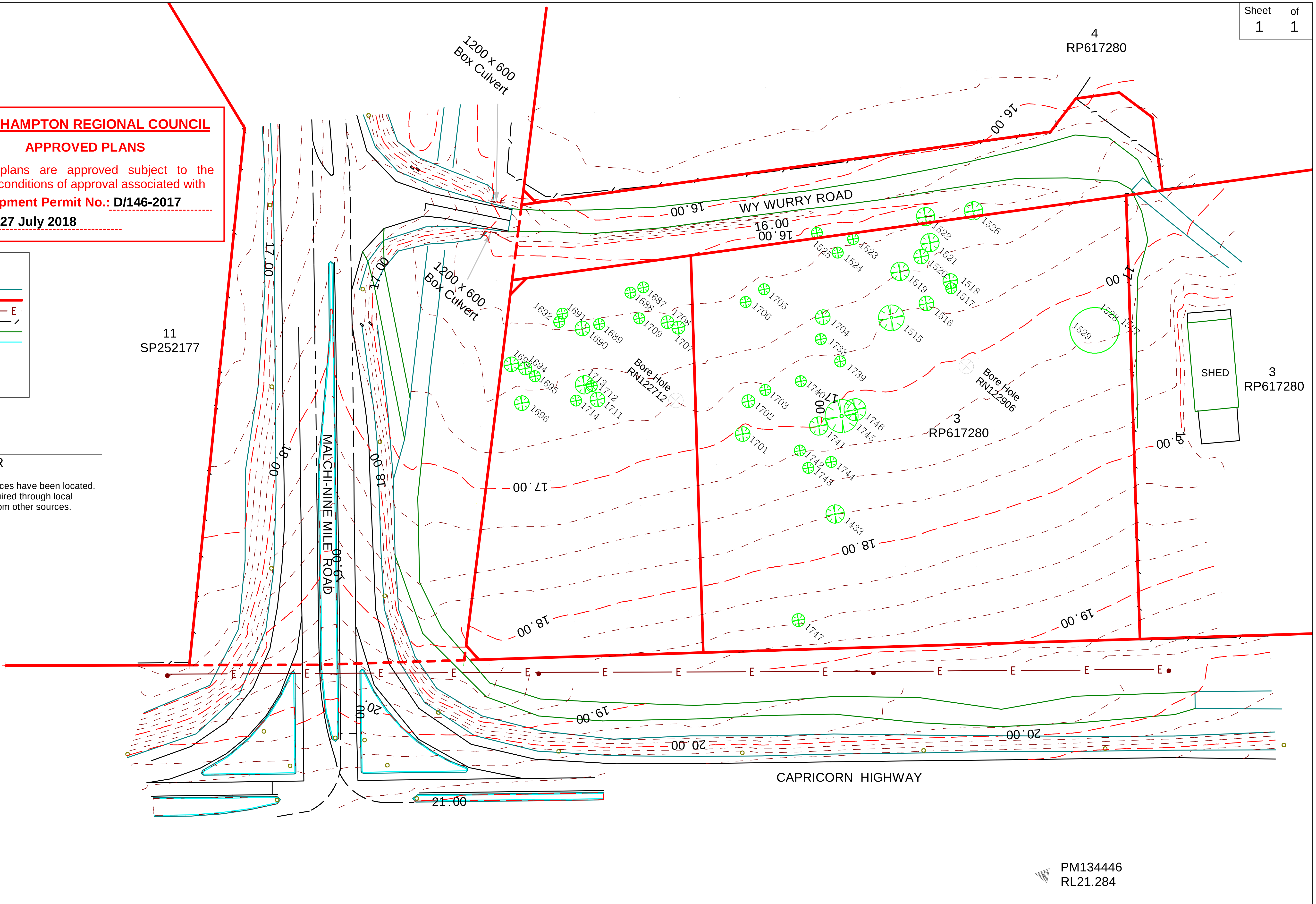
ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/146-2017

Dated: 27 July 2018



LEGEND

- Bitumen
- Boundaries
- Electricity
- Fence
- Tracks
- Traffic Islands
- Bore Holes
- Lights Street & Traffic
- Power Pole
- Trees

Contour Interval
Major 1.0 metre labled
Minor 0.25 metre

DISCLAIMER

Some visible underground services have been located. Further information may be required through local service authorities records or from other sources.

Number	
1433	Girth 500 Height 10 Spread 10
1515	Girth 700 Height 20 Spread 10
1516	Girth 400 Height 15 Spread 5
1517	Girth 300 Height 10 Spread 8
1518	Girth 400 Height 15 Spread 10
1519	Girth 500 Height 18 Spread 10
1520	Girth 400 Height 12 Spread 8
1521	Girth 500 Height 18 Spread 10
1522	Girth 500 Height 20 Spread 10
1523	Girth 300 Height 12 Spread 7
1524	Girth 300 Height 10 Spread 6
1525	Girth 300 Height 12 Spread 7
1526	Girth 500 Height 15 Spread 12
1687	Girth 300 Height 15 Spread 6
1688	Girth 300 Height 15 Spread 6
1689	Girth 300 Height 15 Spread 6
1690	Girth 400 Height 18 Spread 8
1691	Girth 300 Height 15 Spread 6
1692	Girth 300 Height 15 Spread 6
1693	Girth 400 Height 18 Spread 8
1694	Girth 350 Height 15 Spread 6
1695	Girth 300 Height 18 Spread 8
1696	Girth 400 Height 20 Spread 8
1701	Girth 400 Height 12 Spread 6
1702	Girth 350 Height 12 Spread 8
1703	Girth 300 Height 12 Spread 5
1704	Girth 400 Height 15 Spread 6
1705	Girth 300 Height 10 Spread 5
1706	Girth 300 Height 10 Spread 5
1707	Girth 350 Height 10 Spread 5
1708	Girth 350 Height 12 Spread 6
1709	Girth 300 Height 10 Spread 5
1710	Girth 300 Height 10 Spread 5
1711	Girth 400 Height 12 Spread 7
1712	Girth 300 Height 10 Spread 4
1713	Girth 500 Height 15 Spread 8
1714	Girth 300 Height 10 Spread 4
1737	Girth 300 Height 8 Spread 5
1738	Girth 300 Height 10 Spread 4
1739	Girth 300 Height 12 Spread 5
1740	Girth 300 Height 12 Spread 6
1741	Girth 500 Height 12 Spread 7
1742	Girth 300 Height 10 Spread 5
1743	Girth 300 Height 10 Spread 6
1744	Girth 300 Height 10 Spread 5
1745	Girth 900 Height 18 Spread 10
1746	Girth 600 Height 15 Spread 8
1747	Girth 350 Height 10 Spread 6

Scale 1:1000 on A3
Scale 1:500 on A1

0 10 20 30 40 50 100

Client: CORBERT'S GROUP

Meridian: MGA Zone 56

Vertical Datum: A.H.D.D

RL of Origin: 21.284

Derived from: PM134446

Plan of:

Contour and Detail Survey of Lots 1 & 2 on RP617280 Wy Wurry Road Gracemere

HOFFMANN SURVEYORS A.B.N. 98 124 394 378

Head Office 37 Withers St. Rockhampton Q 4701 P 07 4922 3834 hoffmannsurveyors.com.au

Rockhampton Longreach Blackall Charleville — CADASTRAL ENGINEERING MAPPING TOWN PLANNING

Drawn: K.McDougall	Locality: Gracemere
Date: 27/02/2017	Parish:
Surveyed & Checked: K.McDougall	County:
Date: 23-02-2017	Ref. No. R17005-1 A1

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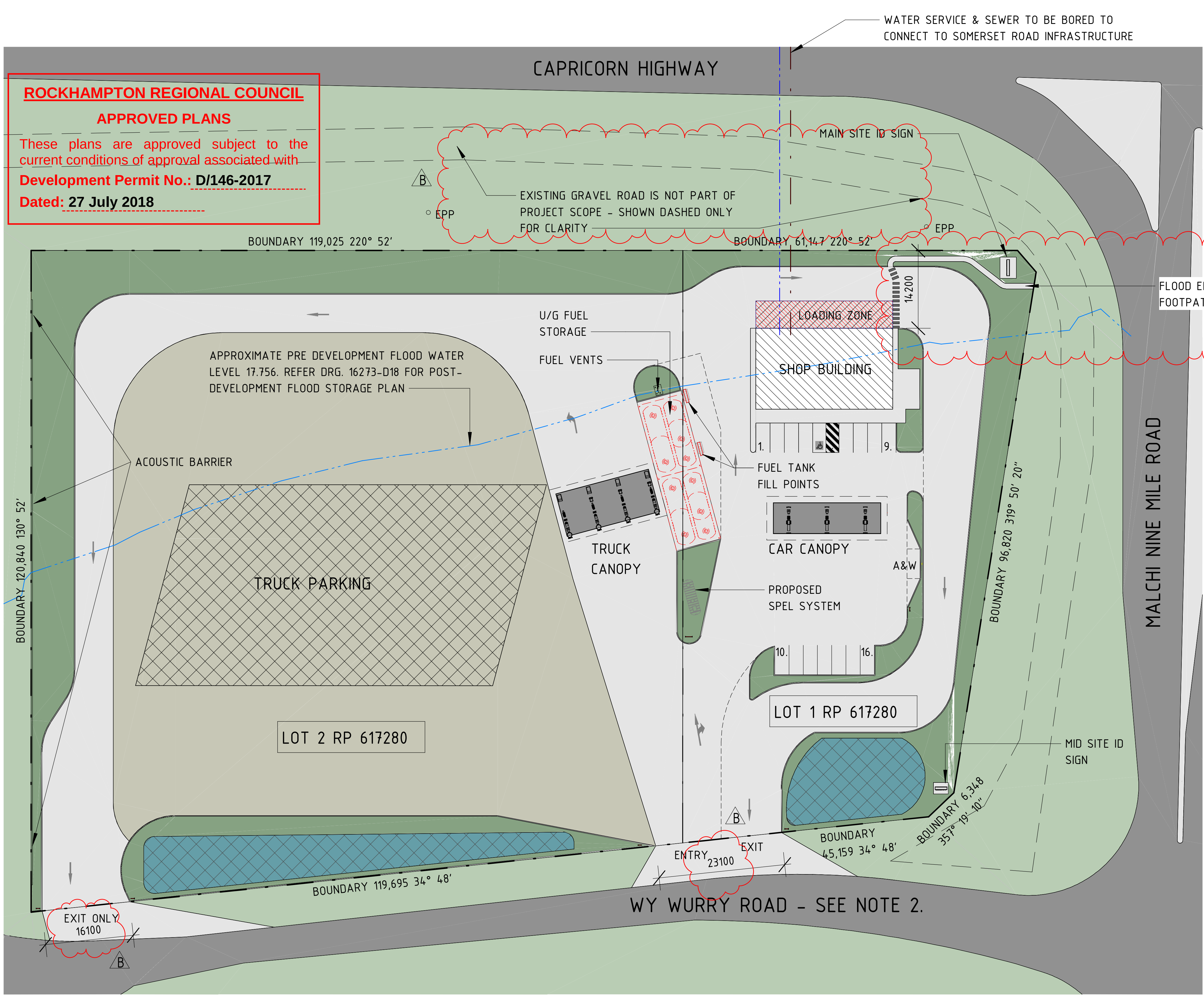

PROPERTY DESCRIPTION

LOT 1 & 2 ON RP 617280
LGA: ROCKHAMPTON REGIONAL COUNCIL
LOT 1 AREA: 5,984m²
LOT 2 AREA: 13,630m²

NOTES

1. PRELIMINARY - NOT FOR TENDER OR CONSTRUCTION.
2. WY WURRY RD TO BE UPGRADED TO ACCOMMODATE B-DOUBLES AS PER TRAFFIC REPORT
3. LINEMARKING SHOWN INDICATIVE ONLY - SUBJECT TO CHANGE AT DETAIL DESIGN BY TRAFFIC ENGINEER.
4. CARPARKING & ROAD AISLES TO BE IN ACCORDANCE WITH AS2890.1 & AS2890.6.
5. STANDARD PARKING BAYS PROVIDED AT 5.4m x 2.6m WITH MINIMUM 6.6m AISLES.
6. DISABLED PARKING BAYS TO BE 5.4m x 2.4m WITH 5.4m x 2.4m SHARED BAY.
7. FOR STORMWATER TREATMENT AND DETENTION DETAILS, REFER ENGINEER'S REPORTS.
8. FOR ROAD WORKS EXTERNAL TO SITE BOUNDARY REFER TRAFFIC ENGINEER'S REPORT.

LEGEND

EPP — EXISTING POWER POLE
A&W — AIR & WATER POINT
CONCRETE PAVEMENT
LANDSCAPE
COMPACT GRAVEL
DETENTION BASIN
CANOPY SLABS WITH BLACK OXIDE FINISH
BOUNDARY
SITE WATER SUPPLY
SITE SEWER

SITE COVERAGE SCHEDULE

SHOP (FOOTPRINT):	369m²	1.9%
CAR CANOPY (FOOTPRINT):	110m²	0.5%
TRUCK CANOPY (FOOTPRINT):	140m²	0.7%
COMPACT GRAVEL:	7386m²	37.6%
CONCRETE PAVEMENT:	7309m²	37%
FOOTPATH:	134m²	0.7%
KERB:	128m²	0.6%
LANDSCAPE:	3153m²	16%
DETENTION:	885m²	5%
TOTAL AREA:	19,614m²	100%

PARKING SCHEDULE

DISABLED 2.4m x 5.4m	1
STANDARD 2.6m x 5.4m	15
AIR & WATER 2.4m x 5.4m	1
B-TRIPLE TRUCK 4.5m x 48m	9
B-DOUBLE TRUCK 4.5m x 26m	3
AV TRUCK 4.5m x 21m	2

5 0 10 20 30 40m
Metres

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DESIGNERS | ENGINEERS
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REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	MG	DA ISSUE	
A	30.11.17	MG	DA ISSUE	
B	11.04.18	MG	AREAS UPDATED/ FOOTPATH ADDED	DGC

PROJECT DETAILS
SERVICE STATION DEVELOPMENT
for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
PROPOSED SITE PLAN

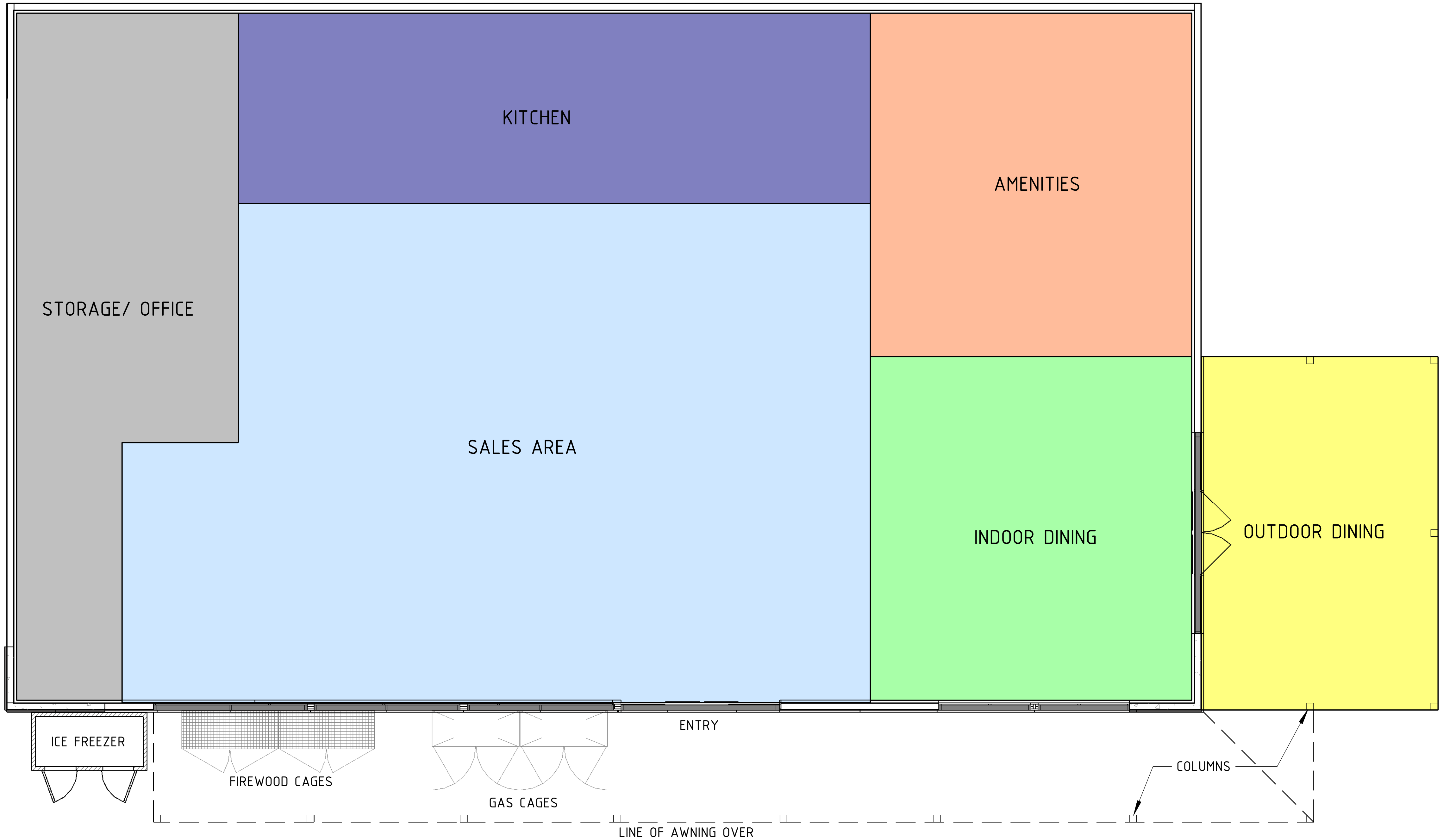
STATUS
DA ISSUE

DRAWN	APPROVED
MG	LC LAC

DATE CREATED	A1 SCALE	A3 SCALE
15.08.17		1 : 750

DRAWING NO	REV
16273 D03	B

18/04/2018 4:04:23 PM



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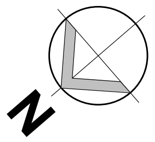

AREA SCHEDULE

BUILDING GFA = 369m²
(NOT INCLUDING OUTDOOR DINING)

SALES AREA GFA = 150m²

NOTES

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ROCKHAMPTON REGIONAL COUNCIL

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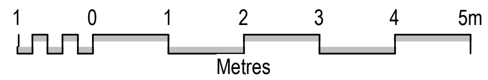
Dated: 27 July 2018



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1	28.08.17	MG	DA ISSUE	
A	30.11.17	MG	DA ISSUE	DGC

PROJECT DETAILS
SERVICE STATION DEVELOPMENT for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
PROPOSED BUILDING FLOOR PLAN

STATUS
DA ISSUE

DRAWN	APPROVED		
MG	JG		
DATE CREATED	A1 SCALE		A3 SCALE
23.08.17			1 : 100
DRAWING NO		REV	
16273	D04	A	

1 SHOP - NW ELEVATION

1 : 100

2 SHOP - SW ELEVATION

1 : 100

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1 0 1 2 3 4 5m

Metres

30/11/2017 12:04:20 PM

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1	28.08.17	MG	DA ISSUE	DGC
A	30.11.17	MG	DA ISSUE	

PROJECT DETAILS

SERVICE STATION DEVELOPMENT for CORBETS GROUP CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

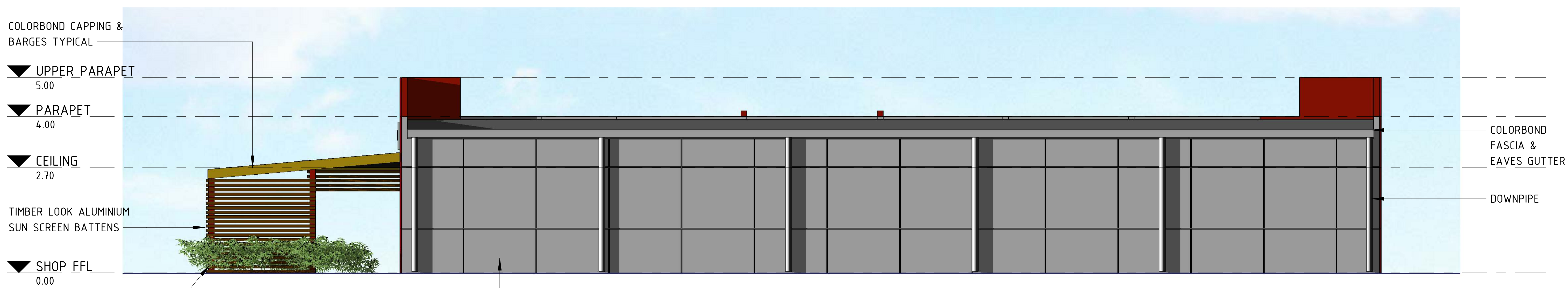
DRAWING TITLE

PROPOSED BUILDING ELEVATIONS SHEET 1

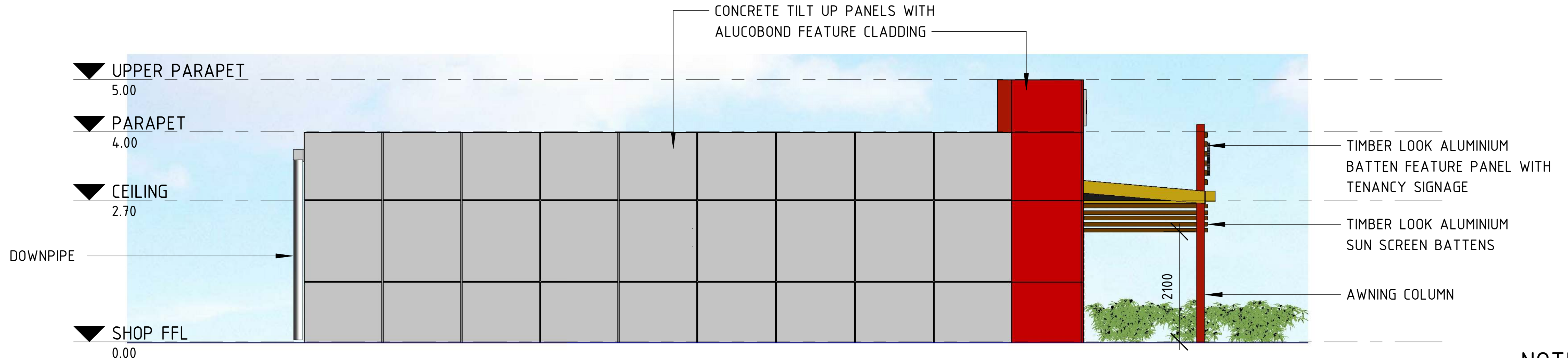
STATUS

DA ISSUE

DRAWN	APPROVED		
MG	JG		
DATE CREATED	A1 SCALE	A3 SCALE	
23.08.17		1 : 100	
DRAWING NO			REV
16273	D05		A



3 SHOP - SE ELEVATION
1 : 100



4 SHOP - NE ELEVATION
1 : 100

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1 0 1 2 3 4 5m
Metres

30/11/2017 12:09:07 PM

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REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	MG	DA ISSUE	
A	30.11.17	MG	DA ISSUE	

DGC

PROJECT DETAILS
SERVICE STATION DEVELOPMENT
for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
PROPOSED BUILDING ELEVATIONS SHEET 2

STATUS
DA ISSUE

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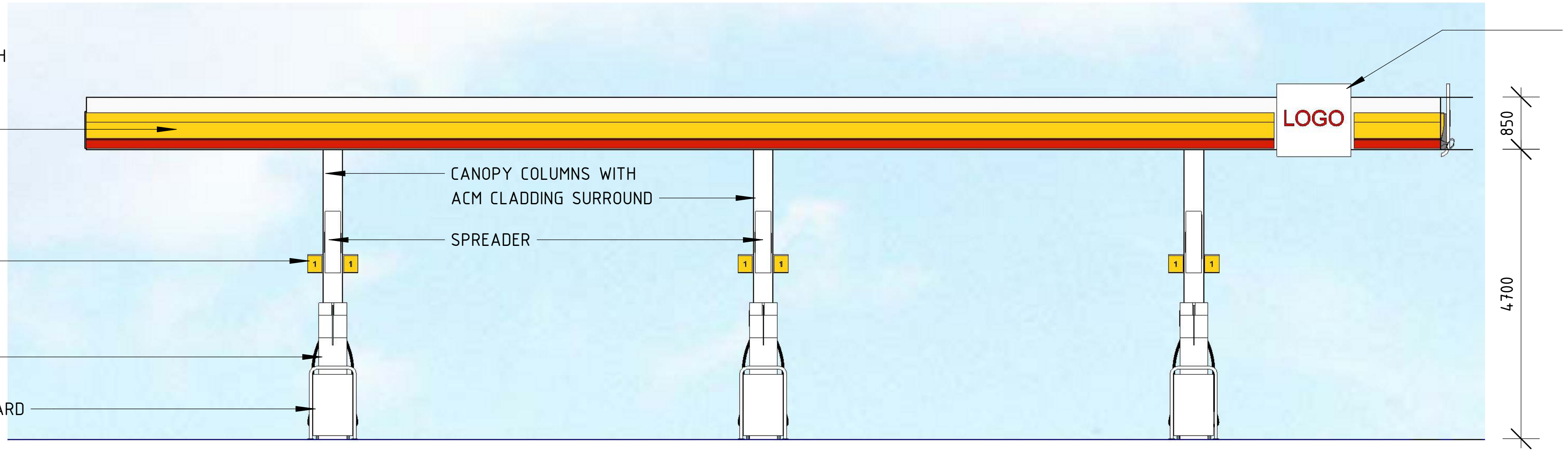
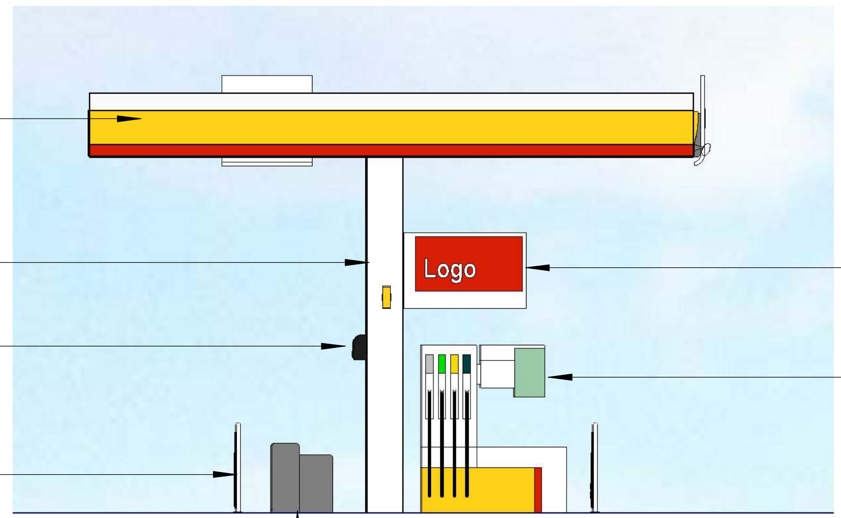
MG	JG	
DATE CREATED	A1 SCALE	A3 SCALE
25.08.17		1 : 100

DRAWING NO 16273 D06
REV A



1 CAR CANOPY - NW ELEVATION

1 : 100



2 CAR CANOPY NE ELEVATION

1 : 100

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1 0 1 2 3 4 5m

Metres

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1	28.08.17	MG	DA ISSUE	DGC
A	30.11.17	MG	DA ISSUE	

PROJECT DETAILS

SERVICE STATION DEVELOPMENT for CORBETS GROUP CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE

PROPOSED CAR CANOPY ELEVATIONS SHEET 1

STATUS

DA ISSUE

DRAWN	APPROVED
MG	JG

DATE CREATED	A1 SCALE	A3 SCALE
25.08.17		1 : 100

DRAWING NO		REV
16273	D07	A

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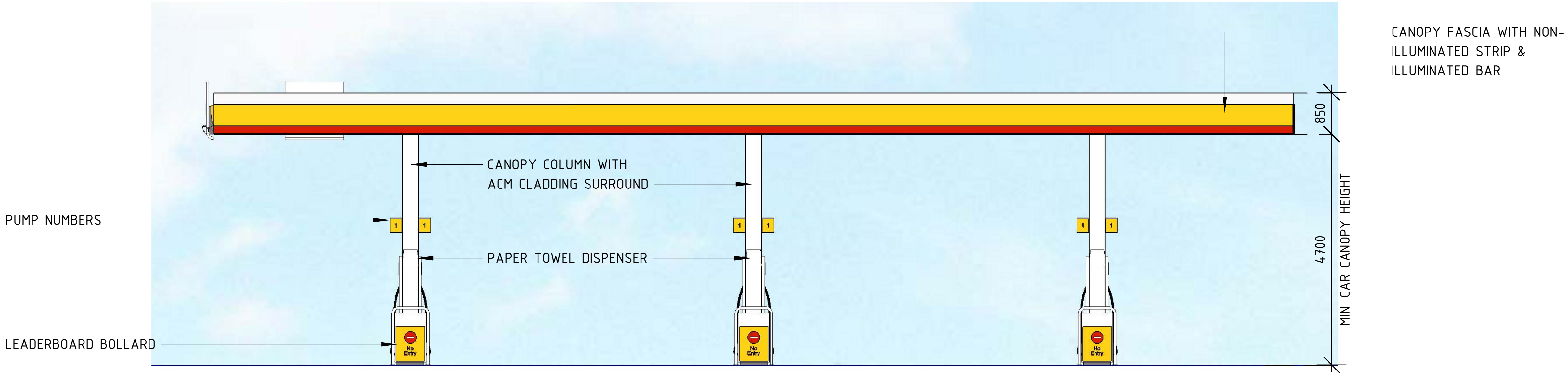
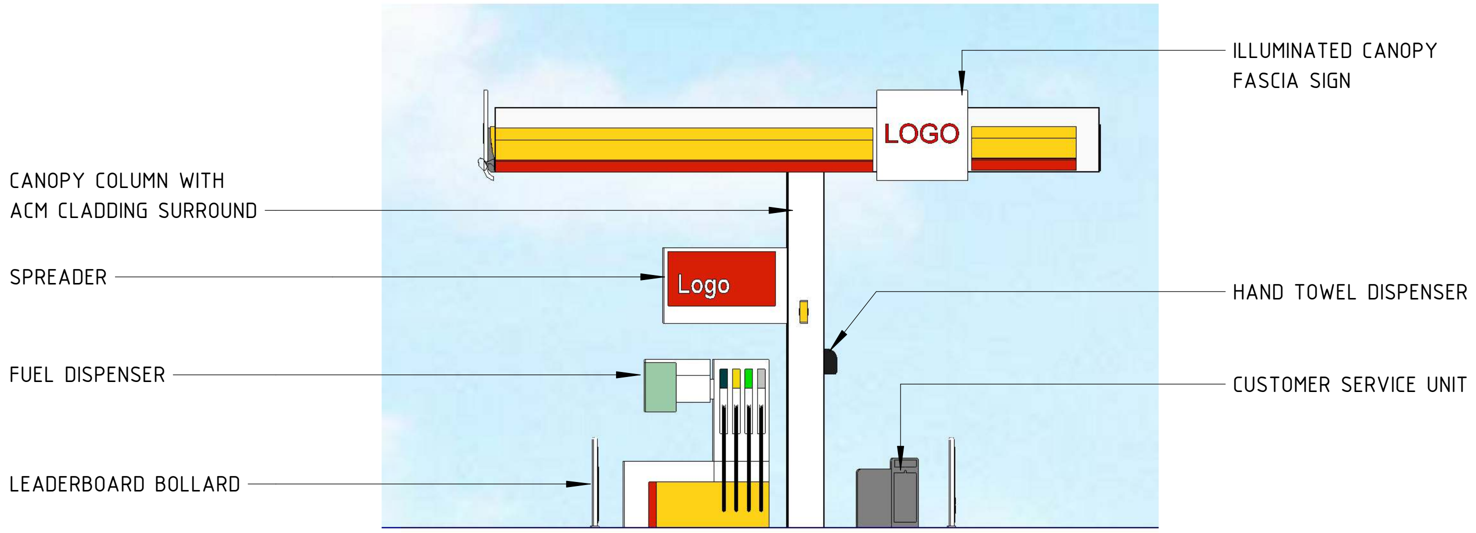


3 CAR CANOPY - SE ELEVATION
1 : 100



4 CAR CANOPY - SW ELEVATION
1 : 100

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1 0 1 2 3 4 5m
Metres

30/11/2017 12:04:25 PM

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DESIGNERS | ENGINEERS

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REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	MG	DA ISSUE	DGC
A	30.11.17	MG	DA ISSUE	

PROJECT DETAILS
SERVICE STATION DEVELOPMENT for CORBETS GROUP CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

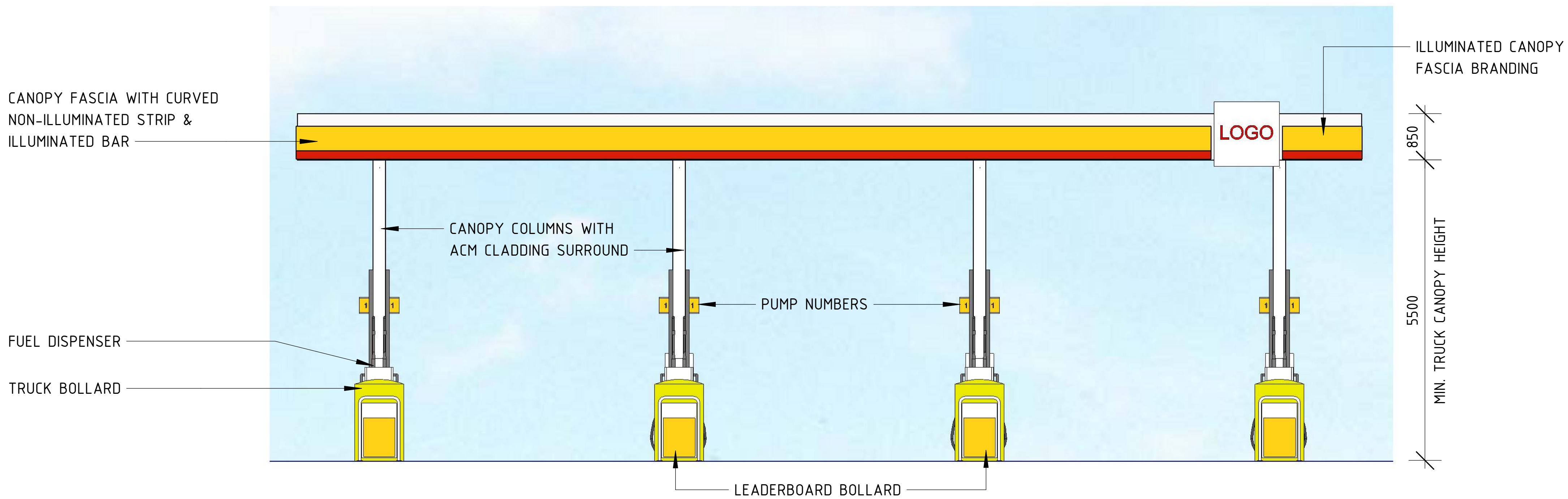
DRAWING TITLE
PROPOSED CAR CANOPY ELEVATIONS SHEET 2

STATUS
DA ISSUE

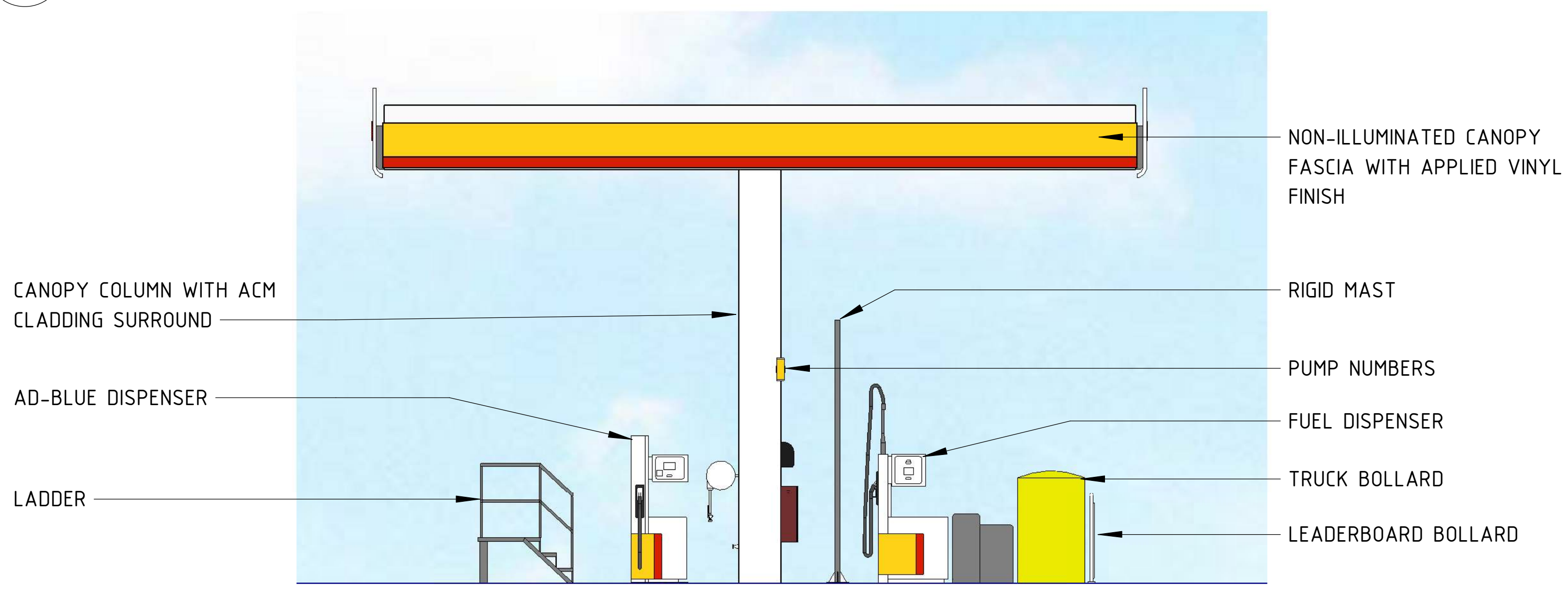
DRAWN	APPROVED
MG	JG

DATE CREATED	A1 SCALE	A3 SCALE
24.08.17		1 : 100

DRAWING NO		REV
16273	D08	A



1 TRUCK CANOPY WEST ELEVATION
1 : 100



2 TRUCK CANOPY NORTH ELEVATION
1 : 100

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1 0 1 2 3 4 5m
Metres

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A	30.11.17	MG	DA ISSUE	

PROJECT DETAILS
SERVICE STATION DEVELOPMENT for CORBETS GROUP CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
PROPOSED TRUCK CANOPY ELEVATIONS - SHEET 1

STATUS
DA ISSUE

DRAWN	APPROVED		
MG	JG		
DATE CREATED	A1 SCALE	A3 SCALE	
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DRAWING NO		REV	
16273	D09	A	

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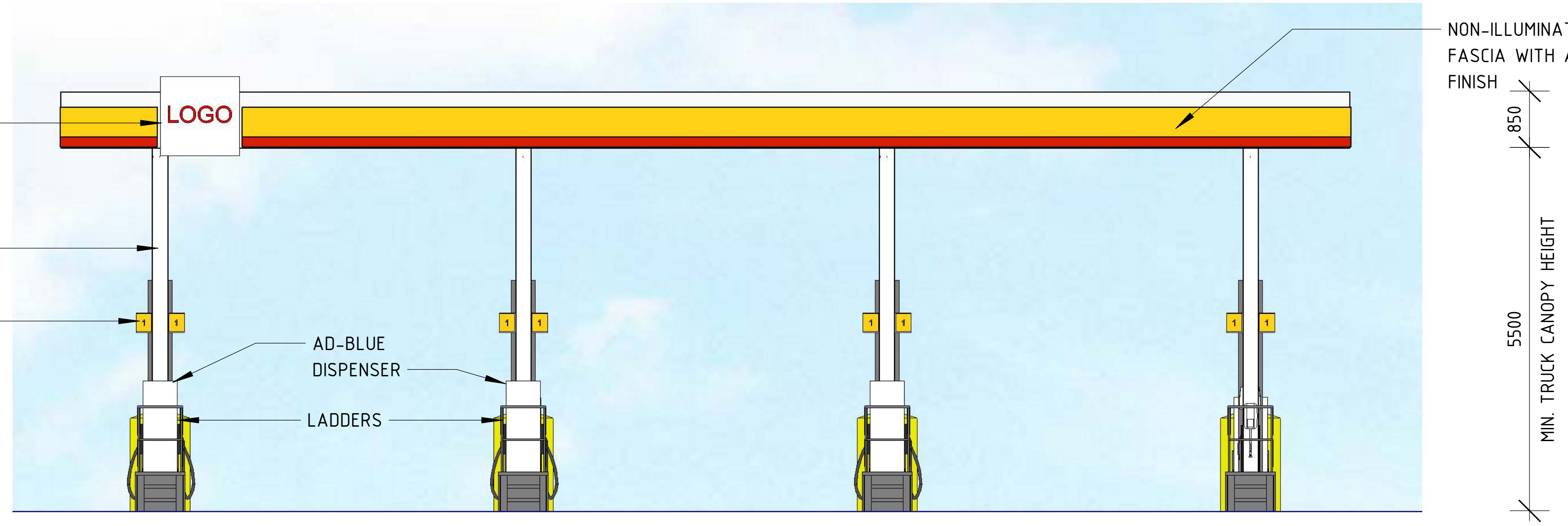
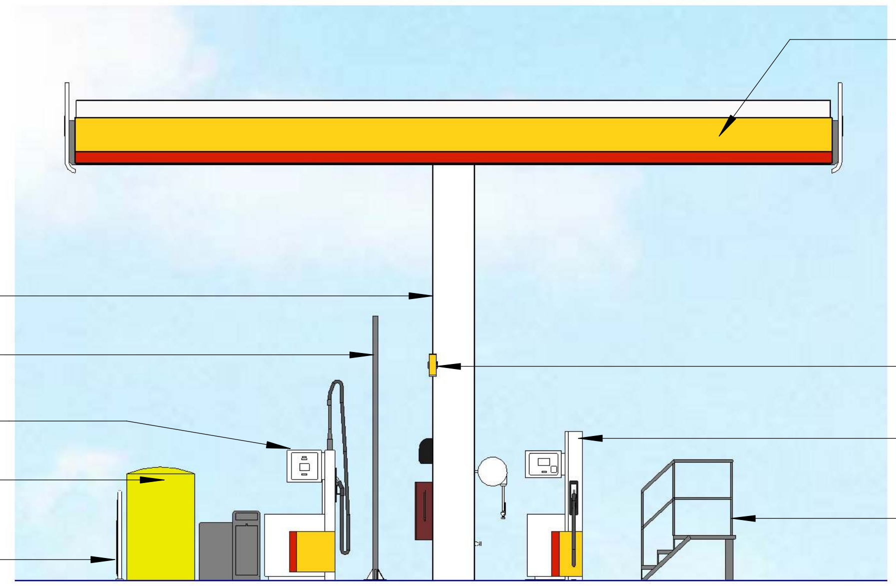


3 TRUCK CANOPY EAST ELEVATION
1 : 100



4 TRUCK CANOPY SOUTH ELEVATION
1 : 100

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1 0 1 2 3 4 5m
Metres

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REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	MG	DA ISSUE	
A	30.11.17	MG	DA ISSUE	

PROJECT DETAILS
SERVICE STATION DEVELOPMENT
for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

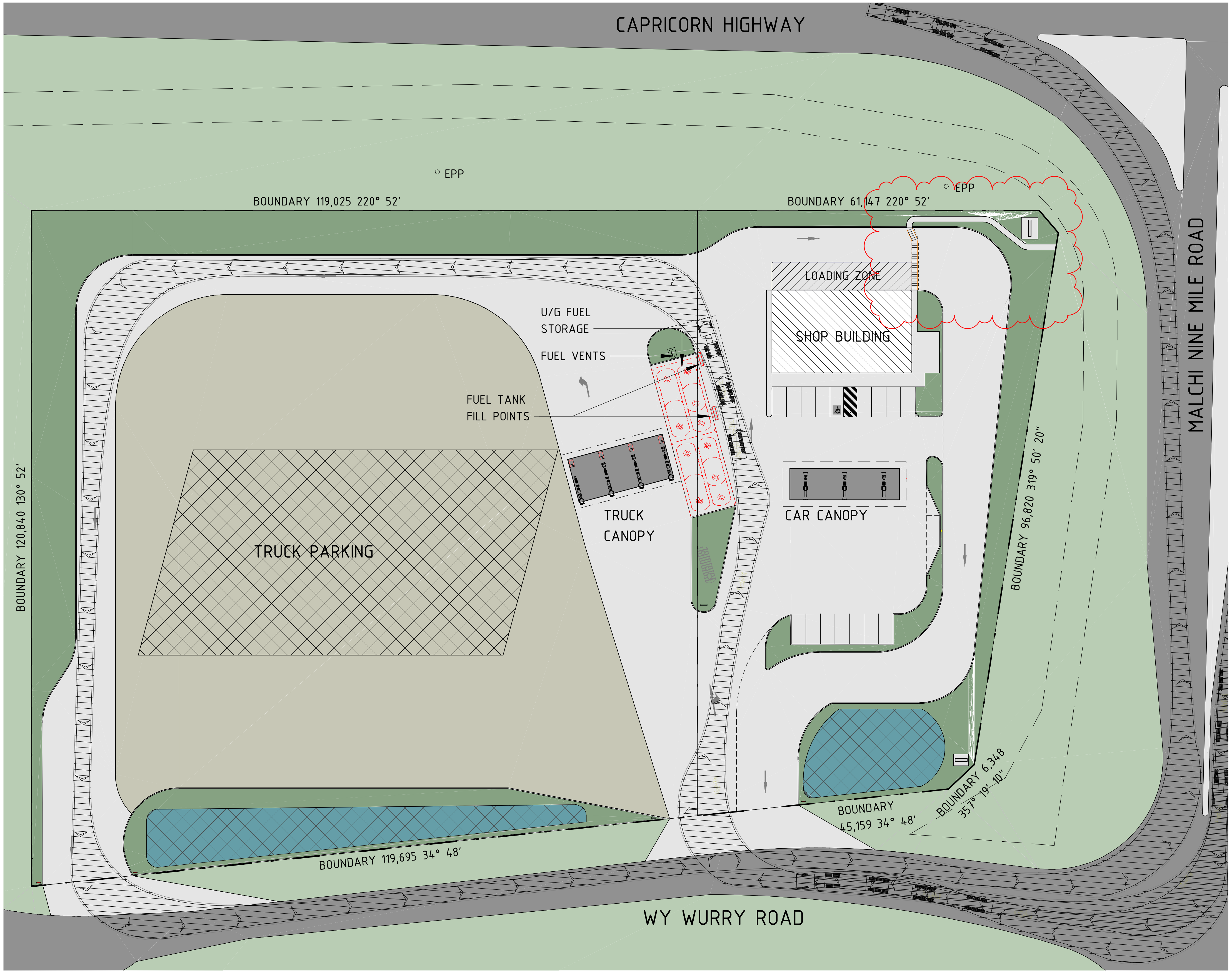
DRAWING TITLE
PROPOSED TRUCK CANOPY ELEVATIONS - SHEET 2

STATUS
DA ISSUE

DRAWN	APPROVED	
MG	JG	
DATE CREATED	A1 SCALE	A3 SCALE
29/08/17		1 : 100

DRAWING NO		REV
16273	D10	A

30/11/2017 12:04:27 PM



PROPERTY DESCRIPTION

LOT 1 & 2 ON RP 617280
LGA: ROCKHAMPTON REGIONAL COUNCIL
LOT 1 AREA: 5,984m²
LOT 2 AREA: 13,630m²

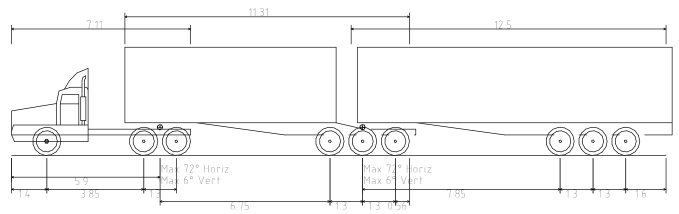
N

LEGEND

EPP — EXISTING POWER POLE

NOTE

1. REFER TO TRAFFIC ENGINEERS REPORT FOR DETAILS



B-Double (26.0m)

Overall Length	26.000m
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	15.000m

NOT TO SCALE

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SCALE 1:750

5 0 10 20 30 40m
Metres

18/04/2018 4:05:12 PM

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B	11.04.18	MG	AREAS UPDATED/ FOOTPATH ADDED	

PROJECT DETAILS
SERVICE STATION DEVELOPMENT
for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

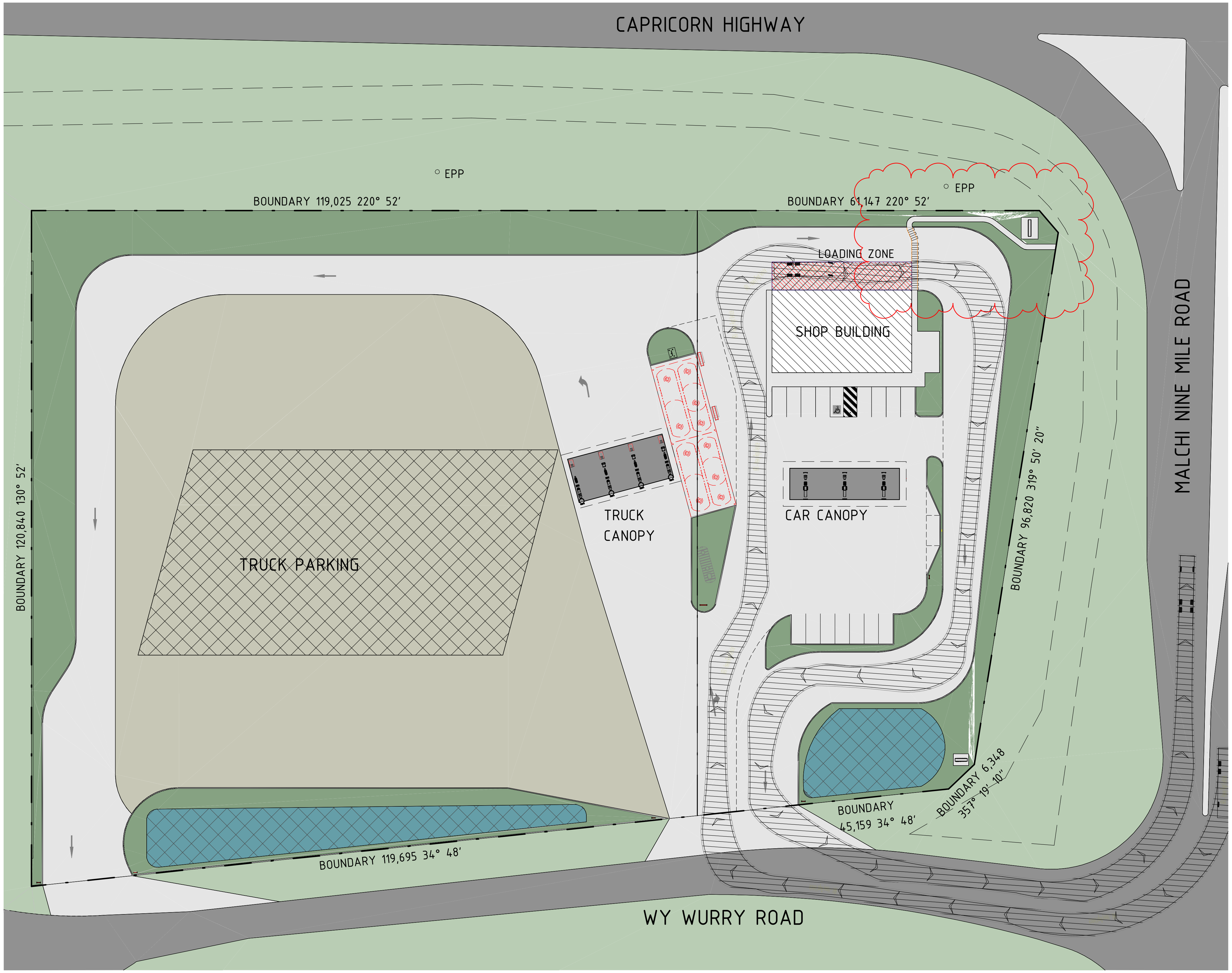
DRAWING TITLE
SWEPT PATH ANALYSIS - FUEL DELIVERY TANKERS

STATUS
DA ISSUE

DRAWN	APPROVED
MG	LC LAC

DATE CREATED	A1 SCALE	A3 SCALE
24.08.17		As indicated

DRAWING NO		REV
16273	D11	B



SCALE 1:750

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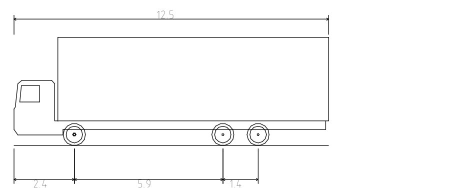
LEGEND

EPP EXISTING POWER POLE

NOTE

1. REFER TO TRAFFIC ENGINEERS REPORT FOR DETAILS



NOT TO SCALE

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/146-2017

Dated: 27 July 2018

100 0 100 200 300 400 500m
Metres

18/04/2018 4:05:58 PM

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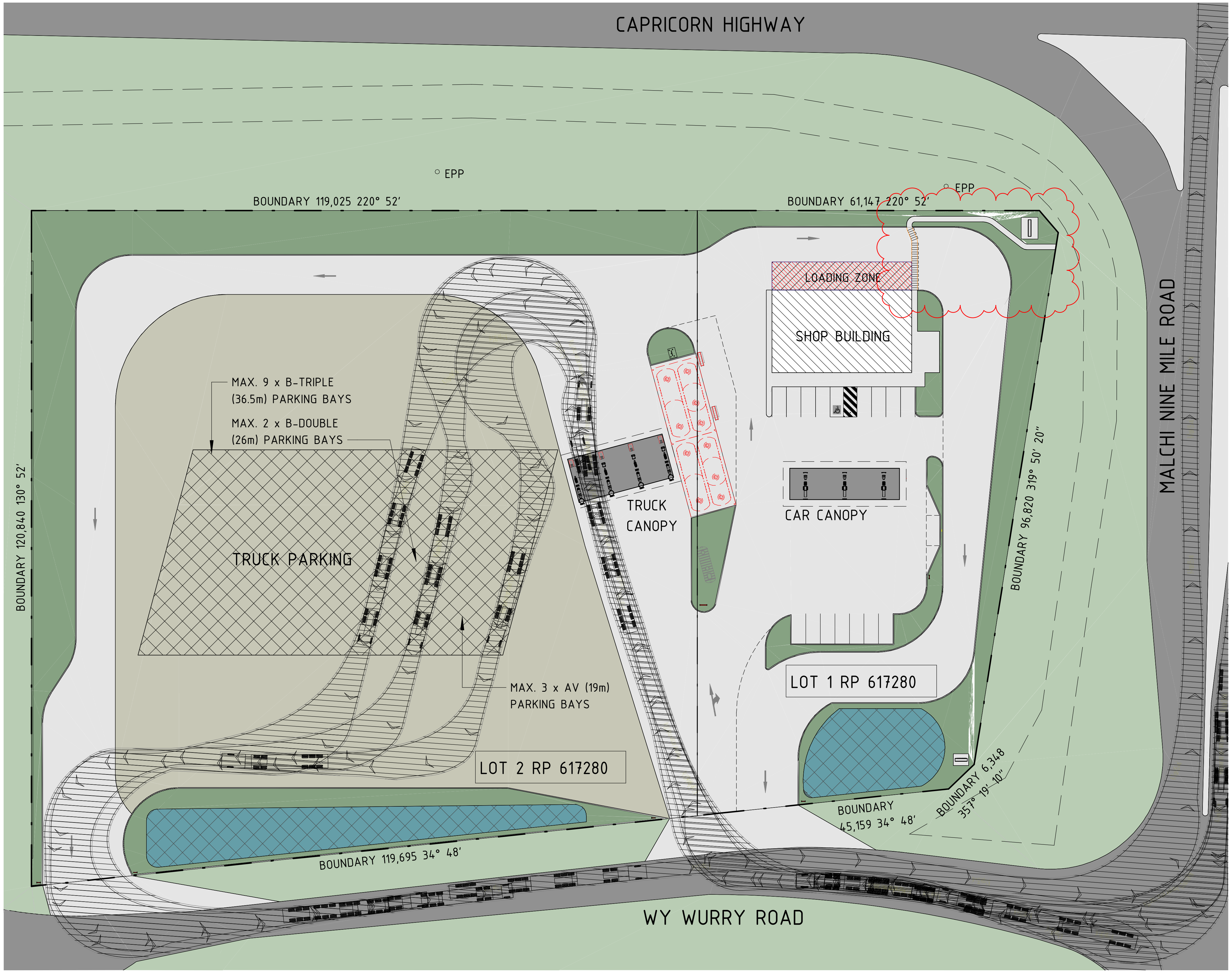
REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	MG	DA ISSUE	DGC
A	30.11.17	MG	DA ISSUE	
B	11.04.18	MG	AREAS UPDATED/ FOOTPATH ADDED	

PROJECT DETAILS
SERVICE STATION DEVELOPMENT for CORBETS GROUP CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
SWEPT PATH ANALYSIS - SERVICE VEHICLE

STATUS
DA ISSUE

DRAWN	APPROVED		
MG	LC		LAC
DATE CREATED	A1 SCALE	A3 SCALE	
24.08.17		As indicated	
DRAWING NO		REV	
16273	D12	B	



SCALE 1:750

PROPERTY DESCRIPTION

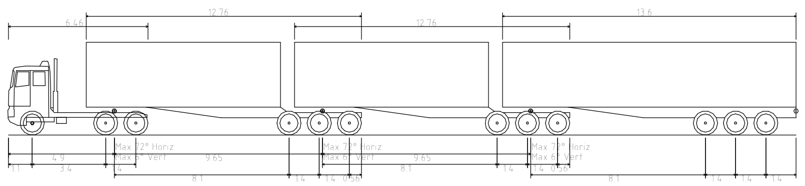
LOT 1 & 2 ON RP 617280
LGA: ROCKHAMPTON REGIONAL COUNCIL
LOT 1 AREA: 5,984m²
LOT 2 AREA: 13,630m²

LEGEND

EPP EXISTING POWER POLE

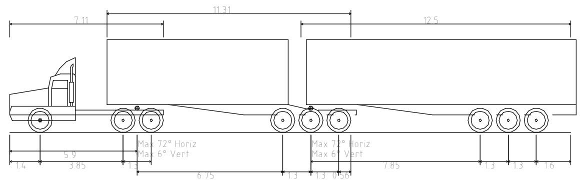
NOTE

1. REFER TO TRAFFIC ENGINEERS REPORT FOR DETAILS



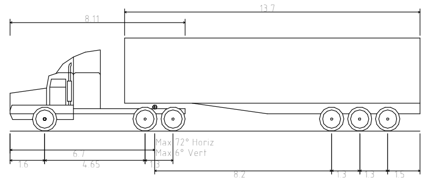
B-Triple (36.5 m)

Overall Length	36.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.455m
Track Width	2.500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	15.000m



B-Double (26.0m)

Overall Length	26.000m
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	15.000m



Prime mover and semi-trailer (19 m)

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

NOT TO SCALE

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

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Development Permit No.: D/146-2017

Dated: 27 July 2018

5 0 10 20 30 40m
Metres

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A	30.11.17	MG	DA ISSUE	
B	11.04.18	MG	AREAS UPDATED/ FOOTPATH ADDED	
				DGC

PROJECT DETAILS
SERVICE STATION DEVELOPMENT
for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
SWEPT PATH ANALYSIS - TRUCK PARKING

STATUS
DA ISSUE

DRAWN	APPROVED
MG	LC LAC

DATE CREATED	A1 SCALE	A3 SCALE
24.07.17		As indicated

DRAWING NO		REV
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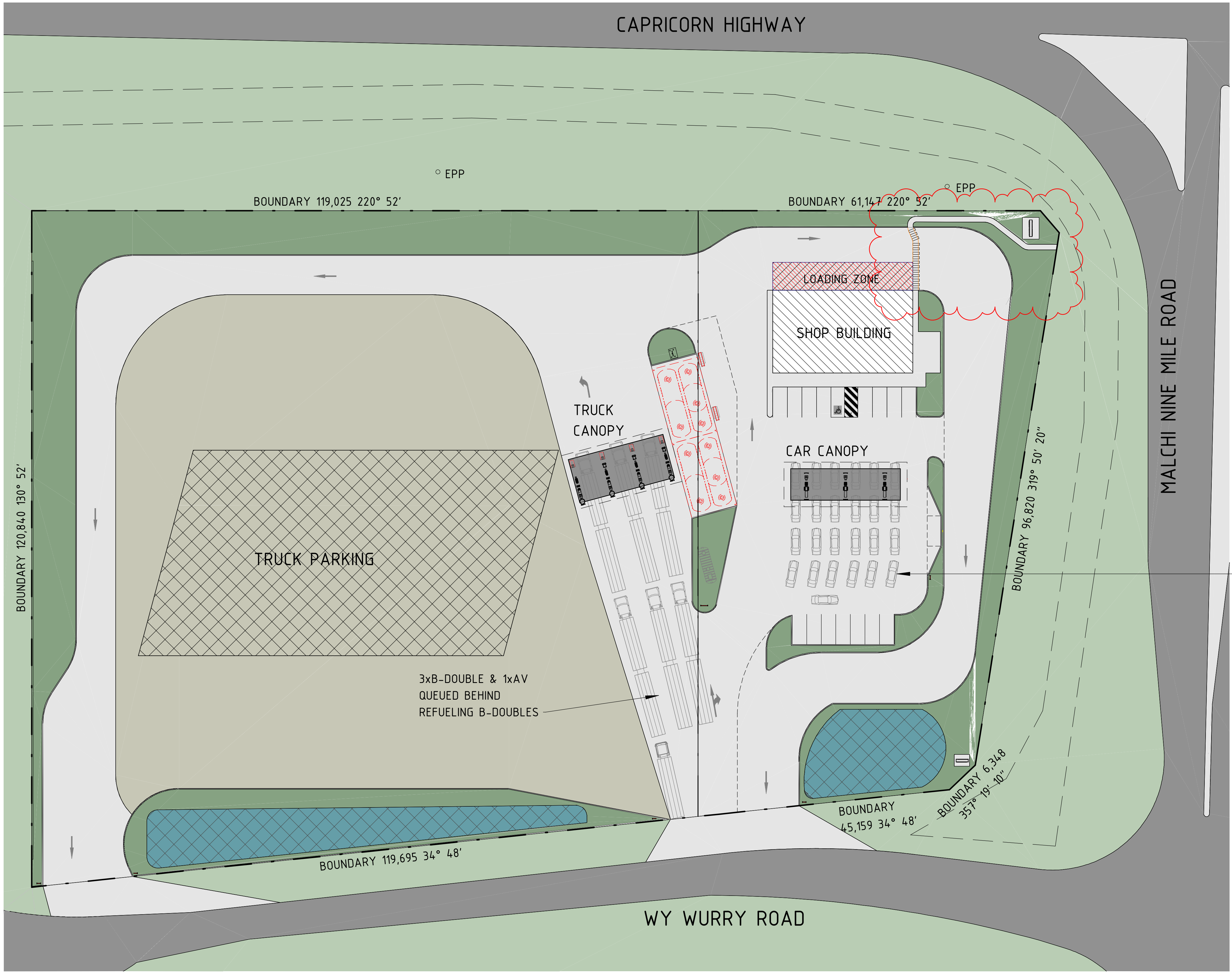

PROPERTY DESCRIPTION

LOT 1 & 2 ON RP 617280
LGA: ROCKHAMPTON REGIONAL COUNCIL
LOT 1 AREA: 5,984m²
LOT 2 AREA: 13,630m²

LEGEND

EPP EXISTING POWER POLE

NOTE

1. REFER TO TRAFFIC ENGINEERS REPORT FOR DETAILS

NOT TO SCALE

QUEUING MIN. 3 CARS
BEHIND FORWARD
DISPENSER

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

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Dated: 27 July 2018

SCALE 1:750

5 0 10 20 30 40m
Metres

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1	28.08.17	MG	DA ISSUE	
A	30.11.17	MG	DA ISSUE	
B	11.04.18	MG	AREAS UPDATED/ FOOTPATH ADDED	

PROJECT DETAILS
SERVICE STATION DEVELOPMENT
for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
SWEPT PATH ANALYSIS - QUEUING PLAN

STATUS
DA ISSUE

DRAWN	APPROVED		
MG	LC	LAC	
DATE CREATED	A1 SCALE	A3 SCALE	
24.08.17		As indicated	
DRAWING NO		REV	
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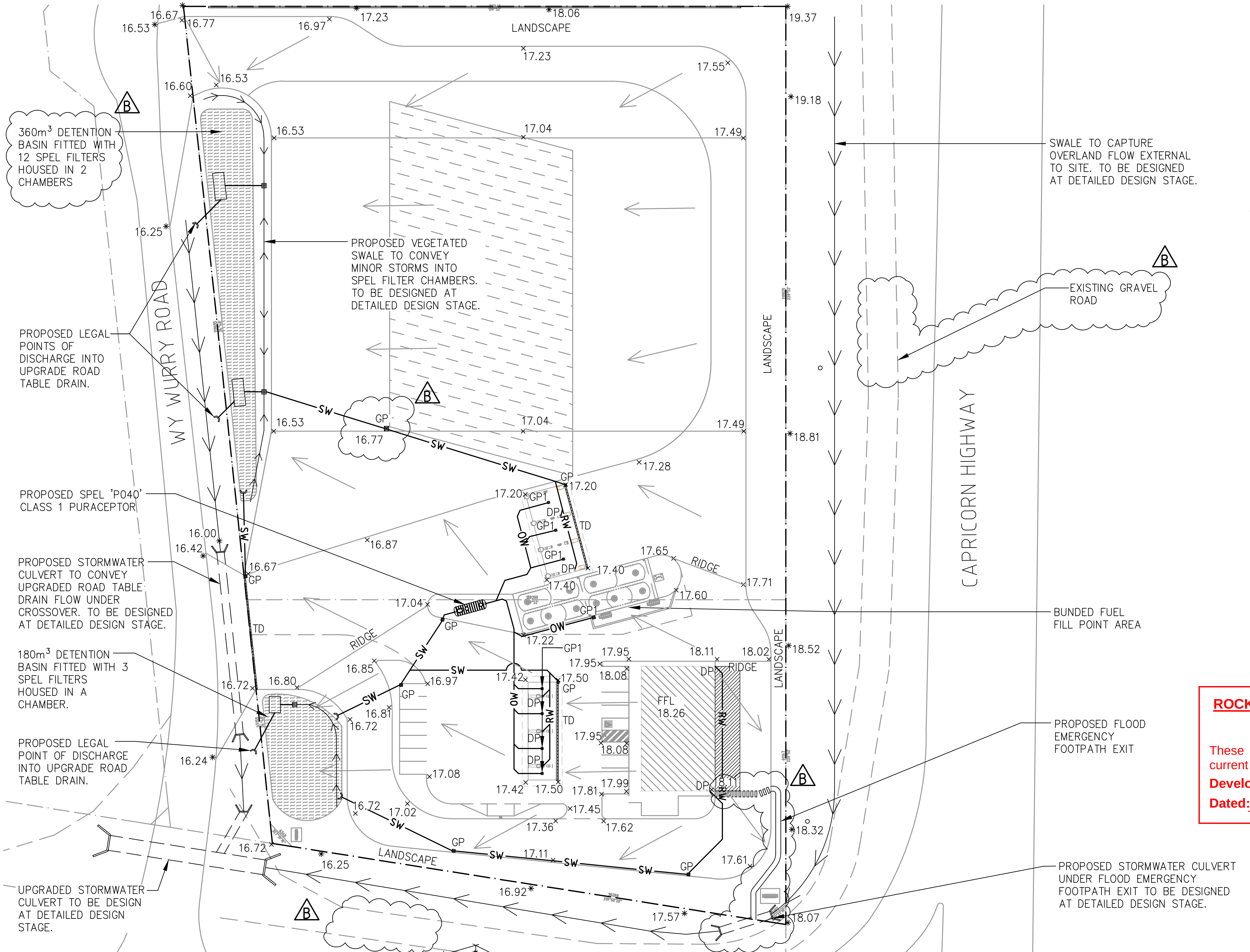

RPD
LOT 1 ON RP617280
AREA: 5984m²

LOT 2 ON RP617280
AREA: 1.363ha

LGA: ROCKHAMPTON REGIONAL COUNCIL

LEGEND:

	PROPERTY BOUNDARY
	PROPOSED STORMWATER
SW	EXISTING STORMWATER
	PROPOSED OILY WATER
	PROPOSED RAINWATER
GP	GULLY PIT FITTED WITH SPEL STORMSACKS
EGP	EXISTING GULLY PIT
GP1	OILY WATER GULLY PIT (WATER SEALED)
MH	STORMWATER MANHOLE
TD	TRENCH DRAIN
DP	DOWN PIPE
×9.99	PROPOSED SPOT HEIGHT
∗9.99	EXISTING SPOT HEIGHT
FFL 9.99	FINISHED FLOOR LEVEL
→	GENERAL DIRECTION OF SURFACE FALL

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

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Dated: 27 July 2018

PROJECT MANAGERS | PLANNERS
DESIGNERS | ENGINEERS

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REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	DY	ISSUED FOR CLIENT REVIEW	BM
A	28.11.17	LS	TRUCK CANOPY AMENDED. LEVELS AMENDED	LS
B	11.04.18	LS	DETENION SIZE & FILTERS QTY REVISED. FOOTPATH & GP ADDED	

PROJECT DETAILS

PROPOSED SERVICES STATION
CNR CAPRICORN HWY &
HALL ROAD
GRACEMERE, QLD.

DRAWING TITLE

CONCEPTUAL STORMWATER MANAGEMENT PLAN

STATUS

DA ISSUE

DRAWN	APPROVED		
DY	JA		
DATE CREATED	A1 SCALE	A3 SCALE	
15.08.17	1:375	1:750	
DRAWING NO			REV
16273-D17			B

RPD
LOT 1 ON RP617280
AREA: 5984m²

LOT 2 ON RP617280
AREA: 1.363ha

LGA: ROCKHAMPTON REGIONAL COUNCIL

LEGEND:

— — - —	PROPERTY BOUNDARY
——17.00——	PROPOSED CONTOUR
FFL 18.26	FINISHED FLOOR LEVEL
(green)	PROPOSED SURFACE ABOVE DEFINED FLOOD LEVEL OF 17.756 AHD
(pink)	PROPOSED SURFACE BELOW DEFINED FLOOD LEVEL OF 17.756 AHD

FLOOD STORAGE VOLUME

TOTAL POST-DEVELOPMENT STORAGE VOLUME = 11736m³

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/146-2017

Dated: 27 July 2018

10 5 0 10 20 30m

Metres

PROJECT MANAGERS | PLANNERS
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REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	DY	ISSUED FOR CLIENT REVIEW	BM
A	28.11.17	LS	TRUCK CANOPY AMENDED. LEVELS AMENDED	LS
B	16.04.18	LS	FLOOD EMERGENCY FOOTPATH EXIT ADDED	

PROJECT DETAILS

PROPOSED SERVICES STATION
CNR CAPRICORN HWY &
HALL ROAD
GRACEMERE, QLD.

DRAWING TITLE

POST-DEVELOPMENT FLOOD STORAGE PLAN

STATUS

DA ISSUE

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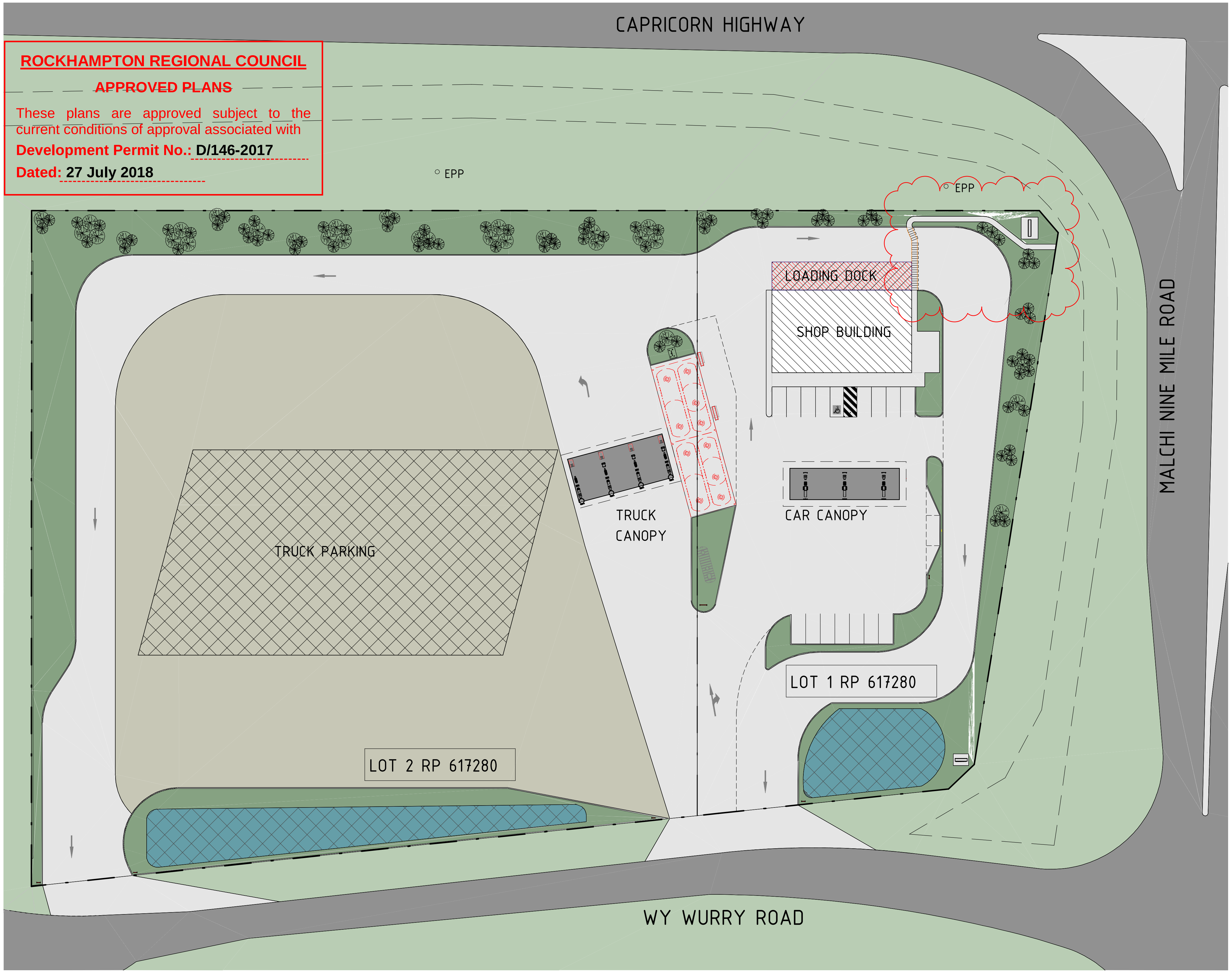
25.08.17	1:375	1:750

DRAWING NO: 16273-D18 REV: B



SCALE 1:750

PROPERTY DESCRIPTION

LOT 1 & 2 ON RP 617280
LGA: ROCKHAMPTON REGIONAL COUNCIL
LOT 1 AREA: 5,984m²
LOT 2 AREA: 13,630m²

NOTES

- THE SITE CONTAINS NO SIGNIFICANT EXISTING VEGETATION.
- AREAS AROUND ENTRANCES, EXITS & PEDESTRIAN CROSSING POINTS TO CONSIST OF LOW SHRUBS & GROUND COVERS TO ENABLE GOOD VISIBILITY FOR SAFE MOVEMENT OF VEHICLES & PEDESTRIANS.
- LANDSCAPE PLANTINGS TO BE VERIFIED WHEN DETAILED DESIGN LOCATES PROPOSED UNDERGROUND SERVICE LINES, WITH AN EMPHASIS ON DROUGHT HARDY SPECIES.
- ALL PAVEMENT AREAS TO HAVE 150mm CONTINUOUS CONCRETE BARRIER TO LANDSCAPE AREAS.
- THIS DRAWING IS INTENDED AS A LANDSCAPE CONCEPT DRAWING ONLY. AT THE OPERATIONAL WORKS STAGE, A FULLY DETAILED LANDSCAPE PLAN WILL BE SUBMITTED, ALONG WITH ALL RELEVANT DETAILS & PLANT SPECIES.
- LOCAL NATIVE SPECIES WILL BE SELECTED WHERE APPROPRIATE.

LEGEND

LOW HEIGHT SHRUBS

MULCHED GARDEN BEDS WITH MASS PLANTINGS OF LOW LEVEL SHRUBS & GROUND COVERS

BIO-RETENTION

SHADE & FEATURE TREES

5 0 10 20 30 40m
Metres

18/04/2018 4:09:38 PM

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PROJECT DETAILS
SERVICE STATION DEVELOPMENT
for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
CONCEPT LANDSCAPE PLAN

STATUS
DA ISSUE

DRAWN	APPROVED		
MG	LC	LAC	
DATE CREATED	A1 SCALE	A3 SCALE	
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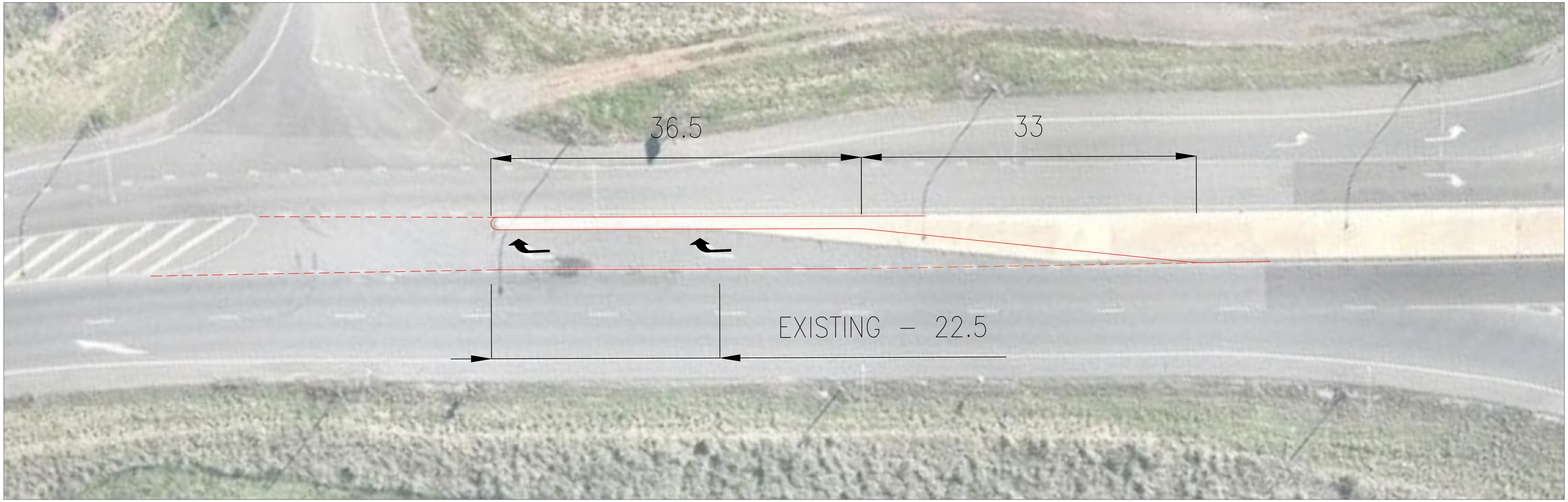
DRAWING NO		REV	
16273	D20	B	



ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

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Development Permit No.: D/146-2017

Dated: 27 July 2018

0 2 4 6 8m SCALE 1:200 (A1)	Project: CNR CAPRICORN HWY AND WY WURRY ROAD GRACEMERE	Client: *COBERT'S GROUP C/O: TFA PROJECT GROUP PTY LTD* Title: TURN LANE CONCEPT CHANNELISED RIGHT TURN	LAMBERT & REHBEIN ENGINEERS • MANAGERS • SCIENTISTS CBD HOUSE LEVEL 3, 120 WICKHAM STREET FORTITUDE VALLEY QLD 4006 P.O. BOX 112 FORTITUDE VALLEY QLD 4006 TELEPHONE (07) 3250 9000 FACSIMILE (07) 3250 9001 EMAIL mail@lar.net.au A.C.N. 010 451 902 Drawn: JC Checked: Approved:	A 19/03/18 Rev. Date	Figure No: B17141-SK-003 Scale: AS SHOWN File Ref: SEE BELOW A1 Sheet Size

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SITE BASED STORMWATER MANAGEMENT PLAN

CORBET'S GROUP - GRACEMERE

PROPOSED SERVICE STATION & TRUCK REFUELLING DEVELOPMENT

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

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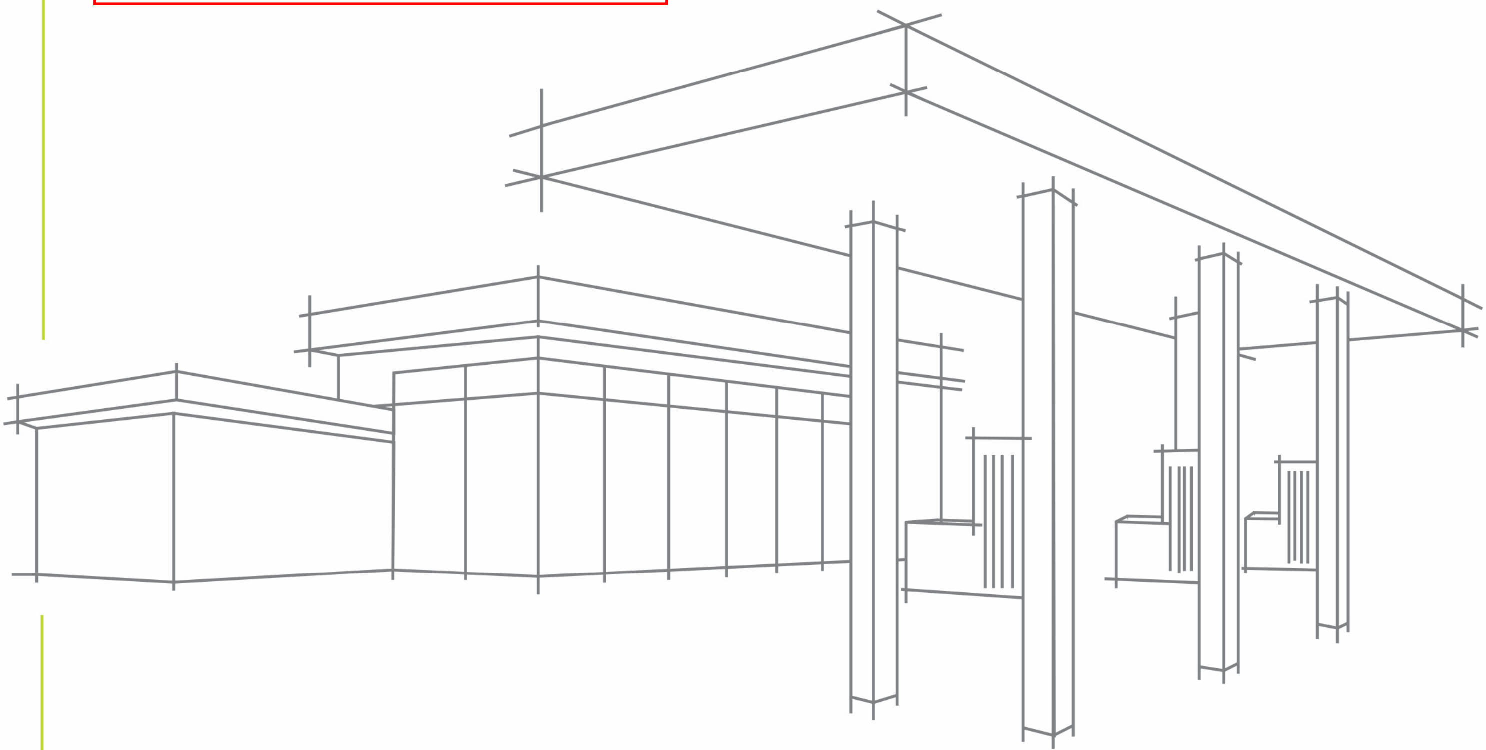
Dated: 27 July 2018



TfA Project Group

CREATE · PLAN · DELIVER

PROJECT MANAGERS | PLANNERS | DESIGNERS | ENGINEERS

SITE BASED STORMWATER MANAGEMENT PLAN

Corbet's Group - Gracemere

Proposed Service Station & Truck Refuelling Development

CLIENT: Corbet Property Group Pty Ltd (Corbet's Group)

ADDRESS: Lot 1 Capricorn Highway, Gracemere QLD

TFA REFERENCE: 16273

TFA CONTACT: Leo Salinas

Document Control

REVISION	DATE	PREPARED BY	REVIEWED BY	COMMENTS
D	09 May 2018	L. Salinas	J. Avella	MUSIC model Stormwater Catchments Plan amended & SPEL MUSIC nodes efficiencies included in report.
C	10 April 2018	L. Salinas	J. Avella	Issue for Approval
B	05 Dec 2017	L. Salinas	J. Avella	Issue for Approval
A	12-Nov-17	D. Yuen	J. Avella	Preliminary

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TABLE OF CONTENTS

APPENDICES

FIGURES

TABLES

1.0 INTRODUCTION

This Site Based Stormwater Management Plan (SBSMP) has been prepared by TFA Group on behalf of Corbet's Group (the applicant). The development consists of a new service station & truck refuelling facility, comprising a paypoint building, canopies over vehicle & truck fuel dispensing areas, vehicle and truck parking areas with associated driveways, walkways and landscape areas. The purpose of this document is to verify that stormwater quality and quantity have been considered as part of this development and does not have any adverse impact on the downstream environment as outlined in the State Planning Policy July 2017 and Rockhampton Regional Planning Scheme 2015 for design and construction of civil infrastructure works.

The SBSMP is part of the Development Approval process and addresses both the construction and operational phases of the development. Table 1 below shows additional details of the proposed development. The proposed site layout plan is shown in **Appendix A.**

Table 1: Details of proposed development

Developer	Corbet's Group
Address	Lot 1 Capricorn Highway, Gracemere QLD
Property Description	Lot 1 & 2 on RP617280
Area of Development	19,614 m^2
Stormwater Risk Classification	High Risk (due to the storage and transfer on site of petroleum products that have the potential to cause harm to the environment, if released)
Existing Land Use	Vacant Land

2.0 THE SITE

The development site is located on the corner of Capricorn Highway and Hall Road, Gracemere QLD 4702, within Rockhampton Regional Council area. The subject site is in Lot 1 & 2 on RP617280. It has a regular shape containing an area of approximately 19,614m². The site is currently vacant. A location of the site is shown on Figure 1.

A geotechnical investigation will be completed to determine soil type and any specific treatment or management requirements to mitigate erosion or pollution of the environment. This will be developed at the Operational Works stage.

Figure 1: Location of the proposed development site

3.0 SITE TOPOGRAPHY AND EXISTING DRAINAGE

Refer to **Appendix B** for the survey plans provided by Hoffman Surveyors dated 23 February 2017, which shows the condition of the site.

The development site has existing surface levels approximately between RL 19.38m AHD and 16.11m AHD. The site has abundant grass cover with numerous trees across the site.

According to the survey information the land falls generally from South East to North West. All of the stormwater runoff from the site discharges as overland runoff into an existing earth table drain, which then conveys through a culvert to the land on the opposite side of Wy Wurry Road. It has been assumed that the legal point of discharge for the proposed development will be the land on the opposite side of Wy Wurry Road. Refer to **Appendix D** for the Conceptual Stormwater Management Plan for the proposed development.

A landscape plan will be prepared for the final form of the development site that will incorporate stormwater measures.

4.0 FLOODING

The Flood Hazard Map for Gracemere obtained from Rockhampton Regional Council on 25th May 2017 indicates that the proposed site will most likely be affected by 1% AEP flood levels. As notified by council, the 1% AEP flood level is expected to be RL 17.756m AHD, which was determined from AECOM's latest (12 April 2017) GPU model. According to Rockhampton Regional Council's Flood Hazard Overlay Code, the minimum building floor level shall be 500mm above the defined flood level, therefore the minimum Building Floor Level is designed to be RL 18.256m AHD. The Flood Hazard Map can be found in **Appendix C.** A close up of the map is shown in Figure 2 below.

Volumetric analysis using AutoCAD Civil 3d shows that with the proposed site grading levels, the 1% AEP flood storage volume in the post development scenario will be matching or exceeding existing. Refer to the Flood Storage Plan in **Appendix D** for the extent of flooding and volume amounts.

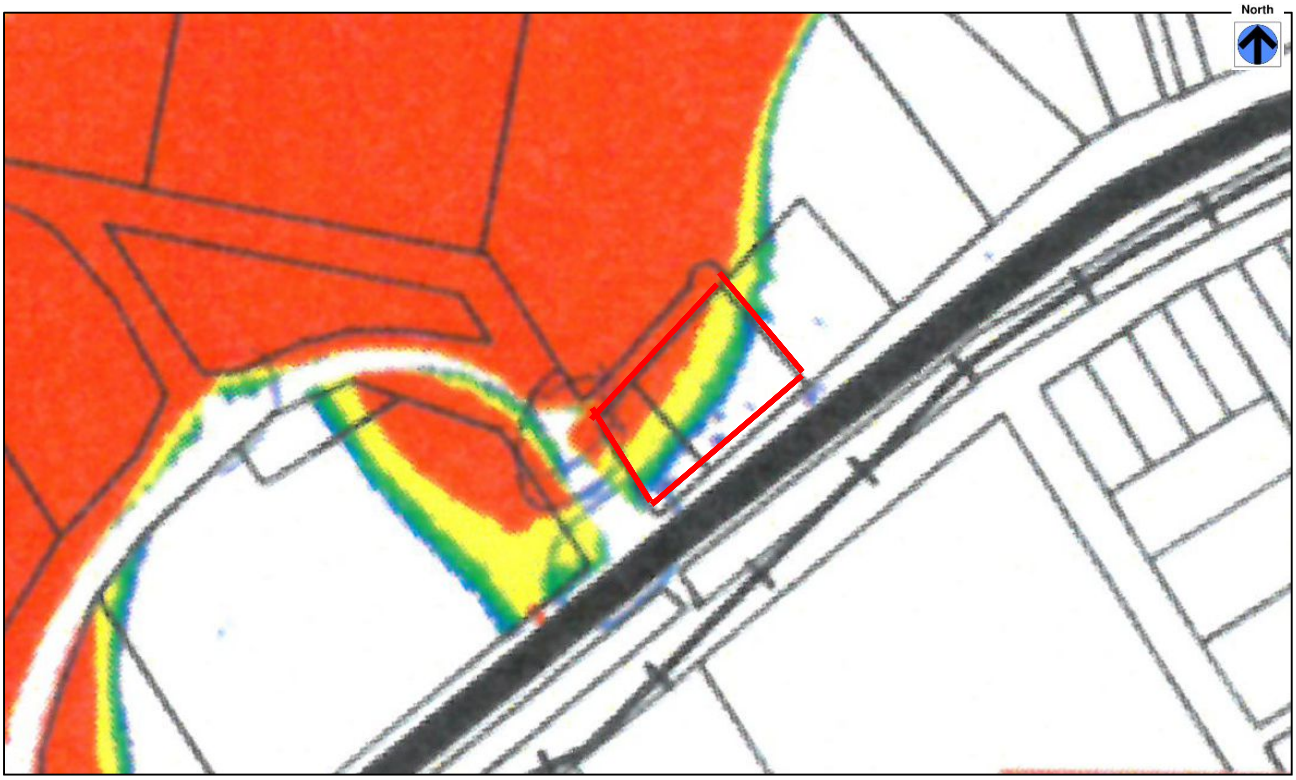


Figure 2: Development Flooding Information

5.0 PROPOSED DRAINAGE LAYOUT

The post development stormwater drainage design generally maintains the overall catchment boundary. The design separates the high risk (hydrocarbon generating e.g. under the canopies) area from the low risk areas (the rest of the site). Any spillage or minor spills from under the canopy will be captured by grated gully pits and directed to a SPEL Puraceptor for hydrocarbon removal, which then discharges to the stormwater network. There will be two fuel delivery fill points (unloading area), both of which are located outside the canopy areas. Any spills that might occur during unloading of fuel in these unloading areas will be channelled by bunding surrounding the fill points, which are then captured by a grated gully pit and directed to the proposed SPEL Puraceptor. A licensed contractor will remove the contents of the Puraceptor when required.

Stormwater runoff generated from low risk areas (the rest of the site) will be captured and conveyed by gully pits and underground pipes, which then discharge to the stormwater network. All the stormwater runoff generated from high & low risk areas on the site will be treated using a combination of SPEL Stormsacks and SPEL filters or similar approved treatment devices for nutrients removal. SPEL filters will be provided in lieu of bioretention basins due to the limited depth available to fit the bioretention. Additional flows above the pre-development flows will be detained by adequately sized onsite detention basins before ultimately discharging to the proposed legal points of discharge along Wy Wurry Road. The SPEL filters will be housed within a concrete chamber located within the detention basins. Refer to **Appendix D** for a concept plan of the stormwater drainage and site grading.

6.0 WATER QUANTITY ASSESSMENT

The purpose of this part of the assessment is to investigate whether there is a need to attenuate stormwater flows to negate any adverse impacts on upstream or downstream environments. Stormwater runoff from both pre and post-development scenarios will be calculated and the results analysed and possible solutions proposed.

6.1 Catchment Analysis

The total site area is 19,614m² (1.961 Ha), details of the pre-development catchment are shown in Figure 3 and Table 2 below, which shows the surface types, areas, percentage imperviousness and fraction impervious.

Figure 3: Pre-development catchment details

Table 2: Pre-development catchment characteristics

Surface Type	Area (m²)	Percentage Imperviousness	Fraction impervious
Roof and Paved Area	0	100	0.00
Landscaped Area	19,614	0	

Details of the post-development catchment areas are shown in Figure 4 and Table 3 below, which shows the surface types, areas, percentage imperviousness and fraction impervious.

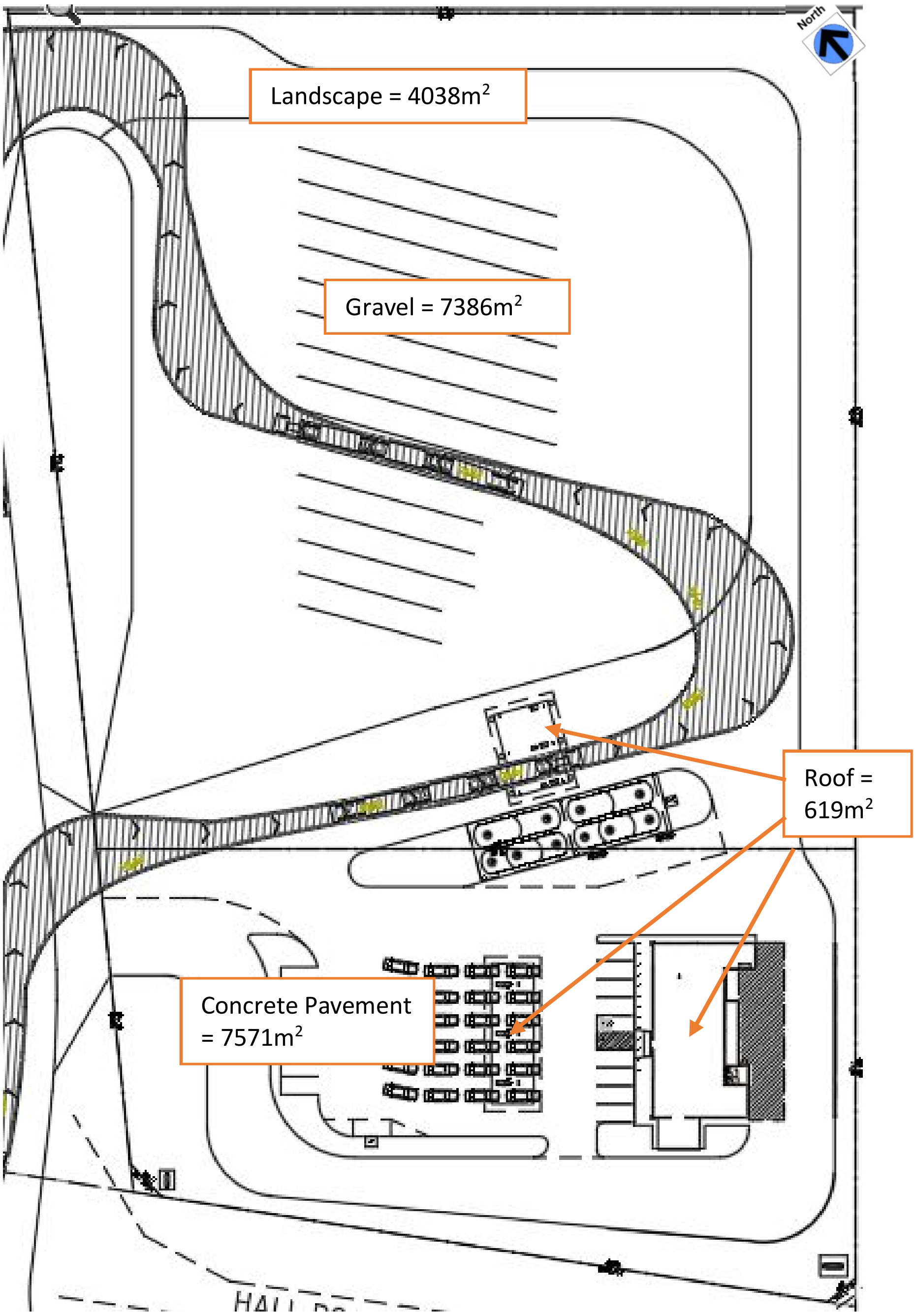


Figure 4: Post-development catchment details

Table 3: Post-development catchment characteristics

Surface Type	Area (m²)	Percentage Imperviousness	Fraction impervious
Roof and Paved Area	8,190	100	0.61
Gravel area	7,386	50	
Landscaped Area	4,038	0	

Table 2 and Table 3 above show that the fraction impervious for the post-development case is higher than the fraction impervious of the pre-development case. This will result in increased peak flows in the post-development case, therefore onsite stormwater detention is required.

6.2 Stormwater Detention Sizing

6.2.1 Rational Method

The rational method was used to calculate the stormwater runoff flows from the site for the pre and post-development scenarios. The formula is as follows:

$$Qy = (Cy \times {}^{t}I_{y} \times A) / 360 \qquad \textbf{(QUDM 2013 Equation 4.2)}$$

Where:

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

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

A = area of catchment (ha)

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

t = the nominal design storm duration as defined by the time of concentration (tc).

The value '360' is a conversion factor to suit the units used.

6.2.2 Catchments

The existing catchment boundary has been maintained in the post development scenario. Pre and post-development catchment information is tabulated in Table 4 below.

Table 4: Catchment details

Pre-development Area (Ha)	Pre-development fraction impervious	Post-development Area (Ha)	Post-development fraction impervious
1.961	0.00	1.961	0.61

6.2.3 Time of concentration

The time of concentration of the pre-development scenario was calculated using the Friend's equation for overland sheet flow and figure 4.8 and 4.9 of the Queensland Urban Drainage Manual (QUDM 2013). The equation is shown below:

$$t_c = (107.n\,.L^{0.333}) / S^{0.2} \qquad \textbf{(QUDM 2013: Equation 4.5)}$$

Where:

tc = overland sheet flow travel time (min)

L = overland sheet flow path length (m)

n = Horton's surface roughness factor

S = slope of surface (%)

The value '107' is a conversion factor to suit the units used.

Based on the survey information the assumed flow path for this calculation is indicated in Figure 5, a thick red line represents the flow path.

Table 5: Pre-development time of concentration assumptions

Assumptions	Value
Overland sheet flow length (m)	127.0
Overland sheet flow slope (%)	2.45
Horton's coefficient *(Table 4.6.5 QUDM 2013)*	0.045
Overland sheet flow travel time (min)	19.00

The time of concentration for post-development scenarios was determined using clause 5.4.4 of AS3500.3:2015 Plumbing and Drainage: Stormwater Drainage. Table 6 below shows the times of concentration used in the water quantity assessment.

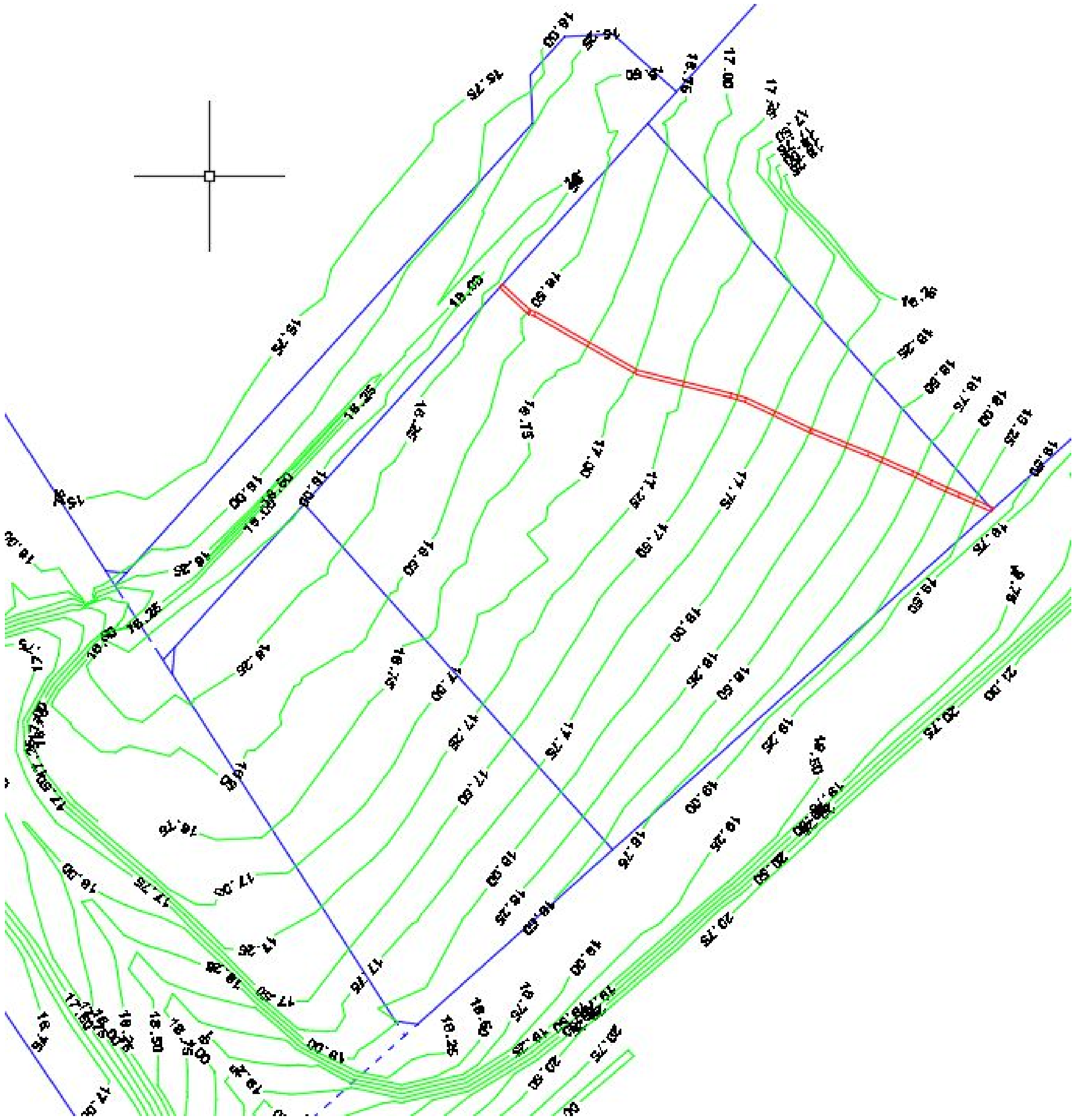


Figure 5: Assumed site overland flow path for time of concentration calculations

Table 6: Time of concentration for the catchment

Catchment	Time of concentration
Pre-development	19.00
Post-development	5.00

6.2.4 Coefficient of discharge

From *Table 4.5.3* and *4.5.4* of QUDM, a one hour rainfall intensity for a 1 in 10 year ARI (1I10) of 60.9mm/hr and fraction impervious fi of 0.00 has a C10 value for the pre-development catchment of 0.70. The post- development C10 value is 0.78. Table 7 below shows the Fy factor used to calculate the Cy value for each ARI.

Table 7: Fy factors for the nominated ARI's

	1 year ARI (mm/hr)	2 year ARI (mm/hr)	5 year ARI (mm/hr)	10 year ARI (mm/hr)	20 year ARI (mm/hr)	50 year ARI (mm/hr)	100 year ARI (mm/hr)
F_y	0.80	0.85	0.95	1.00	1.05	1.15	1.20

The coefficient of discharge for both pre and post-development catchments is calculated based on equation 4.4 of QUDM and the results shown in *Table 8*.

Table 8: Coefficients of discharge for pre and post-development scenarios

Coefficient of Discharge	1 year ARI	2 year ARI	5 year ARI	10 year ARI	20 year ARI	50 year ARI	100 year ARI
Pre-development Catchment	0.56	0.60	0.67	0.70	0.74	0.81	0.84
Post-development Catchment	0.62	0.66	0.74	0.78	0.82	0.90	0.94

6.2.5 Rainfall Intensities

The rainfall intensities for the site were read from an IFD table obtained from the BOM website for the project site on 30 May 2017. The rainfall intensities for a given time of concentration for the pre and post-development cases for the nominated ARI's are shown in Table 9.

Table 9: Rainfall intensities for the nominated ARI's for the pre-development scenario

t_c (mins)	1 year ARI (mm/hr)	2 year ARI (mm/hr)	5 year ARI (mm/hr)	10 year ARI (mm/hr)	20 year ARI (mm/hr)	50 year ARI (mm/hr)	100 year ARI (mm/hr)
5.00	103	134	172	196	228	271	306
19.00	61.9	79.7	101.1	114.0	131.8	155.8	175.5

6.2.6 Stormwater Design Flows

Table 10 shows the stormwater runoff flows for the pre-development case calculated using the rational method.

Table 10: Stormwater flows generated by the pre-development catchment

Catchment	Q1 *(l/s)*	Q2 *(l/s)*	Q5 *(l/s)*	Q10 *(l/s)*	Q20 *(l/s)*	Q50 *(l/s)*	Q100 *(l/s)*
A (QoutPC)	188.8	258.3	366.4	434.8	527.8	683.3	803.2

Table 11 shows the stormwater runoff flows for the post-development case calculated using the rational method

Table 11: Stormwater flows generated by the post-development catchment

Catchment	Q1 *(l/s)*	Q2 *(l/s)*	Q5 *(l/s)*	Q10 *(l/s)*	Q20 *(l/s)*	Q50 *(l/s)*	Q100 *(l/s)*
A (Qin)	346.6	479.1	687.3	824.4	1017.0	1310.9	1544.6

As can be seen from Table 12 below, the development will increase stormwater runoff for the catchment for the nominated ARI's, therefore onsite stormwater detention will be required to mitigate the peak discharge and achieve the "no worsening" of the stormwater drainage conditions external to the site.

Table 12: Stormwater flow differences between post and pre-development for standard ARI's

Change in Flow	Q1 *(l/s)*	Q2 *(l/s)*	Q5 *(l/s)*	Q10 *(l/s)*	Q20 *(l/s)*	Q50 *(l/s)*	Q100 *(l/s)*
A	157.8	220.8	320.9	389.7	479.2	627.6	741.4

Table 13: Stormwater runoff bypassing the detention basin for the post-development catchment

Catchment	Q1 *(l/s)*	Q2 *(l/s)*	Q5 *(l/s)*	Q10 *(l/s)*	Q20 *(l/s)*	Q50 *(l/s)*	Q100 *(l/s)*
A (QoutL)	3.6	4.9	7.1	8.5	10.4	13.0	16.0

The stormwater flows as a result of bypassing landscaped areas are shown in Table 13 above, which further reduce allowable post development flows from the entire site to achieve pre-development flows. The adjusted allowable discharge from the detention basin is shown in Table 14 below.

Qout = QoutPC – QoutL

Table 14: Allowable stormwater discharge from the detention basin

Catchment	Q1 *(l/s)*	Q2 *(l/s)*	Q5 *(l/s)*	Q10 *(l/s)*	Q20 *(l/s)*	Q50 *(l/s)*	Q100 *(l/s)*
A (QoutPC)	188.8	258.3	366.4	434.8	527.8	683.3	803.2
A (QoutL)	3.6	4.9	7.1	8.5	10.4	13.0	16.0
A (Qout)	**185.2**	**253.4**	**359.3**	**426.3**	**517.4**	**670.0**	**787.3**

6.2.7 Required Detention Volume

The total onsite detention volume will restrict the post-development flows to pre–development levels. The required detention volumes and outlet arrangement was modelled, designed and sized using DRAINS software. Table 15 shows pre and post-development flow rates compared to the design output flows from DRAINS based on the detention storage, and the detention storage volume required to achieve the "no-worsening" of the drainage conditions external to the development site for the nominated ARI's. A screenshot of the model in DRAINS is shown in Figure 6 below.

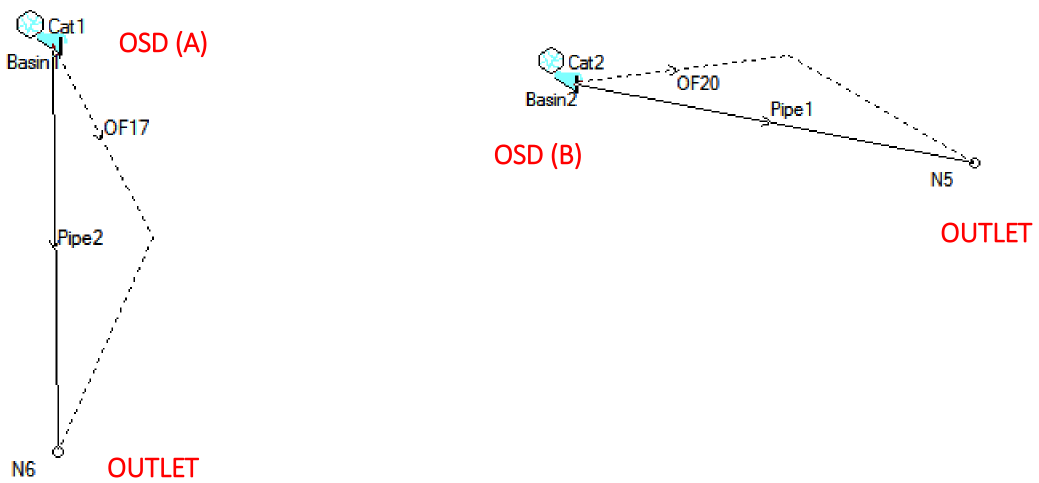


Figure 6: Screenshot of the drainage model from DRAINS software

Table 15: Required detention volume for the catchment

Design Storm	Post Development	Allowable stormwater discharge	Post Development achieved (From DRAINS)	Required Detention volume (From DRAINS)
ARI	*Flow rate*	*Flow rate*	*Flow rate*	*Volume*
Years	*L/S*	*L/S*	*L/S*	*L*
1	350.2	185.2	183.0	183,491
2	484.0	253.4	251.0	234,176
5	694.4	359.3	312.0	323,980
10	832.9	426.3	348.0	386,523
20	1017.4	517.4	391.0	477,194
50	1324.4	670.0	656.0	443,580
100	1560.5	787.3	774.0	530,530

Based on Table 15 above, the minimum required detention volume is 540kL to mitigate post-development flows, consequently, two landscaped detention basins will be constructed with the outlet arrangement as follows:

- A 360kL detention basin with 6 x 225mm diameter pipe outlets at the base of the detention for OSD A. High level outlet for ARI 50 and above will consist of 5 x 225mm diameter pipes.
- A 180kL detention basin with 6 x 150mm diameter pipe outlets at the base of the detention for OSD B. High level outlet for ARI 50 and above will consist of 3 x 150mm diameter pipes.

The above mentioned outlet arrangement will ensure that the design flow rates do not exceed pre-development flow rates for the nominated design storm events. Refer to **Appendix G** for outputs from DRAINS.

7.0 WATER QUALITY ASSESSMENT

7.1 Construction Phase

Impacts on receiving waters and surrounding areas will be minimised during the construction phase with measures as outlined in this SBMP and the Erosion and Sediment Control Plan.

7.1.1 Pollutants

Typical pollutants generated during the construction phase of the development are shown below in Table 16.

Table 16: Pollutant typically generated during the construction phase

Pollutant	Sources
Litter	Paper, construction packaging, food packaging, cement bags, off-cuts
Sediment	Unprotected exposed soils and stockpiles during earthworks and building
Hydrocarbons	Fuel and oil spills, leaks from construction equipment
Toxic materials	Cement slurry, asphalt prime, solvents, cleaning agents, wash-waters
pH altering substances	Acid sulphate soils, cement slurry and wash-waters

7.1.2 Performance objectives

The objectives are:

- Minimise the amount of sediment entering waterways and stormwater drains;
- Minimise or prevent environmental harm to waterways and associated ecosystems;
- Minimise localised flooding caused by sediment runoff;
- Minimise exposure of soils.

Table 17: Construction phase performance criteria

Indicator	Water Quality Objectives
pH	6.5 – 8.5
Suspended Solids	Annual Mean < 50mg/L
Oils and Grease	No visible films or odour
Litter/ Gross pollutants	No anthropogenic (man-made) materials greater than 5mm in any dimension
Dissolved oxygen	85-110% saturation

7.1.3 Monitor and maintenance

The general requirement of monitoring during the construction phase will be:

- Work activities are restricted to designated construction areas;
- Earthworks and site clearing are undertaken in accordance with an Erosion and Sediment Control Plan;
- Erosion and sediment control devices are to be constructed/installed in accordance with an Erosion and Sediment Control Plan;

- Inspection of sediment fences, erosion and sediment control structures/devices on a weekly basis as well as after any rain event exceeding 25mm in 24hrs (major storm event);
- Stormwater discharges from the site are not having any adverse effect on the downstream environment;
- Monitoring and recording of the performance of the drainage control devices including water quality testing where required;
- Any failure in the stormwater system shall be immediately rectified to prevent uncontrolled discharge from the site;
- Any failure to the stormwater system causing damage to surroundings should implement immediate remedial work to the damaged area.

7.1.4 Responsibility and reporting

- The contractor shall be responsible for monitoring the performance of all drainage control and erosion and sediment control devices;
- Records of any failures to devices should be kept and reported to the Construction Manager;
- Regular inspections of the devices shall be reported to the Construction Manager;
- Inspections of the devices after heavy rainfall shall be reported to the Construction Manager;

7.2 Operational Phase

7.2.1 Pollutants

The key pollutants typically generated during this phase for the entire catchment are shown in Table 18.

Table 18: Pollutant typically generated during the operational phase

Pollutant	Potential Source
Litter / Gross Pollutants	Waste materials, food, food packaging etc.
Hydrocarbons	Fuel and oil spills, dispensing areas, car park
Nutrients (N & P)	Nitrogen, Phosphorus
Sediments	Aggregates bins, wind deposits and car trails
Surfactants	Detergents, cleaning agents

7.2.2 Water quality objectives

The development is required to achieve the TN, TP and TSS pollutant reductions outlined in Table 19 below.

Table 19: Operational Phase water quality objectives (Central Queensland (south))

Pollutant	Reduction*
Total Suspended Solids	85%
Total Phosphorus	60%
Total Nitrogen	45%
Gross Pollutants >5mm	90%
Hydrocarbon	No visible film or odour

**These values represent the minimum required reductions in the average annual pollutant loads generated from an unmitigated development.*

7.3 Proposed Stormwater Treatment

7.3.1 Stormwater treatment philosophy

Waterways and other aquatic environments are valued by the community for their social, cultural, economic and environmental benefits. Urban runoff, contaminated with nutrients, sediment and other pollutants adversely impacts theses valued resources. Water Sensitive Urban Design (WSUD) is a holistic approach to the planning and design of urban landscapes that minimises theses negative impacts. This approach is used on this project to select the treatment options that considers the civil, landscape and ecological aspects of the site.

7.3.2 Source controls

Rubbish bins can be an effective source control for litter and are appropriate for most developments. Bins will be placed in appropriate areas (such as buildings and staff amenity) to encourage thoughtful waste disposal.

7.3.3 Gross pollutant traps

A GPT is a treatment device designed to capture coarse sediment, trash and vegetation matter in stormwater runoff. GPTs are often used as the first treatment element in a treatment train. SPEL Stormsacks or a similar approved product will be used within this development; the Stormsacks capture 99.99% of gross pollutants and will be installed in gully pits, refer to **Appendix E** for typical details.

7.3.4 Vegetated Swales

Vegetated swales are used to collect and treat minor stormwater flows in the detention basins' perimeter and convey it towards the SPEL Filter chambers for tertiary treatment. They are effective in removal of sediment and total suspended solids, they also remove some nitrogen and phosphorus. Refer to **Appendix E** for details of Vegetated Swales.

7.4 Fuel Related Stormwater Treatment

The treatment train shown in Figure 7 uses the Best Management guidelines to treat stormwater runoff from the site.

7.4.1 Fuel dispensing areas

The fuel dispensing areas will be concrete surfaced and covered by two canopies. The fuel dispensing areas will be bunded to prevent stormwater runoff from outside the canopies flowing into the dispensing areas and to ensure that any spills are contained within this area. The perimeter of the canopy will overhang the dispensing containment areas by 10 degrees to reduce windblown rain into the area. Any flows/spills in the containment area will drain to gully pits which will discharge to an appropriately sized SPEL Puraceptor.

Bulk fuel transfers from a road tanker to underground tanks will take place at two remote Fill Points located outside the canopies but within a bunded concrete area; any runoff from the dispensing areas and from the Fill Point area will be directed to a SPEL Puraceptor during unloading operations and when not used for bulk transfers. A spill containment box at each fill point will capture any minor fuel spills that may occur during unloading; the spilt fuel will then drain from the containment box into the fuel storage tanks.

7.4.1.1 SPEL Puraceptor

The Puraceptor P.040 (Class 1) unit has a minimum containment volume of 8,000 litres and a working capacity of 14,400 litres, which allows for containment for spill from an 8,000 litre tanker compartment plus allowances for wind-blown rain. The Puraceptor will remove hydrocarbons, gross pollutants and total suspended solids. Refer to **Appendix E** for details of the SPEL Puraceptor P.040.

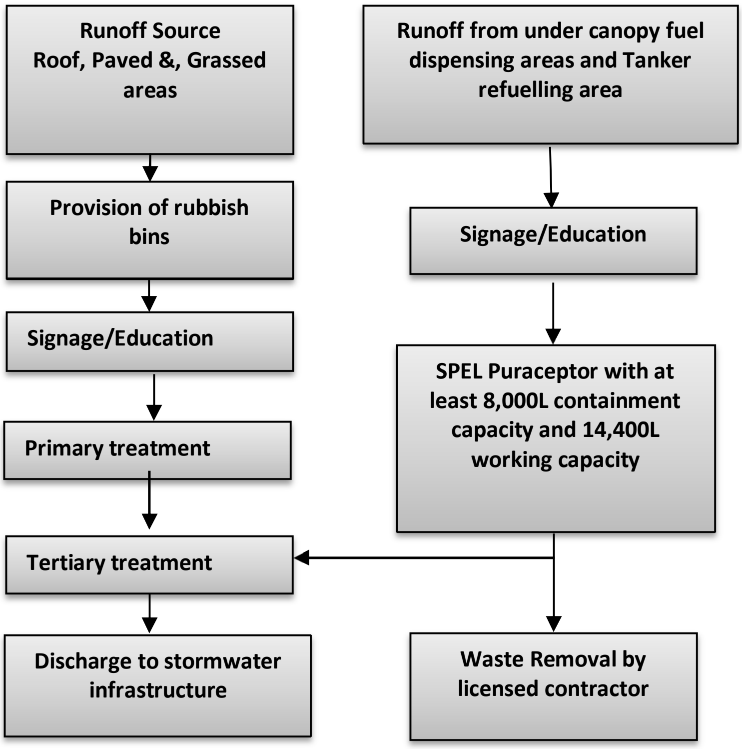


Figure 7: Fuel related stormwater treatment philosophy

7.4.2 Underground Fuel Storage Tanks

Underground fuel storage tanks, piping and fuel dispensers will be installed in accordance with the Australian Institute of Petroleum (AIP) standards.

7.5 MUSIC Modelling

7.5.1 Introduction

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC - Version 6.2.1) was used to assess the performance of the proposed stormwater treatment measures and determine the number of SPEL Stormsacks and SPEL Filters required to achieve statutory pollutant reduction targets for the operational phase of the project.

7.5.2 Music Model Setup

The input parameters for source node, soil behaviour and pollutant generation characteristics are based on *Table 3.7 and 3.8* of MUSIC *Modelling Guidelines Version 1.0 - 2010, WaterByDesign (2010).*

The details of the catchment/source nodes used in the MUSIC model are shown in Table 20 below and clearly illustrated in Drawing 16293-SK4 ' MUSIC Model Stormwater Catchments' attached in **Appendix D** of this report.

Table 20: MUSIC catchment parameters

Catchment	Total Area (Ha)	Split Catchment Area (Ha)	Land Use	% Impervious
A	1.386	0.014	Building Roof (Truck Canopy)	100
		0.345	Car park, Driveways	100
		0.288	Landscape being treated	0
		0.739	Compact gravel	50
B	0.576	0.048	Building Roof (Service Station & Car Canopy)	100
		0.412	Car park, Driveways	100
		0.096	Landscape being treated	0
		0.020	Landscape bypassing treatment	0

The proposed stormwater treatment train modelled in MUSIC consists of SPEL Stormsacks and SPEL Filters as shown in Figure 8.

7.5.3 SPEL Music nodes efficiencies

The proposed stormwater treatment train for this development includes SPEL devices. The SPEL treatment nodes utilised in the MUSIC model have been supplied by SPEL Environmental. The MUSIC nodes treatment efficiencies have been set by SPEL based on field testing undertaken to evaluate their effectiveness.

Refer to **Appendix H** for the SPEL stormwater treatment train efficiencies report.

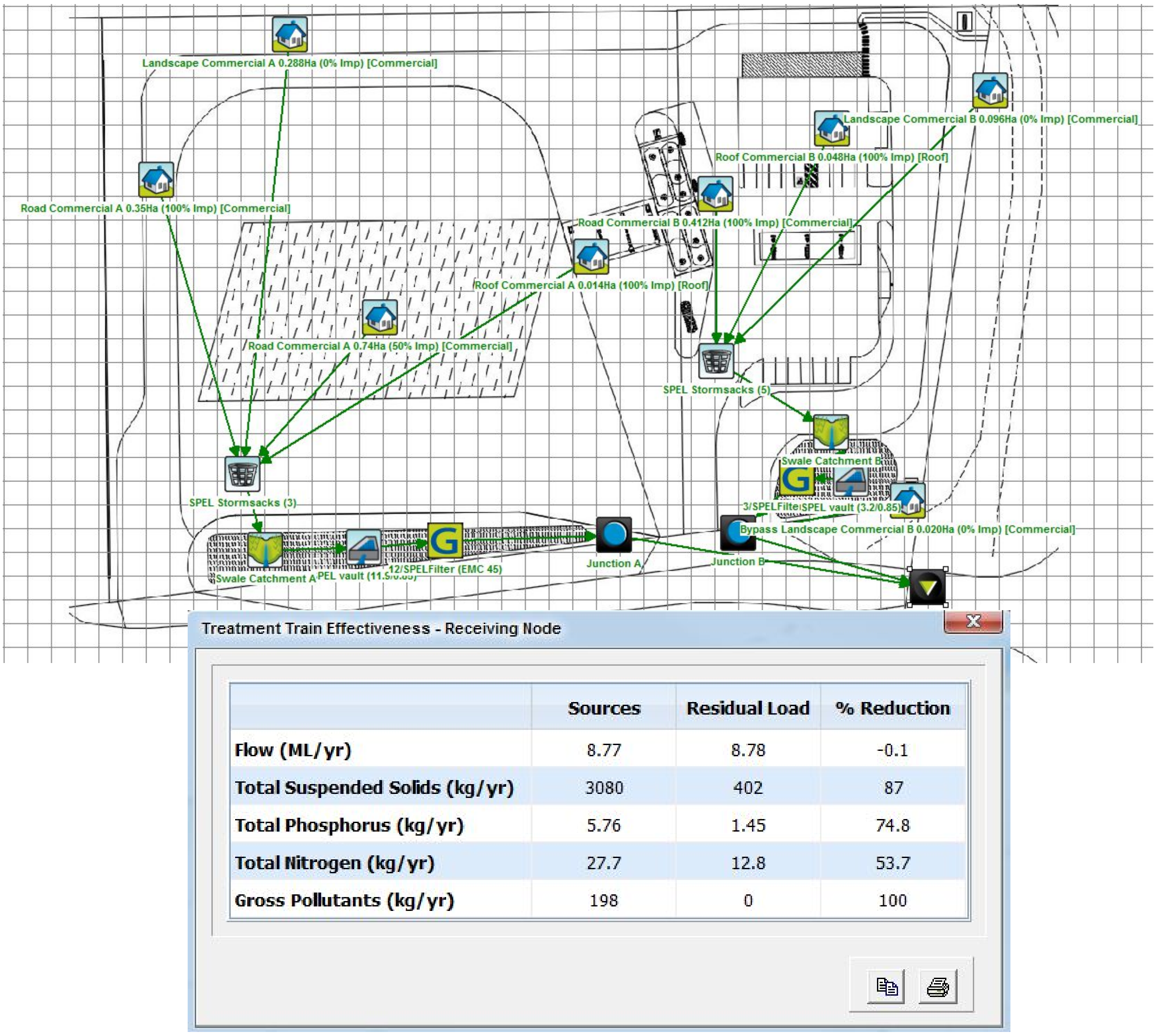
7.5.4 Music modelling results

The proposed stormwater treatment measures were modelled in MUSIC as a treatment train consisting of SPEL Stormsacks and SPEL Filters connected in series. The generic nodes in MUSIC have been modified by SPEL based on 2nd & 3rd Party Field testing data for their products; these test results and papers are available upon request Table 21 below shows details of proprietary products modelled in MUSIC.

Table 21: Details of proprietary treatment systems as modelled in MUSIC

Catchment	System Used	Total Treatable Flow Rate (L/s)	Number of units
A	Stormsacks (600x600)	11.0	3
	SPEL Filter EMC 45	2.83	12
B	Stormsacks (600x600)	11.0	5
	SPEL Filter EMC 45	2.83	3

Figure 8 below shows a schematic representation of the model analysed in MUSIC and Table 22 below demonstrates that the pollutant load reduction objectives for the site have been achieved, i.e. the treatment methods proposed are adequate.



	Sources	Residual Load	% Reduction
Flow (ML/yr)	8.77	8.78	-0.1
Total Suspended Solids (kg/yr)	3080	402	87
Total Phosphorus (kg/yr)	5.76	1.45	74.8
Total Nitrogen (kg/yr)	27.7	12.8	53.7
Gross Pollutants (kg/yr)	198	0	100

Figure 8: MUSIC model schematic

Table 22: MUSIC model treatment effectiveness

Parameter	Required Load Reduction	Music Results Achieved	Objective Achieved
Total Suspended Solids	85.0%	87.0 %	Yes
Total Phosphorus	60.0%	74.8 %	Yes
Total Nitrogen	45.0%	53.7 %	Yes
Gross Pollutants	90.0%	100.0 %	Yes

8.0 SITE MAINTENANCE AND MANAGEMENT PROCEDURES

8.1 Petrol Station Maintenance and Management Procedure

The service station operator will have a Petrol Handling Manual that will set out all requirements for the safe handling of combustible and flammable materials. This manual will dictate weekly, monthly and annual checking procedures with checklists, which will be completed, and the records stored.

The manual will also set out dry cleaning methods to be employed within the fuel dispensing area in lieu of washing down to reduce possible contaminated runoff. Emergency procedures will be also clearly set out detailing actions to be taken by site personnel in the case of varying possible emergencies such as spills, fire or risk of fire, vehicle accidents, etc.

In addition a regular cleaning, maintenance program/contract is to be established for emptying of rubbish bins located around the site, removal of general litter from the site, inspection of stormwater gully pits and removal of any sediment or captured litter from the SPEL Stormsacks systems. The SPEL Stormsacks, SPEL Puraceptor and SPEL Filters will be inspected and maintained in accordance with the manufacturer's instructions. Refer to **Appendix F** for maintenance plans.

The maintenance plan will address the following:

- Inspection frequency;
- Maintenance frequency;
- Data collection/storage requirements;
- Detailed cleanout procedures.

The plan will include inspection procedures covering aspects such as equipment needs, maintenance techniques, occupational health and safety, public safety, environmental management considerations, disposal requirements of pollutants collected and access issues.

8.2 Maintenance Plans for Stormwater treatment devices

All stormwater quality improvement systems require regular maintenance in order to function adequately. Table 23 details the basic maintenance requirements for each type of stormwater quality improvements systems. A detailed maintenance schedule will be developed as part of the detailed design of the site.

Table 23: Maintenance Requirements

Control	Maintenance Requirement	Maintenance Period
SPEL Stormsacks	Remove sediment and captured litter	4 Months (inspect after major storms)
SPEL Filters	Inspect for any damage to filter cartridge or chamber. Remove sediment accumulated on the vault floor.	6 Months (inspect after major storms)
SPEL Puraceptor	Replacement of oil separators and coalescer units, removal of oil, sediment & gross pollutants (skimmers and vacuum truck)	6 Months (inspect after major spill)
Onsite Detention Basins	Removal of litter, debris, weeds and excessive sediment build up	3-4 Months (inspect after major storms)
Vegetated Swales	Periodic mowing, weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages.	3-4 Months (inspect after major storms)

For operational and maintenance guidelines refer to **Appendix F** and relevant manufacturer's documentation.

9.0 CONCLUSION

A Site Based Stormwater Management Plan has been prepared with respect to the proposed service station development. The location of the site is shown on Figure 1 and the proposed development site layout is shown in Appendix A.

- Stormwater Quantity

  An assessment of the water quantity has resulted in the requirement of two onsite detention basins with a total volume of 540kL. It is proposed to construct a 360kL detention basin with 6 x 225mm diameter pipe outlets and 5 x 225mm diameter high flow bypass outlets; and a 180kL detention basin with 6 x 150mm diameter pipe outlets and 3 x 150mm diameter high flow bypass outlets to mitigate the peak discharge and achieve “no worsening” of stormwater conditions external to the site.
- Stormwater Quality- Construction Phase

  An Erosion and Sediment Control Plan aimed at minimising unacceptable impacts during the construction phase will be developed at the Operational Works stage, in accordance with Rockhampton Regional Council Guidelines and Standards aiming to minimise unacceptable impacts to occur during the construction phase.
- Stormwater Quality- Operational Phase

  A conceptual MUSIC model for the site indicated that the proposed treatment measures will achieve the statutory water quality objectives for the site. The proposed treatment is shown in **Appendix D**.

This Site Based Stormwater Management Plan has demonstrated that adequate stormwater quantity and quality management principles and techniques will be employed during the construction and operational phases of this development to comply with the Queensland State Planning Policy 2017 and Rockhampton Regional Council’s requirements. The methods proposed are considered current best management practice for a development of this type, on this site.

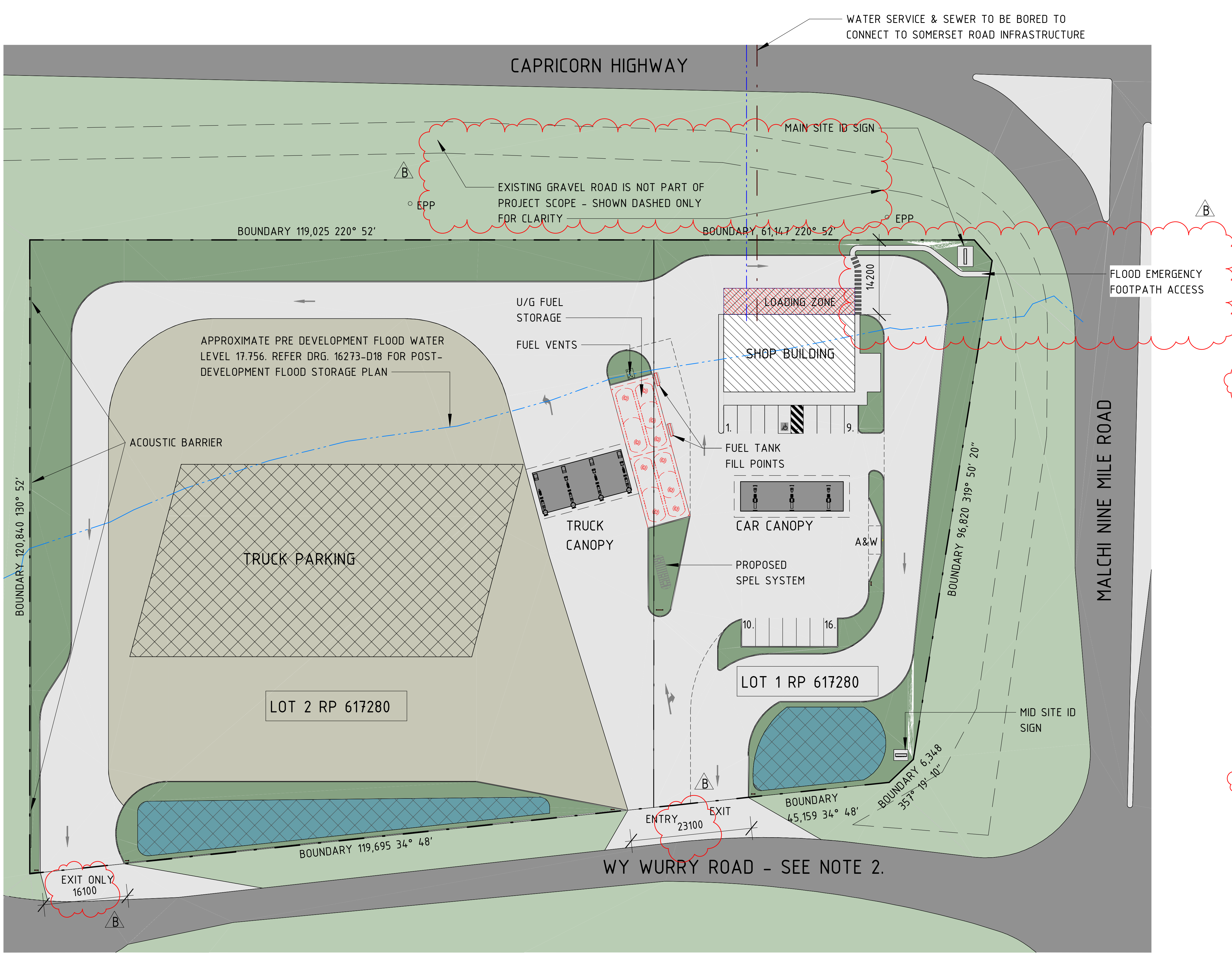
Yours faithfully

Leo Salinas
BEng, MIEAust
Civil Engineer
For and on behalf of TfA Group

Reviewed by

Juan Avella (RPEQ 11899)
BEng, MIEAust, CPEng, NER
Director Civil/Structural Engineering
For and on behalf of TfA Group

APPENDIX A – PROPOSED SITE LAYOUT PLAN



PROPERTY DESCRIPTION

LOT 1 & 2 ON RP 617280
LGA: ROCKHAMPTON REGIONAL COUNCIL
LOT 1 AREA: 5,984m²
LOT 2 AREA: 13,630m²

NOTES

1. PRELIMINARY - NOT FOR TENDER OR CONSTRUCTION.
2. WY WURRY RD TO BE UPGRADED TO ACCOMMODATE B-DOUBLES AS PER TRAFFIC REPORT
3. LINEMARKING SHOWN INDICATIVE ONLY - SUBJECT TO CHANGE AT DETAIL DESIGN BY TRAFFIC ENGINEER.
4. CARPARKING & ROAD AISLES TO BE IN ACCORDANCE WITH AS2890.1 & AS2890.6.
5. STANDARD PARKING BAYS PROVIDED AT 5.4m x 2.6m WITH MINIMUM 6.6m AISLES.
6. DISABLED PARKING BAYS TO BE 5.4m x 2.4m WITH 5.4m x 2.4m SHARED BAY.
7. FOR STORMWATER TREATMENT AND DETENTION DETAILS, REFER ENGINEER'S REPORTS.
8. FOR ROAD WORKS EXTERNAL TO SITE BOUNDARY REFER TRAFFIC ENGINEER'S REPORT.

LEGEND

EPP	EXISTING POWER POLE
A&W	AIR & WATER POINT
	CONCRETE PAVEMENT
	LANDSCAPE
	COMPACT GRAVEL
	DETENTION BASIN
	CANOPY SLABS WITH BLACK OXIDE FINISH
	BOUNDARY
	SITE WATER SUPPLY
	SITE SEWER

SITE COVERAGE SCHEDULE

SHOP (FOOTPRINT):	369m²	1.9%
CAR CANOPY (FOOTPRINT):	110m²	0.5%
TRUCK CANOPY (FOOTPRINT):	140m²	0.7%
COMPACT GRAVEL:	7386m²	37.6%
CONCRETE PAVEMENT:	7309m²	37%
FOOTPATH:	134m²	0.7%
KERB:	128m²	0.6%
LANDSCAPE:	3153m²	16%
DETENTION:	885m²	5%
TOTAL AREA:	19,614m²	100%

PARKING SCHEDULE

DISABLED 2.4m x 5.4m	1
STANDARD 2.6m x 5.4m	15
AIR & WATER 2.4m x 5.4m	1
B-TRIPLE TRUCK 4.5m x 48m	9
B-DOUBLE TRUCK 4.5m x 26m	3
AV TRUCK 4.5m x 21m	2

5 0 10 20 30 40m
Metres

PROJECT MANAGERS | PLANNERS
DESIGNERS | ENGINEERS
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Ph: 61 3 9640 0206
Email: enquiry@tfa.com.au

REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	MG	DA ISSUE	
A	30.11.17	MG	DA ISSUE	
B	11.04.18	MG	AREAS UPDATED/ FOOTPATH ADDED	DGC

PROJECT DETAILS
SERVICE STATION DEVELOPMENT for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

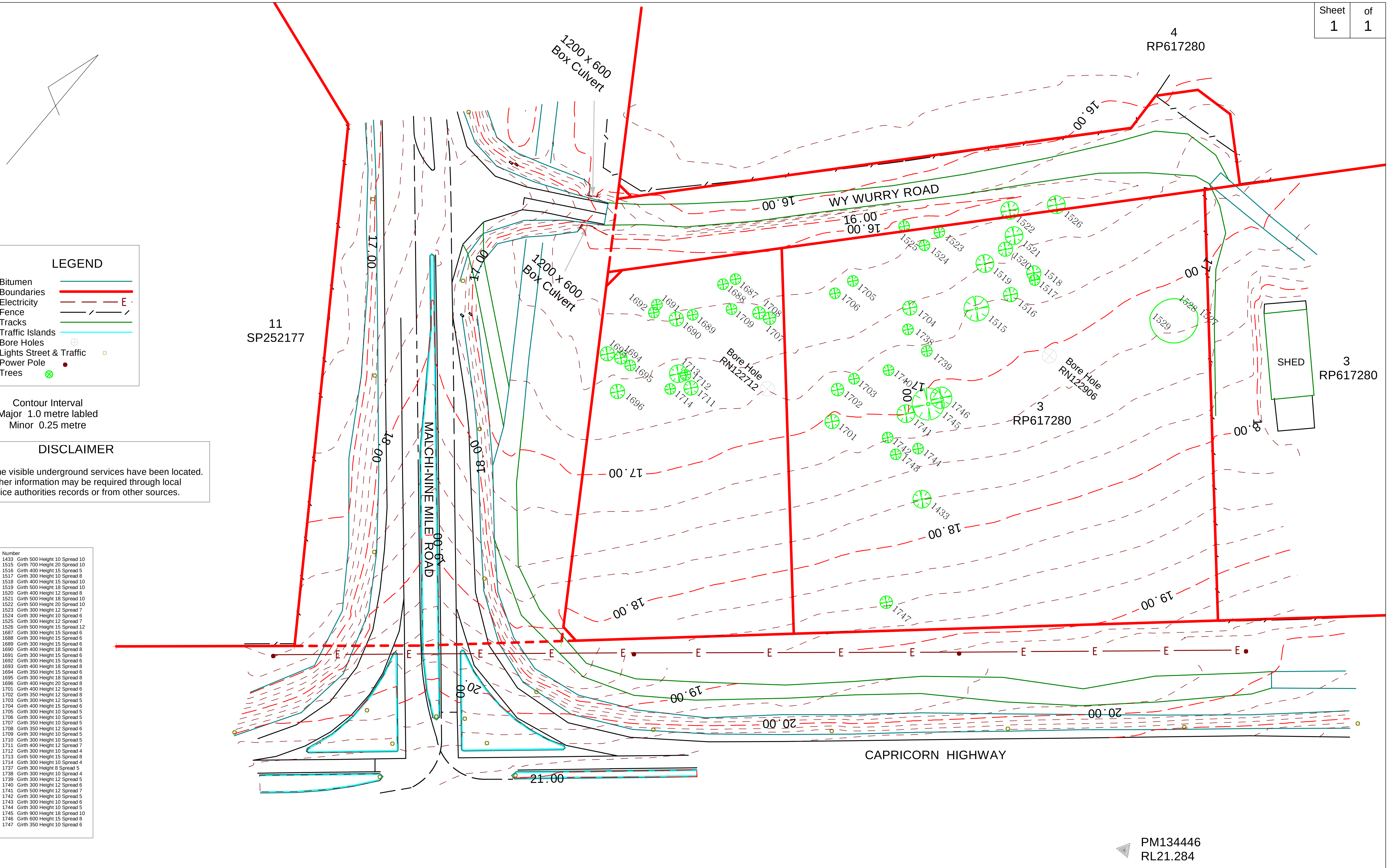
DRAWING TITLE
PROPOSED SITE PLAN

STATUS
DA ISSUE

DRAWN	APPROVED	
MG	LC LAC	
DATE CREATED	A1 SCALE	A3 SCALE
15.08.17		1 : 750
DRAWING NO		REV
16273	D03	B

18/04/2018 4:04:23 PM

APPENDIX B – SITE SURVEY PLAN



LEGEND

Bitumen	
Boundaries	
Electricity	E
Fence	
Tracks	
Traffic Islands	
Bore Holes	
Lights Street & Traffic	
Power Pole	
Trees	

Contour Interval
Major 1.0 metre labled
Minor 0.25 metre

DISCLAIMER

Some visible underground services have been located. Further information may be required through local service authorities records or from other sources.

Number	
1433	Girth 500 Height 10 Spread 10
1515	Girth 700 Height 20 Spread 10
1516	Girth 400 Height 15 Spread 5
1517	Girth 300 Height 10 Spread 8
1518	Girth 400 Height 15 Spread 10
1519	Girth 500 Height 18 Spread 10
1520	Girth 400 Height 12 Spread 8
1521	Girth 500 Height 18 Spread 10
1522	Girth 500 Height 20 Spread 10
1523	Girth 300 Height 12 Spread 7
1524	Girth 300 Height 10 Spread 6
1525	Girth 300 Height 12 Spread 7
1526	Girth 500 Height 15 Spread 12
1687	Girth 300 Height 15 Spread 6
1688	Girth 300 Height 15 Spread 6
1689	Girth 300 Height 15 Spread 6
1690	Girth 400 Height 18 Spread 8
1691	Girth 300 Height 15 Spread 6
1692	Girth 300 Height 15 Spread 6
1693	Girth 400 Height 18 Spread 8
1694	Girth 350 Height 15 Spread 6
1695	Girth 300 Height 18 Spread 8
1696	Girth 400 Height 20 Spread 8
1701	Girth 400 Height 12 Spread 6
1702	Girth 350 Height 12 Spread 8
1703	Girth 300 Height 12 Spread 5
1704	Girth 400 Height 15 Spread 6
1705	Girth 300 Height 10 Spread 5
1706	Girth 300 Height 10 Spread 5
1707	Girth 350 Height 10 Spread 5
1708	Girth 350 Height 12 Spread 6
1709	Girth 300 Height 10 Spread 5
1710	Girth 300 Height 10 Spread 5
1711	Girth 400 Height 12 Spread 7
1712	Girth 300 Height 10 Spread 4
1713	Girth 500 Height 15 Spread 8
1714	Girth 300 Height 10 Spread 4
1737	Girth 300 Height 8 Spread 5
1738	Girth 300 Height 10 Spread 4
1739	Girth 300 Height 12 Spread 5
1740	Girth 300 Height 12 Spread 6
1741	Girth 500 Height 12 Spread 7
1742	Girth 300 Height 10 Spread 5
1743	Girth 300 Height 10 Spread 6
1744	Girth 300 Height 10 Spread 5
1745	Girth 900 Height 18 Spread 10
1746	Girth 600 Height 15 Spread 8
1747	Girth 350 Height 10 Spread 6

Scale 1:1000 on A3
Scale 1:500 on A1
0 10 20 30 40 50 100

Client:
CORBERT'S GROUP

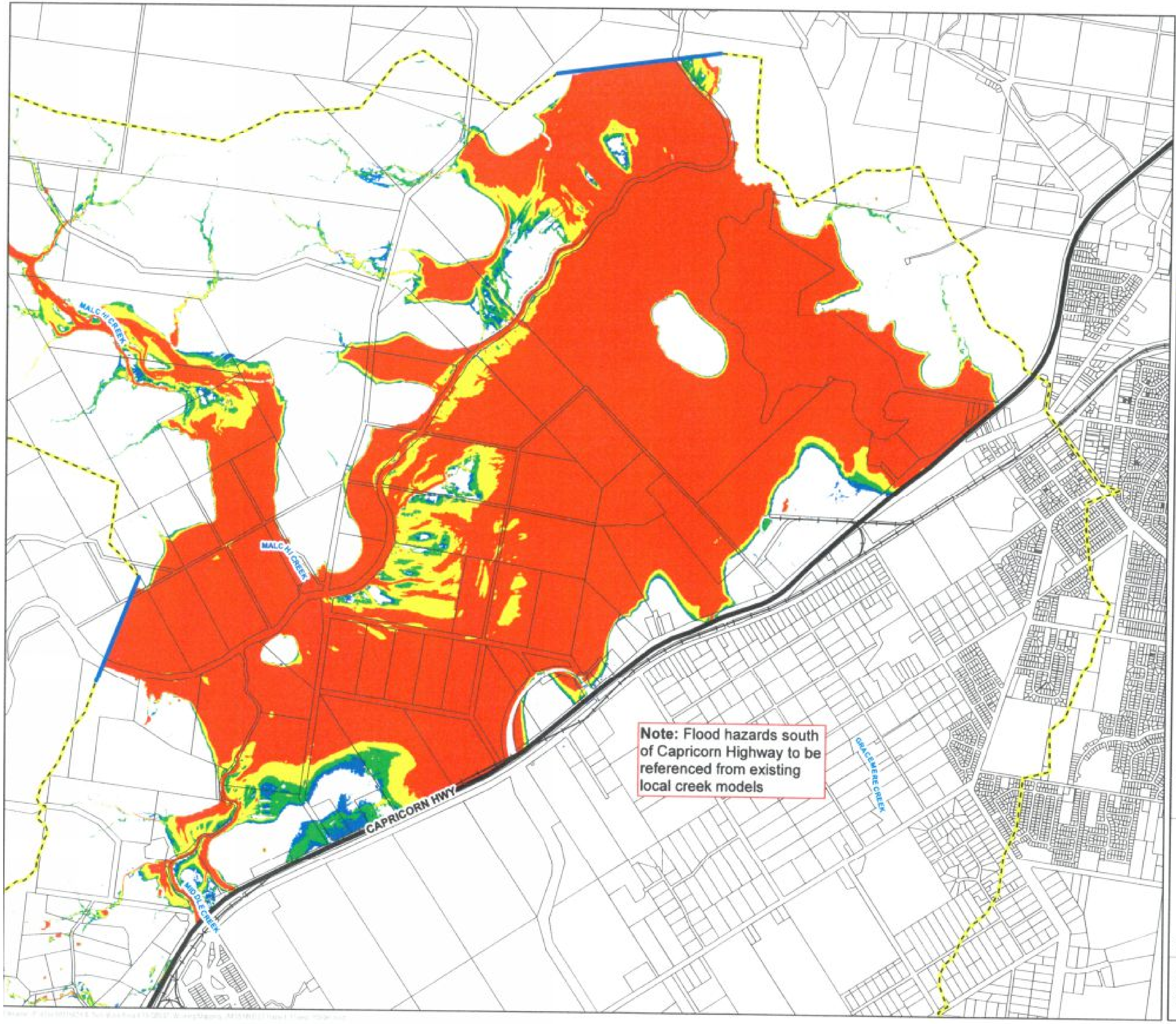
Meridian: MGA Zone 56
Vertical Datum: A.H.D.D
RL of Origin: 21.284
Derived from: PM134446

Plan of:
Contour and Detail Survey of Lots 1 & 2 on RP617280 Wy Wurry Road Gracemere

HOFFMANN SURVEYORS A.B.N. 98 124 394 378
Head Office 37 Withers St. Rockhampton Q 4701 P 07 4922 3834 hoffmannsurveyors.com.au
Rockhampton Longreach Blackall Charleville
CADASTRAL ENGINEERING MAPPING TOWN PLANNING

Drawn: K.McDougall
Date: 27/02/2017
Surveyed & Checked: K.McDougall
Date: 23-02-2017
Locality: Gracemere
Parish:
County:
Ref. No. R17005-1 A1

APPENDIX C – FLOOD INFORMATION



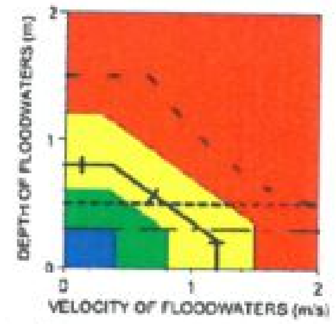
RRC GRACEMERE POUND
GRACEMERE

Flood Hazard Map
1% AEP Event

Map 07

LEGEND

- 2D Boundaries
- Highways
- Railway Lines
- Hydraulic Model Extent
- Property Boundary



Hazard Categories	Hazard Thresholds
Extreme	Safe to Use Small Cars
High	Safe to Use 4WDs
Medium	Wading Limit - Children
Low	Wading Limit - Adults

N

DATUM GDA 1994, PROJECTION MGA ZONE 56

0 250 500 1,000 1,500
Metres

1:25,000 (when printed at A3)

Rockhampton Regional Council

AECOM
www.aecom.com

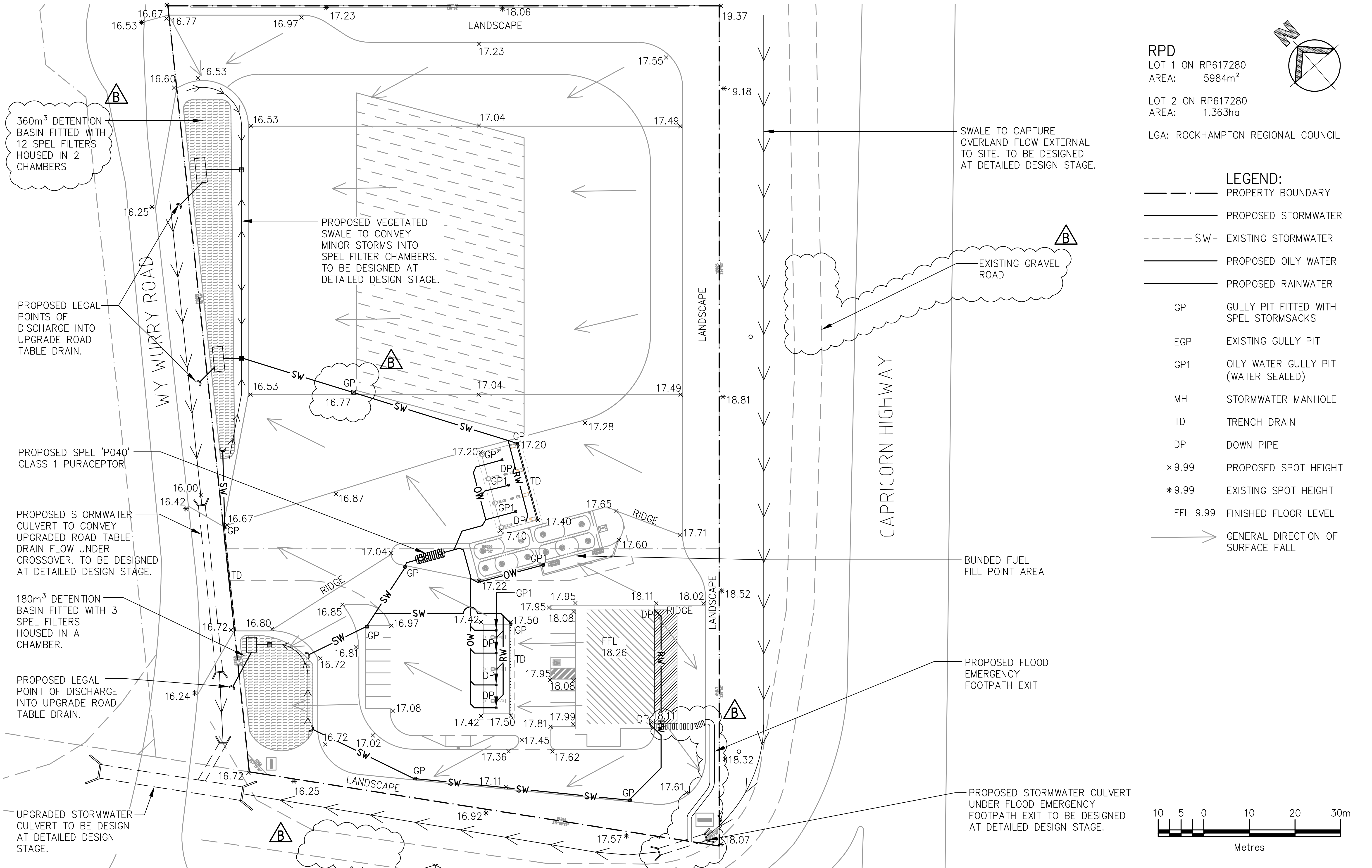
Data sources:
Highways, Roads, Rail, Watercourses - StreetPro 2016

PROJECT ID	60518629
CREATED BY	maultbyj
LAST MODIFIED	04-Oct-2016
VERSION	Rev 2

Map
H5

A3 size

APPENDIX D – CONCEPTUAL STORMWATER MANAGEMENT PLAN, FLOOD STORAGE PLAN & MUSIC MODEL STORMWATER CATCHMENTS



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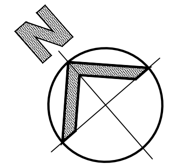
REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	DY	ISSUED FOR CLIENT REVIEW	BM
A	28.11.17	LS	TRUCK CANOPY AMENDED. LEVELS AMENDED	LS
B	11.04.18	LS	DETENION SIZE & FILTERS QTY REVISED. FOOTPATH & GP ADDED	

PROJECT DETAILS
PROPOSED SERVICES STATION
CNR CAPRICORN HWY &
HALL ROAD
GRACEMERE, QLD.

DRAWING TITLE
CONCEPTUAL STORMWATER MANAGEMENT PLAN

STATUS
DA ISSUE

DRAWN	APPROVED	
DY	JA	
DATE CREATED	A1 SCALE	A3 SCALE
15.08.17	1:375	1:750
DRAWING NO		REV
16273-D17		B



RPD
LOT 1 ON RP617280
AREA: 5984m²

LOT 2 ON RP617280
AREA: 1.363ha

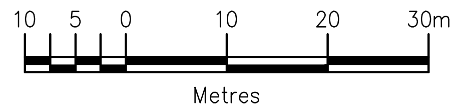
LGA: ROCKHAMPTON REGIONAL COUNCIL

LEGEND:

— — - —	PROPERTY BOUNDARY
—17.00—	PROPOSED CONTOUR
FFL 18.26	FINISHED FLOOR LEVEL
(green)	PROPOSED SURFACE ABOVE DEFINED FLOOD LEVEL OF 17.756 AHD
(pink)	PROPOSED SURFACE BELOW DEFINED FLOOD LEVEL OF 17.756 AHD

FLOOD STORAGE VOLUME

TOTAL POST-DEVELOPMENT STORAGE VOLUME = 11736m³



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REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	DY	ISSUED FOR CLIENT REVIEW	BM
A	28.11.17	LS	TRUCK CANOPY AMENDED. LEVELS AMENDED	LS
B	16.04.18	LS	FLOOD EMERGENCY FOOTPATH EXIT ADDED	

PROJECT DETAILS
PROPOSED SERVICES STATION
CNR CAPRICORN HWY &
HALL ROAD
GRACEMERE, QLD.

DRAWING TITLE
POST-DEVELOPMENT FLOOD STORAGE PLAN

STATUS
DA ISSUE

DRAWN	APPROVED
DY	JA

DATE CREATED	A1 SCALE	A3 SCALE
25.08.17	1:375	1:750

DRAWING NO	REV
16273-D18	B

RPD
LOT 1 ON RP617280
AREA: 5984m²

LOT 2 ON RP617280
AREA: 1.363ha

LGA: ROCKHAMPTON REGIONAL COUNCIL

LEGEND:

PROPERTY BOUNDARY

EXISTING SURFACE ABOVE DEFINED FLOOD LEVEL OF 17.756 AHD

EXISTING SURFACE BELOW DEFINED FLOOD LEVEL OF 17.756 AHD

FLOOD STORAGE VOLUME

TOTAL PRE-DEVELOPMENT STORAGE VOLUME = 11430m³

10 5 0 10 20 30m
Metres

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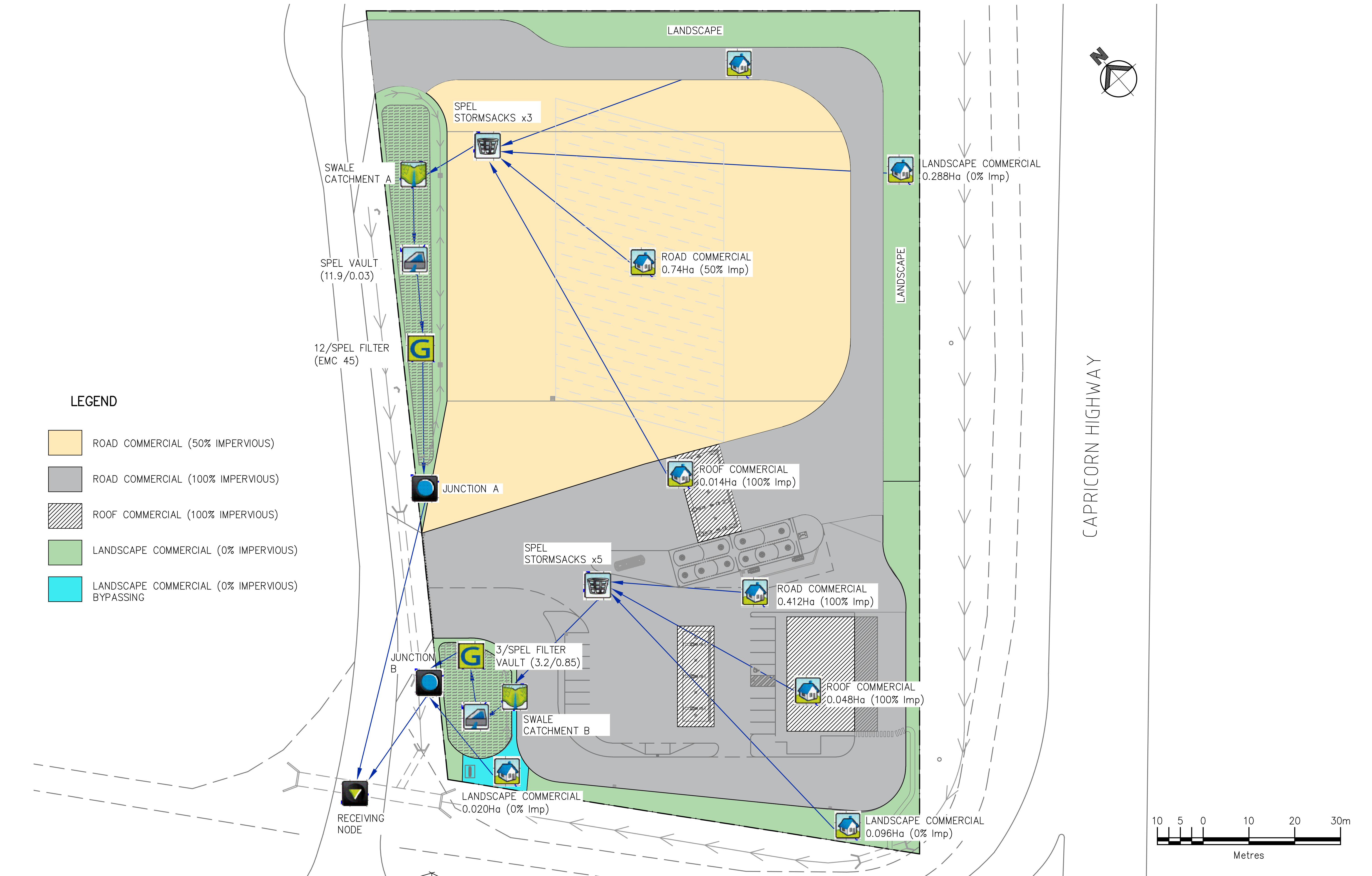
enquiry@tfa.com.au

REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	DY	ISSUED FOR CLIENT REVIEW	BM
A	29.11.17	LS	TRUCK CANOPY AMENDED	LS
B	16.04.18	LS	FLOOD EMERGENCY FOOTPATH EXIT ADDED	

PROJECT DETAILS
PROPOSED SERVICES STATION
CNR CAPRICORN HWY &
HALL ROAD
GRACEMERE, QLD.

DRAWING TITLE
PRE-DEVELOPMENT FLOOD STORAGE PLAN

STATUS		
DA ISSUE		
DRAWN: DY	APPROVED: JA	
DATE CREATED: 25.08.17	A1 SCALE: 1:375	A3 SCALE: 1:750
DRAWING NO: 16273-D19	REV: B	



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Sydney
Ph: 61 2 8814 5219
Melbourne
Ph: 1300 794 300
Email: enquiry@tfa.com.au

REV	DATE	BY	DESCRIPTION	CHK
A	12.04.18	CV	ISSUED FOR REVIEW	
B	01.05.18	LS	ROOF COMMERCIAL NODE CONNECTED TO STORMSACK NODE	

PROJECT DETAILS
PROPOSED SERVICES STATION
CNR CAPRICORN HWY &
HALL ROAD
GRACEMERE, QLD.

DRAWING TITLE
MUSIC MODEL
STORMWATER CATCHMENTS

STATUS
DA ISSUE

DRAWN	APPROVED
CV	JA

DATE CREATED	A1 SCALE	A3 SCALE
12.04.18	1:375	1:750

DRAWING NO	REV
16273-SK4	B

APPENDIX E – STORMWATER & OILY WATER TREATMENT SYSTEM

REVISION HISTORY				
REV	DESCRIPTION	DESIGNER	DATE	CHECKED BY
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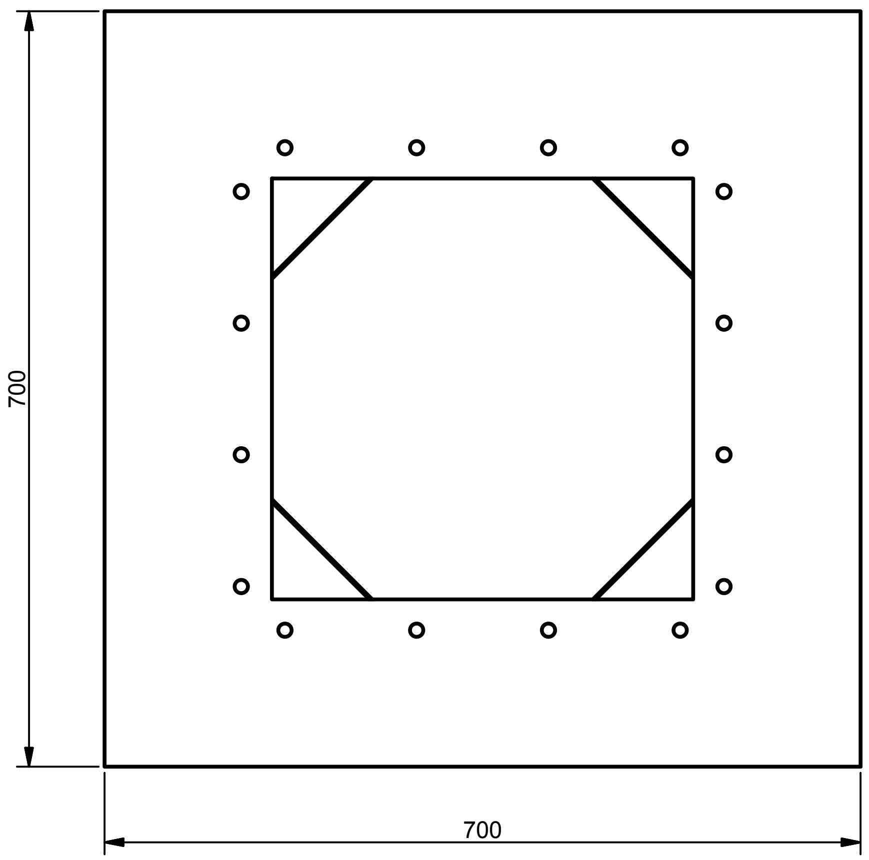
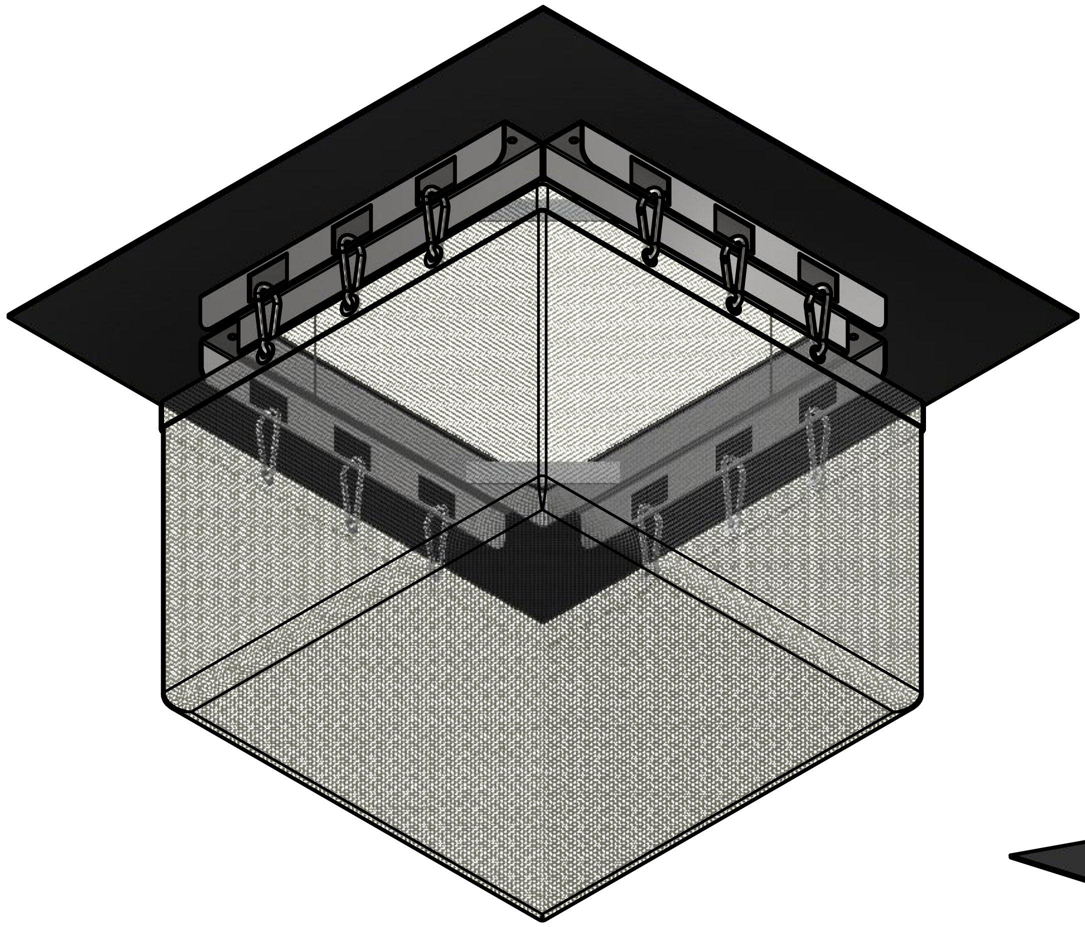
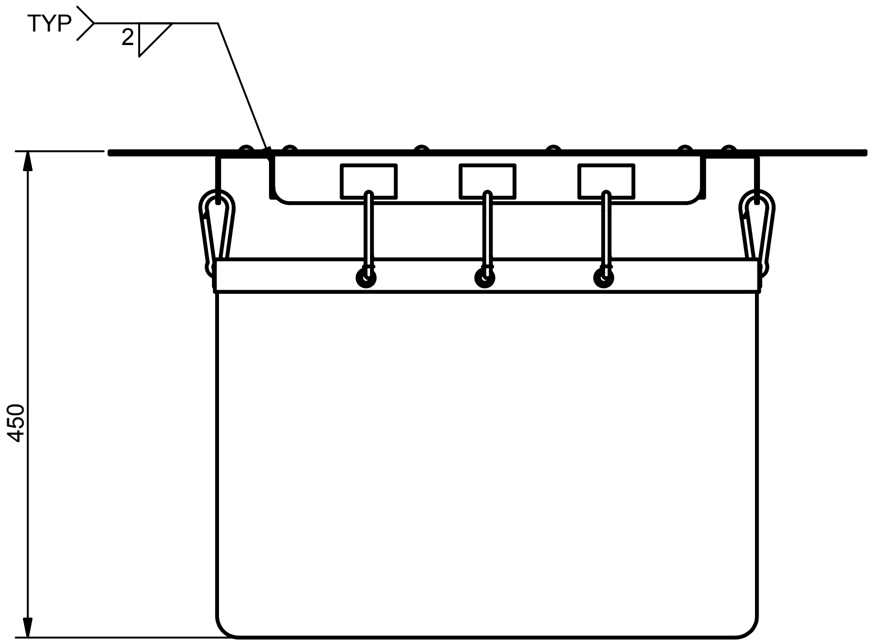


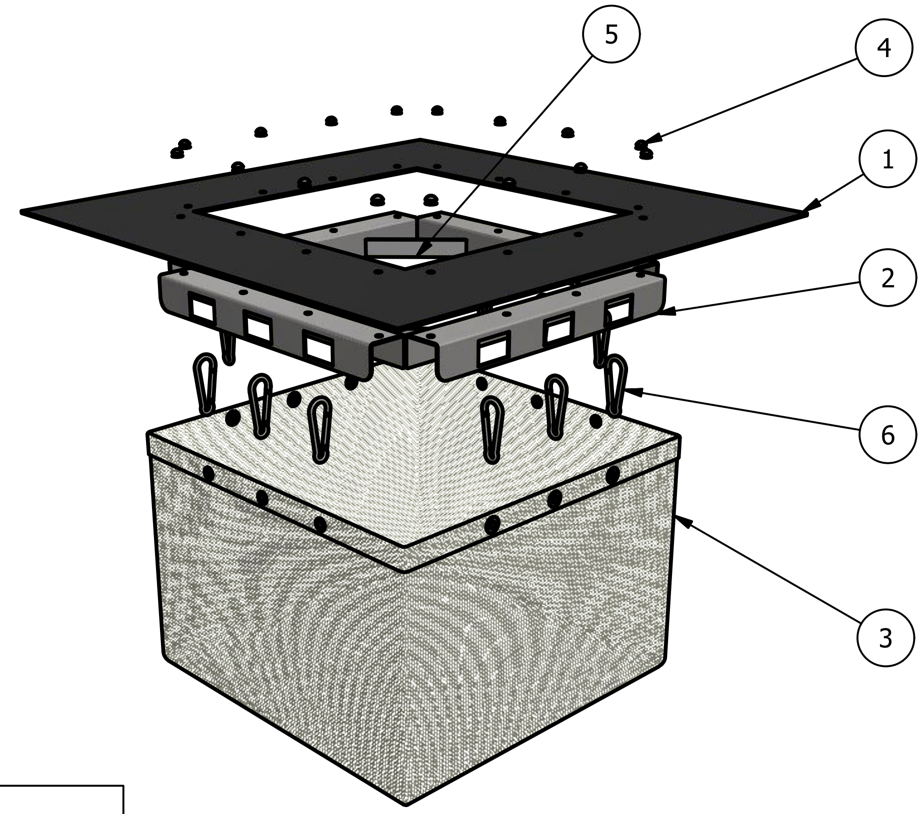
PLAN VIEW



ISOMETRIC VIEW
BOTTOM VIEW



ELEVATION VIEW



ISOMETRIC VIEW
EXPLOSION

PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	PLASTIC SHEETING	HDPE
2	4	SHEET METAL BENDING	STAINLESS STEEL 304
3	1	TEXTILE FABRIC & MESH LINER	HDPE
4	16	BLIND RIVIT 7 DIA.	STAINLESS STEEL 304
5	4	CORNER ESTIFFENER - FLAT BAR 25 x 2 - 141 LG	STAINLESS STEEL 304
6	12	CARABINER CLIP 6	ALUMINIUM

CLIENT:

DISTRIBUTOR

Drawn M.M	Date 25/03/2015
CHECKED BY	Date
Verified	Date
Approved	Date
Customer Code :	

SPEL
ENVIRONMENTAL
INTEGRATED WATER SOLUTIONS

100 Silverwater Road Silverwater NSW 2128
PH: 1300 773 500 | E: sales@spel.com.au
www.spel.com.au

TITLE
SPEL STOMSACK
FRAME 600 x 600
BASKET MOUNTING ASSEMBLY DRAWING

REQUEST No.	SIZE	SHEET	REV
D20194	A3	1	1

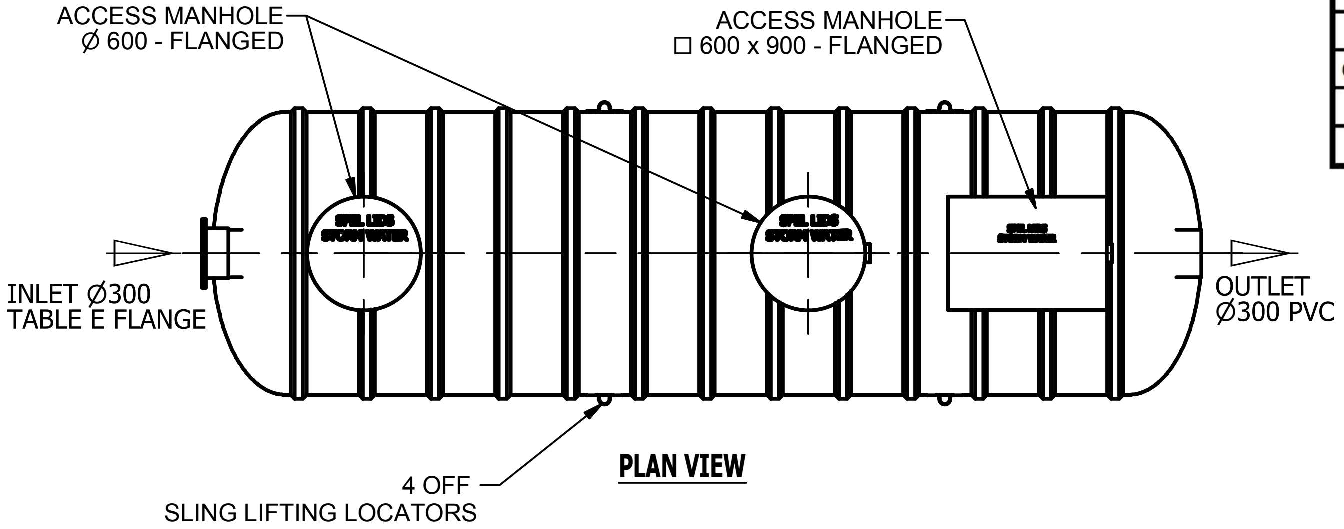
SCALE	DWG No.
N.T.S	SP15-BB4610-S

Site Level Confirmation

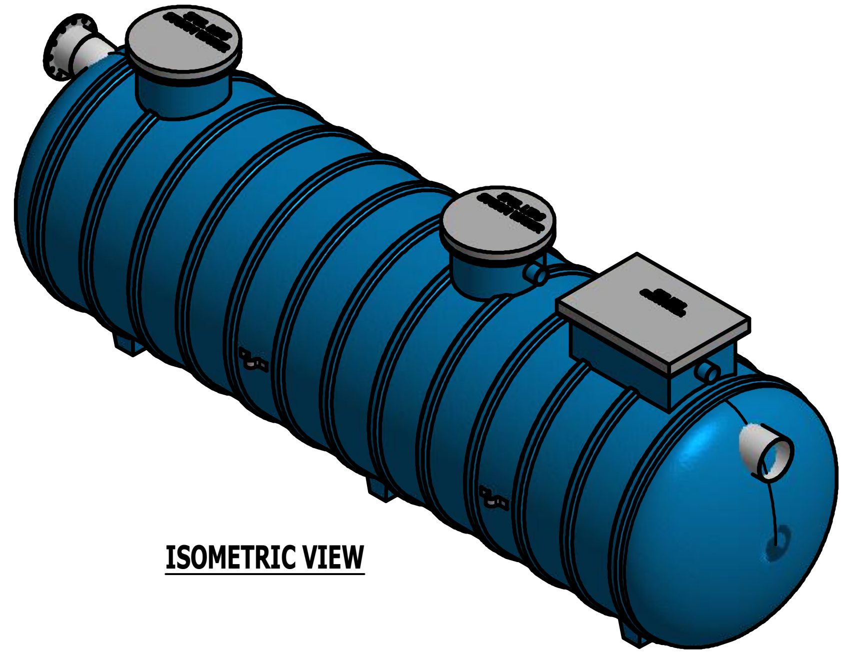
Finished Surface Level (FSL)	RL:
Access Cover Thickness	mm
Inlet Invert Level	RL:
Outlet Invert Level	RL:
Company:	
Name:	
Date:	

REVISION HISTORY

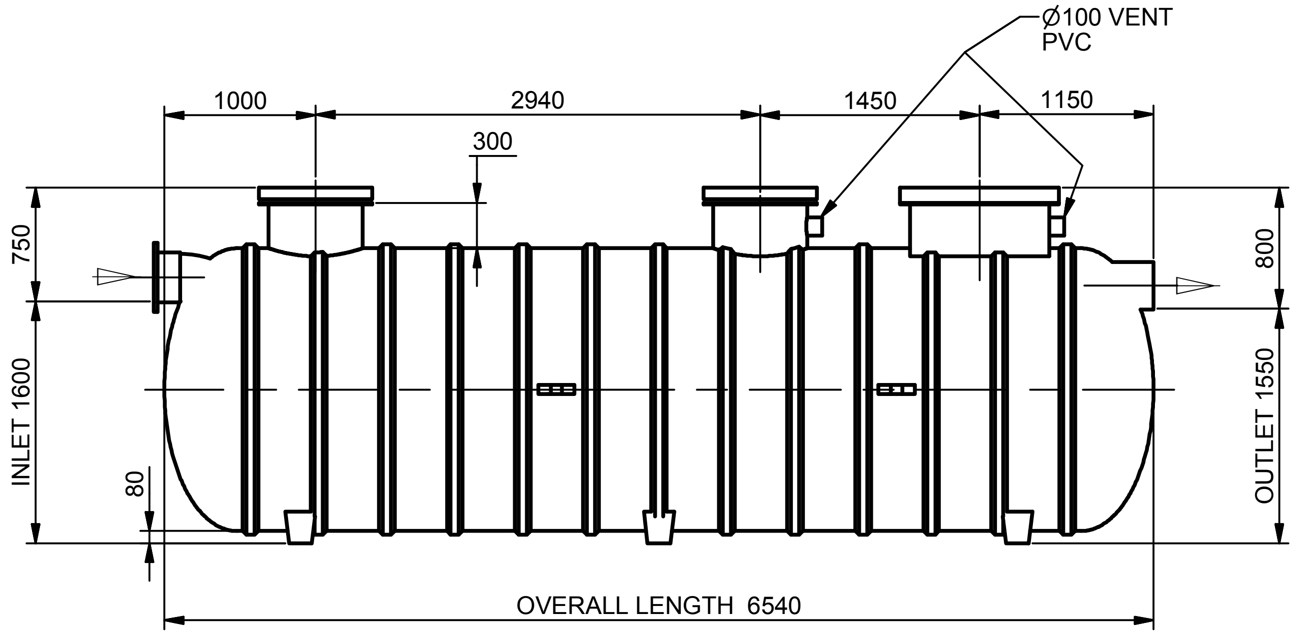
REV	DESCRIPTION	DESIGNER	CREATION DATE	CHECKED BY
1	INITIAL RELEASE	P.Z.	19-07-17	
2	VENTS REVISED	P.Z.	19-07-17	



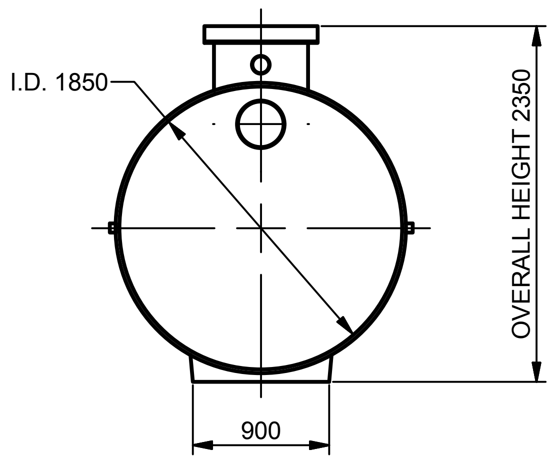
PLAN VIEW



ISOMETRIC VIEW



ELEVATION VIEW



END VIEW
OUTLET END

APPROVED................ ☐
NAME..............................
SIGNED............................
DATE........./........../..........

ISSUE FOR APPROVAL
NOT FOR CONSTRUCTION

C:\Vault Working Folder\Designs\SPEL\PRODUCTS\PURACEPTOR\300 Series\P.040.C1.2C\PROJECTS\SHELL EUMUNDI-NOOSA ROAD\SP17-PC35930-P2.idw

TOLERANCE: ALL DIMENSIONS 10mm UNLESS OTHERWISE STATED.

CLIENT:

DISTRIBUTOR :

Drawn P.Z.	Date 18-07-17
Check	Date
Verified	Date
Approved	Date

Request No. RN4268

SPEL ENVIRONMENTAL
INTEGRATED WATER SOLUTIONS

100 Silverwater Road Silverwater NSW 2128
PH: 1300 773 500 | E: sales@spel.com.au
www.spel.com.au

PROJECT :

TITLE SPEL PURACEPTOR
P.040.C1.2C.A.300
GENERAL ARRANGEMENT

SCALE	SIZE	SHEET	REV
N.T.S	A3	1	2

CUSTOMER CODE :

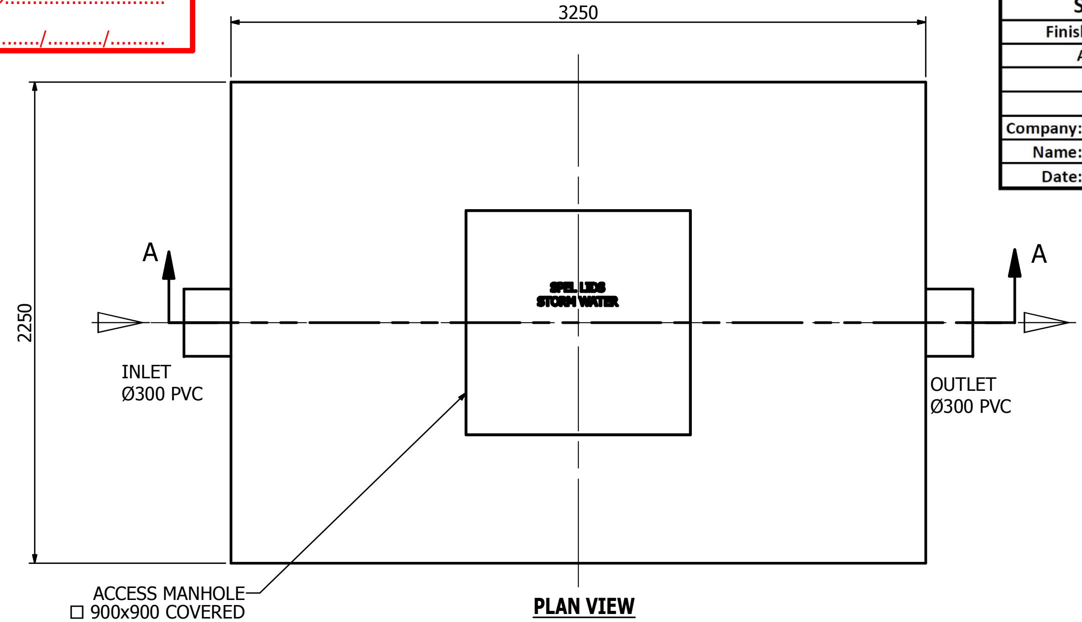
DWG No. SP17-PC35930-P

APPROVED................ ☐
NAME...............................
SIGNED............................
DATE........../........../..........

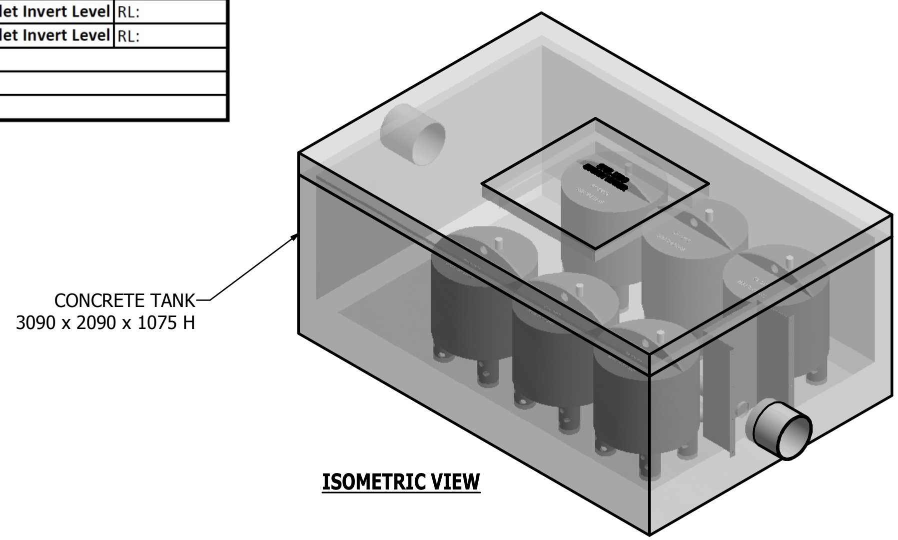
ISSUE FOR APPROVAL
NOT FOR CONSTRUCTION

REVISION HISTORY				
REV	DESCRIPTION	AUTHOR	DATE	APPROVED
1	GENERAL ARRANGEMENT	P.Z.	15/02/16	M.M.

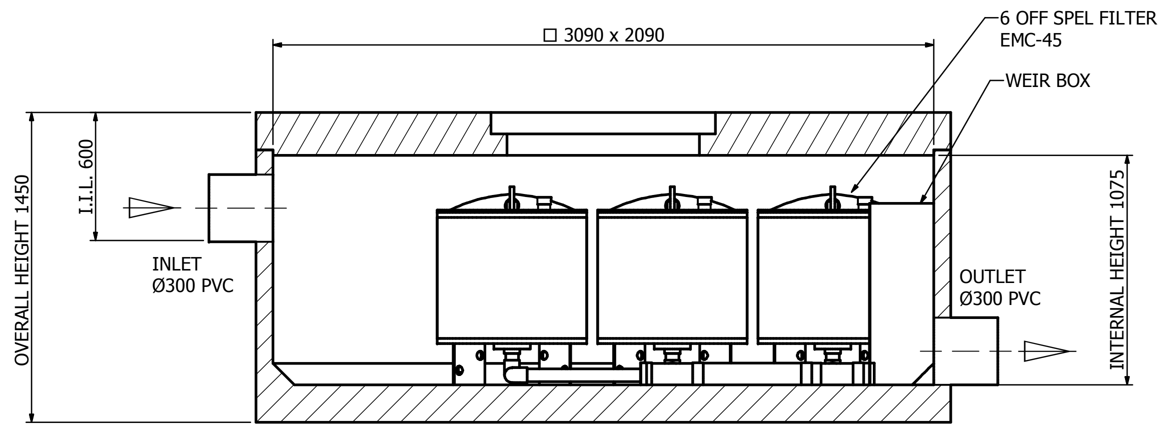
Site Level Confirmation	
Finished Surface Level (FSL)	RL:
Access Cover Thickness	mm
Inlet Invert Level	RL:
Outlet Invert Level	RL:
Company:	
Name:	
Date:	



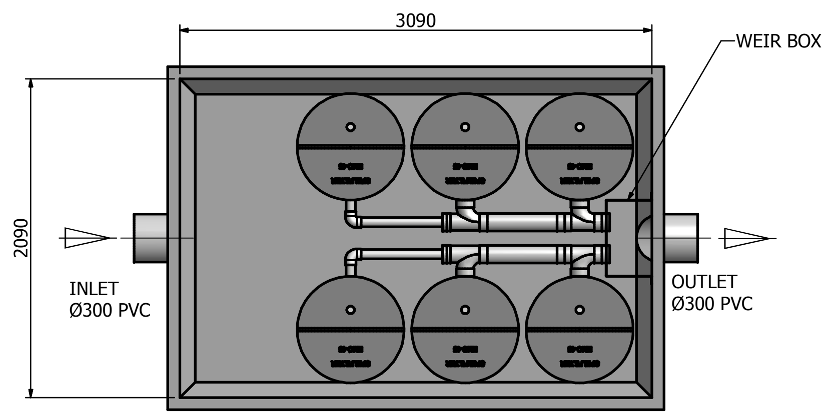
PLAN VIEW



ISOMETRIC VIEW



SECTION A-A
ELEVATION VIEW



PLAN VIEW
COVER & LID REMOVED FOR CLARITY

C:\Vault Working Folder\Designs\SPEL PRODUCTS\FILTER\EMC-45\STANDARD\6 FILTERS\CONCRETE\AUSTANK SQ 7KL\SP16-SF1720-S.idw

TOLERANCE: ALL DIMENSIONS 10mm UNLESS OTHERWISE STATED.

CLIENT:

DISTRIBUTOR :

Drawn P.Z.	Date 15-02-16
Check M.M.	Date 10-03-16
Verified	Date
Approved	Date
Request No. RN2319	

SPEL ENVIRONMENTAL
INTEGRATED WATER SOLUTIONS
100 Silverwater Road Silverwater NSW 2128
PH: 1300 773 500 | E: sales@spel.com.au
www.spel.com.au

PROJECT :

TITLE: SPEL FILTER SYSTEM
SF.2030/06-29.CON.300.PVC
6 SPEL FILTER CARTRIDGES
GENERAL ARRANGEMENT

SCALE	SIZE	SHEET	REV
N.T.S	A3	1	1

CUSTOMER CODE : -
DWG No. SP16-SF1720-S

Vegetated swales and drains

This fact sheet is one of a series which provides advice to extension officers and land owners on the use of vegetated swales and drains to improve farm run-off water quality, specific to coastal agriculture in the wet/dry tropics region between central and Far North Queensland.

Vegetated swales and drains

Vegetated swales and drains are shallow, open, vegetated channels primarily designed for conveying water in a longitudinal manner through a drainage pathway. They can also be designed to manage water quality by reducing flow velocities (speeds) compared to bare soil, piped or concreted conveyance systems.

They can remove coarse and medium sized sediments and are commonly combined with buffer strips, sediment basins and constructed wetlands to provide further treatment.

The main difference between swales and drains is how they hold water. Swales are located in areas which can fully drain and are therefore typically dry. Swales can also be headlands or access tracks that are not used regularly for farm traffic. Drains are located on flat or backwatered locations which results in them holding water. Swales ideally have a trapezoidal cross-section with a flat base, while drains have a shallow 'v'-shaped configuration (Figure 1).

Swales and drains should be designed to convey the required run-off volume effectively, and be well vegetated to allow for seasonal slashing. Ideally they will be located on slopes with 1-4% grade.

Treatment processes

The interaction between water flow and vegetation within these systems facilitates settlement and retention of pollutants. Vegetation type/height will influence the treatment performance.

- **Swales/drains with low vegetation** (such as mown grass) can achieve moderate sediment deposition rates provided flows are well distributed across the full width and length of the swale and the longitudinal grade of the swale is kept low enough to maintain slower flow conditions (less than 4%).
- **Swales/drains with taller/reed type vegetation** can offer improved sediment retention by slowing flows more and providing enhanced sedimentation for deeper flows. However, densely vegetated swales have higher hydraulic roughness and therefore require a larger area to convey flows compared to grass swales.

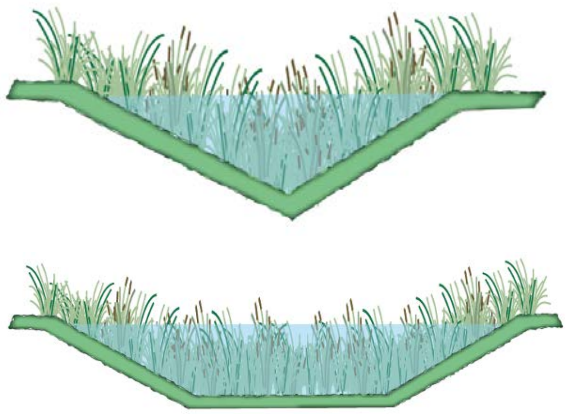


Figure 1 – Vegetated drain (top) and vegetated swale (bottom) cross sections.

Table 1 – Summary of vegetated swale and drain treatment processes

Pollutant Size / Type	Treatment Performance	Description of Vegetated Swales and Drains Treatment Process
Coarse to medium sized pollutants (e.g. sediments)		Vegetation facilitates enhanced sedimentation of particles, particularly coarse to medium sediments, through filtration and deposition.
Fine particulates (e.g. fine sediments and particulate nutrients)		Vegetation may also trap some fine particles which may retain or adsorb pollutants.
Dissolved pollutants (e.g. nutrients, chemicals and pesticides)		There may be some direct uptake of nutrients by vegetation. Regular wetting and drying in swales and drains will enhance the decomposition of organic matter and decreases the availability of phosphorus trapped in the sediments.

Use of vegetated swales and drains on farms to manage run-off

Vegetated swales and drains can be used as part of an overall farm drainage strategy to improve run-off water quality provided best practice farm management practices are implemented and a number of key design considerations are addressed. Planning treatment elements should also consider their position in the catchment and whether the location is suitable.

Sizing

Typically, swales and drains are applicable for smaller scale contributing catchments up to 2 hectares provided the pollutant load is not excessive. For an area of this size the vegetated swales and drains should be able to convey and treat frequent storm flows effectively. The width and length required to treat flows from catchment areas larger than this can be problematic (especially for flat bottom swales).

Site constraints

Vegetated swales and drains are not ideally suited to sites with:

- Steep topography (>4%) - check dams may be required for these slopes to protect scour.
- Flat topography (<1%) – swales can become waterlogged or boggy if they are unable to drain effectively, which can be difficult to maintain and can be problematic for vehicle movement and result in problems with mosquitoes. Drains are more suited to these conditions.
- Large catchment (>2ha) - swales and drains would need to be large and specifically designed to reduce risk of failure due to large flow depths and velocities generated from larger catchment.
- Acid sulphate soils (follow best practice guidelines).

These site characteristics don't preclude the use of swales or drains, but it may require additional design considerations and have cost implications.

Vegetated Swale
Photo: QDAFF

Drain
Photo: QDAFF

Position and role in a run-off treatment train

The adoption of in-paddock best management practices and appropriate location within the farm are critical to reduce the loads entering the swales and drains.

Once these preventative methods have been employed, swales and drains can be used. They alone cannot provide sufficient treatment to significantly reduce pollutant loads in farm run-off, but can provide an important pre-treatment function for other elements in a treatment train.

Swales and drains are ideally located as one of the first elements in a treatment train, removing coarse sediments from farm run-off before it enters tertiary treatment systems such as sediment basins or constructed wetlands (Figure 2).

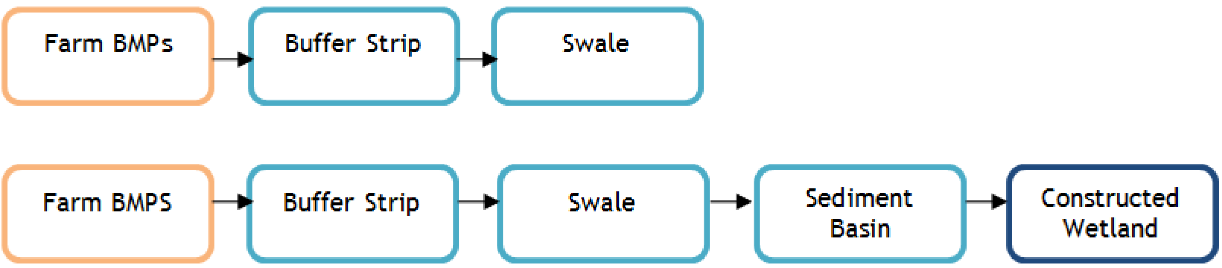


Figure 2 - Possible locations of vegetated swales and drains in farm run-off treatment trains.

Design, construction and maintenance

Design requirements

For water quality improvement functions, swales and drains should focus on ensuring frequent storm flows (typically up to the 3 month Average Recurrence Interval flow (ARI)) are conveyed within the swale or drain profile. Flows above these levels should exit the farm via breakout and overflow channels as these high flows can damage the swales and drains. In most cases, a swale or drain will also be required to provide a flow conveyance function as part of a larger drainage system.

The design of vegetated swales and drains should consider the following design features:

Batter slope and depth

Depth and batter slope will influence the conveyance capacity and overall footprint (top width) of the swale or drain and should be designed with consideration of maintenance (mown/slashed edges shouldn't be steeper than 1 in 4) and vehicle crossings (at grade crossings shouldn't be steeper than 1 in 9). For vegetated swales the floor of the drainage path should be configured to have a flat cross section.

Width

Width will be driven largely by the available space, but the greater the width, the greater the conveyance and treatment capacity for a shallow swale or drain.

Length

Length will be driven by the available space but the greater the length the greater the area for treatment.

Soils

Soils need to be appropriate to support construction of swales and drains and not be erosive.

Longitudinal slope

The longitudinal slope of the drainage path should be between 0.5% and 5%. A steeper longitudinal slope will still provide an effective drain, but can increase erosion risk and diminish treatment effectiveness.

Additional design considerations:

Weed management

Densely vegetated emergent macrophytes (reeds and sedges) within the swale or drain can make it difficult for weeds to establish by occupying the habitat.

Flow velocities

Velocities within swales and drains should be kept low, preferably less than 0.1m/s for frequent flows and less than 2 m/sec in major storm events to prevent damaging the vegetation.

Check dams

If check dams are required to manage flow velocities (e.g. on steep sites), these can be small e.g. 100mm rock weirs or equivalent, placed along the base of the swale to slow flows and protect it from scour. A rule of thumb for locating check dams is for the crest of a downstream check dam to be at 4% grade from 100mm below the toe of an upstream check dam (Figure 3).

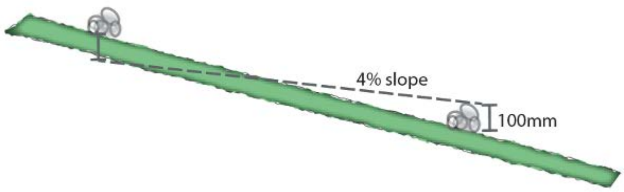


Figure 3 – Rock check dams on base of steep swales/drains

Design checklist:

Vegetated drain:

- Upstream catchment <2ha
- 1 in 4 batters
- Longitudinal slope less than 5%

Vegetated swale:

- Upstream catchment <2ha
- Batters between 1 in 4 and 1 in 9 (for vehicle access)
- Longitudinal slope between 0.5% and 5%
- Floor of swale has a flat cross section
- Swale is able to drain completely

Typical construction issues

Existing vegetation and approvals

Swales and drains should be established to minimise impacts on existing wetlands/waterways and native vegetation. Typically, swales and drains would be located within the production area. The likelihood of requiring a clearance approval would be low.

Earthworks

Swales and drains will require some earthworks to create the conveyance/treatment channel. The amount of earthworks should be minimal to avoid disturbing acid sulfate soils and shallow bedrock. Exposing bare soils should be minimised during construction to reduce the risk of sediment moving off site of earthworks approvals.

Any potential changes in hydrology resulting from flows being directed into or away from existing wetlands or waterways needs to be carefully managed to avoid creek bank erosion. Also, earthworks and any changes to hydrology within the vicinity of an area mapped as a wetland protection area may require an approval.

Planting and establishment

Swales and drains need to be well vegetated with grasses, sedges and rushes. The most cost effective approach is to seed the system with a mix of native species or if suitable vegetation exists nearby on farm, allow the vegetation to recruit or colonise naturally. Natural recruitment however increases the risk of erosion, weeds and increased maintenance.

Use local guidelines if they are available to assist with plant selection or contact your local Landcare or NRM group. Natural wetlands and riparian zones are a good reference from which to create a species template.

The dry season is the best time to establish vegetation in the swales and drains to reduce the risk of erosion. This allows for adequate establishment/root growth before the heavy summer rainfall period. Establishing it early in the dry season allows for growth of the root system while the ground is still moist. Some watering may still be required during the dry season.

Cost implications/risk

The risk of not achieving the desired design planting densities is poor treatment performance and the colonisation of weeds. Therefore it is important that the vegetation in the swales and drains is established successfully.

Swale being established in new block
Photo: QDAFF

Maintenance

Swales and drains rely on good vegetation for optimal treatment, therefore ensuring adequate vegetation growth is the key maintenance objective for these systems. Plant cover should be at least 80% with plants not slashed lower than 300mm.

Typical maintenance of swales and drains can be done with slashers or by hand and will involve:

- Removing weeds and pest habitat (slashing, not spraying).
- Reseeding of to achieve design densities.
- Irrigating vegetation, if required. This could be necessary if headlands and tracks are the swales and are damaged by machinery during harvest. Irrigation may be needed to re-establish cover before the onset of the wet season.
- Removing sediment where it is building up and impeding flows. This should be done during the dry season and removed sediment should be disposed of in the farm blocks, away from drainage lines.
- Filling in any areas impacted by erosion especially if it is creating isolated pools.
- Protecting boggy, wet swales from traffic. As part of farm BMP wet season routes need to be identified.

Swales and drains should be inspected every six months and before the wet season to ensure they are ready to receive run-off.

Further information

This fact sheet is part of a series on run-off treatment systems, as listed below. The Wetland Management Handbook provides more detail on treatment structures and general farm management to improve water quality leaving farms.

These resources and other wetland management tools and guides are available at http://wetlandinfo.ehp.qld.gov.au/wetlands/management/wetland-management/

Number	Publication Title
Fact sheet 1	Farm runoff treatment systems—toolkit
Fact sheet 2	Buffer strips
Fact sheet 3	Vegetated swales and drains
Fact sheet 4	Sediment basins
Fact sheet 5	Constructed (treatment) wetlands

These factsheets were developed by the Queensland Department of Agriculture, Fisheries and Forestry (QDAFF), Healthy Waterways and E2DesignLab with funding from the Queensland Wetlands Program.

The Queensland Wetlands Program supports projects and activities that result in long-term benefits to the sustainable management, wise use and protection of wetlands in Queensland. The tools developed by the Program help wetlands landholders, managers and decision makers in government and industry. The Program is a joint initiative of the Australian and Queensland governments.

Contact wetlands@ehp.qld.gov.au
or visit www.wetlandinfo.ehp.qld.gov.au

QWP/2013/20

E2DESIGNLAB

HEALTHY WATERWAYS

APPENDIX F – STORMWATER & OILY WATER TREATMENT SYSTEM MANAGEMENT PLANS

Model Number

Job Number

SPEL StormSack

OPERATIONS & MAINTENANCE

www.spel.com.au

SPEL ENVIRONMENTAL
INTEGRATED WATER SOLUTIONS

Manual Introduction

CHAPTER 1

Maintenance of the SPEL StormSack is essential to preservation of its condition to ensure lifetime operational effectiveness.

The SPEL StormSack is a highly engineered water quality device that is deployed directly in the stormwater system as primary treatment to capture contaminants close to the surface. To ensure full operational capacity, it is vital to ensure that the pollutants it captures are periodically removed, and filtration components are thoroughly cleaned.

Maintenance frequencies and requirements of the SPEL StormSack are dependent on the biological factors of the site in which it is situated. These factors can include excessive sediment loading or occurrence of toxic chemicals due to the natural and unnatural factors such as site erosion, chemical spills or extreme storms.

This manual has been designed by the SPEL StormSack Manufacturer the client or device owner in the maintenance of the SPEL StormSacks.

This manual should be used in conjunction with the relevant site traffic management and safety plans, as well as any other provided documentation from SPEL.

SPEL StormSack Specifications/Features

CHAPTER 2

1. General Description

The SPEL StormSack provides effective filtration of solid pollutants and debris typical of urban runoff, while utilising the existing or new storm drain infrastructure. The StormSack is designed to rest on the flanges of conventional catch basin frames and is engineered for most hydraulic and cold climate conditions.

Components:

a. Adjustable Flange and Deflector: Aluminium Alloy 6063-T6
b. Splash Guard: neoprene rubber
c. StormSack: woven polypropylene geotextile with US Mesh 20
d. Corner Filler: Aluminium Allow 5052-H32
e. Lifting Tabs: Aluminium Allow 5052-H32
f. Replaceable Oil Boom: polypropylene 3 inch (76 mm) diameter
g. Mesh Liner: HDPE, diamond configuration
h. Support Hardware: CRES 300 Series

Sizes:

STANDARD SPEL STORMSACK TO SUIT PIT SIZES

- 450x450mm
- 600x600mm
- 900x600mm
- 900x900mm

Custom sizes (i.e. 1200x900mm) can be manufactured on short lead times.

Health and Safety

CHAPTER 3

1. Personal Health & Safety

When carrying out maintenance operations of the SPEL StormSack all contractors and staff personnel must comply with all current workplace health and safety legislation.

The below measures should be adhered as practically as possible:

• Comply with all applicable laws, regulations and standards
• All those involved are informed and understand their obligations in respect of the workplace health and safety legislation.
• Ensure responsibility is accepted by all employees to practice and promote a safe and healthy work environment.

2. Personal Protective Equipment

When carrying out maintenance operations of the SPEL StormSack, wearing the appropriate personal protective equipment is vital to reducing potential hazards. Personal protective equipment in this application includes:

• Eye protection
• Safety apron
• Fluorescent safety vest
• Form of skin protection
• Puncture resistant gloves
• Steel capped safety boots

3. Maintenance of the SPEL StormSacks is a specialist activity.

When carrying out maintenance operations of the SPEL StormSack, factors such as equipment handling methods, pollutants and site circumstances can impose potential risks to the maintainer and nearby civilians.

4. Captured Pollutants

The material captured by the SPEL StormSack can be harmful and needs to be handled correctly. The nature and amount of the captured pollutants depends on the characteristics of the site. Pollutants can include from organic material such as leaves and sticks through to debris such as plastics, glass and other foreign objects such as syringes.

5. Site Circumstances

It is essential that Occupational Safety and Health guidelines and site specific safety requirements are followed at all times. It is important that all following steps specified by SPEL are carried out to ensure safety in the entire maintenance operation. The general workplace hazards associated with working outdoors also need to be taken into account.

6. Equipment Handling

Handling activities such as a removing the drain grate a well as managing pedestrians and other non-worker personnel at the site should be exercised in accordance with specified safety procedures and guidelines.

7. Confined Spaces

Confined space entry procedures are not covered in this manual. It is requested that all personnel carrying out maintenance of the SPEL StormSack must evaluate their own needs for confined space entry and compliance with occupational health and safety regulations

When maintenance operations cannot be carried out from the surface and there is a need to enter confined space, only personnel that currently hold a Confined Space Entry Permit are allowed to enter the confined space. All appropriate safety equipment must be worn, and only trained personnel are permitted to use any required breathing apparatus gear. Necessary measures and controls must always be exercised to meet the confined space entry requirements. Non trained staff are not permitted to participle in any confined space entries.

8. Traffic Management

Typically stormwater gully pits are situated on roads and carparks, or adjacent to roads in a footpath or swale. As traffic requirements vary depending on the circumstance of the site, separate traffic control plans should be prepared for each site.

The specific road safety requirements for each site can be obtained from the relevant road authority to ensure all maintenance operations comply with the laws and regulations. State government publications can also be useful to find out the signage requirements, placement of safety cones and barricades that are required when working on public roads.

Operations

CHAPTER 4

1. General Monitoring

The SPEL Stormsack must be checked on a regular basis to analyse whether it requires maintenance or cleaning.

As gully pit grates are usually quite heavy, it is vital to exercise the correct lifting techniques and also ensure that the area surrounding the open pit is shielded from access of non-work personnel.

To ensure optimal performance of the SPEL Stormsack, the material collected by the filter bag should not exceed the level of approximately a half to two thirds of the total bag depth. When this material collected is showing signs of exceeding this level they should be scheduled to be emptied.

It is also recommended that additional monitoring is conducted following moderate to extreme rainfall events, especially when previous months have had little or no rainfall.

CHAPTER 4

2. Gully Pit Cover Removal

Opening a Hinged Pit Cover

A. Insert the lifting hooks beneath the grate

B. Check hinge points are not damaged and debris is not caught in the hinge area

C. Fully open pit grate, ensuring that the grate will stay in the open position without any external forces applied. Grates that do not remain open without being held, should be removed or secured during maintenance activities.

Opening a Non-Hinged Pit Cover

A. Place lifting hooks beneath grate, where possible in the four corners of the grate. Concrete lids may have Gatic lifting points, a key arrangement or holes in the lid, which may require special equipment such as Gatic lifters. Alternatively if safe to do so grip the grade with your hands.

B. Position each person on either side of the grate.

C. Lift the grate, ensuring that good heavy lifting posture is used at all times.

D. Place the grate on angle on the gutter, to allow for the lifting hooks to be removed.

E. For extremely heavy one-piece grates and concrete Gatic covers, insert the lifters in place and slide the lids back.

3. Cleaning Methods

Cleaning using an inductor truck

A. Open Gully pit

B. Place the indicator hose, suck out all of the sediment, organic leaf material, litter and other materials that were collected in the filter bag

C. Allow the filter bag to be sucked up in the inductor hose for a few seconds to allow for the filter mesh pores to be cleaned.

D. Use the inductor hose to remove any build-up of material around the overflows and in the bottom of the pit.

E. Remove filter back from pit

F. Remove any sediment and litter caught in the Gully pit grate

G. Back opening channels are to be cleared of any debris to ensure flow is not hindered.

H. Thoroughly examine the structural integrity of the filter bag and frame.

I. Reinstate filter bag and gully pit covers

Hand Maintenance

A. Open Gully pit

B. Using the correct lifting technique, lift the StormSack out by the diagonal lifting corners fitted to the frame.

C. For extremely heavy and overfilled bags either use a hydraulic lifting arm to lift the StormSack, or remove excess material using a shovel or etc. Take care not to damage the bag when removing litter form the bag.

D. Lift the StormSack clear of the stormwater pit.

E. Position the StormSack over the collection bin or vehicle.

F. Lift and empty the bag by holding the bottom lifting loops only.

G. Brush the StormSack with a stiff brush to remove the sediment from the filter pores.

H. Thoroughly examine the structural integrity of the filter bag and frame.

I. Reinstate StormSack and gully pit covers.

CHAPTER 4

4. SPEL StormSack Post Maintenance Inspection

After the SPEL Stormsack has been removed, emptied and cleaned, it should be thoroughly examined to sure that:

- There is no movement or damage to the Cage
- There is no movement or damage to the plastic pit seals
- Structural integrity is in good condition including all fixings, joints and connections.
- The filter bag pores are not clogged
- The filter bag is not damaged in anyway.

The gully pit, pipe inlet/outlets and its cover should also be inspected to ensure there is no damage, debris build up or any potential to cause the SPEL StormSack to operate inefficiently.

5. Material Disposal

Collected materials can be potentially harmful to humans and the environment.

Once all captured material from the SPEL Stormsack has been removed, it must be taken off site and disposed of at a transfer station or a similar approved disposal site.

6. SPEL StormSack Repairs

Depending on the extent of the damage to the SPEL StormSack unit, it can usually be repaired.

Small tears to the filter bag can be repaired by either sewing the tear back together with additional fabric to increase the strength of the stitching, or by sewing a patch of filter material onto the filter bag.

If large tears or irreparable damage to the frame and structure are present, it is advisable to replace the components.

All required spare parts can be sourced from SPEL Environmental at a cost to the owner of the SPEL Stormsack.

7. Emergency Procedures

Spills and blockages can be detrimental to the performance of a stormwater management system, potentially damaging the surrounding built infrastructure, waterways and environment.

Spill Procedures

In the event of a spill discharging into a gully pit, all effected sediment must be removed from the filter bags and the filter bags are to be removed and replaced with new filter bags. All additional cleaning as a result of the spill should also be carried out in accordance with the normal operation procedures.

Blockages

In the unlikely event of surface flooding around a gully pit which has a SPEL StormSack fitted, the following steps should be carried out:

A. Check the overflow bypass.

B. If overflow is clear and surface flooding still exists remove the SPEL StormSack and check the outlet pipe for blockages. Removal of the SPEL StormSack can be difficult if clogged with sediment and holding water.

C. If the filter is clogged brush the side walls to dislodge particles trapped at the interface allowing water to flow through the filter.

D. If the outlet pipe is blocked, it is likely that a gully sucker truck will be required to unblock it. Litter can be removed from the SPEL StormSack using the gully sucker truck before the SPEL StormSack is removed. If a gully sucker truck is not available and the SPEL StormSacks need to be removed by hand follow the below steps.

   i. Remove excess debris by hand or brush the side of the filter bag

   ii. Remove entire SPEL Stormsack by taking hold of the inside of the frame.

   iii. Unblock the outlet pipe

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SPEL ENVIRONMENTAL
INTEGRATED WATER SOLUTIONS

SPEL Separator Commisioning Operation and Maintenance

SPEL

Puraceptor Class 1

Operation and Maintenance Manual

Introduction

Congratulations on your purchase of a SPEL Environmental Stormwater Quality Improvements Device. With proper care and by following a few simple guide lines your system will give you many years of dependable service.

Important

Only qualified personnel should maintain, operate and repair you Stormwater system. Any wiring of equipment should be performed by a qualified electrician.

Warning

Operation may cause injury. Take all necessary precautions, wear protective equipment, refer to Engineers Department. For your own safety, read all instruction manuals prior to working on equipment.

Safety Precautions

- Follow all “occupation, health and safety” regulations.
- Ensure maintenance personnel are aware of “Confined Spaces” guidelines, which must be followed.
- Make sure that there is sufficient oxygen and that there are no poisonous gases present.
- Check the explosion risk before wielding or using electric hand tools.
- Do not ignore health hazards. Observe strict cleanliness.
- Ensure that the lifting equipment (where required) is in good condition.
- All personnel who are to work with these systems should be vaccinated against diseases that can occur.
- Keep a first aid kit handy.

Health & Safety

Maintenace should be carried out by a competent contractor in accordance with the above procedures.
Health and Safety at Work legislation and good building practice.
A warning notice should be visible at the top of each access shaft - ‘danger, harmful fumes’ and ‘ respirators should be worn in this tank.’ Before entering persons must be qualified in accordance with ‘confined space’ requirements

Information contained in this data sheet is approximate and for general guidance only. In accordance with the companies policy of constant improvement and development SPEL Products reserves the right to change the specification without prior notice.

Puraceptor Class 1

SPEL

Operation and Maintenance Manual

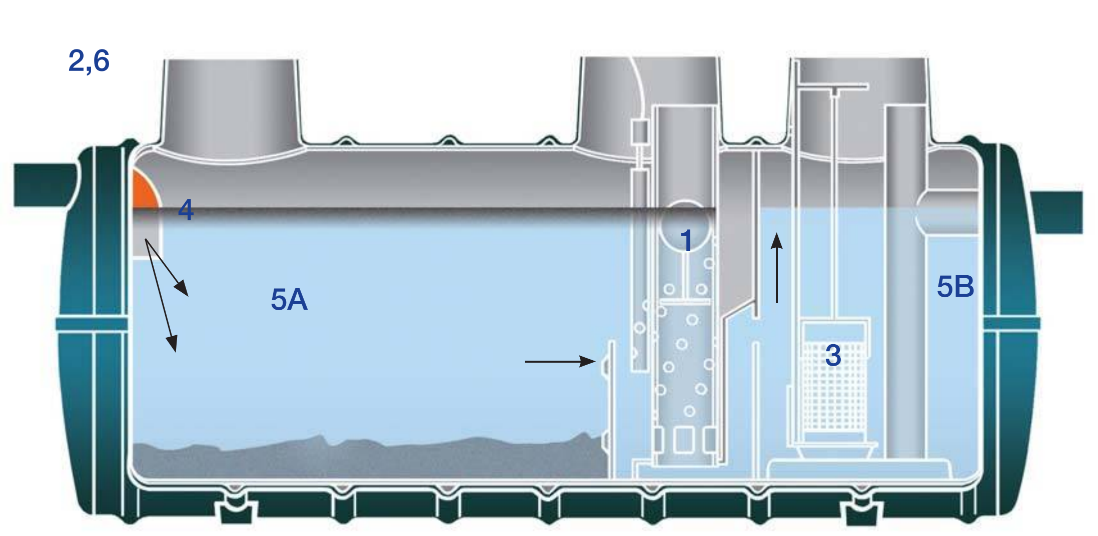
- Service Stations
- Fuel Depots
- Windfarms
- Switchyards
- Sub Stations
- Power Stations
- Industrial Locations

Contents

SPEL PURACEPTOR™ CLASS 1

Oil containment

"How it works"



SPEL PURACEPTOR™ is a FULL RETENTION separator that treats all flows and is sized to contain more than the anticipated maximum oil spillage enabling it to be fully operational at all times.

It has two chambers, a coalescer and is fitted with an automatic closure device specifically designed to treat and contain major oil spills thereby making it suitable for high risk applications.

It achieves a water discharge quality of 5mg light liquids per litre complying to European Standard BS EN 858.1. 2006. Treatable flow rates range from 2LPS to 200LPS. Pipe sizes range from 100mm to 450mm (larger sizes on request).

Careful and proper planning by corporate Australia and government bodies is essential when designing and implementing systems that are effective in protecting our environment.The proven and independently accredited SPEL PURACEPTOR™ (complies to European Standard BS EN 858.1 2006) is an Australian made stormwater treatment and oil containment device that can contain and prevent light liquid pollutants from discharging into our waterways.

1 **AUTOMATIC CLOSURE DEVICE**
The AUTOMATIC CLOSURE DEVICE (A.C.D.) is a precisely engineered device comprising a water-bouyant ball that is sensitive to any change in the water density as a consequence of light liquids build up, thereby automatically activating a process of depressing the A.C.D. to SHUT OFF the separator, preventing pollutants from discharging to drains and waterways.

2 **FULL RETENTION**
All liquid is treated. There is no by-pass operation.

3 **COALESCER EQUIPPED**
Provides a coalescing process for the separation of smaller globular of light liquid pollutants to reduce the light liquid content in the outlet to **5mg/litre or less.**

4 **INLET DIP PIPE - FLAME TRAP**
For minimum turbulence and to prevent fire and inflammable vapours passing through to the drainage system.

5 **TWO CHAMBER**
A non-turbulant flow through two horizontal treatment chambers, utilising the underflow principle to retain light liquids in all flow conditions.

A. CONTAINMENT CHAMBER: Where Total Suspended Solids (TSS) silt, sediments, sludge and gross pollutants are trapped and settle on the chamber floor and where light liquids are contained.

B. COALESCER CHAMBER: Where light liquids separation is enhanced reducing it to **5mg/litre** or less prior to discharge.

6 **GRAVITY OPERATED**
Will function in the event of power failure and fits into existing pipe drainage systems or new sites.

7 **MAINTENANCE**
Easy and safe with no entering of the tank required.

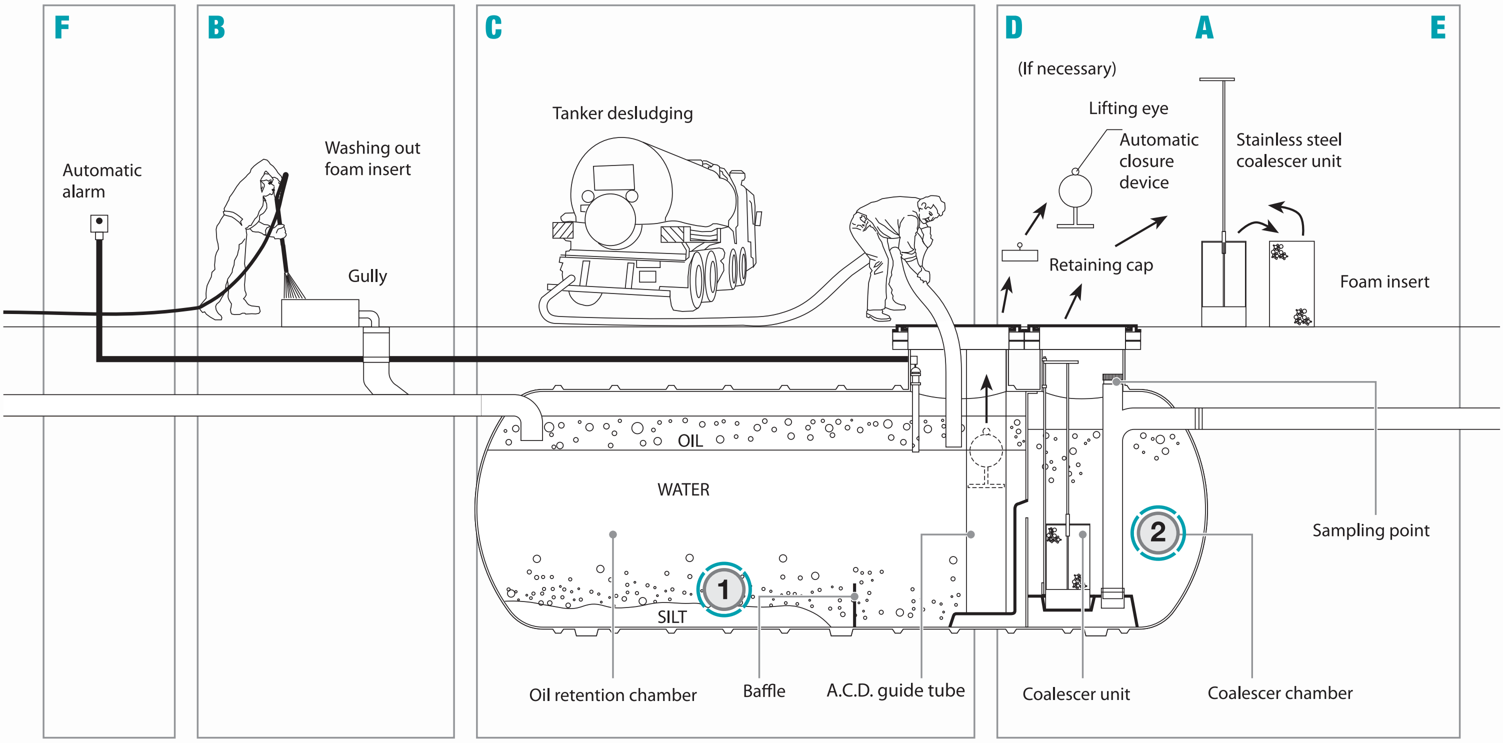
SPEL ENVIRONMENTAL

SPEL PURACEPTOR™

Puraceptors™ should be inspected at three - six - or twelve monthly intervals depending on site conditions, to determine the depth of retained pollutants and silt in both chambers and the correct operating of the ACD (automatic closure device). When the depth of the oil/fuel retained has reached the predetermined design level, (approx. 50mm) or after a spill it should be cleaned out.

1 **CONTAINMENT CHAMBER:** Where silt, sediments, sludge, gross pollutants settle out and light liquids are retained. The auto closure device operates in its retaining tube next to the oil alert sensor probe.

2 **COALESCER CHAMBER:** Where light liquids separation is enhanced prior to discharge and where the coalescer unit is incorporated, the coalescer should be removed and cleaned in accordance with the requirements set out in the coalescer data sheet.



MAINTENANCE PROCEDURE

A Coalescer unit
Use the lifting handle or the chain and lift the coalescer unit out of the tank and place it near the Puraceptor™. In a retained area so pollutants do not escape.

B Cleaning foam insert
Remove foam insert and wash with normal water pressure ensuring the dirty water runs into the Puraceptor™.

C Sucking out oil/fuel and silt
Suck off the retained oil from both chambers of the Puraceptor™ and then the silt deposited on the bottom, leaving sufficient water to ensure the (auto closure device) ACD remains floating.

D Sucking out complete contents (if necessary)
If the quantity of pollutants exceeds recommended level, the complete contents of the Puraceptor™ may need to be removed. After sucking out completely, remove the ACD. Using a pole with a hook, lift out the ACD using the lifting eye on the float, if fitted.

Important note:
When cleaning out, ensure both chambers are sucked out equally starting with the first chamber and then the second chamber and back again. Ensuring even water pressure against baffle wall.

E Re-insert coalescer unit and ACD
Re-insert the foam insert into the stainless steel coalescer unit and re-insert the coalescer unit into the Puraceptor™ as provided with the SPEL lifting/location/locking system.

Partially fill the Puraceptor™ with clean water (if necessary) to ensure the ACD when re-inserted remains floating. Re-insert the ACD.

Finally check the ACD is floating after it has been replaced to safeguard against its removal by unauthorised persons, unless depth of tank precludes doing so from ground level.

F SPEL automatic alarm/monitoring system
The SPEL automatic alarm/monitoring system probe should be lifted out of the probe protection tube, wiped clean and re-inserted. the system should now be reset according to instructions.

SPEL COALESCER UNITS

The SPEL Puraceptor™ Class 1 separator and the SPEL Stormceptor™ Class 1 by-pass separators incorporate coalescer units. The coalescer units provide a coalescence process for the separation of small globules of light liquid pollutants before final discharge to the surface water drain.

Coalescers are found in the second chamber of the SPEL Puraceptor™ and the second chamber of the SPEL Stormceptor™ Class 1

Prior to installation

1. Remove any strapping / ropes which have been used to hold the coalescer units from shifting in transit.
2. The access shaft(s) above the coalescer units should be covered to prevent ingress of concrete, dust, debris etc., which could clog the foam inserts.
3. On completion of installation, check that the coalescer unit is inserted securely into the base socket.

On heavily polluted sites silt and contaminants may build up in the coalescer unit foam inserts and add significantly to it's weight. Use lifting chain sets that are on hooks at ground level for safe lifting with a tripod or hoist.

Installation

During installation, it is important that the foam inserts are not clogged with dust, debris or drops of wet concrete. To safeguard against this, we recommend covering the access shaft with a sheet of polythene, if not already covered.

Commissioning

On completion of installation, check the foam insert is fitted inside the stainless steel coalescer unit and the coalescer unit is inserted securely into the base socket.

Maintenance

1. Lift handle and coalescer unit out of the tank and place in a retained area so pollutants do not escape.
2. Remove foam insert and wash with normal water pressure ensuring the dirty water runs into the Puraceptor™ / Stormceptor™.
3. Make sure the hole in the centre of the coalescer foam is facing towards the manhole when installed in the tank.
4. Re-insert the foam insert into the stainless steel coalescer unit and re-insert the coalescer into the Puraceptor™ / Stormceptor™. After the tank has been cleaned.

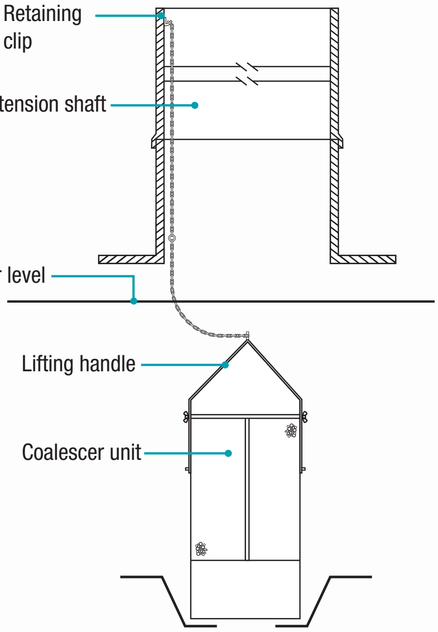


Figure 1. Coalescer unit with lifting chains

SPEL COALESCER UNITS GUIDE RAIL SYSTEM/LIFTING, LOCATING AND LOCKING SYSTEM

SPEL coalescer unit guide rail system

This facilitates easy insertion and removal of coalescer units. The system is robust, manufactured throughout in stainless steel and is action positive, leaving no doubt the coalescer unit is located properly.

Brackets fixed to the top and bottom of the coalescer unit simply engage the stainless steel guide rail fixed to the top of the stub access shaft. The coalescer is then lowered in the normal way, being guided at the correct angle into the conical base unit which finally locates the coalescer unit into it's final position.

Extension guide rails can be incorporated into the SPEL extension shafts to suit (preferably when ordered with the separator).

However, when the separator is full of water, debris or sludge accumulated over a period could prevent the coalescer unit from re-seating correctly after servicing.

The coalescer unit lifting / locating / locking system ensures the coalescer unit is seated correctly and can be locked into position to prevent tampering.

The stainless steel lifting handle can be extended to suit deep tank inverts and provide easy access for lifting manually or with a tripod and hoist utilising the lifting hook.

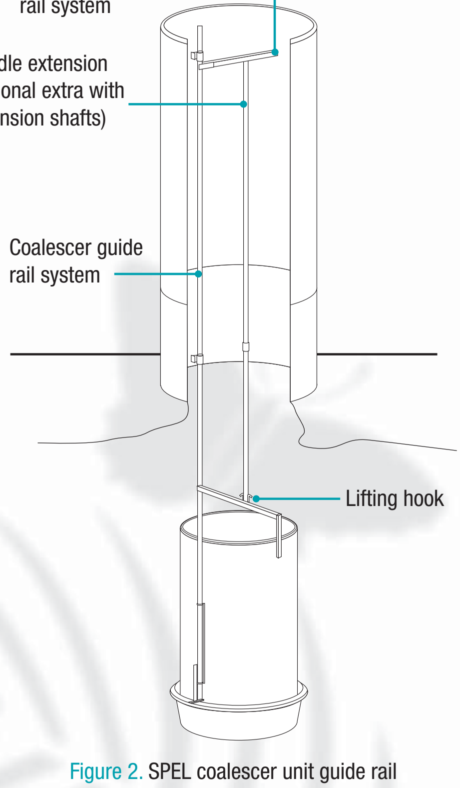


Figure 2. SPEL coalescer unit guide rail system/lifting, locating and locking system

SPEL AUTO CLOSURE DEVICE (ACD)

• SPEL ACDThe Automatic Closure Device (ACD) is found in the first chamber of a Puraceptor™. The purpose of the ACD is to close the separator off automatically when the maximum storage capacity of light liquid is attained.

The ACD is to ensure that in the event of a major spillage, pollutants do not pass into the drainage system; it should not be regarded as a substitute for an automatic alarm / monitoring system.

Prior to installation

Prior to installation the ACD retaining tube should be covered to prevent ingress of concrete etc., which could fall onto the ACD and upset it's calibration.

Operation and Maintenance

If the tank should fill with light liquid, the ACD which is calibrated for a specific gravity of 0.85, will automatically sink and close off the SPEL Puraceptor™.

Normally routine maintenance would include removing light liquid intercepted within the Puraceptor™. If a SPEL automatic alarm / monitoring system is incorporated, it will automatically indicate when the Puraceptor™ should be emptied. Only in an emergency will the Puraceptor™ fill to it's maximum and operate the ACD.

In such an event the Puraceptor™ should be completely sucked out and the ACD lifted out. Check that the ACD is in good working condition – ie. Lifting hook secure and sealed; float not leaking; knuckle joint free and clean; sealing ring intact and complete. Clean with warm soapy water before re-inserting.

To re-insert the ACD, partially fill the Puraceptor™ with clean water (if necessary) to ensure the ACD when re-inserted remains floating. Re-insert the ACD.

Finally check the ACD is floating after it has been replaced.

SPEL Puraceptor™ Class 1 separators – Two Chamber Models

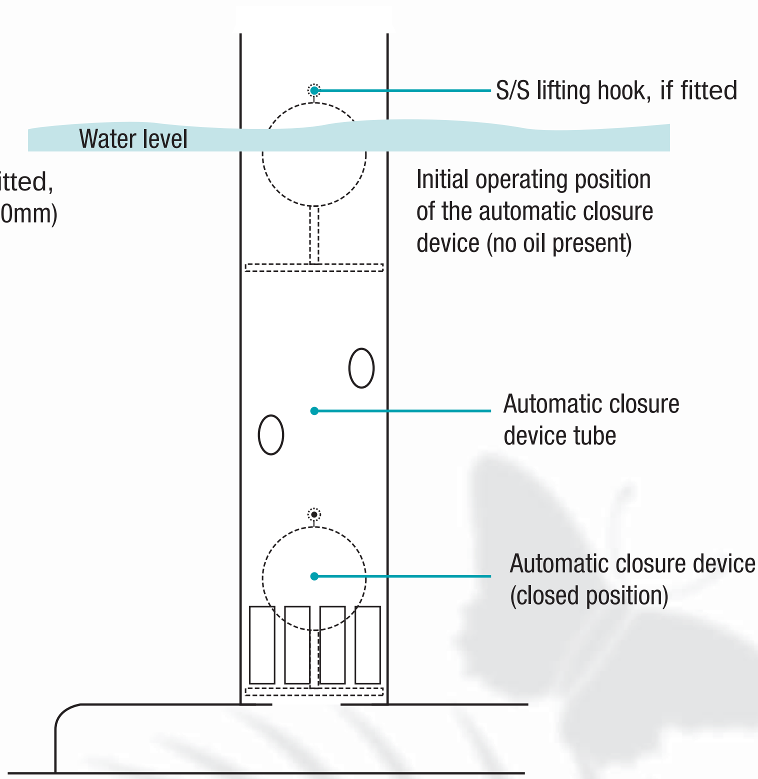
Commissioning

After the tank has been installed, leave the water in.

1. Remove the ACD from the packing box, taking care not to cause damage.

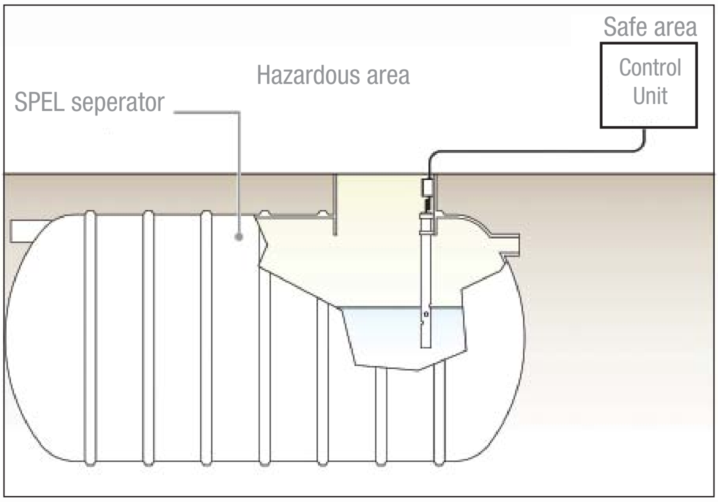
2. Insert the ACD into the retaining tube using the lifting eye, if fitted, ensuring it floats correctly with the float (top section approx. 50mm) just visible above the water level.

Automatic closure device SPEL Puraceptor™ Class 1 separators (two chamber)



SPEL Automatic Alarm/Monitoring System

The SPEL automatic alarm/monitoring system provides a audible warning alarm when the level of the oil in the SPEL separator reaches approximately 10% of the storage volume under static liquid level conditions. This is a early warning system that is used for spills or lack of maintenance.
The system comprises of a probe mounted in the main separation chamber which senses when the designed volume of light liquids has accumulated and sends a signal to the electronic control unit activating a red ‘empty now’ warning light and an audible alarm,



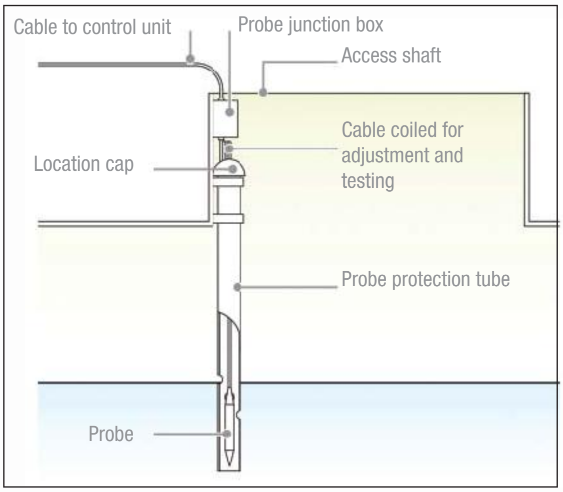
Operation

The probe is freely suspended in the probe protection tube in the separator at the correct level. When the oil-layer or depth of hydrocarbons reaches the predetermined level, the top of the probe will be immersed in the oil, breaking the circuit and activating the alarm. It is a ‘fail-safe’ system providing complete assurance that it is operative. If a fault occurs it will be signalled immediately.

Installation

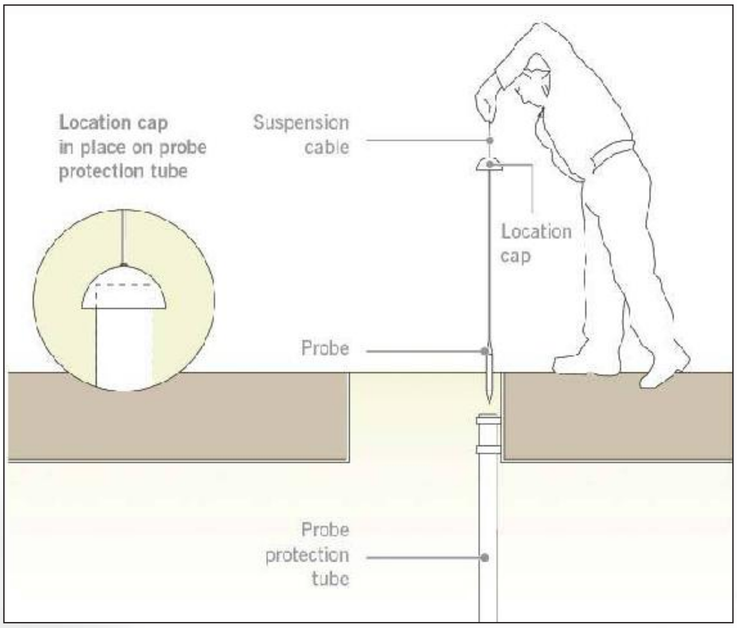
Control unit (general positioning)

The control unit has been designed to be located indoors and outdoors, within a nonhazardous area. It should be wall mounted and positioned such that the LED display and push switches on the front panel can be readily seen and accessed. The unit can be secured to the wall by using the four mounting holes provided. Included within the control is an intrinsically safe circuit (approved according to ATEX Directive 94/9/EC), to which the probe unit is connected.



Maintenance

When the separator is maintained, lift the probe out of the probe protection tube, check it operates the alarm (see under Tests Ref. 10.2) and at the same time wipe oil and contaminants from the probe to prevent a fake alarm after re-inserting.



Insert probe onsite

The probe protection tube is factory fitted and the probe matched to ensure the alarm is activated when the light liquids reach approximately 10% of the storage volume the SPEL separator is designed for.

All that is required on site is to undertake the electrical installation in accordance with the instructions provided and lower the probe with the pre-fixed location cap into the probe protection tube. When the cap locates onto the top of the probe protection tube, the probe is suspended at the correct level.

Control unit (electrical connections)

1. Mains voltage connection;

The control unit should be connected to a suitable 220/240V AC supply and fused at 3 amps.

Note: This appliance must be earthed.

2. Control unit/probe junction box connection

Wiring from the control unit to the probe junction box in the separator chamber requires a 3-core screened. 0.75mm core section cable.

Maximum cable length: 300 metres.

3. Probe connection

A 5 metre 3-core probe cable is normally fitted to the junction box and the probe.

After all connections have been made, the cables must be secured by tightening each entry gland.

Probe

The probe is installed freely suspended in the SPEL separator within the probe protection tube. The 3-core cable is connected into the junction box mounted in the access shaft above the probe protection tube. Extra cable is provided to enable raising the junction box where extension shafts are incorporated.

Important note: In all cases good, standard electrical practice should be followed and the installation must conform to the Australian Wiring Rules – AS 3000 – 2007. In essence, the installation must be such that the intrinsic safety is no compromised by:

- Exposure to risk of mechanical damage
- Unauthorised modification of interference
- Exposure to moisture, dust and foreign bodies
- Excessive heat
- Invasion of intrinsically safe circuit by other electrical equipment or circuitry

Certificate of conformity

The alarm device has been approved to be used in explosion-hazardous areas. The control unit and probe are approved according to ATEX Directive 94/9/EC. These approvals mean that the probes can be installed in Zone 0, which is continuously explosion-hazardous.

The SPEL oilset control unit must be located in the safe area, but it can be connected to the probe without any barrier.

Tests (10.2)

The function can be tested by lifting the probe within the probe protection tube. In approximately 5 seconds, the alarm is given by a red light and audible signal. Both relays release. Push the RESET button - the buzzer goes off and relay pulls in.

When the probe is placed in water again, relay pulls in and the red light goes off.

Cable break and short circuit test

Also the function can be tested in case of cable fault or short circuit. First cause short circuit in probe cable terminals 1 and 2. Then the yellow light of short circuit is lit. Both the relays pick up and the buzzer goes on. Remove the short circuit and reset the buzzer.

Simulated Function Test

The function of probe, cable and electronics can be tested. Push the TEST button for 2 to 5 seconds. Both relays pick up, and the red light is lit. When the TEST button is released, the red light goes off and relay returns to its normal position. The buzzer and relay must be reset.

Installation

Important note: It is important that installation is carried out by a competent technician familiar with this type of equipment or contact our Special Products Division for installation, commissioning and maintenance service.

PHONE: +61 (0)2 8838 1055
FAX: +61 (0)2 8014 8699

SPARE PARTS LIST

DATE:____________________

INVOICE NO:____________________

TYPE:____________________

MODEL:____________________

SERIAL NO:____________________

JOB NO:____________________

LINE	DESCRIPTION	QTY	PART No.
1			
2			
3			
4			
5			
6			
7			
8			

For all spare parts enquiries, please ring 13 SPEL or 13 77 35

PHONE: +61 (0)2 8838 1055
FAX: +61 (0)2 8014 8699

MAINTENANCE SERVICE LEDGER

MODEL No	
INSTALLATION ADDRESS	
INITIAL OPERATING DATE	
WORKING CAPACITY	
PRIMARY CHAMBER SPILL CAPACITY	
OIL ALERT PROBE trigger threshold	
MINUMUM MAINTENANCE FREQUENCIES	***ANNUALLY from the initial operational date or if indicated by the oil alert probe alarm***

Note: Oil Alert Probe alarm is triggered when fuel/oil hydrocarbons reaches 10% of primary chamber capacity.

MAINTENANCE RECORD

SERVICE DATE	COALESCER FLUSHED	PRIMARY CHAMBER SEDIMENT REMOVED & HYDROCARBONS SKIMMED	SECONDARY CHAMBER SEDIMENT REMOVED & HYDROCARBONS SKIMMED	OIL ALERT PROBE CLEANED & ALARM CHECKED	SERVICE MANAGER NAME & SIGNATURE

MAINTENANCE RECORD

SERVICE DATE	COALESCER FLUSHED	PRIMARY CHAMBER SEDIMENT REMOVED & HYDROCARBONS SKIMMED	SECONDARY CHAMBER SEDIMENT REMOVED & HYDROCARBONS SKIMMED	OIL ALERT PROBE CLEANED & ALARM CHECKED	SERVICE STATION MANAGER NAME & SIGNATURE

4.2 Inspection and maintenance checklist for swales

For bioretention swales, use the checklist for bioretention systems (Section 4.3).

ASSET TYPE	**Swale**	**ASSET ID**
Location		
Date		
Date of last rainfall		Weather
Officer's name		

Swale plan

Insert diagram or plan of the asset showing key features e.g. locations of inlet, outlet, overflow

Additional information	
Time taken to complete inspection or maintenance	
Photos of site (explanatory notes)	1. 2. 3. 4. 5. 6.
General comments and sketches	
Officer's signature	

What to look for	Performance Indicator (PI)	Condition rating*	Maintenance undertaken**	Additional work needed
SURROUNDS				
Damaged or removed structures e.g. traffic bollards	No damage that poses a risk to public safety or structural integrity			
INLET				
Erosion	Inlet is structurally sound and there is no evidence of erosion or subsidence/settlement			
Damaged or removed structures e.g. pit lids or grates	No damage that poses a risk to public safety or structural integrity			
Sediment, litter, or debris	No blockage			
BATTER SLOPES AND BASE INVERT				
Erosion	Minor erosion only that does not pose a risk to public safety or structural integrity and would not worsen if left unattended			
Sediment	Minor amount of sediment accumulated			
Surface ponding or boggy conditions	No surface ponding or boggy areas			

* 1 – PI met; 2–PI met after maintenance activity undertaken; 3 – Additional maintenance needed; 4 – Rectification may be needed; NI – not inspected; NA – not applicable

** Quantify where possible e.g. amount of sediment or litter removed

What to look for	Performance Indicator (PI)	Condition rating*	Maintenance undertaken**	Additional work needed
Litter	Maximum 1 piece litter per 4 m^2			
Unusual odours, colours, or substances (e.g. oil and grease)	None detected			
Vegetation	Minimum 80% vegetation cover (minimal bare batches); 100% cover if turfed			
	Plants healthy and free from disease			
Weeds	No declared weeds (or declared weeds are controlled)			
	Maximum 10% cover of weeds			
Erosion	Outlet is structurally sound and there is no evidence of erosion or subsidence/settlement			
Damaged or removed structures e.g. pit lids or grates	No damage that poses a risk to public safety or structural integrity			
Sediment, litter, or debris	No blockage			

* 1 – PI met; 2–PI met after maintenance activity undertaken; 3 – Additional maintenance needed; 4 – Rectification may be needed; NI – not inspected; NA – not applicable

** Quantify where possible e.g. amount of sediment or litter removed

SPEL ENVIRONMENTAL
INTEGRATED WATER SOLUTIONS

SPELFilter System

Technical & Design Manual

CHAPTER 1

INTRODUCTION

SPEL Environmental is a manufacturer of stormwater treatment technologies. SPEL Filter™ (1) is a stormwater filtration device designed to remove fine sediments, heavy metals, nitrogen and phosphorus from stormwater runoff.

SPEL Filter™ relies on a spiral wound media filter cartridge with approximately 43 square feet of active filtration area. The filter cartridges are housed in a concrete structure that evenly distributes the flow between cartridges. System design is offline with an external bypass that routes high intensity storms away from the system to prevent sediment resuspension. Flow through the filter cartridges is gravity driven and self-regulating, which makes the SPEL Filter™ system a low maintenance, high performance stormwater treatment technology. This manual provides detailed technical information on the SPEL Filter™ system including its capabilities and limitations. The manual describes the steps involved in designing a SPEL Filter™ system as well as the installation and maintenance requirements of the system.

SPEL Environmental is a complete stormwater solutions provider. We are always willing to assist design professionals to achieve the most efficient, economical systems for their clients and projects.

PRINCIPLES OF OPERATION

The SPELFilter system removes contaminants from stormwater runoff via media filtration. This Technical and Design Manual describes the principles by which the SPELFilter system works to improve the quality of the environment throughout the United States.

MEDIA FILTRATION

Media filtration has long been used in drinking water and wastewater treatment processes. This technology has proven effective at removing sediments, nutrients, heavy metals, and a wide variety of organic contaminants. The target pollutants, hydraulic retention time, filter media, pretreatment, and flow rate all affect the removal efficiency of the filter.

MECHANISMS OF REMOVAL

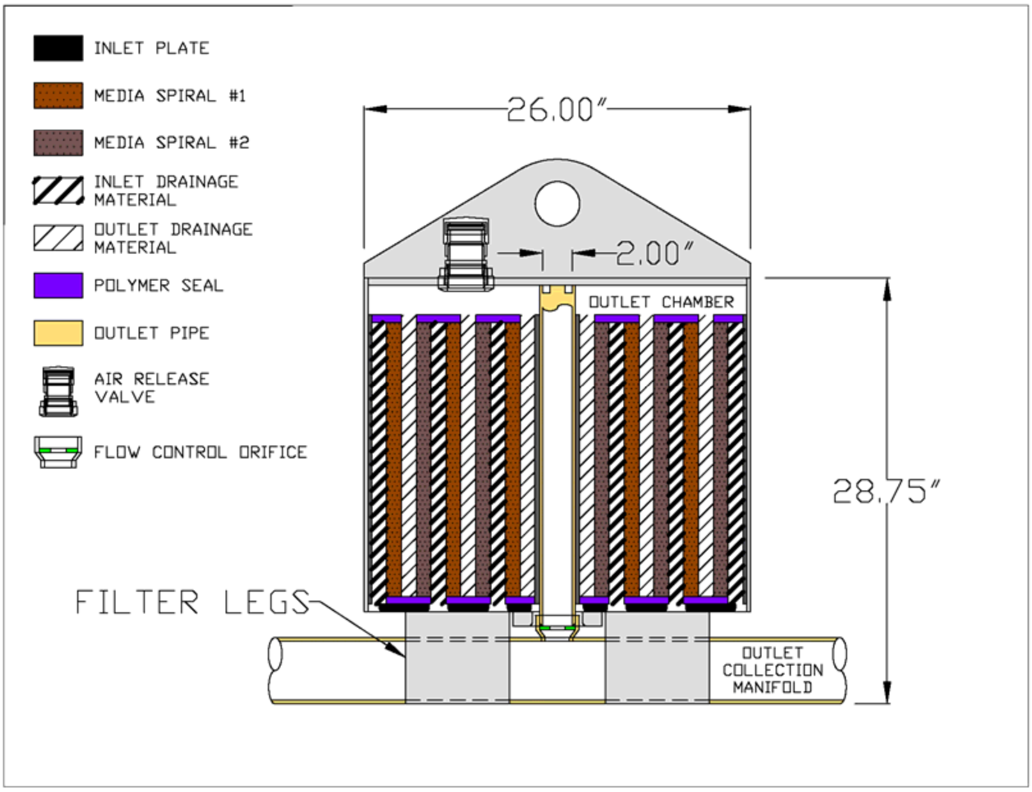
The SPELFilter removes pollutants from water by two mechanisms: 1) interception/attachment and 2) adsorption. Interception occurs when a pollutant becomes trapped within the filter media. A sediment particle, for example, may be carried into the filter media by the water and become stuck in the interstices of the media. Such a particle will typically remain trapped within the media until the media is removed or the filter is backwashed.

Attachment occurs when pollutants bind themselves to the surface of the filter media, and this happens primarily through adsorption. Adsorption is a surface process by which dissolved ions are removed from a solution and chemically bind themselves to the surface of the media. This occurs when the surface of the filter media particle contains sites that are chemically attractive to the dissolved ions. The SPELFilter system uses a proprietary media containing activated alumina, zeolite and pearlite to enhance adsorption of anions such as phosphates and nitrogen (ammonia and organic).

THE SPEL FILTER CARTRIDGE

The main building block of the SPELFilter stormwater filtration system is the SPELFilter cartridge (SFC), shown in Figure 1. The SFCs are housed in a structure which may be a vault, manhole or other structure. This structure contains the inlet and outlet pipes as well as an internal manifold that delivers treated water to the outlet of the SPELFilter system.

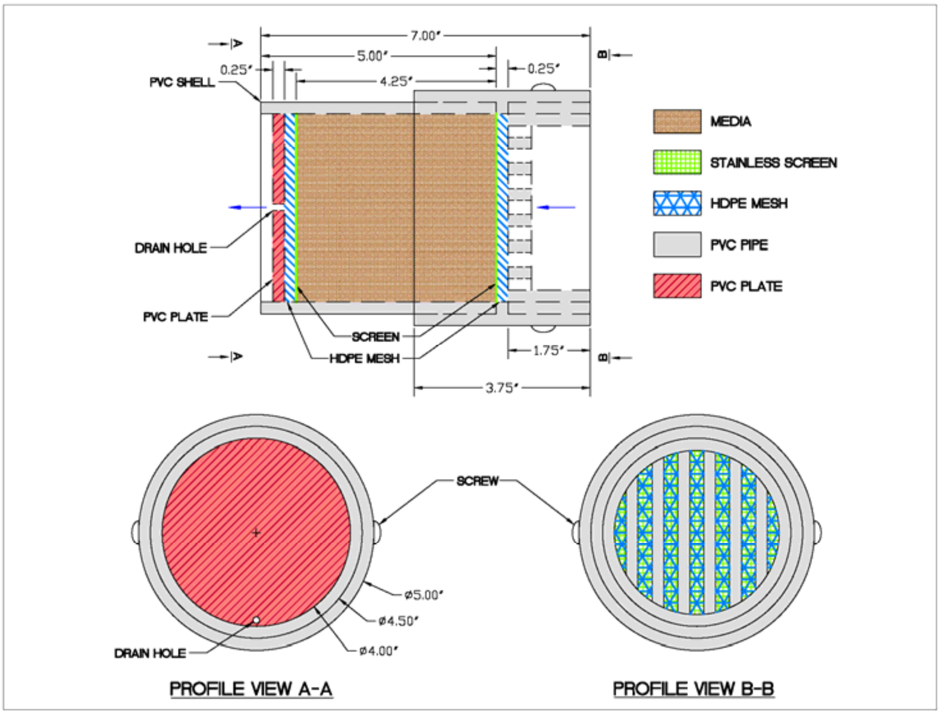
PRINCIPLES OF OPERATION



Stormwater runoff enters the manhole or concrete structure via an inlet pipe and begins to fill the structure. When the water surface elevation in the vault/manhole reaches operating level, water flows through the SFC driven by a hydrostatic head. Within the SFC, the water flows through a proprietary filter media and drains via a vertical pipe. The vertical drain is connected to the under drain system which conveys filtered water to the outfall. During a typical storm event, the SPELFilter system has four cycles:

1. Vault fill and air release;
2. Uniform bed load hydrodynamic filtration;
3. Uniform bed load siphon filtration; and
4. Siphon break and hydrodynamic backwash.

PRINCIPLES OF OPERATION



PRINCIPLES OF OPERATION

The Filter has been extensively tested in the laboratory. This testing has been carried out using SIL-CO-SIL 106 as a sediment source. SIL-CO-SIL 106 is a silica product containing approximately 90% fine sediments (d50 = 23 microns), and is widely accepted as a sediment source for stormwater simulations by regulatory agencies such as the Washington State Department of Ecology (TAPE) program, New Jersey Department of Environmental Protection (TARP), as well as other leading agencies.

The SFC needs only 71cm of depth of water to begin full flow operation. Once the full flow operation has been achieved, the SFC will operate to a depth of 16cm at which time the siphon will break and the system will backwash. At this point the only flow is from the drain down cartridge which will drain the vault to a depth below 3cm.

Each SFC has a maximum nominal flow of 2.8LPS. At this flow, each cartridge can treat 68kg of the total sediment load before maintenance. In addition, through the use of different size flow control orifice(s), the SFC flow is regulated. As the flow is lowered, the treated sediment load increases. For example, when the flow is lowered to 0.94LPS, the cartridge is able to treat 136kg of the total sediment load before maintenance.

DESIGN GUIDELINES

CHAPTER 2

DESIGN GUIDELINES FOR THE SPELFilter SYSTEM

Designing a SPELFilter system is done in four phases: (1) determine the treatment train design; (2) locate the system on the site and incorporate it into the plans; (3) determine the number of cartridges, size of the flow restrictor disks and number of drain down modules necessary; and (4) select a system configuration. It is important to realize that the design process can be iterative until the desired design parameters are satisfied. Again, it is important to note that the SPELFilter systems are designed offline. This section details the design process and provides examples for each of the three steps. During the design process, the engineer must consider factors in addition to regulatory requirements. These include:

- Site specific constraints
- Proposed system location
- System configuration (flow through or extended detention
- Pretreatment
- Efficiency requirements
- Pollutant loading (sediment load)
- Treatment flow rates and hydraulics
- Maintenance intervals

SPELFilter TREATMENT TRAIN DESIGN

On-line and Off-line Systems:
SPELFilter systems are usually designed to treat moderate to low flow rates. In the vast majority of applications, the peak design flow through the storm drain system will be significantly greater than the treatment design flow through SPELFilter. Because of this difference, a bypass structure is required for most SPELFilter installations. Therefore, SPELFilter systems are installed offline, utilizing an external bypass to route high flows around the system.

A schematic of an offline SPELFilter system is shown in Figure 3 below. The bypass structure diverts low flows to the SPELFilter system and allows high flows to pass to a separate outfall. The bypass structure will feature flow controls designed by an engineer to ensure that the required treatment flows are sent to the SPELFilter. The two effluent streams (the treated effluent from the SPELFilter and the high intensity bypass) may be combined into a single stream or discharged to separate outfalls. These configurations typically involve higher flow per cartridge, but reduced treated sediment load per cartridge. These configurations are, however, usually limited more by flow sediment capacity.

DESIGN GUIDELINES

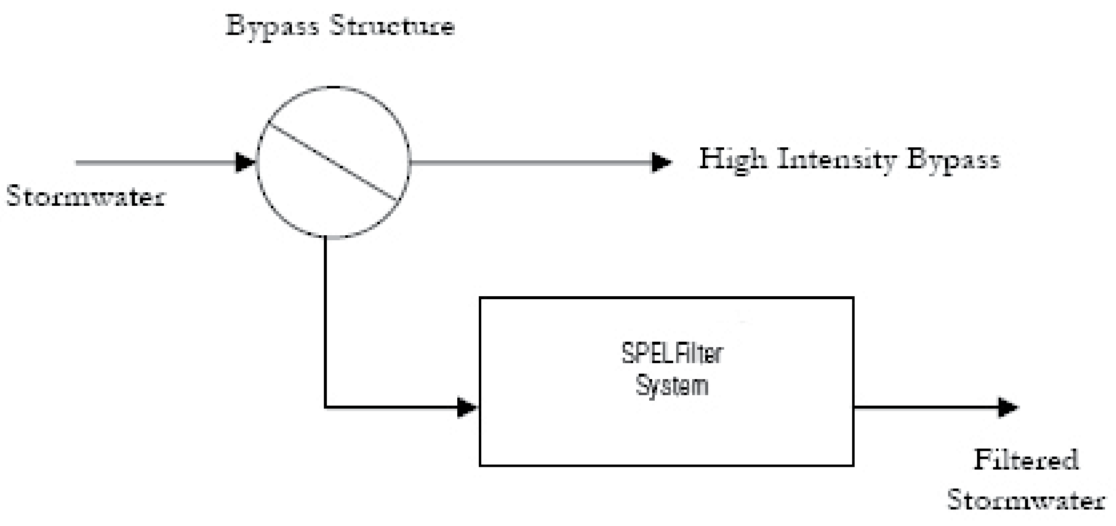


Figure 3: Offline SPEL Environmetal System

In SPELFilter installations sediment will accumulate in the vault as well as in the filter cartridges. In offline installations high intensity flows are routed away from the vault minimizing the risk of resuspending this accumulated sediment. In online applications it is possible for high flows to mobilize and release this sediment.

Pretreatment
The SPELFilter system is designed to remove a minimum of 80% of suspended sediments. If the anticipated sediment load is particularly heavy or if there will be a significant oil load, the system may require pretreatment.

Pretreatment may also be required by local regulations. Pretreatment systems will remove a portion of the influent pollutant load. SPEL Environmental Stormceptor Class 1 system is an ideal hydrodynamic separator that removes sediments and floatables from stormwater runoff.

DESIGN GUIDELINES

Figure 4 shows a schematic of a typical SPELFilter installation with pretreatment. Note that the pretreatment structure is downstream from the bypass. The system will work as long as 28” of head is achieved to activate the cartridge flow and will continue to work until it reaches the siphon break level (6”). Consult SPEL Environmental for verification based on your particular site conditions.

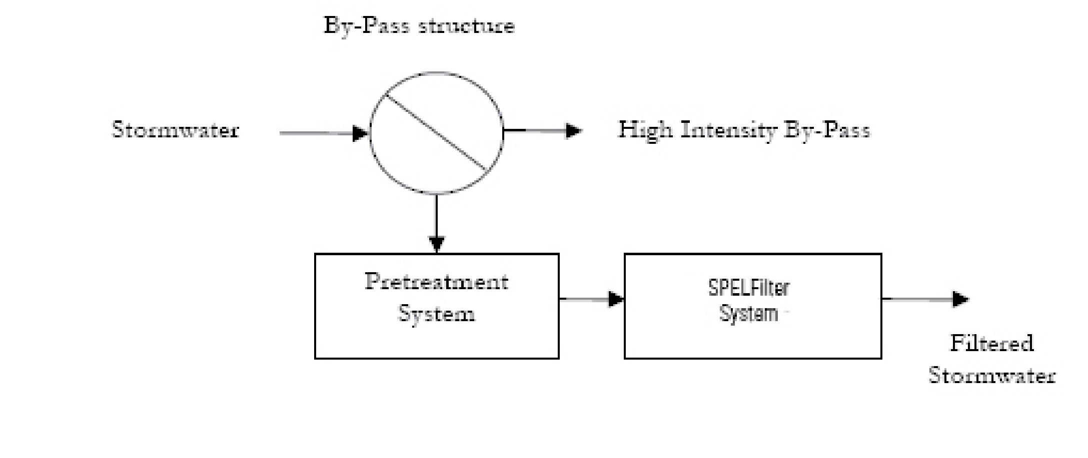


Figure 4: Offline SPELFilter system with Pretreatment

Extended Detention Systems
In some applications, SPELFilter systems will be installed in conjunction with extended detention systems. Extended detention systems attenuate peak flow rates within the storm drain system. In these cases, the SPELFilter is placed downstream from an extended detention system, as shown in Figure 5.

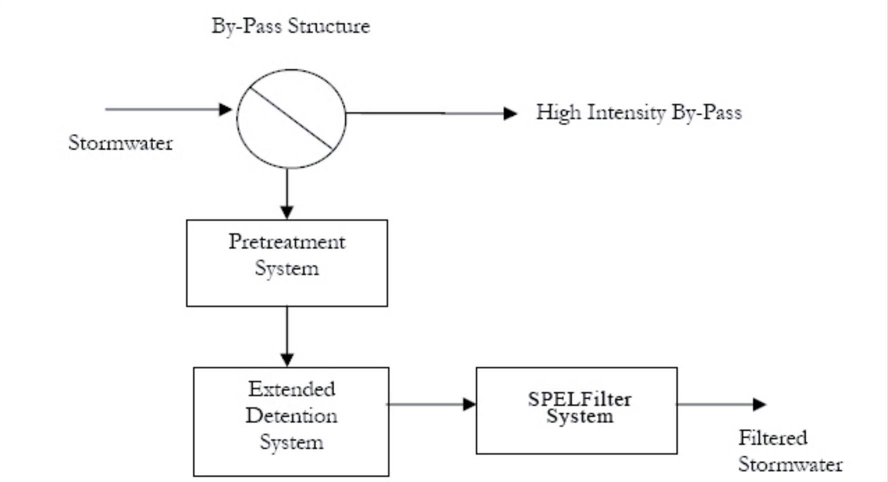


Figure 5: Offline SPELFilter System with Extended Detentions

DESIGN GUIDELINES

SELECTION THE NUMBER OF CARTRIDGES

Each SPELFilter system relies on a collection of individual cartridges to achieve the desired removal efficiency and it is important to correctly determine the number of filter cartridges required. Too few cartridges will result in a system that does not meet the performance specifications while too many cartridges will result in a system larger than necessary for the site.

To accurately determine the number of cartridges required for a SPELFilter installation, three factors must be considered:

- The flow capacity of the system
- Treated sediment load of the system
- Jurisdiction – specific sizing requirements (water quality volume)

Each of the above factors when evaluated will determine a minimum of cartridges required to address that design parameter. Calculations for all three factors need to be done to determine which design parameter is the limiting factor. In each case it will be the computation that results in the highest minimum number of cartridges, the one that will determine the cartridge count. In other words, whichever item requires the most cartridges to meet any one particular design parameter will determine the minimum number of cartridges required for the system.

Required Data
To ensure that the correct number of cartridges is specified for the SPELFilter system, the designer must be aware of the local regulatory requirements for stormwater treatment. Depending on the jurisdiction in which the project site is located, the engineer may have to meet minimum treatment flow rates, treatment volumes or some other criteria such as filter bed area. Some jurisdictions specify a methodology for calculating a minimum treatment flow rate for a given site. Other jurisdictions may require extended detention upstream from the filtration system or have volume-based rather than flow-based requirements.

DESIGN GUIDELINES

Flow Capacity

At many sites regulatory requirements will specify a minimum treatment flow rate (QTRT) that must be passed through the stormwater treatment system.These regulatory requirements may also specify pretreatment or extended detention practices that need to be included in the site design. Some jurisdictions specify that the stormwater filtration systems be designed on the basis of filter area following prescribed methodologies.

In most cases pretreatment can be provided by a hydrodynamic separator like the SPEL Environmental Stormceptor Class 1 system. Regardless of the pretreatment design, the minimum number of SPELFilter cartridges can be determined by dividing the treatment flow rate by 2.83LPS and rounding up to the next whole number. This calculation provides the minimum number of SFCs that will be necessary to fully treat the water quality flow from the site. This computation does not take into account the sediment load portion of the design, which needs to be performed as well. The design flow per cartridge will ultimately be determined by the cartridge sediment load (Table 1). The step-by-step procedure is shown below.

1.Determine the required treatment flow rate (QTRT) based on locally approved methodologies for the project site. This may involve the use of the Rational Method, TR-55 or another locally specified hydrologic model. If a locally approved methodology is not specified, SPEL Environmental recommends using one of these commonly accepted models.

2.Using the treatment flow rate, calculate the minimum numbers of SPELFilter cartridges required to treat that flow.

DESIGN GUIDELINES

Sediment Load Capacity

Once the minimum number of SFCs required to treat the flow is known, the engineer must ensure that the number of SFCs specified will be capable of handling the sediment load from the site. SPELFilter systems are typically designed around a maintenance cycle. It is important to note that the number of SFCs required to treat the anticipated total system sediment load is a minimum number.

For any site, it is necessary to calculate the minimum number of SFCs required to treat both the peak flow rate and the total system sediment load (as discussed in this section). The number of SFCs required for the site is the greater of the calculated numbers. To ensure that the SPELFilter will function acceptably with annual maintenance, it is necessary to calculate the incoming annual sediment load from the site.

$$V_{TRT}\left(ft^3\right) = P * A * c * \frac{1ft}{12in} * \frac{43560\,ft^2}{acre} * \%\,Capture$$

Equation 2

1. Calculate the annual treated runoff volume according to Equation 2. In Equation 3, VTRT is the annual treated runoff volume, P is the Equation 2 average annual precipitation (in inches), A is the area of the site (in acres), c is the runoff coefficient of the site (c is dimensionless), and % Capture is the fraction of the total runoff that is treated by the stormwater quality system. If % Capture is not otherwise specified, a default value of 0.90 can be used.

$$L = V_{TRT} * TSS_{IN} * \frac{28.3L}{ft^3} * \frac{kg}{10^6\,mg} * \frac{2.2lbs}{kg}$$

Equation 3

2. Using the annual treated runoff volume, calculate the anticipated total system sediment load to SPELFilter according to Equation 3. In Equation 3, L is the mass of sediment that SPELFilter is exposed to annually (in pounds), VTRT is the annual treated runoff volume as calculated in step 1 (in ft3), and TSSIN is the influent concentration of TSS in the runoff (in mg/L). The influent TSS concentration (TSSIN) depends greatly on the site and the surrounding land use. In the absence of readily available data, SPEL Environmental recommends using a minimum event mean concentration (EMC) TSS value of 60 mg/l. The impact of the on the filter cartridge will also be less if the filtration system is preceded by pretreatment. In these cases, the influent TSS to the SPELFilter system need to be reduced to reflect pretreatment sediment removal. SPEL Environmental can assist with these calculations.

3. Once the total annual system sediment load (L) is calculated, the engineer must ensure that the number of cartridges specified will be able to remove that sediment load at the specified design flow rate. Divide the total system sediment load L by the capacity of each SFC and note the associated SFC flow rate. Round up to the next whole number to get the minimum number of SFCs required to treat this sediment load at the required flow rate per SFC.

Water Quality Volume

In some cases the SPELFilter system will have to be placed downstream from an extended detention facility or local regulations will specify a treatment volume rather than a treatment flow rate. In these cases the minimum number of SFCs may not be determined using the treatment flow rate calculation. Instead, the minimum number of cartridges for this system depends on the controlled discharge rate QTRT from the upstream detention facility or the filtration system.

1. Determine the WQv for the site. This may vary significantly from one jurisdiction to the next based on local regulations. Maryland for instance requires that new developments treat the first one inch of water coming off of the site.

2. Most jurisdictions will also specify a drain down time for the detention system. This is usually in the 24 to 40 hour range. It is recommended that the maximum drain down time not exceed 40 hours, beyond which the detained water could potentially become anoxic. SPELFilter systems should instead be designed with an initial drain down time of less than 40 hours. Then, as the filter cartridges become occluded, the drain down time will gradually increase to 40 hours. Once it takes in excess of 40 hours for the detention system to fully drain out then the SPELFilter system should be maintained.

3. Once you have determined the WQv and the drain down time, the quantity of SPELFilter cartridges can be determined by dividing the WQv by the drain down time and then dividing the resulting number by the treatment flow rate of a SPELFilter cartridge. For volume based SPELFilter systems, the treatment flow rate of each cartridge should be limited to 15 gpm. For example if:

WQv = 10,000cf
Drain down time = 24hrs (1440min)
SFC flow rate = 15gpm
Number of SFC's = ((10,000cf/86,400)*448.83)/15gpm
Number of SFC's = 4

DESIGN GUIDELINES

PREPARING SITE PLANS FOR THE SPELFILTER SYSTEM

Once the SPELFilter system has been selected, the chosen system must be included on the site plans.

Location
The location of SPELFilter on the site will be determined by several factors; maintenance access, the unit's footprint, available drop, available depth, and the surface elevation of the receiving waters must all be considered when selecting the system's location. The location and configuration must be in compliance with MCDPS's underground SWM Structure regulations.

The SPELFilter system must be installed in an area that is accessible to maintenance equipment. The maintenance of a SPELFilter system requires a vacuum truck as well as the removal and replacement of the filter cartridges. The manhole covers, and or Access Hatches of the SPELFilter must be placed in locations that can be easily reached by such a vehicle.

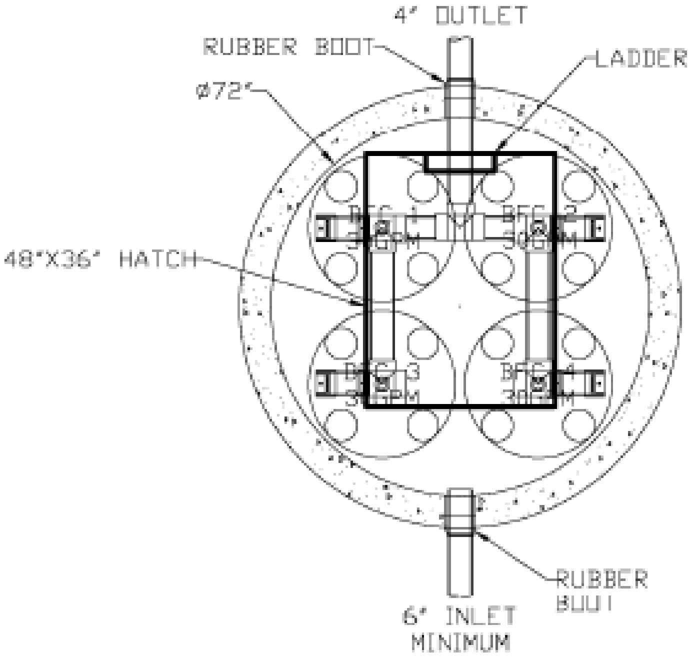
The SPELFilter should be placed in a location that minimizes its interference with other existing or planned underground utilities. Standard Details and Notes All of the standard details and notes for the plans are available in AutoCAD and .pdf format from SPEL Environmental.

DESIGN GUIDELINES

SPELFilter SYSTEM CONFIGURATION

There are four (4) types of SPELFilter systems:

1.) Manhole: Standard precast manholes with O-Ring gasket joints
2.) Precast vault: Monolithically poured concrete vault (base and walls)
3.) Box culvert vault: Must be made by an approved supplier
4.) Cast in place vault: Custom designed for site.

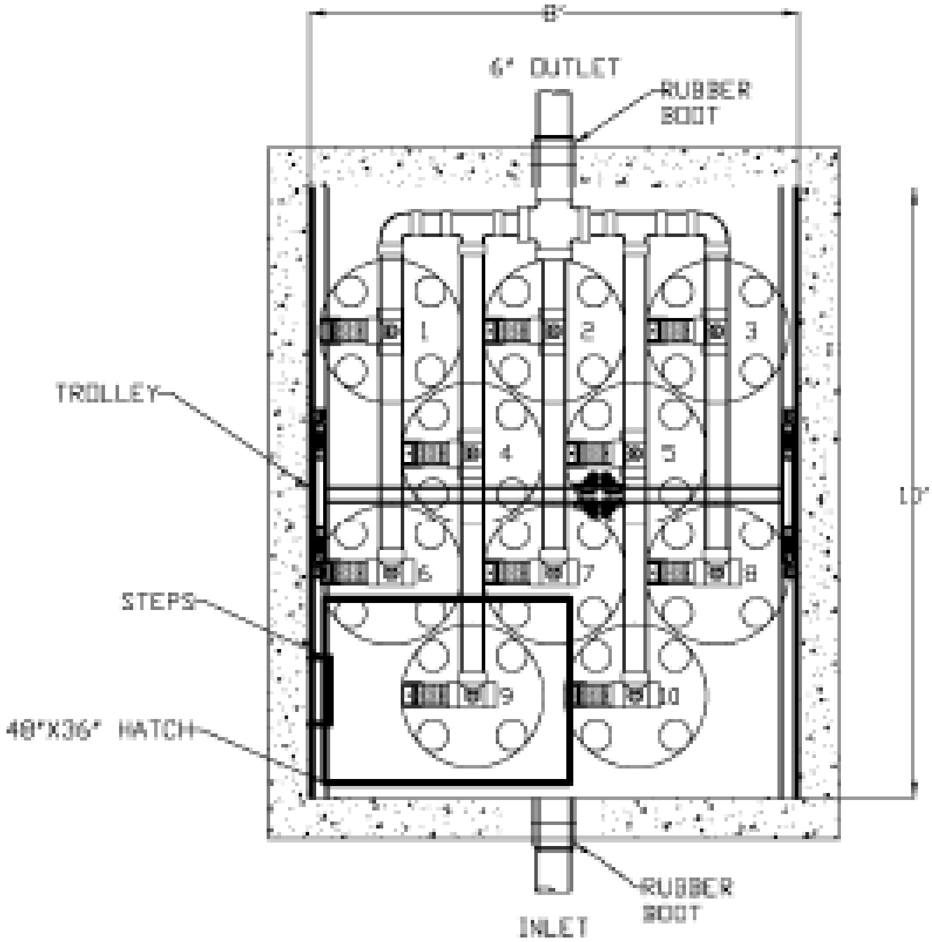


Manhole SPELFilter systems have a small footprint, and can be fit into site plans easily without interfering with other underground utilities. Manhole SPELFilter systems are ideal for applications downstream from water quality detention structures. Please consult with the SPEL Environmental for more details.

Access to the Manhole SPELFilter for inspection or maintenance is achieved through a minimum 900mm x 900mm or diameter frame and cover. In each Manhole SPELFilter system, the SFCs are arranged so that a maintenance worker can stand on the floor of the manhole while installing or removing the cartridges. Please refer to Appendix C for engineering drawings showing the available Manhole SPELFilter configurations.

DESIGN GUIDELINES

Precast Vault SPELFilter



The minimum system drop is typically 71cm however this can be reduced on a site specific basis by SPEL Environmental in conjunction with an engineer.

Box Culvert SPELFilter

Like the manhole SPELFilter, access to the box culvert SPELFilter is provided through the hinged access hatch. The box culvert SPELFilter is constructed in 10' x 6' sections. Each vault has at least one access hatch. The SFCs and outlet manifolds are arranged to allow maintenance personnel to stand on the concrete floor while working inside the structure. The SPELFilter cartridges and under drain manifold components are supplied by SPEL Environmental together with the precast vaults. Please refer to Appendix C for a complete set of box culvert SPELFilter configurations. Available precast vault and box culvert filter systems include:

DESIGN GUIDELINES

Cast-in-place SPELFilter

For sites requiring more than 66 SFCs or for projects on which a large precast vault or box culvert SPELFilter is not feasible, SPEL Environmental can supply custom-designed SPELFilter systems. These custom systems utilize a cast in place vault or other system, and can be designed around specific site constraints. High flow rates, shallow installations, very flat sites, limited footprints, and other design considerations can be addressed with a cast

CHAPTER
3

INSTALLATION

SPELFilter systems are installed along with the storm drain. Installation procedures vary depending on the configuration of the SPELFilter system. Installation instructions for manhole SPELFilter systems and precast vault SPELFilter systems are contained in this section.

Custom SPELFilter systems may have particular installation issues that will be addressed during the design. Installation instruction for a custom SPELFilter will be included with the custom design documents.

INSTALLATION OF A SPELFILTER SYSTEM

1. Contact utility locator to mark any nearby underground utilities and make sure it is safe to excavate.
2. Reference the site plan and stake out the location of the SPELFilter manhole/vault.
3. Excavate the hole, providing any sheeting and shoring necessary to comply with all federal, state and local safety regulations.
4. Level the subgrade to the proper elevation. Verify the elevation against the manhole/vault dimensions, the invert elevations, and the site plans. Adjust the base aggregate, if necessary.
5. Have the soil bearing capacity verified by a licensed engineer for the required load bearing capacity. On solid subgrade, set the first section of the SPELFilter manhole/vault.
6. Check the level and elevation of the first section to ensure it is correct before adding any riser sections.
7. If additional section(s) are required, add a watertight seal to the first section of the SPELFilter manhole/vault. Set additional section(s) of the manhole/vault, adding a watertight seal to each joint.
8. Install the trolley system (if applicable). See separate instruction sheet.
9. Install the PVC outlet manifold. Glue all PVC joints with the exception of the SPELFilter cartridge coupling.
10. Install the PVC outlet pipe in SPELFilter manhole/vault.
11. Install the inlet pipe to the SPELFilter manhole/vault.
12. After the site is stabilized, remove any accumulated sediment or debris from the vault and install the SPELFilter cartridges.

Tool List:

- PVC glue and primer
- Crane / lifting mechanism to lower cartridges in to the vault (each cartridge weighs 350 lb)
- Screwdriver or nut driver for Fernco couplers
- Soft blow hammer
- Saw (in case PVC manifold length needs to be adjusted)

INSTALLATION

Trolley Installation Instructions

1. Attach the mounting brackets to the track.
2. Mark a horizontal line 6” down from the ceiling of the vault structure on the two long walls.
3. Each track is split in sections. The length and number of sections vary depending on the vault. It is generally better to start installing longer track sections first. Hold a section in place and align the top of the brackets with the horizontal line on the wall. Mark the center of the hole in each bracket and remove the track.
4. Using a hammer drill and ¼” bit, drill a hole approximately 3” deep at each mark.
5. Hold the track back in place and realign the brackets with the holes. Place a plastic spacer block behind each bracket and using the supplied ¼” x 3¼” anchor bolts mount the track in place. Only install one section of track at this stage.
6. Repeat this procedure on the opposite wall of the vault directly across from the first section.
7. Bolt the 4 trolleys to the aluminum I-beam as shown in the attached diagram. Make sure that the wheels for each trolley are mounted an equal distance from the top of the I-beam.
8. Lift the I-beam in to place and insert the trolleys in to the track.
9. Using the supplied couplers, install the second sections of track via the same procedure. Continue until the track runs the length of the vault or as designed.

CHAPTER 4

MAINTENANCE

The SPELFilter system requires periodic maintenance to continue operating at the design efficiency. The maintenance process comprises the removal and replacement of each SPELFilter cartridge and the cleaning of the vault or manhole with a vacuum truck. SPELFilter maintenance should be performed by a SPEL Environmental certified maintenance contractor.

The maintenance cycle of the SPELFilter system will be driven mostly by the actual solids load on the filter. The system should be periodically monitored to be certain it is operating correctly. Since stormwater solids loads can be variable, it is possible that the maintenance cycle could be more or less than the projected duration.

The SPELFilter systems in New Development applications are designed to treat the WQv in 24 hours initially. Later in the cycle these cartridges will flow at a slower rate, and when the WQv does not drain down within +/- 40 hours after the storm event, the system must be maintained.

When a SPELFilter system is first installed, it is recommended that it be inspected every six (6) months. When the filter system exhibits flows below design levels the system should be maintained. Filter cartridge replacement should also be considered when sediment levels are at or above the level of the 4 inch manifold system. Please contact SPEL Environmental for maintenance cycle estimations or assistance at 13 SPEL.

MAINTENANCE

1. Remove the manhole covers and open all access hatches.
2. Before entering the system make sure the air is safe per OSHA Standards or use a breathing apparatus. Use low O2, high CO, or other applicable warning devices per regulatory requirements.
3. Using a vacuum truck remove any liquid and sediments that can be removed prior to entry.
4. Using a small lift or the boom of the vacuum truck, remove the used cartridges by lifting them out.
5. Any cartridges that cannot be readily lifted directly out of the vault should be removed from their location and carried to the lifting point using the Trolley system installed in the Vault (if applicable).
6. When all cartridges are removed, remove the balance of the solids and water; then loosen the stainless clamps on the couplings in the pipe manifold; remove the drain pipes as well. Carefully cap the manifold and rinse the floor removing the balance of the collected solids.
7. Clean the manifold pipes, inspect, and reinstall.
8. Install the exchange cartridges and close all covers.
9. The used cartridges must be sent back to SPEL Environmental for exchange/recycling and credit on undamaged units.

CHAPTER 5

COSTS & AVAILABILITY

SPELFilter systems are available throughout the Australia and New Zealand from SPEL Environmental or from an authorized representative. Material, installation, and maintenance costs can vary significantly with location. For SPELFilter pricing in your area, please contact SPEL Environmental at 13 SPEL or an authorized representative directly.

SPELFilter cartridges and outlet components can be shipped anywhere in the continental Australia. Manholes and precast vaults are also supplied by SPEL Environmental as part of a complete stormwater filtration system.

OPERATING SEQUENCE

APPENDIX
A

The cycle operation of a SPELFilter is as follows:

A. Vault Fill and Air Release: Water enters the system through an inlet pipe which fills the SPELFilter vault. As the vault fills, water enters the cartridge through the inlet plate on the bottom.

As the water level rises in the vault, air from inside the SFC is exhausted via an air release valve. This operation is critical for the proper functioning of the siphon, which drives the SPELFilter during periods of low water level in the vault. (Refer to Figure A-1) for details on this operation).

OPERATING SEQUENCE

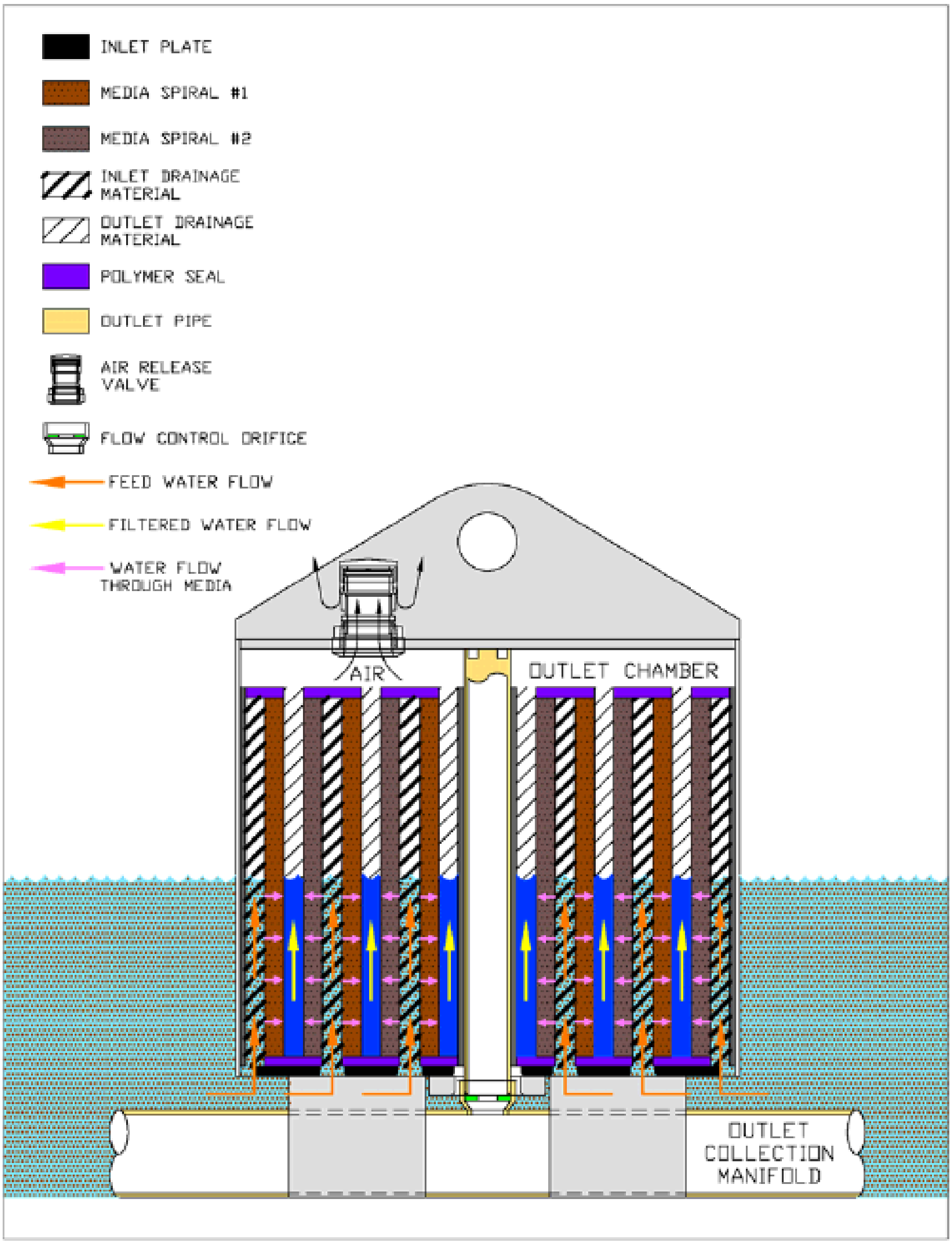


Figure A-1: Vault filling operation and release

OPERATING SEQUENCE

B. Filtration: As water enters the continuous inlet drainage spiral, air is exhausted. Water then flows horizontally through the engineered media. Next it flows to the outlet drainage spiral which is also one continuous piece material. Filtered water then flows vertically to the outlet chamber located at the top of the filter media inside of the cartridge. Finally, filtered water flows in to the center outlet drain and leaves the system via the outlet manifold below the inlet plate. (Figure A-2)

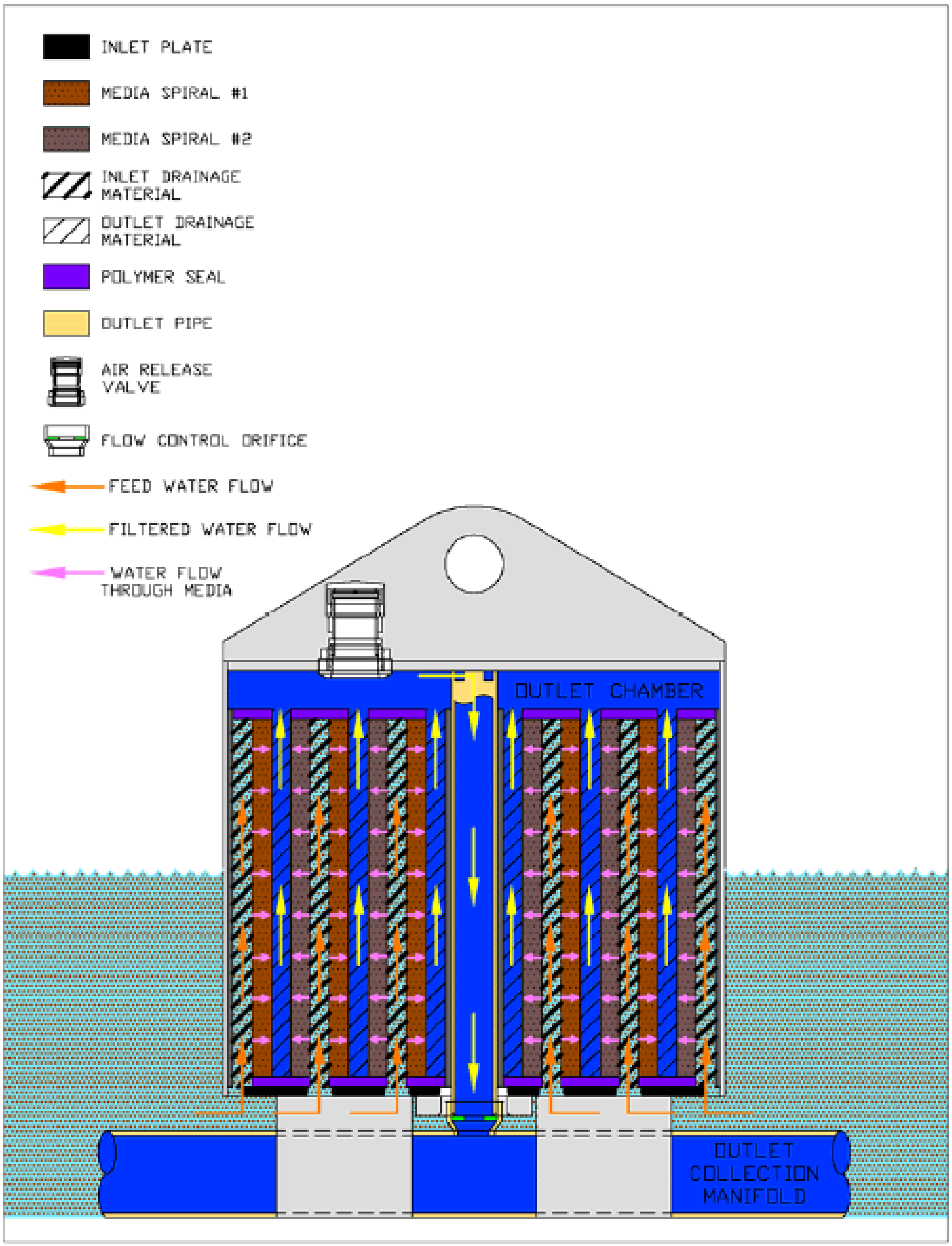


Figure A-3: Siphon filtration

OPERATING SEQUENCE

C. Siphon Filtration: After the water level in the vault falls below the top of the filter cartridge, a siphon is established and water will continue to flow (Figure A-3) until the siphon is broken. During siphon the water level in the vault will decrease until it reaches the base of the SFC; air then enters the filter cartridge and breaks the siphon. This cause's filtration flow to stop and hydrodynamic backwash begins.

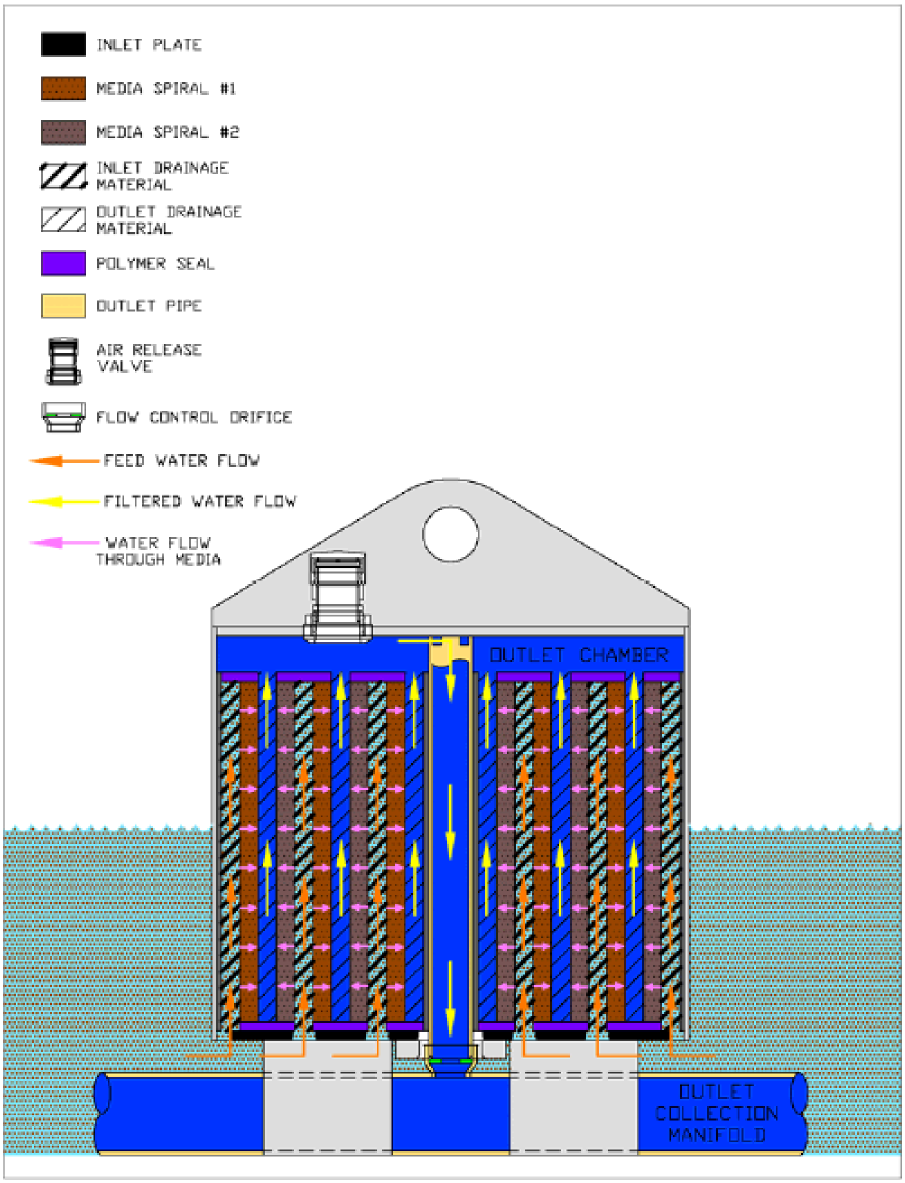


Figure A-3: Siphon filtration

OPERATING SEQUENCE

D. When air enters the filter, the siphon breaks (Figure A-4), and a gravity-driven backwash occurs with all of the water flowing from the outlet chamber backwards through the filter media (Figure A-5). This backwash has the effect of dislodging particles captured in the filtration layers and re-establishing porosity. Dislodged particles are transported back in to the filter vault and accumulate on the filter vault floor.

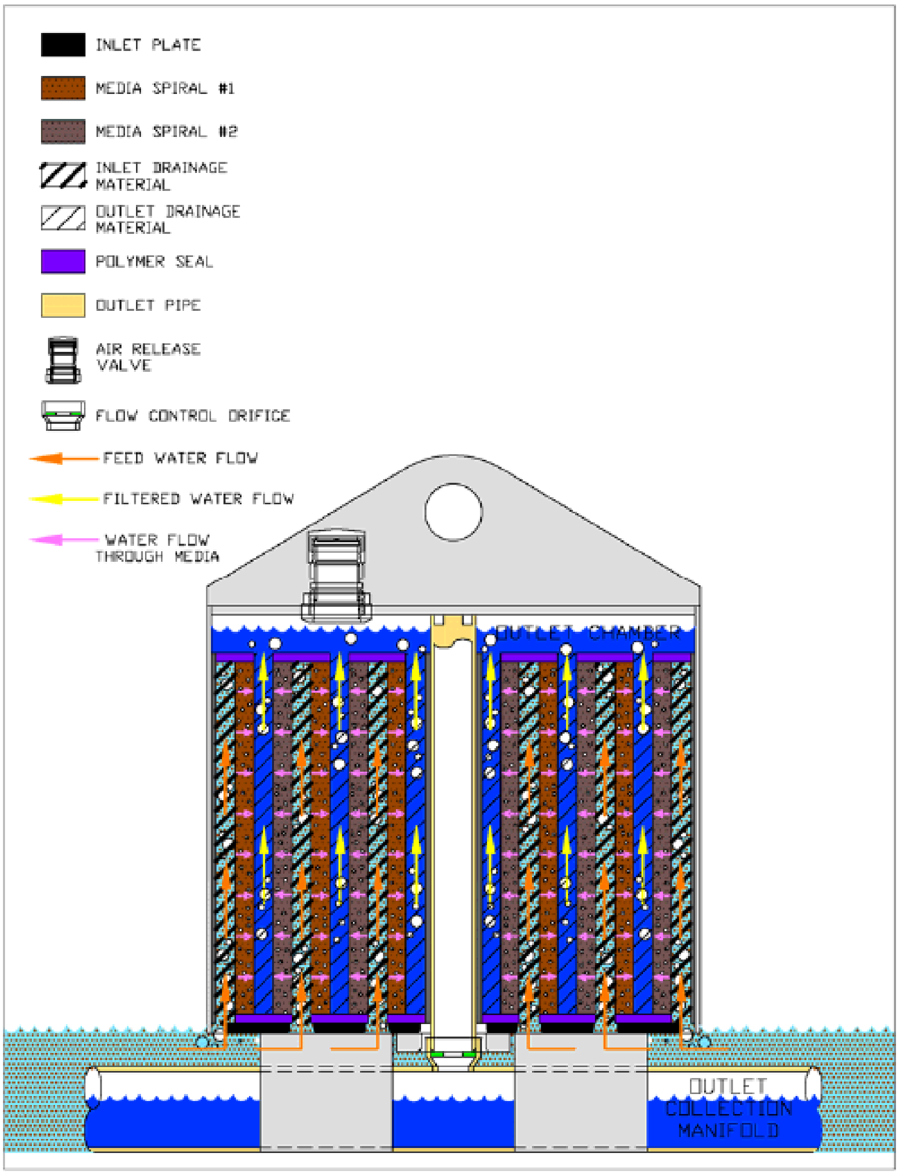


Figure A-4: Siphon Break

OPERATING SEQUENCE

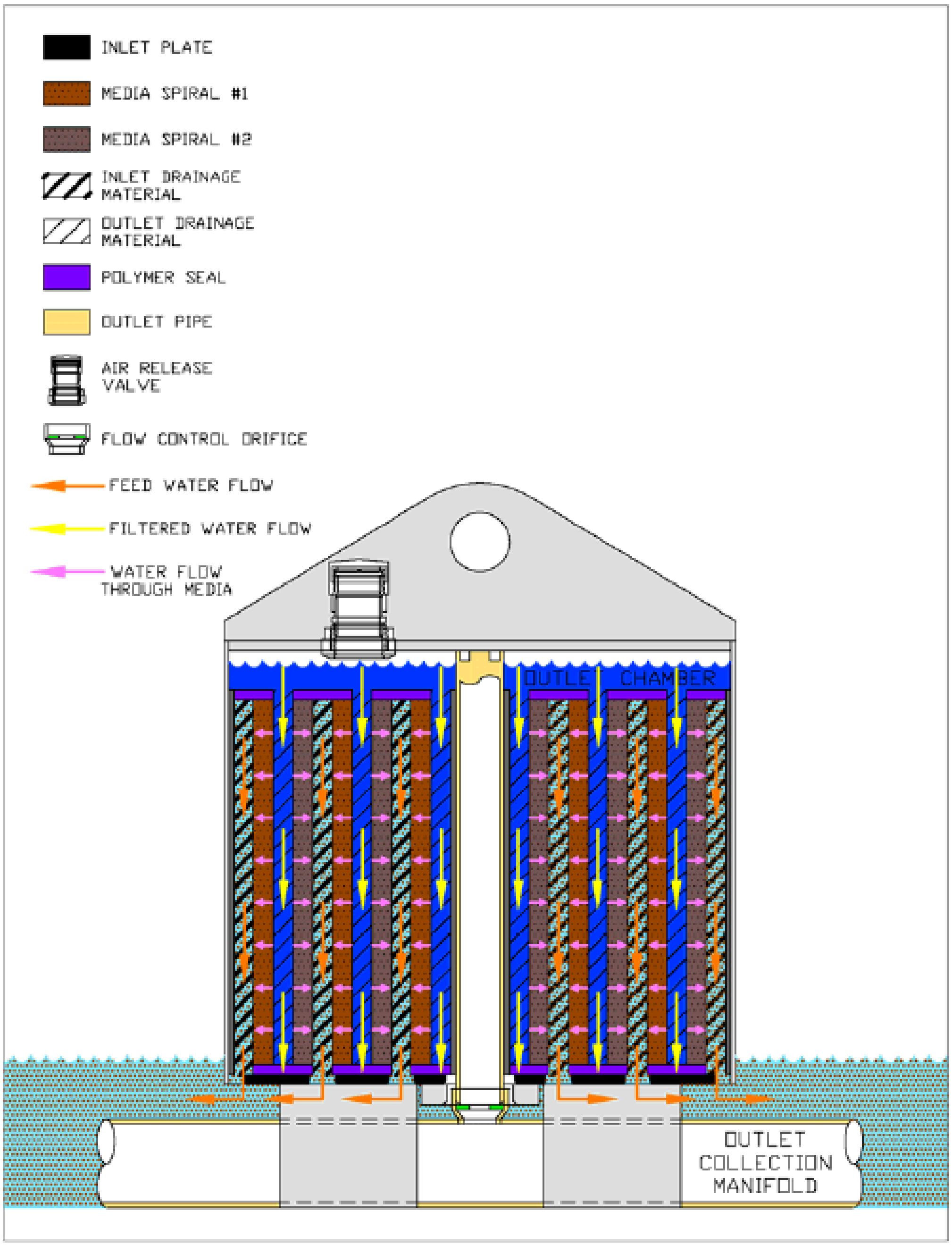
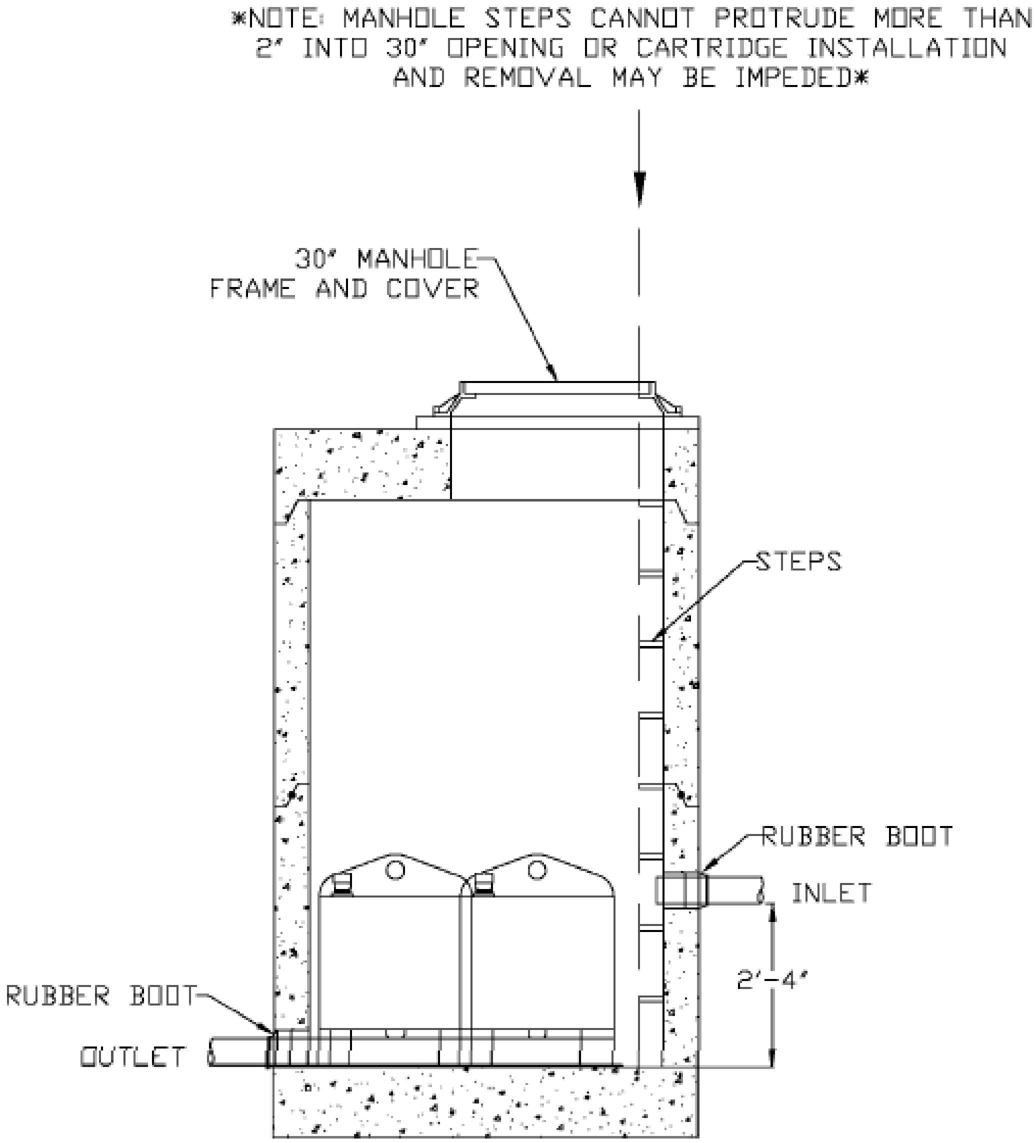


Figure A-5: Backwash

SYSTEM DRAWINGS



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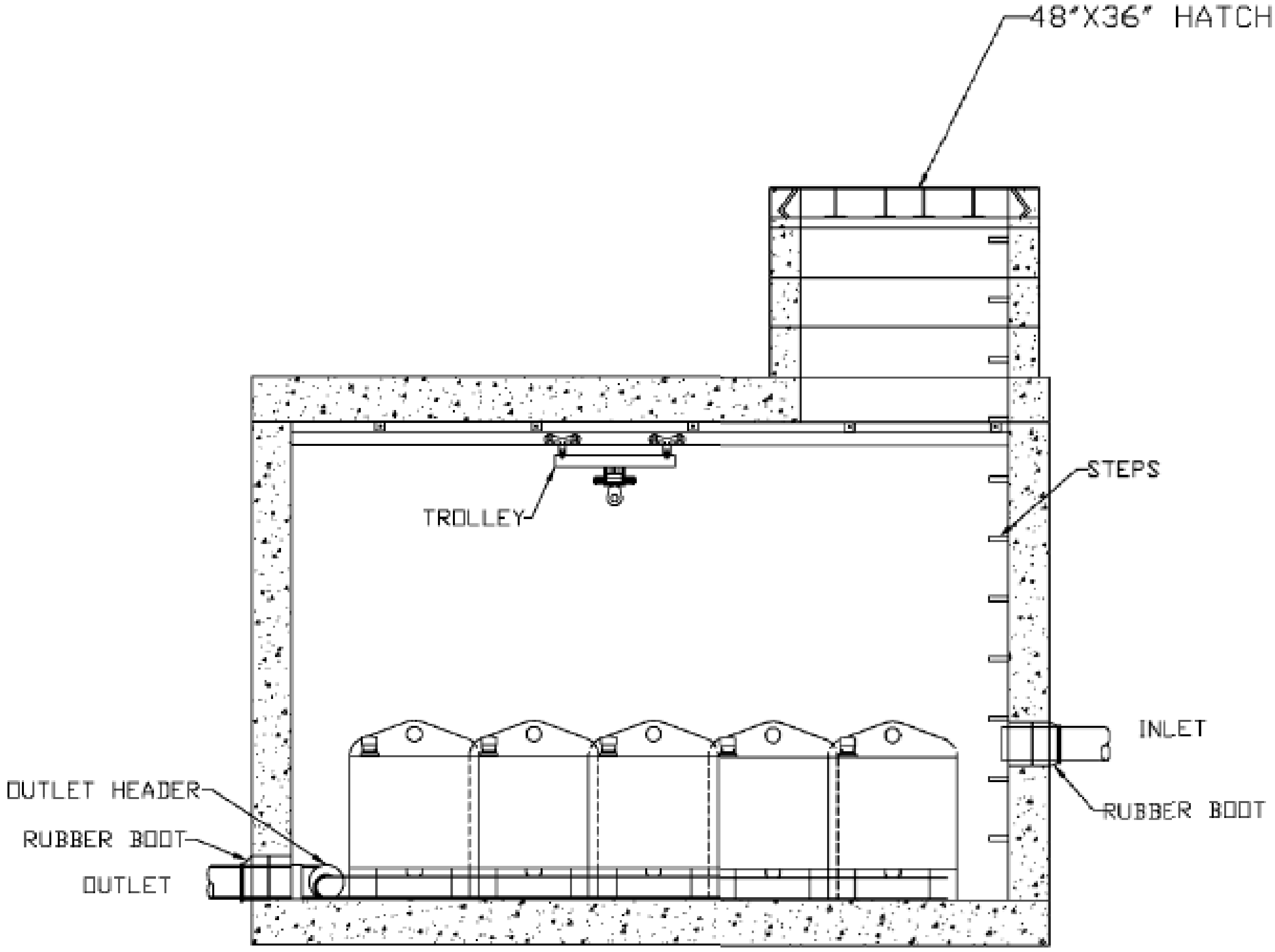

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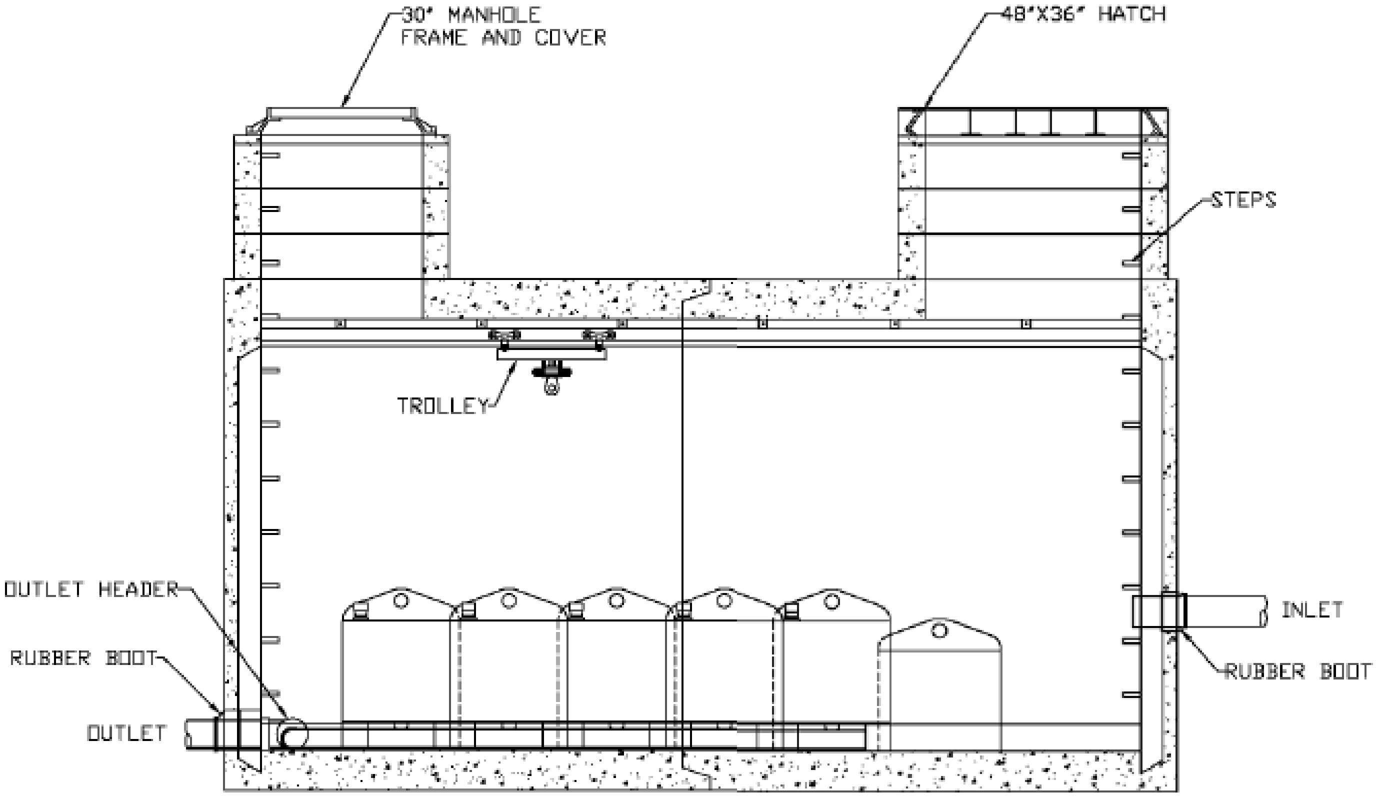

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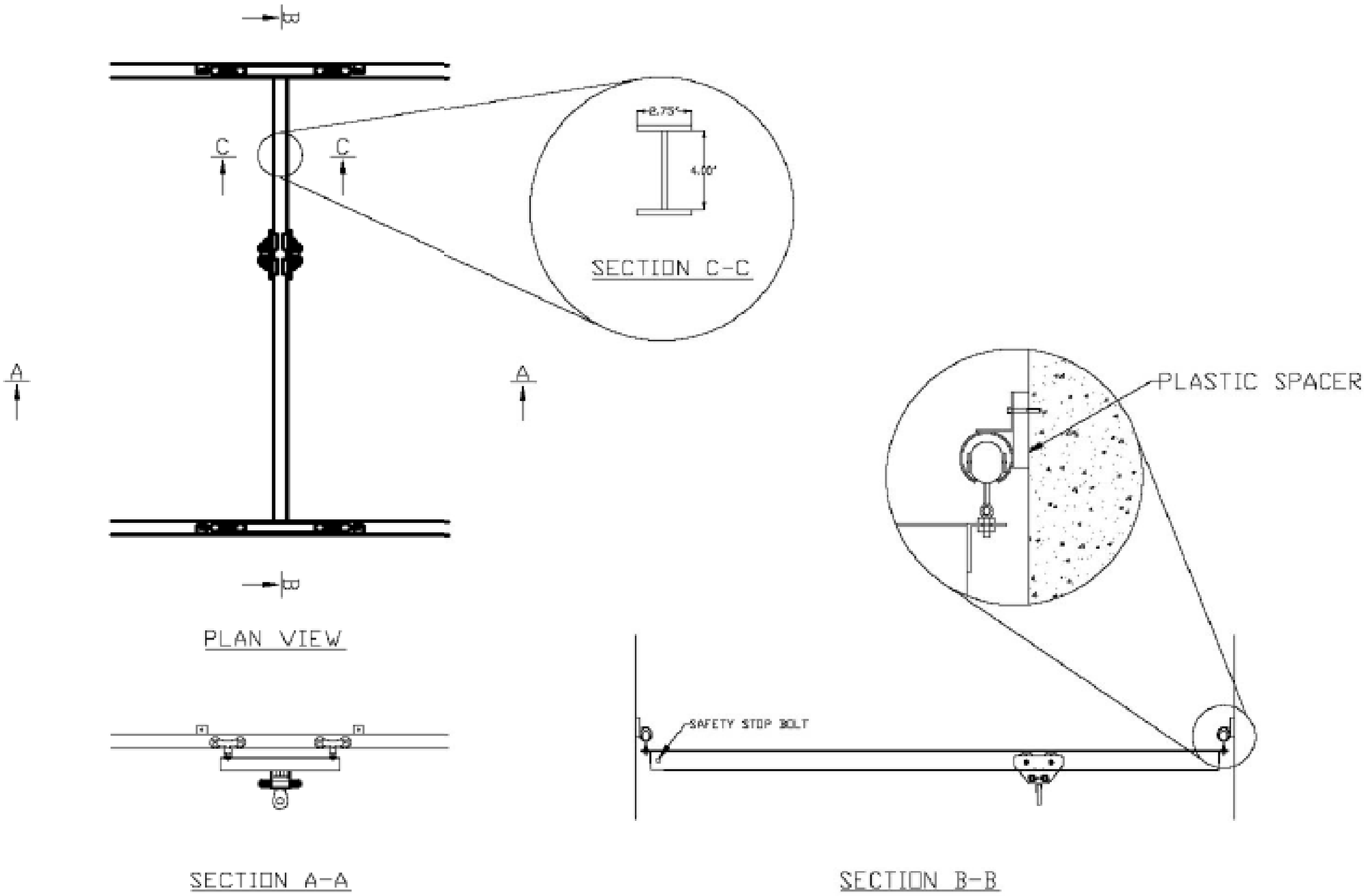

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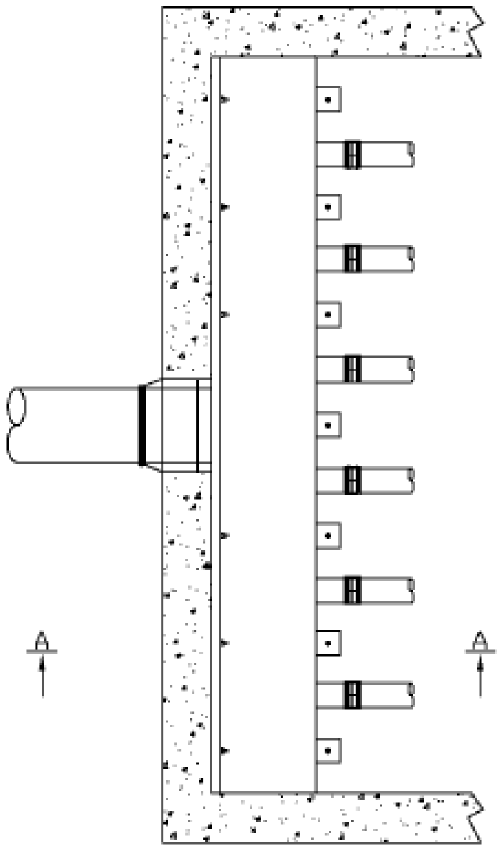
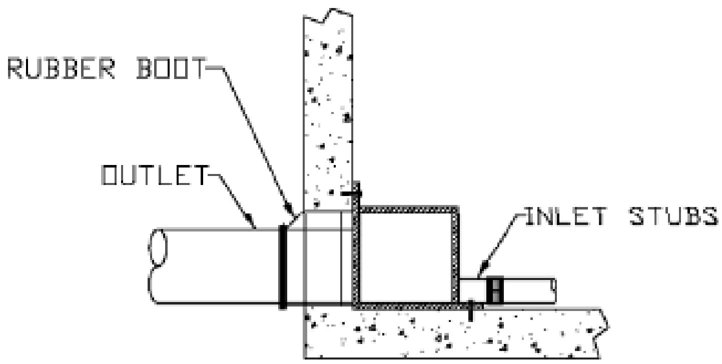
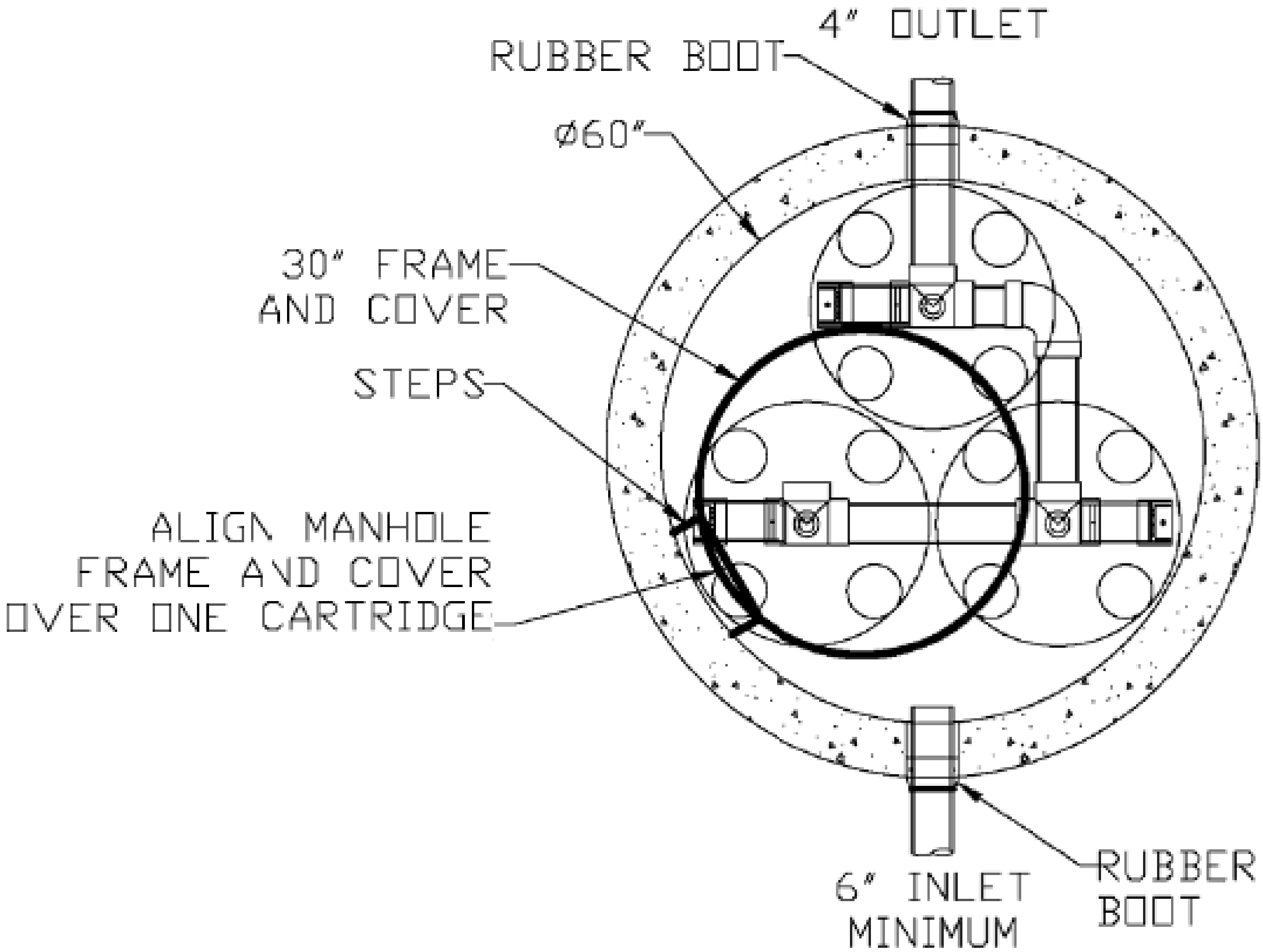


PLAN VIEW



SECTION A-A

SYSTEM DRAWINGS



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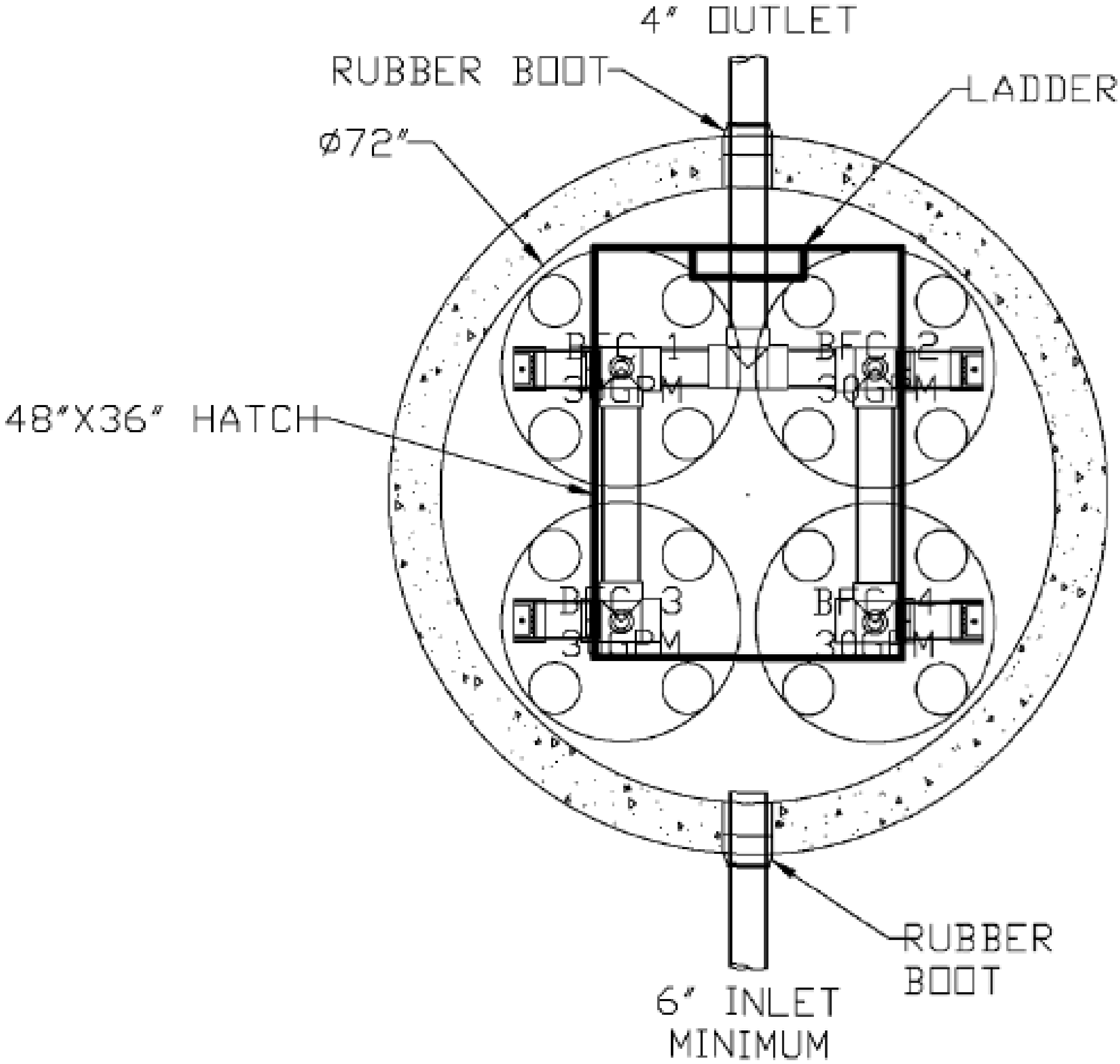

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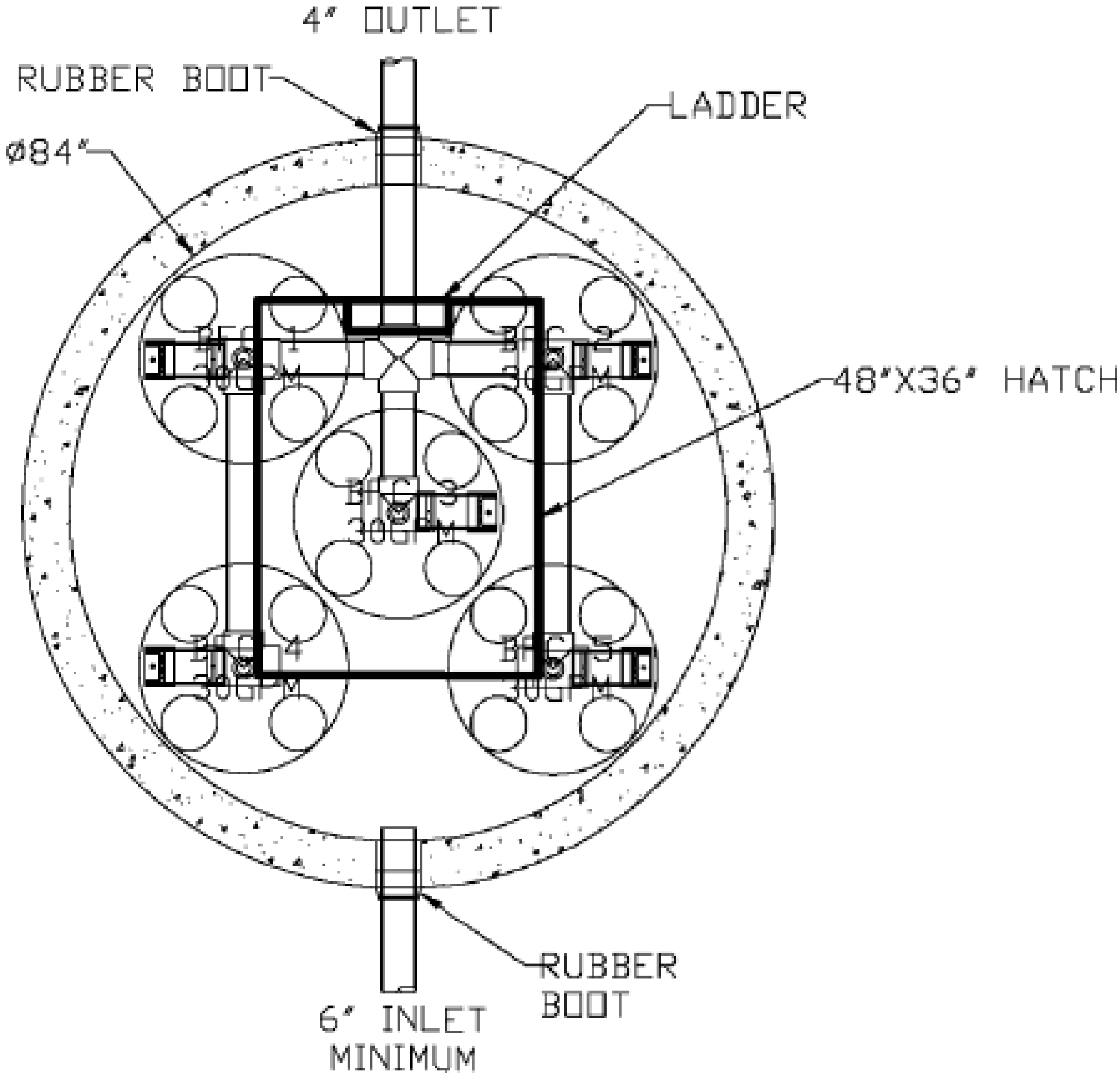

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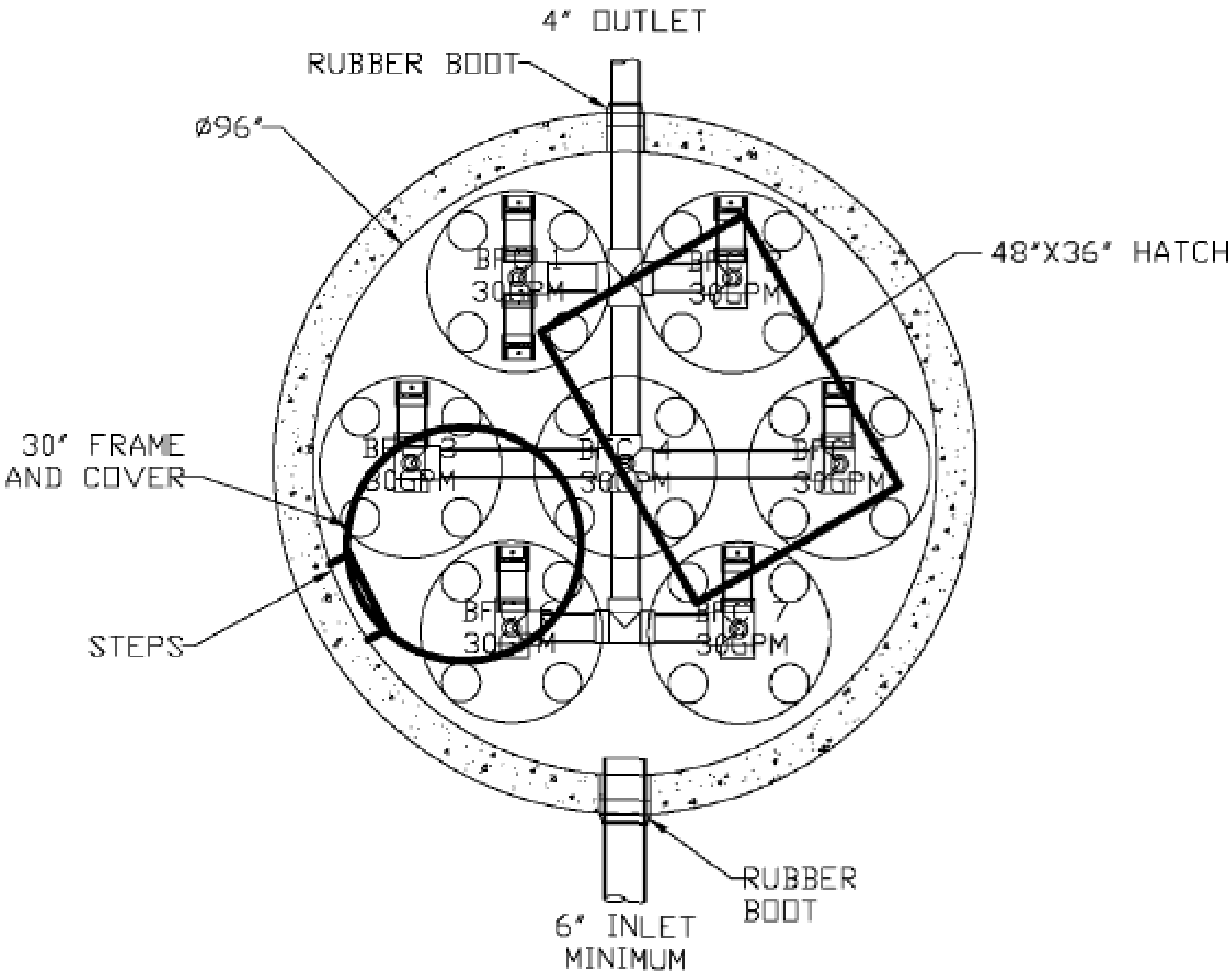

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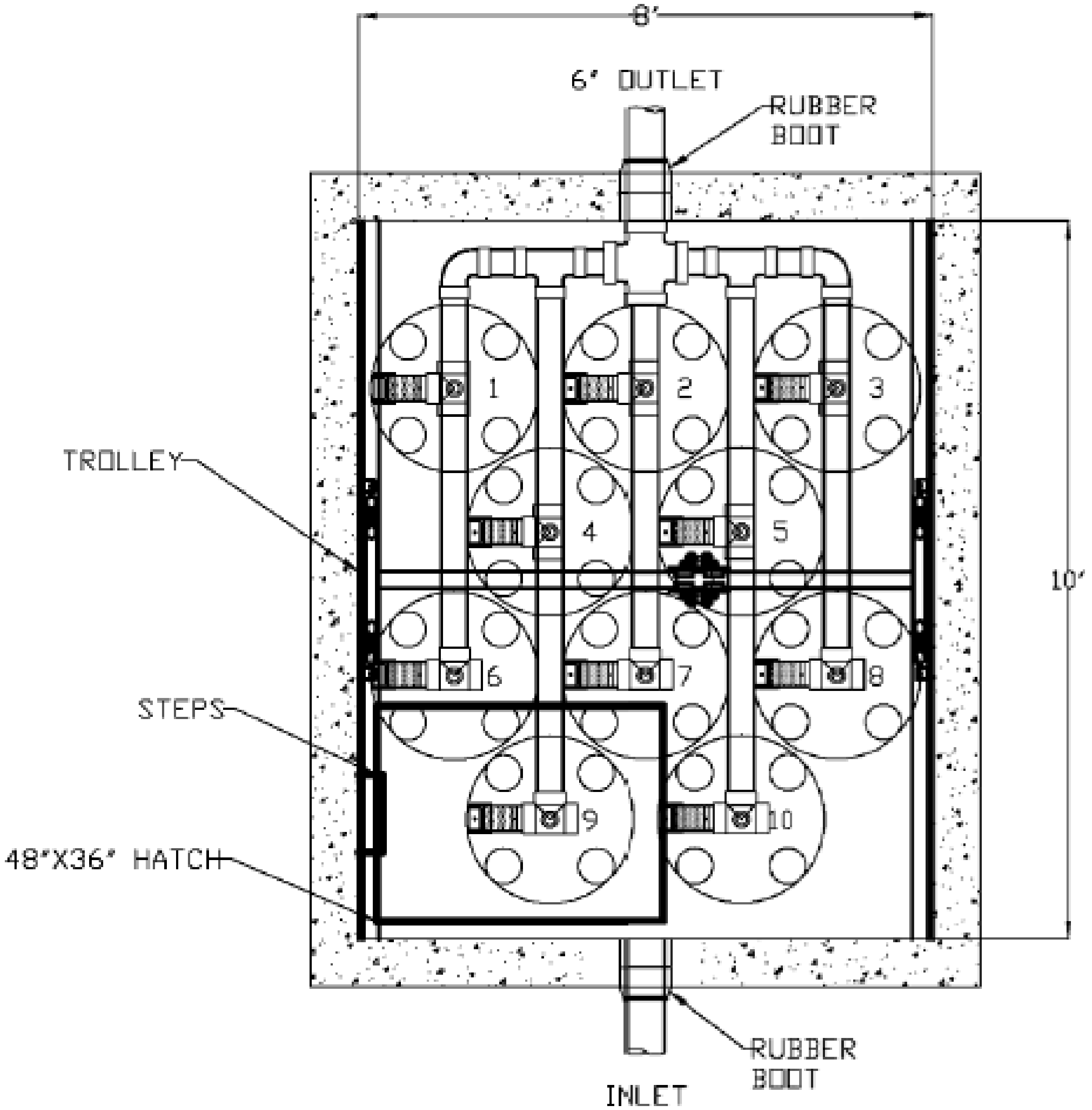

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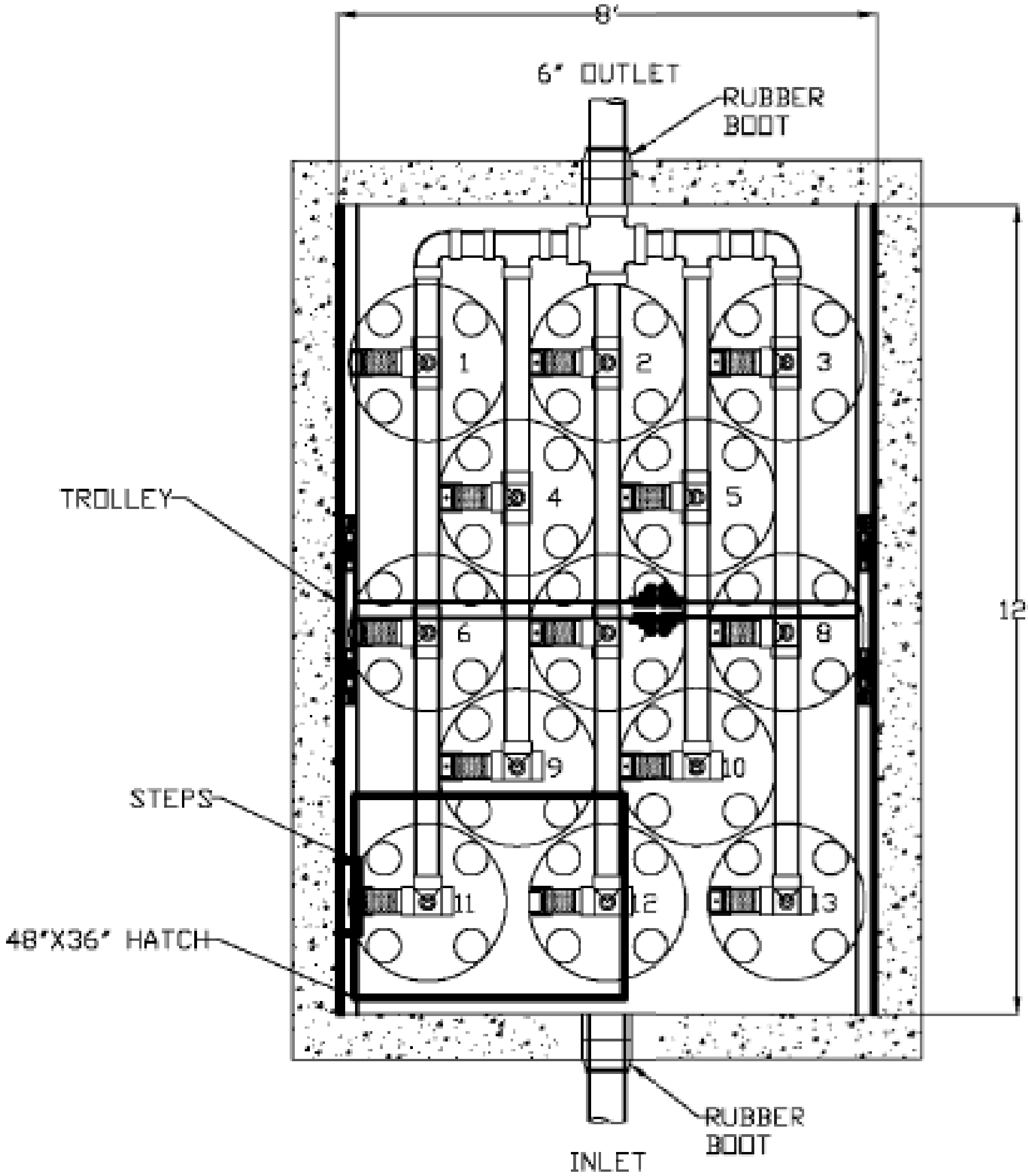

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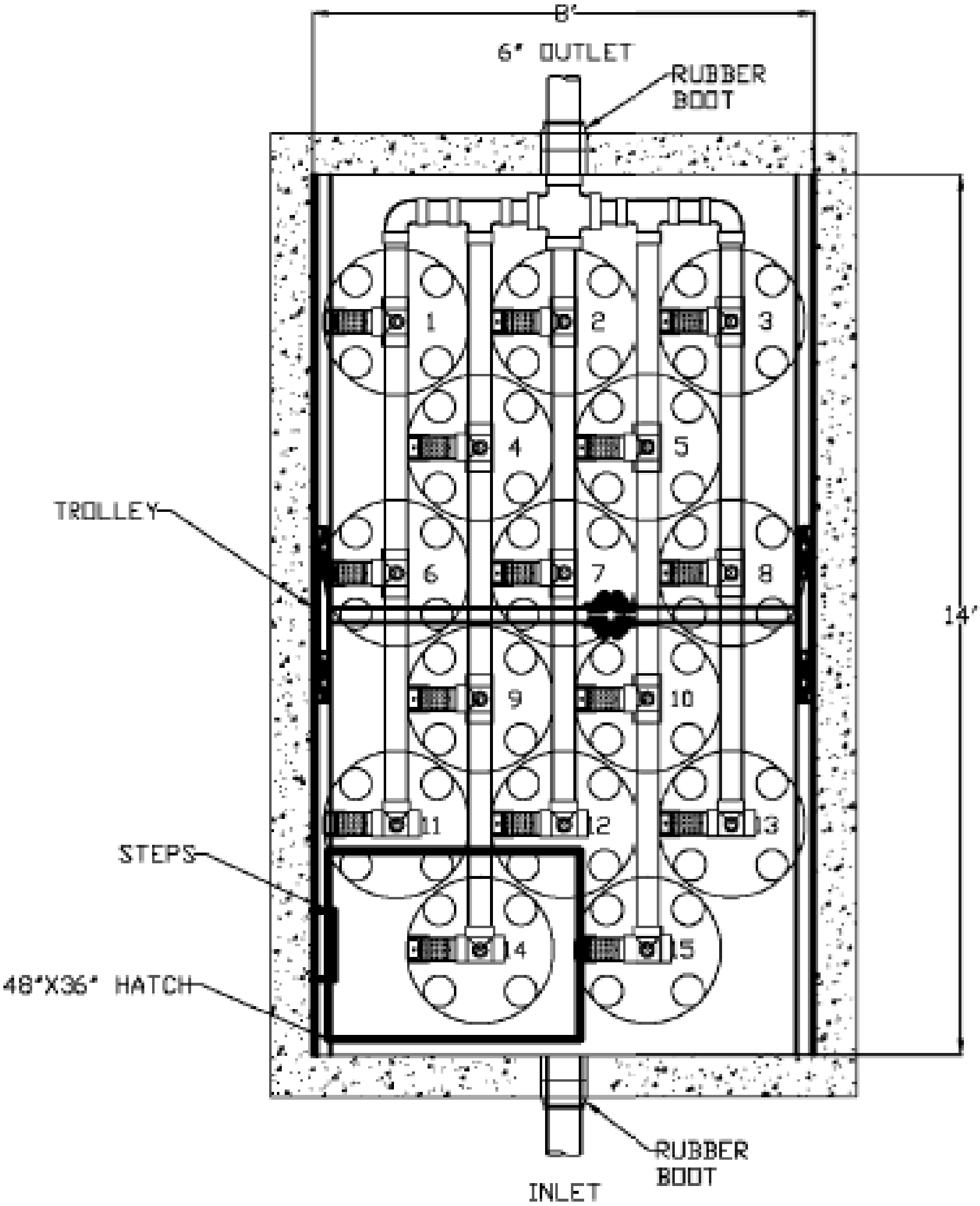

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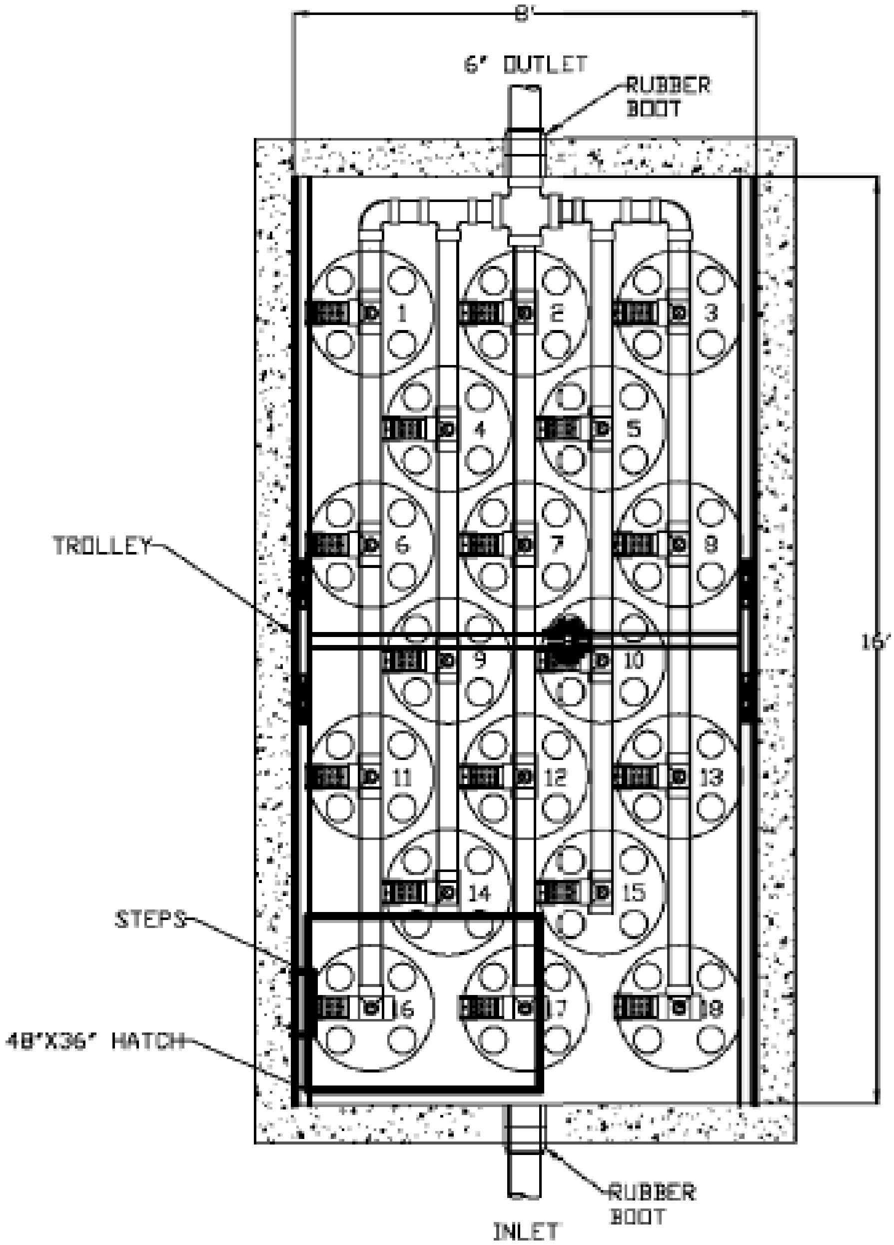

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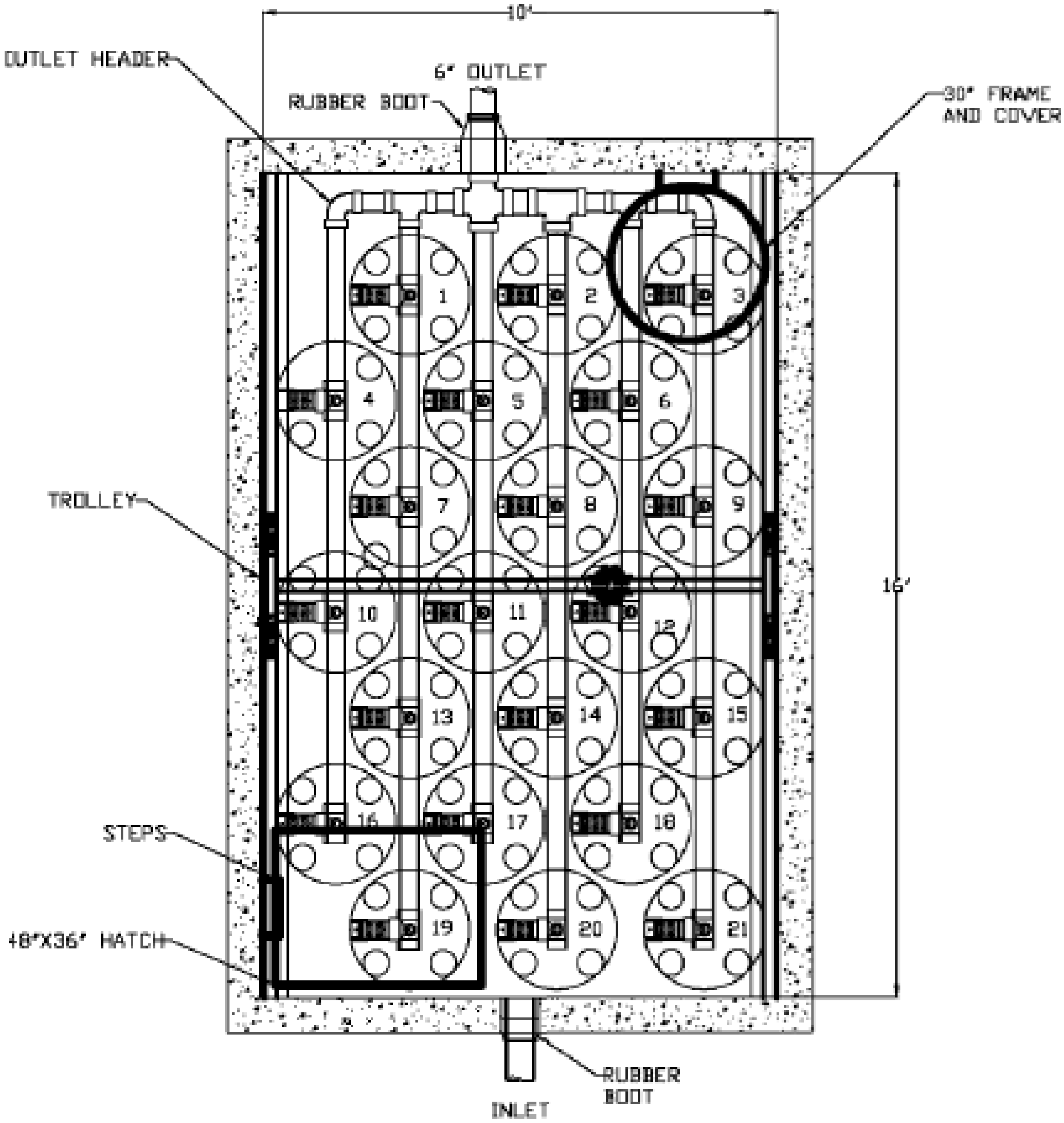

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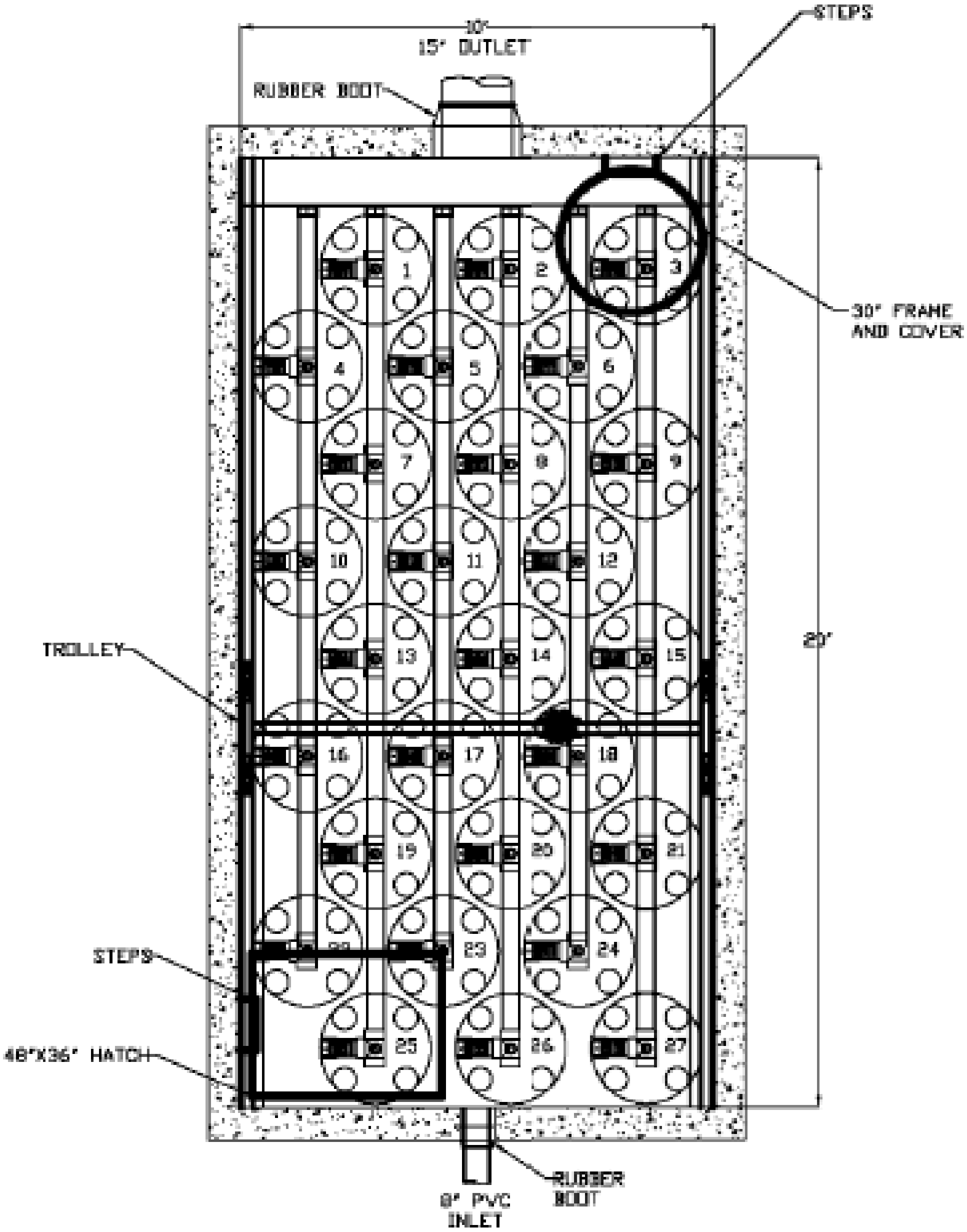

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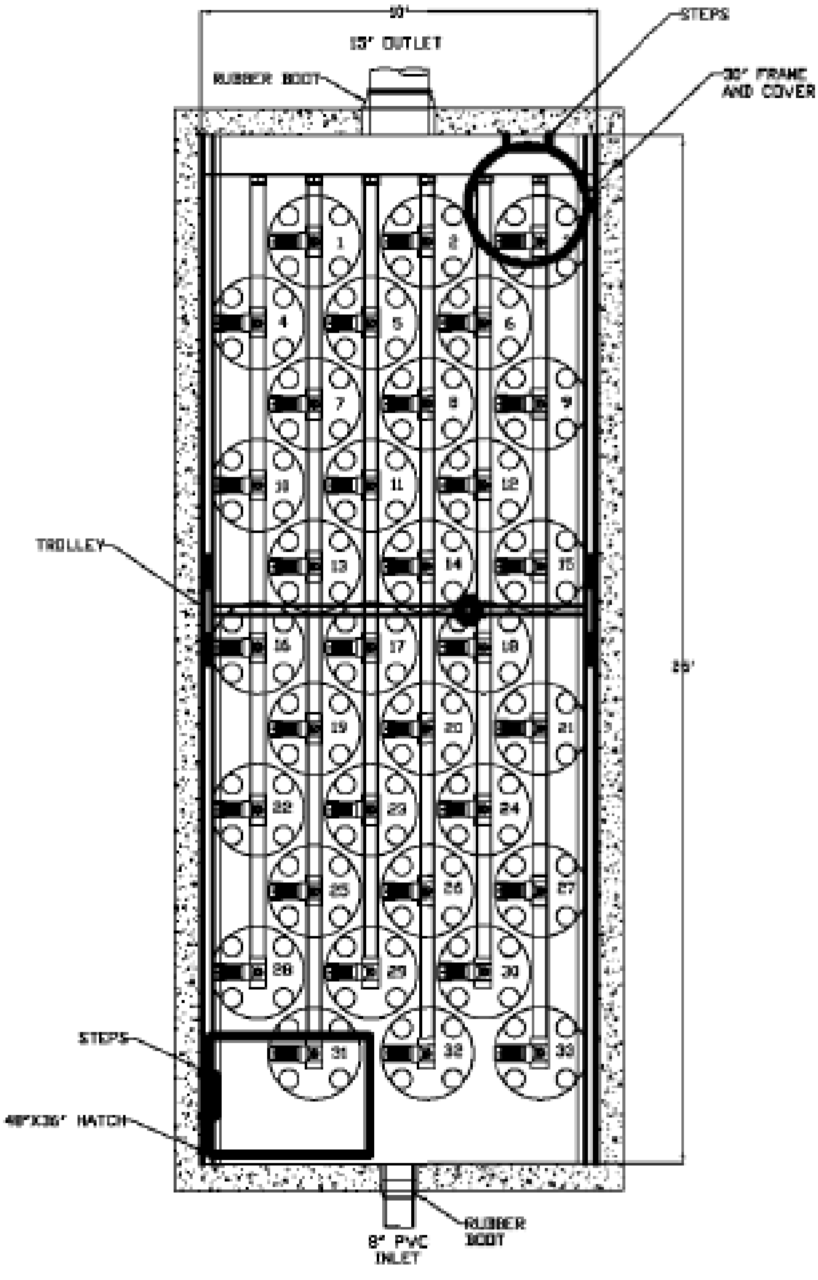

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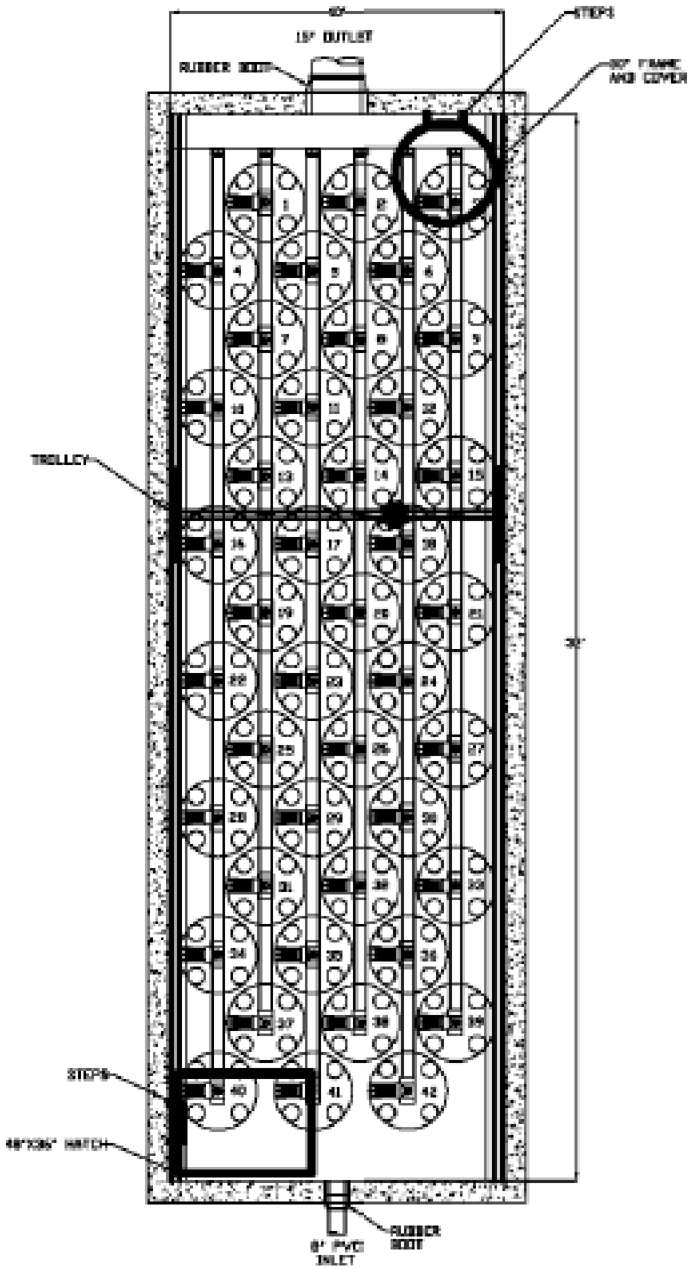

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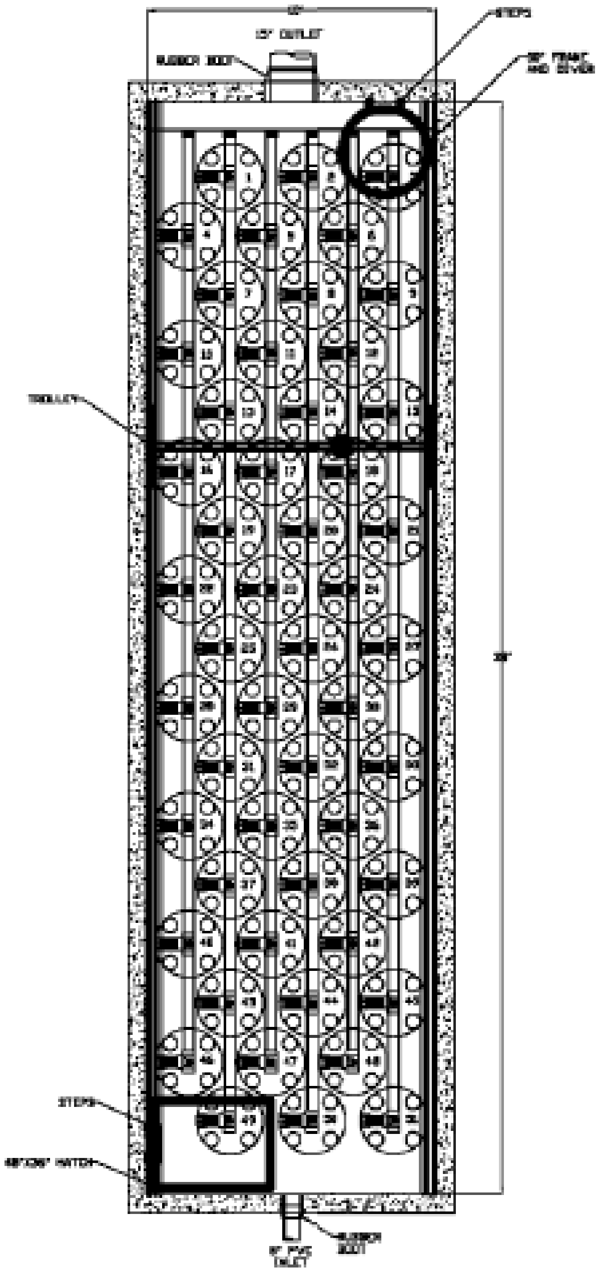

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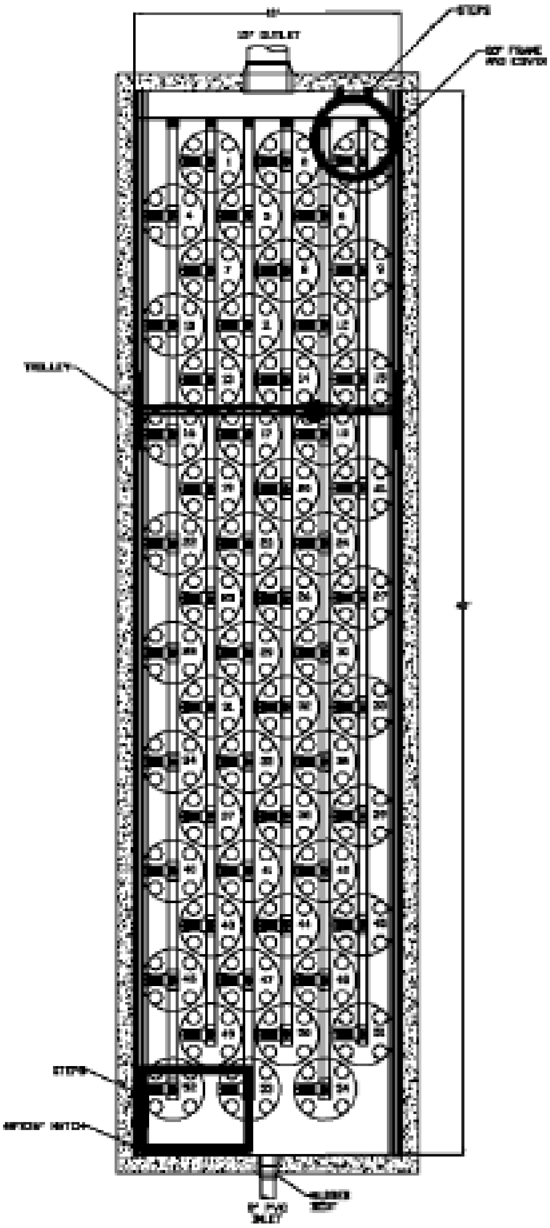

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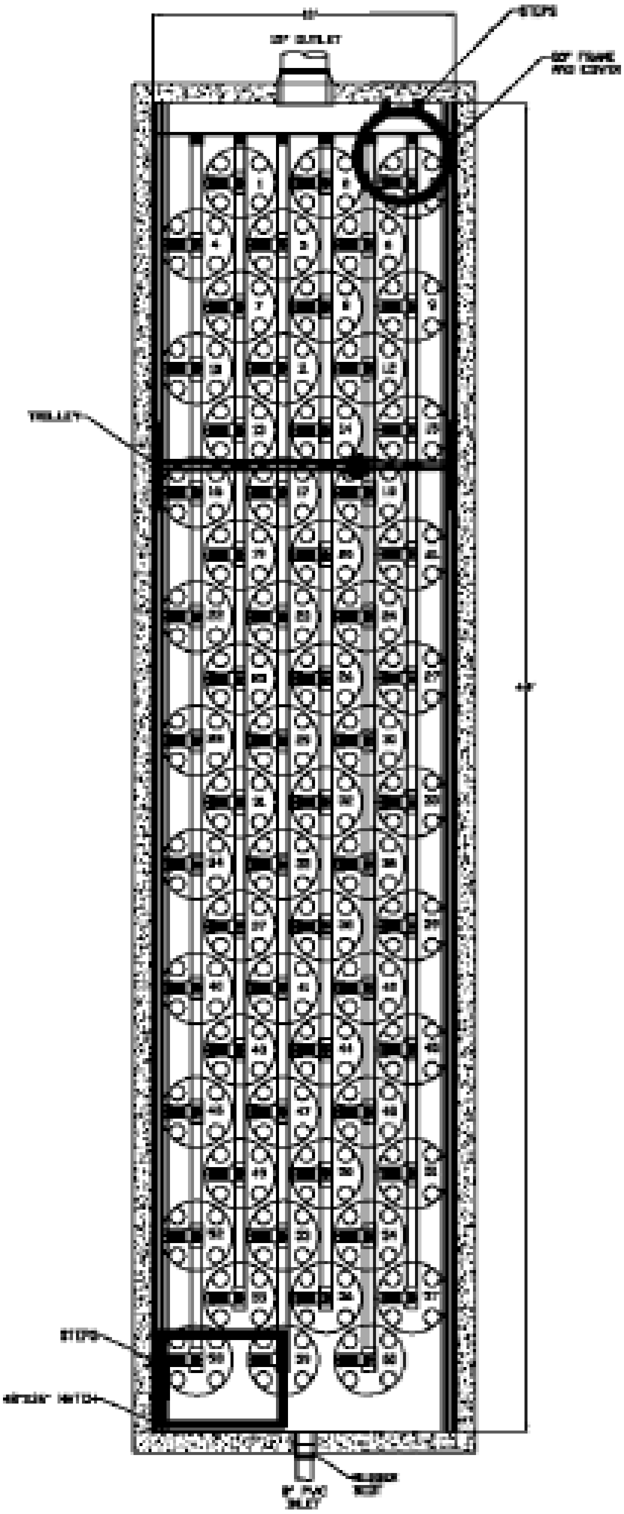

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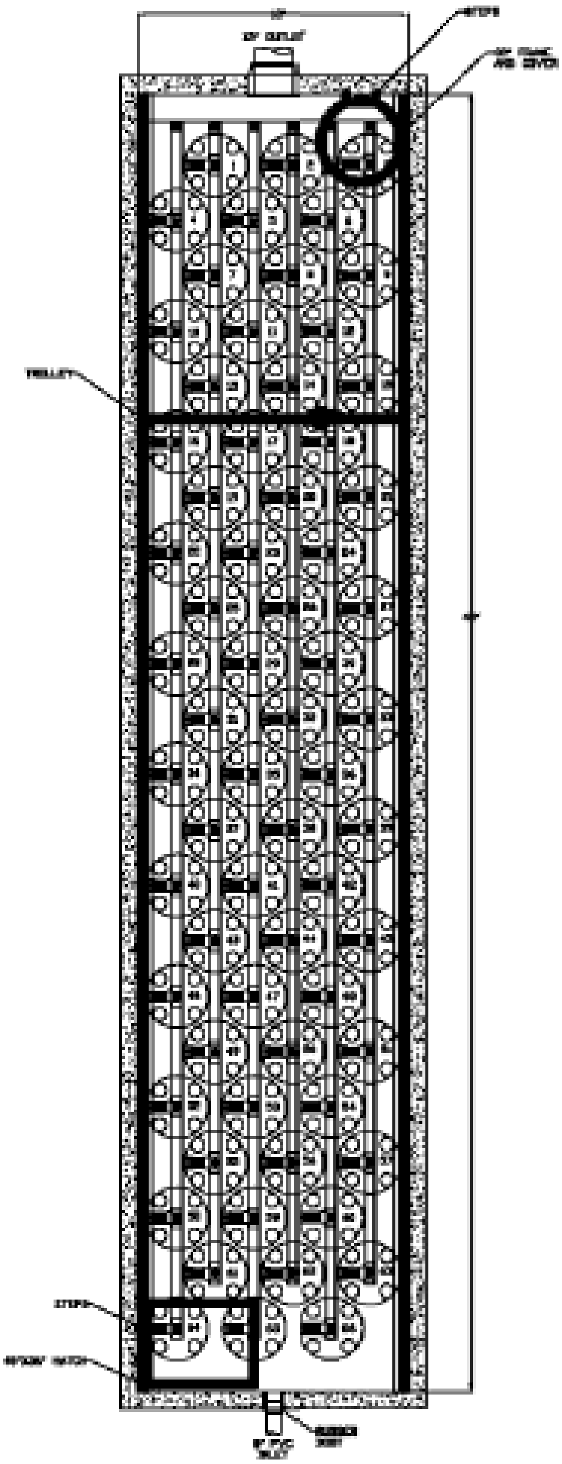

APPENDIX G – DRAINS OUTPUTS

APPENDIX G – DRAINS OUTPUTS

APPENDIX H – SPEL ENVIRONMENTAL FIELD EVALUATION OF STORMWATER TREATMENT TRAIN

Water **2015**, *7*, 4496-4510; doi:10.3390/w7084496

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water

ISSN 2073-4441

www.mdpi.com/journal/water

Article

Field Evaluation of a Stormwater Treatment Train with Pit Baskets and Filter Media Cartridges in Southeast Queensland

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Academic Editor: Young-Seuk Park

Received: 12 June 2015 / Accepted: 6 August 2015 / Published: 17 August 2015

Abstract: Field monitoring of a stormwater treatment train has been underway between November 2013 and May 2015 at a townhouse development located at Ormiston, southeast Queensland. The research was undertaken to evaluate the effectiveness of a 200 micron mesh pit basket in a 900 square format and an 850 mm high media filtration cartridge system for removing total suspended solids and nutrients from stormwater runoff. The monitoring protocol was developed with Queensland University of Technology (QUT), reflecting the Auckland Regional Council Proprietary Device Evaluation Protocol (PDEP) and United States Urban Stormwater BMP Performance Monitoring Manual with some minor improvements reflecting local conditions. During the 18 month period, more than 30 rain events have occurred, of which nine comply with the protocol. The Efficiency Ratio (ER) observed for the treatment devices are 32% total suspended solids (TSS), 37% for total phosphorus (TP) and 38% total nitrogen (TN) for the pit basket, and an Efficiency Ratio of 87% TSS, 55% TP and 42% TN for the cartridge filter. The performance results on nine events have been observed to be significantly different statistically (p < 0.05) for the filters but not the pit baskets. The research has also identified the significant influence of analytical variability on performance results, specifically when influent concentrations are near the limits of detection.

Keywords: stormwater; monitoring; protocols; suspended solids; nitrogen; phosphorus; filters

1. Introduction

The release of the Queensland State Planning Policy (SPP) requires local planning schemes to integrate the state's interest in water quality by applying stormwater management objectives relevant to the climatic region, or demonstrating current best practice environmental management for urban developments. The SPP seeks to facilitate innovative and locally appropriate solutions to achieve the stormwater management design objectives typically 80% total suspended solids (TSS), 60% total phosphorus (TP), and 45% total nitrogen (TN) [1].

Several documents have been released in Australia over the past decade providing guidance on the design, modelling, construction, implementation and maintenance of stormwater quality management measures to achieve these objectives [2–4]. These guidelines have typically focussed on the constructed "natural" treatment measures including swales, biofiltration and wetlands.

Few of the guidelines include sections for demonstrating the performance of other types of stormwater treatment solutions. When compared with international evaluation protocols, it is apparent that the necessary detail to demonstrate performance to local conditions is omitted from these local guidelines. This paper presents a protocol developed for local Australian conditions by local universities in conjunction with SPEL Environmental (SPEL), a stormwater technology supplier, and applies it to testing an innovative stormwater treatment train in southeast Queensland, with discussion of the performance results observed.

2. Local Field Testing Site Details

Testing has been under way for more than 18 months at a townhouse complex at Ormiston, Queensland. The site is about 28 km east of the Brisbane Central Business District. Runoff from the site enters the local drainage network via grated inlets and is transported to an underground chamber for further treatment and detention prior to its discharge into the Council network. The site has a total area of 2028 m^2 with approximately 1140 m^2 of roof area (56%), 500 m^2 of impervious driveway (25%) and the balance, 388 m^2 (19%) of pervious area. The stormwater treatment train includes rainwater tanks for roof water, 900 mm square pit baskets (also known as catch basin inserts) with a 200 micron mesh bag in each of the gully pits (catch basins), and an underground vault with two 850 mm high media cartridge filters. The surface runoff from the site drains through the pit baskets into the pipe network, whereas the roofwater overflow from the rainwater tanks enters the pipe network beneath the pit baskets. This configuration is a typical stormwater treatment train for a medium- to high-density residential development in southeast Queensland. The site is also representative of typical applications for the pit basket and media filter treatment train.

The pit baskets are designed to capture the gross pollutants and coarse sediment leaving the pervious and impervious ground surfaces and are installed in the gully pits (catch basins). Figure 1 shows a plan view of a typical installation. The cartridge filters utilise a perlite, zeolite and activated alumina media to provide physical filtration and adsorption of stormwater pollutants, including nutrients. Overflow from the small rainwater tanks (3 kL per dwelling) enters the pipe drainage network beneath the pit baskets, and hence will provide significant dilution to the stormwater water quality exiting the pit baskets. Figure 2 is a photograph of the monitoring site. Figure 3 is a schematic of the catchment, and Figure 4 is a schematic cross-section of the filter vault and monitoring installation.

(**a**) (**b**)

Figure 1. Typical pit basket (catch basin insert) installation plan view (**a**); side view (**b**).

Figure 2. Townhouse development at Ormiston, QLD, showing driveway area, landscaping and filter cartridge for installation.

Runoff samples are collected by four ISCO GLS auto-samplers at the locations shown in Figure 4. Runoff is sampled as it leaves the driveway surface and enters the pit basket (1). A second sampler to determine the water quality of runoff in the conveyance pipe is installed because the roofwater enters the pipe drainage network beneath the pit baskets and provides dilution to the surface runoff. A third sampler collects water from the outlet pipe of the cartridge media filters, which are located upstream of the 850 mm baffle wall in the detention chamber (3). A fourth sampler collects filtered water from a tray beneath the pit basket (4). A photograph of the StormSack collection point is presented in Figure 5.

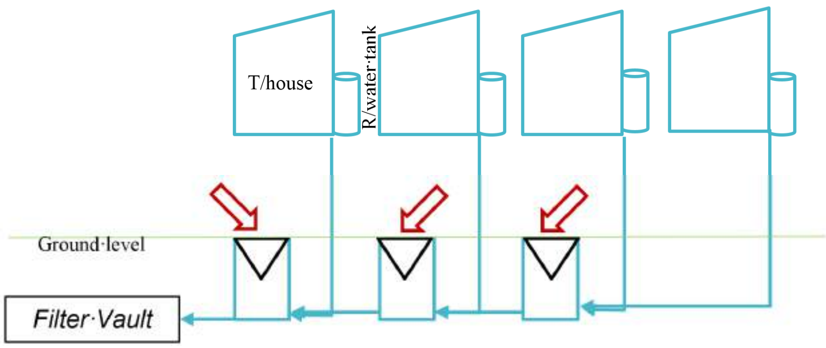


Figure 3. Schematic of the runoff pathways for the townhouse development at Ormiston. The red arrows indicate stormwater runoff entering the pit baskets. Excess rainfall (blue lines) enters the central drainage pipe, which then passes into the filter vault.

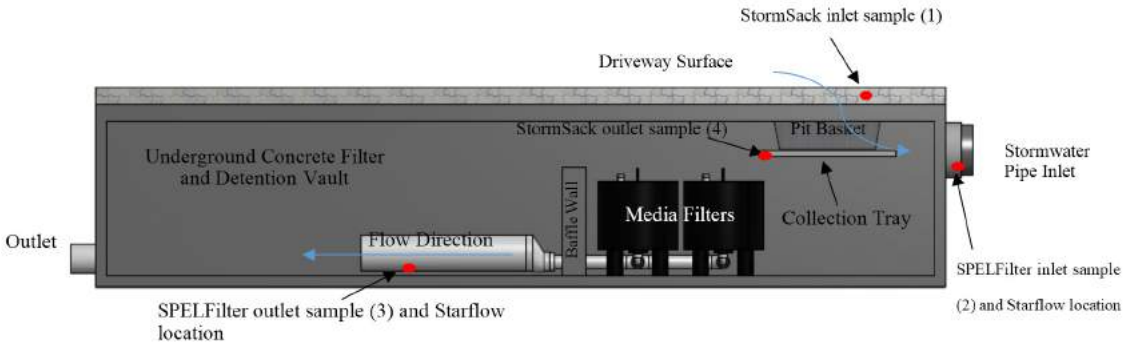


Figure 4. Schematic cross section of the filter vault with the stormwater treatment system.

Figure 5. StormSack sample collection photograph (inlet circled).

3. Local Field Testing Methodology

Due to the lack of formalised testing protocols in Australia, the University of the Sunshine Coast (USC), Queensland University of Technology (QUT), Griffith University (GU) and SPEL have formulated testing protocols based on the Auckland Council Proprietary Device Evaluation Protocol (PDEP), Washington Department of Ecology (WDOE) and Stormwater Equipment Manufacturers Association (SWEMA) protocols [5–7]. The protocols have been formalised to deliver a robust, scientifically defensible outcome. Even so, the protocols developed at the initiation stage have needed refinement once actual site data was observed, influenced by local hydrological conditions and equipment constraints. The protocol applied at the Ormiston test location, and monitored by QUT is detailed in Table 1.

Much of these protocol criteria appear in the Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP) released as a consultation draft by Stormwater Australia [8].

Table 1. QUT-SPEL Field Testing Protocol Requirements for Ormiston.

Parameter	Ormiston
Minimum Storm Duration	5 min
Catchment type	Medium density townhouse property
Stormwater Treatment Device Type	Full scale—200 micron mesh pit basket and radially-wound media filter combination
Target Number of Storm events	15
Minimum rainfall depth per event	5 mm
Minimum inter-event period	48–72 h, depending on influent concentrations > Limit of Detection (LOD)
Minimum hydrograph sampling	First 60% of hydrograph
Flow rates tested	At least 3 events >75% of the treatable flow rate (TFR) with 1 exceeding the TFR.
Minimum number of water sub-samples collected per event	Minimum 8 influent and 8 effluent subsamples for each event. (Based on advice from the laboratory regarding minimum sample amount)
Sampling method	Auto-sampler, flow-weighted in 1000 L intervals (pipe network) and 0.5 mm rainfall for pit basket samples
Data Management	Campbell Scientific CR800 Data logger with Ethernet Modem
Particle Size Distribution (PSD) analysis via Laser Diffraction	Continuously stirred, without chemical dispersion or sonication
Total Suspended Solids (TSS)	American Public Health Association (APHA) (2005) 2540 D [9]
Total Nitrogen and species (water samples only)	APHA (2005) 4500 N, APHA (2005) 4500 NH3, APHA (2005) 4500 NO3
Total Phosphorus and Orthophosphate (water samples only)	APHA (2005) 4500 P
pH and Electrical Conductivity (EC)	Handheld probe, calibrated to manufacturer's specifications

The sampling program listed in Table 1 is triggered by two criteria. Firstly, >2 mm of rainfall over a rolling 30-min window must occur, based on field experience. This was programmed into the datalogger, to ensure sufficient water depth was available in the pipe to collect samples. Rainfall is measured onsite by a 0.2 mm waterlog tipping bucket rain gauge. The second criteria is flow volume, where a sample is initiated after 1000 L of stormwater discharge past each of the two pipe sampling points shown in Figure 4. Flow rate/volume was measured by two Starflow ultrasonic probes installed at the inlet and outlet pipes of the concrete chamber shown in Figure 4. For the pit basket where flow measurement was impracticable, sample intervals were triggered at 0.5 mm rainfall intervals. As the basket effectively has zero residence time, the inlet and outlet samples were triggered simultaneously.

Ultrasonic probes were selected for flow measurement due to a reported accuracy of ±2% for flow and ±0.25% for depth [10]. This accuracy is comparable to flumes and weirs but without the associated interference with water quality, especially TSS, observed with the latter.

A 1000 L volume of water was chosen as the sampling interval as this is 50% of the cartridge vault volume. This volume also corresponded to 0.5 mm of runoff over the site, assuming zero losses. Analysis of a smaller flow volume trigger indicated that it could challenge the physical limitations of the samplers' purge/collection cycle (about a 90 s cycle). All the subsamples collected during a runoff event were composited within the sampler in a 9 L bottle. Each subsample was 200 mL to ensure sufficient volume was available for the suite of subsequent chemical analyses (listed in Table 1). This flow-weighted sampling protocol provides an Event Mean Concentration (EMC).

As has been noted previously [11], the physical limitations of the equipment and analysis process can subsequently affect the protocol. Therefore, any nominated protocol needs flexibility to respond to these potential constraints. For example, to collect eight subsamples practically restricts the minimum time for a "qualifying" storm to greater than 12 min, even though flow may occur quicker. Hence, for this site, a storm event less than ten minutes duration is unlikely to provide sufficient time to collect eight aliquots even if sufficient volume were present. As the project progressed, the laboratory advised that analyses could be performed on much smaller volumes, thereby permitting as few as three aliquots to be sufficient from short duration events. The intent of the monitoring program, however, is to collect a spread of subsamples across the hydrograph of every event regardless of the duration.

On the other hand, a maximum number of subsamples can be collected before the container is full, and therefore an analysis of the likelihood of rainfall events exceeding the maximum capacity of the containers was undertaken to identify the likely upper event size. As the ISCO sampler can collect a maximum of 9 L of sample, 45 sub samples, each of 200 mL, are possible. For Ormiston, this equates to approximately 22.5 mm total rainfall. Statistical analysis of rainfall events for Brisbane between July 2000 and July 2010 (assuming no runoff losses) indicates that this 9 L capacity would allow capture of >90% of the daily runoff events.

The inter-event period (antecedent duration) was set in the protocol to 48–72 h between rainfall events, as previous QUT research into pollutant build-up and wash-off on urban surfaces indicated that this was the optimal point at which pollutants reach a detectable level in runoff [12,13]. This research has shown that low intensity, low-volume events do not produce detectable concentrations for antecedent periods (ADP) less than 72 h. However, the Ormiston project has shown that high intensity events with less than 72 h ADP can produce detectable concentrations. Therefore, the protocol has been adjusted to include events where ADP might be <72 h, if pollutant concentrations are measurable. The minimum rainfall depth for a qualifying storm will vary between monitoring sites, depending on the catchment characteristics. For the medium density Ormiston townhouse site with a high fraction of impervious area, the minimum daily rainfall for monitoring has been set to 5 mm, as this is the level at which observable runoff can be measured. Other monitored sites with larger, more pervious catchments will require more rainfall to produce sufficient runoff for sampling. Therefore, we caution against setting a rigid minimum rainfall volume for qualifying storms in monitoring protocols, as this is inherently site-specific.

The draft SQIDEP also requires a minimum of three flow events >75% of the maximum treatable flow rate (TFR), with at least 1 event greater than the TFR [8]. It should be noted that a requirement for *all* events be at the TFR, or >75% of the TFR, may be statistically rare. For example, an evaluation of the hydrology for the Ormiston site across 10 years of historical data, indicates that this may be achieved less than three times annually. Hence to achieve 15 qualifying events at the TFR, would require a minimum of five years of sampling.

The monitoring equipment and sample collection were independently undertaken by staff from QUT, and analysed in NATA registered laboratories. Reports on the findings were prepared by QUT [14]. This maintains independence and integrity of the sampling, collection and analysis process. As there is a range of possible metrics used to assess performance data, this paper presents several of them.

Average Concentration Removal Efficiency (CRE) is calculated from the function:

$$Avg.CRE = \frac{\sum\left[\frac{\{EMCin - EMCout\}}{EMCin}\right]}{no.of\ events} \tag{1}$$

Efficiency Ratio (ER) is calculated from the function:

$$ER = 1 - \frac{Mean\ EMCout}{Mean\ EMCin} \tag{2}$$

To briefly paraphrase the above, the CRE is the average of the removal ratios (percentages) for every event, whereas the ER is the removal ratio of the average inflow and outflow concentrations for all events. The ER weights EMCs (flow-weighted concentrations) from all storms equally, regardless of the pollutant concentration or runoff volume, and minimises the potential impacts of smaller, cleaner events on performance calculations. The ER can, however, be influenced by a small number of high influent concentration events that skew average concentration results. Therefore, other metrics, including Average CRE, should also be considered [15]. The Average CRE quantifies the percent removal for each event, and calculates an average value of the percentages, allowing the smaller, cleaner events to have greater influence on the average CRE, and hence minimise the influence of the few, large influent concentrations.

4. Results and Discussion

A report on 18 months of monitoring has been released by QUT [14]. Of sixteen (16) captured rainfall events > 5 mm, nine events are qualifying. Where the results have been less than the limits of detection (LOD), they have been shown as 50% of the LOD. All events reported in this paper had flows >75% of the TFR, with one event exceeding the TFR.

Table 2 presents the water quality data observed at the pit basket (catch basin insert) and shows influent concentrations for TSS similar to those reported as typical by guidelines for urban residential catchments, whereas the TN and TP concentrations are mostly below guideline figures. The preliminary results indicate that the relatively simple 200 micron filter bag removes about 32% of the suspended solids and 37% and 38% of the TP and TN concentrations respectively based on the ER metric. The performance indicated by the CRE metric, is strongly influenced by very low inflow concentrations and slightly higher outflow concentrations, generating a negative ratio.

Water quality data from the media filter samples is presented in Table 3. It can be seen that the pollutant concentrations observed in the pipe inflow (inlet to the filters) is significantly lower than the pit basket outflow concentrations shown in Table 2. This is a direct result of stormwater dilution by overflow from the rainwater tanks entering the network at the base of the gully pits (catch basins). Even so, the data indicates that the filters are removing TSS, TN and TP, at very low concentrations. Mean

ERs of 87%, 55% and 42% for TSS, TP and TN respectively are observed. Of particular note, the outflow TSS concentrations from the media filter are consistently below detection limits (<5 mg/L), for most events. Similarly the outflow TP concentrations are very close to the limits of detection.

Table 2. Pit Basket Water Quality Results.

Parameter	**TSS**		**TN**		**TP**	
LOD (mg/L) [1]	**5**		**0.1**		**0.01**	
Event	**In (mg/L)**	**Out (mg/L)**	**In (mg/L)**	**Out (mg/L)**	**In (mg/L)**	**Out (mg/L)**
23 June 2014	10	NC [2]	0.60	NC	0.04	NC
16 August 2014	122	40	0.90	0.40	0.13	0.10
18 August 2014	12	2.5	0.20	0.20	0.05	0.05
23 August 2014	9	2.5	0.20	0.10	0.05	0.15
26 September 2014	346	253	2.40	1.90	0.58	0.36
9 December 2014	202	186	3.85	2.20	0.40	0.10
18 December 2014	2.5	10	0.30	0.30	0.03	0.07
20 Febuary 2015	34	6	0.70	0.30	0.09	0.02
30 April 2015	90	58	0.90	0.50	0.13	0.07
Average Conc.	102.19	69.75	1.18	0.74	0.18	0.11
Median Conc.	34.00	25.00	0.70	0.35	0.09	0.08
Efficiency Ratio (Avg)	-	32%	-	38%	-	37%
Average CRE	-	9%	-	34%	-	−9%
Efficiency Ratio (Median)	-	26%	-	50%	-	7%
Median CRE	-	51%	-	44%	-	31%

Notes: [1] LOD = Limits of Detection of the analytical method; [2] As Outflow samples were not collected (NC) from this event, it has been excluded from the calculations.

Table 3. Media filter cartridge Water Quality Results.

Parameter	**TSS**		**TN**		**TP**	
LOD (mg/L) [1]	**5**		**0.1**		**0.01**	
Event	**In (mg/L)**	**Out (mg/L)**	**In (mg/L)**	**Out (mg/L)**	**In (mg/L)**	**Out (mg/L)**
22 June 2014	2.72	2.50	0.70	0.60	0.02	0.01
16 August 2014	22.69	2.50	0.40	0.30	0.04	0.02
18 August 2014	24.95	2.50	0.39	0.20	0.06	0.04
23 August 2014	2.50	2.50	0.20	0.10	0.03	0.03
25 September 2014	74.39	2.50	0.75	0.30	0.08	0.02
8 December 2014	31.59	15	0.47	0.20	0.03	0.02
18 December 2014	2.50	2.50	0.44	0.20	0.02	0.01
20 Febuary 2015	20.65	2.50	0.41	0.40	0.01	0.01
30 April 2015	65.65	0.50 *	0.31	0.05	0.03	0.01
Average Conc.	24.7	3.67	0.45	0.26	0.04	0.02
Median Conc.	12.6	2.5	0.41	0.2	0.03	0.02
Efficiency Ratio (Avg)	-	87%	-	42%	-	55%
Average CRE	-	58%	-	44%	-	56%
Efficiency Ratio (Median)	-	89%	-	52%	-	33%
Median CRE	-	88%	-	49%	-	64%

Notes: [1] LOD = Limits of Detection of the analytical method; * LOD = 1 mg/L for this event.

As can be seen in Tables 2 and 3, the ER and CRE metrics vary, though both use the same concentration data. This is the result of the two methods using different mathematical logic. For example, the pit basket result for TP on 23 August 14 indicates a CRE of −200% that subsequently causes the average CRE to be negative, even though all the other events show positive CRE values. Results near the limits of detection, such as that for 23 August 14, can skew the average CRE metric. A recorded inflow concentration of 0.01 mg/L, for example, and an outflow concentration of 0.02 mg/L will provide an individual CRE of −100% and influence the average CRE, yet be as a result of analytical error. Results on duplicate samples from Ormiston have been observed to differ by 0.3 mg/L for TN and 0.02 mg/L for TP, and result in a "theoretical export" of pollutants of ~200% for these very low influent concentrations. This large negative percent removal then has a knock-on effect on the average CRE value, and so we suggest CRE is not an appropriate metric when influent concentrations are close to the LOD.

We suggest that ER is the better metric for evaluation of this dataset. However, in the instances that high concentration influent outliers are recorded (for example, above the Water by Design MUSIC modelling guidelines [4]) as the dataset grows, we suggest that Average CRE, Comparison of Medians, and statistical analyses should all be used to validate performance. In the dataset observed by this research, there are no outliers based on the Water by Design MUSIC Modelling Guidelines for storm concentrations from an urban residential catchment [4]. In fact, the observed concentrations at Ormiston are low in comparison with the guideline values, as shown in Table 4. We therefore maintain that ER is the more suitable metric to be used at this point in time, for this site.

Table 4. Comparison of Ormiston Surface Water Quality Results with Brisbane MUSIC Guidelines for urban residential areas.

Parameter	MUSIC Guideline Values (Lumped Urban Residential Catchment) [1]			Ormiston Surface Influent (Pit Basket Inflow)		
	−1SD	Mean	+1SD	−1SD	Mean	+1SD
TSS (mg/L)	61.7	151	372	0	102.2	222.52
TP (mg/L)	0.162	0.339	0.708	0	0.182	0.380
TN (mg/L)	1.07	1.82	3.09	0	1.181	2.474

Note: [1] Reference: [4].

Significant debate continues as to the "best" method to calculate device performance. Statistical validation (Paired *t*-test) of the dataset is also recommended to confirm significant differences between the influent and effluent sample sets [5]. The Auckland PDEP also indicates that where the median and the mean of the performance metric (e.g., ER) vary by more than 10%, additional sampling events are recommended. The median concentrations presented in Tables 2 and 3, when used to calculate an Efficiency Ratio, result in a difference of more than 10% for TN and TP when compared with a Mean Efficiency Ratio. In comparison, however, the Median CRE values appear to be generally consistent with the Average ER.

5. Normality and Log-Normality Tests

Environmental monitoring data is typically log-normally distributed, therefore, the data sets recorded for this site were evaluated against a normal distribution, in a log-transformed basis. The

Anderson-Darling Normality test identifies normal distributions where the p-value is >0.05 (alpha). As can be seen from Table 5, all of the datasets are log-normally-distributed, except for TSS outflow and TP outflow on the media filters.

Table 5. Anderson-Darling Normality tests on log-transformed dataset, statistically significant results shown in bold.

Treatment Device	***p*-value**					
	TSS in	**TSS out**	**TN in**	**TN out**	**TP in**	**TP out**
StormSack	0.748	0.497	0.506	0.328	0.518	0.615
SPELFilter	0.054	0.005	0.418	0.413	0.906	0.015

This is likely a result of the outflow concentrations converging on similar results (*i.e.*, Below or at Detection limits). This information is relevant for confirming that a Student's paired t test is a valid method to compare the influent and effluent datasets. Figure 6 presents the Q-Q plots for the StormSack pollutant data in log-transformed format. Figure 7 presents the Q-Q plots for the SPELFilter pollutant data in log-transformed format.

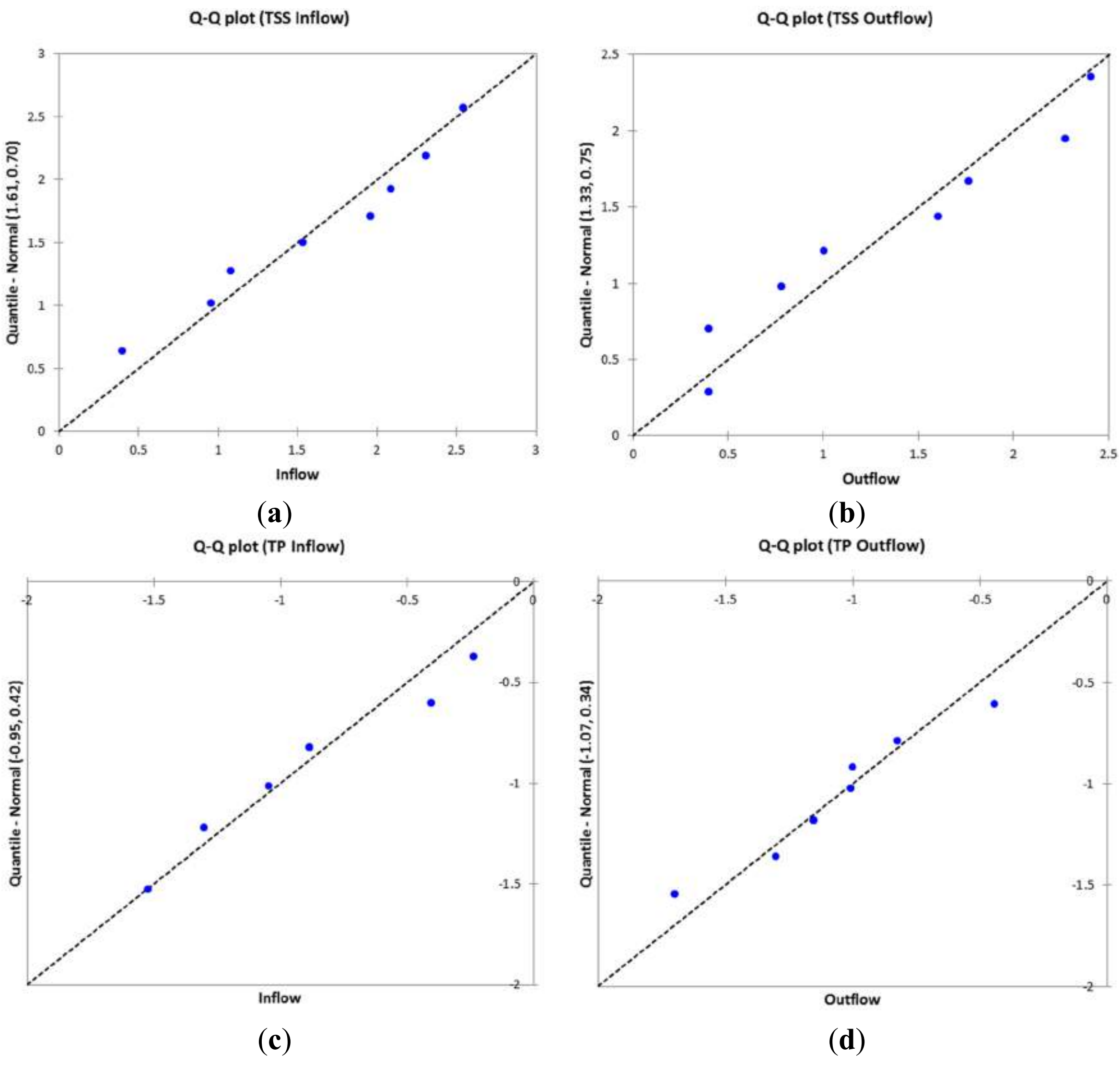
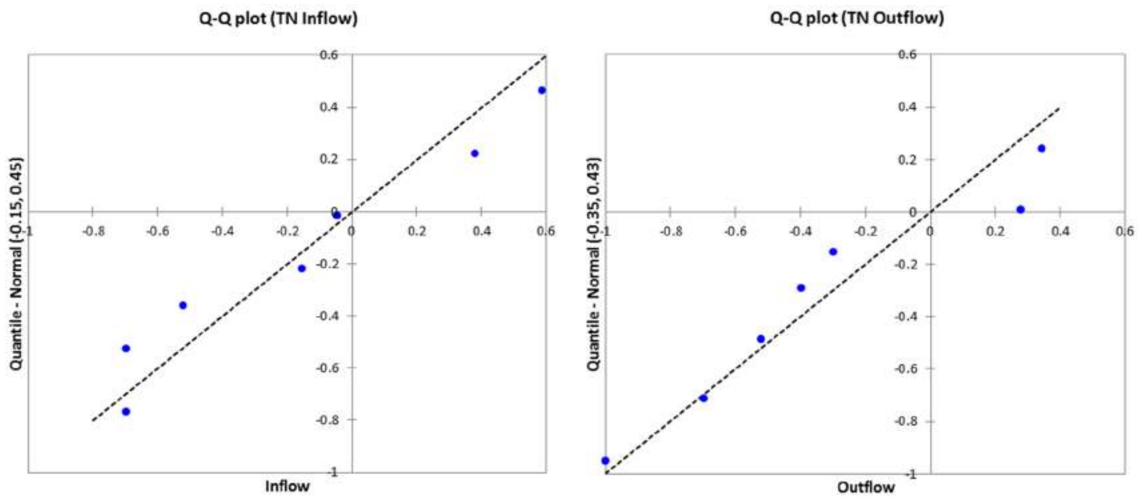
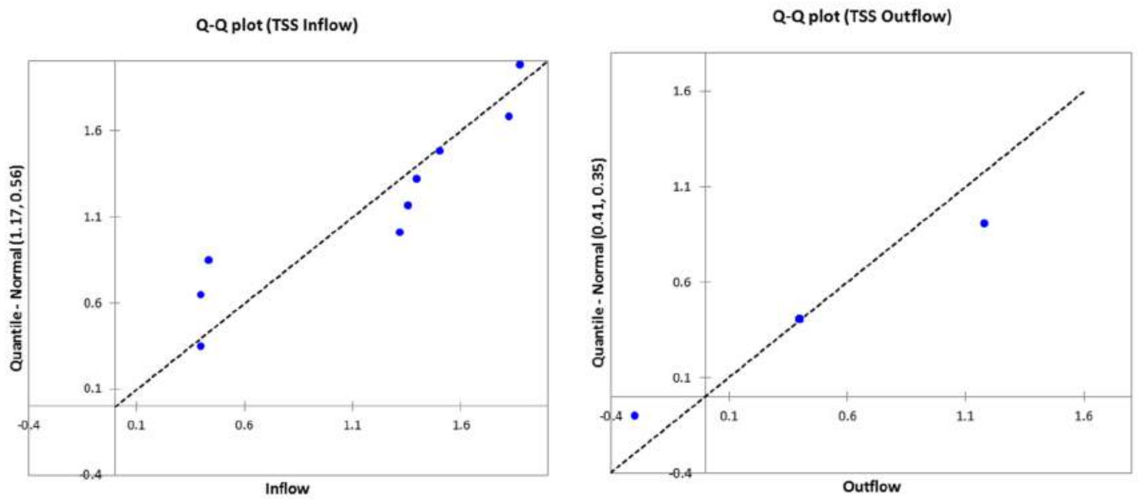


Figure 6. *Cont.*

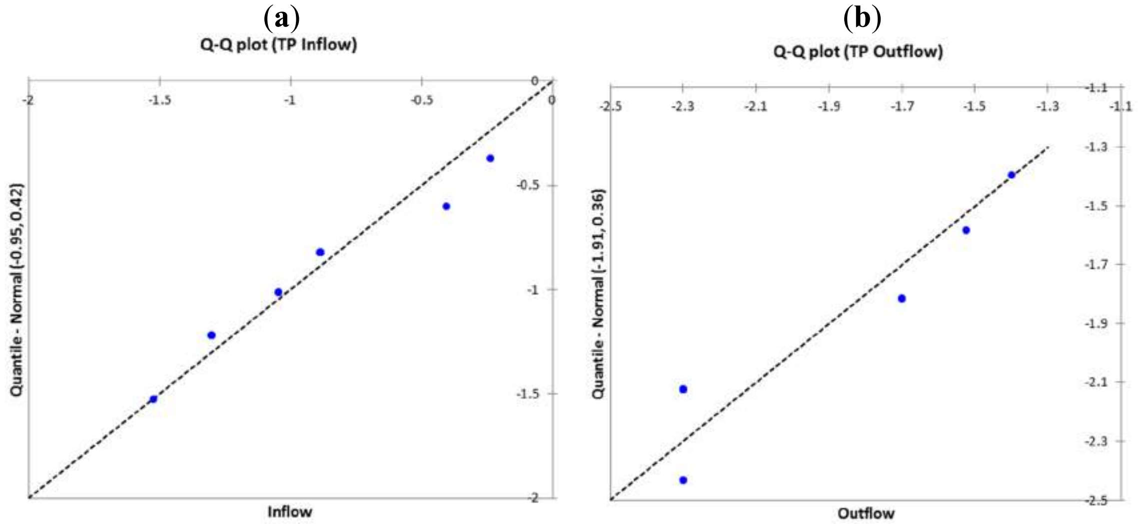


(**e**) (**f**)

Figure 6. Q-Q Plots of log-normal distributions—Pit Basket (**a**) TSS Inflow; (**b**) TSS Outflow; (**c**) TP inflow; (**d**) TP outflow; (**e**) TN inflow; (**f**) TN outflow.

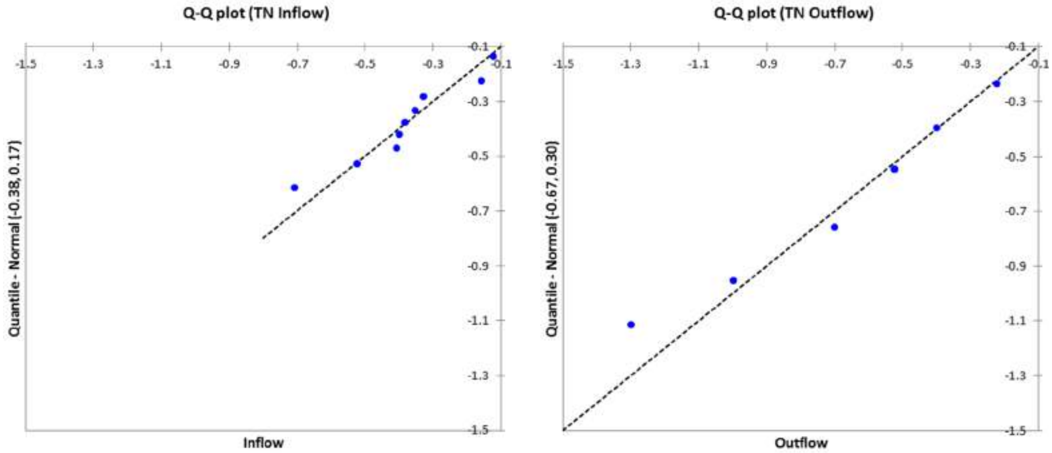


(**a**) (**b**)



(**c**) (**d**)

Figure 7. *Cont.*



(e) **(f)**

Figure 7. Q-Q Plots of log-normal distributions—SPELFilter Inflow and Outflow, TSS, TN and TP respectively. (**a**) TSS Inflow; (**b**) TSS Outflow; (**c**) TP Inflow; (**d**) TP Outflow; (**e**) TN Inflow; (**f**) TN Outflow.

6. Statistical Significance Tests

To evaluate whether the data demonstrate that the treated flow is statistically different from the inflow, statistical tests were performed on the log-transformed datasets. The paired Student's *t* test evaluates whether the two datasets have the same mean. Therefore, if the datasets are considered statistically to be significantly different, they are shown in bold below. As can be seen from *t* tests on the log-transformed data, all pollutants in and out of the media filter are statistically significantly different. The pit basket concentrations data is not statistically significantly different, according to this test. The *t* test results are presented in Table 6. Given the inherent variability of environmental data, a further statistical test was performed on the raw dataset. The Mann-Whitney (Wilcoxon) Rank-Sum test was performed on the raw datasets for the pit basket and media filter. As can be seen in Table 7, the media filter results are confirmed to be statistically significantly different, however, the pit basket datasets are not.

Table 6. Student's *t* tests on log-transformed dataset, statistically significant results shown in bold.

Treatment Device	***p*-value (Two-Tailed)**		
	TSS	**TN**	**TP**
StormSack	0.117	0.006	0.412
SPELFilter	0.015	0.005	0.002

Table 7. Wilcoxon-Mann-Whitney Rank-Sum test on raw data, statistically significant results shown in bold.

Treatment Device	**TSS**		**TN**		**TP**	
	***p*-value**	**Sig.**	***p*-value**	**Sig.**	***p*-value**	**Sig.**
StormSack	0.496	no	0.429	no	0.711	no
SPELFilter	0.008	yes	0.021	yes	0.031	yes

These results confirm international observations that environmental data may require large datasets that are economically unviable to demonstrate statistical significance [15]. Further, the concentrations observed on the catchment are beyond the control of the researcher. For example, an estimation of the number of samples required for a paired comparison on the pit basket dataset, as indicated by the equation described by Burton and Pitt [16] shown below, suggests that 160 samples are required for TSS, 103 samples are required for TP and 220 samples are necessary for TN.

$$n = 2\left[\frac{Z_{1-\alpha} + Z_{1-\beta}}{\mu_1 - \mu_2}\right]^2 \sigma^2 \tag{3}$$

where n = number of sample pairs needed; α = false positive rate ($1-\alpha$ is the degree of confidence. A value of α of 0.05 is usually considered statistically significant, corresponding to a $1-\alpha$ degree of confidence or 95%); β = false negative rate ($1-\beta$ is the power. If used, a value of β of 0.2 is common but it is frequently ignored, corresponding to a β of 0.5); $Z_{1-\alpha}$ = Z score (associated with area under normal curve) corresponding to $1-\alpha$; $Z_{1-\beta}$ = Z score corresponding to $1-\beta$ value; μ_1 = mean of dataset one; μ_2 = mean of dataset two; σ = standard deviation (same for both datasets, assuming normally-distributed).

SPEL and Drapper Environmental Consultants (DEC) are monitoring seven research sites across southeast Queensland, and have observed that for each qualifying event there are three others discarded for non-conformance with the protocol. Continuing a monitoring program to achieve 220 qualifying events required for statistical certainty (>600 events overall) would be financially prohibitive for any research program and delay outcomes for many years.

7. Conclusions

Evaluation of alternate stormwater treatment devices has been under way for decades internationally and, appears to be gaining momentum in Australia. While a number of existing guidelines stipulate that performance of alternate stormwater treatment devices must be demonstrated for local and regional conditions, the guidelines generally do not define how this should be accomplished. USC, QUT, GU, DEC and SPEL have worked together to adapt international protocols to suit local and regional conditions on a variety of sites and treatment measures in southeast Queensland. This paper details the protocol being implemented on one of the monitoring sites at Ormiston, Southeast Queensland. A report published by QUT on the nine complying events at the site indicate Efficiency Ratios of 32% TSS, 37% TP and 38% TN for the 900 square StormSack pit basket, and 87% TSS, 55% TP and 42% TN for the 85mm high, radially-wound, multi-media SPELFilter cartridge. Given the dataset analyses on the field testing of this treatment train indicates that the performance of the SPELFilter is statistically proven, and, when combined in a treatment train, it will comply with the QLD SPP water quality objectives of 80% TSS, 60% TP and 45% TN removal.

Acknowledgments

The authors acknowledge the contribution to this research by QUT, including Ashantha Goonetilleke, Prasanna Egodawatta, and Buddhi Srinath Wijesiri Mahappu Kankanamalage.

Author Contributions

Darren Drapper has been engaged to project manage the research and supervise the ongoing operation of the monitoring system; Andy Hornbuckle is the National Manager for SPEL Environmental and pioneered the site selection, approvals, financing and regulator liaison for the project. Both authors have contributed to the preparation of this journal article.

Conflicts of Interest

The authors declare no conflict of interest

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CRGACOUSTICS

Proposed Service Station Development,
Corner Hall Road & Capricorn Highway, Gracemere

ENVIRONMENTAL NOISE IMPACT REPORT

Prepared for

Corbet Property Pty Ltd

1 December 2017
crgref: 17061 Report rev.1

1.0 INTRODUCTION

This report is in response to a request from Corbet Property Pty Ltd for an environmental noise impact assessment of proposed service station in Gracemere.

In undertaking the noise assessment, noise monitoring was conducted at the site and through modelling, predictions of onsite activity noise emissions were produced. Based upon the predicted noise impact levels, recommendations regarding acoustic treatment to the development have been provided.

2.0 DESCRIPTION OF THE DEVELOPMENT

The site is described as Lots 1 & 2 on RP617280, located at the corner of Hall Road and the Capricorn Highway, Gracemere. The site and surrounds are basically flat, and the site is vacant. The nearest noise sensitive receivers (i.e. dwellings) are located adjacent to the northeast and further away to the southwest across Hall road and across The Capricorn Highway to the southeast. For site location refer to Appendix A.

The proposal is to develop a new service station towards the western portion of the site, with truck parking on the eastern part of the site. Access is proposed via WyWurry Road to the northern boundary. For development plans refer to Appendix B.

Onsite activities (i.e. car and truck movements, car door closures, deliveries, waste collection and mechanical plant) have been assessed to ensure the acceptable acoustical amenity can be achieved at the nearest potentially affected noise sensitive receivers.

3.0 SITE NOISE SURVEY

3.1 Instrumentation

The following equipment was used to measure the existing acoustical environment at the site:

- Rion NC 73 Calibrator;
- Rion NL 21 Sound Level Noise Logging Meter.

All instrumentation used in this assessment hold current calibration certificates from a certified NATA calibration laboratory.

3.2 Ambient Noise Level Measurement Methodology

A noise logger was located in the southwestern part of the subject site, with the microphone located in a free-field position approximately 1.2 m above ground. The logger location was chosen to represent the acoustical environment at the nearest dwellings. For the logger location refer to Figure 1 in Appendix A of this report.

The logger was set to record noise statistics in 15 minute blocks continually between Wednesday 14/06/2017 to Wednesday 21/06/2017. Noise measurements were conducted generally in accordance with Australian Standard AS1055 1997 "*Acoustics – Description & Measurement of Environmental Noise*". The operation of the sound level equipment was field calibrated before and after the measurement session, with no significant drift from the reference signal recorded.

Weather conditions during the monitoring period were obtained from the Bureau of Meteorology website from the Rockhampton weather station, which is approximately 9km away. Weather conditions during the monitoring period were fine with a temperature range between 11 and 28°C, a relative humidity range between 29 and 81%. Refer to the Bureau of Meteorology weather report for the month in Appendix "A" of this report.

3.3 Ambient Noise Level Measurement Results

Table 1 below presents the Rating Background Levels calculated from logger data in accordance with the methodology specified in the Queensland EPA document "Planning for noise control" Ecoaccess guideline. Graphical presentation of the measured levels is presented in Appendix C.

Descriptor and period	Time period	Measured level dB(A)
Daytime Background L_{90}	7am to 6pm	41
Evening Background L_{90}	6pm to 10pm	38
Night-time Background L_{90}	10pm to 7am	28

Table 1: Rating Background Levels from data recorded at the noise logger location.

The acoustical environment is comprised of a mixture of natural sounds and road traffic noise from the Capricorn Highway (which carries in the order of 4,870 vehicles per day with 22% heavy vehicles).

4.0 NOISE ASSESSMENT CRITERION

The Livingstone Shire Council's Residential Zone Code states the following with respect to protection of amenity:

Specific Outcomes		Self-assessment Solutions	
O6	Uses and works are located, designed and operated to minimise adverse impacts on: ◗ existing environmental conditions relating to air, water and soil, ◗ the amenity of adjacent properties and public spaces, ◗ visual quality of landscapes in terms of: – reducing ribbon development and sprawl, – loss of green break separations, ◗ obstructing significant local and distant views of prominent natural features and landmarks, and ◗ the health and safety of people using the premises and adjacent premises.	S6	(a) Non-residential purposes are buffered from adjoining properties used for residential purposes by provision of: (i) 1.8 metre high solid screen fence along common side and rear boundaries; (ii) 6 metre wide landscaped area along the main road frontage; (iii) 3 metre wide landscaped area adjacent to other road frontages and side and rear boundaries common with premises used for residential purposes. (b) Night lighting is designed, constructed and operated in accordance with *Australian Standard AS4282 – Control of the obtrusive effects of outdoor lighting*. (c) Non-residential purposes do not generate levels of noise that exceed levels interpreted under the *Environmental Protection (Noise) Policy* provisions, as 'unreasonable', or the following whichever is the lesser:

Period	Noise Level at Noise Sensitive Place
O700 – 2000	Background noise level plus 5 dB(A)
2000 – O700	Background noise level plus 3 dB(A)

Measured as the adjusted maximum sound pressure level Lmax adj T

Schedule 1 of the Environmental Protection (Noise) Policy 2008 provides the following specific Acoustic Quality Objectives to ensure that the above is achieved:

Column 1	Column 2	Column 3			Column 4
Sensitive receptor	**Time of day**	**Acoustic quality objectives (measured at the receptor) *dB(A)***			**Environmental value**
		$L_{Aeq,adj,1hr}$	$L_{A10,adj,1hr}$	$L_{A1,adj,1hr}$	
dwelling (for outdoors)	daytime and evening	50	55	65	health and wellbeing
dwelling (for indoors)	daytime and evening	35	40	45	health and wellbeing
	night-time	30	35	40	health and wellbeing, in relation to the ability to sleep
childcare centre or kindergarten (for indoors)	when open for business, other than when the children usually sleep	35			health and wellbeing
childcare centre or kindergarten (for indoors)	when the children usually sleep	30			health and wellbeing, in relation to the ability to sleep
school or playground (for outdoors)	when the children usually play outside	55			health and wellbeing, and community amenity

Table 2: Criterion from Schedule 1 of the Environmental Protection (Noise) Policy 2008.

We note that *"It is intended that the acoustic quality objectives are to be progressively achieved as part of achieving the purpose of this policy over the long term"* (Environmental Protection (Noise) Policy 2008).

Section 10 of the Environmental Protection (Noise) Policy 2008 provides the following guidance for control of *"Background Creep"*[1]:

10 Controlling background creep

(1) This section states the management intent for an activity involving noise.

Note—

See section 51 of the *Environmental Protection Regulation 2008.*

(2) To the extent that it is reasonable to do so, noise from an activity must not be—

(a) for noise that is continuous noise measured by $L_{A90,T}$—more than nil dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$; or

(b) for noise that varies over time measured by $L_{Aeq,adj,T}$—more than 5dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$.

Based upon the measured levels presented in Table 1 of Section 3.3 the above *"Background Creep"* criterion equates to the following levels, when assessed at the surrounding noise sensitive receivers.

Time Period	**Noise Limit, SPL dB(A) L_{eq}**
Time Varying Noise (i.e. car door closures)	
Day 7am to 6pm	46 (Measured L_{90} level 41 + 5 dB)
Evening 6pm to 10pm	43 (Measured L_{90} level 38 + 5 dB)
Night 10pm to 7am	33 (Measured L_{90} level 28 + 5 dB)
Continuous Noise (i.e. mechanical plant)	
Day 7am to 6pm	41 (Measured L_{90} level 41 + 0 dB)
Evening 6pm to 10pm	38 (Measured L_{90} level 38 + 0 dB)
Night 10pm to 7am	28 (Measured L_{90} level 28 + 0 dB)

Table 3: Noise limit criterion for *"Background Creep"*.

For time-varying noise sources (i.e. car door closures) is concluded that the default criteria applied in the table under part (c) of the Code is more stringent than the EPP (Noise), therefore, the criteria in the table under part (c) of the Code has been applied, as follows:

Time Period	**Noise Limit, SPL dB(A) L_{max}**
Time Varying Noise (i.e. car door closures)	
Day 7am to 6pm	46 (Measured L_{90} level 41 + 5 dB)
Evening 6pm to 10pm	43 (Measured L_{90} level 38 + 5 dB)
Night 10pm to 7am	31 (Measured L_{90} level 28 + 3 dB)

Time Period	**Noise Limit, SPL dB(A) L_{max}**
Continuous Noise (i.e. mechanical plant)	
Day 7am to 6pm	41 (Measured L_{90} level 41 + 0 dB)
Evening 6pm to 10pm	38 (Measured L_{90} level 38 + 0 dB)
Night 10pm to 7am	28 (Measured L_{90} level 28 + 0 dB)

Table 4: Overall noise limit criterion.

[1] "Background creep" is the effect of assessing continuous noise such as air conditioners at levels above background conditions. The new plant will raise background noise levels, therefore, if extra plant is added, a higher noise limit results from the effect of the existing plant. As more plant is added, the noise limits increase, thereby increasing the allowable level of noise from plant.

Further to the above, it is submitted that it is reasonable to apply sleep disturbance criteria for the night period, and also taking into account the existing acoustical environment noise levels assessed as a maximum level. This approach has been applied many times as a reasonable assessment criteria in the Planning and Environment Court for service stations (most recently, being Planning & Environment Court Appeal 2569/16 Synergy Property Partners SEQ Pty Ltd -v- Sunshine Regional Coast Council). A limit of 45 dB(A) L_{max} for time varying noise and 30 dB(A) for continuous noise is typically accepted as a level that protects a person from sleep disturbance, with the following average maximum noise levels recorded at the logger location:

Time Period	**Measured Average Noise Level, SPL dB(A) L_{max}**
Day 7am to 6pm	68
Evening 6pm to 10pm	67
Night 10pm to 7am	65

Table 5: Measured Average L_{max} Noise Levels from Logger Data.

5.0 PREDICTED ONSITE ACTIVITY NOISE IMPACTS

5.1 Fluctuating Noise Source Emissions

All noise source levels used in the assessment have been collected from similar assessments, and have been corrected for impulsiveness or tonality as per Australian Standard AS 1055:1997 – *"Acoustics-Description and measurement of environmental noise*". The following noise source levels would typically occur as part of the proposed development and have been assessed within this report.

Noise source	**Noise Level, dB(A) L_{max} @ 1m**
Vehicle door closures	83**
Car movement	77
Truck movement	88
Truck unloading	83**
Articulated truck airbrake	92**
Tyre valve air escape checking tyres	87**
Checking tyre pressure audible alarm	85**
Patrons dining at outdoor area	65
Waste collection	97**

* Denotes + 5 dB correction for impulsiveness in accordance with AS1055. ** Denotes + 5 dB correction for tonality in accordance with AS1055.

Table 6: Typical noise source levels associated with the proposed development.

Based upon the future location of the onsite activities in relation to the surrounding noise sensitive receivers, we predict the following noise impact levels as presented in Table 7.

The predicted levels assume that the recommended treatments detailed in Section 6 are incorporated into the development, and also assume that for indoor impacts, that windows are open.

For point source calculations refer to Appendix C.

Receptor location	Predicted Noise Impact, dB(A) L_{max}	
R1: Dwelling Northeast at 60 Hall Road (Lot 3 on RP617280)		
Noise source	**Nearest Façade**	**Inside Open Windows**
Vehicle door closures at fuel dispensers	27	<20
Vehicle door closures at shopfront	25	<20
Vehicle door closures at air/water	24	<20
Car movement nearest receiver	20	<20
Truck movement nearest receiver	44	37
Truck unloading at loading bay	29	21
Truck airbrake nearest receiver	43	36
Air escape from tyre pressure check	28	21
Tyre pressure gauge alarm	26	<20
Patrons dining in outdoor area	<20	<20
Waste collection at loading bay	48	40
R2: Dwelling Southwest at 996 Capricorn Highway (Lot 11 on SP252177)		
Noise source	**Nearest Façade**	**Inside Open Windows**
Vehicle door closures at fuel dispensers	33	26
Vehicle door closures at shopfront	33	26
Vehicle door closures at air/water	33	26
Car movement nearest receiver	27	20
Truck movement nearest receiver	38	31
Truck unloading at loading bay	33	26
Truck airbrake nearest receiver	43	36
Air escape from tyre pressure check	37	30
Tyre pressure gauge alarm	35	28
Patrons dining in outdoor area	<20	<20
Waste collection at loading bay	47	40
R3: Dwelling Southeast at 179 Somerset Road (Lot 1 on RP616167)		
Noise source	**Nearest Façade**	**Inside Open Windows**
Vehicle door closures at fuel dispensers	34	27
Vehicle door closures at shopfront	34	27
Vehicle door closures at air/water	34	26
Car movement nearest receiver	30	22
Truck movement nearest receiver	43	35
Truck unloading at loading bay	35	27
Truck airbrake nearest receiver	48	40
Air escape from tyre pressure check	38	30
Tyre pressure gauge alarm	36	28
Patrons dining in outdoor area	<20	<20
Waste collection at loading bay	49	41
Council Noise Limit Criteria under Residential Zone	**Day 46 Eve 43 Night 31**	**N/A**
Existing L_{max} Levels from Logger Data	**Day 68 Eve 67 Night 65**	**N/A**
Indoor Sleep Disturbance Criteria	**N/A**	**45**

Table 7: Predicted onsite short duration noise impact levels at offsite noise sensitive receivers.

5.2 Continuous Onsite Noise Source Emissions

Continuous activity noise source levels have been compiled from similar previous investigations. All noise levels have been corrected for impulsiveness or tonality as per Australian Standard AS 1055:1997 – *"Acoustics-Description and measurement of environmental noise*".

It should be stressed that mechanical plant selections have yet to be undertaken, for this reason; we have applied noise levels from other similar commercial sites as follows:

- Air conditioner unit x 2 generating 56 dB(A) at 3m (along southeast façade of building).
- Refrigeration compressor generating 60 dB(A) at 3m (along southeast façade of building).
- Air compressor generating 55 dB(A) at 3m (along southeast façade of building).
- Toilet exhaust generating 50 dB(A) at 3m (along southeast façade of building).

Based upon the assumed onsite mechanical plant in relation to the noise sensitive receivers (building façade and inside rooms with windows open), we predict the following noise impact levels as presented in Table 8.

As a worst case scenario we have assumed that all mechanical plant will be running at the same time particularly during the night-time period.

The predicted levels assume that the recommended treatments detailed in Section 6 are incorporated into the development.

For point source calculations refer to Appendix C.

Noise Source	**Indicative Predicted Noise Impact, SPL L_{eq} dB(A)**	
	Nearest Façade	**Inside Windows Open**
R1: Dwelling Northeast at 60 Hall Road (Lot 3 on RP617280)		
Combined mech. plant	<20	<20
R2: Dwelling Southwest at 996 Capricorn Highway (Lot 11 on SP252177)		
Combined mech. plant	<20	<20
R3: Dwelling Southeast at 179 Somerset Road (Lot 1 on RP616167)		
Combined mech. Plant	24	<20
Daytime / Evening Criterion	**41 / 38**	**35**
Night-time Criterion	**28**	**30**

Table 8: Indicative predicted onsite continuous noise impact levels at nearest noise sensitive receivers.

6.0 RECOMMENDED ACOUSTIC TREATMENTS

We recommend that the following acoustic treatments be incorporated into the development to mitigate onsite activity noise impacts:

- Construction of the acoustic barrier as detailed in Sketch No. 1 of Appendix A. Typical materials include earth berms, 19mm lapped timber fence (40% overlap), 9mm FC sheet, toughened glass, Perspex, masonry, or a combination of the above (a minimum surface mass of 11kg/m^2 is required).

- Waste collection be limited to the daytime period between 7am and 6pm.

- Driveway and carpark areas be finished with surface coatings which prevent tyre squeal (an uncoated unpolished concrete surface is acceptable).

- Drainage grating over trafficable areas be well secured to prevent rattling.

- Mechanical plant be designed and installed to comply with the noise criterion presented in Section 4. As final plant selection has not been completed, an assessment of plant should be conducted during the design phase. Such assessments should be undertaken prior to Building Approval; and be conditioned within the Development Approval.

7.0 DISCUSSION

The proposal is to develop a new service station with truck parking on land currently vacant (Lots 1 & 2 on RP617280). The nearest noise sensitive receivers (i.e. dwellings) are located adjacent to the northeast and further away to the southwest across Hall road and across The Capricorn Highway to the southeast.

Based upon the assumed source levels and recommended acoustic treatments (i.e. north-eastern boundary acoustic barrier), onsite activity noise is predicted to impact the offsite noise sensitive receivers within the daytime and evening Council's Residential Zone Code *"Background +"* criterion with the exception of truck airbrakes at the southeast receiver (across the Highway), truck movements at the eastern adjoining dwelling (exceedance of 1 dB) and waste collection. As noted previously, the acoustical environment of the locale is comprised of naturally occurring noise, and road traffic from the Capricorn Highway, which carries in the order of 3,800 cars and over 1,000 heavy vehicles per day. Hence, truck airbrakes and movements will more than likely be lower levels than road traffic on the Highway.

Noise from normal activity that would occur during the night period are predicted within 3 dB of the night-time *"Background +"* criterion. As the average person cannot typically detect 3 dB variation in sound pressure such a rise is unlikely to be detectable. Further, for the night-time period, when people are typically indoors (i.e. sleeping), noise impacts are within the adopted internal sleep disturbance noise limit of 45 dB(A) with the exception of waste collection.

For all activities, predicted impacts are well below the existing measured L_{max} levels sourced from the logger data.

To minimise noise we have recommended that waste collection be limited to outside the night period to avoid impacts on quality of sleep.

We have provided an indication of potential noise impact levels of likely onsite mechanical plant; although the levels are merely a guide as no plant selections have yet been completed. For this reason, further and more detailed assessment/s should be conducted upon determination of plant. Such assessments should be undertaken prior to Building Approval; and be conditioned within the Development Approval.

While the Livingstone Shire Council's Residential Zone Code provides some assessment criteria for noise impacts, we have also considered other relevant criteria that has been applied by Experts in the Planning and Environment Court, as recently as November 2016, and has been accepted by Council for a similar site in Yeppoon earlier this year. By taking into account all of the assessment criteria, it is concluded that the proposed development is reasonable, subject to the recommended acoustical controls detailed in this report being applied and maintained.

8.0 CONCLUSIONS

This report is in response to a request from Corbet Property Pty Ltd for an environmental noise impact assessment of proposed service station in Gracemere.

Overall, the proposed redevelopment of the site will comply with the noise limit criteria as determined, and is suitable for 24 hour operations.

Report Compiled By:

JAY CARTER BSc
Director

APPENDIX A

Subject Site, Measurement Location, Surrounding Noise Sensitive Receivers and Acoustical Treatment Sketch

Figure No. 1: Subject Site Location (Google Maps).

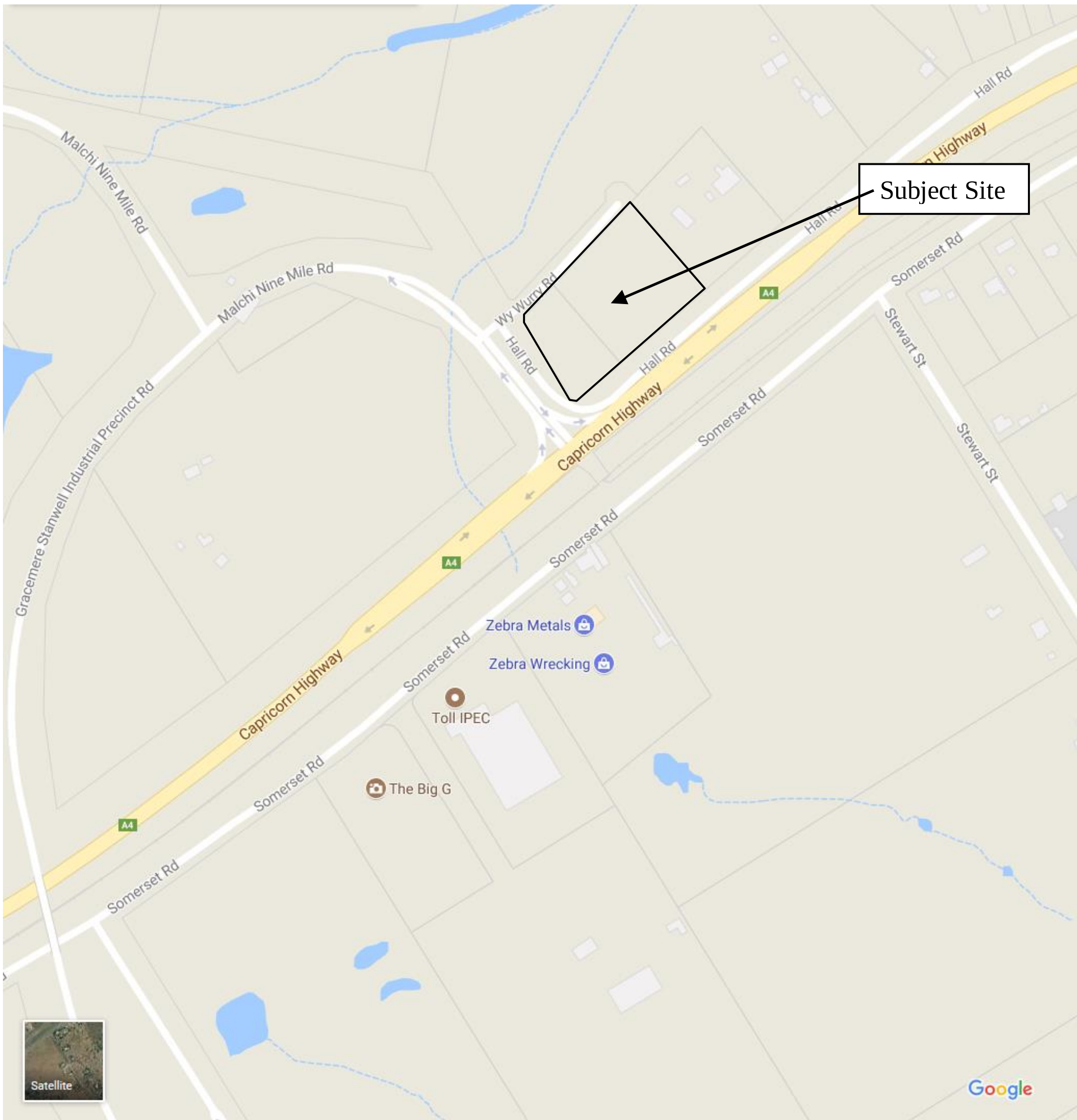
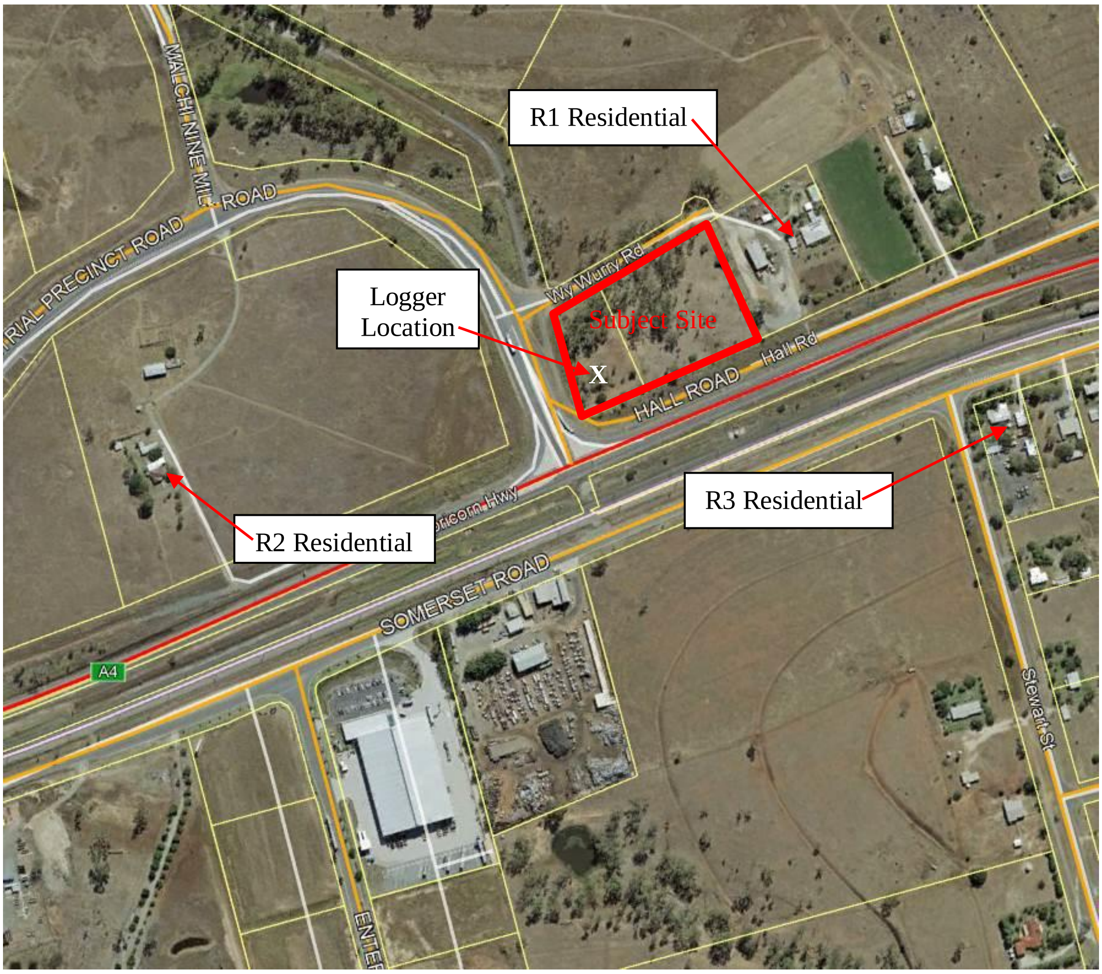
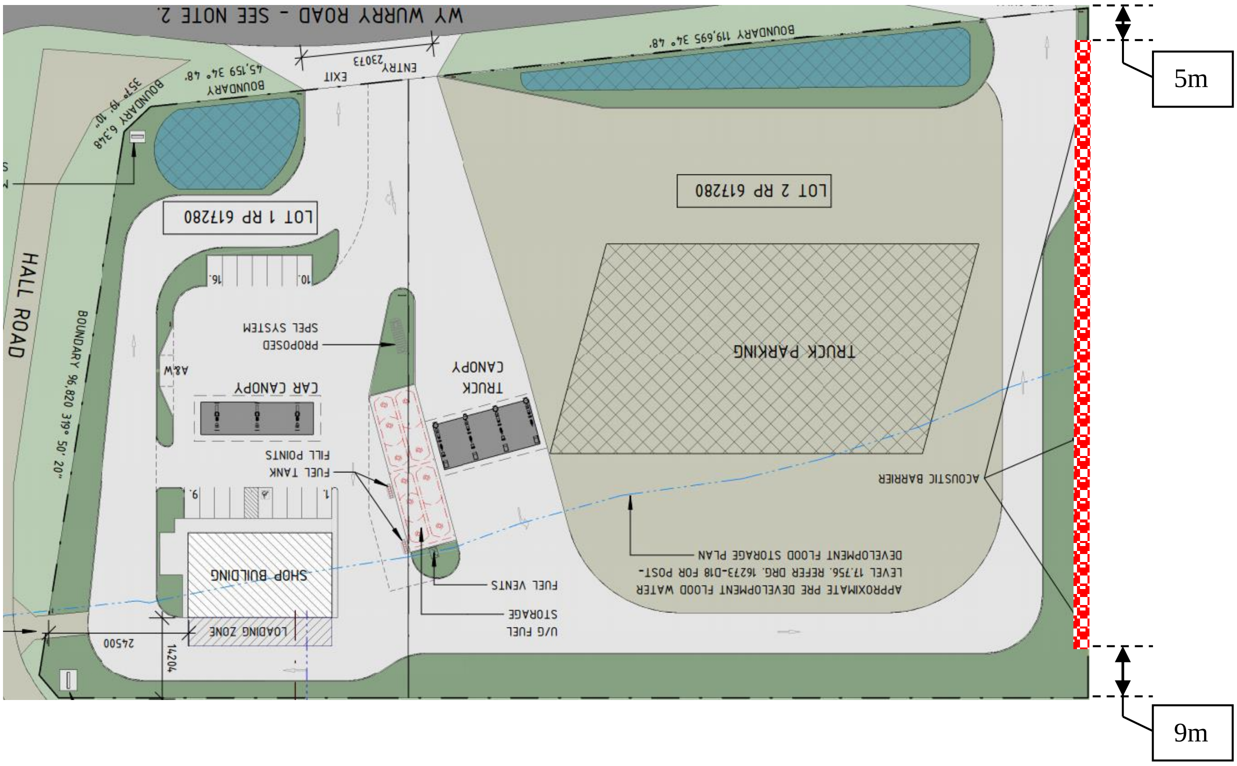


Figure No. 2: Subject Site, Unattended Measurement Location and Surrounding Dwellings (Google Earth with DNRM QLD GLOBE DATA Overlay).



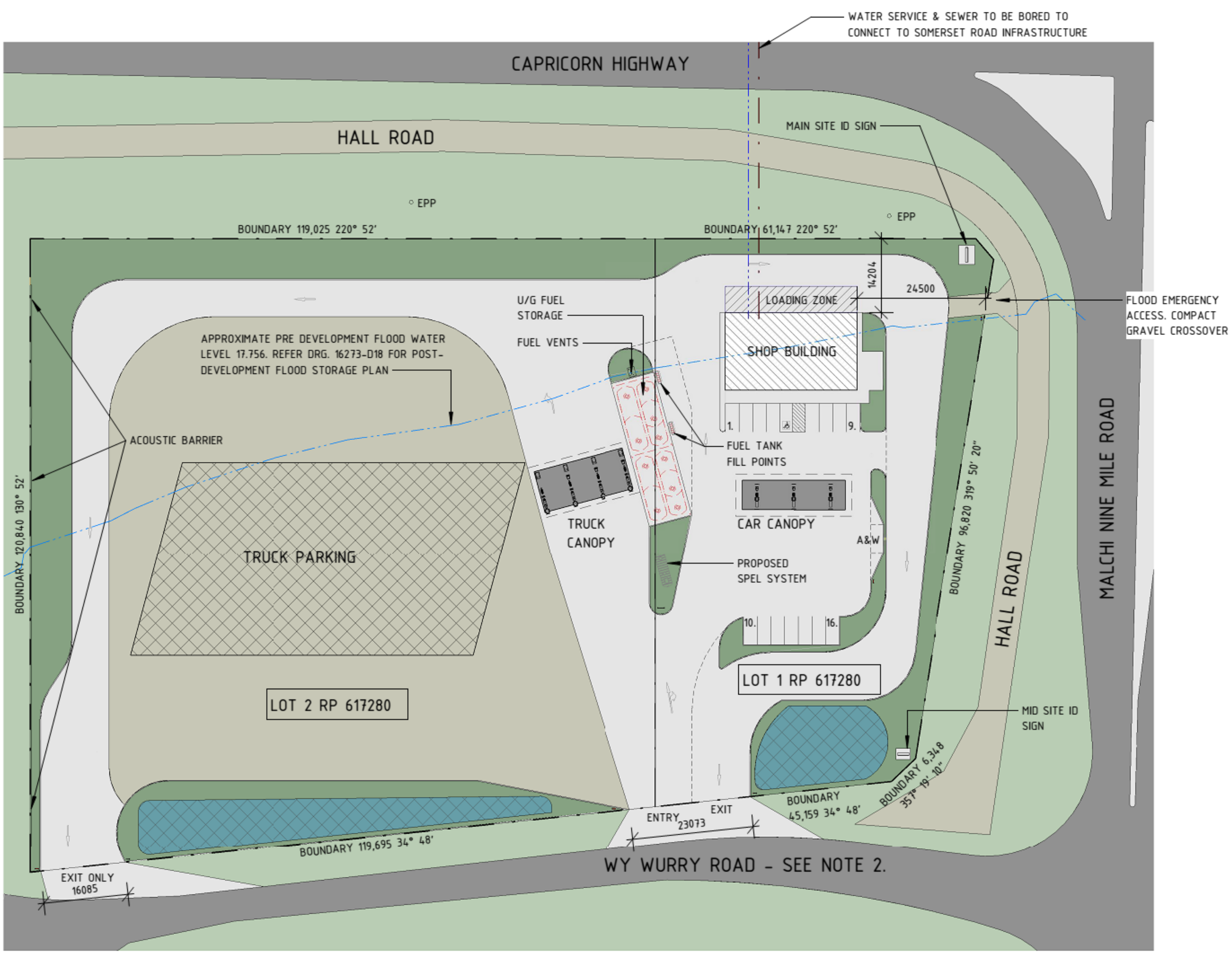
Sketch No. 1: Site Layout and Recommended Acoustic Treatments (Not to Scale).



ACOUSTIC TREATMENT LEGEND	
(red/white barrier symbol)	Recommended acoustic barrier height of 4m above finished ground level.
	Barriers are to be free of gaps and holes. Typical materials include earth berms, 19mm lapped timber fence (40% overlap), 9mm FC sheet, toughened glass, Perspex, masonry, or a combination of the above (a minimum surface mass of 11kg/m^2 is required).

APPENDIX B

Development Plans



PROPERTY DESCRIPTION

LOT 1 & 2 ON RP 617280
LGA: ROCKHAMPTON REGIONAL COUNCIL
LOT 1 AREA: 5,984m²
LOT 2 AREA: 13,630m²

N

NOTES

1. PRELIMINARY - NOT FOR TENDER OR CONSTRUCTION.
2. WY WURRY RD TO BE UPGRADED TO ACCOMMODATE B-DOUBLES AS PER TRAFFIC REPORT
3. LINEMARKING SHOWN INDICATIVE ONLY - SUBJECT TO CHANGE AT DETAIL DESIGN BY TRAFFIC ENGINEER.
4. CARPARKING & ROAD AISLES TO BE IN ACCORDANCE WITH AS2890.1 & AS2890.6.
5. STANDARD PARKING BAYS PROVIDED AT 5.4m x 2.6m WITH MINIMUM 6.6m AISLES.
6. DISABLED PARKING BAYS TO BE 5.4m x 2.4m WITH 5.4m x 2.4m SHARED BAY.
7. FOR STORMWATER TREATMENT AND DETENTION DETAILS, REFER ENGINEER'S REPORTS.
8. FOR ROAD WORKS EXTERNAL TO SITE BOUNDARY REFER TRAFFIC ENGINEER'S REPORT.

LEGEND

PP	POWER POLE
A&W	AIR & WATER POINT
	CONCRETE PAVEMENT
	LANDSCAPE
	COMPACT GRAVEL
	BIO-RETENTION SYSTEM
	CANOPY SLABS WITH BLACK OXIDE FINISH
	BOUNDARY
	SITE WATER SUPPLY
	SITE SEWER

SITE COVERAGE SCHEDULE

SHOP (FOOTPRINT):	293m²	1.5%
CAR CANOPY (FOOTPRINT):	110m²	0.6%
TRUCK CANOPY (FOOTPRINT):	96m²	0.5%
COMPACT GRAVEL:	7414m²	37%
CONCRETE PAVEMENT:	7432m²	38%
FOOTPATH:	133m²	0.8%
KERB:	122m²	0.6%
LANDSCAPE:	3037m²	16%
BIO-RETENTION:	912m²	5%
TOTAL AREA:	19,614m²	100%

PARKING SCHEDULE

DISABLED 2.4m x 5.4m	1
STANDARD 2.6m x 5.4m	15
AIR & WATER 2.4m x 5.4m	1
B-TRIPLE TRUCK 4.5m x 48m	9
B-DOUBLE TRUCK 4.5m x 26m	3
AV TRUCK 4.5m x 21m	2

5 0 10 20 30 40m
Metres

30/11/2017 12:04:16 PM

PROJECT MANAGERS | PLANNERS
DESIGNERS | ENGINEERS
TfA Project Group
Brisbane (Head office)
166 Knapp St
Fortitude Valley
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Melbourne
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REV	DATE	BY	DESCRIPTION	CHK
1	28.08.17	MG	DA ISSUE	DGC
A	30.11.17	MG	DA ISSUE	

PROJECT DETAILS
SERVICE STATION DEVELOPMENT for CORBETS GROUP
CNR CAPRICORN HWY & HALL ROAD, GRACEMERE, QLD

DRAWING TITLE
PROPOSED SITE PLAN

STATUS
DA ISSUE

DRAWN	APPROVED
MG	JG

DATE CREATED	A1 SCALE	A3 SCALE
15.08.17		1 : 750

DRAWING NO		REV
16273	D03	A

APPENDIX C

Measurement Results and Model Calculations / Predictions

Rockhampton, Queensland
June 2017 Daily Weather Observations

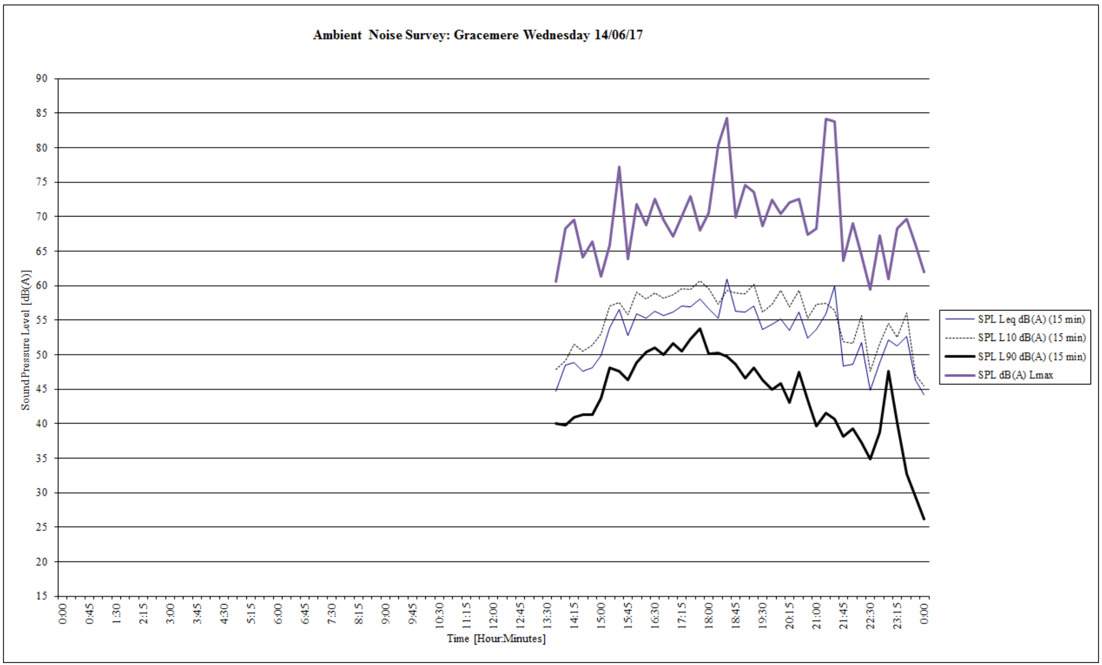
Australian Government
Bureau of Meteorology

Date	Day	Temps Min	Temps Max	Rain	Evap	Sun	Max wind gust Dirn	Max wind gust Spd	Max wind gust Time	9am Temp	9am RH	9am Cld	9am Dirn	9am Spd	9am MSLP	3pm Temp	3pm RH	3pm Cld	3pm Dirn	3pm Spd	3pm MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	eighths		km/h	hPa	°C	%	eighths		km/h	hPa
1	Th	9.3	23.1	0			ESE	33	15:22	14.7	47		S	9	1026.4	22.6	34		ESE	20	1022.9
2	Fr	12.6	24.6	0			SE	35	09:50	17.7	57		SE	20	1026.5	24.0	36		ESE	17	1022.9
3	Sa	10.9	24.2	0			ESE	31	11:05	18.0	55		SE	13	1025.2	23.7	31		SE	9	1021.4
4	Su	8.8	24.3	0			ESE	30	11:05	17.8	58		SSE	9	1023.4	23.9	37		E	13	1019.3
5	Mo	10.7	24.8	0			SE	33	10:49	19.4	61		SE	15	1023.0	24.2	40	1	ESE	13	1019.4
6	Tu	11.1	25.7	0			SW	30	14:25	16.9	79		SW	7	1022.5	25.1	30	1	WSW	17	1017.8
7	We	8.6	21.6	0			SSW	43	10:48	16.0	43		SW	9	1021.9	21.0	24		SW	22	1018.0
8	Th	6.3	22.0	0			SW	37	12:45	14.9	44		SW	17	1022.6	21.3	29		SW	17	1018.6
9	Fr	6.4	24.3	0			SE	22	14:22	16.0	51		SSW	9	1022.5	23.6	27		W	7	1019.1
10	Sa	7.9	25.1	0			ESE	20	11:04	13.3	78		SSW	6	1022.8	23.8	41	3	SE	11	1020.1
11	Su	13.2	22.3	0			SE	28	10:51	17.8	78	8	SE	13	1022.5	22.1	59	8	E	11	1019.3
12	Mo	15.7	25.2	1.2			SW	17	10:06	17.9	87	7	S	9	1021.2	24.2	49	8	S	7	1016.8
13	Tu	12.0	23.9	0			SSW	35	11:14	17.7	59		SW	9	1021.0	23.4	41		SSW	20	1018.2
14	We	12.9	25.2	0			SE	39	17:03	18.2	68	8	SW	7	1022.2	24.6	48		ESE	13	1019.3
15	Th	15.3	26.1	0			SE	30	10:18	19.1	73	7	SE	7	1022.2	25.8	45	1	ESE	15	1018.8
16	Fr	17.0	25.6	0			SE	28	10:26	20.5	71	8	SE	11	1020.9	25.2	53	8	S	11	1017.7
17	Sa	14.6	27.0	0.2			SE	20	09:57	19.9	81	5	S	7	1020.2	26.4	49		WSW	11	1016.0
18	Su	13.1	27.6	0			SW	31	13:50	19.6	76		SSW	7	1020.2	27.0	29		SSW	19	1016.9
19	Mo	11.4	26.3	0			SE	28	12:42	17.9	52		S	6	1021.8	25.6	31	2	SSE	11	1017.9
20	Tu	11.6	25.5	0			SE	33	11:19	19.0	63		S	6	1021.6	25.2	39		ESE	17	1018.2
21	We	11.1	24.8	0			SE	30	14:14	17.6	71		SSW	7	1023.4	24.4	34		ENE	9	1019.8
22	Th	9.0	25.6	0			SSE	28	11:26	17.9	59	4	S	6	1024.6	24.5	38		ESE	13	1020.4
23	Fr	15.7	26.0	0			SE	28	11:21	18.9	67	7	SE	13	1022.4	25.2	36	2	WSW	6	1017.7
24	Sa	10.1	26.4	0			NW	24	12:02	17.2	76		S	6	1019.7	25.8	34		NW	9	1016.0
25	Su	9.3	26.7	0			ESE	20	14:14	16.9	70		SSW	6	1019.8	25.9	30		NE	7	1016.9
26	Mo	10.6	26.2	0			ESE	22	15:24	18.3	80		S	9	1021.1	25.5	39		ESE	15	1018.7
27	Tu	12.8	25.3	0			ENE	33	14:09	17.0	96	8	SE	13	1023.2	24.6	48	2	ENE	17	1020.8
28	We	16.4	25.2	0			E	30	14:50	20.4	81		SE	13	1022.8	25.1	54		E	19	1020.5
29	Th	17.3	26.7	0			NNE	30	11:16	20.2	73	8	SE	17	1021.8	25.1	52	8	NNE	11	1018.1
30	Fr	16.4	24.5	0.2			SW	35	13:28	21.0	59	8	S	22	1021.6	23.6	47		SW	22	1019.0
Statistics for June 2017																					
	Mean	11.9	25.1							17.9	67	7		10	1022.4	24.4	39	4		13	1018.9
	Lowest	6.3	21.6							13.3	43	4	#	6	1019.7	21.0	24	1	WSW	6	1016.0
	Highest	17.3	27.6	1.2			SSW	43		21.0	96	8	S	22	1026.5	27.0	59	8	SW	22	1022.9
	Total			1.6																	

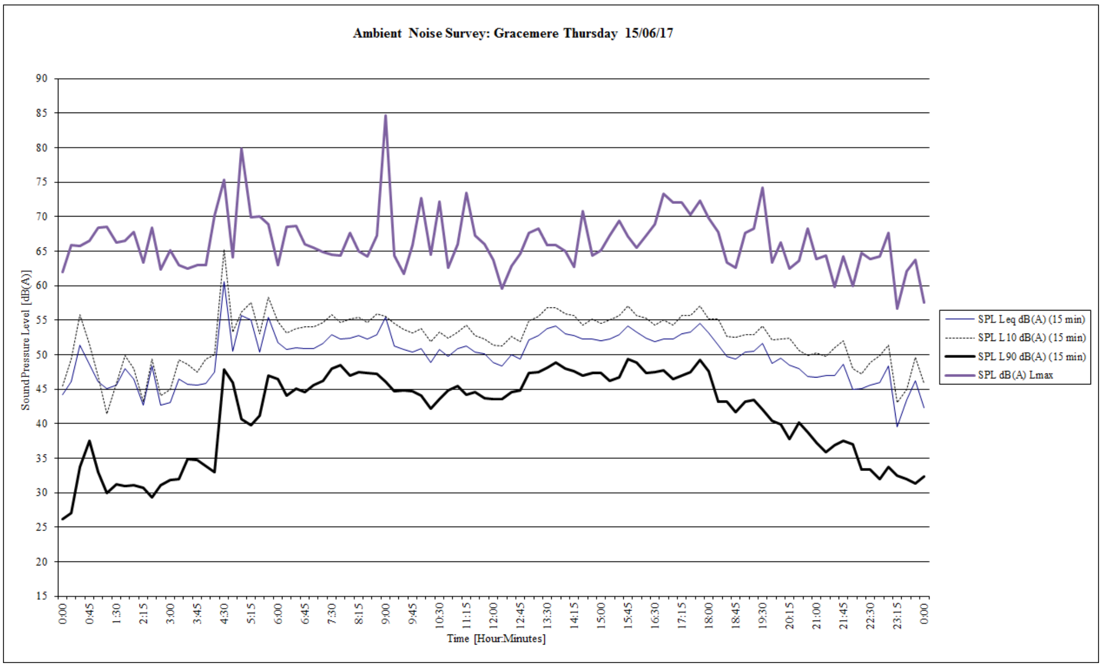
Observations were drawn from Rockhampton Aero {station 039083}

Some cloud observations are from automated equipment; these are somewhat different to those made by a human observer and may not appear every day.

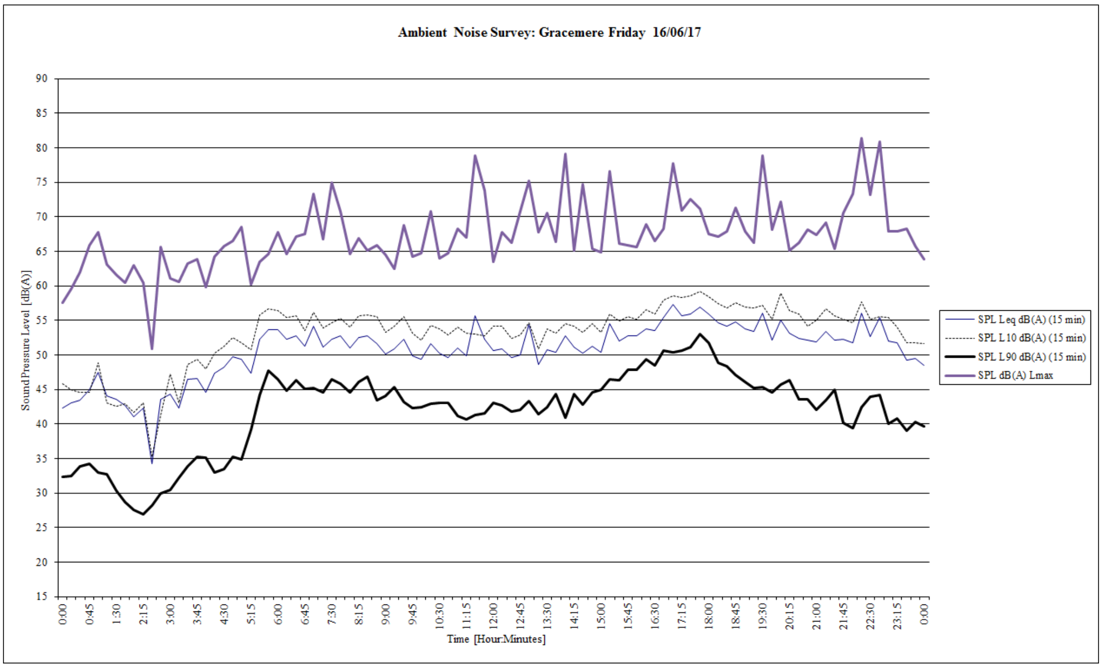
IDCJDW4102.201706 Prepared at 16:07 GMT on 2 Aug 2017



Ambient Noise Survey: Gracemere Wednesday 14/06/17
Sound Pressure Level [dB(A)]
Time [Hour:Minutes]
SPL Leq dB(A) (15 min)
SPL L10 dB(A) (15 min)
SPL L90 dB(A) (15 min)
SPL dB(A) Lmax



Ambient Noise Survey: Gracemere Thursday 15/06/17
Sound Pressure Level [dB(A)]
Time [Hour:Minutes]
SPL Leq dB(A) (15 min)
SPL L10 dB(A) (15 min)
SPL L90 dB(A) (15 min)
SPL dB(A) Lmax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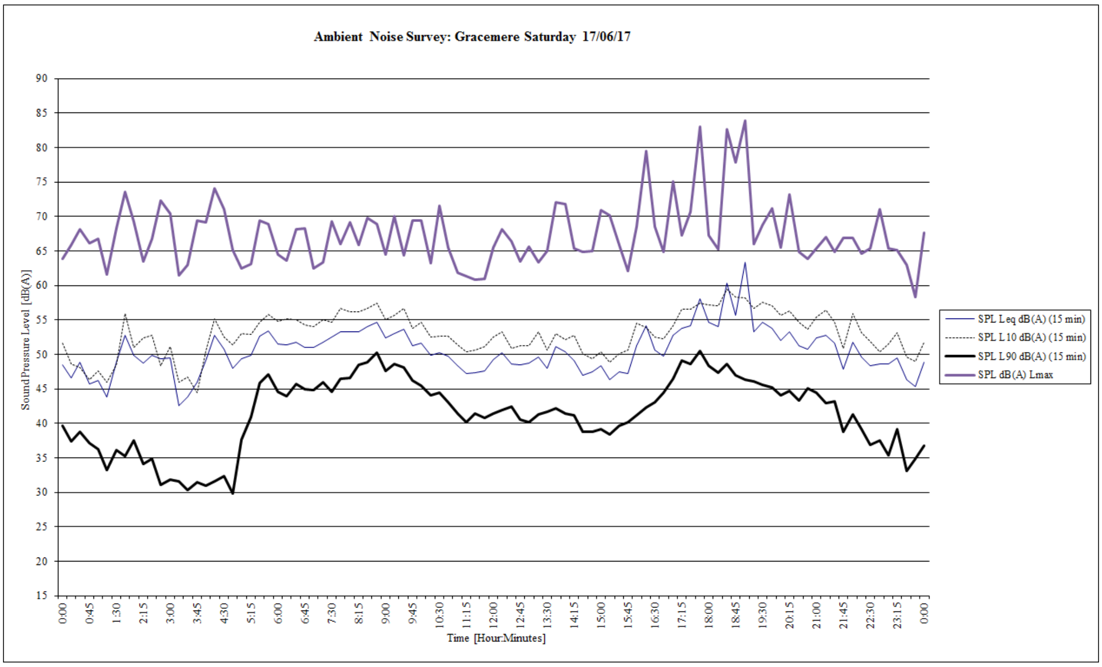
Sound Pressure Level [dB(A)]
Time [Hour:Minutes]
SPL Leq dB(A) (15 min)
SPL L10 dB(A) (15 min)
SPL L90 dB(A) (15 min)
SPL dB(A) Lmax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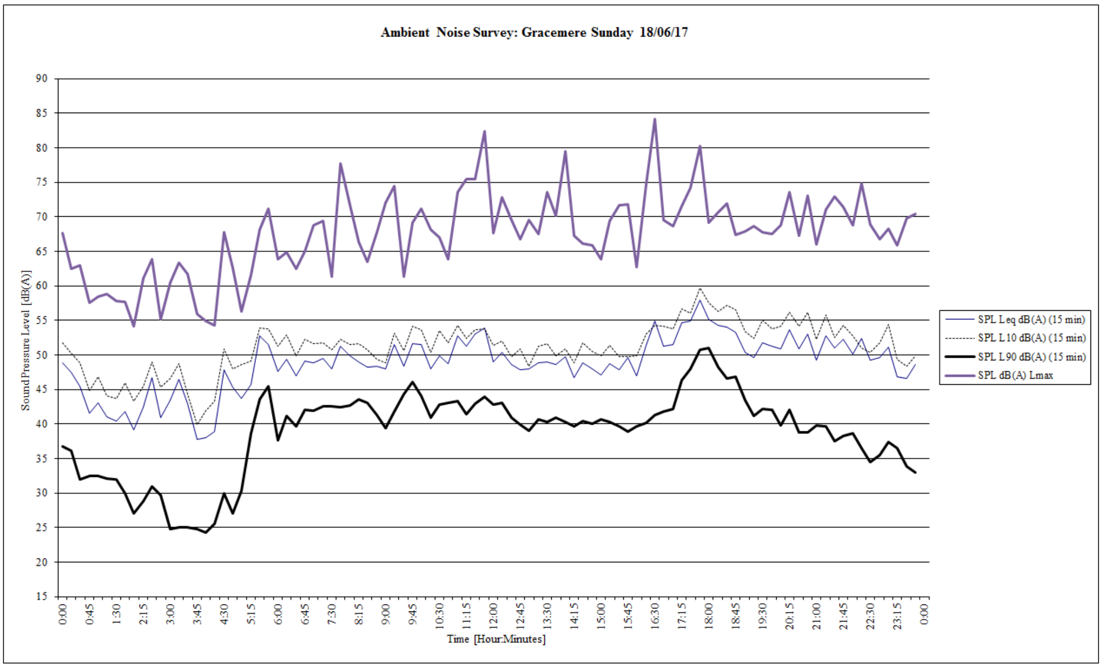
Sound Pressure Level [dB(A)]
Time [Hour:Minutes]
SPL Leq dB(A) (15 min)
SPL L10 dB(A) (15 min)
SPL L90 dB(A) (15 min)
SPL dB(A) Lmax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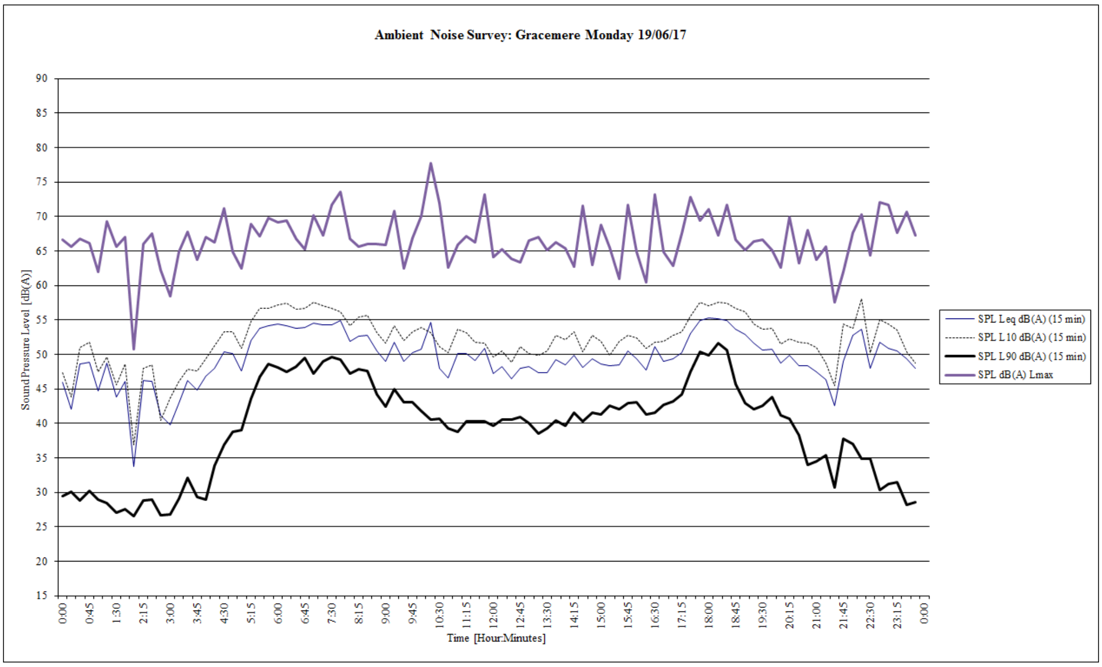
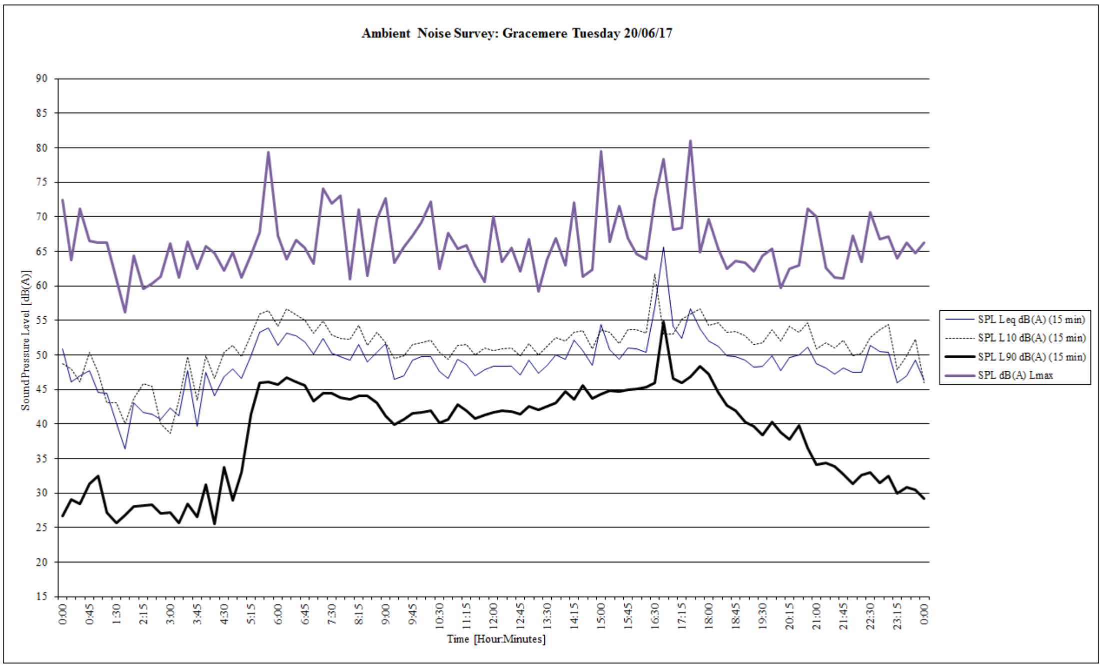
Sound Pressure Level [dB(A)]
Time [Hour:Minutes]
SPL Leq dB(A) (15 min)
SPL L10 dB(A) (15 min)
SPL L90 dB(A) (15 min)
SPL dB(A) Lmax


Ambient Noise Survey: Gracemere Monday 19/06/17
Sound Pressure Level [dB(A)]
Time [Hour:Minutes]
SPL Leq dB(A) (15 min)
SPL L10 dB(A) (15 min)
SPL L90 dB(A) (15 min)
SPL dB(A) Lmax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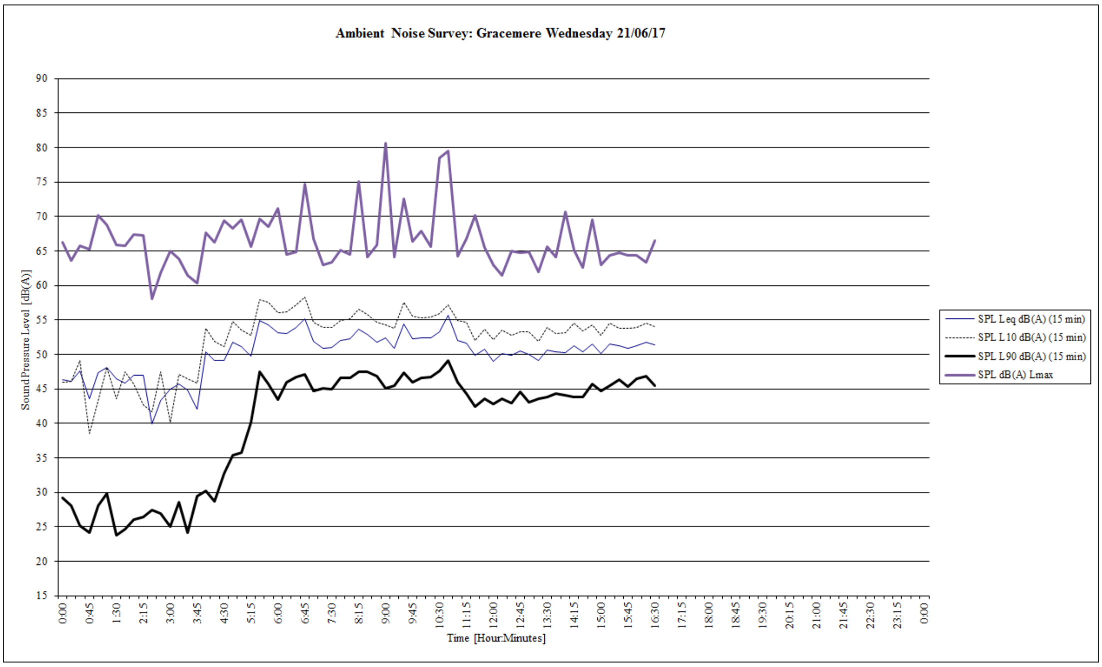
Sound Pressure Level [dB(A)]
Time [Hour:Minutes]
SPL Leq dB(A) (15 min)
SPL L10 dB(A) (15 min)
SPL L90 dB(A) (15 min)
SPL dB(A) Lmax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Sound Pressure Level [dB(A)]
Time [Hour:Minutes]
SPL Leq dB(A) (15 min)
SPL L10 dB(A) (15 min)
SPL L90 dB(A) (15 min)
SPL dB(A) Lmax

ONSITE ACTIVITY NOISE PREDICTION CALCULATIONS:

R1: Dwelling Northeast at 60 Hall Road (Lot 3 on RP617280)			**R2: Dwelling Southwest at 996 Capricorn Highway (Lot 11 on SP252**			**R3: Dwelling Southeast at 179 Somerset Road (Lot 1 on RP61616**		
Vehicle door closure at fuel dispenser	78	dB(A) @ 1m	Vehicle door closure at fuel dispenser	78	dB(A) @ 1m	Vehicle door closure at fuel dispenser	78	dB(A) @ 1m
Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)
Distance to receiver	175	m	Distance to receiver	415	m	Distance to receiver	360	m
Distance attenuation	-45	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-51	dB(A)
Acoustical screening	-14	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	27	dB(A)	Impact at façade	33	dB(A)	Impact at façade	34	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	19	dB(A)	Impact inside open windows	26	dB(A)	Impact inside open windows	27	dB(A)
Vehicle door closures at shopfront	78	dB(A) @ 1m	Vehicle door closures at shopfront	78	dB(A) @ 1m	Vehicle door closures at shopfront	78	dB(A) @ 1m
Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)
Distance to receiver	210	m	Distance to receiver	415	m	Distance to receiver	355	m
Distance attenuation	-46	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-51	dB(A)
Acoustical screening	-14	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	25	dB(A)	Impact at façade	33	dB(A)	Impact at façade	34	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	18	dB(A)	Impact inside open windows	26	dB(A)	Impact inside open windows	27	dB(A)
Vehicle door closures at air/water	78	dB(A) @ 1m	Vehicle door closures at air/water	78	dB(A) @ 1m	Vehicle door closures at air/water	78	dB(A) @ 1m
Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)
Distance to receiver	235	m	Distance to receiver	407	m	Distance to receiver	385	m
Distance attenuation	-47	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-52	dB(A)
Acoustical screening	-14	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	24	dB(A)	Impact at façade	33	dB(A)	Impact at façade	34	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	17	dB(A)	Impact inside open windows	26	dB(A)	Impact inside open windows	26	dB(A)
Car movement	77	dB(A) @ 1m	Car movement	77	dB(A) @ 1m	Car movement	77	dB(A) @ 1m
Tone / Impulse correction	0	dB(A)	Tone / Impulse correction	0	dB(A)	Tone / Impulse correction	0	dB(A)
Distance to receiver	195	m	Distance to receiver	400	m	Distance to receiver	300	m
Distance attenuation	-46	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-50	dB(A)
Acoustical screening	-14	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	20	dB(A)	Impact at façade	27	dB(A)	Impact at façade	30	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	12	dB(A)	Impact inside open windows	20	dB(A)	Impact inside open windows	22	dB(A)
Truck movement	88	dB(A) @ 1m	Truck movement	88	dB(A) @ 1m	Truck movement	88	dB(A) @ 1m
Tone / Impulse correction	0	dB(A)	Tone / Impulse correction	0	dB(A)	Tone / Impulse correction	0	dB(A)
Distance to receiver	80	m	Distance to receiver	400	m	Distance to receiver	240	m
Distance attenuation	-38	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-48	dB(A)
Acoustical screening	-8	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	44	dB(A)	Impact at façade	38	dB(A)	Impact at façade	43	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	37	dB(A)	Impact inside open windows	31	dB(A)	Impact inside open windows	35	dB(A)
Truck unloading at loading bay	78	dB(A) @ 1m	Truck unloading at loading bay	78	dB(A) @ 1m	Truck unloading at loading bay	78	dB(A) @ 1m
Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)
Distance to receiver	215	m	Distance to receiver	420	m	Distance to receiver	340	m
Distance attenuation	-47	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-51	dB(A)
Acoustical screening	-10	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	29	dB(A)	Impact at façade	33	dB(A)	Impact at façade	35	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	21	dB(A)	Impact inside open windows	26	dB(A)	Impact inside open windows	27	dB(A)

ONSITE ACTIVITY NOISE PREDICTION CALCULATIONS:

R1: Dwelling Northeast at 60 Hall Road (Lot 3 on RP617280)			**R2: Dwelling Southwest at 996 Capricorn Highway (Lot 11 on SP252**			**R3: Dwelling Southeast at 179 Somerset Road (Lot 1 on RP61616**		
Truck airbrake	88	dB(A) @ 1m	Truck airbrake	88	dB(A) @ 1m	Truck airbrake	88	dB(A) @ 1m
Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)
Distance to receiver	80	m	Distance to receiver	400	m	Distance to receiver	240	m
Distance attenuation	-38	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-48	dB(A)
Acoustical screening	-14	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	43	dB(A)	Impact at façade	43	dB(A)	Impact at façade	48	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	36	dB(A)	Impact inside open windows	36	dB(A)	Impact inside open windows	40	dB(A)
Air escape from tyre pressure check	82	dB(A) @ 1m	Air escape from tyre pressure check	82	dB(A) @ 1m	Air escape from tyre pressure check	82	dB(A) @ 1m
Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)
Distance to receiver	235	m	Distance to receiver	407	m	Distance to receiver	385	m
Distance attenuation	-47	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-52	dB(A)
Acoustical screening	-14	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	28	dB(A)	Impact at façade	37	dB(A)	Impact at façade	38	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	21	dB(A)	Impact inside open windows	30	dB(A)	Impact inside open windows	30	dB(A)
Tyre pressure gauge alarm	80	dB(A) @ 1m	Tyre pressure gauge alarm	80	dB(A) @ 1m	Tyre pressure gauge alarm	80	dB(A) @ 1m
Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)
Distance to receiver	235	m	Distance to receiver	407	m	Distance to receiver	385	m
Distance attenuation	-47	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-52	dB(A)
Acoustical screening	-14	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	26	dB(A)	Impact at façade	35	dB(A)	Impact at façade	36	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	19	dB(A)	Impact inside open windows	28	dB(A)	Impact inside open windows	28	dB(A)
Patrons dining at outdoor area	65	dB(A) @ 1m	Patrons dining at outdoor area	65	dB(A) @ 1m	Patrons dining at outdoor area	65	dB(A) @ 1m
Tone / Impulse correction	0	dB(A)	Tone / Impulse correction	0	dB(A)	Tone / Impulse correction	0	dB(A)
Distance to receiver	235	m	Distance to receiver	410	m	Distance to receiver	365	m
Distance attenuation	-47	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-51	dB(A)
Acoustical screening	-14	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	6	dB(A)	Impact at façade	15	dB(A)	Impact at façade	16	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	-1	dB(A)	Impact inside open windows	8	dB(A)	Impact inside open windows	9	dB(A)
Waste collection at loading bay	92	dB(A) @ 1m	Waste collection at loading bay	92	dB(A) @ 1m	Waste collection at loading bay	92	dB(A) @ 1m
Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)	Tone / Impulse correction	5	dB(A)
Distance to receiver	215	m	Distance to receiver	420	m	Distance to receiver	340	m
Distance attenuation	-47	dB(A)	Distance attenuation	-52	dB(A)	Distance attenuation	-51	dB(A)
Acoustical screening	-5	dB(A)	Acoustical screening	0	dB(A)	Acoustical screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	48	dB(A)	Impact at façade	47	dB(A)	Impact at façade	49	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open windows	40	dB(A)	Impact inside open windows	40	dB(A)	Impact inside open windows	41	dB(A)

ONSITE MECH PLANT NOISE PREDICTION CALCULATIONS:

R1: Dwelling Northeast at 60 Hall Road (Lot 3 on RP617280)			R2: Dwelling Southwest at 996 Capricorn Highway (Lot 11 on SP252			R3: Dwelling Southeast at 179 Somerset Road (Lot 1 on RP616167)		
Refrigeration unit	60	dB(A) @ 3m	Refrigeration unit	60	dB(A) @ 3m	Refrigeration unit	60	dB(A) @ 3m
Number of units	1	units	Number of units	1	units	Number of units	1	units
Total noise level	60	dB(A) @ 3m	Total noise level	60	dB(A) @ 3m	Total noise level	60	dB(A) @ 3m
Distance to receiver	215	m	Distance to receiver	420	m	Distance to receiver	345	m
Distance attenuation	-37	dB(A)	Distance attenuation	-43	dB(A)	Distance attenuation	-41	dB(A)
Building screening + barrier screening	-15	dB(A)	Building screening	-10	dB(A)	Building screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	10	dB(A)	Impact at façade	10	dB(A)	Impact at façade	21	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open window	3	dB(A)	Impact inside open window	2	dB(A)	Impact inside open window	14	dB(A)
A/C Units	53	dB(A) @ 3m	A/C Units	53	dB(A) @ 3m	A/C Units	53	dB(A) @ 3m
Number of units	2	units	Number of units	2	units	Number of units	2	units
Total noise level	56	dB(A) @ 3m	Total noise level	56	dB(A) @ 3m	Total noise level	56	dB(A) @ 3m
Distance to receiver	215	m	Distance to receiver	420	m	Distance to receiver	345	m
Distance attenuation	-37	dB(A)	Distance attenuation	-43	dB(A)	Distance attenuation	-41	dB(A)
Building screening + barrier screening	-15	dB(A)	Building screening	-10	dB(A)	Building screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	6	dB(A)	Impact at façade	6	dB(A)	Impact at façade	17	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open window	-1	dB(A)	Impact inside open window	-2	dB(A)	Impact inside open window	10	dB(A)
Air compressor	55	dB(A) @ 3m	Air compressor	55	dB(A) @ 3m	Air compressor	55	dB(A) @ 3m
Number of units	1	units	Number of units	1	units	Number of units	1	units
Total noise level	55	dB(A) @ 3m	Total noise level	55	dB(A) @ 3m	Total noise level	55	dB(A) @ 3m
Distance to receiver	215	m	Distance to receiver	420	m	Distance to receiver	345	m
Distance attenuation	-37	dB(A)	Distance attenuation	-43	dB(A)	Distance attenuation	-41	dB(A)
Building screening + barrier screening	-15	dB(A)	Building screening	-10	dB(A)	Building screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	5	dB(A)	Impact at façade	5	dB(A)	Impact at façade	16	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open window	-2	dB(A)	Impact inside open window	-3	dB(A)	Impact inside open window	9	dB(A)
Rooftop toilet exhaust	50	dB(A) @ 3m	Rooftop toilet exhaust	50	dB(A) @ 3m	Rooftop toilet exhaust	50	dB(A) @ 3m
Number of units	1	units	Number of units	1	units	Number of units	1	units
Total noise level	50	dB(A) @ 3m	Total noise level	50	dB(A) @ 3m	Total noise level	50	dB(A) @ 3m
Distance to receiver	215	m	Distance to receiver	420	m	Distance to receiver	345	m
Distance attenuation	-37	dB(A)	Distance attenuation	-43	dB(A)	Distance attenuation	-41	dB(A)
Building screening + barrier screening	-15	dB(A)	Building screening	-10	dB(A)	Building screening	0	dB(A)
Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)	Façade reflection	2.5	dB(A)
Impact at façade	0	dB(A)	Impact at façade	0	dB(A)	Impact at façade	11	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Impact inside open window	-7	dB(A)	Impact inside open window	-8	dB(A)	Impact inside open window	4	dB(A)
Combined impact at façade	13	dB(A)	Combined impact at façade	12	dB(A)	Combined impact at façade	24	dB(A)
Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)	Reduction through open window	-7.5	dB(A)
Combined impact inside open window	5	dB(A)	Combined impact inside open window	5	dB(A)	Combined impact inside open window	16	dB(A)