concrete barriers shall be provided between the road and railway corridor as outlined in the following sections. The possible future rail and road status shall be taken into consideration in the barrier selection process to accommodate future requirements.

Note: The road barrier is to be located on the road shoulder.

Step 1: Determine measured horizontal offset between road/rail interface

From the typical design cross-section, determine the measured horizontal offset (X_H) from the edge-line of the road to the closest railway infrastructure (either 3m from the centre-line of the nearest railway track or to the nearest significant QR Network building/structure). Refer to Appendix 1 which shows barrier placement for different road/rail interface scenarios.

Step 2: Apply slope adjustment factor to determine slope adjusted horizontal offset, XS

The measured horizontal offset (XH) is adjusted to take into account the slope of the embankment from the road corridor down to the rail corridor. No adjustment is necessary where the rail corridor is above the road corridor. For slopes between 1 to 4 and 1 to 2.5, the following equation is used to calculate the slope adjusted offset.

Slope adjusted horizontal offset XS = (XH x FS)

Where:
XH = measured horizontal offset
FS = slope adjustment factor (refer to Table 1)

For embankments with compound slopes, each section with a different slope is calculated individually and each slope adjusted offset is added to obtain the overall slope adjusted offset, XS, such that:

Slope adjusted horizontal offset XS = ∑ (XHi x FSi)

Embankment Slope (V to H)	F_S
Horizontal/Flat	1.00
Less than 1 to 4	1.00
1 to 4	0.38
1 to 3.5	0.29
1 to 3	0.17
1 to 2.5 or steeper	0.00

Table 1. Slope Adjustment Factors

Example

If a railway was located at the base of a 1 to 3 embankment, and the offset between the railway infrastructure and the hinge point at the top of the embankment was 4.0m, and the distance from the edge-line of the road to the hinge point of the slope was 2.5m (refer to Figure 1.) then:

$X_S = \sum (X_{Hi} \times F_{Si})$
$= (X_{H1} \times F_{S1}) + (X_{H2} \times F_{S2})$
$= (2.5 \times 1.00) + (4.0 \times 0.17) = 3.18m$

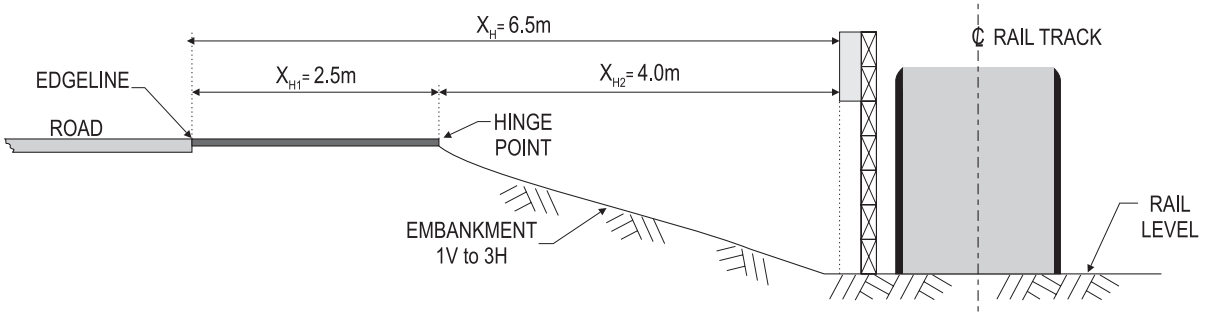


Figure 1. Example: Applying slope adjustment factor

Notes

1. For slopes flatter than 1 to 4, the slope adjustment factor (F_{Si}) should be taken as 1.00. That is, $X_S = X_H$
2. For slopes steeper than 1 to 2.5, slope adjustment factor (F_{Si}) should be taken as 0.00. In this instance, the slope adjusted offset distance (X_S) will become the measured distance from the road edge-line to the top of embankment hinge point.
3. At the locations where the railway is above the level of the road, $X_S = X_H$.

Step 3: Apply horizontal road curve adjustment factor

If the design radius of the road is equal to or less than 2000m, a horizontal curve adjustment factor, F_C, is applied to the slope adjusted horizontal offset determined in the previous step, X_S, to calculate the design offset, X_D, therefore:

The design offset, $X_D = (X_S \times F_C)$

Where:
X_S = slope adjusted offset
F_C = horizontal curve adjustment factor (refer to Table 2)
$X_D = X_H$ where the road is on a straight alignment or the radius is greater than 2000m.

Horizontal curve radii (m)	**Horizontal Road Curve Adjustment Factor (F_c)**						
100	0.56	0.50	0.43	0.37	0.31	0.26	0.21
150	0.66	0.60	0.54	0.47	0.41	0.34	0.29
200	0.72	0.67	0.61	0.54	0.48	0.41	0.35
250	0.76	0.71	0.66	0.60	0.53	0.47	0.40
300	0.80	0.75	0.70	0.64	0.58	0.51	0.45
400		0.80	0.75	0.70	0.65	0.58	0.52
500			0.79	0.75	0.69	0.64	0.57
600				0.78	0.73	0.68	0.62
700				0.81	0.76	0.71	0.65
800					0.78	0.74	0.68
900						0.76	0.71
1000						0.78	0.73
1200						0.81	0.76
2000							0.84
Design Speed Environment (km/h)	**60**	**70**	**80**	**90**	**100**	**110**	**120**

Table 2. Horizontal road curve adjustment factors

Note:

1. The design speed environment is 10km/h above the posted speed limit of the road on the approach to the horizontal curve.

Example

Continuing from the previous example, consider that the road also has a 600m horizontal curve, a posted speed of 100km/h and hence a design speed of 110km/h. If X_S = 3.18m, the horizontal curve radius on the road is 600 m and the design speed is 110 km/h, then to calculate the design offset:

$X_D = (X_S \times F_C)$.
$= (3.18 \times 0.68) = 2.16m$

Example summary
$X_D = \sum (X_{Hi} \times F_{Si}) F_C$

Where:
$X_H = 6.5m = X_D$ *if no slope or curve adjustment is required*
$Xs = 3.18m = X_D$ *, if only the slope adjustment is required*
$X_D = 2.16m$, *if both the slope and curve adjustment factors are required.*

The barrier is to be located on the road shoulder.

Step 4: Determine rail status

The railway status should be classified as shown in Table 3.

Rail status	Description
MPE	Main-line electrified (high passenger train frequency), i.e. the suburban network
MC & DG	Main country passenger and goods lines (eg. NCL) & light trafficked dangerous goods lines (i.e. explosive or highly flammable)
SP	Secondary passenger and/or goods lines. 1-5 trains / 24 hours
L	Light country lines < 7 trains per week
C	Coal/mineral lines

Table 3. Rail Status

Step 5: Determine road status

The design speed and road classification should be used to determine the road status. Refer to Table 4.

Road status	Description	Design Speed (km/h)	Upper limit AADT (veh/day)
1A	Arterial & dual carriageway	110	130,000
1B	Arterial & dual carriageway	80	90,000
1C	Arterial & dual carriageway	60	65,000
2A	Arterial, connection roads and rural highways	110	65,000
2B	Arterial, connection roads and rural highways	80	40,000
2C	Urban road	70	10,000
3	Residential Street	60	1,000

Note: The road speeds shown above, represent the design speed.

Table 4. Road Status

Step 6: Select/design road barrier

To select an appropriate road barrier, where a barrier is TL5 (height 1.1m) or TL4; refer to Main Roads document "Road Safety Barriers and End Treatments, assessed as compliant with AS 3845" (www.mainroads.qld.gov.au). Where the required barrier is TL5 (height 1.5m) or TL6, the barrier should be designed for the loads described in Table 5. Refer to road safety barrier "first principles" design procedure for road bridge barriers in the next section.

Barrier Performance Level	*Height (m)*	*Effective height H_e (m)*	*Transverse Load (kN)*	*Vehicle Contact Length (m)****
TL4	*0.8*	*Refer to MR document: "Road Safety Barriers and End Treatments, assessed as compliant with AS 3845" (available on QMR website.)*		
TL4	*1.1*			
TL5	*1.1*			
TL5	*1.5*	*1.40*	*500*	*2.4 (AS 5100.2 Table A2)*
TL6	*1.5*	*1.40*	*750*	*2.4 (AS 5100.2 Table A2)*
*TL6**	*1.5*	*1.40*	*1000*	*2.4 (AS 5100.2 Table A2)*
*TL6***	*2.0***	*1.40*	*1000*	*2.4 (AS 5100.2 Table A2)*

Notes to table 6a:
** 44 t articulated truck*
*** 2.0 m height for fire protection*
**** Length of barrier that vehicle load is distributed over.*

Table 5. Road barrier design criteria

Note: for TL5 barrier (height 1.5m) and TL6 barriers (heights 1.5, 2m) there are no proprietary barriers available in Australia. Advice on their design can be sought from the Road Authority.

Step 7: Determine the road barrier test level and height.

Use Table 6 "road/rail interface barrier selection" to select the appropriate barrier type and design height, using the rail and road status, and design offset, X_D.

Road /Rail corridor characteristics		1A-MPE	1B-MPE 2A-MPE	1C-MPE 1A-MC 1A-C 2B-MPE	1B-MC 2A-MC	1C-MC 2B-MC 1A-SP 2A-SP 2A-C 1B-C 2C-MPE	2C-MC 1B-SP 2B-SP 2B-C 1A-L 2A-L 1C-SP	2C-SP 2C-C 1B-L 3-MPE	1C-L 2B-L 2C-L 3-MC	3-SP 3-C 3-L
Design Offset, X_D (m)	≤4	TL6 2.0	TL6 1.5	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL4 1.1	TL4 1.1	TL4 1.1
	5	TL6 2.0	TL6 1.5	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL4 1.1	TL4 1.1	TL4 0.8
	6	TL6 2.0	TL6 1.5	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL4 1.1	TL4 0.8	
	7	TL6 1.5	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.5	TL4 1.1	TL4 0.8		
	8	TL6 1.5	TL5 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL4 1.1			
	9	TL5 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL5 1.1	TL4 0.8			
	10	TL5 1.5	TL5 1.5	TL5 1.5	TL5 1.1	TL5 1.1				
	11	TL5 1.5	TL5 1.5	TL5 1.1	TL5 1.1	TL4 1.1				
	12	TL5 1.5	TL5 1.1	TL5 1.1	TL5 1.1	TL4 1.1				
	13	TL5 1.1	TL5 1.1	TL5 1.1	TL5 1.1	TL4 1.1				
	14	TL5 1.1	TL5 1.1	TL5 1.1	TL4 1.1	TL4 0.8				
	15	TL5 1.1	TL5 1.1	TL4 1.1	TL4 1.1					
	16	TL5 1.1	TL5 1.1	TL4 1.1	TL4 1.1					
	17	TL5 1.1	TL5 1.1	TL4 1.1	TL4 0.8					
	18	TL5 1.1	TL4 1.1	TL4 1.1	TL4 0.8					
	19	TL4 1.1	TL4 1.1	TL4 0.8						
	20	TL4 1.1	TL4 1.1	TL4 0.8						
	21	TL4 1.1	TL4 1.1							
	22	TL4 1.1	TL4 1.1							
	23	TL4 1.1	TL4 0.8							
	24	TL4 1.1	TL4 0.8							
	25	TL4 0.8								

	26	TL4 0.8								
	27	TL4 0.8								
	28									
	29									
	30									
	31							Note: Light Green shaded area denotes that a barrier may be required where directed by the Road and/or Rail authority as determined by a risk assessment.		
	32									
	33									
	34									
	35									

Table 6. Road / Rail interface barrier selection

Step 8: Increase barrier height for electrification, and/or anti-throw screen (if required)

Additional height may be required for electrification, anti-throw, anti-glare screens and/or fire protection. This is determined on a case by case basis.

6.0 ANTI THROW AND ELECTRIFICATION SCREENS FOR ROAD BARRIERS

Anti throw screens shall be provided on the side of the road or path nearest to the railway, where the horizontal distance from the road edge, fence line or traffic barrier to the nearest track centre line is less than 6m. The anti throw screen shall be 2.4m high, if see-through and 2.0m high, if not see-through.

Electrification screens shall be provided on the side of the road or path nearest to the railway, where the minimum horizontal distance from the road/path, fence line or traffic barrier is less than 3m horizontally (in any direction), from overhead line equipment or wiring. The minimum required height (measured from the highest point of the adjacent pavement) for the electrification screen is 1.8m.

Subject to Rail Authority approval, anti glare screens may be suitable as anti throw or electrification screens. Also, the screens may be incorporated in the height of the crash barrier, subject to Rail Authority approval. Refer to Appendix 2 at the end of this document, and QR Network documents, CIVIL-SR-006, CIVIL-SR-001, for additional information.

7.0 BRIDGES OVER RAILWAY CORRIDOR

Suitable reinforced concrete barriers shall be provided over the full width of the railway corridor on both sides of road bridges over railways and on bridge approaches (the length of the approach barrier is to be determined by a risk assessment). The Rail Authority may allow the barrier to partially span the railway corridor, based on the current and future frequency of rail traffic and other railway activity in the railway corridor.

The possible future rail and road status shall be taken into consideration in the barrier selection process and the bridge designed accordingly to also accommodate future barrier requirements.

Road Bridge Overpass/Rail Interface Barrier Selection and Design

Step 1: Determine rail status

The railway status shall be classified as shown in Table 3.

Step 2: Determine road bridge overpass status

The design speed (i.e. the posted speed plus 10km/h) and road classification should be used to determine the road status. Refer to Table 4.

Step 3: Determine the bridge barrier test level and height.

Use Table 7 to select the appropriate bridge barrier type and height, using the rail and road status.

Road Status	Bridge Barrier Height (m) and Barrier Performance Level to AS 5100

1A	2.0 (Special)	1.5 (Special)	1.5 (Medium)	1.1 (Medium)	1.5 (Special)
1B	1.5 (Special)	1.5 (Medium)	1.1 (Medium)	1.1 (Regular)	1.5 (Medium)
1C	1.5 (Special)	1.5 (Medium)	1.1 (Medium)	1.1 (Regular)	1.5 (Medium)
2A	1.5 (Special)	1.5 (Medium)	1.5 (Medium)	1.1 (Medium)	1.5 (Medium)
2B	1.5 (Special)	1.5 (Medium)	1.1 (Medium)	1.1 (Regular)	1.1 (Medium)
2C	1.5 (Medium)	1.1 (Medium)	1.1 (Regular)	1.1 (Regular)	1.1 (Medium)
3	1.1 (Regular)	1.1 (Regular)	1.1 (Regular)	1.1 (Regular)	1.1 (Regular)
Rail Status	**MPE**	**MC & DG**	**SP**	**L**	**C**

Note:
[1.1 (Regular)] denotes the barrier is 1100mm high, measured from the edge of the adjacent road lane pavement level with a barrier performance level "Regular".

Table 5. Road bridge over railway barrier selection

Step 4: Select bridge barrier criteria

Design bridge barrier for loads described in Table 8 and refer to barrier design procedure.

Bridge barrier performance Level	***Barrier height (m)***	***Effective height H_e of transverse load (m)*****	***Transverse Load (kN)***	***Vehicle Contact Length (m)******
Regular	*1.1*	*1.05*	*250*	*1.1 (AS 5100.2 Table 11.2.2)*
Medium	*1.1*	*1.05*	*500*	*2.4 (AS 5100.2 Table A1)*
Medium	*1.5*	*1.45*	*500*	*2.4 (AS 5100.2 Table A1)*
Special	*1.5*	*1.45*	*750*	*2.4 (AS 5100.2 Table A2)*
*Special**	*1.5*	*1.45*	*1000*	*2.5 (AS 5100.2 Table A2)*
*Special**	*2.0*	*1.95*	*1000*	*2.5 (AS 5100.2 Table A2)*

Notes to table:
** 44 t articulated truck*
*** Length of barrier that vehicle load is applied over.*
**** Refer to AS 3845 Figure 3.5 "Dimensions"*

Table 6. Bridge barrier design criteria

Step 5: Analyze the barrier structure

The analysis can be undertaken by either of the proposed methods:

(a) simple design model
(b) complex computer model (approval by the Road Authority and Rail Authority is required prior to use)

Refer also to AS 3845, Appendix C, clause 3.4 “Analysis of stresses in rigid barriers”.

Simple Design Method

The analysis can be undertaken by assuming the distribution of the transverse load at 45o to the horizontal from the point of application of the load to the deck. Refer to Figure 2 below.

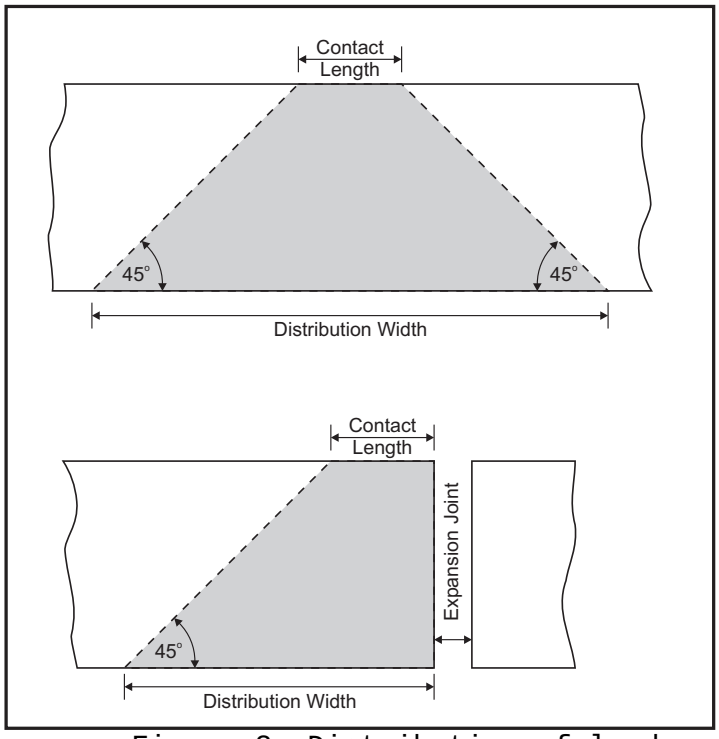


Figure 2. Distribution of load

The design method shall consider the actual distribution of loads that produce the most adverse ultimate bending moment (M), ultimate shear force (V*) and ultimate torsion force (T*) effects. End effects such as expansion joints shall be considered to determine the effective distribution length. Also, additional analysis of the connection between the barrier and the bridge superstructure is required.*

Special analysis case - Bridge to Road Barrier where barrier is anchored by piles/footing

There may be a requirement, such as where a bridge crosses a railway on a "skew" angle, where a barrier needs to be continued from a bridge to a road. In these instances, depending on the barrier performance level, barriers on the road may need to be supported on piles or a footing so that they meet the same requirements as the bridge barrier. This should be undertaken from first principles using a recognised design method approved by both the Road and Rail Authorities.

Step 6: Reinforcement design

Design of reinforcing steel shall be in accordance with AS 5100.5 "Concrete".

Step 7: Transition design

Bridge barriers either need to have a barrier end treatment or a transition between the bridge barrier and the road barrier. Refer to Appendix 3 "Road bridge over rail" which shows the extent of barrier required over railway corridor. In addition to this barrier, a risk assessment is required to determine the length of barrier required on the bridge approaches.

The transition barrier shall be either:

- *A barrier conforming to Queensland Main Roads standard drawings; or*
- *A barrier designed from first principles using a recognised design method approved by both the Road and Rail Authorities.*

The design process is similar to the bridge barrier design for the analysis and the reinforcement design. A transition in stiffness may also be required between barrier types and where the height between the barriers varies, the height should be transitioned with a 1 in 10 taper, refer to Appendix 3. (This can be used to obtain the minimum length of the transition.) The most adverse M, V* and T* effects shall be determined. Load cases should show the transverse loading effects with the required effective height, transverse load and vehicle contact length. A load case is applied separately to each end of the transition segment.*

Step 8: Increase barrier height for electrification, and/or anti-throw screen and/or fire protection (if required)

In addition to the barrier height required to structurally contain/re-direct a vehicle, the height of the barrier may need to be increased due to electrification, anti-throw and/or fire protection requirements. This may be created through the additional of metal screens or by increasing the height of the concrete barrier (refer to Appendix 2).

Note: the additional barrier height is not to be modelled in the above analysis, as it is not required for vehicle redirection. The minimum reinforcement required in the additional barrier height shall be the same as the reinforcement used in the lower section of the barrier. The maximum spacing of the horizontal bars shall not exceed 200mm.

8.0 BARRIER DESIGN CONSIDERATIONS

AS 5100.1 Table 10.4 shows the controlling strength of the test vehicles, associated barrier performance levels and NCHRP report 350 Test Levels (TL). The test levels range from TL2/low performance barrier to TL6/special performance barrier. A 36 tonne articulated tanker has been nominated as the controlling vehicle. (Refer to AS 5100.1 Table B3 and AS 5100.2 Table A2 and to NCHRP Report 350)

Barriers shall be designed to contain any part of the nominated design vehicle, its load and/or debris resulting from the collision and remnants of any secondary collisions, within the road corridor. The design shall take into consideration:

- Strength of the barrier to stop the vehicle or its load penetrating the barrier.
- Barrier height to minimise the risk of the vehicle or its load being propelled over the barrier.
- Containment of debris from any secondary vehicle collisions within the road corridor.
- Limiting the impact of any fire within the road corridor from adversely impacting on railway operations.
- Fire in either corridor can impact both the railway and road corridors from excessive smoke, and can damage infrastructure or in larger fires, power to the railway may be required to be switched off due to safety issues.

Typically, barriers are to be located within the road corridor adjacent to the road shoulder unless directed otherwise by the Road and Rail Authorities. Where the railway is located above the road, a single slope barrier may be incorporated into the base of the embankment or retaining wall to redirect a vehicle and shield the embankment/retaining wall.

For regular, medium and special barriers, concrete barriers are preferred. Afflux considerations in urban areas normally exclude concrete parapets. Where the road is subject to flooding, and an afflux will have an adverse effect on road users and adjacent property owners, steel or other barrier types, as directed by the Road and Rail Authorities, shall be considered.

9.0 ANTI THROW AND ELECTRIFICATION SCREENS ON BRIDGE OVERPASSES

Anti-throw screens

Anti throw screens are required on all road bridges, bike path and foot bridges over a railway corridor. The screen shall be provided over the total width of the corridor unless the Rail Authority has given approval in writing to reduce the length. This approval is based on rail traffic frequency and the extent of other railway activity under the bridge. The minimum extent of the screen on bridges shall be 3m (horizontally) either side of the track centre line, on both sides of the bridge. The height requirement for an anti throw screen is 2.4m, if see-through and 2.0m if not see-through.

Electrification screens

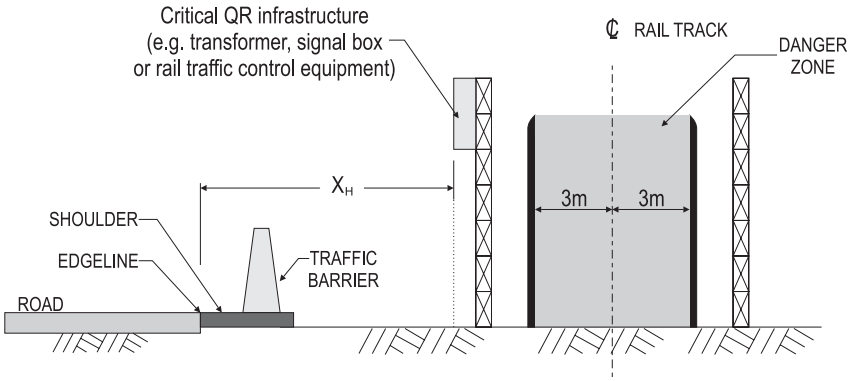
Electrification screens are required where the railway corridor is electrified. The screen shall be provided over the total width of the corridor unless the Rail Authority has given approval in writing for a reduced screen length to be provided. This approval is based on rail traffic frequency and extent of other railway activity under the bridge. The minimum extent of the screen on bridges shall be 3m (horizontally) either side of the track centre line, or overhead line equipment. The minimum required height of the electrification screen is 1.8m.

Anti-throw screens and electrification screens

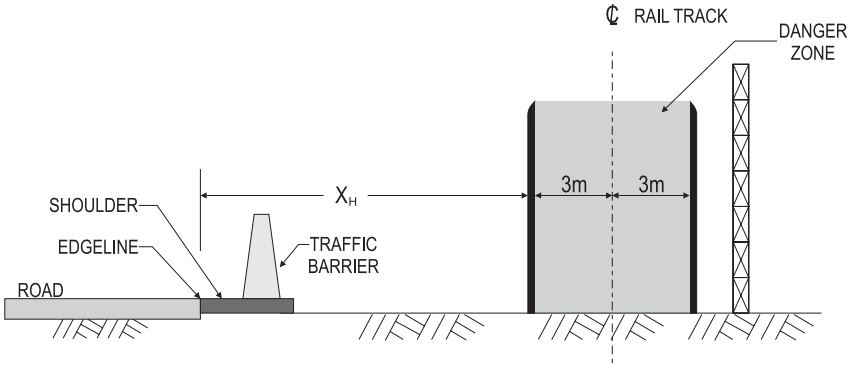
The other main difference between the two screens is the minimum allowable size of the screen openings. The height is measured from the highest point of the adjacent pavement level. The screens may be incorporated in the height of the crash barrier, subject to Rail Authority approval. Refer to

Appendix 2, and QR Network documents, CIVIL- SR – 006 and CIVIL – SR – 001, for additional information.

APPENDIX 1



HORIZONTAL / FLAT
(Option A)

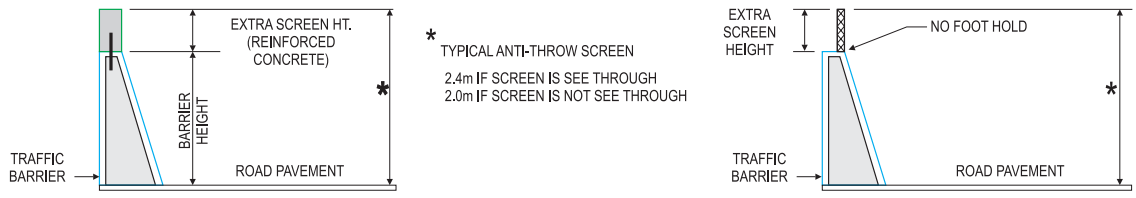


HORIZONTAL / FLAT
(Option B)

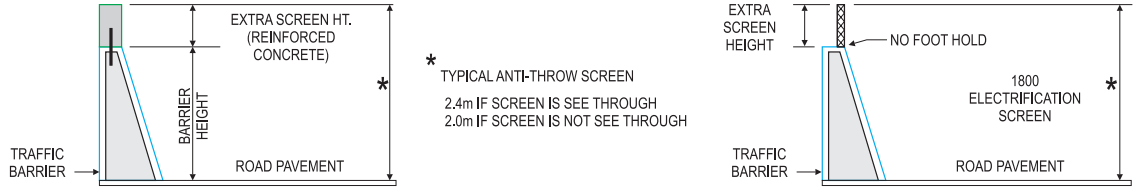
NOTE
BARRIERS ARE TO BE LOCATED ON THE ROAD SHOULDER.

Appendix 1

APPENDIX 2



TYPICAL BARRIER SECTION (NON ELECTRIFIED RAILWAY)



TYPICAL BARRIER SECTION (ELECTRIFIED RAILWAY)

NOTES

1. GENERAL

   - FOR BARRIERS ON ROAD OVER RAIL AND WHERE THE ELECTRIFICATION WIRING OR WIRING EQUIPMENT IS <3m HORIZONTALLY FROM SCREEN FOR ROAD/RAIL SEPARATION BARRIERS.
   - EXTRA SCREEN HEIGHT TO BE FIRMLY SECURED TO TRAFFIC BARRIER.

2. TYPICAL ANTI THROW SCREEN

SEE-THROUGH	NON SEE-THROUGH
LOUVRE MESH	REINFORCED CONCRETE
WELDED WIRE MESH	GALVANISED STEEL PLATE
PERFORATED STEEL SHEETING	
MAX OPENING IS 25mm x 25mm	

3. TYPICAL ELECTRIFICATION SCREEN

   * PERFORATED STEEL SHEETING
   * CRIM SAFE WIRE MESH
   * LOUVRE MESH
   * APPROVED GLASS PANE

   TYPE OF SCREEN TO BE SUBJECT TO RAIL AUTHORITY APPROVAL

4. FOR ANTI-THROW AND ELECTRIFICATION SCREENS

   ALSO REFER TO QR NETWORK TECHNICAL SPECIFICATIONS
   MCE-SR-001, MCE-SR-006 & MCE-SR-015 (ELECTRIFICATION SCREEN SELECTION)

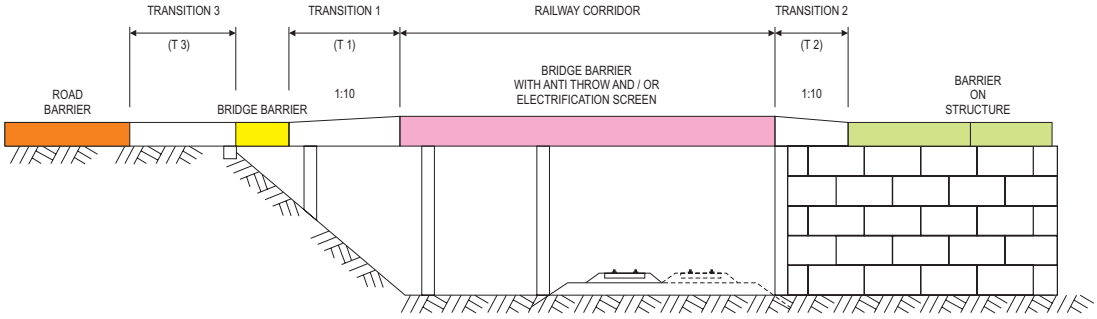
5. ANTI GLARE SCREEN

   A SUITABLE ANTI HEADLIGHT GLARE SCREEN MAY ALSO BE INCORPORATED IN THE ROAD/RAIL INTERFACE BARRIER WHERE REQUIRED.

ANTI THROW AND ELECTRIFICATION SCREENS

Appendix 2

APPENDIX 3



TYPICAL BRIDGE SECTION

NOTE

T1 = TRANSITION IN HEIGHT 1(v) TO 10(h)
T2 = TRANSITION IN HEIGHT 1(v) TO 10(h) AND IN STIFFNESS
T3 = TRANSITION IN STIFFNESS

BARRIER TRANSITIONS

ROAD BRIDGE OVER RAILWAY CORRIDOR

Appendix 3

Civil Engineering Technical Requirement

CIVIL-SR-016

SERVICES UNDER RAILWAY PROPERTY (Non-Queensland Rail Services)

Revision: 5

Updated: 05/08/2013

Document Information		
Current Revision:	5	
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Reviewed by:	Ali Sadry (Principal Systems Engineer - Civil)(RPEQ)	Date: 05/08/2013
Approved by:	David Sylvester (Manager Civil Standards)	Date: 05/08/2013
Authorised by:	Gary Smith (Track and Structures Discipline Head)	Date: 05/08/2013

Document Amendment History

Revision	Date	Section(s) Amended	Summary of Amendment
Initial	14/10/2009		
A	30/09/2010		Rebranded with new disclaimer
B	30/05/2011		Rebranded, minor amendments
3	28/03/2012		General revision
4	7/12/2012	2.9	Supervision clause added, last sentence in Section 2.9
5	05/08/2013		Clarification of requirements for gas lines and speed restrictions; explanations of individual requirements; information on backfilling excavations; use of steel enveloping pipes; inspections for erosion above services

Compliance:
Significant issues with compliance to the Civil Engineering Technical Requirements detailed in this document shall be addressed through the Rail Infrastructure Manager who will liaise with the Track and Structures Discipline Head as necessary.

Feedback:
If you have any suggestions for improvement to any documentation, especially inaccuracies or ambiguities, please email CivilEngineeringStandards@qr.com.au with the document number in the subject heading.

CONTENTS

1 INTRODUCTION

This Technical Requirement details the criteria which must be met by:

- external service owners,
- Queensland Rail and external authorities where the service is jointly owned, and
- external service owners where Queensland Rail uses a proportion of the service,

where the services are to traverse Queensland Rail's property and / or pass under railway tracks.

The requirements for solely Queensland Rail-owned services on Queensland Rail's property are covered in Technical Requirement CIVIL-SR-17 or the General Signalling Specification GSS Part 6 "Cable Route Construction, Cables and Cable Installation".

Although the relevant Australian Standards for undertrack service crossings are used as the basis for this Technical Requirement, a number of special measures are required. These are to increase the level of safety for the railway as well as for field staff performing future excavation work in the vicinity of those crossings. Increased depths below the track and natural ground surface or the provision of stronger encasing pipes are required to minimise the potential dangers caused by combustible, high pressure or high voltage services.

Those additional measures have been determined from past experience with undertrack excavation failures, associated problems and the need to perform the work in and around the operating railway.

The interaction of Queensland Rail's track protection staff and the drilling / boring operators is described. A fundamental measure for preventing railway traffic damage and derailment is continuous observation by contractors' and Queensland Rail's staff during the excavation work under and in the vicinity of the tracks. Any variation from the pre-existing track geometry will be immediately assessed by Queensland Rail's staff on site for the necessary imposition of traffic restrictions and follow-up remedial trackwork.

The minimum depths of services below the track have generally been increased over the Australian Standard's minimum requirements in order to decrease the effects of the bore on the surface and to improve safety for future excavation work in the area.

A range of drilling / boring / tunnelling / pipe ramming / trenching methods are available and it will remain the responsibility of the service provider and contractor to determine the most appropriate method for each job site subject to appropriate geotechnical assessment. The method chosen and the appropriate controls must aim to eliminate the possibility of lifting / lowering / altering the track geometry in any way.

Wet boring (high pressure water drilling) must not be used under any circumstances.

Where this Technical Requirement prescribes a higher degree of protection than any other standard, including Australian Standards, then this document will take precedence.

2 ALL TYPES OF UNDERTRACK SERVICES

2.1 Queensland Rail's Costs to be covered by Service Owner

All of Queensland Rail's costs associated with the work and the implementation of these Technical Requirements will be charged to the service owner or its agent. This includes any remedial work necessary to the track and trackside drains as a result of this work and any accidental damage, as well as costs associated with train delays. Rates will be set by Queensland Rail.

2.2 Australian Standards and Codes of Practice

AS 4799 "Installation of underground utility services and pipelines within railway boundaries" provides for the minimum requirements, while also allowing the railway authority to impose those additional safety matters described in this Technical Requirement.

Water Services Association of Australia provides guidance for undertrack crossings by water and sewer pipes through their "Water Supply Code of Australia" and "Sewerage Code of Australia".

AS 1289 "Methods of testing soils for engineering purposes" provides information for the compaction of backfill where a service has been installed in a trench.

The requirements for the design, operation and maintenance of gas and fuel pipelines as they relate to this Technical Requirement are covered by:

- AS 2885.1 "Pipelines – Gas and liquid petroleum – Design and construction",
- AS 2885.3 "Pipelines – Gas and liquid petroleum – Operation and maintenance",
- AS/NZS 4645.1 "Gas distribution networks – Network management",
- AS/NZS 4645.2 "Gas distribution networks – Steel pipe systems", and
- AS 2832.1 "Cathodic protection of metals – Pipes and cables".

2.3 Safety during Service Installation and Maintenance

It is the responsibility of the service owner / its agent to perform safely all work associated with the installation and maintenance of the service.

The following additional Technical Requirements must be satisfied while all workers are on Queensland Rail's property:

- CIVIL-SR-002 "Requirements for work in or about Queensland Rail's property", and
- CIVIL-SR-003 "Requirements for work adjacent to overhead line equipment" (if appropriate).

2.4 Orientation, Location and Depth of Services

All externally-owned services should be orientated in plan to pass through Queensland Rail's property in a straight line and within approximately 5^{o} of 90^{o} to the track centreline. 90^{o} was chosen so that any future subsidence or heave along the line of the service will not create a rolling effect between the rails which would cause a derailment. This restriction may be relaxed in exceptional circumstances at the discretion of the Rail Infrastructure Manager if the depth of the service is greater than 4 m below formation level or if geotechnical investigation shows that the bore will be self-supporting under railway loads.

For a service which Queensland Rail jointly owns or where Queensland Rail uses an externally-owned service, and where that service runs along the corridor, the alignment will be:

- within approx. 1 m of the boundary fence,
- more than 6 m from the toe of a bank or top of a cutting, and
- more than 10 m from the nearest rail.

These conditions also apply in exceptional circumstances, where externally-owned services may be permitted to run along the corridor. Permission may be given at the discretion of the Rail Infrastructure Manager. These conditions are so that the service will generally be clear of future Queensland Rail developments.

No services should pass within 5 m horizontally of any infrastructure foundation or pipe / culvert (cross-track drainage). If this is impractical in a specific location, the details of the situation need to be presented to the Rail Infrastructure Manager for a determination based on the nature of the footing and the diameter of the pipe.

No services are to be located under track turnouts or crossovers. Any future subsidence or heave under these critical areas would cause a derailment.

Services are only permitted to pass under level crossings with the bitumen / road surface remaining in place, if installation is by pipe ramming. If any other method is used, the road surface must first be removed and then replaced after the service installation has been completed. This restriction is because experience has shown that holes can appear below the bitumen / road surface without being detected by survey checks of rail level. The subsidence only becomes apparent under the passage of the next train.

The minimum clear horizontal distance between an existing service and a new service must be greater than 2 m. For the situation where a new service is to be 2 m – 3 m from a gas pipeline, the owner of the new service must first obtain a permit / approval from the owner of the gas pipeline (copy to Queensland Rail). For new services being installed in a group, it is preferable to combine all services into a single enveloping pipe. For a number of bores in a group, the minimum clear horizontal distance between enveloping pipes within the group must be 2 m.

Non-Queensland Rail services must be at a depth greater than 2 m below both formation level and ground level. Depths less than 2 m are reserved for Queensland Rail's services and activities. The required minimum depth (2 m or greater) depends on the nature of the service (Section 2.7); its method of installation (Section 3); the effect on the track should the service fail; and the safety issues associated with future excavation work.

No service will be allowed vertically above / below and parallel to another service or an existing service.

Where a new service is to pass above / below an existing service, where they are not parallel (usually at 90^{o}), a vertical clearance typically greater than 300 mm should be achieved. The owner of the new service must contact the existing service owner for a determination of the required clearance in each case. This clearance will depend on the accuracy of the installation method (trench, laser guided micro-tunnelling, etc.) and the nature of the crossing (gas, water, fibre optic cables, etc.).

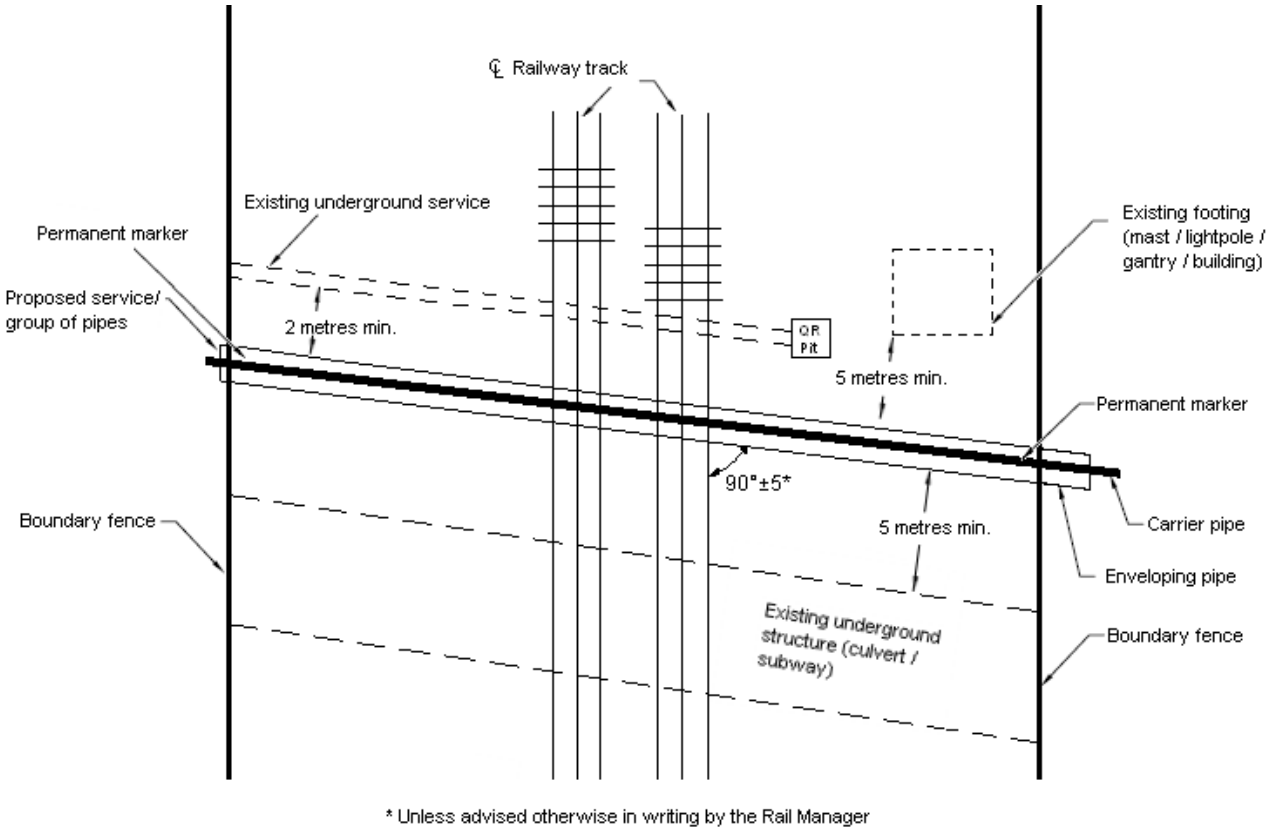


Figure 1: Plan Showing Service Pipe Crossing the Railway Corridor

No manholes, chambers, pits or anchor blocks are to be installed in Queensland Rail's property as part of services solely owned by non-Queensland Rail authorities. For pipelines carrying liquids under pressure, a valve is to be installed in the pipeline (on the inlet side) outside of Queensland Rail's boundary.

The contractor is responsible for determining the exact locations of all underground services in the vicinity of the proposed work. The approximate locations of Queensland Rail-owned services will be provided in response to the contractor's application. It should be noted that many of Queensland Rail's services (water, sewerage, electrical, signalling, etc.) were installed many years ago and do not have permanent markers showing their locations and have not been installed at right angles to the track and at the minimum depths below the track as nominated in AS 4799.

2.5 Entry and Exit Pits / Shafts

For drilling / boring / tunnelling methods, entry and exit pits are to be outside of Queensland Rail's property. For safety reasons, the movement of the contractor's staff on Queensland Rail's property is to be minimised.

In exceptional circumstances, pits / shafts may be permitted in Queensland Rail's property at the discretion of the Rail Infrastructure Manager subject to site-specific railway traffic protection requirements. After the installation of the service, the pits / shafts are to be backfilled with material appropriate to the nature of the surrounding soil / rock:

- If the pit / shaft will be free draining, the backfill material may be fine crushed rock, sand, gravel, lean mix concrete or other material approved by the Rail Infrastructure Manager. The backfill is to be compacted to 90% of the maximum dry density (Modified Compaction Test) up to 600 mm below formation / ground level. The top 600 mm is to be compacted to 95% of the maximum dry density (Modified Compaction Test). This is to be in accordance with AS 1289.E2.1. The fill is to be placed and then compacted in 300 mm layers.
- If the pit / shaft is non-draining, e.g. impervious rock, the backfill material is to be impermeable when compacted. Cement stabilised sand (2% cement) may be used or other material approved by the Rail Infrastructure Manager. The backfill is to be compacted to 95% of the maximum dry

density (Modified Compaction Test). This is to be in accordance with AS 1289.E2.1. The fill is to be placed and then compacted in 300 mm layers.

2.6 Geotechnical Advice

For bore holes / tunnels greater than 150 mm dia. and prior to any excavation work commencing on site, the service owner / its agent is required to obtain a geotechnical assessment of the ground conditions (soil types and depth of water table) over the length of the bore. For smaller diameter holes, this advice can be sought at the discretion of the service owner / its agent. This information is to be used by the service owner / its agent to determine the most suitable method for the work and the detailed equipment requirements to successfully complete the bore without causing any disruption to the track and ground surface.

The service owner must make the contractor aware that obstacles, such as large rocks, old rails and old timber bridge piers, may be encountered while excavating through railway embankments or areas of fill. Problems have also been encountered where the bore has broken into loose material, e.g. ballast, causing the loose material to run freely into the bore, creating a sink hole / subsidence at the surface.

If exploratory vertical bore holes are to be sunk, they must not be on the line of the bore / tunnel. They must be properly backfilled and sealed.

2.7 Future Track Safety and Protection of Services from Excavations

Special requirements are to apply to services which have the ability to cause damage to the ground surface and track should they fail (leak / rupture / break / collapse) or to create a dangerous situation in the event of future excavations damaging the service.

These measures involve:

- using an impact-resistant enveloping pipe, or
- installing a concrete slab and warning tapes above the service (trench installation only), or
- increasing the depth of the top of the bore to more than 3 m below both the top of the railway formation (underside of ballast) and the ground surface level,

and apply to the full length of the service under Queensland Rail's property.

Enveloping Pipes

A suitable enveloping pipe provides an additional level of safety:

- against rupture from future excavation work or deterioration of the carrier pipe which would allow the escape of combustible gases / liquids or pressurised water into the track area, and
- in the case of sewers and stormwater drains, against erosion of the soil around a break in the pipe and the formation of a cavity leading to a sink hole / subsidence under the track.

Where a suitable enveloping pipe is used, grouting may be required outside (depending on the method of installation), but not necessarily inside the enveloping pipe. This allows for the future replacement of the carrier pipe if necessary. The ends of the enveloping pipe are to be sealed.

In the case of a steel enveloping pipe (subject to corrosion because of soil contact):

- cathodic protection must be established and maintained for the life of the service, and
- the enveloping pipe must be grouted both externally and internally.

The enveloping pipe must be able to withstand the impact of an excavator, e.g. a Class 4 concrete pipe or a steel enveloping pipe grouted outside would be suitable. Plastic materials are generally not suitable, however HDPE pipe with impact resistance of PN20 and material PE100 would be acceptable. Enveloping pipes made from other materials may be submitted to the Rail Infrastructure Manager for comment on suitability / acceptability.

Slab Protection

For gas and liquid fuel lines and electrical conduits (all with or without an enveloping pipe) to be installed at a depth of 2 m – 3 m, the service must be installed in a trench and protected from future excavation by a concrete protection slab and buried warning tapes.

Increased Depth
For gas and liquid fuel lines and electrical conduits, if the provision of an impact resistant enveloping pipe or concrete protection slab is impractical in a specific location / application, the depth of the service must be increased to more than 3 m below both formation level and ground level in an attempt to eliminate the possibility of future accidental damage.

To ensure that this depth of cover is maintained where the pipe passes under a water course / gully / drain, the service owner is to perform regular inspections for erosion above the pipe. Typically, additional inspections would be required after heavy rains where erosion is occurring. Any decrease in the cover will require the service owner to arrange for remedial earthworks to restore cover and to stabilise the soil against further erosion.

2.7.1 Water Supply, Sewers and Stormwater Drains

Track safety can be compromised in the future by the failure of these services.

A suitable enveloping pipe must always be used with these services, irrespective of the depth. In the case of pressurised services, e.g. water supply or rising sewer mains, the enveloping pipe adds an extra level of safety against pressurised liquid finding its way to the surface, causing erosion of the formation / ballast, striking the underside of trains or interfering with the overhead electrical traction wiring. In the case of pipes which do not flow full, e.g. gravity sewers or stormwater drains, the enveloping pipe is to prevent sink holes / subsidence forming should a piece break out of the carrier pipe.

2.7.2 Electrical Power Cables

These requirements apply to both low and high voltage cables.

The requirements for the various methods of installation are:

- **Trench** …. This method is suitable for HDPE conduits where the top of a protection slab (above the conduits) is between 2 m and 3 m depth below both formation level and ground level. An enveloping pipe is not required in this case. Protection from future excavation will be achieved by the use of a protection slab similar to that described in AS 4799. The slab is to be a minimum of 150 mm thick reinforced concrete designed to resist excavator impact. It is to be 1000 mm greater in width than the group of conduits and is to be placed centrally over the conduits. Electrical warning tapes are also to be used. The minimum depth of the top of the conduits below the underside of the slab is to be 300 mm. Groups of conduits below the slab are to be protected by backfilling the trench with flowable grout (approx. 2 MPa) up to a minimum of 300 mm above the uppermost conduit.

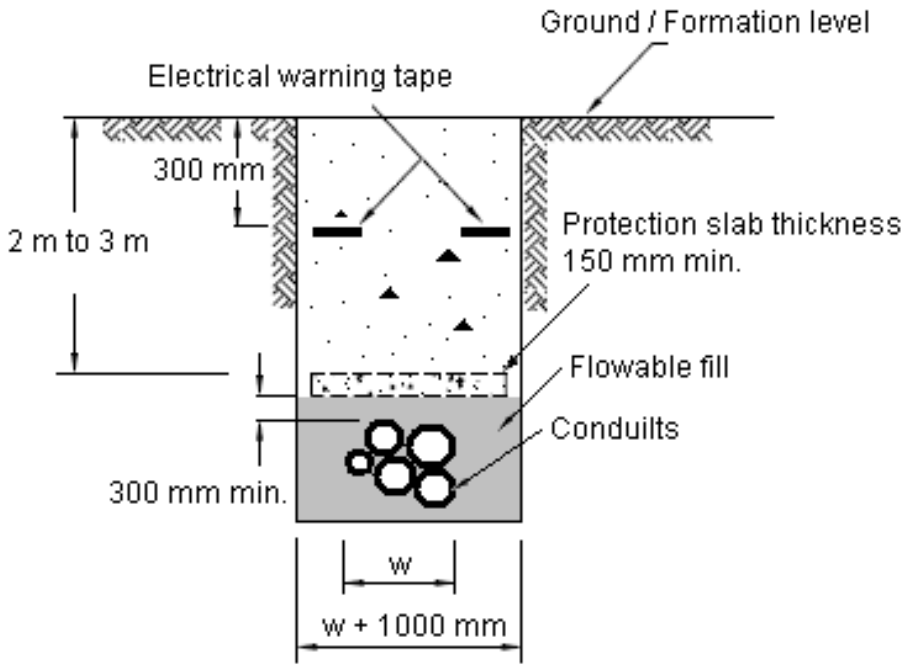
- **Directional drilling** …. HDPE conduits (without an enveloping pipe) may be used where the depth of the top of the bore is greater than 3 m below both formation level and ground level. The conduits are to be installed within a single bore with a maximum diameter of 350 mm. If a larger bore is necessary, a different installation method must be used. An enveloping pipe is not essential in this case.

- **Pipe jacking / tunnel boring / micro-tunnelling / pipe ramming** …. These methods can be used to install a suitable impact-resistant enveloping pipe, e.g. HDPE, steel or concrete. The top of the bore must be greater than 2 m below both formation level and ground level.

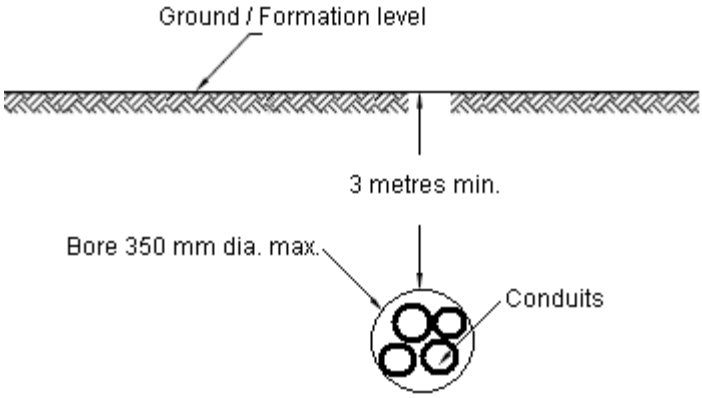
HDPE conduits are to be at least designation PN12.5 and material PE100. The HDPE enveloping pipe is to be at least designation PN20 and material PE100.

Steel enveloping pipes are to be grouted inside and outside, as well as having cathodic protection in accordance with Section 2.7 *Enveloping Pipes.*

Concrete enveloping pipes are to be Class 4 and grouted inside and outside.



Installation in a Trench
(section through trench)



Installation by Directional Drilling
(section through bore)

Figure 2: Vertical Sections Showing Electrical Power Services Under the Railway Corridor

2.7.3 Gas Pipelines

Gas carrier pipes are usually made from either high density polyethylene (HDPE) or steel coated with a protective film.

HDPE Gas Carrier Pipe
An enveloping pipe of HDPE, concrete or steel is required to be used for the full length of the service under Queensland Rail's property, irrespective of the depth.

A HDPE enveloping pipe is to be at least designation PN20 and material PE100, with the space between the gas pipe and the enveloping pipe is to be sealed and vented at the ends outside of Queensland Rail's property. The vent pipes are to be clear of and not attached to the boundary fence.

Steel enveloping pipes are to be grouted inside and outside, as well as having cathodic protection, in accordance with Section 2.7 *Enveloping Pipes* above.

Concrete enveloping pipes are to be Class 4 and grouted inside and outside.

The requirements for the various methods of installation are:

- **Trench ….** This method is suitable for a HDPE enveloping pipe protected from above by a concrete slab where the top of the slab is between 2 m and 3 m below formation level and ground level. Protection from future excavation will be achieved by the use of a protection slab similar to that described in AS 4799. The slab is to be a minimum of 150 mm thick reinforced concrete designed to resist excavator impact. It is to be 1000 mm greater in width than the enveloping pipe and is to be placed centrally over it. Warning tapes are also to be used.
  The minimum depth of the top of the enveloping pipe below the underside of the slab is to be 300 mm. The gas line below the slab is to be protected by backfilling the trench with min. 20 MPa mass concrete up to a minimum of 300 mm above the top of the enveloping pipe.

- **Directional drilling ….** HDPE may be used for the enveloping pipe where the depth of the top of the bore is greater than 3 m below both formation level and ground level. The maximum diameter of the bore is to be 350 mm. If a larger bore is necessary, a different method must be used.

- **Pipe jacking / tunnel boring / micro-tunnelling / pipe ramming** …. These methods can be used to install a suitable impact-resistant enveloping pipe, e.g. HDPE, steel or concrete. The top of the bore must be greater than 3 m below both formation level and ground level.

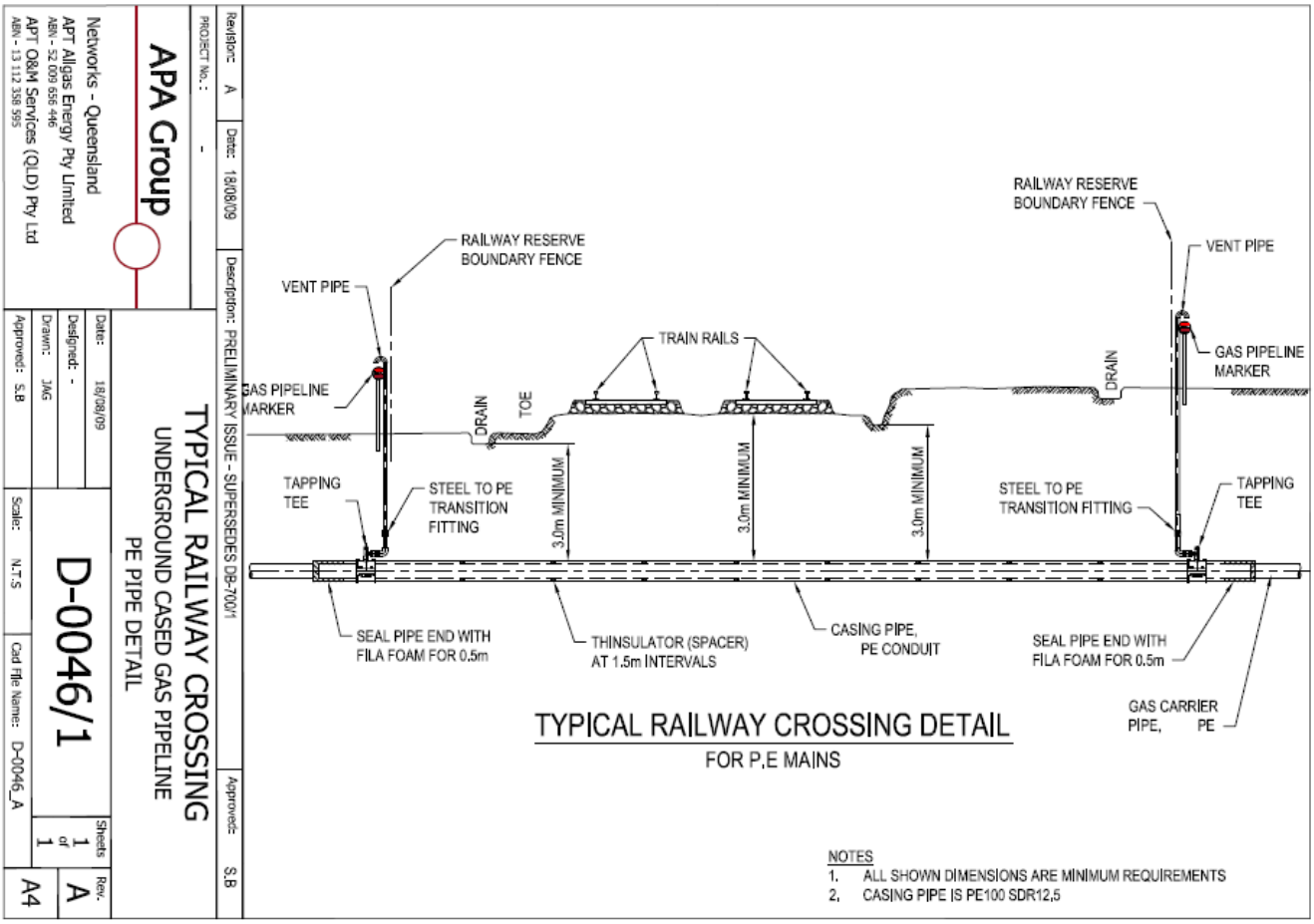
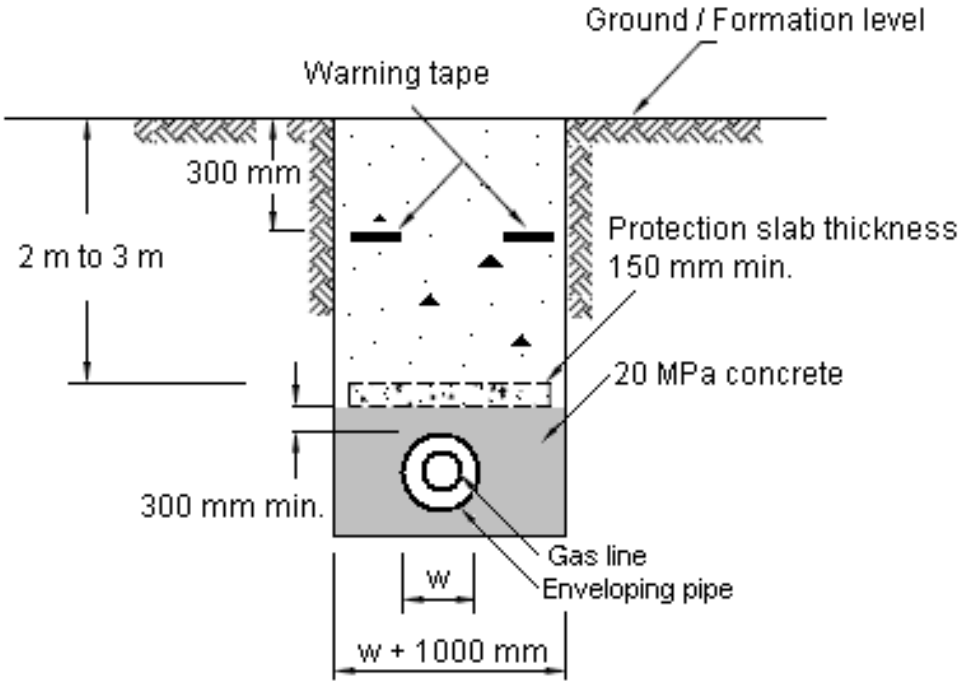
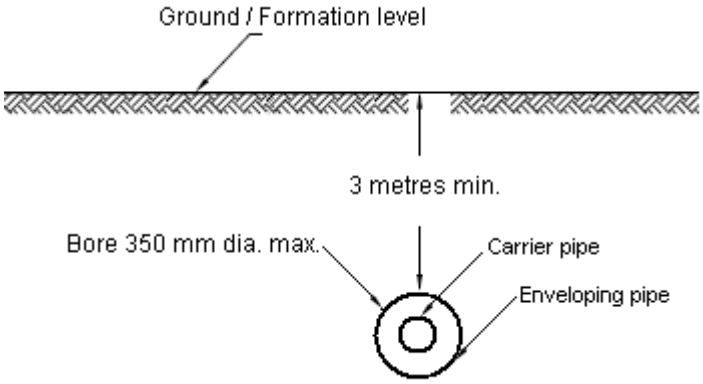


Figure 3: Enveloping Pipe and Venting Arrangement- Underground Gas Pipeline
Courtesy of APA Group



Installation in a Trench
(section through trench)



Installation by All Non-trenching Methods
(section through bore)

Figure 4: Vertical Sections Showing Gas Line Under the Railway Corridor

Steel Gas Carrier Pipe

Steel pipes are generally used for the carriage of high pressure gas. These installations may or may not be designed to use an enveloping pipe. Typically, an enveloping pipe could be a fully grouted (inside and outside) Class 4 concrete pipe. For pipelines without an enveloping pipe, the protective coating needs to provide greater protection from corrosion and abrasion than if an enveloping pipe had been used.

Steel gas pipelines must be designed, constructed and maintained in accordance with AS 4799, as well as AS 2885 or AS 4645, as applicable. The steel carrier pipe's strength, wall thickness and depth are to be sufficient to resist all expected stresses, including internal gas pressure, bending stress during installation, and the worst case for railway and soil loading. The Registered Professional Engineer of Australia (RPEQ) engaged by the pipeline owner is to provide confirmation that the design meets all of these requirements.

As part of the design process for each installation within railway property, the pipeline owner must conduct a risk assessment in accordance with AS 2885. The risk assessment is to document the threats confronting the particular pipeline as it crosses under railway property. It needs to identify the threats, evaluate each threat and analyse the likely consequences. The Rail Infrastructure Manager is to be given the option of attending the risk assessment to ensure that all threats are identified and reduced to acceptable levels. In response to this information, the pipeline owner is to detail and document the design, the physical protection and procedural measures that will be used during and after installation in order to mitigate these threats. A copy of the risk assessment document is to be provided to Queensland Rail.

For services without an enveloping pipe, if additional protection on either side of the tracks is required to ensure safety from future excavator activity because of the site conditions, warning tapes and a concrete protection slab are to be installed in a similar arrangement to Figure 4, but with the following differences. The protection slab and marker board / tape are to be installed above the pipeline between the property boundary and a point 1 m from the ends of the sleepers (both sides of the tracks). The slab would be 800 mm - 1 m below ground level, 1.2 m greater in width than the pipe's diameter, and placed centrally over it.

To provide protection against corrosion, the carrier pipe must have both a durable coating, as well as cathodic protection.

The coating is to be of sufficient thickness and hardness to prevent any damage to the coating during installation. An abrasive resistant protective coating of greater thickness than required by the relevant Australian Standard is required for a carrier pipe installed without an enveloping pipe. Coating continuity tests, e.g. a Jeep / Holiday inspection, are to be performed to identify any defects before installation of the pipe, and again after the pipeline is in place to check whether the coating has been damaged during installation.

The cathodic protection system is to satisfy AS 2832.1. There is to be a test point outside the railway property boundary, adjacent to the gas pipeline marker post.

The pipeline owner must certify (copy to Queensland Rail) that it will conduct regular tests:

- of the cathodic protection, at least every 6 months,
- a leak survey at least every 6 months, and
- regular checks on the integrity of the pipeline.

The pipeline owner is to have protocols in place so that Queensland Rail is advised if the ongoing mitigation measures remain effective. The Rail Infrastructure Manager is to be provided with copies of the results of these tests, surveys and patrols of the crossings. The pipeline owner is to advise Queensland Rail if any actions are necessary to maintain the pipeline's integrity.

If a steel enveloping pipe is to be used, it must be grouted inside and outside, as well as having cathodic protection, in accordance with Section 2.7 *Enveloping Pipe.*

The requirements for the various methods of installation are the same as for "PE Gas Carrier Pipe" above.

2.8 Boreholes below the Water Table

Excavation below the water table can greatly increase the likelihood of subsidence or heave at the surface. In those excavation methods where it is necessary to balance the hydrostatic pressure of the groundwater against the pressurised slurry inside the bore, the risk to track safety is unacceptable and the work must be performed during a track closure.

The service owner must be informed of its liability for injuries and the cost of repairs resulting from any damage to railway property and for any disruption to train services. This cost can be substantial.

The preferred installation method in this situation is pipe ramming, where the spoil is not removed until the enveloping pipe is fully in place. A track closure would not be required.

2.9 On-site QR Involvement

Before work commences, an on-site meeting is to be held between a Queensland Rail representative (usually the Track Maintenance Supervisor) and the contractor. The contractor is to explain all details of the work and also present the Work Method Statement (Track Safety).

The Rail Infrastructure Manager will conduct field audits during the progress of the work to check on compliance with the Work Method Statement (Track Safety).

A Track Protection Officer is required to be on site at all times while the contractor is on Queensland Rail property.

The Rail Infrastructure Maintainer will appoint a track competent person to be on site at all times while undertrack work is being performed under or within 3 m horizontally of the outer edge of the ballast on the railway tracks. The role of the track competent person will be:

- to observe the work,
- to ensure the safety of railway traffic by assessing any changes in the track alignment / level and applying a speed restriction / closure / other formal operational control if required,
- for pipes greater than 600 mm dia., to arrange for inspections of the site while running the road, checking for any changes in the track alignment / level during the week after the completion of work, and
- to arrange for repairs, should any settlement / heave / alignment problems occur in the track.

Undertrack work by the contractor must not proceed unless the track competent person and Track Protection Officer are on site.

The Track Maintenance Supervisor is to inform the local track maintenance gang of the location and timing of the service installation.

Speed restrictions for trains crossing the bore should be applied by the Rail Infrastructure Maintainer during the work according to the following:

- From the time that the excavation reaches a point 3 m horizontally from the outer edge of the ballast on the closest railway track until the work is fully completed, including grouting: 25 km/hr. The support of the bore needs to be complete before this speed restriction is removed. The purpose of this speed restriction is to reduce vibrations and pressure exerted on the bore and the boring equipment, as well as to minimise the damage resulting from a train derailing on misaligned track (heave / subsidence) above the bore.
- A speed restriction of 50 km/hr is to be applied for 24 hrs after completion of the work for pipes greater than 600 mm diameter only. This allows for any delayed settlement or heave as the result of having introduced water to the surrounding soil.
- The above requirements for speed restrictions may be relaxed in exceptional circumstances at the discretion of the Rail Infrastructure Manager based on geotechnical advice that the depth of the service and the material are such that the track alignment will be isolated from any defects occurring in the bore.

2.10 Track Monitoring

The track competent person on site will observe the work and take any appropriate actions to ensure the safety of railway traffic.

The contractor is responsible for engaging a suitably qualified surveyor (registered with the Surveyors' Board) to monitor the alignment and level of each track at the service crossing. For example, if the service passes under four tracks, each track is to be monitored.

The requirements for track monitoring during the work are as follows:

- Survey marks are to be established in pairs on sleepers along each track, one on each side of the rails of each track. The marks need to be on the sleepers closest to the centre-line of the pipe, and then at 2 m, 5 m, 8 m and 10 m away from the pipe in both directions along each track.
- Prior to the start of excavations, the surveyor must take the datum readings for alignment and level.
- While the bore is under and within 3 m horizontally of the track ballast, the surveyor must take readings between 15 and 40 minutes prior to the passage of every train across the bore.
- Readings need to be taken using a Total Station surveying instrument (for alignment and level) and / or a Spirit Level (for level). The surveyor must check the results immediately against the datum readings.
- Any deviation from the datum must be reported to the track competent person immediately, so that they can assess the situation and implement any necessary actions to protect railway traffic.
- If the track competent person is not on site and a deviation from the datum in excess of 15 mm is observed, this must be reported by telephone / radio to Queensland Rail Control immediately with a request to stop trains running through the site. Excavation work must also stop. Trains and excavation are not to resume until the situation has been assessed by a track competent person and the required actions have been completed.
- After remedial works to track / formation / drainage have been performed, further monitoring of the situation will be required until all movement has stabilised.

Monitoring by the contractor is to be continued after the completion of the work in case of settlement or lift in the following situations:

- pipes greater than 600 mm dia. (all installation methods),
- all directional drilling and micro-tunnelling installations (all pipe diameters) where the bore has passed through expansive clays. The contractor is to advise the Rail infrastructure Manager of the presence of this type of clay.

Readings are to be taken after each of the next three trains, at the end of the next day, and then after another 2 days.

2.11 Permanent Markers

The Contractor is to provide permanent markers at Queensland Rail's property boundaries directly above the service as described in AS 4799. These markers will remain the property of the service owner and it will be their responsibility to maintain them in good condition and to make any replacements as required.

The Rail Infrastructure Manager will:

- Check the installation of the markers,
- Maintain a register of the locations and nature of all services under Queensland Rail's property for its own use, and
- Conduct future regular inspections in accordance with the Civil Engineering Structures Standard MD-10-586.

2.12 As Constructed Drawings

As constructed plan and section drawings (in electronic pdf format), showing the vertical and horizontal alignment of the service in relation to the ground surface, railway track and all infrastructure within approx. 10 m of the service, as well as the railway km and line (e.g. 610.450 km Western Line), shall be submitted to Queensland Rail's Property Section within 30 working days after practical completion of the service installation for permanent storage.

3 METHODS OF INSTALLATION

3.1 Directional Drilling

The process of directional drilling involves a number of drilling and reaming runs before the enveloping pipe is installed in the bore. A pilot hole is first drilled from the entry pit to the exit pit. This is followed by a number of cuts with reamers of increasing size until the final diameter is reached. The enveloping pipe with a diameter smaller than the bore is then pulled through the bore. At the completion of the work, the annulus between the enveloping pipe and the bore remains filled with a clay slurry. If a drilling / reaming run is interrupted for more than 2 days before running the full length of the bore, precautions must be taken to prevent the equipment from seizing in the bore.

During drilling, reaming and pipe installation, a specially designed slurry is pumped at high pressure through the drill pipes to the cutting head, from where it is forced back along the outside of the pipes, thereby clearing away the cuttings and providing some support to the bore. A potential problem exists if the bore becomes suddenly obstructed and the slurry pressure rises rapidly. The slurry either lifts the ground surface (including the track) or it breaks through to the surface in a fissure. Because of this problem and the serious implications for railway traffic, directional drilling requires strict operational controls.

It should be noted that certain soil types, e.g. clays, appear to be more prone to lifting of the surface. From Queensland Rail's experience, it is clear that this can occur despite reasonable controls and vigilance on the part of the operator of the equipment. Consequently, for directional drilling it is expected that track alignment problems will occasionally occur. To control the consequences and prevent derailments, it is imperative that track monitoring procedures and the requirements of Section 2.10 are fully in place.

At all times during the work, the contractor must remain vigilant to the slurry and water pressures and the return flow from the bore to ensure that the bore remains clear. The pressure must not be allowed to increase to a level which will cause track heave.

AS 4799 does not cover the specific requirements for this type of work.

The following special conditions shall apply:

- Only pipes with a diameter up to and including 250 mm (max. hole dia. 350 mm) are permitted to be installed using directional drilling. This value has been set as larger diameter bores have an increased potential to cause surface heave if a blockage should occur. Larger pipes are to be installed by boring and pipe jacking, micro-tunnelling, pipe ramming or trenching as approved by the Rail Infrastructure Manager.
- Under the track and within 3 m horizontally of the outer edge of the track ballast, the minimum depth of the top of the bore is to be 3 m below the top of railway formation (underside of ballast). This value has been set in an attempt to limit the amount of surface heave if a blockage should occur. This depth restriction may be relaxed in exceptional circumstances at the discretion of the Rail Infrastructure Manager if specific site conditions and service arrangements make this requirement impractical.
- From the Queensland Rail boundary to 3 m horizontally from the outer edge of the track ballast, the minimum depth of the top of the bore will be 2 m below ground surface level. This is to minimise restrictions on the future use of the railway corridor.
- To reduce the possibility of track lift as a result of an undesirable increase in slurry / mud pressure, the pump equipment should have fitted an automatic cut-off device which will shut off the pump immediately a pre-determined increase in the slurry pressure is reached. An expert's recommendation for this cut-off pressure and the contractor's confirmation that the chosen pressure has been set are to be provided to the Rail Infrastructure Manager before drilling commences. The contractor should also provide evidence that the cut-off device has been calibrated and is in sound functioning condition.
- The contractor is to provide Queensland Rail with a Work Method Statement (Track Safety) including:
    - Plan and longitudinal section showing location (horizontally and vertically) of other services and railway corridor infrastructure within approx. 10 m of the proposed service.

Information to be shown typically includes property boundaries, railway tracks, culverts, bridge piers, buildings and footings for masts. The locations of the entry and exit pits, the proposed pipe alignment and the depths of the service below the ground and formation levels, as well as horizontal clearances to the nearest existing services and structures are to be shown.

- Copy of the geotechnical recommendations as they relate to possible surface heave / subsidence problems associated with the soil type.
- The work process including controls, process monitoring and the automatic slurry cut-off pressure. This pressure is to be determined and certified by a qualified and experienced expert competent in this field, as determined appropriate for the geotechnical site conditions.
- Establishment arrangements.
- Survey arrangements to establish the bore alignment.
- Identification of the risks and methods of control for possible problems that could cause interference to the railway track (lifting / settlement / change of alignment).
- Track monitoring procedures to detect lifting / settlement / change of alignment.

These points should be addressed briefly in a single document. One copy will need to be provided to Queensland Rail's Property Section for assessment as part of the application and a second copy provided to the Track Maintenance Supervisor at the pre-start meeting.

- The directional drilling, reaming and pipe installation work under the track formation must be performed during certain hours set by the Rail Infrastructure Manager. This will avoid peak railway traffic times. In suburban areas, the available time during daylight hours would be typically 9:30 am – 2:30 pm. Night works between the afternoon and morning peak periods may be possible, subject to the availability of staff and the noise impact on neighbours.
- Directional drilling work is to stop temporarily while a train is crossing the bore site. Notification of train arrival times will be communicated to all on-site staff by the Track Protection Officer.

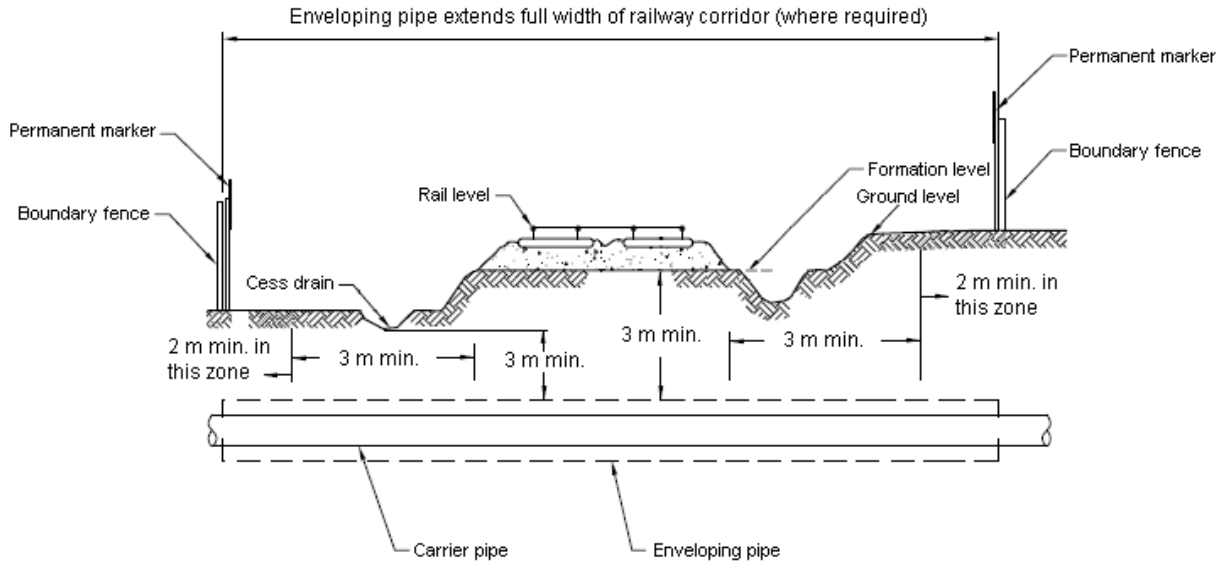


Figure 5: Cross-section Showing Service Pipe Under the Railway Corridor Installation by directional drilling

3.2 Pipe Jacking / Tunnel Boring / Micro-tunnelling

The term "pipe jacking" covers a number of excavation methods, including "tunnel boring" and "micro-tunnelling". All generally involve making a bore using a cutting head and shield attached to an enveloping pipe, which is pushed forward by hydraulic jacks. This means that the bore is always supported. Additional pipes are lowered into the entry pit and joined to the previous pipe. The excavation and jacking process is then continued. The process leaves a negligible gap between the bore and the outside of the enveloping pipe. "Micro-tunnelling" is a method of excavation used for the smaller diameter pipe jacking work. "Tunnel boring" is another method of excavation which uses a

shield and a rotating cutting head. There are numerous variations on these methods, but they can be considered in the same way with regards to railway operations.

There are a variety of different cutting heads, face support, excavation and spoil removal methods used, depending on the ground conditions. Steering of the excavation can be achieved by such means as laser and computer guidance for the shield. It is important that suitable equipment and methods are used to control the stability of the face of the tunnel, particularly in unstable ground.

AS 4799 covers the minimum requirements for this type of work. However, the following special conditions shall also apply:

- Pipes of any diameter may be installed using pipe jacking / tunnel boring / micro-tunnelling.
- The minimum allowable depth of the top of the bore below both the top of the railway formation (underside of ballast) and the ground surface level depends on the type of service and whether a suitable impact resistant enveloping pipe is used. See Section 2.7. This is to minimise restrictions on the future use of the railway corridor. The depth restrictions may be relaxed in exceptional circumstances at the discretion of the Rail Infrastructure Manager if specific site conditions and service arrangements make this requirement impractical.
- The contractor is to provide Queensland Rail with a Work Method Statement (Track Safety) including:
    - Plan and longitudinal section showing location (horizontally and vertically) of other services and railway corridor infrastructure within approx. 10 m of the proposed service. Information to be shown typically includes property boundaries, railway tracks, culverts, bridge piers, buildings and footings for masts. The locations of the entry and exit pits, the proposed pipe alignment and the depths of the service below the ground and formation levels, as well as horizontal clearances to the nearest existing services and structures are to be shown.
    - Copy of the geotechnical recommendations as they relate to possible surface heave / subsidence problems associated with the soil type.
    - The work process including controls and process monitoring.
    - Establishment arrangements.
    - Survey arrangements to establish the bore alignment.
    - Identification of the risks and methods of control for possible problems that could cause interference to the railway track (lifting / settlement / change of alignment).
    - Track monitoring procedures to detect lifting / settlement / change of alignment.

  These points should be addressed briefly in a single document. One copy will need to be provided to Queensland Rail's Property Section for assessment as part of the application and a second copy provided to the Track Maintenance Supervisor at the pre-start meeting.
- The boring and pipe jacking work under the track formation must be performed during certain hours set by Queensland Rail. This will avoid peak railway traffic times. In suburban areas, the available time during daylight hours would be typically 9:30 am – 2:30 pm. Night works between the afternoon and morning peak periods may be possible, subject to the availability of staff and the noise impact on neighbours.
- Boring / pipe jacking is to stop temporarily while a train is crossing the bore site. Notification of train arrival times will be communicated to all on-site staff by the Track Protection Officer.
- The enveloping pipe must be installed to the full extent of the bored length prior to the passage of every train across the bore site.
- A cementitious grout (5 MPa) is to be pressure injected into the annular space between the outer surface of the enveloping pipe and the bored hole. This work is to be done between trains. A requirement for internal grouting between the carrier pipe and the enveloping pipe will be determined for each case.

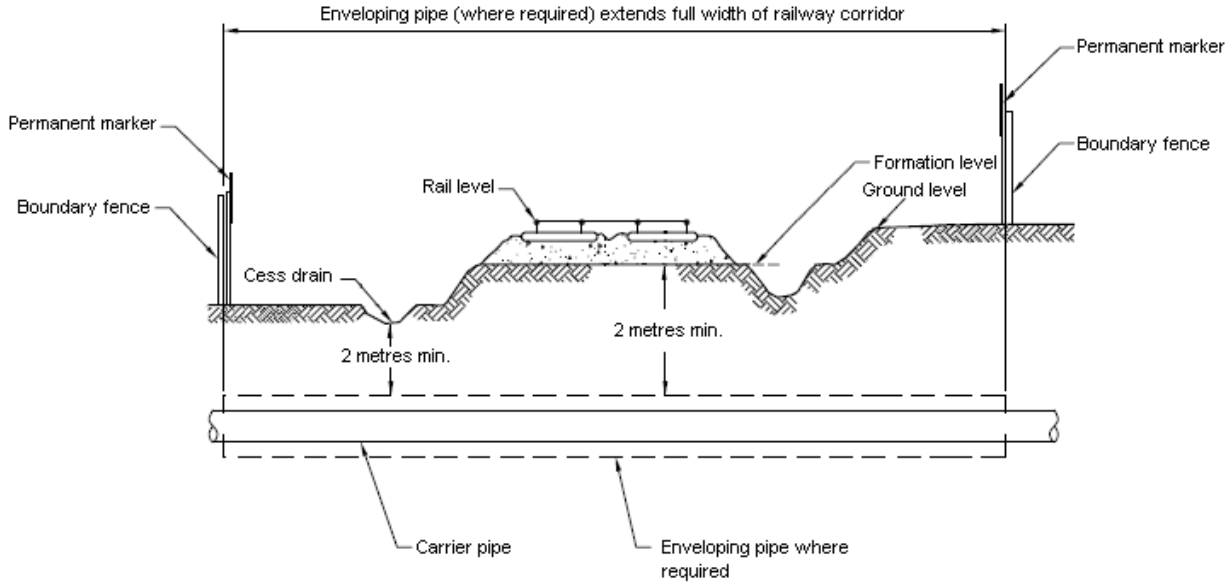


Figure 6: Cross-section Showing Service Pipe Under the Railway Corridor Installation by pipe jacking / tunnel boring / micro-tunnelling / pipe ramming

3.3 Pipe Ramming

The process of pipe ramming involves direct driving of a steel enveloping pipe in a similar fashion to pile driving. Additional pipes are lowered into the entry pit and welded / attached to the previous pipe. The ramming process is then continued. The spoil within the pipe is only removed once the pipe is fully in place with the use of compressed air and / or water or an auger. There is no gap between the outside of the enveloping pipe and the surrounding soil. This method is preferred because water and pressurised slurries are not used during installation of the enveloping pipe and do not come into contact with the surrounding soil. Soil disturbance around the pipe is minimised, with no ground heave / settlement occurring during / after installation.

AS 4799 does not cover the specific requirements for this type of work. The following special conditions shall apply:

- Pipes of any diameter may be installed using pipe ramming.
- The minimum allowable depth of the top of the bore below both the top of the railway formation (underside of ballast) and the ground surface level depends on the type of service. The pipe being rammed as part of this method would be considered to be a suitable impact resistant enveloping pipe. See Section 2.7. This is to minimise restrictions on the future use of the railway corridor. This depth restriction may be relaxed in exceptional circumstances at the discretion of the Rail Infrastructure Manager if specific site conditions and service arrangements make this requirement impractical.
- The contractor is to provide Queensland Rail with a Work Method Statement (Track Safety) including:
    - Plan and longitudinal section showing location (horizontally and vertically) of other services and railway corridor infrastructure within approx. 10 m of the proposed service. Information to be shown typically includes property boundaries, railway tracks, culverts, bridge piers, buildings and footings for masts. The locations of the entry and exit pits, the proposed pipe alignment and the depths of the service below the ground and formation levels, as well as horizontal clearances to the nearest existing services and structures are to be shown.
    - The work process including controls and process monitoring.
    - Establishment arrangements.
    - Survey arrangements to establish the bore alignment.
    - Identification of the risks and methods of control for possible problems that could cause interference to the railway track (lifting / settlement / change of alignment).

- Track monitoring procedures to detect lifting / settlement / change of alignment.

These points should be addressed briefly in a single document. One copy will need to be provided to Queensland Rail's Property Section for assessment as part of the application and a second copy provided to the Track Maintenance Supervisor at the pre-start meeting.

- The pipe ramming work under the track formation must be performed during certain hours set by the Rail Infrastructure Manager. As there is never any unsupported material in this method, and consequently no danger of surface heave or subsidence, it is not necessary to avoid work during peak railway traffic times. Night works may be possible subject to the availability of staff and the noise impact on neighbours.
- Pipe ramming can continue while trains are crossing the bore site and there is no need to impose a speed restriction.
- The requirement for internal grouting between the carrier pipe and the enveloping pipe will be determined for each case.

3.4 Trenching

Trenching under the tracks is the least preferred method (most expensive and time consuming) and will only be permitted by the Rail Infrastructure Manager if all other methods are shown to be impractical. It involves the excavation of a trench across Queensland Rail's property and under the tracks, causing disturbance to the formation, ballast and track. Normally, excavation under the track would be done during a track closure, but if this is not possible, the use of track supports would be necessary. It may lend itself to low traffic lines where the equipment for other methods is not readily available

However, for services running parallel to the property boundary (not under the tracks), it could be a viable alternative for particular services and with specialised installation equipment. Special consideration would need to be given to the circumstances for its use.

When trenching under overhead traction wiring, an isolation will be required, as well as special methods for installing the shoring, as no equipment, e.g. crane, is to come within the electrical exclusion zone.

All Queensland Rail's costs related to trenching are to be paid by the service owner. In addition to the cost of a track closure, these include the following work which would be performed by Queensland Rail's staff:

- removal and replacement of the track components,
- removal, replacement and compaction of the ballast, and
- the provision of temporary track supports (if required).

AS 4799 covers the minimum requirements for this type of work with the following modification. After the service has been placed in the trench, it will be necessary to backfill with fine crushed rock, sand, gravel, lean mix concrete or other material approved by the Rail Infrastructure Manager. The backfill is to be compacted to 90% of the maximum dry density (Modified Compaction Test) up to 600 mm below formation level. The top 600 mm is to be compacted to 95% of the maximum dry density (Modified Compaction Test). This is to be in accordance with AS 1289.E2.1.

The following special conditions shall also apply:

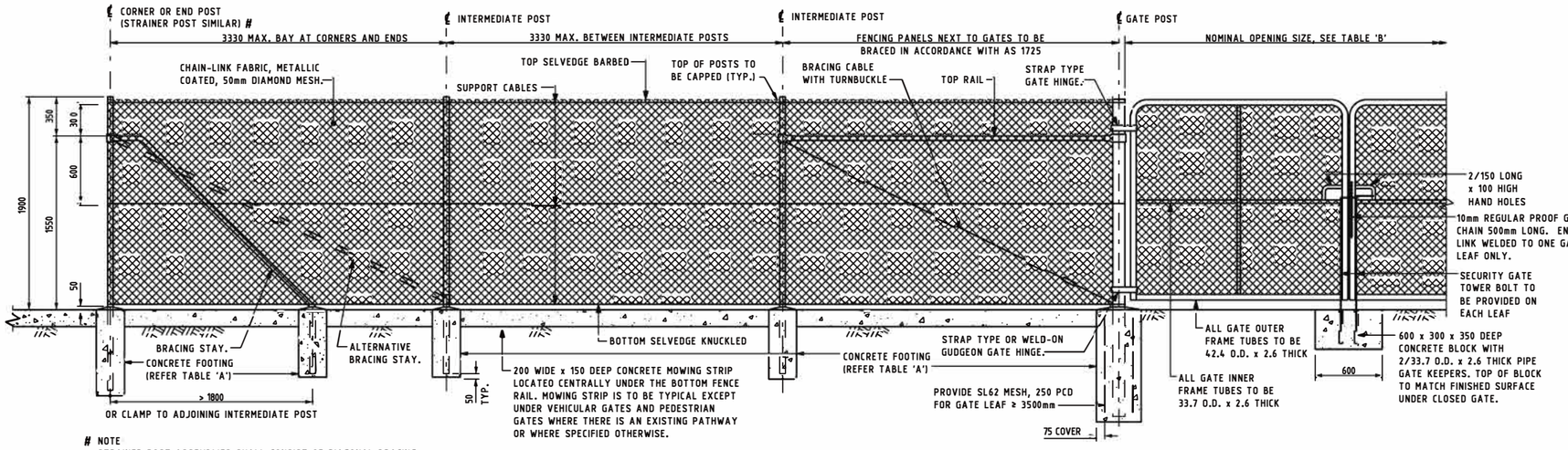
- Pipes of any diameter may be installed using trenching.
- The minimum allowable depth of the top of the bore below both the top of the railway formation (underside of ballast) and the ground surface level depends on the type of service and whether a suitable impact resistant enveloping pipe or concrete protection slab is used. See Section 2.7. This is to minimise restrictions on the future use of the railway corridor. This depth restriction may be relaxed in exceptional circumstances at the discretion of the Rail Infrastructure Manager if specific site conditions and service arrangements make this requirement impractical.
- The contractor is to provide Queensland Rail with a Work Method Statement (Track Safety) including:
    - Plan and longitudinal section showing location (horizontally and vertically) of other services and railway corridor infrastructure within approx. 10 m of the proposed service. Information to be shown typically includes property boundaries, railway tracks, culverts,

bridge piers, buildings and footings for masts. The proposed pipe alignment and depths below the ground and formation level, as well as horizontal clearances to the nearest existing services and structures are to be shown.
- The work process including controls and process monitoring.
- Establishment arrangements.
- Survey arrangements to establish the bore alignment.
- Identification of the risks and methods of control for possible problems that could cause interference to the railway track (settlement / change of alignment).
- Track monitoring procedures to detect settlement / change of alignment.

These points should be addressed briefly in a single document. One copy will need to be provided to Queensland Rail's Property Section for assessment as part of the application and a second copy provided to the Track Maintenance Supervisor at the pre-start meeting.

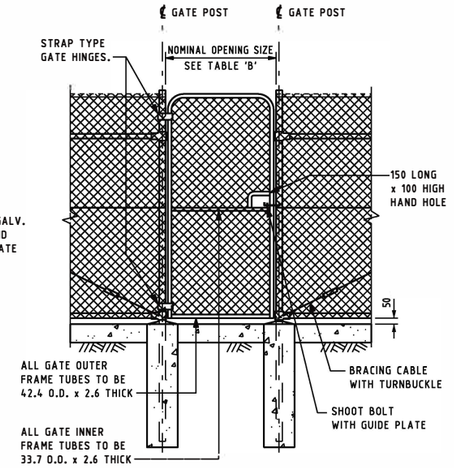
- The trenching work under Queensland Rail's property must be performed during certain hours set by Queensland Rail. This may be during a track closure or between trains and under traffic. Night works may be possible subject to the availability of staff and the noise impact on neighbours.

Excavations will cease while a train is crossing the site. Notification of train arrival times will be communicated to all on-site staff by the Track Protection Officer.



TYPICAL ELEVATION

SCALE 1 : 25

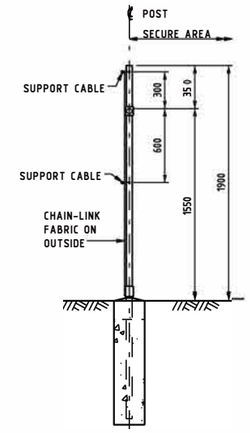


DOUBLE LEAF GATE

SCALE 1 : 25

SINGLE LEAF GATE

SCALE 1 : 25



TYPICAL SECTION

SCALE 1 : 25

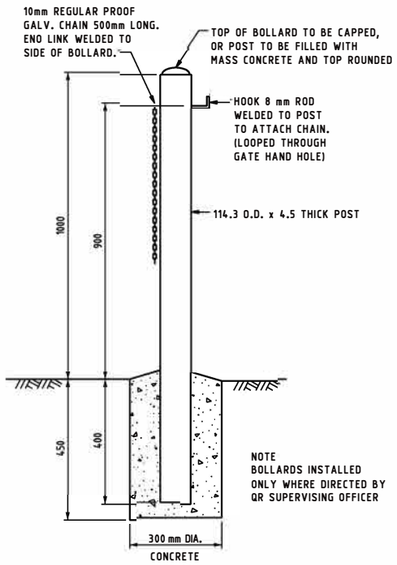
NOTE
STRAINER POST ASSEMBLIES SHALL CONSIST OF DIAGONAL BRACING STAYS EACH SIDE OF POST AS SHOWN ON CORNER POST DETAIL. STRAINER POSTS SHALL BE INSTALLED AT 150m MAXIMUM INTERVALS ON STRAIGHT LENGTHS AND AT ANY SIGNIFICANT CHANGES IN DIRECTION IN ACCORDANCE WITH AS 1725.

PLANS AND DOCUMENTS referred to in the REFERRAL AGENCY RESPONSE

Queensland Government

SARA ref: 1910-13906 SRA

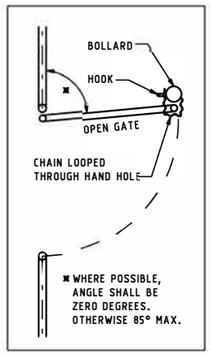
Date: 12 February 2020



NOTE
BOLLARDS INSTALLED ONLY WHERE DIRECTED BY QR SUPERVISING OFFICER

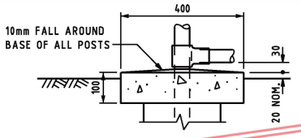
BOLLARD DETAIL

SCALE 1 : 10



BOLLARD LOCATION RELATIVE TO GATE

N.T.S.

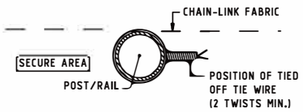


NOTE REFER "ORDERING CONSIDERATIONS".
MOWING STRIP SHALL NOT BE INSTALLED UNDER GATES.

NOTE
THE PURPOSE OF THIS DRAWING IS TO PROVIDE TYPICAL STANDARD DETAILS. THE SUITABILITY OF THIS DRAWING SHALL BE DETERMINED AND CERTIFIED BY A RPEQ ENGINEER FOR THE SPECIFIC PROJECT.

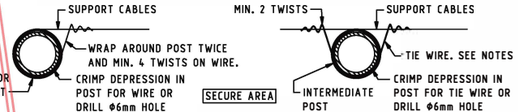
MOWING STRIP

SCALE 1 : 10



CHAIN-LINK FABRIC TIE-OFF DETAIL

N.T.S.



TIE-OFF DETAIL AT CORNER, END OR STRAINER POSTS

N.T.S.

TIE-OFF DETAIL AT INTERMEDIATE POSTS

N.T.S.

ORDERING CONSIDERATIONS

MOWING STRIP	ALWAYS INSTALLED UNLESS SPECIFIED OTHERWISE BY QUEENSLAND RAIL. SIZE OF MOWING STRIP CAN BE MODIFIED TO SUIT SITE SPECIFIC REQUIREMENTS.
PLASTIC COATING	NOT PROVIDED UNLESS SPECIFIED BY QUEENSLAND RAIL INFRASTRUCTURE OWNER. COST SHARING OPTIONS MAY BE NEGOTIATED WHERE ADJOINING OWNERS MAKE SPECIFIC REQUEST FOR PROVISION OF PLASTIC COATED CHAIN-LINK FABRIC. COATING COLOUR PREFERENCE (BLACK OR GREEN) TO BE CONFIRMED WITH QUEENSLAND RAIL INFRASTRUCTURE OWNER AND ADJOINING OWNER.
"LIGHT DUTY" (2.5mm) CHAIN LINK FABRIC	"HEAVY DUTY" (3.15mm) FABRIC MAY BE REPLACED WITH "LIGHT DUTY" (2.5mm) FABRIC ONLY WHERE SPECIFIED BY QUEENSLAND RAIL INFRASTRUCTURE OWNER. NOTE "LIGHT DUTY" CHAIN-LINK FABRIC PROVIDES FOR ONLY APPROX. 60% OF THE LOAD BEARING CAPACITY OF "HEAVY DUTY" CHAIN-LINK FABRIC.

TABLE 'A'

FENCE MEMBERS AND FOOTINGS SIZES		
TYPE OF MEMBER	**TUBE SIZE**	**CONCRETE FOOTING**
END, CORNER AND STRAINER POSTS	60.3 O.D. x 3.6 THICK	Φ250 x 750 DEEP
INTERMEDIATE POSTS	48.3 O.D. x 3.2 THICK	Φ250 x 600 DEEP
TOP RAIL	42.4 O.D. x 3.2 THICK	-
BRACING STAY	42.4 O.D. x 3.2 THICK	Φ250 x 600 DEEP
GATE POSTS FOR GATE LEAF SHOWN		
1800mm AND UNDER	60.3 O.D. x 3.6 THICK	Φ250 x 900 DEEP
2000 UP TO AND INCLUDING 3000mm	88.9 O.D. x 4.0 THICK	Φ300 x 1000 DEEP
3500 UP TO AND INCLUDING 4000mm	114.3 O.D. x 4.5 THICK	Φ400 x 1100 DEEP

TABLE 'B'

GATE TABLE		
LOCATION	**NOMINAL OPENING SIZE**	**LEAF TYPE (NOMINAL SIZE)**
PEDESTRIAN - PUBLIC ACCESS	1800	SINGLE 1800 OR DOUBLE 900
PEDESTRIAN - QUEENSLAND RAIL STAFF ONLY	1200	SINGLE 1200
VEHICULAR	3000 MIN. 8000 MAX.	DOUBLE 1500 (MIN.) DOUBLE 4000 (MAX.)

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS NOTED OTHERWISE.
2. ALL STEEL PLATES SHALL BE GRADE 250 MIN. IN ACCORDANCE WITH AS/NZS 3678.
3. ALL WELDS SHALL BE 5mm CONTINUOUS FILLET WELDS UNLESS NOTED.
4. ALL WELDS SHALL BE IN ACCORDANCE WITH AS 1554.1 WITH ELECTRODES GRADE EXX48 TO AS 1553 UNLESS NOTED OTHERWISE.
5. ALL BOLTS, NUTS SHALL BE HOT DIP GALVANISED IN ACCORDANCE WITH AS/NZS 1214 AND WASHERS TO AS 4680.
6. AREAS WHERE GALVANISING (OR PLASTIC COATING) HAS BEEN REMOVED BY WELDING OR ABRASIONS SHALL BE CLEANED OF FOREIGN MATTER INCLUDING WELDING SLAG AND PAINTED WITH TWO COATS OF AN APPROVED ORGANIC ZINC-RICH PAINT TO PROVIDE A MIN. DRY FILM THICKNESS OF 0.10mm. COLOUR MATCHING SHALL BE ACHIEVED WHERE DIRECTED BY THE INSPECTOR.
7. CONCRETE SHALL BE GRADE N25 (MIN.).
8. "SL" DENOTES GRADE D500N REINFORCING MESH IN ACCORDANCE WITH AS/NZS 4671.

GATE NOTES

1. GATE FRAME CONFIGURATION, FABRICATION AND INSTALLATION SHALL BE IN ACCORDANCE WITH AS 1725.
2. WHERE STRAP TYPE HINGES ARE USED AT BOTH TOP AND BOTTOM OF GATE, A COLLAR SHALL BE WELDED TO THE GATE FRAME TO PROVIDE A BEARING SURFACE FOR EITHER TOP OR BOTTOM HINGE. BOTH STRAP TYPE AND GUDGEON GATE HINGES SHALL BE WELDED TO GATE POSTS.
3. SINGLE GATES SHALL BE FITTED WITH SHOOT BOLT, DOUBLE GATES SHALL BE FITTED WITH FLAG PIN DROP BOLT AS SHOWN ON THE DRAWING.
4. ALL GATE FRAMES SHALL BE WELDED. FRAMES SHALL BE HOT DIP GALVANISED AFTER FABRICATION IN ACCORDANCE WITH AS/NZS 4680.
5. GATES SHALL BE INSTALLED FOR QUEENSLAND RAIL PURPOSES ONLY. GATES SHALL NOT BE INSTALLED FOR DOMESTIC USE.

FENCING IN ELECTRIFIED AREAS

1. IN GENERAL THESE FENCES ARE SELF EARTHING, HOWEVER, WHERE FENCING IS ERECTED CLOSER THAN 3000mm TO ELECTRIFICATION MASTS OR OTHER ELECTRICALLY BONDED STEELWORK, EARTHING OR INSULATED SECTIONS MAY BE REQUIRED IN ACCORDANCE WITH QUEENSLAND RAIL PRINCIPAL ENGINEER, TRACTION DISTRIBUTION.
2. GATES AND BOLLARDS SHALL BE POSITIONED TO PREVENT AN OPEN GATE FROM COMING WITHIN 3.0m OF ELECTRIFICATION WIRING EQUIPMENT SUPPORTS OR ANY METALWORK CONNECTED TO THEM.
3. SUPPORT CABLES SHALL BE GALVANISED ONLY (NO PLASTIC COATING).

FENCING NOTES

1. ALL POSTS AND RAILS SHALL BE STEEL CIRCULAR HOLLOW SECTION (CHS) GRADE C250 IN ACCORDANCE WITH AS/NZS 1163 "STRUCTURAL STEEL HOLLOW SECTIONS".
2. ALL PIPE CLAMP FITTINGS, GATE HINGES, GATE KEEPERS, etc SHALL BE "DOWNEE" OR AN APPROVED EQUIVALENT.
3. EACH RAIL BETWEEN POSTS SHALL BE A CONTINUOUS LENGTH.
4. ALL TUBES, FITTINGS AND FASTENERS SHALL BE HOT DIP GALVANISED AFTER FABRICATION IN ACCORDANCE WITH AS/NZS 4680.
5. FENCING MATERIALS INCLUDING WIRES, BARBED WIRE (WHERE ORDERED) AND CHAIN-LINK FENCING FABRIC SHALL BE MANUFACTURED IN ACCORDANCE WITH AS 2423 "COATED STEEL WIRE FENCING PRODUCTS".
6. ERECTION SHALL BE IN ACCORDANCE WITH AS 1725 "CHAIN-LINK FABRIC SECURITY FENCES AND GATES", UNLESS NOTED OTHERWISE.
7. FENCING WIRE SHALL BE CONTINUOUS FROM GATE POST TO GATE POST AND BE CONSTRUCTED WITH 1800 mm HIGH CHAIN-LINK FABRIC. CHAIN-LINK FABRIC SHALL BE "HEAVY DUTY", MANUFACTURED FROM 3.15 mm DIA. GALV. CORE WIRE, WITH UNIFORM 50mm DIAMOND MESH. THE TOP SELVEDGE SHALL BE BARBED AND THE BOTTOM SELVEDGE SHALL BE KNUCKLED.
8. SUPPORT CABLES SHALL CONSIST OF 2 x 3.15mm DIA. GALV. CABLE WIRE, TWISTED TOGETHER BETWEEN POSTS, OR 1 x 4mm DIA. GALV. HELICOIL CABLE WIRE HELIX SPIRALLED. SUPPORT CABLES SHALL BE INSTALLED IN ACCORDANCE WITH AS 1725.
9. LACING WIRE SHALL BE 2mm DIA. GALV. WIRE INSTALLED IN ACCORDANCE WITH AS 1725.
10. TIE WIRE TO SECURE CHAIN-LINK FABRIC TO POSTS, AND SECURE SUPPORT CABLES TO INTERMEDIATE POSTS, SHALL BE 2 x 1.57mm DIA. GALV. WIRES, OR 1 x 2mm DIA. GALV. WIRE. TIE WIRE TO SECURE CHAIN-LINK FABRIC TO CABLES SHALL BE 1 x 1.57mm DIA. GALV. WIRE TWISTED TWICE AND NEATLY CUT OFF, OR 2mm DIA. GALV. WIRE NETTING CLIPS. TIE WIRES SHALL BE AND INSTALLED IN ACCORDANCE WITH AS 1725. (SEE ALSO TIE-OFF DETAIL)
11. BRACING CABLES (WITH TURNBUCKLE) SHALL CONSIST OF 2 x 3.15mm DIA. GALV. CORE WIRES TWISTED TOGETHER AND TENSIONED IN CONJUNCTION WITH A GALVANISED 12mm TURNBUCKLE. BRACING CABLES SHALL BE GALVANISED AND INSTALLED IN ACCORDANCE WITH AS 1725.
12. STRAINER ASSEMBLIES SHALL BE INSTALLED AT 150m MAXIMUM CENTRES ON STRAIGHT LENGTHS AND AT SIGNIFICANT CHANGES IN DIRECTION. ALL CORNER AND STRAINER PANELS SHALL HAVE BRACING INSTALLED IN ACCORDANCE WITH AS 1725.
13. BOLLARDS SHALL BE INSTALLED AT GATES TO SECURE OPEN GATE PANELS ONLY WHERE DIRECTED BY QUEENSLAND RAIL INFRASTRUCTURE OWNER. SEE DETAILS THIS DRAWING.
14. IN CORROSIVE ENVIRONMENTS EXTRA GALVANISING SHALL BE PROVIDED FOR POSTS AND/OR PLASTIC COATED MESH (WHERE ORDERED).

THE PURPOSE OF THIS DRAWING IS TO PROVIDE TYPICAL STANDARD DETAILS. THE FITNESS FOR PURPOSE OF THIS DRAWING FOR A SPECIFIC PROJECT SHALL BE DETERMINED AND CERTIFIED BY A RPEQ ENGINEER.

1:10 0 200 400mm

1:25 0 500 1000mm

FILE No	ALTERATIONS				
13/26948	ISSUE	DESCRIPTION	NAME	RPEQ	DATE
SCALES SHOWN ARE FOR AN A1 SIZE ORIGINAL DRAWING					

WIND LOADS
AS/NZS 1170.2 2011
REGION C
WIND SPEED V100 = 56 m/s
TERRAIN CATEGORY 1

DESIGNED	BASED ON STD DGN No. 2544		APPROVED _D. GIBB_ DESIGN ENGINEER 27/08/15 DATE; RPEQ No. 13065
DES CHK			
DRAWN	A. POWER	20.08.15	ISSUE AUTHORISED
DRG CHK	D. GIBB	25.08.15	_G. SMITH_ DISCIPLINE HEAD TRACK & STRUCTURES 26/08/15 DATE

QueenslandRail
ACN 132 181 090

Network - Civil Engineering

STANDARD - FENCING

1.8m HIGH CHAIN LINK SECURITY FENCE

WITHOUT RAILS USING 50mm DIAMOND MESH

GENERAL ARRANGEMENT

DRAWING NUMBER: QR-C-S3230

ISSUE:

LEGEND

- EXISTING CONTOURS (MAJOR) 10.0m INTERVALS
- EXISTING CONTOURS (MINOR) 1.0m INTERVALS
- EXISTING LOT BOUNDARY
- EXISTING EASEMENT BOUNARY
- PROPOSED LOT BOUNDARY
- PROPOSED EASEMENT BOUNDARY
- PROPOSED SITE BOUNDARY
- EXISTING SEWERAGE RETICULATION ALIGNMENT (SIZES SHOWN)
- EXISTING STORMWATER RETICULATION ALIGNMENT (SIZES SHOWN)
- PROPOSED EDGE OF PAVEMENT
- EXISTING EDGE OF PAVEMENT
- PROPOSED TYPE 1 - BARRIER KERB AND CHANNEL (REFER TO CMDG STANDARD DWG CMDG-R-060)
- PROPOSED STORMWATER RETICULATION ALIGNMENT (SIZES TO BE CONFIRMED IN DETAIL DESIGN)
- PROPOSED SEALED PAVEMENT AREA (TO BE CONFIRMED IN DETAIL DESIGN)
- EXISTING SEWER MANHOLE
- EXISTING STORMWATER PIT
- PROPOSED STORMWATER PIT (SIZES TO BE CONFIRMED IN DETAIL DESIGN)

KNIGHT STREET

PRIME MOVER AND SEMI TRAILER SWEPT PATH (REFER VEHICLE DETAILS)

DOWLING STREET

HORACE STREET

PROPOSED TYPE 1 - BARRIER KERB AND CHANNEL

PROPOSED TYPE 1 - BARRIER KERB AND CHANNEL

8.0m WIDE LANDSCAPE BUFFER

STORMWATER DETENTION BASIN
BASIN IL:7.80m APPROX

CONSTRUCT 12m WIDE REINFORCED CONCRETE DRIVEWAY CROSSING INTO LOT 12 IN ACCORDANCE WITH CMDG STANDARD DRAWING CMDG-R-042

12.0m

EXISTING SEWERAGE EASEMENT 4.0m WIDE

SEWERAGE EASEMENT 3.0m WIDE

EXISTING RAIL LEVEL CROSSING TO REMAIN. NEW PAVEMENT IS TO TRANSITION SMOOTHLY TO EXISTING FORMATION.

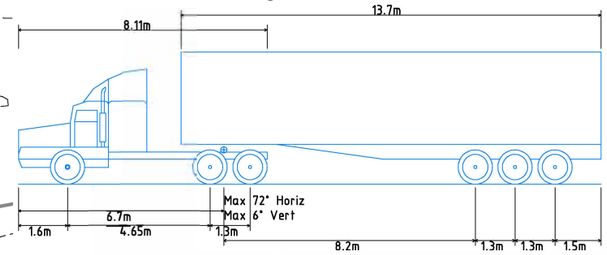
RAILWAY CORRIDOR

LOT 13
23373m²

LOT 12
5811m²

RAILWAY CORRIDOR

JOINS PLAN 0591819-SK-0002



OVERALL LENGTH	19.000m
OVERALL WIDTH	2.500m
OVERALL BODY HEIGHT	4.300m
MIN BODY GROUND CLEARANCE	0.540m
TRACK WIDTH	2.500m
LOCK-TO-LOCK TIME	6.00s
CURB TO CURB TURNING RADIUS	12.500m

PRIME MOVER AND SEMI-TRAILER (19m)
SCALE: 1:100(A1) 1:200(A3)

PLANS AND DOCUMENTS referred to in the REFERRAL AGENCY RESPONSE

SARA ref: 1910-13906 SRA

Date: 12 February 2020

10 0 10 20 30 40 50m
SCALE 1:500 @ A1 SCALE 1:1 000 @ A3

LAYOUT PLAN
SCALE: 1:500(A1) 1:1000(A3)

FOR INFORMATION ONLY

REV	DATE	REVISION DESCRIPTION	DRAFT	DESIGN
C	24.01.2020	AMENDED CHANGES AS PER ROCKHAMPTON REGIONAL COUNCIL INFORMATION REQUEST	RPC	PDM
B	27.06.2019	LOT LAYOUT AMENDED AS PER CLIENT REQUEST	PDM	PDM
A		SUBMITTED FOR INFORMATION	PDM	PDM

SURVEYOR
ADDRESS:
CO-ORDINATE DATUM
HEIGHT DATUM

REVIEWED BY DATE
RPEQ ENG
RPEQ No:

CLIENT: AURIZON

SCALE: AS SHOWN

PREPARED BY 0591819
mcmurtrie CONSULTING ENGINEERS
Address: 63 Charles Street NORTH ROCKHAMPTON QLD 4701
Postal: PO BOX 2149, WANDAL QLD 4700
E-mail: mail@mcmengineers.com
Phone: (07) 4921 1780
Mobile: 0407 631 066
Fax: (07) 4921 1790

CLIENT AURIZON
PROJECT 33-53 KNIGHT STREET INDUSTRIAL SUBDIVISION
TITLE GENERAL CONCEPT LOT LAYOUT

A1
DRAWING NUMBER 0591819-SK-0003
REVISION C

DRAWING LOCATION: S:\PROJECT RECORDS\18-19\0591-18-19\ACAD\DRAWINGS\[SHEET SETS, INDIVIDUAL DRAWINGS]\SHEET SETS\SHEETS\0003 - CONCEPT LOT LAYOUT.DWG
PLOT DATE: 24/01/2020 10:28:37 AM

mcmurtrie
CONSULTING ENGINEERS

Stormwater Management Plan

Low Impact Industrial Development
33-53 Knight Street, Park Avenue, Rockhampton

Prepared For: AURIZON Pty Ltd

Job No. 059-18-19
24 January 2020
Revision C

ABN 69 958 286 371
P (07) 4921 1780
F (07) 4921 1790
E mail@mcmengineers.com

PO Box 2149
Wandal Q 4700
63 Charles Street
North Rockhampton Q 4701

Stormwater Management Plan

Rev.	Description	Signature	RPEQ No	Date
C	Amended to include Council IR (D/95-2019) items response		5141	24.01.20
B	Issued For Approval		5141	04.09.19
A	Issued For Client Comment		5141	30.08.19

CONTENTS

Stormwater Management Plan

Low Impact Industrial Development

1.0 INTRODUCTION AND APPROACH

1.1. PROJECT OVERVIEW

McMurtrie Consulting Engineers (MCE) have been commissioned by Aurizon Pty Ltd to undertake a site based Stormwater Management Plan (SMP) for a proposed low impact industrial subdivision. The site is located at 33-53 Knight Street, Park Avenue on Lots 2 and 3 on RP611882 and Lot 4 on SP134379.

The aim of this SMP is to demonstrate that the proposed development will comply with Capricorn Municipal Development Guidelines (CMDG), Queensland Urban Drainage Manual (QUDM 2016), Australian Rainfall and Runoff 2016 (ARR'16) and State Planning Policy (SPP 2017).

1.2. METHODOLOGY

The assessment methodology adopted for this SMP is summarised below.

- Broadly identify the contributing catchments to the project.
- Identify Lawful Point of Discharge (LPOD) for the site stormwater runoff.
- Identify the critical storm events and duration for this project
- Estimate peak discharge runoff for pre-development and post-development scenarios.
- Identify potential mitigation and management strategies to ensure no worsening to downstream catchments and infrastructure.
- Assess the stormwater quality treatment requirements for the project.

1.3. DATA SOURCES

The background data used to undertake this assessment were collected from the following sources:

- ARR'16 data hub
    - Rainfall data
    - Design storm ensemble temporal patterns
- Rockhampton Regional Council GIS data
- Preliminary overall layout plan (completed by Veris)
- Pluviograph rainfall data for the 'Rockhampton Aero' station

2.0 SITE CHARCTERISTICS

2.1. SITE LOCATION

The site is located at 33-53 Knight Street, Park Avenue on Lots 2 and 3 on RP611882 and Lot 4 on SP134379 at 33-53 Knight Street, Park Avenue, Rockhampton. Site details have been summarised within Table 1. The proposed site is located as per **Figure 1** below.

Table 1: Site Description

Registered Owner	Property and Location	
	Lot and Property Description	Address
Aurizon Pty Ltd	Lots 2 and 3 on RP611882 and Lot 4 on SP134379	33-53 Knight Street, Park Avenue, Rockhampton

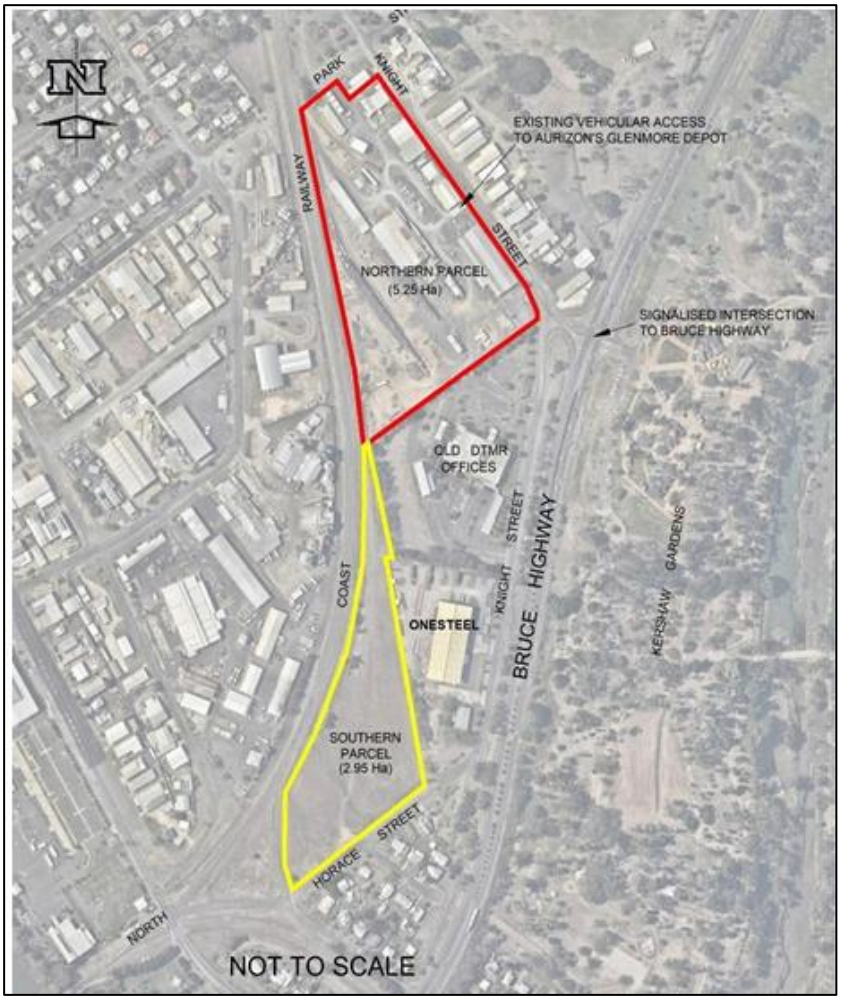


Figure 1: Site Location

The proposed development site is located in the Park Avenue area within the Rockhampton Regional Council Local Government Area. The site is approximately 8.2 ha in size and is divided into 2 distinct areas, being:

- Northern parcel – Approx. 5.25 ha (Shown RED in **Figure 1**)
  Containing Lots 2 & 3 on RP 611882 & part Lot 4 on SP 134379 (northern parcel)
- Southern parcel – Approx. 2.95 ha (Shown YELLOW in **Figure 1**)
  Containing part Lot 4 on SP 134379 (southern parcel)

2.2. TOPOGRAPHY

2.2.1. NORTHERN PARCEL

The northern area (outlined in RED) is presently occupied by Aurizon's Glenmore Depot with numerous fabrication and maintenance sheds, hardstand areas, rail siding lines and vehicular access roadways. The site is bounded on the west by north coast rail corridor, the north by Park Street, the east by Knight Street and the south by the Queensland Department of Transport and Main Roads (DTMR) Regional Offices for the Fitzroy District. Typically, existing ground levels across the northern parcel are at RL13. See **Appendix A** for details. The site appears to be clear of the Fitzroy River 1% AEP flood event.

Figure 2: Northern Parcel looking West on Knight Street

2.2.2. SOUTHERN PARCEL

The southern parcel (outlined in YELLOW) of the site is principally vacant of any development and is vegetated with an open grass surface. The site is bounded on the west by the north coast rail corridor, the east by One Steel and the south Horace Street. Existing natural surface levels across the southern parcel range from RL13 down to RL7. See **Appendix A** for details. It should be noted that the southern parcel has an existing easement located along the north-eastern common boundary with OneSteel. The easement is nominally 4m wide and drains towards Horace Street.

Figure 3: Southern Parcel looking West on Horace Street

The southern parcel appears not to have been significantly affected by regional backwater flooding from Moores Creek or the Fitzroy River during the 2011 event. However, backwater flood modelling of Moores Creek during the local 1% AEP storm event does show some inundation and flooding on the property.

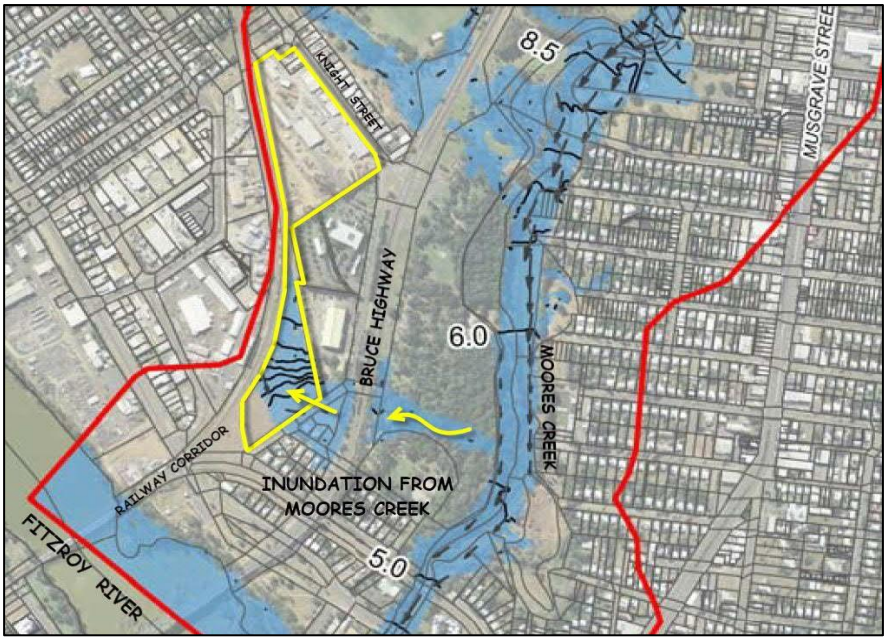


Figure 4: Inundation to the Southern Parcel from Moores Creek Road across the Bruce Highway (Source: Aurecon Australia Pty Ltd, dated 30 May 2014)

The below image is an extract from Moores Creek Local Catchment Study. This study is under review and not yet approved by Council. The inundation area of the southern parcel is much lesser compared to the previous study due to Stage 1 flood mitigation works completed as part of North Rockhampton Flood Management.

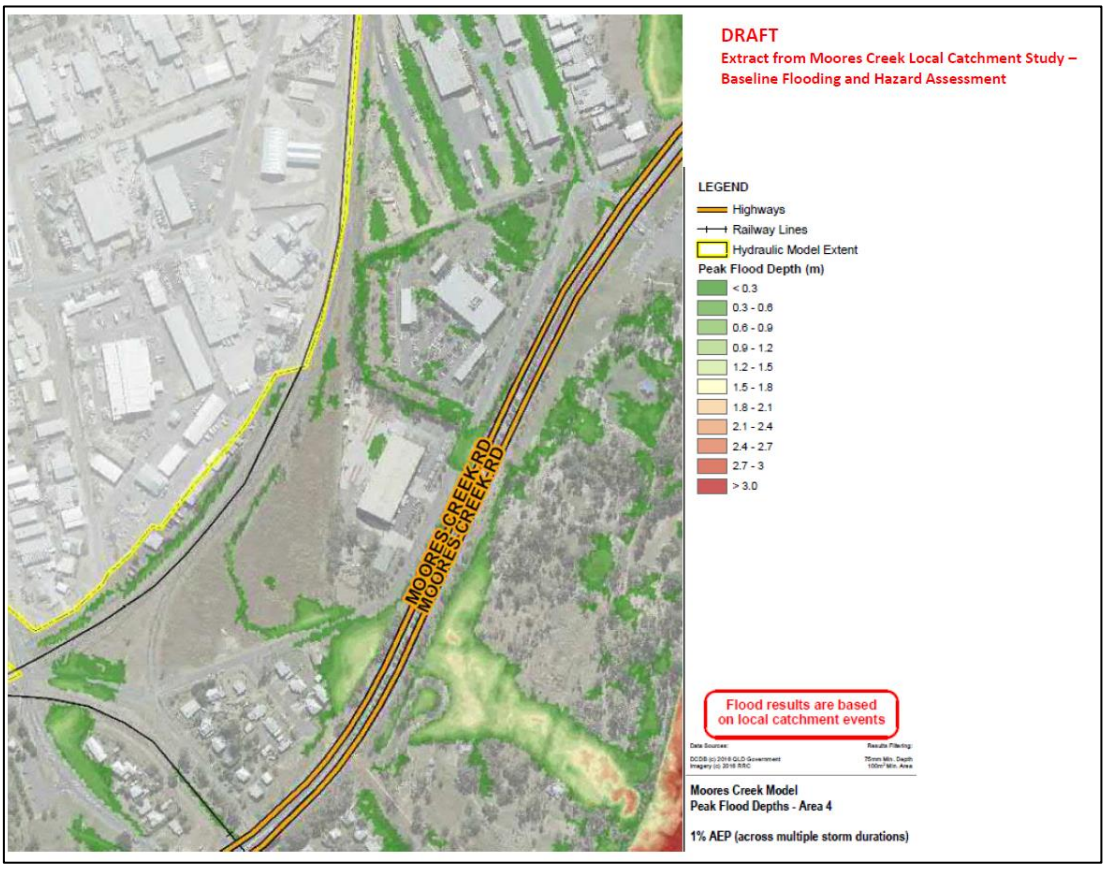


Figure 5: Extract from Moores Creek Local Catchment Study (Under Review)

3.0 HYDROLOGY ASSESSMENT

3.1. LAWFUL POINT OF DISCHARGE

Both northern and southern parcels are grading towards the low point in southern corner of the southern parcel and ultimately discharging onto Horace Street. This point of discharge is under the lawful control of the local government and satisfies the Lawful Points of Discharge in accordance with QUDM.

Any stormwater volume increase from post development will be detained to ensure there will be no adverse impacts on downstream properties and infrastructure.

3.2. HYDROLOGIC MODELLING

Hydrologic calculations have been undertaken using XPSTORM 2019 V1 for pre and post development scenarios. The modelling within XPSTORM environment has been undertaken to estimate the peak discharge for storms up to 1% AEP. Hydrologic modelling has been undertaken using the Laurenson Runoff Routing Method. Laurenson's Method is an industry leading hydrologic routing method that can be used for catchments ranging between 10m² up to 20,000km². The information required to apply Laurenson's Method include:

- Rainfall Intensity Data (obtained from the Bureau of Meteorology 2016 IFD utility)
- Rainfall Temporal Patterns (obtained from the ARR'16 Data Hub)
- Catchment Area (ha)
- Catchment Slope
- Initial and Continuing Infiltration Data
- Catchment Roughness (Manning's 'n')

Given the relatively limited scope of this hydraulic impact assessment a lumped catchment approach, as defined by ARR'16 and shown in Figure 2 below, was applied to the hydrologic review of the site. The lumped approach is suitable for this site given the relative consistency in land use and the ultimate purpose of the model.

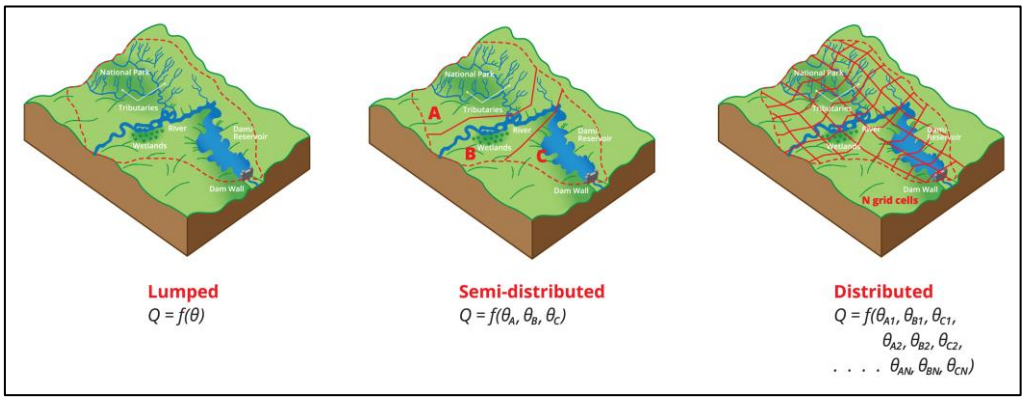


Figure 6: Catchment Analysis Options

3.2.1. CATCHMENT HYDROLOGY PARAMETERS

Table 2 and 3 summarises the input data for the development site in pre-development and post-development conditions.

Table 2: Pre-Development Model Parameters (XP Storm)

Parameter		Northern Parcel (Aurizon Rail Depot)		Southern Parcel (Vacant Land)
		Pervious	Impervious	Pervious
Area (ha)		1.3	3.95	2.95
Impervious (%)		0.0	100	0.0
Slope (%)		0.5	0.5	0.5
Laurenson 'n' (storage non-linearity exponent)		-0.285	-0.285	-0.285
Infiltration	Initial Loss (mm/hr)	0.0	0.0	0.0
	Continuing Loss (mm/hr)	2.0	0.0	2.0
Manning's Roughness (n)		0.020	0.018	0.045

Table 3: Post-Development Model Parameters (XP Storm)

Parameter		Northern Parcel (Low Impact Industrial Subdivision)		Southern Parcel (Low Impact Industrial Development)	
		Pervious	Impervious	Pervious	Impervious
Area (ha)		0.525	4.725	2.40	0.55 (Lot 13)
Impervious (%)		0.0	100	0.0	100
Slope (%)		0.5	0.5	0.5	0.5
Laurenson 'n' (storage non-linearity exponent)		-0.285	-0.285	-0.285	-0.285
Infiltration	Initial Loss (mm/hr)	0.0	0.0	0.0	0.0
	Continuing Loss (mm/hr)	2.0	0.0	2.0	0.0
Manning's Roughness (n)		0.045	0.018	0.045	0.018

3.2.2. HYDROLOGY RESULTS

Applying the ARR'16 ensemble temporal patterns to the catchment allowed the identification of the critical duration for the mean minor and major storm event. Below figures are screen shots of Box and Whisker plot taken from XPSTORM software. This plot shows the comparison of storm ensembles for different durations for minor and major storm events.

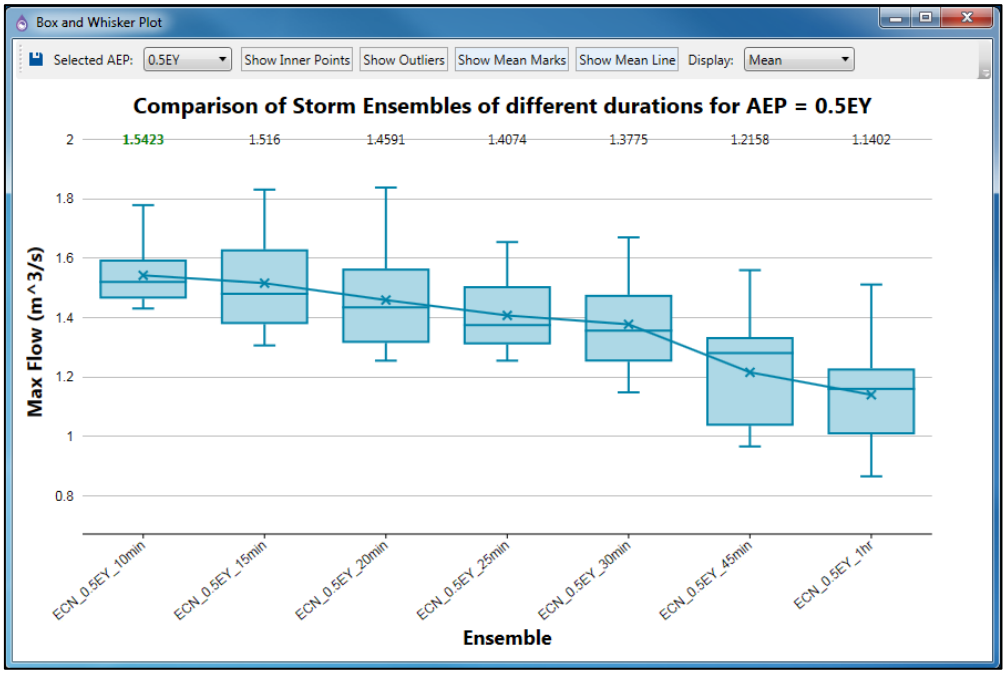


Figure 7: Comparison of Storm Ensembles of different durations for 39.35% AEP (XPSTORM Model)

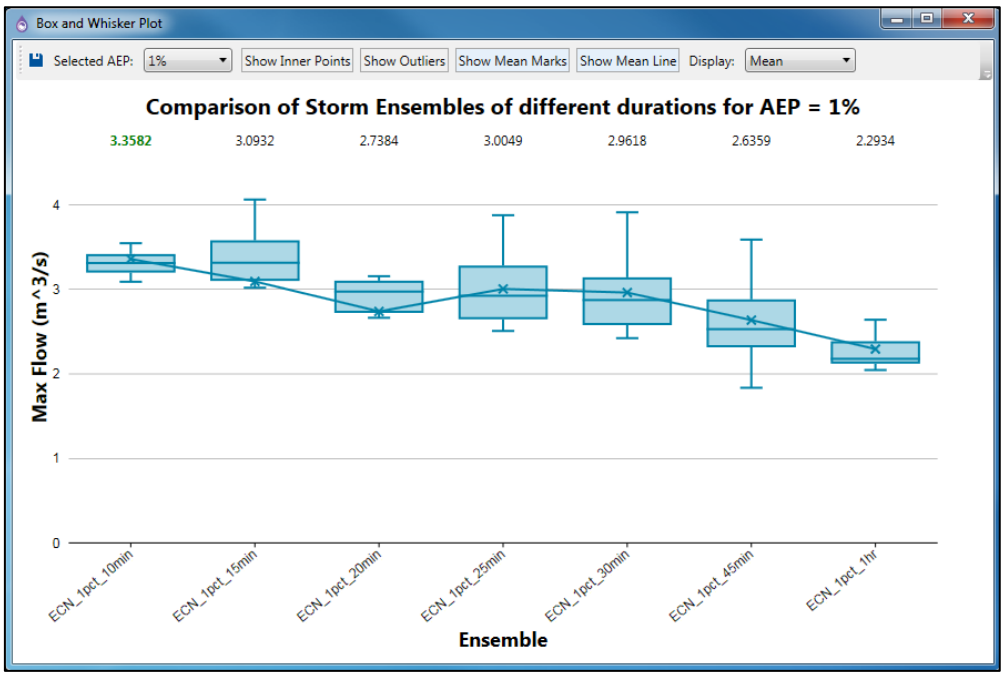


Figure 8: Comparison of Storm Ensembles of different durations for 1% AEP (XPSTORM Model)

The results of each of the ensembles are summarised in Table 4. The same storm events are applied to the hydraulic analysis.

Table 4: Critical Storm Events

Annual Exceedance Probability (AEP %)	Critical Storm Event
39.35%	0.5EY_10min_8
10% (Minor Event)	10pct_15min_2
5%	5pct_10min_5
1% (Major Event)	1pct_10min_3

3.2.3. EXTERNAL CATCHMENTS

There are no external catchments impacting the subject site as it is bounded by North Coast rail corridor on the west, Knight Street on east, Park Street on North and Horace Street on south.

4.0 HYDRAULIC ASSESSMENT

4.1 BACKGROUND

The hydraulic assessment for the site has been carried out using XPSTORM 2019 V1. The aim of the hydraulic modelling is to demonstrate that the post-development minor and major storm peak discharge at the LPOD is equal or less than the peak pre-development discharge. A detention basin will be constructed in the Lot 13 in southern parcel to detain any additional flows from the northern and southern parcels.

The northern parcel is an established site with numerous fabrication and maintenance sheds, hardstand areas, rail siding lines and vehicular access roadways. This site will be subdivided into 11 low impact industrial lots. Refer Appendix A for proposed industrial subdivision layout. Runoff from this proposed subdivision will be collected via an underground pipe network and grass lined open channel constructed along western boundary of this parcel. Refer Appendix B for open channel flow calculations. This channel has been sized to accept major overland flow (Q100 – Q2) from the development for all relevant design storm events up to 1% AEP. The flow velocity in the channel is well within the maximum permissible velocity for a grassed channel in accordance with Clause 9.5, QUDM 2016. The ultimate discharge point for the northern parcel will be the detention basin in the southern parcel.

The southern parcel is principally vacant of any development and is vegetated with an open grass surface. The southern parcel is subdivided into two lots. Lot 13 will be transferred to Council as freehold land which will contain a detention basin and open channel. The ultimate discharge point for Lot 12 and 13 will be the detention basin located in Lot 13.

4.2 DETENTION

The proposed development will require approximately 900m³ of detention volume to ensure no worsening to downstream catchments and infrastructure. The proposed method of detention is to detain the runoff captured within the northern and southern parcel in an open detention basin located in Lot 13.

Table 5: Peak Discharge Rate at LPOD

Storm Event (AEP %)	Pre-Development Discharge (m³/s)	Post-Development Discharge – Undetained (m³/s)	Outflow from Open Detention Basin (m³/s)		
			2 x 525mm pipes	20m Weir	Total
39.35%	1.696	2.091	0.782	0.000	0.782
10% (Minor Event)	2.338	2.984	0.919	0.947	1.866
5%	2.702	3.265	0.955	1.732	2.687
1% (Major Event)	3.506	4.444	0.979	2.357	3.336

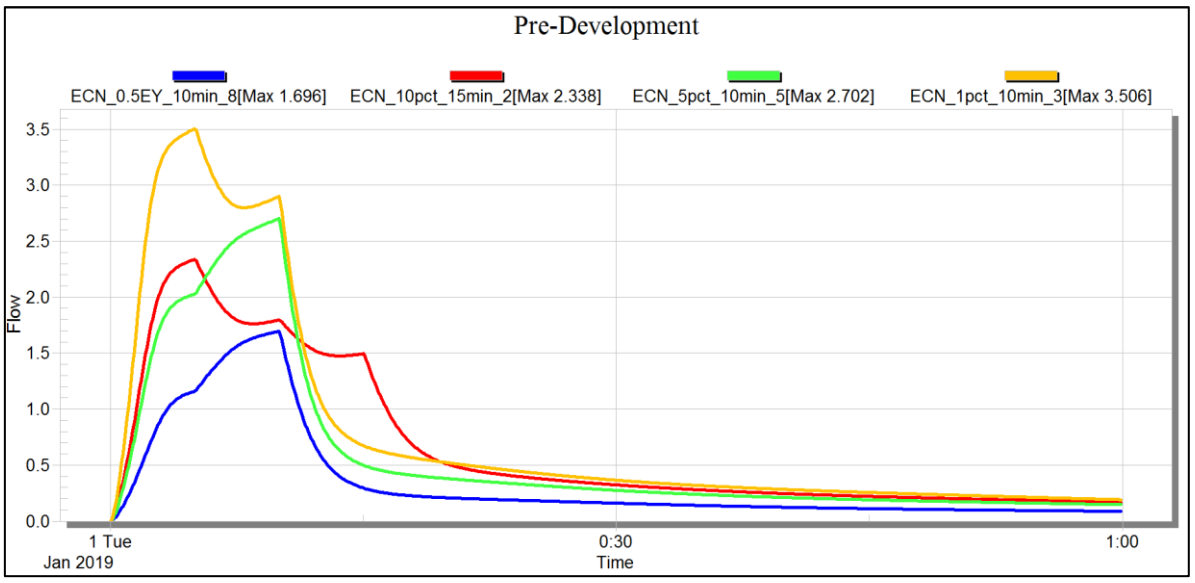


Figure 9: Northern and Southern Parcel Pre-Development Peak Discharge Rate at LPOD

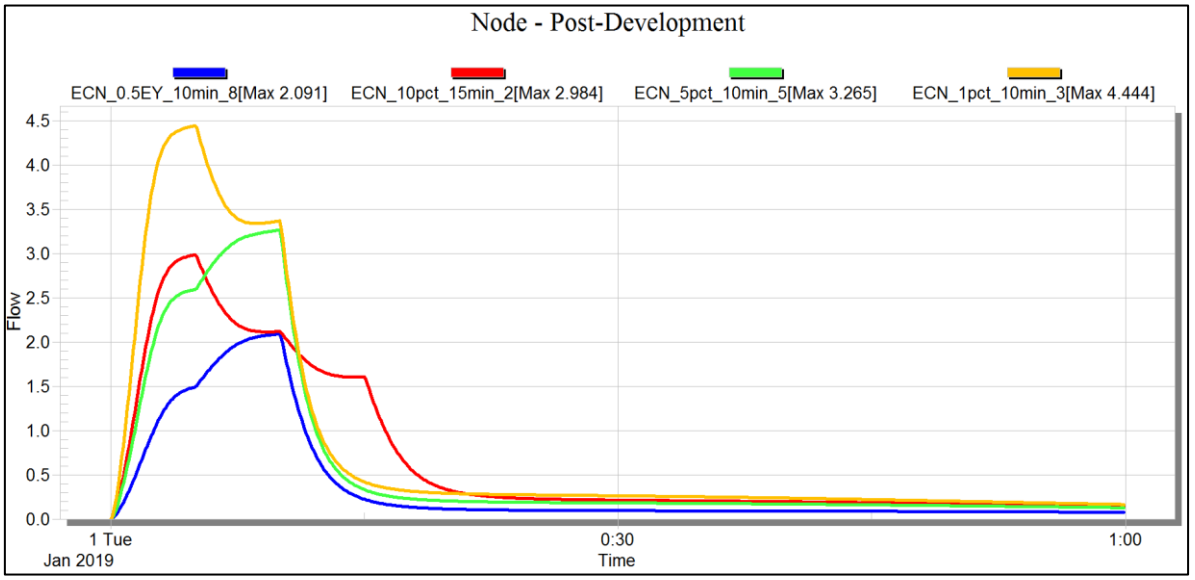


Figure 10: Northern and Southern Parcel Post-Development Peak Discharge Rate at LPOD

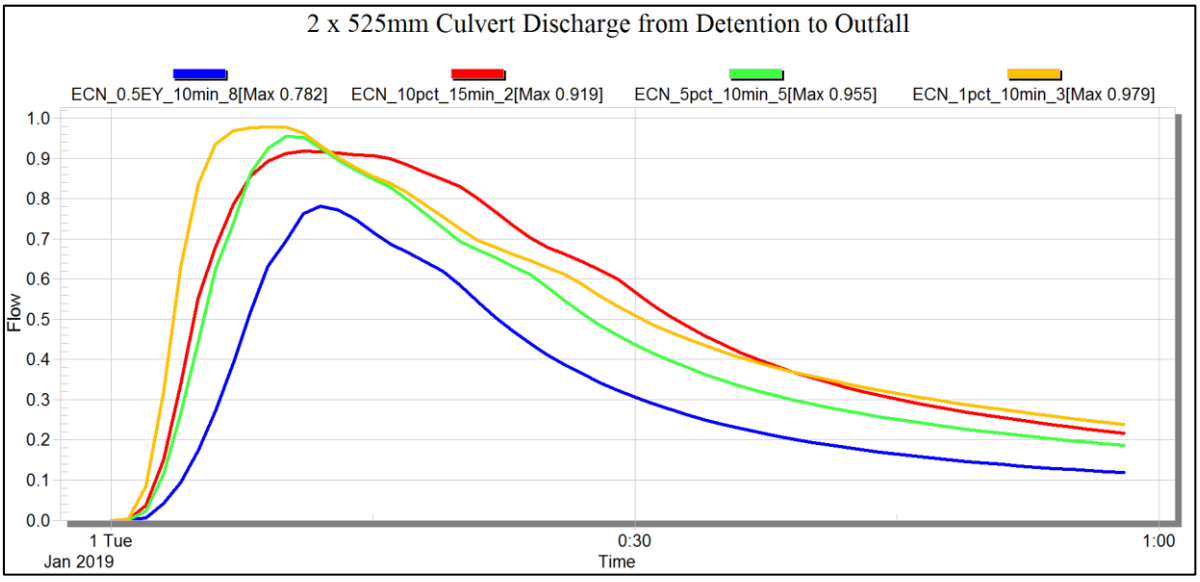


Figure 11: Outflow from Detention Basin – 2 x 525mm Culvert

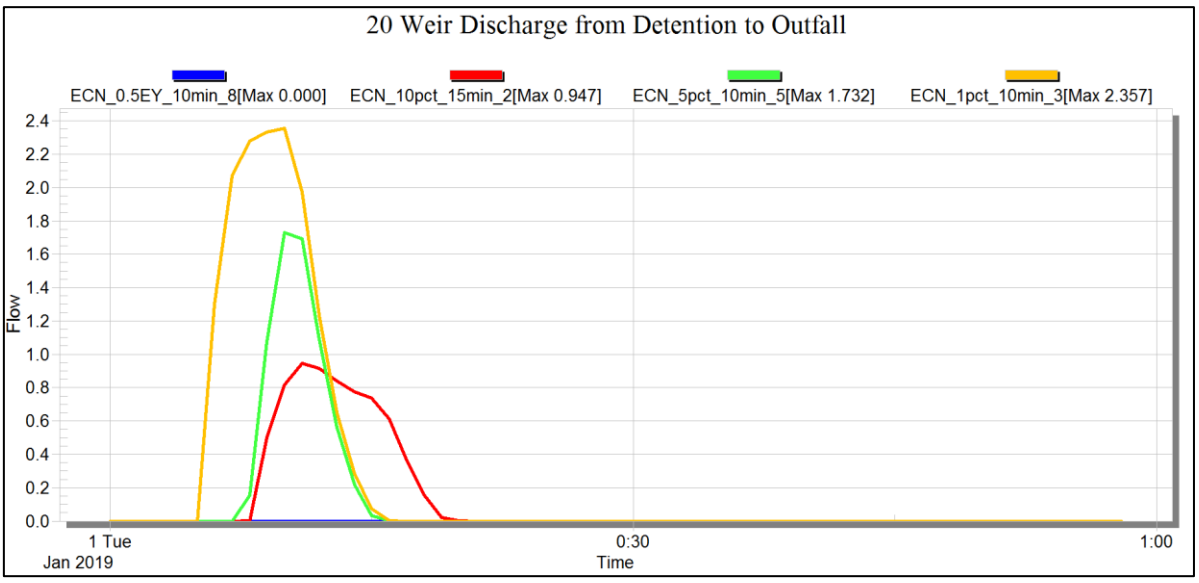


Figure 12: Outflow from Detention Basin – 20m Weir

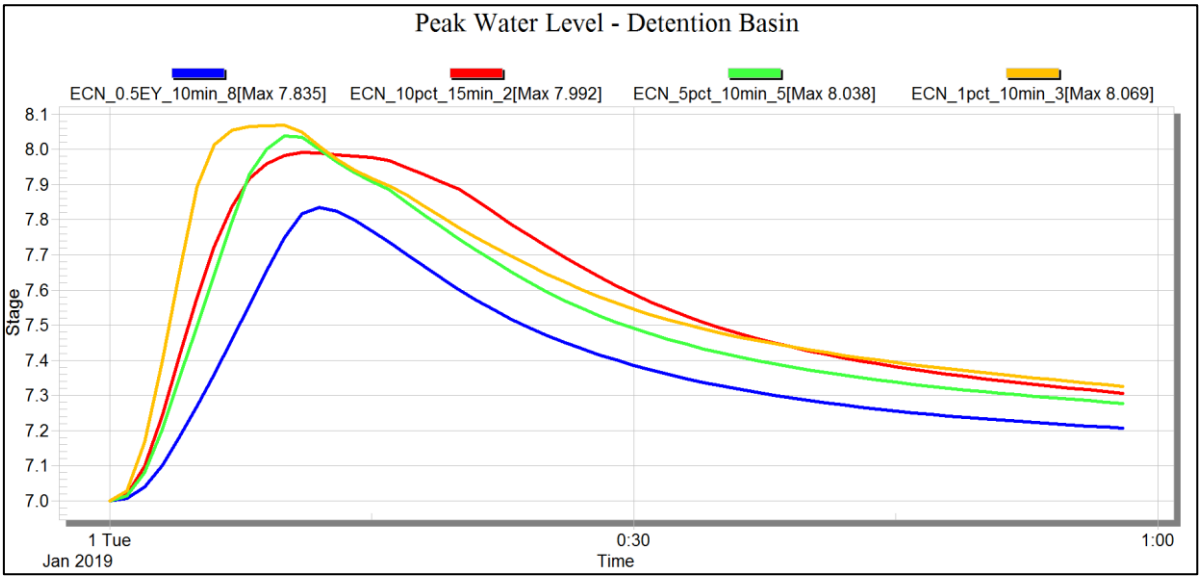


Figure 13: Peak Water Level

Table 6 summarises detention basin parameters to achieve the target mitigated pre-development flow rates.

Table 6: Detention Basin Parameters

Effective Detention Volume (approximate)	**900m³**
Base Level (Bio-Filter Surface)	**7.80m**
Extended Detention Depth over Bio-Filter (Not included in effective detention volume)	**0.20m**
Peak Water Level in 1% AEP (approximate)	**9.0m**
Peak Water Depth in 1% AEP (approximate)	**1.20m**
Outlet Structure	**2 x 525mm RCP with 20m Weir**
Outlet Invert Level (approximate)	**8.0m**

Outflow from detention basin will be discharged onto Horace Street road reserve and existing 900mm pipe under Horace Street.

5.0 QUALITY ASSESSMENT

5.1. BACKGROUND

The proposed development will result in an impervious area greater than 25 per cent of the net developable area and therefore will require to satisfy the water quality assessment benchmarks setout in State Planning Policy (July 2017).

The development of the land has the potential to increase the pollutant loads within stormwater runoff and downstream watercourses. During construction phase of the development, disturbances to the existing ground have the potential to significantly increase sediment loads entering downstream drainage systems and watercourses. The operational phase of the development will potentially increase the amount of sediments and nutrients washing from the site.

The following sections describe construction and operational phase controls and water quality modelling of the proposed treatment train in compliance with Council guidelines.

5.2. CONSTRUCTION PHASE

5.2.1. KEY POLLUTANTS

During the construction phase a number of key pollutants have been identified for this development. Table 9 illustrates the key pollutants that have been identified.

Pollutant	Sources
Litter	Paper, construction packaging, food packaging, cement bags, material off cuts.
Sediment	Exposed soils and stockpiles during earthworks and building works.
Hydrocarbons	Fuel and oil spills, leaks from construction equipment and temporary car park areas.

Table 7: Key Pollutants – Construction Phase

5.2.2. EROSION AND SEDIMENT CONTROLS

Erosion and Sediment Control (ESC) devices employed on the site shall be designed and constructed in accordance with CMDG.

PRE CONSTRUCTION

- Stabilised site access/exit on Knight Street and Horace Street.
- Sediment fences to be located along the contour lines downstream of disturbed areas.
- Diversion drains to divert clean runoff around the construction site.
- Educate site personnel to the requirements of the Sediment and Erosion Control Plan.

CONSTRUCTION

- Maintain construction access/exit, sediment fencing, catch drains and all other existing controls as required.
- Progressively surface and revegetate finished areas as appropriate.

During construction, all areas of exposed soils allowing dust generation are to be suitably treated. Treatments will include mulching the soil and watering. Road access is to be regularly cleaned to prevent the transmission of soil on vehicle wheels and eliminate any build-up of typical road dirt and tyre dusts from delivery vehicles.

Adequate waste disposal facilities are to be provided and maintained on the site to cater for all waste materials such as litter hydrocarbons, toxic materials, acids or alkaline substances.

5.3. OPERATIONAL PHASE

The following section describes the preliminary design of the Stormwater Quality Improvement Devices (SQID's) that form a treatment train for the operational phase of the development that complies with State Planning Policy 2017 water quality objectives as follows:

- 85% reduction in Total Suspended Sediment (TSS)
- 60% reduction in Total Phosphorus (TP)
- 45% reduction in Total Nitrogen (TN)
- 90% reduction in litter (sized 5 mm or greater)

5.3.1. STORMWATER QUALITY MODELLING

Stormwater Pollutant modelling for the development has been generated using the modelling program 'Model for Urban Stormwater Improvement Conceptualisation' (MUSIC), version 6.3, adhering to the prescribed Water by Design MUSIC modelling guidelines Version 1.0, 2010. A "Lumped Catchment" approach has been adopted using lumped industrial source nodes for the northern parcel and southern parcel.

Further assumptions associated with the model involve:

- Default routing (No flow routing or translation between nodes);
- No seepage/exfiltration (0 mm/hr);
- Adopted meteorology data from Rockhampton Aero rainfall station – 039083, 6-minute time step from 2000-2010; and
- All other parameters used within the modelling were based on Water by Design MUSIC Modelling Guidelines Version 1.0, 2010.

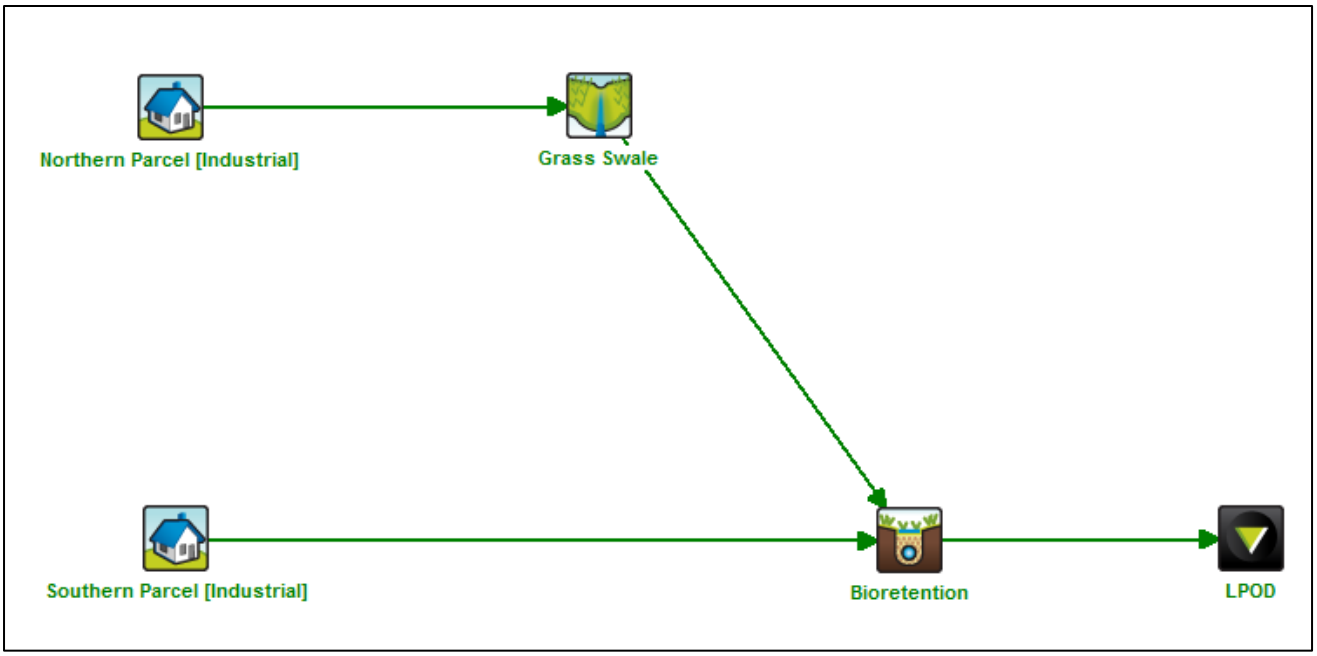


Figure 14: Stormwater Quality Treatment Train

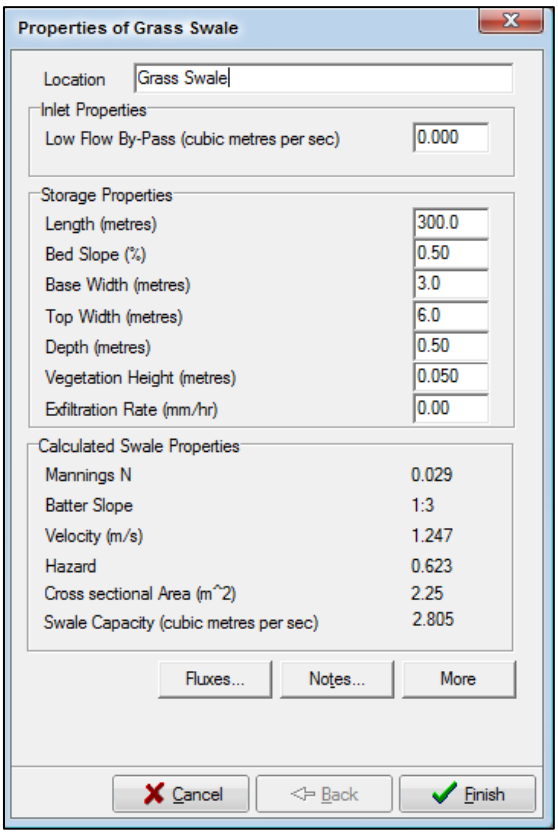


Figure 15: Properties of Grass Swale

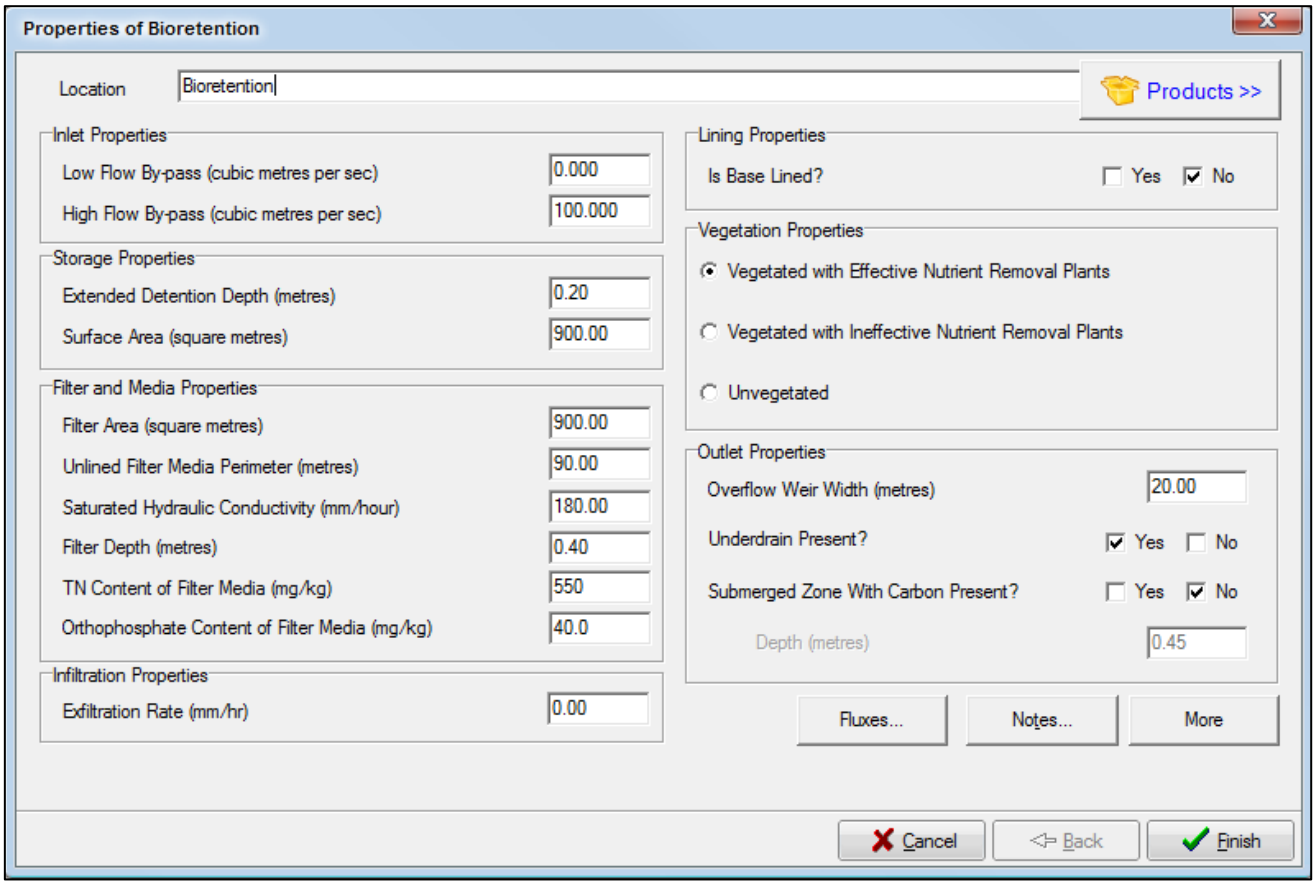
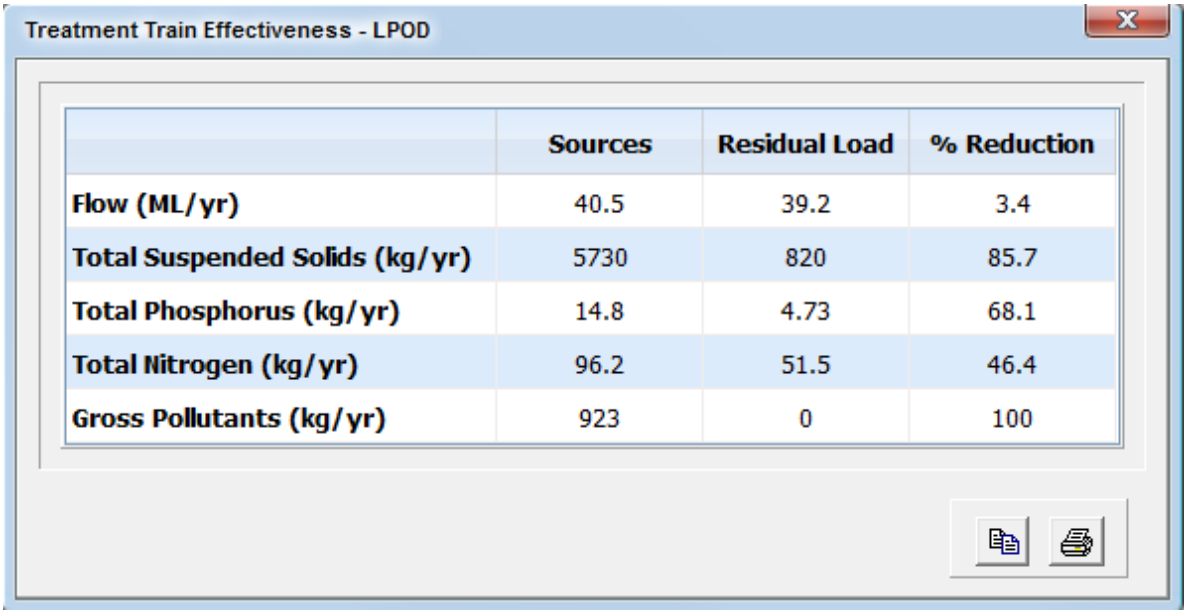


Figure 16: Properties of Bioretention



	Sources	Residual Load	% Reduction
Flow (ML/yr)	40.5	39.2	3.4
Total Suspended Solids (kg/yr)	5730	820	85.7
Total Phosphorus (kg/yr)	14.8	4.73	68.1
Total Nitrogen (kg/yr)	96.2	51.5	46.4
Gross Pollutants (kg/yr)	923	0	100

Figure 17: Stormwater Quality Treatment Train Effectiveness

The above treatment train achieves the State Planning Policy water quality benchmarks.

6.0 CONCLUSION

The following conclusions are drawn based on the above study of the site;

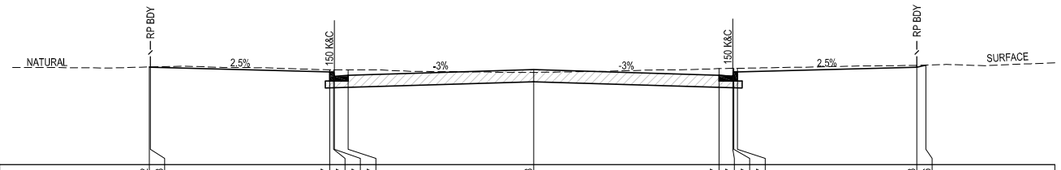
- Post-development runoff from northern parcel will be collected via an underground pipe network and grass lined open channel constructed along western boundary of this parcel. The open channel and the underground pipe network will be continued through Lot 13 and discharging into the detention basin.
- Post-development runoff from southern parcel will be discharging into the detention basin in the southern parcel.
- Outflow from the detention basin will be discharged into Horace Street road reserve via 2 x 525mm pipes and 20m weir.
- The detention basin will also perform as bio-retention basin to treat the water quality to satisfy the benchmarks setout in State Planning Policy (July 2017).

APPENDIX A

Stormwater Management Plan

NOTE:

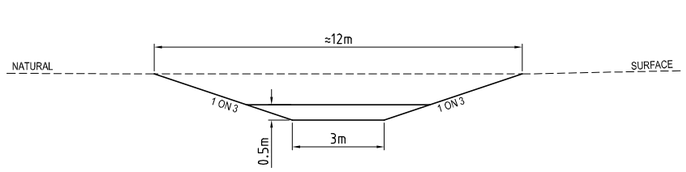
1. ALL BASIN AND OPEN CHANNEL DIMENSIONS AND GRADIENTS ARE SUBJECT TO DETAILED STORMWATER HYDROLOGIC AND HYDRAULIC CALCULATIONS.



DATUM R.L.10.00

DESIGN SURFACE LEVEL	13.182	13.173		13.027	13.027	12.877	12.817		13.098			12.917	12.877	13.027	13.027		13.173	13.246	
EXISTING SURFACE LEVEL	13.182	13.183		13.094	13.091	13.090	13.093		13.098			13.134	13.139	13.139	13.141		13.237	13.246	
OFFSET	12.637	12.500		6.650	6.530	6.500	6.650		0.000			6.050	6.500	6.530	6.650		12.500	12.791	

TYPICAL SECTION - ROAD 1
SCALE: 1:100(A1) 1:200(A3)



TYPICAL SECTION - OPEN CHANNEL
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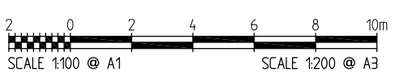

FOR INFORMATION ONLY

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B	27.06.2019	LOT LAYOUT AMENDED AS PER CLIENT REQUEST	PDM	PDM
A		SUBMITTED FOR INFORMATION	PDM	PDM

SURVEYOR
ADDRESS:
CO-ORDINATE DATUM
HEIGHT DATUM

	BY	DATE
REVIEWED		
RPEQ ENG		

RPEQ No:

CLIENT: AURIZON

SCALE: AS SHOWN |

PREPARED BY 0591819
mcmurtrie CONSULTING ENGINEERS
Address: 63 Charles Street NORTH ROCKHAMPTON QLD 4701
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Fax: (07) 4921 1790
E-mail: mail@mcmengineers.com

CLIENT AURIZON
PROJECT 33-53 KNIGHT STREET INDUSTRIAL SUBDIVISION
TITLE GENERAL TYPICAL SECTIONS

A1 | DRAWING NUMBER 0591819-SK-0005 | REVISION C

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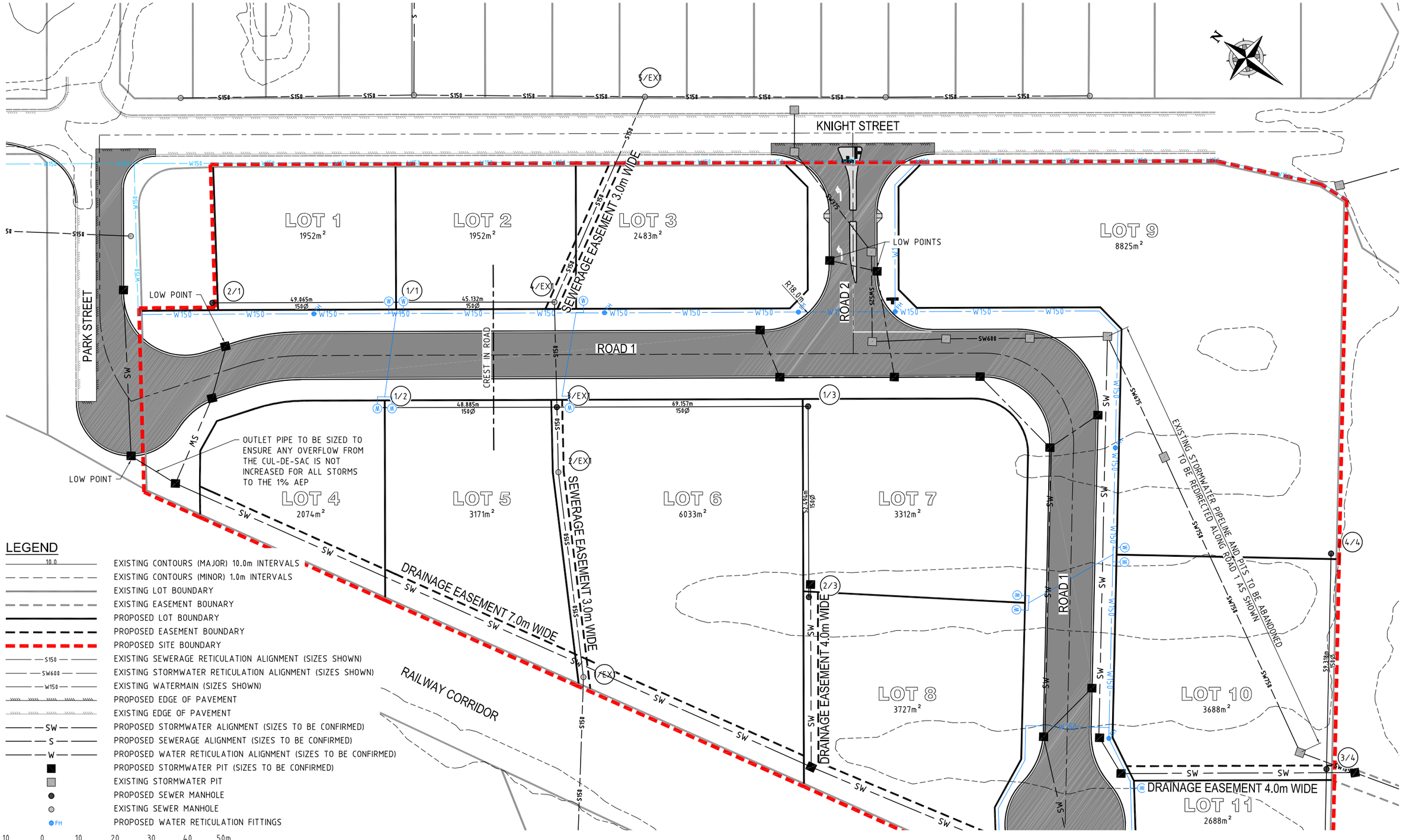

LEGEND

- EXISTING CONTOURS (MAJOR) 10.0m INTERVALS
- EXISTING CONTOURS (MINOR) 1.0m INTERVALS
- EXISTING LOT BOUNDARY
- EXISTING EASEMENT BOUNARY
- PROPOSED LOT BOUNDARY
- PROPOSED EASEMENT BOUNDARY
- PROPOSED SITE BOUNDARY
- EXISTING SEWERAGE RETICULATION ALIGNMENT (SIZES SHOWN)
- EXISTING STORMWATER RETICULATION ALIGNMENT (SIZES SHOWN)
- EXISTING WATERMAIN (SIZES SHOWN)
- PROPOSED EDGE OF PAVEMENT
- EXISTING EDGE OF PAVEMENT
- PROPOSED STORMWATER ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED SEWERAGE ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED WATER RETICULATION ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED STORMWATER PIT (SIZES TO BE CONFIRMED)
- EXISTING STORMWATER PIT
- PROPOSED SEWER MANHOLE
- EXISTING SEWER MANHOLE
- PROPOSED WATER RETICULATION FITTINGS

10 0 10 20 30 40 50m

SCALE 1:500 @ A1 SCALE 1:1 000 @ A3

LAYOUT PLAN
SCALE: 1:500(A1) 1:1000(A3)

FOR INFORMATION ONLY

REV	DATE	REVISION DESCRIPTION	DRAFT	DESIGN
A	24.01.2020	SUBMITTED FOR INFORMATION AS PER ROCKHAMPTON REGIONAL COUNCIL INFORMATION REQUEST	MT	PDM

SURVEYOR
ADDRESS:
CO-ORDINATE DATUM
HEIGHT DATUM

	BY	DATE
REVIEWED		
RPEQ ENG		

RPEQ No:

CLIENT: AURIZON

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SCALE: AS SHOWN

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Mobile: 0407 631 066
Fax: (07) 4921 1790

CLIENT AURIZON
PROJECT 33-53 KNIGHT STREET INDUSTRIAL SUBDIVISION
TITLE GENERAL SERVICES LAYOUT

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LEGEND

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- EXISTING CONTOURS (MINOR) 1.0m INTERVALS
- EXISTING LOT BOUNDARY
- EXISTING EASEMENT BOUNARY
- PROPOSED LOT BOUNDARY
- PROPOSED EASEMENT BOUNDARY
- PROPOSED SITE BOUNDARY
- EXISTING SEWERAGE RETICULATION ALIGNMENT (SIZES SHOWN)
- EXISTING STORMWATER RETICULATION ALIGNMENT (SIZES SHOWN)
- EXISTING WATERMAIN (SIZES SHOWN)
- PROPOSED EDGE OF PAVEMENT
- EXISTING EDGE OF PAVEMENT
- PROPOSED STORMWATER ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED SEWERAGE ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED WATER RETICULATION ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED STORMWATER PIT (SIZES TO BE CONFIRMED)
- EXISTING STORMWATER PIT
- PROPOSED SEWER MANHOLE
- EXISTING SEWER MANHOLE
- PROPOSED WATER RETICULATION FITTINGS
- OVERLAND FLOW PATH

BRUCE HIGHWAY

KNIGHT STREET

DEPARTMENT OF TRANSPORT AND MAIN ROADS

LOT 9
8825m²

LOT 10
3688m²

LOT 7
3312m²

LOT 8
3727m²

LOT 11
2688m²

LOT 13
23373m²

ROAD 1

EXISTING STORMWATER PIPELINE AND PITS TO BE ABANDONED TO BE REDIRECTED ALONG ROAD 1 AS SHOWN

EXISTING DRAINAGE EASEMENT 5.0m WIDE

DRAINAGE EASEMENT 4.0m WIDE

DRAINAGE EASEMENT WIDTH VARIES

EXISTING SEWERAGE EASEMENT 4.0m WIDE

CONSTRUCT NEW GULLY PIT ON ROAD WITHIN DEPARTMENT OF TRANSPORT AND MAIN ROADS PROPERTY BOUNDARY

LOW POINT

RAILWAY CORRIDOR

JOINS PLAN 0591819-SK-0001

JOINS PLAN 0591819-SK-0003

10 0 10 20 30 40 50m

SCALE 1:500 @ A1 SCALE 1:1 000 @ A3

LAYOUT PLAN
SCALE: 1:500(A1) 1:1000(A3)

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SURVEYOR						
ADDRESS:						
CO-ORDINATE DATUM						
HEIGHT DATUM	A	24.01.2020	SUBMITTED FOR INFORMATION AS PER ROCKHAMPTON REGIONAL COUNCIL INFORMATION REQUEST	MT	PDM
	REV	DATE	REVISION DESCRIPTION	DRAFT	DESIGN

	BY	DATE
REVIEWED		
RPEQ ENG		

RPEQ No:

CLIENT: AURIZON

SCALE: AS SHOWN

PREPARED BY 0591819
mcmurtrie CONSULTING ENGINEERS
Address: 63 Charles Street NORTH ROCKHAMPTON QLD 4701
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CLIENT AURIZON
PROJECT 33-53 KNIGHT STREET INDUSTRIAL SUBDIVISION
TITLE GENERAL SERVICES LAYOUT

A1

DRAWING NUMBER 0591819-SK-0007

REVISION A

DRAWING LOCATION: S:\PROJECT RECORDS\18-19\05a-18-19\ACAD\DRAWINGS\SHEET SETS\INDIVIDUAL DRAWINGS\SHEET SETS\SHEETS\SK-0007 SERVICES LAYOUT.DWG
PLOT DATE: 24/01/2020 10:28:57 AM

LEGEND

- EXISTING CONTOURS (MAJOR) 10.0m INTERVALS
- EXISTING CONTOURS (MINOR) 1.0m INTERVALS
- EXISTING LOT BOUNDARY
- EXISTING EASEMENT BOUNARY
- PROPOSED LOT BOUNDARY
- PROPOSED EASEMENT BOUNDARY
- PROPOSED SITE BOUNDARY
- EXISTING SEWERAGE RETICULATION ALIGNMENT (SIZES SHOWN)
- EXISTING STORMWATER RETICULATION ALIGNMENT (SIZES SHOWN)
- EXISTING WATERMAIN (SIZES SHOWN)
- PROPOSED EDGE OF PAVEMENT
- EXISTING EDGE OF PAVEMENT
- PROPOSED STORMWATER ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED SEWERAGE ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED WATER RETICULATION ALIGNMENT (SIZES TO BE CONFIRMED)
- PROPOSED STORMWATER PIT (SIZES TO BE CONFIRMED)
- EXISTING STORMWATER PIT
- PROPOSED SEWER MANHOLE
- EXISTING SEWER MANHOLE
- PROPOSED WATER RETICULATION FITTINGS
- OVERLAND FLOW PATH

KNIGHT STREET
DOWLING STREET
HORACE STREET
EXISTING SEWERAGE EASEMENT 4.0m WIDE
2 x 525mmØ RCP
STORMWATER DETENTION BASIN
BASIN IL:7.80m APPROX
APPROXIMATE VOLUME 900m³
8.0m WIDE LANDSCAPE BUFFER
SEWERAGE EASEMENT 3.0m WIDE
RAILWAY CORRIDOR
LOT 13
23373m²
LOT 12
5811m²
RAILWAY CORRIDOR

10 0 10 20 30 40 50m
SCALE 1:500 @ A1 SCALE 1:1 000 @ A3

LAYOUT PLAN
SCALE: 1:500(A1) 1:1000(A3)

FOR INFORMATION ONLY

JOINS PLAN 0591819-SK-0002

DRAWING LOCATION: S:\PROJECT RECORDS\18-19\0591819\CAD\DRAWINGS\SHEET SETS_INDIVIDUAL DRAWINGS\SHEET SETS\SHEETS\SK-0008 SERVICES LAYOUT.DWG

PLOT DATE: 24/01/2020 10:29:01 AM

SURVEYOR					
ADDRESS:					
CO-ORDINATE DATUM					
HEIGHT DATUM	A	24.01.2020	SUBMITTED FOR INFORMATION AS PER ROCKHAMPTON REGIONAL COUNCIL INFORMATION REQUEST	MT	PDM
	REV	DATE	REVISION DESCRIPTION	DRAFT	DESIGN

	BY	DATE
REVIEWED		
RPEQ ENG		

RPEQ No:

CLIENT: AURIZON

SCALE: AS SHOWN

PREPARED BY 0591819
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CLIENT AURIZON
PROJECT 33-53 KNIGHT STREET INDUSTRIAL SUBDIVISION
TITLE GENERAL SERVICES LAYOUT

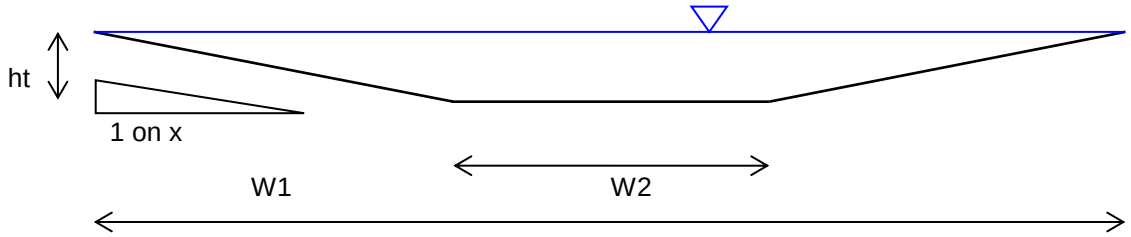
A1 | DRAWING NUMBER 0591819-SK-0008 | REVISION A

APPENDIX B

Open Channel Capacity Calculations

Stormwater Design
Open Channel Flow Capacity
Flat Bottom Drain

Project No: **059-18-19**
Project Descrption: **Industrial Subdivision, Grass Lined Open Channel**



Descrption	Symbol	Units	
Manning's Roughness	n		0.030
Hydraulic Radius	Rh	m	0.37
Wetted Perimeter	P	m	6.16
Area	A	m^2	2.25
Flow depth	ht	m	0.500
Batter Slope	1 on x		3.000
Batter Slope (in %)	%	m/m	0.33
Longitudinal Grade	S	m/m	0.0050
Flat Bottom Drain Width	W2		3.0000
Flow Width	W1	m	6.000
Velocity	V	m/s	1.20
Flow Rate	Q	m^3/s	2.71
Overland Flow	$Q_{100} - Q_2$	m^3/s	4.444 - 2.091 = 2.353 < 2.71