APPENDIX 12.3

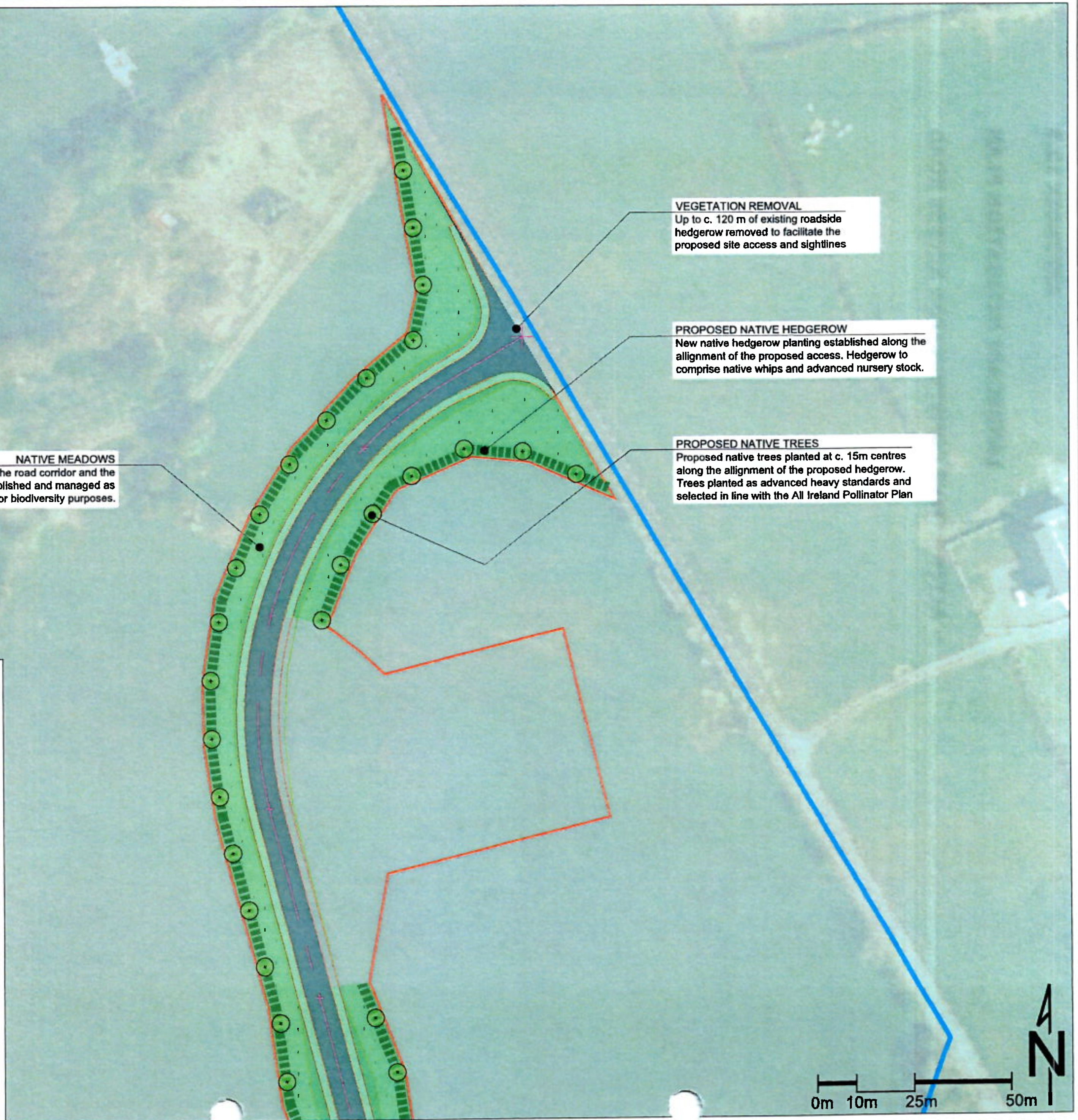
LANDSCAPE MITIGATION PLAN

– ALTERNATIVE CONSTRUCTION ACCESS ROAD

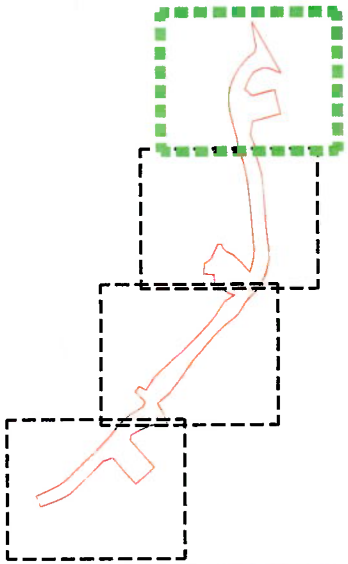
NATIVE HEDGEROW SPECIES:

Planted as a triple staggered row at 600mm centres 50% of the primary structure to be planted as 8-10cm g standard trees

Botanical name	Common name	Size	%
Primary structure:			
Crataegus monogyna	Hawthorn	1+2tr 90-120cm / 10-12cm girth 3m br standard trees	60%
Secondary structure:			
Prunus spinosa	Blackthorn	1+2tr 90-120cm	15%
Ilex aquifolium	Holly	1+2tr 90-120cm	15%
Shrub species structure:			
Rubus fruticosus	Bramble	1+1tr 60-90cm	2.5%
Corylus avellana	Hazel	1+1tr 60-90cm	2.5%
Rosa canina	Dog-rose	1+1tr 60-90cm	2.5%
Euonymus europaeus	Spindle	1+1tr 60-90cm	2.5%



CONTEXT MAP:



Registered Landscape Architect

macroworks

LEGEND

- PROPOSED NATIVE TREES
- PROPOSED NATIVE HEDGEROW
- PROPOSED NATIVE MEADOW
- SITE BOUNDARY
- OWNERSHIP BOUNDARY

NOTES

It is imperative to use native Irish species in so far as possible as they are adapted to Irish conditions and therefore more likely to thrive compared to imported stock. Selected species should also represent woodland and hedgerows in the surrounding environs although non-native species are not to be used, unless otherwise agreed with the Planning Authority.

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REVISIONS

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Prepared by
MACRO WORKS,
HIBERNIA HOUSE,
CHERRYWOOD BUSINESS PARK,
LOUGHLINSTOWN, DUBLIN 18
00353 (01) 2363500
info@macroworks.ie

Site location
COOLPOWRA, COUNTY GALWAY

Drawing Title
LANDSCAPE PLAN

Project
COOLPOWRA ACCESS ROAD

Drawn by: CD
Checked by: RB

Drawing Ref: LD.CLPWRA_ACCESS 1.1

Scale: 1:500 @ A1
Date: DECEMBER 2025

ISSUED

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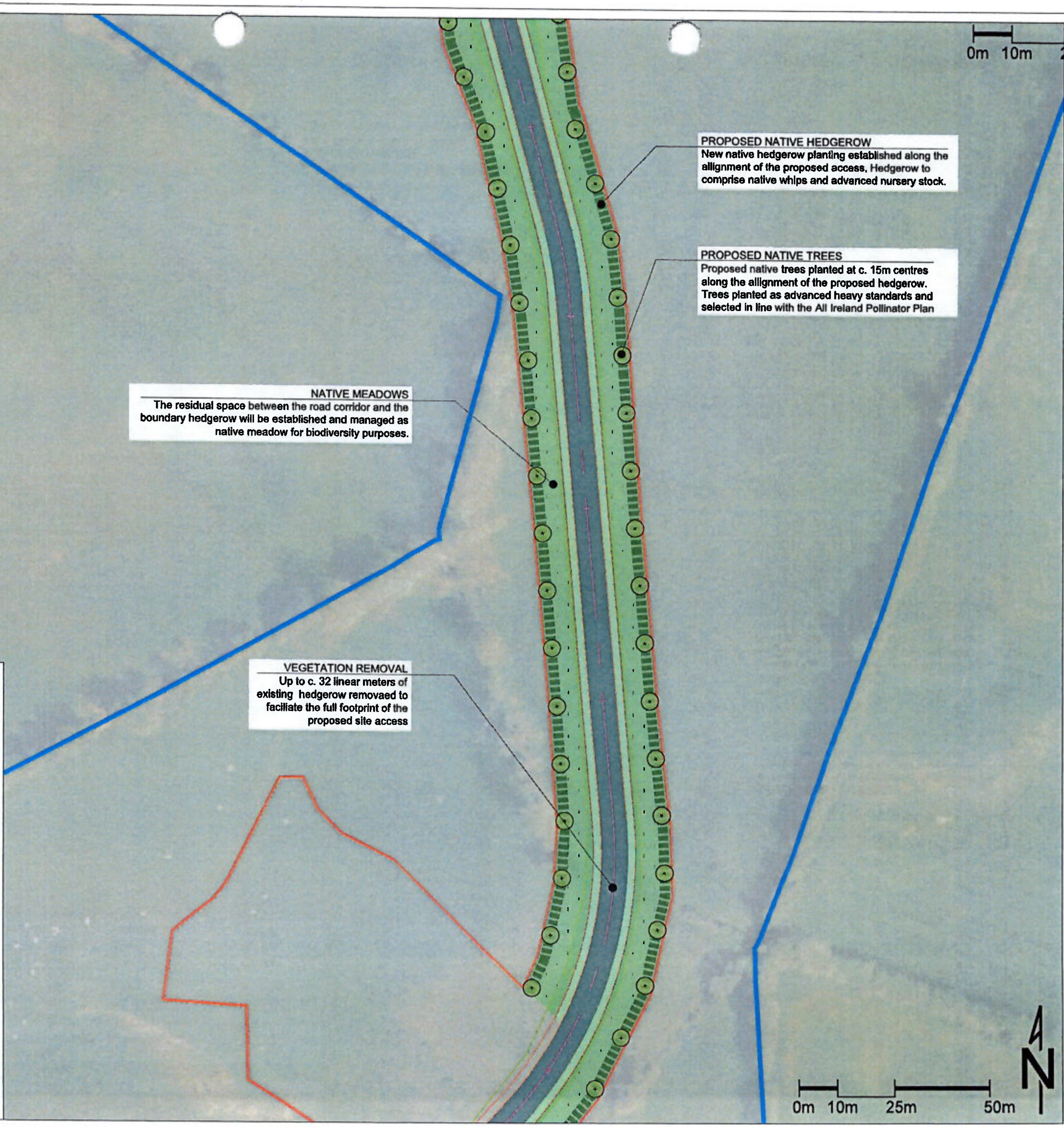

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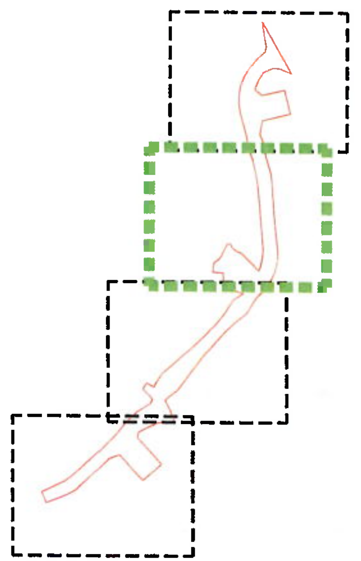

Registered Landscape Architect

macroworks

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Site location
COOLPOWRA, COUNTY GALWAY

Drawing Title
LANDSCAPE PLAN

Project
COOLPOWRA ACCESS ROAD

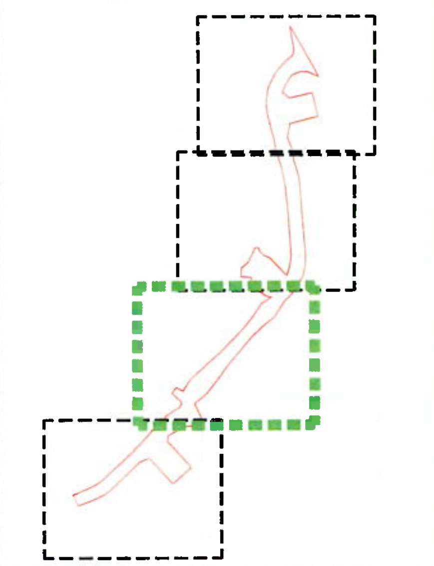
Drawn by: CD
Checked by: RB

Drawing Ref: LD.CLPWRA_ACCESS 1.2

Scale: 1:500 @ A1
Date: DECEMBER 2025

ISSUED

CONTEXT MAP:



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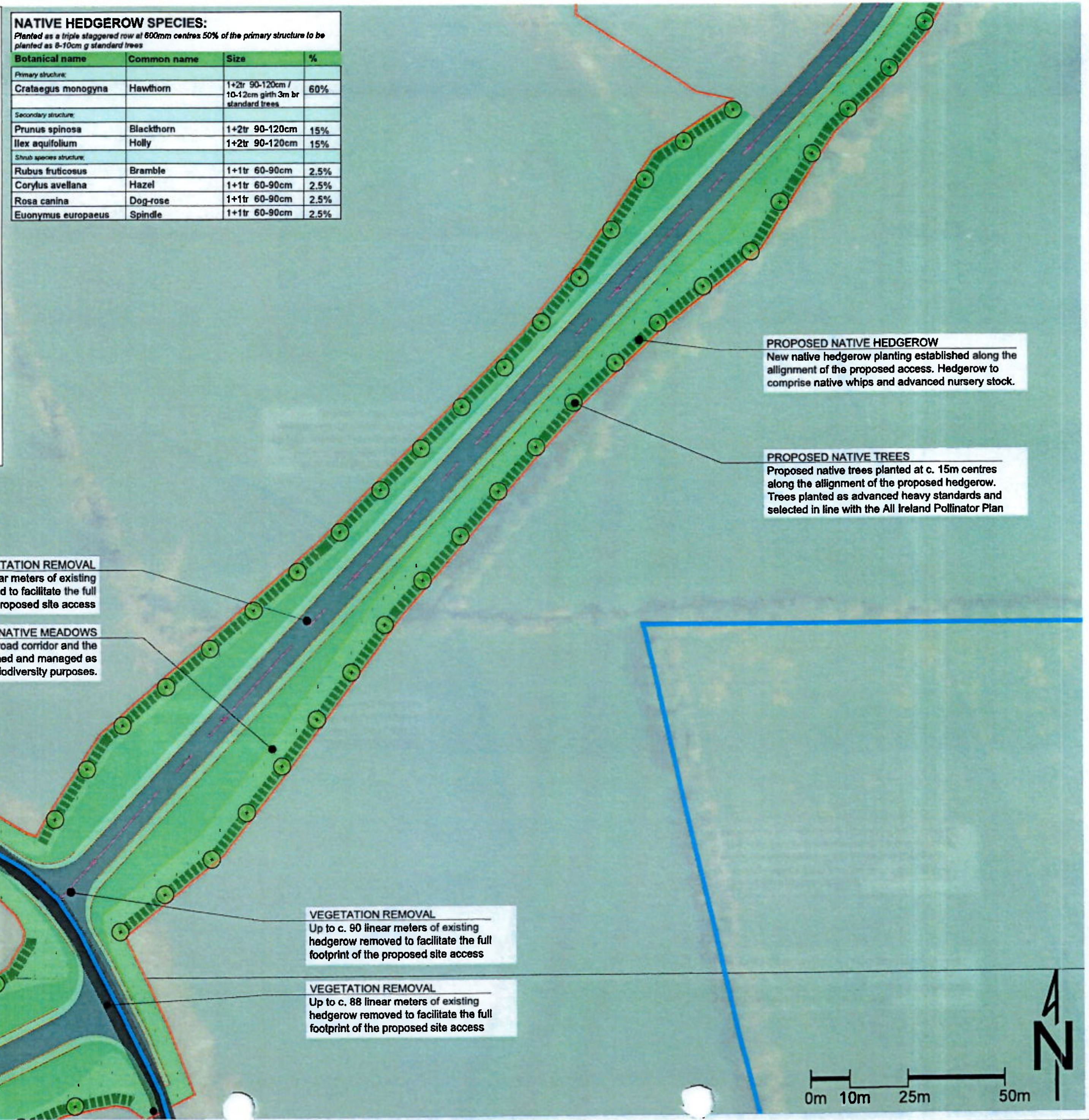

Registered Landscape Architect

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Site location
COOLPOWRA, COUNTY GALWAY

Drawing Title
LANDSCAPE PLAN

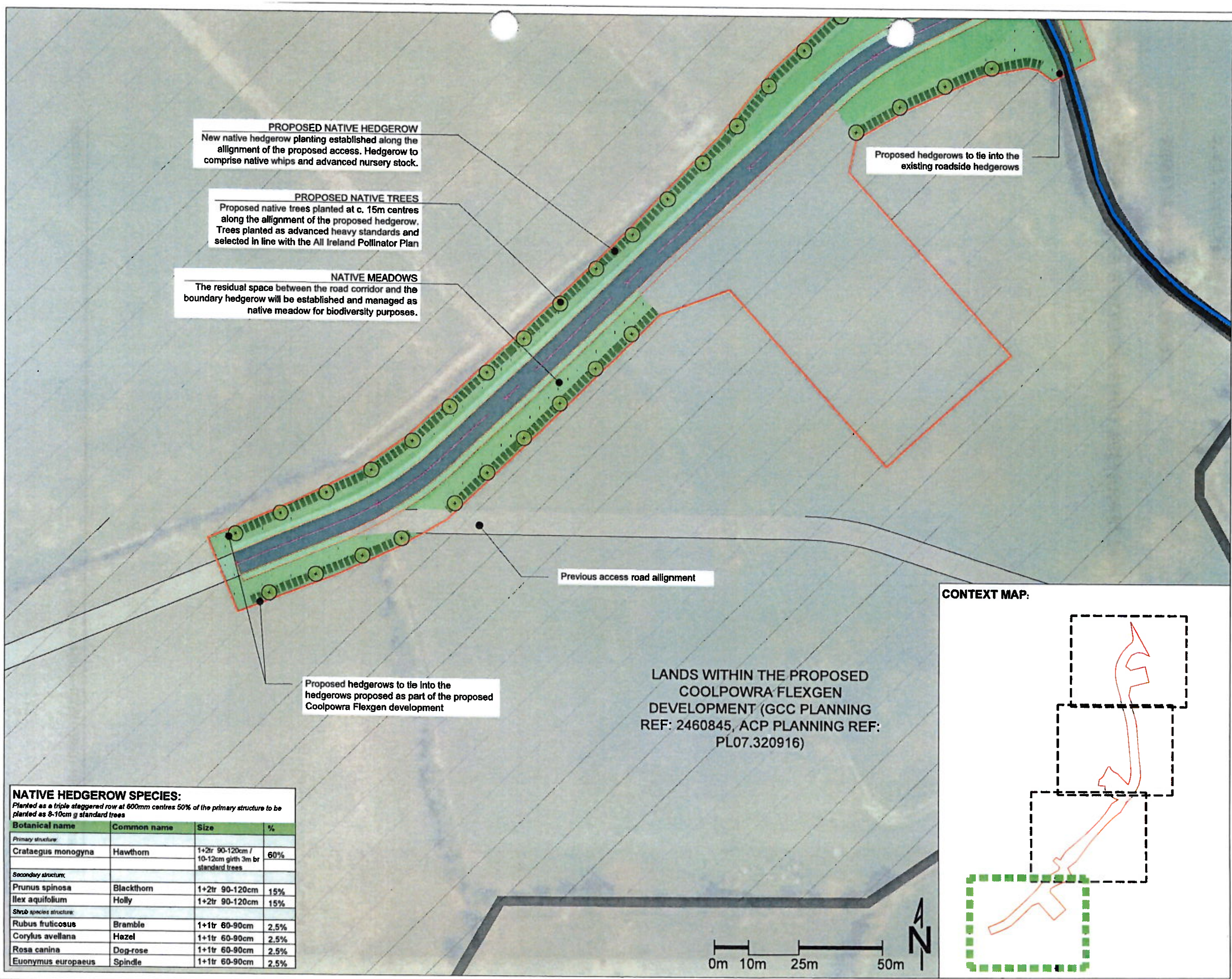
Project
COOLPOWRA ACCESS ROAD

Drawn by: CG
Checked by: RB

Drawing Ref: LD.CLPWRA_ACCESS 1.3

Scale: 1:500 @ A1
Date: DECEMBER 2025

ISSUED



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Registered Landscape Architect

macroworks

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Site location: COOLPOWRA, COUNTY GALWAY

Drawing Title: LANDSCAPE PLAN

Project: COOLPOWRA ACCESS ROAD

Drawn by: CD | Checked by: RB

Drawing Ref: LD.CLPWRA_ACCESS 1.4

Scale: 1:500 @A1 | Date: DECEMBER 2025

ISSUED

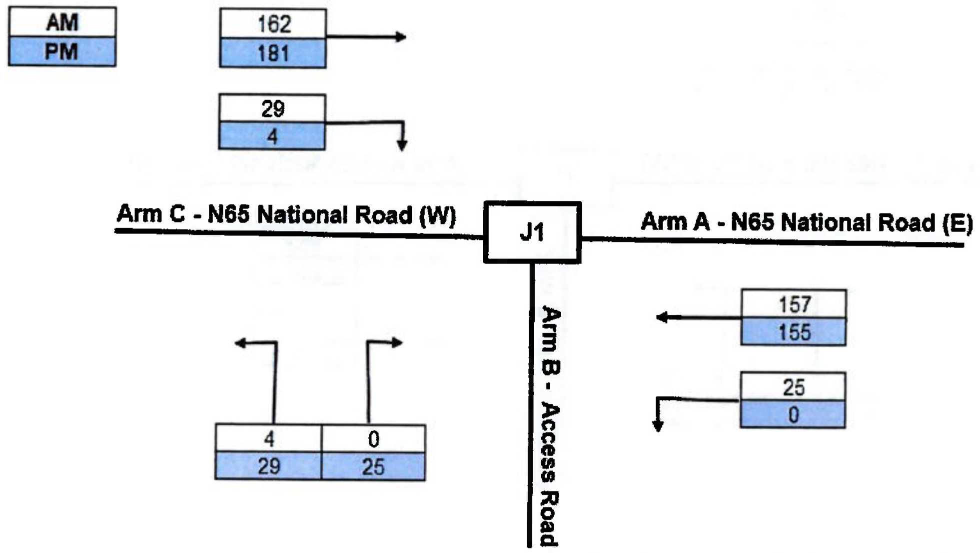
APPENDIX 13.6

TRAFFIC CALCULATIONS

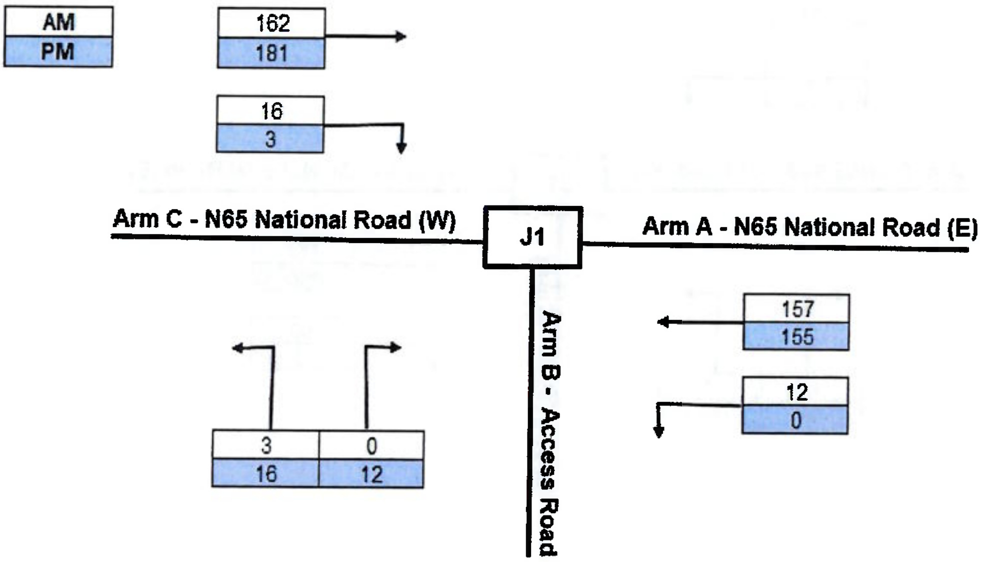
– ALTERNATIVE CONSTRUCTION ACCESS ROAD

N65 National Road/Access Road New Priority T-Junction

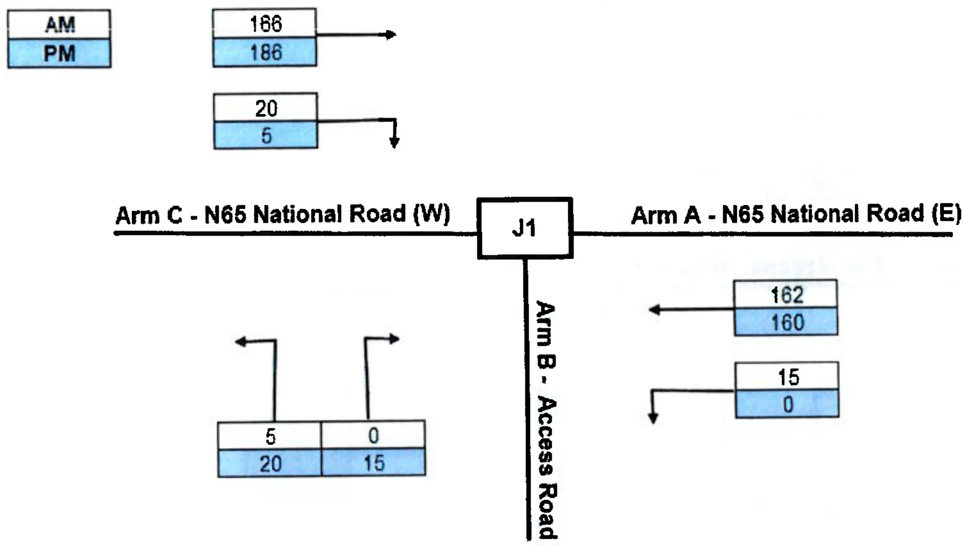
2027 - Traffic Data - Generator Construction



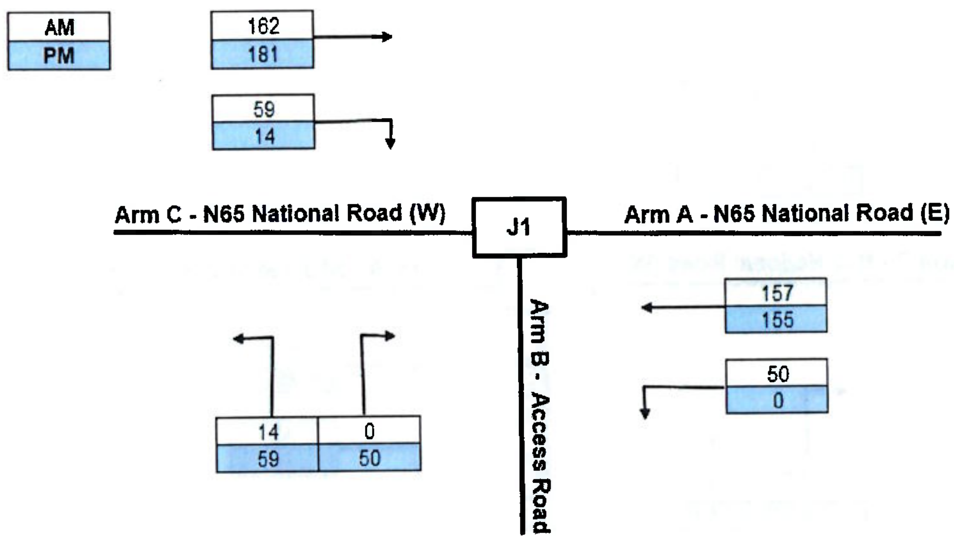
2027 - Traffic Data - GIS Construction



2028 - Traffic Data - ESS Construction

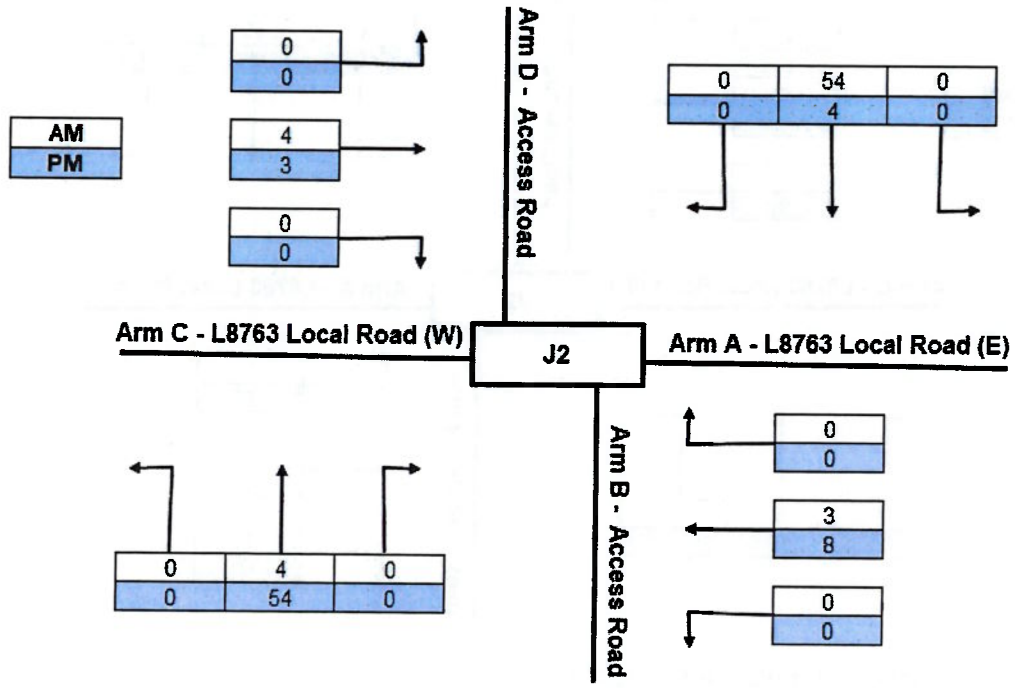


2027 - Traffic Data - Cumulative Construction



L8763 Local Road/Access Road New Priority Crossroad Junction

2027 - Traffic Data - Generator Construction



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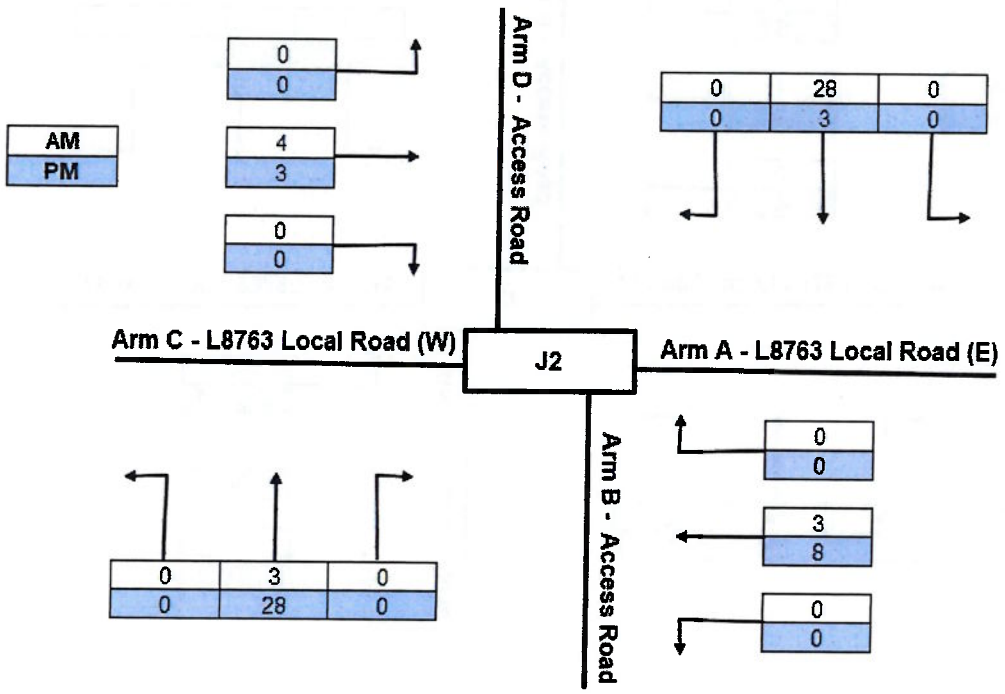
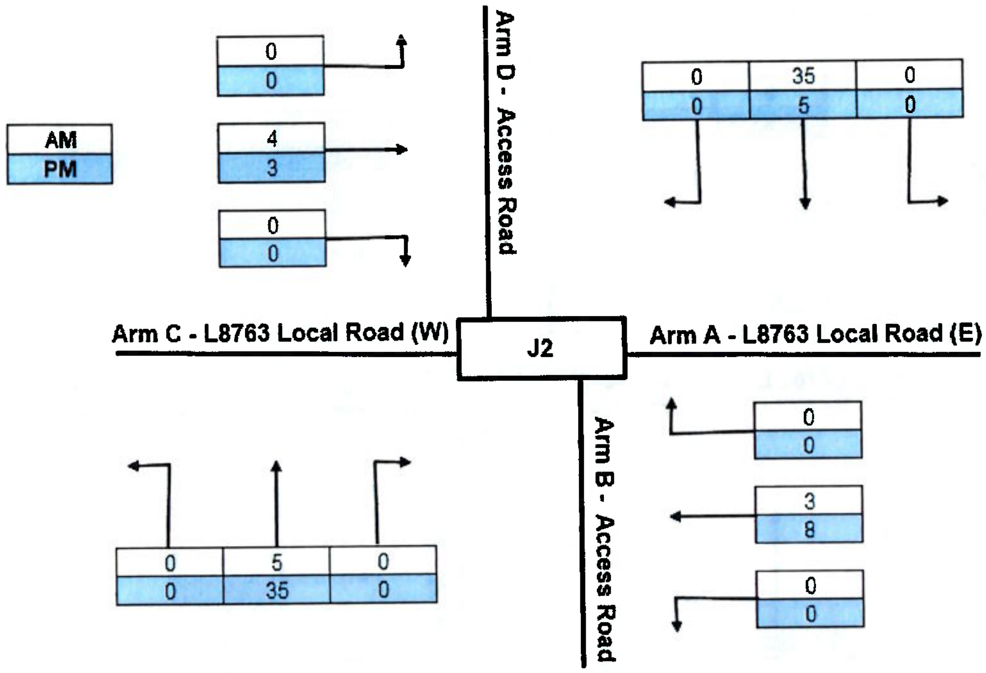
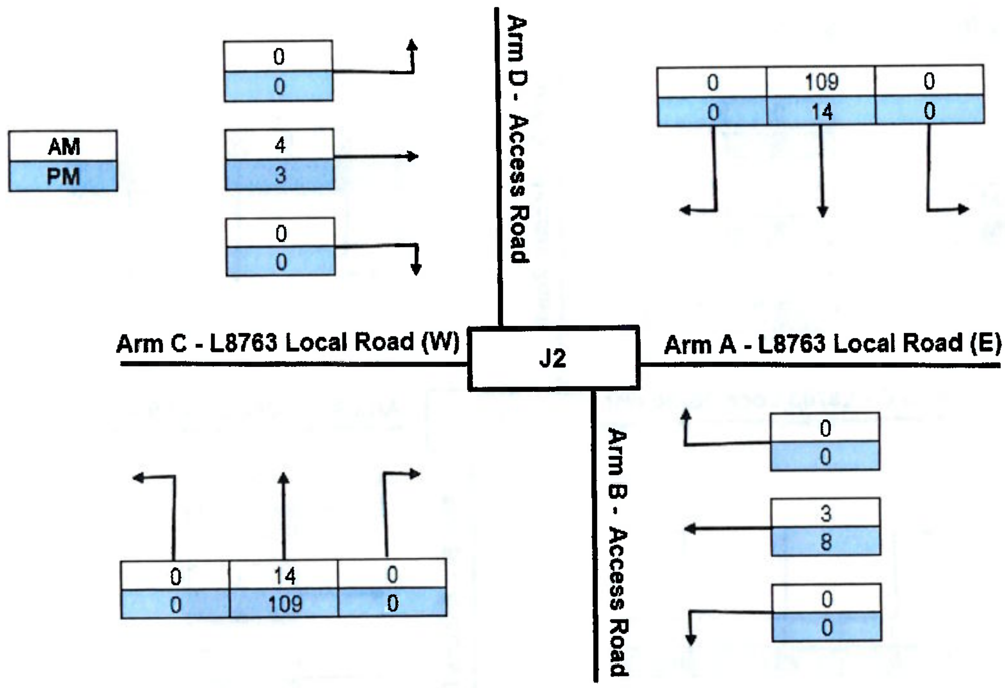


2028 - Traffic Data - ESS Construction



2027 - Traffic Data - Cumulative Construction



APPENDIX 13.7

PICADY ANALYSIS

– ALTERNATIVE CONSTRUCTION ACCESS ROAD

Junctions 11

PICADY 11 - Priority Intersection Module

Filename: Junction 1.j11
Path: T:\01 Trasky\06 Trasky Projects\2025\500582 - Coolpowra SID Energy Project - Road Design & Traffic Services\07 Calculations\02 Traffic Analysis
Report generation date: 14/11/2025 11:22:21

Summary of junction performance

	AM									PM								
	Set ID	Queue (PCU)	95% Queue (PCU)	Delay (s)	RFC	LOS	Junction Delay (s)	Junction LOS	Network Residual Capacity	Set ID	Queue (PCU)	95% Queue (PCU)	Delay (s)	RFC	LOS	Junction Delay (s)	Junction LOS	Network Residual Capacity
	2027 - Generator Construction																	
Stream B-AC	D1	0.0	~1	0.00	0.00	A	0.52	A	671 % [Stream C-AB]	D5	0.1	0.6	8.33	0.09	A	1.02	A	310 % [Stream B-AC]
Stream C-AB		0.1	0.6	6.62	0.05	A					0.0	0.5	6.36	0.01	A			
	2027 - GIS Construction																	
Stream B-AC	D2	0.0	~1	0.00	0.00	A	0.31	A	900 % ▯	D6	0.1	0.6	7.69	0.05	A	0.64	A	401 % [Stream B-AC]
Stream C-AB		0.0	0.5	6.46	0.03	A					0.0	0.5	6.36	0.01	A			
	2028 - ESS Construction																	
Stream B-AC	D3	0.0	0.5	6.41	0.01	A	0.45	A	793 % [Stream C-AB]	D7	0.1	0.6	7.84	0.07	A	0.79	A	359 % [Stream B-AC]
Stream C-AB		0.0	0.5	6.53	0.03	A					0.0	0.5	6.38	0.01	A			
	2027 - Cumulative Construction																	
Stream B-AC	D4	0.0	0.5	6.54	0.02	A	1.11	A	415 % [Stream C-AB]	D8	0.3	1.5	9.39	0.21	A	2.43	A	170 % [Stream B-AC]
Stream C-AB		0.1	0.6	6.93	0.10	A					0.0	0.5	6.42	0.02	A			

There are warnings associated with one or more model runs - see the 'Data Errors and Warnings' tables for each Analysis or Demand Set

Values shown are the highest values encountered over all time segments. Delay is the maximum value of average delay per arriving vehicle. Junction LOS and Junction Delay are demand-weighted averages. Network Residual Capacity indicates the amount by which network flow could be increased before a user-definable threshold (see Analysis Options) is met.

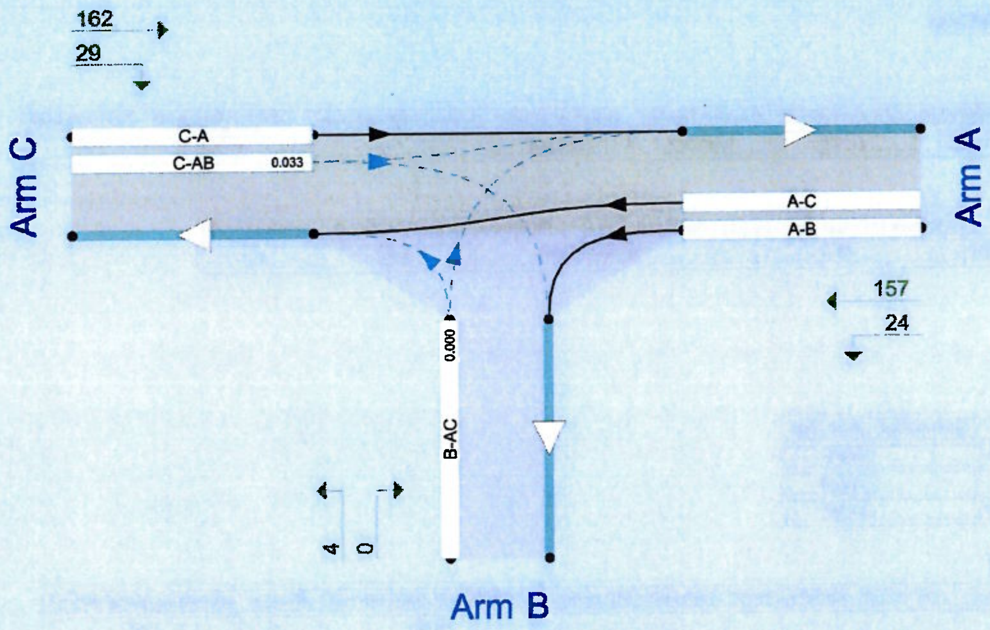
File summary

File Description

Title	Junction 1
Location	N65 National Road
Site number	1
Date	10/11/2025
Version	
Status	
Identifier	
Client	
Jobnumber	
Enumerator	DESKTOP-GDBF06V\jason
Description	

Units

Distance units	Speed units	Traffic units input	Traffic units results	Flow units	Average delay units	Total delay units	Rate of delay units
m	kph	PCU	PCU	perHour	s	-Min	perMin



Flows show original traffic demand (PCU/hr)
Streams (downstream end) show RFC ()

The junction diagram reflects the last run of Junctions.

Analysis Options

PICADY short flare model	Vehicle length (m)	Calculate Queue Percentiles	Calculate detailed queueing delay	Show lane queues in feet / metres	Show all PICADY stream intercepts	Calculate residual capacity	Residual capacity criteria type	RFC Threshold	Average Delay threshold (s)	Queue threshold (PCU)	Use simulation for HCM roundabouts	Use iterations for HCM roundabouts
JUNCTIONS 11.1	5.75	✓				✓	Delay	0.85	36.00	20.00		

Demand Set Summary

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D1	2027	Generator Construction	AM	ONE HOUR	08:15	09:45	15	✓
D2	2027	GIS Construction	AM	ONE HOUR	08:15	09:45	15	✓
D3	2028	ESS Construction	AM	ONE HOUR	08:15	09:45	15	✓
D4	2027	Cumulative Construction	AM	ONE HOUR	08:15	09:45	15	✓
D5	2027	Generator Construction	PM	ONE HOUR	17:00	18:30	15	✓
D6	2027	GIS Construction	PM	ONE HOUR	17:00	18:30	15	✓
D7	2028	ESS Construction	PM	ONE HOUR	17:00	18:30	15	✓
D8	2027	Cumulative Construction	PM	ONE HOUR	17:00	18:30	15	✓

Analysis Set Details

ID	Include in report	Network flow scaling factor (%)	Network capacity scaling factor (%)
A1	✓	100.000	100.000

D1 - 2027 | Generator Construction | AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	Junction 1	T-Junction	Two-way	Two-way	Two-way		0.52	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	671	Stream C-AB	0.52	A

Arms

Arms

Arm	Name	Description	Arm type
A	N65 National Road (E)		Major
B	Access Road		Minor
C	N65 National Road (W)		Major

Major Arm Geometry

Arm	Width of carriageway (m)	Has kerbed central reserve	Has right-turn storage	Visibility for right turn (m)	Blocks?	Blocking queue (PCU)
C	6.00			215.0	✓	1.00

Geometries for Arm C are measured opposite Arm B. Geometries for Arm A (if relevant) are measured opposite Arm D.

Minor Arm Geometry

Arm	Minor arm type	Lane width (m)	Visibility to left (m)	Visibility to right (m)
B	One lane	3.50	70	70

Slope / Intercept / Capacity

Priority Intersection Slopes and Intercepts

Stream	Intercept (PCU/hr)	Slope for A-B	Slope for A-C	Slope for C-A	Slope for C-B
B-A	562	0.102	0.259	0.163	0.370
B-C	701	0.108	0.272	-	-
C-B	698	0.271	0.271	-	-

The slopes and intercepts shown above include custom intercept adjustments only.
Streams may be combined, in which case capacity will be adjusted.
Values are shown for the first time segment only; they may differ for subsequent time segments.

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D1	2027	Generator Construction	AM	ONE HOUR	08:15	09:45	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	181	100.000
B		ONE HOUR	✓	4	100.000
C		ONE HOUR	✓	191	100.000

Origin-Destination Data

Demand (PCU/hr)

		To		
		A	B	C
From	A	0	24	157
	B	0	0	4
	C	162	29	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To		
		A	B	C
From	A	10	15	10
	B	15	10	15
	C	10	15	10

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-AC	0.00	0.00	0.0	~1	A	0	0
C-AB	0.05	6.62	0.1	0.6	A	27	41
C-A						148	222
A-B						22	33
A-C						144	216

Main Results for each time segment

08:15 - 08:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	573	0.000	0	0.0	0.0	0.000	A
C-AB	22	6	0.00	668	0.033	22	0.0	0.0	6.404	A
C-A	122	30	0.00			122				
A-B	18	5	0.00			18				
A-C	118	30	0.00			118				

08:30 - 08:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	563	0.000	0	0.0	0.0	0.000	A
C-AB	26	7	0.00	663	0.040	26	0.0	0.0	6.496	A
C-A	145	36	0.00			145				
A-B	22	5	0.00			22				
A-C	141	35	0.00			141				

08:45 - 09:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	549	0.000	0	0.0	0.0	0.000	A
C-AB	33	8	0.00	658	0.050	33	0.0	0.1	6.616	A
C-A	178	44	0.00			178				
A-B	26	7	0.00			26				
A-C	173	43	0.00			173				

09:00 - 09:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	549	0.000	0	0.0	0.0	0.000	A
C-AB	33	8	0.00	658	0.050	33	0.1	0.1	6.616	A
C-A	178	44	0.00			178				
A-B	26	7	0.00			26				
A-C	173	43	0.00			173				

09:15 - 09:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	563	0.000	0	0.0	0.0	0.000	A
C-AB	26	7	0.00	663	0.040	26	0.1	0.0	6.499	A
C-A	145	36	0.00			145				
A-B	22	5	0.00			22				
A-C	141	35	0.00			141				

09:30 - 09:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	573	0.000	0	0.0	0.0	0.000	A
C-AB	22	6	0.00	668	0.033	22	0.0	0.0	6.410	A
C-A	122	30	0.00			122				
A-B	18	5	0.00			18				
A-C	118	30	0.00			118				

Queue Variation Results for each time segment

08:15 - 08:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.04	0.00	0.00	0.04	0.04			N/A	N/A

08:30 - 08:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.05	0.03	0.29	0.52	0.55			N/A	N/A

08:45 - 09:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.06	0.03	0.30	0.53	0.56			N/A	N/A

09:00 - 09:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.06	0.00	0.00	0.06	0.06			N/A	N/A

09:15 - 09:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.05	0.00	0.00	0.05	0.05			N/A	N/A

09:30 - 09:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.04	0.00	0.00	0.04	0.04			N/A	N/A

D2 - 2027 | GIS Construction | AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	Junction 1	T-Junction	Two-way	Two-way	Two-way		0.31	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	900		0.31	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D2	2027	GIS Construction	AM	ONE HOUR	08:15	09:45	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	159	100.000
B		ONE HOUR	✓	3	100.000
C		ONE HOUR	✓	178	100.000

Origin-Destination Data

Demand (PCU/hr)

		To		
		A	B	C
From	A	0	12	147
	B	0	0	3
	C	162	16	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To		
		A	B	C
From	A	10	15	10
	B	15	10	15
	C	10	15	10

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-AC	0.00	0.00	0.0	~1	A	0	0
C-AB	0.03	6.46	0.0	0.5	A	15	22
C-A						149	223
A-B						11	17
A-C						135	202

Main Results for each time segment

08:15 - 08:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	578	0.000	0	0.0	0.0	0.000	A
C-AB	12	3	0.00	670	0.018	12	0.0	0.0	6.292	A
C-A	122	30	0.00			122				
A-B	9	2	0.00			9				
A-C	111	28	0.00			111				

08:30 - 08:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	569	0.000	0	0.0	0.0	0.000	A
C-AB	14	4	0.00	665	0.022	14	0.0	0.0	6.361	A
C-A	146	36	0.00			146				
A-B	11	3	0.00			11				
A-C	132	33	0.00			132				

08:45 - 09:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	557	0.000	0	0.0	0.0	0.000	A
C-AB	18	4	0.00	659	0.027	18	0.0	0.0	6.454	A
C-A	178	45	0.00			178				
A-B	13	3	0.00			13				
A-C	162	40	0.00			162				

09:00 - 09:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	556	0.000	0	0.0	0.0	0.000	A
C-AB	18	4	0.00	659	0.027	18	0.0	0.0	6.457	A
C-A	178	45	0.00			178				
A-B	13	3	0.00			13				
A-C	162	40	0.00			162				

09:15 - 09:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	569	0.000	0	0.0	0.0	0.000	A
C-AB	14	4	0.00	665	0.022	15	0.0	0.0	6.361	A
C-A	146	36	0.00			146				
A-B	11	3	0.00			11				
A-C	132	33	0.00			132				

09:30 - 09:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	0	0	0.00	578	0.000	0	0.0	0.0	0.000	A
C-AB	12	3	0.00	670	0.018	12	0.0	0.0	6.295	A
C-A	122	30	0.00			122				
A-B	9	2	0.00			9				
A-C	111	28	0.00			111				

Queue Variation Results for each time segment

08:15 - 08:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.02	0.00	0.00	0.02	0.02			N/A	N/A

08:30 - 08:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.03	0.03	0.29	0.52	0.55			N/A	N/A

08:45 - 09:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.03	0.00	0.00	0.03	0.03			N/A	N/A

09:00 - 09:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.03	0.00	0.00	0.03	0.03			N/A	N/A

09:15 - 09:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.03	0.00	0.00	0.03	0.03			N/A	N/A

09:30 - 09:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.02	0.00	0.00	0.02	0.02			N/A	N/A

D3 - 2028 | ESS Construction | AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	Junction 1	T-Junction	Two-way	Two-way	Two-way		0.45	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	793	Stream C-AB	0.45	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D3	2028	ESS Construction	AM	ONE HOUR	08:15	09:45	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	177	100.000
B		ONE HOUR	✓	5	100.000
C		ONE HOUR	✓	186	100.000

Origin-Destination Data

Demand (PCU/hr)

		To		
		A	B	C
From	A	0	15	162
	B	0	0	5
	C	166	20	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To		
		A	B	C
From	A	10	15	10
	B	15	10	15
	C	10	15	10

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-AC	0.01	6.41	0.0	0.5	A	5	7
C-AB	0.03	6.53	0.0	0.5	A	19	28
C-A						152	228
A-B						14	21
A-C						149	223

Main Results for each time segment

08:15 - 08:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	4	0.94	0.00	667	0.006	4	0.0	0.0	6.240	A
C-AB	15	4	0.00	667	0.023	15	0.0	0.0	6.347	A
C-A	125	31	0.00			125				
A-B	11	3	0.00			11				
A-C	122	30	0.00			122				

08:30 - 08:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	4	1	0.00	660	0.007	4	0.0	0.0	6.311	A
C-AB	18	5	0.00	662	0.027	18	0.0	0.0	6.426	A
C-A	149	37	0.00			149				
A-B	13	3	0.00			13				
A-C	146	36	0.00			146				

08:45 - 09:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	6	1	0.00	651	0.008	5	0.0	0.0	6.411	A
C-AB	22	6	0.00	655	0.034	22	0.0	0.0	6.534	A
C-A	182	46	0.00			182				
A-B	17	4	0.00			17				
A-C	178	45	0.00			178				

09:00 - 09:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	6	1	0.00	651	0.008	6	0.0	0.0	6.411	A
C-AB	22	6	0.00	655	0.034	22	0.0	0.0	6.534	A
C-A	182	46	0.00			182				
A-B	17	4	0.00			17				
A-C	178	45	0.00			178				

09:15 - 09:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	4	1	0.00	660	0.007	5	0.0	0.0	6.313	A
C-AB	18	5	0.00	662	0.027	18	0.0	0.0	6.430	A
C-A	149	37	0.00			149				
A-B	13	3	0.00			13				
A-C	146	36	0.00			146				

09:30 - 09:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	4	0.94	0.00	667	0.006	4	0.0	0.0	6.243	A
C-AB	15	4	0.00	667	0.023	15	0.0	0.0	6.348	A
C-A	125	31	0.00			125				
A-B	11	3	0.00			11				
A-C	122	30	0.00			122				

Queue Variation Results for each time segment

08:15 - 08:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
C-AB	0.03	0.00	0.00	0.03	0.03			N/A	N/A

08:30 - 08:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.01	0.01	0.29	0.52	0.55			N/A	N/A
C-AB	0.03	0.03	0.29	0.52	0.55			N/A	N/A

08:45 - 09:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
C-AB	0.04	0.03	0.29	0.52	0.55			N/A	N/A

09:00 - 09:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
C-AB	0.04	0.00	0.00	0.04	0.04			N/A	N/A

09:15 - 09:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
C-AB	0.03	0.00	0.00	0.03	0.03			N/A	N/A

09:30 - 09:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
C-AB	0.03	0.00	0.00	0.03	0.03			N/A	N/A

D4 - 2027 | Cumulative Construction | AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	Junction 1	T-Junction	Two-way	Two-way	Two-way		1.11	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	415	Stream C-AB	1.11	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D4	2027	Cumulative Construction	AM	ONE HOUR	08:15	09:45	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	207	100.000
B		ONE HOUR	✓	14	100.000
C		ONE HOUR	✓	241	100.000

Origin-Destination Data

Demand (PCU/hr)

		To		
		A	B	C
From	A	0	50	157
	B	0	0	14
	C	182	59	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To		
		A	B	C
From	A	10	15	10
	B	15	10	15
	C	10	15	10

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-AC	0.02	6.54	0.0	0.5	A	13	19
C-AB	0.10	6.93	0.1	0.6	A	56	84
C-A						165	248
A-B						46	69
A-C						144	216

Main Results for each time segment

08:15 - 08:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	11	3	0.00	665	0.016	10	0.0	0.0	6.322	A
C-AB	45	11	0.00	669	0.068	45	0.0	0.1	6.620	A
C-A	136	34	0.00			136				
A-B	38	9	0.00			38				
A-C	118	30	0.00			118				

08:30 - 08:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	13	3	0.00	658	0.019	13	0.0	0.0	6.411	A
C-AB	55	14	0.00	667	0.082	54	0.1	0.1	6.754	A
C-A	162	41	0.00			162				
A-B	45	11	0.00			45				
A-C	141	35	0.00			141				

08:45 - 09:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	15	4	0.00	649	0.024	15	0.0	0.0	6.538	A
C-AB	68	17	0.00	665	0.102	68	0.1	0.1	6.925	A
C-A	198	49	0.00			198				
A-B	55	14	0.00			55				
A-C	173	43	0.00			173				

09:00 - 09:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	15	4	0.00	649	0.024	15	0.0	0.0	6.538	A
C-AB	68	17	0.00	664	0.102	68	0.1	0.1	6.926	A
C-A	198	49	0.00			198				
A-B	55	14	0.00			55				
A-C	173	43	0.00			173				

09:15 - 09:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	13	3	0.00	658	0.019	13	0.0	0.0	6.411	A
C-AB	55	14	0.00	666	0.082	55	0.1	0.1	6.756	A
C-A	162	41	0.00			162				
A-B	45	11	0.00			45				
A-C	141	35	0.00			141				

09:30 - 09:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	11	3	0.00	665	0.016	11	0.0	0.0	6.322	A
C-AB	45	11	0.00	669	0.068	45	0.1	0.1	6.628	A
C-A	136	34	0.00			136				
A-B	38	9	0.00			38				
A-C	118	30	0.00			118				

Queue Variation Results for each time segment

08:15 - 08:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.02	0.00	0.00	0.02	0.02			N/A	N/A
C-AB	0.08	0.00	0.00	0.08	0.08			N/A	N/A

08:30 - 08:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.02	0.02	0.29	0.52	0.55			N/A	N/A
C-AB	0.10	0.03	0.30	0.54	0.57			N/A	N/A

08:45 - 09:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.03	0.00	0.00	0.03	0.03			N/A	N/A
C-AB	0.13	0.03	0.30	0.54	0.57			N/A	N/A

09:00 - 09:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.03	0.00	0.00	0.03	0.03			N/A	N/A
C-AB	0.14	0.03	0.29	0.52	0.55			N/A	N/A

09:15 - 09:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.02	0.00	0.00	0.02	0.02			N/A	N/A
C-AB	0.11	0.00	0.00	0.11	0.11			N/A	N/A

09:30 - 09:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.02	0.00	0.00	0.02	0.02			N/A	N/A
C-AB	0.09	0.00	0.00	0.09	0.09			N/A	N/A

D5 - 2027 | Generator Construction | PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	Junction 1	T-Junction	Two-way	Two-way	Two-way		1.02	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	310	Stream B-AC	1.02	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D5	2027	Generator Construction	PM	ONE HOUR	17:00	18:30	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	155	100.000
B		ONE HOUR	✓	44	100.000
C		ONE HOUR	✓	185	100.000

Origin-Destination Data

Demand (PCU/hr)

		To		
		A	B	C
From	A	0	0	155
	B	25	0	19
	C	181	4	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To		
		A	B	C
From	A	10	15	10
	B	15	10	15
	C	10	15	10

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-AC	0.09	8.33	0.1	0.6	A	40	61
C-AB	0.01	6.36	0.0	0.5	A	4	6
C-A						166	249
A-B						0	0
A-C						142	213

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	33	8	0.00	568	0.058	33	0.0	0.1	7.739	A
C-AB	3	0.75	0.00	668	0.005	3	0.0	0.0	6.223	A
C-A	136	34	0.00			136				
A-B	0	0	0.00			0				
A-C	117	29	0.00			117				

17:15 - 17:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	40	10	0.00	558	0.071	39	0.1	0.1	7.980	A
C-AB	4	0.90	0.00	663	0.005	4	0.0	0.0	6.281	A
C-A	163	41	0.00			163				
A-B	0	0	0.00			0				
A-C	139	35	0.00			139				

17:30 - 17:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	48	12	0.00	545	0.089	48	0.1	0.1	8.327	A
C-AB	4	1	0.00	655	0.007	4	0.0	0.0	6.362	A
C-A	199	50	0.00			199				
A-B	0	0	0.00			0				
A-C	171	43	0.00			171				

17:45 - 18:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	48	12	0.00	545	0.089	48	0.1	0.1	8.331	A
C-AB	4	1	0.00	655	0.007	4	0.0	0.0	6.362	A
C-A	199	50	0.00			199				
A-B	0	0	0.00			0				
A-C	171	43	0.00			171				

18:00 - 18:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	40	10	0.00	558	0.071	40	0.1	0.1	7.984	A
C-AB	4	0.90	0.00	662	0.005	4	0.0	0.0	6.284	A
C-A	163	41	0.00			163				
A-B	0	0	0.00			0				
A-C	139	35	0.00			139				

18:15 - 18:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	33	8	0.00	568	0.058	33	0.1	0.1	7.750	A
C-AB	3	0.75	0.00	668	0.005	3	0.0	0.0	6.225	A
C-A	136	34	0.00			136				
A-B	0	0	0.00			0				
A-C	117	29	0.00			117				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.07	0.00	0.00	0.07	0.07			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

17:15 - 17:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.09	0.03	0.29	0.52	0.55			N/A	N/A
C-AB	0.01	0.01	0.29	0.52	0.55			N/A	N/A

17:30 - 17:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.11	0.03	0.30	0.54	0.57			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

17:45 - 18:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.11	0.03	0.29	0.52	0.55			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

18:00 - 18:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.09	0.00	0.00	0.09	0.09			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

18:15 - 18:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.07	0.00	0.00	0.07	0.07			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

D6 - 2027 | GIS Construction | PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	Junction 1	T-Junction	Two-way	Two-way	Two-way		0.64	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	401	Stream B-AC	0.64	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D6	2027	GIS Construction	PM	ONE HOUR	17:00	18:30	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	155	100.000
B		ONE HOUR	✓	28	100.000
C		ONE HOUR	✓	184	100.000

Origin-Destination Data

Demand (PCU/hr)

		To		
		A	B	C
From	A	0	0	155
	B	12	0	16
	C	181	3	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To		
		A	B	C
From	A	10	15	10
	B	15	10	15
	C	10	15	10

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-AC	0.05	7.69	0.1	0.6	A	26	39
C-AB	0.01	6.36	0.0	0.5	A	3	4
C-A						166	249
A-B						0	0
A-C						142	213

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	21	5	0.00	590	0.036	21	0.0	0.0	7.275	A
C-AB	2	0.57	0.00	668	0.003	2	0.0	0.0	6.218	A
C-A	136	34	0.00			136				
A-B	0	0	0.00			0				
A-C	117	29	0.00			117				

17:15 - 17:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	25	6	0.00	581	0.043	25	0.0	0.1	7.446	A
C-AB	3	0.68	0.00	662	0.004	3	0.0	0.0	6.276	A
C-A	163	41	0.00			163				
A-B	0	0	0.00			0				
A-C	139	35	0.00			139				

17:30 - 17:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	31	8	0.00	569	0.054	31	0.1	0.1	7.690	A
C-AB	3	0.83	0.00	654	0.005	3	0.0	0.0	6.357	A
C-A	199	50	0.00			199				
A-B	0	0	0.00			0				
A-C	171	43	0.00			171				

17:45 - 18:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	31	8	0.00	569	0.054	31	0.1	0.1	7.692	A
C-AB	3	0.83	0.00	654	0.005	3	0.0	0.0	6.357	A
C-A	199	50	0.00			199				
A-B	0	0	0.00			0				
A-C	171	43	0.00			171				

18:00 - 18:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	25	6	0.00	581	0.043	25	0.1	0.1	7.447	A
C-AB	3	0.68	0.00	662	0.004	3	0.0	0.0	6.279	A
C-A	163	41	0.00			163				
A-B	0	0	0.00			0				
A-C	139	35	0.00			139				

18:15 - 18:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	21	5	0.00	590	0.036	21	0.1	0.0	7.282	A
C-AB	2	0.57	0.00	668	0.003	2	0.0	0.0	6.221	A
C-A	136	34	0.00			136				
A-B	0	0	0.00			0				
A-C	117	29	0.00			117				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.04	0.00	0.00	0.04	0.04			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:15 - 17:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.05	0.03	0.29	0.52	0.55			N/A	N/A
C-AB	0.00	0.00	0.29	0.52	0.55			N/A	N/A

17:30 - 17:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.07	0.03	0.30	0.53	0.56			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

17:45 - 18:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.07	0.00	0.00	0.07	0.07			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

18:00 - 18:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.05	0.00	0.00	0.05	0.05			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

18:15 - 18:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.04	0.00	0.00	0.04	0.04			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

D7 - 2028 | ESS Construction | PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	Junction 1	T-Junction	Two-way	Two-way	Two-way		0.79	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	359	Stream B-AC	0.79	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D7	2028	ESS Construction	PM	ONE HOUR	17:00	18:30	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	160	100.000
B		ONE HOUR	✓	35	100.000
C		ONE HOUR	✓	191	100.000

Origin-Destination Data

Demand (PCU/hr)

		To		
		A	B	C
From	A	0	0	160
	B	15	0	20
	C	186	5	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To		
		A	B	C
From	A	10	15	10
	B	15	10	15
	C	10	15	10

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-AC	0.07	7.84	0.1	0.6	A	32	48
C-AB	0.01	6.38	0.0	0.5	A	5	7
C-A						171	256
A-B						0	0
A-C						147	220

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	26	7	0.00	588	0.045	26	0.0	0.1	7.366	A
C-AB	4	0.94	0.00	667	0.006	4	0.0	0.0	6.236	A
C-A	140	35	0.00			140				
A-B	0	0	0.00			0				
A-C	120	30	0.00			120				

17:15 - 17:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	31	8	0.00	579	0.054	31	0.1	0.1	7.559	A
C-AB	5	1	0.00	662	0.007	5	0.0	0.0	6.297	A
C-A	167	42	0.00			167				
A-B	0	0	0.00			0				
A-C	144	36	0.00			144				

17:30 - 17:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	39	10	0.00	566	0.068	38	0.1	0.1	7.839	A
C-AB	6	1	0.00	654	0.008	6	0.0	0.0	6.381	A
C-A	205	51	0.00			205				
A-B	0	0	0.00			0				
A-C	176	44	0.00			176				

17:45 - 18:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	39	10	0.00	566	0.068	39	0.1	0.1	7.841	A
C-AB	6	1	0.00	654	0.008	6	0.0	0.0	6.381	A
C-A	205	51	0.00			205				
A-B	0	0	0.00			0				
A-C	176	44	0.00			176				

18:00 - 18:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	31	8	0.00	579	0.054	32	0.1	0.1	7.564	A
C-AB	5	1	0.00	662	0.007	5	0.0	0.0	6.297	A
C-A	167	42	0.00			167				
A-B	0	0	0.00			0				
A-C	144	36	0.00			144				

18:15 - 18:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	26	7	0.00	588	0.045	26	0.1	0.1	7.373	A
C-AB	4	0.94	0.00	667	0.006	4	0.0	0.0	6.236	A
C-A	140	35	0.00			140				
A-B	0	0	0.00			0				
A-C	120	30	0.00			120				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.05	0.00	0.00	0.05	0.05			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

17:15 - 17:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.07	0.03	0.29	0.52	0.55			N/A	N/A
C-AB	0.01	0.01	0.29	0.52	0.55			N/A	N/A

17:30 - 17:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.08	0.03	0.30	0.54	0.57			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

17:45 - 18:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.08	0.00	0.00	0.08	0.08			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

18:00 - 18:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.07	0.00	0.00	0.07	0.07			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

18:15 - 18:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.05	0.00	0.00	0.05	0.05			N/A	N/A
C-AB	0.01	0.00	0.00	0.01	0.01			N/A	N/A

D8 - 2027 | Cumulative Construction | PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	Junction 1	T-Junction	Two-way	Two-way	Two-way		2.43	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	170	Stream B-AC	2.43	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D8	2027	Cumulative Construction	PM	ONE HOUR	17:00	18:30	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	155	100.000
B		ONE HOUR	✓	109	100.000
C		ONE HOUR	✓	195	100.000

Origin-Destination Data

Demand (PCU/hr)

		To		
		A	B	C
From	A	0	0	155
	B	50	0	59
	C	181	14	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To		
		A	B	C
From	A	10	15	10
	B	15	10	15
	C	10	15	10

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-AC	0.21	9.39	0.3	1.5	A	100	150
C-AB	0.02	6.42	0.0	0.5	A	13	19
C-A						166	249
A-B						0	0
A-C						142	213

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	82	21	0.00	583	0.141	81	0.0	0.2	8.239	A
C-AB	11	3	0.00	671	0.016	11	0.0	0.0	6.270	A
C-A	136	34	0.00			136				
A-B	0	0	0.00			0				
A-C	117	29	0.00			117				

17:15 - 17:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	98	24	0.00	574	0.171	98	0.2	0.2	8.694	A
C-AB	13	3	0.00	666	0.019	13	0.0	0.0	6.334	A
C-A	163	41	0.00			163				
A-B	0	0	0.00			0				
A-C	139	35	0.00			139				

17:30 - 17:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	120	30	0.00	561	0.214	120	0.2	0.3	9.375	A
C-AB	16	4	0.00	660	0.024	16	0.0	0.0	6.420	A
C-A	199	50	0.00			199				
A-B	0	0	0.00			0				
A-C	171	43	0.00			171				

17:45 - 18:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	120	30	0.00	561	0.214	120	0.3	0.3	9.388	A
C-AB	16	4	0.00	660	0.024	16	0.0	0.0	6.423	A
C-A	199	50	0.00			199				
A-B	0	0	0.00			0				
A-C	171	43	0.00			171				

18:00 - 18:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	98	24	0.00	574	0.171	98	0.3	0.2	8.711	A
C-AB	13	3	0.00	666	0.019	13	0.0	0.0	6.337	A
C-A	163	41	0.00			163				
A-B	0	0	0.00			0				
A-C	139	35	0.00			139				

18:15 - 18:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-AC	82	21	0.00	583	0.141	82	0.2	0.2	8.270	A
C-AB	11	3	0.00	671	0.016	11	0.0	0.0	6.273	A
C-A	136	34	0.00			136				
A-B	0	0	0.00			0				
A-C	117	29	0.00			117				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.19	0.00	0.00	0.19	0.19			N/A	N/A
C-AB	0.02	0.00	0.00	0.02	0.02			N/A	N/A

17:15 - 17:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.23	0.00	0.00	0.23	0.23			N/A	N/A
C-AB	0.02	0.02	0.29	0.52	0.55			N/A	N/A

17:30 - 17:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.31	0.03	0.29	0.53	0.56			N/A	N/A
C-AB	0.03	0.00	0.00	0.03	0.03			N/A	N/A

17:45 - 18:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.31	0.03	0.35	1.10	1.47			N/A	N/A
C-AB	0.03	0.00	0.00	0.03	0.03			N/A	N/A

18:00 - 18:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.24	0.00	0.00	0.24	0.24			N/A	N/A
C-AB	0.02	0.00	0.00	0.02	0.02			N/A	N/A

18:15 - 18:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.19	0.00	0.00	0.19	0.19			N/A	N/A
C-AB	0.02	0.00	0.00	0.02	0.02			N/A	N/A

Junctions 11

PICADY 11 - Priority Intersection Module

Filename: Junction 2.j11
Path: T:\01 Trasky\06 Trasky Projects\2025\500582 - Coolpowra SID Energy Project - Road Design & Traffic Services\07 Calculations\02 Traffic Analysis
Report generation date: 14/11/2025 11:24:08

Summary of junction performance

	AM									PM								
	Set ID	Queue (PCU)	95% Queue (PCU)	Delay (s)	RFC	LOS	Junction Delay (s)	Junction LOS	Network Residual Capacity	Set ID	Queue (PCU)	95% Queue (PCU)	Delay (s)	RFC	LOS	Junction Delay (s)	Junction LOS	Network Residual Capacity
	2027 - Generator Construction																	
Stream B-ACD	D1	0.0	~1	0.00	0.00	A	6.94	A	770 % [Stream CD-AB]	D5	0.1	0.5	5.75	0.09	A	5.27	A	810 % [Stream AB-CD]
Stream AB-CD		0.0	~1	0.00	0.00	A					0.1	~1	6.34	0.09	A			
Stream D-ABC		0.1	0.6	6.58	0.09	A					0.0	~1	0.00	0.00	A			
Stream CD-AB		0.1	~1	7.30	0.09	A					0.0	~1	0.00	0.00	A			
	2027 - GIS Construction																	
Stream B-ACD	D2	0.0	~1	0.00	0.00	A	5.76	A	900 % ▯	D6	0.0	0.5	5.50	0.04	A	4.49	A	900 % ▯
Stream AB-CD		0.0	~1	0.00	0.00	A					0.1	~1	6.04	0.05	A			
Stream D-ABC		0.0	0.5	5.48	0.04	A					0.0	~1	0.00	0.00	A			
Stream CD-AB		0.1	~1	6.05	0.05	A					0.0	~1	0.00	0.00	A			
	2028 - ESS Construction																	
Stream B-ACD	D3	0.0	0.5	5.27	0.01	A	5.80	A	900 % ▯	D7	0.1	0.5	5.56	0.06	A	4.84	A	900 % ▯
Stream AB-CD		0.0	~1	5.80	0.01	A					0.1	~1	6.12	0.06	A			
Stream D-ABC		0.1	0.5	5.54	0.06	A					0.0	0.5	5.27	0.01	A			
Stream CD-AB		0.1	~1	6.13	0.06	A					0.0	~1	5.82	0.01	A			
	2027 - Cumulative Construction																	
Stream B-ACD	D4	0.0	0.5	5.35	0.02	A	6.60	A	344 % [Stream CD-AB]	D8	0.2	0.7	6.36	0.17	A	6.21	A	347 % [Stream AB-CD]
Stream AB-CD		0.0	~1	5.89	0.02	A					0.2	~1	7.09	0.19	A			
Stream D-ABC		0.2	0.7	6.33	0.17	A					0.0	0.5	5.35	0.02	A			
Stream CD-AB		0.2	~1	7.11	0.19	A					0.0	~1	5.92	0.02	A			

There are warnings associated with one or more model runs - see the 'Data Errors and Warnings' tables for each Analysis or Demand Set

Values shown are the highest values encountered over all time segments. Delay is the maximum value of average delay per arriving vehicle. Junction LOS and Junction Delay are demand-weighted averages. Network Residual Capacity indicates the amount by which network flow could be increased before a user-definable threshold (see Analysis Options) is met.

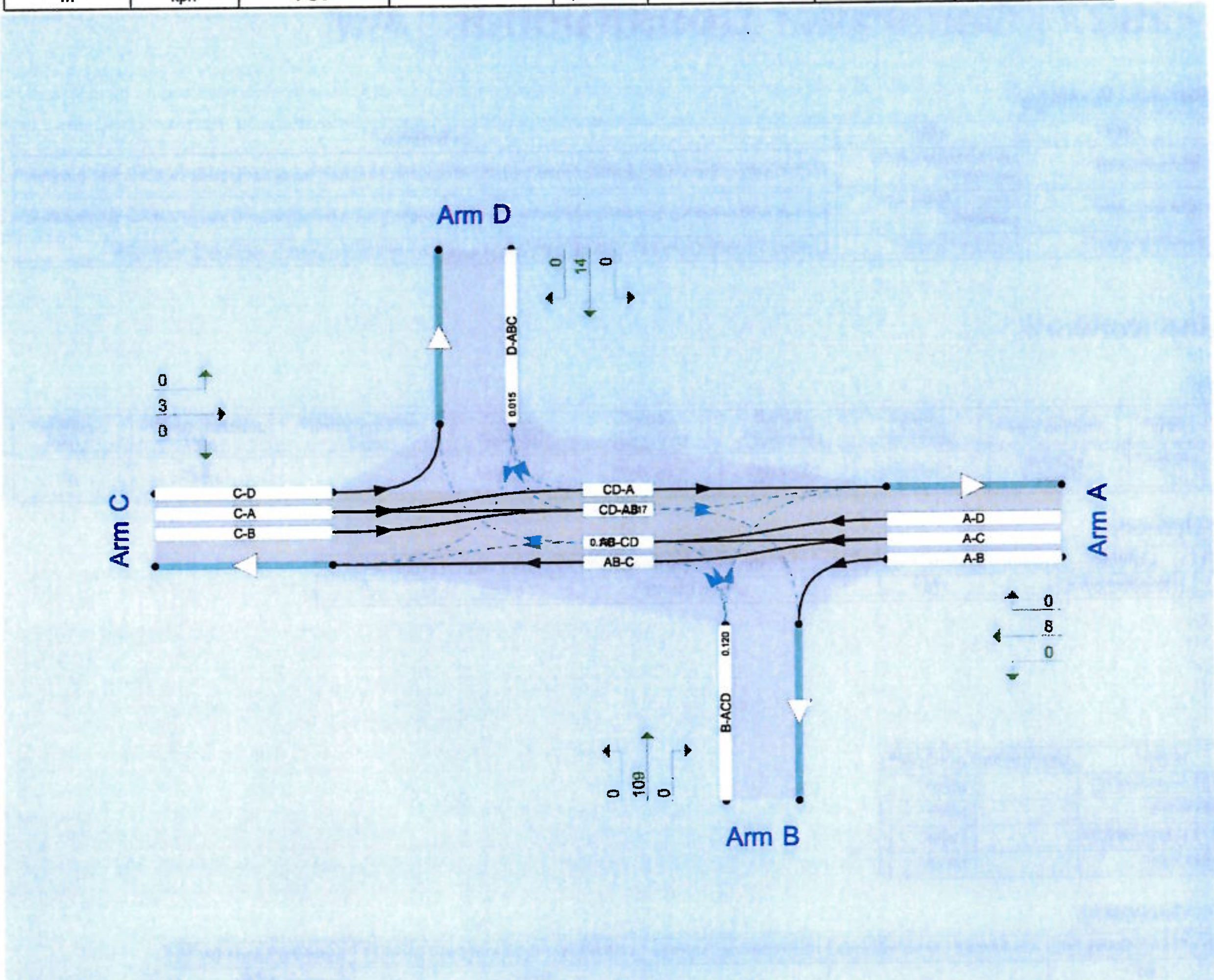
File summary

File Description

Title	Junction 2
Location	L8763 Local Road
Site number	1
Date	10/11/2025
Version	
Status	
Identifier	
Client	
Jobnumber	
Enumerator	DESKTOP-GDBF06V\jason
Description	

Units

Distance units	Speed units	Traffic units input	Traffic units results	Flow units	Average delay units	Total delay units	Rate of delay units
m	kph	PCU	PCU	perHour	s	-Min	perMin



Flows show original traffic demand (PCU/hr)
Streams (downstream end) show RFC ()

The junction diagram reflects the last run of Junctions.

Analysis Options

PICADY short flare model	Vehicle length (m)	Calculate Queue Percentiles	Calculate detailed queueing delay	Show lane queues in feet / metres	Show all PICADY stream intercepts	Calculate residual capacity	Residual capacity criteria type	RFC Threshold	Average Delay threshold (s)	Queue threshold (PCU)	Use simulation for HCM roundabouts	Use iterations for HCM roundabouts
JUNCTIONS 11.1	5.75	✓				✓	Delay	0.85	36.00	20.00		

Demand Set Summary

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D1	2027	Generator Construction	AM	ONE HOUR	08:15	09:45	15	✓
D2	2027	GIS Construction	AM	ONE HOUR	08:15	09:45	15	✓
D3	2028	ESS Construction	AM	ONE HOUR	08:15	09:45	15	✓
D4	2027	Cumulative Construction	AM	ONE HOUR	08:15	09:45	15	✓
D5	2027	Generator Construction	PM	ONE HOUR	17:00	18:30	15	✓
D6	2027	GIS Construction	PM	ONE HOUR	17:00	18:30	15	✓
D7	2028	ESS Construction	PM	ONE HOUR	17:00	18:30	15	✓
D8	2027	Cumulative Construction	PM	ONE HOUR	17:00	18:30	15	✓

Analysis Set Details

ID	Include in report	Network flow scaling factor (%)	Network capacity scaling factor (%)
A2	✓	100.000	100.000

D1 - 2027 | Generator Construction | AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	Arm A - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Major arm width	Arm C - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Arm D Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
2	Junction 2	Left-Right Stagger	Two-way	Two-way	Two-way	Two-way		6.94	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	770	Stream CD-AB	6.94	A

Arms

Arms

Arm	Name	Description	Arm type
A	L8763 Local Road (E)		Major
B	Access Road		Minor
C	L8763 Local Road (W)		Major
D	Access Road		Minor

Major Arm Geometry

Arm	Width of carriageway (m)	Has kerbed central reserve	Has right-turn storage	Visibility for right turn (m)	Blocks?	Blocking queue (PCU)
A	5.50			90.0	✓	1.00
C	5.50			90.0	✓	1.00

Geometries for Arm C are measured opposite Arm B. Geometries for Arm A (if relevant) are measured opposite Arm D.

Minor Arm Geometry

Arm	Minor arm type	Lane width (m)	Visibility to left (m)	Visibility to right (m)
B	One lane	3.50	50	50
D	One lane	3.50	50	50

Slope / Intercept / Capacity

Priority Intersection Slopes and Intercepts

Stream	Intercept (PCU/hr)	Slope for A-B	Slope for A-C	Slope for A-D	Slope for B-C	Slope for B-D	Slope for C-A	Slope for C-B	Slope for C-D	Slope for D-A	Slope for D-B
AB-D	626	-	-	-	-	-	0.248	0.248	0.248	-	-
B-A	544	0.101	0.256	0.256	-	-	0.161	0.366	-	0.161	0.366
B-CD	688	0.108	0.272	0.272	-	-	-	-	-	-	-
CD-B	626	0.248	0.248	0.248	-	-	-	-	-	-	-
D-AB	688	-	-	-	-	-	0.272	0.272	0.108	-	-
D-C	544	-	0.161	0.366	0.161	0.366	0.256	0.256	0.101	-	-

The slopes and intercepts shown above include custom intercept adjustments only.
Streams may be combined, in which case capacity will be adjusted.
Values are shown for the first time segment only; they may differ for subsequent time segments.

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D1	2027	Generator Construction	AM	ONE HOUR	08:15	09:45	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	3	100.000
B		ONE HOUR	✓	4	100.000
C		ONE HOUR	✓	4	100.000
D		ONE HOUR	✓	54	100.000

Origin-Destination Data

Demand (PCU/hr)

		To			
		A	B	C	D
From	A	0	0	3	0
	B	0	0	0	4
	C	4	0	0	0
	D	0	54	0	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To			
		A	B	C	D
From	A	5	5	5	5
	B	5	5	5	15
	C	5	5	5	5
	D	5	15	5	5

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-ACD	0.00	0.00	0.0	~1	A	0	0
A-B						0	0
A-C						0	0
A-D						0	0
AB-CD	0.00	0.00	0.0	~1	A	0	0
AB-C						0	0
D-ABC	0.09	6.58	0.1	0.6	A	50	74
C-D						0	0
C-A						0	0
C-B						0	0
CD-AB	0.09	7.30	0.1	~1	A	50	74
CD-A						0	0

Main Results for each time segment

08:15 - 08:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	599	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1209	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	41	10	0.00	688	0.059	40	0.0	0.1	6.387	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	40	10	0.00	626	0.064	40	0.0	0.1	7.061	A
CD-A	0	0	0.00			0				

08:30 - 08:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	597	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1209	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	49	12	0.00	688	0.071	48	0.1	0.1	6.471	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	48	12	0.00	626	0.077	48	0.1	0.1	7.166	A
CD-A	0	0	0.00			0				

08:45 - 09:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	594	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1209	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	59	15	0.00	688	0.086	59	0.1	0.1	6.583	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	59	15	0.00	626	0.095	59	0.1	0.1	7.304	A
CD-A	0	0	0.00			0				

09:00 - 09:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	594	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1209	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	59	15	0.00	688	0.086	59	0.1	0.1	6.583	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	59	15	0.00	626	0.095	59	0.1	0.1	7.305	A
CD-A	0	0	0.00			0				

09:15 - 09:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	597	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1209	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	49	12	0.00	688	0.071	49	0.1	0.1	6.475	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	49	12	0.00	626	0.078	49	0.1	0.1	7.173	A
CD-A	0	0	0.00			0				

09:30 - 09:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	598	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1209	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	41	10	0.00	688	0.059	41	0.1	0.1	6.396	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	41	10	0.00	626	0.065	41	0.1	0.1	7.073	A
CD-A	0	0	0.00			0				

Queue Variation Results for each time segment

08:15 - 08:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.07	0.00	0.00	0.07	0.07			N/A	N/A
CD-AB	0.08	~1	~1	~1	~1			N/A	N/A

08:30 - 08:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.09	0.03	0.29	0.52	0.55			N/A	N/A
CD-AB	0.10	~1	~1	~1	~1			N/A	N/A

08:45 - 09:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.11	0.03	0.30	0.54	0.57			N/A	N/A
CD-AB	0.12	~1	~1	~1	~1			N/A	N/A

09:00 - 09:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.11	0.00	0.00	0.11	0.11			N/A	N/A
CD-AB	0.12	~1	~1	~1	~1			N/A	N/A

09:15 - 09:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.09	0.00	0.00	0.09	0.09			N/A	N/A
CD-AB	0.10	~1	~1	~1	~1			N/A	N/A

09:30 - 09:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.07	0.00	0.00	0.07	0.07			N/A	N/A
CD-AB	0.08	~1	~1	~1	~1			N/A	N/A

D2 - 2027 | GIS Construction | AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	Arm A - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Major arm width	Arm C - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Arm D Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
2	Junction 2	Left-Right Stagger	Two-way	Two-way	Two-way	Two-way		5.76	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	900		5.76	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D2	2027	GIS Construction	AM	ONE HOUR	08:15	09:45	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	3	100.000
B		ONE HOUR	✓	3	100.000
C		ONE HOUR	✓	4	100.000
D		ONE HOUR	✓	28	100.000

Origin-Destination Data

Demand (PCU/hr)

		To			
		A	B	C	D
From	A	0	0	3	0
	B	0	0	0	3
	C	4	0	0	0
	D	0	28	0	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To			
		A	B	C	D
From	A	10	15	10	0
	B	15	10	15	0
	C	10	15	10	0
	D	0	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-ACD	0.00	0.00	0.0	~1	A	0	0
A-B						0	0
A-C						0	0
A-D						0	0
AB-CD	0.00	0.00	0.0	~1	A	0	0
AB-C						0	0
D-ABC	0.04	5.48	0.0	0.5	A	26	39
C-D						0	0
C-A						0	0
C-B						0	0
CD-AB	0.05	6.05	0.1	~1	A	26	39
CD-A						0	0

Main Results for each time segment

08:15 - 08:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	603	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1377	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	21	5	0.00	688	0.031	21	0.0	0.0	5.395	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	21	5	0.00	626	0.033	21	0.0	0.0	5.946	A
CD-A	0	0	0.00			0				

08:30 - 08:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	602	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1377	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	25	6	0.00	688	0.037	25	0.0	0.0	5.428	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	25	6	0.00	626	0.040	25	0.0	0.0	5.989	A
CD-A	0	0	0.00			0				

08:45 - 09:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	601	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1377	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	31	8	0.00	688	0.045	31	0.0	0.0	5.475	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	31	8	0.00	626	0.049	31	0.0	0.1	6.046	A
CD-A	0	0	0.00			0				

09:00 - 09:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	601	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1377	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	31	8	0.00	688	0.045	31	0.0	0.0	5.475	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	31	8	0.00	626	0.049	31	0.1	0.1	6.047	A
CD-A	0	0	0.00			0				

09:15 - 09:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	602	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1377	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	25	6	0.00	688	0.037	25	0.0	0.0	5.429	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	25	6	0.00	626	0.040	25	0.1	0.0	5.991	A
CD-A	0	0	0.00			0				

09:30 - 09:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	0	0	0.00	603	0.000	0	0.0	0.0	0.000	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	0	0	0.00	1377	0.000	0	0.0	0.0	0.000	A
AB-C	0	0	0.00			0				
D-ABC	21	5	0.00	688	0.031	21	0.0	0.0	5.398	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	21	5	0.00	626	0.034	21	0.0	0.0	5.952	A
CD-A	0	0	0.00			0				

Queue Variation Results for each time segment

08:15 - 08:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.03	0.00	0.00	0.03	0.03			N/A	N/A
CD-AB	0.03	~1	~1	~1	~1			N/A	N/A

08:30 - 08:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.04	0.03	0.25	0.45	0.48			N/A	N/A
CD-AB	0.04	~1	~1	~1	~1			N/A	N/A

08:45 - 09:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.05	0.03	0.26	0.46	0.48			N/A	N/A
CD-AB	0.05	~1	~1	~1	~1			N/A	N/A

09:00 - 09:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.05	0.00	0.00	0.05	0.05			N/A	N/A
CD-AB	0.05	~1	~1	~1	~1			N/A	N/A

09:15 - 09:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.04	0.00	0.00	0.04	0.04			N/A	N/A
CD-AB	0.04	~1	~1	~1	~1			N/A	N/A

09:30 - 09:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.00	0.00	0.00	0.00	0.00			N/A	N/A
AB-CD	0.00	~1	~1	~1	~1			N/A	N/A
D-ABC	0.03	0.00	0.00	0.03	0.03			N/A	N/A
CD-AB	0.04	~1	~1	~1	~1			N/A	N/A

D3 - 2028 | ESS Construction | AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	Arm A - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Major arm width	Arm C - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Arm D Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
2	Junction 2	Left-Right Stagger	Two-way	Two-way	Two-way	Two-way		5.80	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	900		5.80	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D3	2028	ESS Construction	AM	ONE HOUR	08:15	09:45	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	3	100.000
B		ONE HOUR	✓	5	100.000
C		ONE HOUR	✓	4	100.000
D		ONE HOUR	✓	35	100.000

Origin-Destination Data

Demand (PCU/hr)

		To			
		A	B	C	D
From	A	0	0	3	0
	B	0	0	0	5
	C	4	0	0	0
	D	0	35	0	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To			
		A	B	C	D
From	A	10	15	10	0
	B	15	10	15	0
	C	10	15	10	0
	D	0	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-ACD	0.01	5.27	0.0	0.5	A	5	7
A-B						0	0
A-C						0	0
A-D						0	0
AB-CD	0.01	5.80	0.0	~1	A	5	7
AB-C						0	0
D-ABC	0.06	5.54	0.1	0.5	A	32	48
C-D						0	0
C-A						0	0
C-B						0	0
CD-AB	0.06	6.13	0.1	~1	A	32	48
CD-A						0	0

Main Results for each time segment

08:15 - 08:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	4	0.94	0.00	688	0.005	4	0.0	0.0	5.259	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	4	0.94	0.00	626	0.006	4	0.0	0.0	5.783	A
AB-C	0	0	0.00			0				
D-ABC	26	7	0.00	688	0.038	26	0.0	0.0	5.436	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	26	7	0.00	626	0.042	26	0.0	0.0	5.998	A
CD-A	0	0	0.00			0				

08:30 - 08:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	4	1	0.00	688	0.007	4	0.0	0.0	5.264	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	4	1	0.00	626	0.007	4	0.0	0.0	5.790	A
AB-C	0	0	0.00			0				
D-ABC	31	8	0.00	688	0.046	31	0.0	0.0	5.480	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	31	8	0.00	626	0.050	31	0.0	0.1	6.053	A
CD-A	0	0	0.00			0				

08:45 - 09:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	6	1	0.00	688	0.008	5	0.0	0.0	5.272	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	5	1	0.00	626	0.009	5	0.0	0.0	5.800	A
AB-C	0	0	0.00			0				
D-ABC	39	10	0.00	688	0.056	38	0.0	0.1	5.540	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	38	10	0.00	626	0.061	38	0.1	0.1	6.126	A
CD-A	0	0	0.00			0				

09:00 - 09:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	6	1	0.00	688	0.008	6	0.0	0.0	5.272	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	6	1	0.00	626	0.009	6	0.0	0.0	5.800	A
AB-C	0	0	0.00			0				
D-ABC	39	10	0.00	688	0.056	39	0.1	0.1	5.540	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	39	10	0.00	626	0.062	39	0.1	0.1	6.126	A
CD-A	0	0	0.00			0				

09:15 - 09:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	4	1	0.00	688	0.007	5	0.0	0.0	5.266	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	5	1	0.00	626	0.007	5	0.0	0.0	5.791	A
AB-C	0	0	0.00			0				
D-ABC	31	8	0.00	688	0.046	32	0.1	0.0	5.481	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	32	8	0.00	626	0.050	32	0.1	0.1	6.055	A
CD-A	0	0	0.00			0				

09:30 - 09:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	4	0.94	0.00	688	0.005	4	0.0	0.0	5.259	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	4	0.94	0.00	626	0.006	4	0.0	0.0	5.786	A
AB-C	0	0	0.00			0				
D-ABC	26	7	0.00	688	0.038	26	0.0	0.0	5.439	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	26	7	0.00	626	0.042	26	0.1	0.0	6.003	A
CD-A	0	0	0.00			0				

Queue Variation Results for each time segment

08:15 - 08:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.01	0.00	0.00	0.01	0.01			N/A	N/A
AB-CD	0.01	~1	~1	~1	~1			N/A	N/A
D-ABC	0.04	0.00	0.00	0.04	0.04			N/A	N/A
CD-AB	0.04	~1	~1	~1	~1			N/A	N/A

08:30 - 08:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.01	0.01	0.25	0.45	0.48			N/A	N/A
AB-CD	0.01	~1	~1	~1	~1			N/A	N/A
D-ABC	0.05	0.03	0.25	0.45	0.48			N/A	N/A
CD-AB	0.05	~1	~1	~1	~1			N/A	N/A

08:45 - 09:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.01	0.00	0.00	0.01	0.01			N/A	N/A
AB-CD	0.01	~1	~1	~1	~1			N/A	N/A
D-ABC	0.06	0.03	0.26	0.46	0.49			N/A	N/A
CD-AB	0.07	~1	~1	~1	~1			N/A	N/A

09:00 - 09:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.01	0.00	0.00	0.01	0.01			N/A	N/A
AB-CD	0.01	~1	~1	~1	~1			N/A	N/A
D-ABC	0.06	0.00	0.00	0.06	0.06			N/A	N/A
CD-AB	0.07	~1	~1	~1	~1			N/A	N/A

09:15 - 09:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.01	0.00	0.00	0.01	0.01			N/A	N/A
AB-CD	0.01	~1	~1	~1	~1			N/A	N/A
D-ABC	0.05	0.00	0.00	0.05	0.05			N/A	N/A
CD-AB	0.05	~1	~1	~1	~1			N/A	N/A

09:30 - 09:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.01	0.00	0.00	0.01	0.01			N/A	N/A
AB-CD	0.01	~1	~1	~1	~1			N/A	N/A
D-ABC	0.04	0.00	0.00	0.04	0.04			N/A	N/A
CD-AB	0.04	~1	~1	~1	~1			N/A	N/A

D4 - 2027 | Cumulative Construction | AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	Arm A - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Major arm width	Arm C - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Arm D Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
2	Junction 2	Left-Right Stagger	Two-way	Two-way	Two-way	Two-way		6.60	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	344	Stream CD-AB	6.60	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D4	2027	Cumulative Construction	AM	ONE HOUR	08:15	09:45	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	3	100.000
B		ONE HOUR	✓	14	100.000
C		ONE HOUR	✓	4	100.000
D		ONE HOUR	✓	109	100.000

Origin-Destination Data

Demand (PCU/hr)

		To			
		A	B	C	D
From	A	0	0	3	0
	B	0	0	0	14
	C	4	0	0	0
	D	0	109	0	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To			
		A	B	C	D
From	A	10	15	10	0
	B	15	10	15	0
	C	10	15	10	0
	D	0	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-ACD	0.02	5.35	0.0	0.5	A	13	19
A-B						0	0
A-C						0	0
A-D						0	0
AB-CD	0.02	5.89	0.0	~1	A	13	19
AB-C						0	0
D-ABC	0.17	6.33	0.2	0.7	A	100	150
C-D						0	0
C-A						0	0
C-B						0	0
CD-AB	0.19	7.11	0.2	~1	A	100	150
CD-A						0	0

Main Results for each time segment

08:15 - 08:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	11	3	0.00	688	0.015	10	0.0	0.0	5.311	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	10	3	0.00	626	0.017	10	0.0	0.0	5.847	A
AB-C	0	0	0.00			0				
D-ABC	82	21	0.00	688	0.119	82	0.0	0.1	5.929	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	82	20	0.00	626	0.130	81	0.0	0.1	6.597	A
CD-A	0	0	0.00			0				

08:30 - 08:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	13	3	0.00	688	0.018	13	0.0	0.0	5.327	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	13	3	0.00	626	0.020	13	0.0	0.0	5.867	A
AB-C	0	0	0.00			0				
D-ABC	98	24	0.00	688	0.142	98	0.1	0.2	6.096	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	98	24	0.00	626	0.156	98	0.1	0.2	6.811	A
CD-A	0	0	0.00			0				

08:45 - 09:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	15	4	0.00	688	0.022	15	0.0	0.0	5.350	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	15	4	0.00	626	0.025	15	0.0	0.0	5.894	A
AB-C	0	0	0.00			0				
D-ABC	120	30	0.00	688	0.174	120	0.2	0.2	6.332	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	120	30	0.00	626	0.191	120	0.2	0.2	7.104	A
CD-A	0	0	0.00			0				

09:00 - 09:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	15	4	0.00	688	0.022	15	0.0	0.0	5.350	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	15	4	0.00	626	0.025	15	0.0	0.0	5.894	A
AB-C	0	0	0.00			0				
D-ABC	120	30	0.00	688	0.174	120	0.2	0.2	6.334	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	120	30	0.00	626	0.192	120	0.2	0.2	7.112	A
CD-A	0	0	0.00			0				

09:15 - 09:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	13	3	0.00	688	0.018	13	0.0	0.0	5.328	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	13	3	0.00	626	0.020	13	0.0	0.0	5.867	A
AB-C	0	0	0.00			0				
D-ABC	98	24	0.00	688	0.142	98	0.2	0.2	6.102	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	98	25	0.00	626	0.157	98	0.2	0.2	6.823	A
CD-A	0	0	0.00			0				

09:30 - 09:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	11	3	0.00	688	0.015	11	0.0	0.0	5.313	A
A-B	0	0	0.00			0				
A-C	0	0	0.00			0				
A-D	0	0	0.00			0				
AB-CD	11	3	0.00	626	0.017	11	0.0	0.0	5.850	A
AB-C	0	0	0.00			0				
D-ABC	82	21	0.00	688	0.119	82	0.2	0.1	5.940	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	82	21	0.00	626	0.131	82	0.2	0.2	6.621	A
CD-A	0	0	0.00			0				

Queue Variation Results for each time segment

08:15 - 08:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.02	0.00	0.00	0.02	0.02			N/A	N/A
AB-CD	0.02	~1	~1	~1	~1			N/A	N/A
D-ABC	0.13	0.00	0.00	0.13	0.13			N/A	N/A
CD-AB	0.15	~1	~1	~1	~1			N/A	N/A

08:30 - 08:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.02	0.02	0.25	0.45	0.48			N/A	N/A
AB-CD	0.02	~1	~1	~1	~1			N/A	N/A
D-ABC	0.16	0.00	0.00	0.16	0.16			N/A	N/A
CD-AB	0.18	~1	~1	~1	~1			N/A	N/A

08:45 - 09:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.02	0.00	0.00	0.02	0.02			N/A	N/A
AB-CD	0.03	~1	~1	~1	~1			N/A	N/A
D-ABC	0.21	0.03	0.26	0.46	0.48			N/A	N/A
CD-AB	0.23	~1	~1	~1	~1			N/A	N/A

09:00 - 09:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.02	0.00	0.00	0.02	0.02			N/A	N/A
AB-CD	0.03	~1	~1	~1	~1			N/A	N/A
D-ABC	0.21	0.03	0.27	0.48	0.67			N/A	N/A
CD-AB	0.24	~1	~1	~1	~1			N/A	N/A

09:15 - 09:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.02	0.00	0.00	0.02	0.02			N/A	N/A
AB-CD	0.02	~1	~1	~1	~1			N/A	N/A
D-ABC	0.17	0.00	0.00	0.17	0.17			N/A	N/A
CD-AB	0.19	~1	~1	~1	~1			N/A	N/A

09:30 - 09:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.02	0.00	0.00	0.02	0.02			N/A	N/A
AB-CD	0.02	~1	~1	~1	~1			N/A	N/A
D-ABC	0.14	0.00	0.00	0.14	0.14			N/A	N/A
CD-AB	0.15	~1	~1	~1	~1			N/A	N/A

D5 - 2027 | Generator Construction | PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	Arm A - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Major arm width	Arm C - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Arm D Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
2	Junction 2	Left-Right Stagger	Two-way	Two-way	Two-way	Two-way		5.27	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	810	Stream AB-CD	5.27	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D5	2027	Generator Construction	PM	ONE HOUR	17:00	18:30	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	8	100.000
B		ONE HOUR	✓	54	100.000
C		ONE HOUR	✓	3	100.000
D		ONE HOUR	✓	4	100.000

Origin-Destination Data

Demand (PCU/hr)

		To			
		A	B	C	D
From	A	0	0	8	0
	B	0	0	0	54
	C	3	0	0	0
	D	0	4	0	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To			
		A	B	C	D
From	A	10	15	10	0
	B	15	10	15	0
	C	10	15	10	0
	D	0	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-ACD	0.09	5.75	0.1	0.5	A	50	74
A-B						0	0
A-C						7	11
A-D						0	0
AB-CD	0.09	6.34	0.1	~1	A	50	74
AB-C						7	11
D-ABC	0.00	0.00	0.0	~1	A	0	0
C-D						0	0
C-A						0	0
C-B						0	0
CD-AB	0.00	0.00	0.0	~1	A	0	0
CD-A						0	0

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	41	10	0.00	687	0.059	40	0.0	0.1	5.571	A
A-B	0	0	0.00			0				
A-C	6	2	0.00			6				
A-D	0	0	0.00			0				
AB-CD	40	10	0.00	626	0.065	40	0.0	0.1	6.137	A
AB-C	6	1	0.00			6				
D-ABC	0	0	0.00	598	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1213	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

17:15 - 17:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	49	12	0.00	686	0.071	48	0.1	0.1	5.644	A
A-B	0	0	0.00			0				
A-C	7	2	0.00			7				
A-D	0	0	0.00			0				
AB-CD	49	12	0.00	627	0.077	48	0.1	0.1	6.227	A
AB-C	7	2	0.00			7				
D-ABC	0	0	0.00	596	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1212	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

17:30 - 17:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	59	15	0.00	686	0.087	59	0.1	0.1	5.746	A
A-B	0	0	0.00			0				
A-C	9	2	0.00			9				
A-D	0	0	0.00			0				
AB-CD	59	15	0.00	627	0.095	59	0.1	0.1	6.344	A
AB-C	9	2	0.00			9				
D-ABC	0	0	0.00	593	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1212	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

17:45 - 18:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	59	15	0.00	686	0.087	59	0.1	0.1	5.746	A
A-B	0	0	0.00			0				
A-C	9	2	0.00			9				
A-D	0	0	0.00			0				
AB-CD	60	15	0.00	627	0.095	60	0.1	0.1	6.344	A
AB-C	9	2	0.00			9				
D-ABC	0	0	0.00	593	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1212	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

18:00 - 18:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	49	12	0.00	686	0.071	49	0.1	0.1	5.645	A
A-B	0	0	0.00			0				
A-C	7	2	0.00			7				
A-D	0	0	0.00			0				
AB-CD	49	12	0.00	627	0.078	49	0.1	0.1	6.230	A
AB-C	7	2	0.00			7				
D-ABC	0	0	0.00	596	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1212	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

18:15 - 18:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	41	10	0.00	687	0.059	41	0.1	0.1	5.575	A
A-B	0	0	0.00			0				
A-C	6	2	0.00			6				
A-D	0	0	0.00			0				
AB-CD	41	10	0.00	626	0.065	41	0.1	0.1	6.149	A
AB-C	6	1	0.00			6				
D-ABC	0	0	0.00	598	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1213	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.06	0.00	0.00	0.06	0.06			N/A	N/A
AB-CD	0.07	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

17:15 - 17:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.08	0.03	0.25	0.45	0.48			N/A	N/A
AB-CD	0.08	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

17:30 - 17:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.09	0.03	0.26	0.47	0.49			N/A	N/A
AB-CD	0.10	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

17:45 - 18:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.09	0.00	0.00	0.09	0.09			N/A	N/A
AB-CD	0.10	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

18:00 - 18:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.08	0.00	0.00	0.08	0.08			N/A	N/A
AB-CD	0.08	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

18:15 - 18:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.06	0.00	0.00	0.06	0.06			N/A	N/A
AB-CD	0.07	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

D6 - 2027 | GIS Construction | PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	Arm A - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Major arm width	Arm C - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Arm D Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
2	Junction 2	Left-Right Stagger	Two-way	Two-way	Two-way	Two-way		4.49	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	900		4.49	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D6	2027	GIS Construction	PM	ONE HOUR	17:00	18:30	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	8	100.000
B		ONE HOUR	✓	28	100.000
C		ONE HOUR	✓	3	100.000
D		ONE HOUR	✓	3	100.000

Origin-Destination Data

Demand (PCU/hr)

		To			
		A	B	C	D
From	A	0	0	8	0
	B	0	0	0	28
	C	3	0	0	0
	D	0	3	0	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To			
		A	B	C	D
From	A	10	15	10	0
	B	15	10	15	0
	C	10	15	10	0
	D	0	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-ACD	0.04	5.50	0.0	0.5	A	26	39
A-B						0	0
A-C						7	11
A-D						0	0
AB-CD	0.05	6.04	0.1	~1	A	26	39
AB-C						7	11
D-ABC	0.00	0.00	0.0	~1	A	0	0
C-D						0	0
C-A						0	0
C-B						0	0
CD-AB	0.00	0.00	0.0	~1	A	0	0
CD-A						0	0

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	21	5	0.00	687	0.031	21	0.0	0.0	5.408	A
A-B	0	0	0.00			0				
A-C	6	2	0.00			6				
A-D	0	0	0.00			0				
AB-CD	21	5	0.00	626	0.033	21	0.0	0.0	5.944	A
AB-C	6	2	0.00			6				
D-ABC	0	0	0.00	603	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1213	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

17:15 - 17:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	25	6	0.00	686	0.037	25	0.0	0.0	5.444	A
A-B	0	0	0.00			0				
A-C	7	2	0.00			7				
A-D	0	0	0.00			0				
AB-CD	25	6	0.00	626	0.040	25	0.0	0.0	5.987	A
AB-C	7	2	0.00			7				
D-ABC	0	0	0.00	601	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1212	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

17:30 - 17:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	31	8	0.00	686	0.045	31	0.0	0.0	5.495	A
A-B	0	0	0.00			0				
A-C	9	2	0.00			9				
A-D	0	0	0.00			0				
AB-CD	31	8	0.00	627	0.049	31	0.0	0.1	6.042	A
AB-C	9	2	0.00			9				
D-ABC	0	0	0.00	600	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1212	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

17:45 - 18:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	31	8	0.00	686	0.045	31	0.0	0.0	5.495	A
A-B	0	0	0.00			0				
A-C	9	2	0.00			9				
A-D	0	0	0.00			0				
AB-CD	31	8	0.00	627	0.049	31	0.1	0.1	6.043	A
AB-C	9	2	0.00			9				
D-ABC	0	0	0.00	600	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1212	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

18:00 - 18:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	25	6	0.00	686	0.037	25	0.0	0.0	5.445	A
A-B	0	0	0.00			0				
A-C	7	2	0.00			7				
A-D	0	0	0.00			0				
AB-CD	25	6	0.00	626	0.040	25	0.1	0.0	5.991	A
AB-C	7	2	0.00			7				
D-ABC	0	0	0.00	601	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1212	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

18:15 - 18:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	21	5	0.00	687	0.031	21	0.0	0.0	5.411	A
A-B	0	0	0.00			0				
A-C	6	2	0.00			6				
A-D	0	0	0.00			0				
AB-CD	21	5	0.00	626	0.034	21	0.0	0.0	5.948	A
AB-C	6	2	0.00			6				
D-ABC	0	0	0.00	602	0.000	0	0.0	0.0	0.000	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	0	0	0.00	1213	0.000	0	0.0	0.0	0.000	A
CD-A	0	0	0.00			0				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.03	0.00	0.00	0.03	0.03			N/A	N/A
AB-CD	0.03	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

17:15 - 17:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.04	0.03	0.25	0.45	0.48			N/A	N/A
AB-CD	0.04	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

17:30 - 17:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.05	0.03	0.26	0.46	0.48			N/A	N/A
AB-CD	0.05	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

17:45 - 18:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.05	0.00	0.00	0.05	0.05			N/A	N/A
AB-CD	0.05	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

18:00 - 18:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.04	0.00	0.00	0.04	0.04			N/A	N/A
AB-CD	0.04	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

18:15 - 18:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.03	0.00	0.00	0.03	0.03			N/A	N/A
AB-CD	0.04	~1	~1	~1	~1			N/A	N/A
D-ABC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
CD-AB	0.00	~1	~1	~1	~1			N/A	N/A

D7 - 2028 | ESS Construction | PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	Arm A - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Major arm width	Arm C - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Arm D Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
2	Junction 2	Left-Right Stagger	Two-way	Two-way	Two-way	Two-way		4.84	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	900		4.84	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D7	2028	ESS Construction	PM	ONE HOUR	17:00	18:30	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	8	100.000
B		ONE HOUR	✓	35	100.000
C		ONE HOUR	✓	3	100.000
D		ONE HOUR	✓	5	100.000

Origin-Destination Data

Demand (PCU/hr)

		To			
		A	B	C	D
From	A	0	0	8	0
	B	0	0	0	35
	C	3	0	0	0
	D	0	5	0	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To			
		A	B	C	D
From	A	10	15	10	0
	B	15	10	15	0
	C	10	15	10	0
	D	0	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-ACD	0.06	5.56	0.1	0.5	A	32	48
A-B						0	0
A-C						7	11
A-D						0	0
AB-CD	0.06	6.12	0.1	~1	A	32	48
AB-C						7	11
D-ABC	0.01	5.27	0.0	0.5	A	5	7
C-D						0	0
C-A						0	0
C-B						0	0
CD-AB	0.01	5.82	0.0	~1	A	5	7
CD-A						0	0

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	26	7	0.00	687	0.038	26	0.0	0.0	5.449	A
A-B	0	0	0.00			0				
A-C	6	2	0.00			6				
A-D	0	0	0.00			0				
AB-CD	26	7	0.00	626	0.042	26	0.0	0.0	5.995	A
AB-C	6	2	0.00			6				
D-ABC	4	0.94	0.00	688	0.005	4	0.0	0.0	5.259	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	4	0.94	0.00	625	0.006	4	0.0	0.0	5.797	A
CD-A	0	0	0.00			0				

17:15 - 17:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	31	8	0.00	686	0.046	31	0.0	0.0	5.497	A
A-B	0	0	0.00			0				
A-C	7	2	0.00			7				
A-D	0	0	0.00			0				
AB-CD	31	8	0.00	626	0.050	31	0.0	0.1	6.050	A
AB-C	7	2	0.00			7				
D-ABC	4	1	0.00	688	0.007	4	0.0	0.0	5.264	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	4	1	0.00	624	0.007	4	0.0	0.0	5.807	A
CD-A	0	0	0.00			0				

17:30 - 17:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	39	10	0.00	686	0.056	38	0.0	0.1	5.561	A
A-B	0	0	0.00			0				
A-C	9	2	0.00			9				
A-D	0	0	0.00			0				
AB-CD	39	10	0.00	627	0.061	38	0.1	0.1	6.121	A
AB-C	9	2	0.00			9				
D-ABC	6	1	0.00	688	0.008	5	0.0	0.0	5.272	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	5	1	0.00	624	0.009	5	0.0	0.0	5.820	A
CD-A	0	0	0.00			0				

17:45 - 18:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	39	10	0.00	686	0.056	39	0.1	0.1	5.561	A
A-B	0	0	0.00			0				
A-C	9	2	0.00			9				
A-D	0	0	0.00			0				
AB-CD	39	10	0.00	627	0.062	39	0.1	0.1	6.121	A
AB-C	9	2	0.00			9				
D-ABC	6	1	0.00	688	0.008	6	0.0	0.0	5.272	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	6	1	0.00	624	0.009	6	0.0	0.0	5.820	A
CD-A	0	0	0.00			0				

18:00 - 18:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	31	8	0.00	686	0.046	32	0.1	0.0	5.498	A
A-B	0	0	0.00			0				
A-C	7	2	0.00			7				
A-D	0	0	0.00			0				
AB-CD	32	8	0.00	626	0.050	32	0.1	0.1	6.051	A
AB-C	7	2	0.00			7				
D-ABC	4	1	0.00	688	0.007	5	0.0	0.0	5.266	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	5	1	0.00	624	0.007	5	0.0	0.0	5.810	A
CD-A	0	0	0.00			0				

18:15 - 18:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	26	7	0.00	687	0.038	26	0.0	0.0	5.454	A
A-B	0	0	0.00			0				
A-C	6	2	0.00			6				
A-D	0	0	0.00			0				
AB-CD	26	7	0.00	626	0.042	26	0.1	0.0	6.003	A
AB-C	6	2	0.00			6				
D-ABC	4	0.94	0.00	688	0.005	4	0.0	0.0	5.259	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	4	0.94	0.00	625	0.006	4	0.0	0.0	5.798	A
CD-A	0	0	0.00			0				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.04	0.00	0.00	0.04	0.04			N/A	N/A
AB-CD	0.04	~1	~1	~1	~1			N/A	N/A
D-ABC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
CD-AB	0.01	~1	~1	~1	~1			N/A	N/A

17:15 - 17:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.05	0.03	0.25	0.45	0.48			N/A	N/A
AB-CD	0.05	~1	~1	~1	~1			N/A	N/A
D-ABC	0.01	0.01	0.25	0.45	0.48			N/A	N/A
CD-AB	0.01	~1	~1	~1	~1			N/A	N/A

17:30 - 17:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.06	0.03	0.26	0.46	0.49			N/A	N/A
AB-CD	0.07	~1	~1	~1	~1			N/A	N/A
D-ABC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
CD-AB	0.01	~1	~1	~1	~1			N/A	N/A

17:45 - 18:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.06	0.00	0.00	0.06	0.06			N/A	N/A
AB-CD	0.07	~1	~1	~1	~1			N/A	N/A
D-ABC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
CD-AB	0.01	~1	~1	~1	~1			N/A	N/A

18:00 - 18:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.05	0.00	0.00	0.05	0.05			N/A	N/A
AB-CD	0.05	~1	~1	~1	~1			N/A	N/A
D-ABC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
CD-AB	0.01	~1	~1	~1	~1			N/A	N/A

18:15 - 18:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.04	0.00	0.00	0.04	0.04			N/A	N/A
AB-CD	0.04	~1	~1	~1	~1			N/A	N/A
D-ABC	0.01	0.00	0.00	0.01	0.01			N/A	N/A
CD-AB	0.01	~1	~1	~1	~1			N/A	N/A

D8 - 2027 | Cumulative Construction | PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	Arm A - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Major arm width	Arm C - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Arm D Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
2	Junction 2	Left-Right Stagger	Two-way	Two-way	Two-way	Two-way		6.21	A

Junction Network

Driving side	Lighting	Network residual capacity (%)	First arm reaching threshold	Network delay (s)	Network LOS
Left	Normal/unknown	347	Stream AB-CD	6.21	A

Traffic Demand

Demand Set Details

ID	Year	Scenario	Time period	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D8	2027	Cumulative Construction	PM	ONE HOUR	17:00	18:30	15	✓

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (PCU/hr)	Scaling Factor (%)
A		ONE HOUR	✓	8	100.000
B		ONE HOUR	✓	109	100.000
C		ONE HOUR	✓	3	100.000
D		ONE HOUR	✓	14	100.000

Origin-Destination Data

Demand (PCU/hr)

		To			
		A	B	C	D
From	A	0	0	8	0
	B	0	0	0	109
	C	3	0	0	0
	D	0	14	0	0

Vehicle Mix

HV data entry mode	PCU Factor for a HV (PCU)
HV Percentages	2.00

Heavy Vehicle %

		To			
		A	B	C	D
From	A	10	15	10	0
	B	15	10	15	0
	C	10	15	10	0
	D	0	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (PCU)	Max 95th percentile Queue (PCU)	Max LOS	Average Demand (PCU/hr)	Total Junction Arrivals (PCU)
B-ACD	0.17	6.36	0.2	0.7	A	100	150
A-B						0	0
A-C						7	11
A-D						0	0
AB-CD	0.19	7.09	0.2	~1	A	100	150
AB-C						7	11
D-ABC	0.02	5.35	0.0	0.5	A	13	19
C-D						0	0
C-A						0	0
C-B						0	0
CD-AB	0.02	5.92	0.0	~1	A	13	19
CD-A						0	0

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	82	21	0.00	687	0.120	82	0.0	0.1	5.945	A
A-B	0	0	0.00			0				
A-C	6	2	0.00			6				
A-D	0	0	0.00			0				
AB-CD	82	20	0.00	627	0.130	81	0.0	0.1	6.589	A
AB-C	6	1	0.00			6				
D-ABC	11	3	0.00	688	0.015	10	0.0	0.0	5.311	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	10	3	0.00	625	0.017	10	0.0	0.0	5.861	A
CD-A	0	0	0.00			0				

17:15 - 17:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	98	24	0.00	686	0.143	98	0.1	0.2	6.116	A
A-B	0	0	0.00			0				
A-C	7	2	0.00			7				
A-D	0	0	0.00			0				
AB-CD	98	25	0.00	627	0.156	98	0.1	0.2	6.800	A
AB-C	7	2	0.00			7				
D-ABC	13	3	0.00	688	0.018	13	0.0	0.0	5.327	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	13	3	0.00	624	0.020	13	0.0	0.0	5.884	A
CD-A	0	0	0.00			0				

17:30 - 17:45

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	120	30	0.00	686	0.175	120	0.2	0.2	6.359	A
A-B	0	0	0.00			0				
A-C	9	2	0.00			9				
A-D	0	0	0.00			0				
AB-CD	120	30	0.00	628	0.191	120	0.2	0.2	7.087	A
AB-C	8	2	0.00			8				
D-ABC	15	4	0.00	688	0.022	15	0.0	0.0	5.350	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	15	4	0.00	624	0.025	15	0.0	0.0	5.915	A
CD-A	0	0	0.00			0				

17:45 - 18:00

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	120	30	0.00	686	0.175	120	0.2	0.2	6.361	A
A-B	0	0	0.00			0				
A-C	9	2	0.00			9				
A-D	0	0	0.00			0				
AB-CD	120	30	0.00	628	0.192	120	0.2	0.2	7.095	A
AB-C	8	2	0.00			8				
D-ABC	15	4	0.00	688	0.022	15	0.0	0.0	5.350	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	15	4	0.00	624	0.025	15	0.0	0.0	5.915	A
CD-A	0	0	0.00			0				

18:00 - 18:15

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	98	24	0.00	686	0.143	98	0.2	0.2	6.124	A
A-B	0	0	0.00			0				
A-C	7	2	0.00			7				
A-D	0	0	0.00			0				
AB-CD	98	25	0.00	627	0.157	99	0.2	0.2	6.812	A
AB-C	7	2	0.00			7				
D-ABC	13	3	0.00	688	0.018	13	0.0	0.0	5.328	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	13	3	0.00	624	0.020	13	0.0	0.0	5.887	A
CD-A	0	0	0.00			0				

18:15 - 18:30

Stream	Total Demand (PCU/hr)	Junction Arrivals (PCU)	Pedestrian demand (Ped/hr)	Capacity (PCU/hr)	RFC	Throughput (PCU/hr)	Start queue (PCU)	End queue (PCU)	Delay (s)	Unsignalised level of service
B-ACD	82	21	0.00	687	0.120	82	0.2	0.1	5.959	A
A-B	0	0	0.00			0				
A-C	6	2	0.00			6				
A-D	0	0	0.00			0				
AB-CD	82	21	0.00	627	0.131	82	0.2	0.2	6.614	A
AB-C	6	1	0.00			6				
D-ABC	11	3	0.00	688	0.015	11	0.0	0.0	5.313	A
C-D	0	0	0.00			0				
C-A	0	0	0.00			0				
C-B	0	0	0.00			0				
CD-AB	11	3	0.00	625	0.017	11	0.0	0.0	5.864	A
CD-A	0	0	0.00			0				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.13	0.00	0.00	0.13	0.13			N/A	N/A
AB-CD	0.15	~1	~1	~1	~1			N/A	N/A
D-ABC	0.02	0.00	0.00	0.02	0.02			N/A	N/A
CD-AB	0.02	~1	~1	~1	~1			N/A	N/A

17:15 - 17:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.17	0.00	0.00	0.17	0.17			N/A	N/A
AB-CD	0.18	~1	~1	~1	~1			N/A	N/A
D-ABC	0.02	0.02	0.25	0.45	0.48			N/A	N/A
CD-AB	0.02	~1	~1	~1	~1			N/A	N/A

17:30 - 17:45

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.21	0.03	0.26	0.46	0.48			N/A	N/A
AB-CD	0.24	~1	~1	~1	~1			N/A	N/A
D-ABC	0.02	0.00	0.00	0.02	0.02			N/A	N/A
CD-AB	0.03	~1	~1	~1	~1			N/A	N/A

17:45 - 18:00

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.21	0.03	0.27	0.48	0.70			N/A	N/A
AB-CD	0.24	~1	~1	~1	~1			N/A	N/A
D-ABC	0.02	0.00	0.00	0.02	0.02			N/A	N/A
CD-AB	0.03	~1	~1	~1	~1			N/A	N/A

18:00 - 18:15

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.17	0.00	0.00	0.17	0.17			N/A	N/A
AB-CD	0.19	~1	~1	~1	~1			N/A	N/A
D-ABC	0.02	0.00	0.00	0.02	0.02			N/A	N/A
CD-AB	0.02	~1	~1	~1	~1			N/A	N/A

18:15 - 18:30

Stream	Mean (PCU)	Q05 (PCU)	Q50 (PCU)	Q90 (PCU)	Q95 (PCU)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-ACD	0.14	0.00	0.00	0.14	0.14			N/A	N/A
AB-CD	0.15	~1	~1	~1	~1			N/A	N/A
D-ABC	0.02	0.00	0.00	0.02	0.02			N/A	N/A
CD-AB	0.02	~1	~1	~1	~1			N/A	N/A

APPENDIX 13.8

ROAD SAFETY AUDIT REPORT

– ALTERNATIVE CONSTRUCTION ACCESS ROAD

Halston Environmental & Planning Ltd

New Access Road, N65, Co. Galway

Stage 1 Road Safety Audit

PMCE

January 2026

Halston Environmental & Planning Ltd

New Access Road, N65, Co. Galway

Stage 1 Road Safety Audit

Document Ref:	P25266-PMCE-XX-XX-RP-SA-3_0001

Rev	Prepared By	Reviewed By	Approved By	Issue Date	Reason for Revision
2.0	AOR	XY	AOR	26th Jan. 2026	Final
1.0	XY	AOR	AOR	5th Dec. 2025	Draft Report

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Table of Contents

1 Introduction

1.1 General

This report results from a Stage 1 Road Safety Audit on the proposed New Access Road, on the N65, in Co. Galway carried out at the request of Colm Staunton of Halston Environmental & Planning Ltd.

The members of the Road Safety Audit Team are independent of the design team, and include:

Mr. Alan O'Reilly
(BA, BAI, MSc, PGDip(PM), RSACert, CEng, MIEI)
Road Safety Audit Team Leader

Ms. Xue Yan
(BEng, MSc, MIEI)
Road Safety Audit Team Member

The Road Safety Audit took place during November and December 2025 and comprised an examination of the documents provided by the designers (see Appendix A). In addition to examining the documents supplied the Road Safety Audit Team visited the site of the proposed measures on the 12th November 2025. Weather conditions during the site visit were wet and the road surface was wet. Traffic volumes during the site visit were low, pedestrian and cyclist volumes were low and traffic speeds were considered to be generally within the posted speed limit.

Where problems are relevant to specific locations these are shown on drawing extracts within the main body of the report and their locations are shown in Appendix B. Where problems are general to the proposals sample drawing extracts are included within the main body of the report, where considered necessary.

This Stage 1 Road Safety Audit has been carried out in accordance with the requirements of GE-STY-01024 - Road Safety Audit (May 2025), contained on the Transport Infrastructure Ireland (TII) Publications website.

The scheme has been examined and this report compiled in respect of the consideration of those matters that have an adverse effect on road safety and considers the perspective of all road users. It has not been examined or verified for compliance with any other standards or criteria. The problems identified in this report are considered to require action in order to improve the safety of the scheme and minimise collision occurrence.

If any of the recommendations within this road safety audit report are not accepted, a written response is required, stating reasons for non-acceptance. Comments made within the report under the heading of Observations are intended to be for information only. Written responses to Observations are not required.

2 Project Description

The project involves the construction of a new alternative temporary access road to allow for construction of the three Coolpowra Energy Projects – Reserve Gas Fired Generator, GIS and ESS. The proposed access road will extend for approximately 1.1km between the N65 and L87632, in a northeast-southwest direction, and cross the L8763 at a new staggered junction. It is proposed to include one 3.5m wide traffic lane and 2m wide verge (which would include a filter drain) in each direction on the access road. The access road would intersect the N65 at a priority controlled T-junction, the L8763 at a new staggered junction and the L87632 at a T-junction.

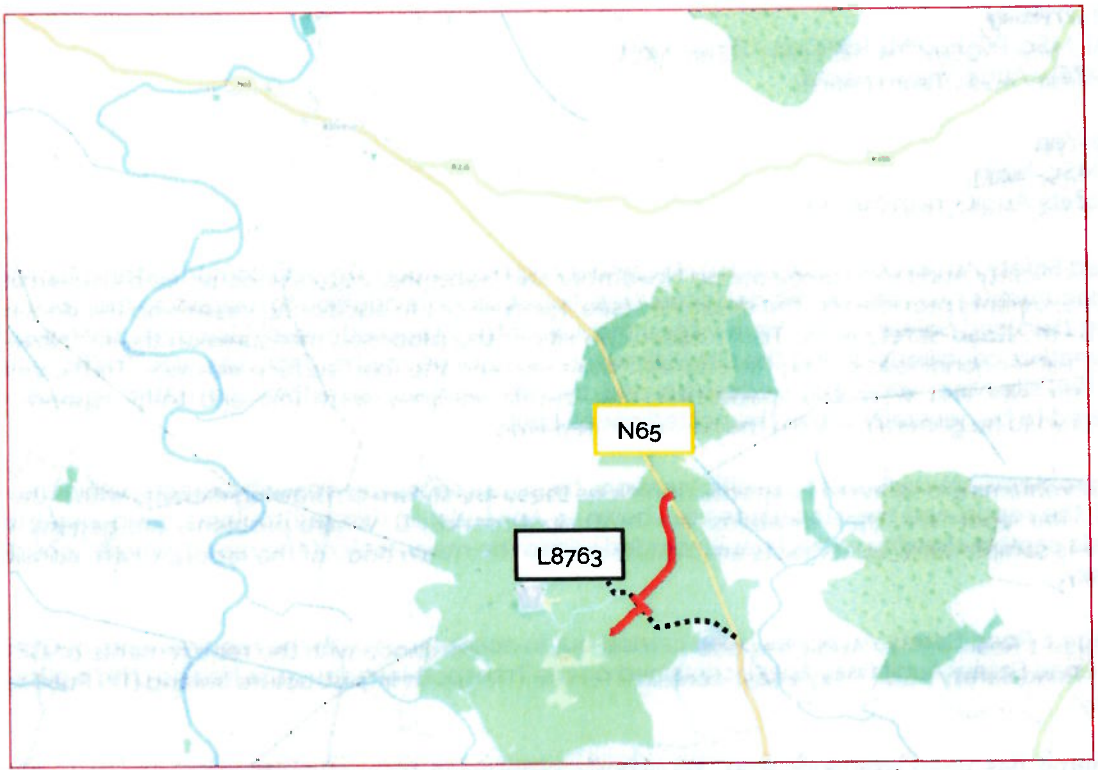


FIGURE 2.1: LOCATION PLAN (SOURCE: WWW.OPENSTREETMAP.ORG)

The N65 National Road is a single carriageway road with a width of between 5.8m and 6m, and no hard shoulders, in the vicinity of the proposed new access junction. There is a maintained verge bounding the road to the east and a verge with a mix of bushes and trees bounding the road to the west. There is a posted speed limit of 100kph on the N65, and no public lighting is provided on the N65 at this location.

The L8763 is a two-way single carriageway road with a width of approx.. 4.5m. There are no road markings and no hard shoulders on the L8763. It includes high-side vegetation and trees on both sides of the road, and has a posted speed limit of 60kph.

The proposed works would include:

- Provision of a new priority controlled T-junction on the N65 National Road for a new 7m wide access road serving the development.
- Provision of junction radii appropriate for the vehicle types utilising the access junction.
- Minor widening (300 – 350mm) of the N65 to the immediate north of the access to provide a 6m carriageway in the vicinity of the proposed access junction.
- Partial removal of existing boundary bushes and trees to provide junction visibility.
- Provision of traffic signs and road markings for the new N65 junction.

- Staggered junction design where the new access roads intersect, and cross, the L8763.

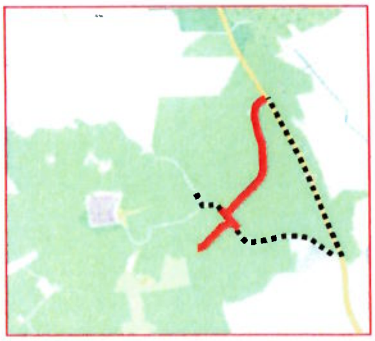
No amendments are proposed to be carried out to the vertical alignment, gradient, or crossfall of the N65 to accommodate the proposed access junction.

3 Items Arising from the Audit

3.1 Unauthorised Access to New Access Road

Location: *General Problem*

Summary: *The proposed access road may attract public traffic as it may be perceived as a short cut, and better quality road, between the L8763 and the N65, rather than using the existing route between these two roads.*



It is unclear what measures, if any, would be provided at each end of the proposed access road to prevent unauthorised access. The Audit Team are concerned that drivers may perceive the proposed new access road as a short cut between the L8763 and the N65, and a wider and better quality carriageway, resulting in unauthorised traffic using the road.

If measures are not provided to prevent public traffic from using the proposed access road it may lead to additional traffic using the road and travelling through the new junctions, which may lead to an increased risk of collisions with construction/site machinery, or junction capacity issues at the new junctions if not designed for use by public traffic also.

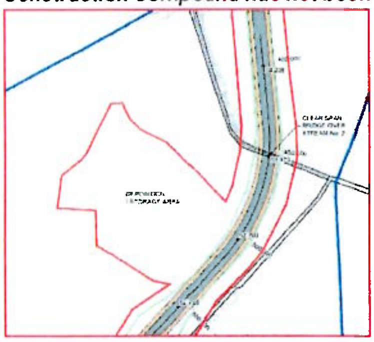
Recommendation

Measures should be provided to prevent unauthorised access onto the proposed access road.

3.2 Access/Egress To/From Storage Area/Construction Compound

Location: *Drawing no. CPA-HAL-NR-XX-DR-PL-2000 (Rev.P03) – General Problem*

Summary: *Information regarding the layout of the Deposition/Storage Areas, and the Construction Compound has not been provided to the Audit Team.*



Information regarding the layout of the Deposition/Storage Areas, and the Construction Compound, particularly their access/junction layout, has not been provided to the Audit Team. It is, therefore, unclear if the proposed layout would support HGVs safely entering, turning around within, and exiting these areas. If the junction layout, and internal road space, provided at these locations is not sufficient to support the movement of HGVs it may lead to collisions with roadside boundaries, or plant and machinery, resulting in material damage.

As the Deposition/Storage Areas, and the Construction Compound, would be located on the inside of a horizontal curve on the proposed access road, drivers leaving these areas may have restricted visibility towards approaching vehicles. This may lead to drivers exiting these areas when it is unsafe to do so resulting in a risk of side-on collisions.

Recommendation

The layout of the access junctions at, and internal space within, the proposed Deposition/Storage Areas, and the Construction Compound, should be sufficient to safely accommodate the swept path of HGVs entering, traversing within, and exiting, these areas.

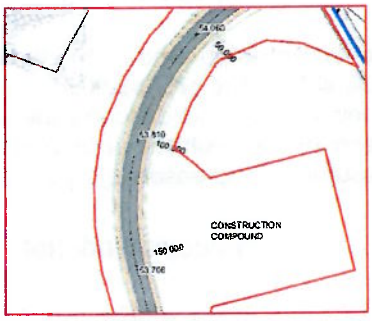
Clear, unobstructed visibility should also be provided for drivers exiting these areas.

3.3 Two HGVs Passing Each Other on Access Road

Location: *Drawing no. CPA-HAL-NR-XX-DR-PL-2000 (Rev. P03) – General Problem*

Summary: *It is unclear if the horizontal curves on the proposed access road would safely accommodate two HGVs passing each other.*

The width of the proposed access road is indicated as 7m wide. While this would likely be sufficient to accommodate two opposing HGVs passing each other on straight sections of the access road, it is unclear if two opposing HGVs can pass each other at horizontal curves on the access road. A failure to provide sufficient widening at horizontal curves may lead to HGVs encroaching into the opposing traffic lane as they traverse the curve resulting in an increased risk of side swipe collisions should an opposing vehicle be travelling through the curve simultaneously.



Recommendation

Undertake a swept path analysis at the horizontal curves on the proposed access road to determine if additional carriageway widening is necessary at these locations.

3.4 Location of Warning Sign

Location: *Drawing no. CPA-HAL-NR-XX-DR-PL-5001 (Rev. P01)*

Summary: *The proposed warning signs on the N65 and L6873 are located such that they appear to encroach into the carriageway, which may increase the risk of the sign being struck, or to the sign being within the visibility splay of a driver exiting the access road, restricting their visibility to oncoming vehicles.*

The proposed warning signs indicated on the N65 and L6873 are located such that they appear to encroach into the adjacent carriageway. A failure to sufficiently set back traffic signs from the edge of the carriageway may lead to an increased risk of the sign being struck, particularly by high-sided vehicles, resulting in material damage, or to the sign no longer being visible to approaching drivers.

In addition, the proposed 'Junction Ahead' warning sign, facing northbound drivers, is indicated within the visibility splay for exiting drivers at the new access road junction. The sign may, therefore, restrict visibility for a driver exiting the access road resulting in them turning onto the N65 when it is unafe to do so, and side-on collisions.

Recommendation

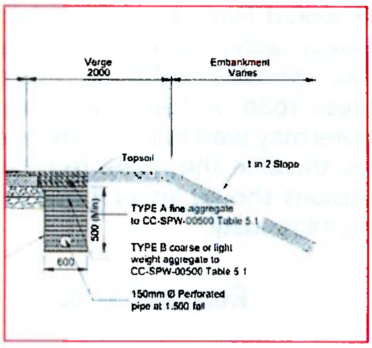
The proposed warning signs, including both the signpost and sign face, should be set back a minimum of 450mm from the edge of the carriageway.

In addition, relocate the 'Junction Ahead' warnng sign on the N65 outside the visibility splay.

3.5 Unprotected Embankment Slope

Location: *Drawing no. CPA-HAL-NR-XX-PL-4000 (Rev. P01)*

Summary: *An unprotected embankment with a gradient of 1V:2H is indicated on one side of the access road and, should an errant driver descend this embankment, it may lead to them being unable to recover their vehicle, or to their vehicle overturning.*



An unprotected embankment with a gradient of 1V:2H is indicated on one side of the proposed access road. Should a drivers lose control of their vehicle and descend the embankment, they may be unable to recover their vehicle, or be at risk of a high-sided vehicle overturning, resulting in increased injury severity for vehicle occupants.

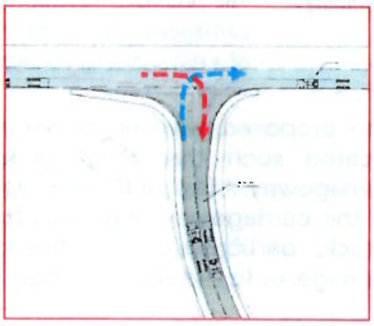
Recommendation

The slope of the embankment should be regraded to a minimum of 1V:3H, or a sufficient vehicle restraint system provided at the top of the embankment.

3.6 Right Turns from the N65 onto the New Access Road

Location: *Drawing no. CPA-HAL-NR-XX-DR-PL-5002 (Rev. P01)*

Summary: *It is unclear if the proposed access road/N65 junction can accommodate the swept path of a right-turning vehicle when entering or exiting the access road.*



Information regarding the swept path of right-turning vehicles entering/exiting the new access road at its junction with the N65 has not been provided to the Audit Team. It is, therefore, unclear if the proposed junction layout would accommodate the swept path of right-turning HGVs when entering/exiting the access road.

If sufficient space is not provided within the junction to accommodate these turning movements it may lead a risk of collisions with roadside boundaries, and material damage, or to HGVs having to undertake multiple point turns to complete these movements resulting in an increased risk of collisions with other road users.

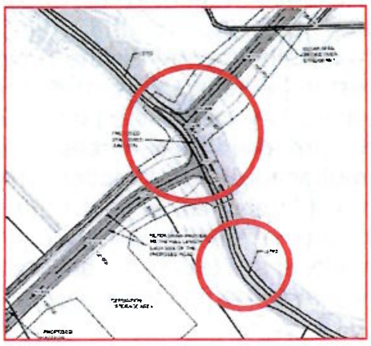
Recommendation

Undertake a swept path analysis to confirm that the proposed access road/N65 junction can safely accommodate right-turning vehicles entering/exiting the access road.

3.7 Restricted Visibility at Staggered Junction

Location: *Drawing no. CPA-HAL-NR-XX-PL-3000 (Rev. P01) & CPA-HAL-NR-XX-DR-PL-2000 (Rev. P03)*

Summary: *Inter-visibility between drivers exiting the proposed access road onto the L8673, and drivers approaching the new staggered junction on the L8763, may be restricted by the horizontal curves on both sides of the junction.*



According to the swept path analysis provided, it appears likely that a HGV will travel through the staggered junction on the L6763, between the two sections of the proposed access road, in a single movement, without stopping on the L8763 before undertaking the subsequent right turn manoeuvre. The swept path also indicates a HGV requiring the full width of the L8763 carriageway when travelling from one section of the access road to the other.

Inter-visibility between drivers exiting the proposed access road onto the L8673, and drivers approaching the new staggered junction on the L8763, however, may be restricted by the horizontal curves on the L8673, particularly to the south, leading to drivers entering the local road when it is unsafe to do so, resulting in side-on collisions with other road users on the L8763.

This problem may be exacerbated should a driver approach the staggered junction on the L8763 particularly while a HGV is completing their turn from one section of the access road to the other, but after they have left the access road junction.

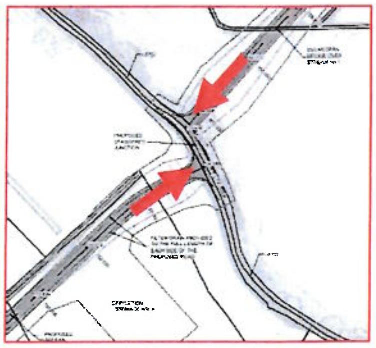
Recommendation

Provide sufficient inter-visibility between HGV drivers travelling between the two sections of access road and oncoming drivers on the L8763, or consider controlling this manoeuvre via a flagman.

3.8 Restricted Forward Visibility on L8763

Location: *Drawing no. CPA-HAL-NR-XX-PL-3000 (Rev. P01) & CPA-HAL-NR-XX-DR-PL-2000 (Rev. P03)*

Summary: *The crest in the vertical align of the proposed access road on both approaches to the junctions with the L8763 may restrict a driver's forward visibility to a vehicle stopped at the junction, or towards a vehicle turning into the access road.*



A vertical crest, and steep uphill gradient (7%), is indicated on the new access road on both approaches to the junctions with the L8763. This may lead to a driver's forward visibility towards a vehicle stopped at the junction, or a vehicle turning into the new access road, being restricted, resulting in them failing to moderate their speed on approach and rear end shunts with vehicles stopped at the junction, or head-on/side swipe collisions with vehicles entering the access road.

This problem would be exacerbated should a HGV be turning into the access road at the same time as an opposing vehicle approaches the junction as the swept path for this movement indicates these vehicles encroaching into the opposing traffic lane when turning from the L8763

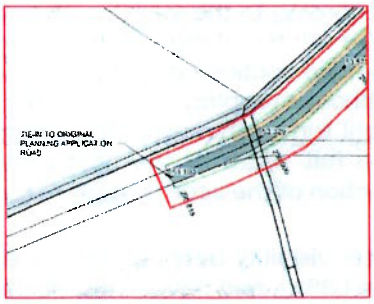
Recommendation

Sufficient forward visibility should be provided on the new access road on the approaches to its junctions with the L8763.

3.9 Construction Plan

Location: *Drawing no.CPA-HAL-NR-XX-DR-PL-2000 (Rev.P03)*

Summary: ***It is unclear if the Original Planning Application Road will still be constructed, and operate, at the same time as the proposed new access road, as no junction control has been indicated at their intersection.***



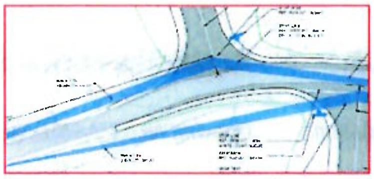
Information regarding the Original Planning Application Road has not been provided to the Audit Team, and this is indicated as intersecting/tying-into the proposed new access road at its south-western extents. It is, therefore, unclear if the Original Planning Application Road will be constructed, or operate, at the same time as the proposed new access road. If both roads are to be used simultaneously, no junction control, and thus priority, is indicated at their intersection. Should both roads operate at the same time, the absence of junction control may lead to drivers misunderstanding the priority at this location resulting in the risk of opposing drivers entering the junction simultaneously and an increased risk of side-on collisions.

In addition, there is a potential risk of sight through for outbound drivers on the proposed access road onto the Original Planning Application Road due to the road layout at this location. If both roads are in operation simultaneously this may lead to outbound drivers inadvertently entering the Original Planning Application Road where there is a risk of head-on collisions with opposing vehicles

Recommendation

If both roads are to operate simultaneously, modify the junction layout and provide appropriate junction control measures, such that priority is clear to drivers at this location.

4 Observations



4.1 Trees have been indicated within the visibility splays on the N65 and the L8673, on both sides of the new junctions, as per drawing no. CPA-HAL-NR-XX-DR-PL-5002 (Rev. P01). However, no existing vegetation, or hedgerow, is indicated as being removed on the drawing.

To avoid confusion during construction, the drawing should be annotated to advise that existing vegetation within the visibility splay will be removed and maintained regularly.

5 Audit Team Statement

We certify that we have examined the drawings referred to in this report. The examination has been carried out with the sole purpose of identifying any features of the design that could be removed or modified in order to improve the safety of the scheme.

The problems identified have been noted in this report together with associated safety improvement suggestions, which we would recommend should be studied for implementation.

No one on the Road Safety Audit Team has been involved with the design of the scheme.

ROAD SAFETY AUDIT TEAM LEADER

Alan O'Reilly Signed: [signature]

Dated: 26th January 2026

ROAD SAFETY AUDIT TEAM MEMBER

Xue Yan Signed: Xue Yan

Dated: 26th January 2026

6 Road Safety Audit Feedback Form

Road Safety Audit Feedback Form

Scheme: New Access Road, N65, Co. Galway

Route No.: N65, L8763

Audit Stage: 1 Date Audit Completed: 04/12/2025

	To be Completed by Designer			To be Completed by Audit Team Leader
Paragraph No. in Safety Audit Report	Problem Accepted (Yes/No)	Recommended Measure(s) Accepted (Yes/No)	Describe Alternative Measure(s). Give reasons for not accepting recommended measure. Only complete if recommended measure is not accepted	Alternative Measures or Reasons Accepted by Auditors (Yes/No)
3.1	Y	Y		
3.2	Y	Y		
3.3	Y	Y		
3.4	Y	Y		
3.5	Y	N	As part of detailed design, a Safety Barrier Risk Assessment will be undertaken to determine the need for the provision of safety barrier or mitigation measures to eliminate the need for safety barrier.	Yes
3.6	Y	Y		
3.7	Y	N	Traffic management control will be provided at the stagger junction to mitigate impacts between construction traffic and traffic on the public road.	Yes
3.8	Y	N	Traffic management control will be provided at the stagger junction to mitigate impacts between construction traffic and traffic on the public road.	Yes

Road Safety Audit Feedback Form

Scheme: New Access Road, N65, Co. Galway

Route No.: N65, L8763

Audit Stage: 1 Date Audit Completed: 04/12/2025

	To be Completed by Designer			To be Completed by Audit Team Leader
Paragraph No. in Safety Audit Report	Problem Accepted (Yes/No)	Recommended Measure(s) Accepted (Yes/No)	Describe Alternative Measure(s). Give reasons for not accepting recommended measure. Only complete if recommended measure is not accepted	Alternative Measures or Reasons Accepted by Auditors (Yes/No)
3.9	Y	N	The original planning application road will be utilised for operation purposes only.	Yes

Jason Walsh (Trasky Ltd.)

Signed: [signature] Designer Date 09/01/2026

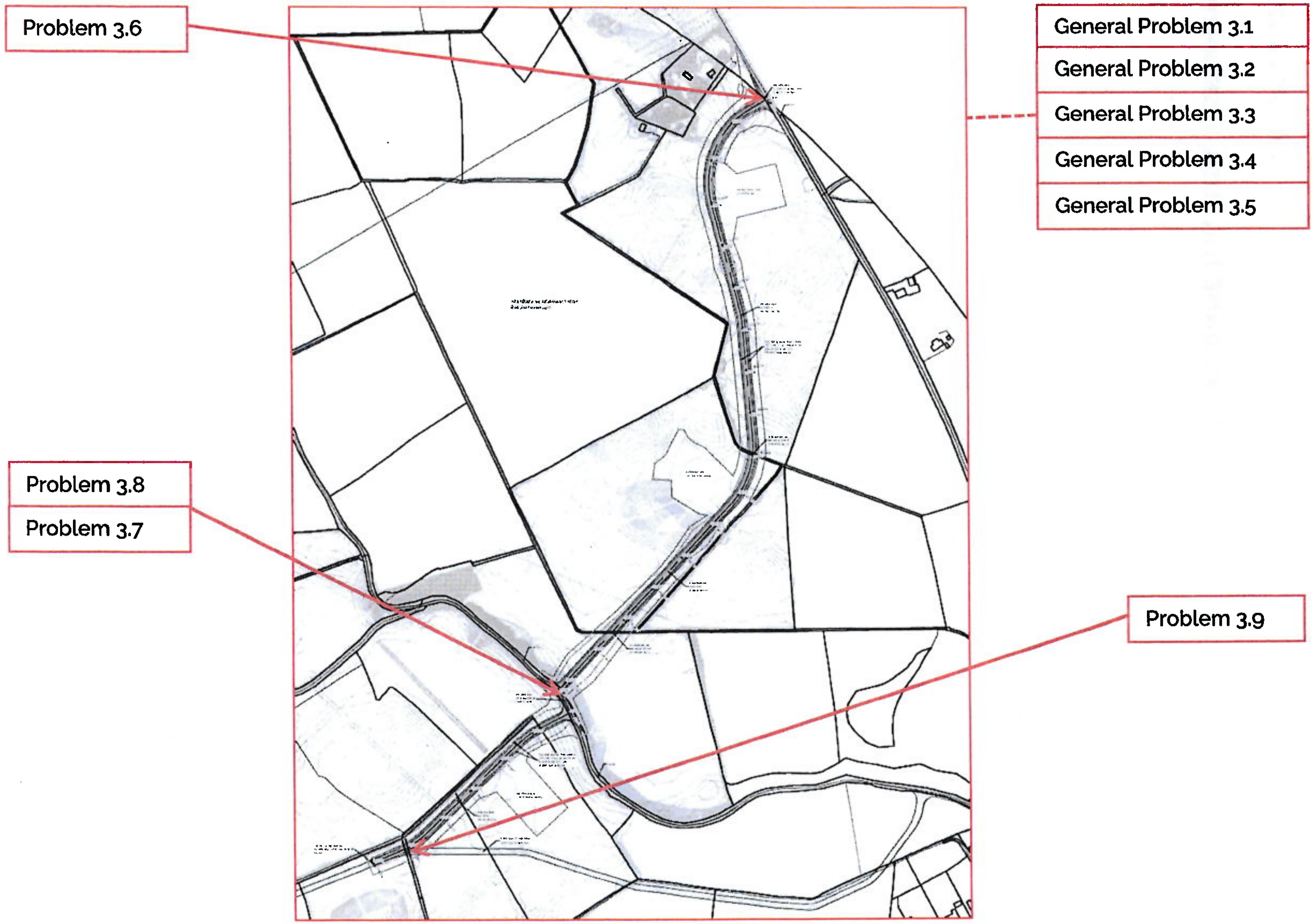
Signed: [signature] Audit Team Leader Date 26th January 2026

Signed: ____________ Employer Date ____________

Appendix A - Documents Submitted to the Road Safety Audit Team

DOCUMENT/DRAWING TITLE	DOCUMENT/DRAWING NO.	REV.
Proposed Site Location	CPA-HAL-NR-XX-DR-PL-1000	P03
New Access Road Layout	CPA-HAL-NR-XX-DR-PL-2000	P03
Longitudinal Sections Roads	CPA-HAL-NR-XX-PL-3000	P01
Access Road Typical Details	CPA-HAL-NR-XX-PL-4000	P01
N65 Junction & Staggered Junction Layout	CPA-HAL-NR-XX-DR-PL-5000	P01
Proposed Junction Road Markings and Visibility Splays	CPA-HAL-NR-XX-DR-PL-5001	P01
Swept Path Analysis	CPA-HAL-NR-XX-DR-PL-5002	P01
Stream Crossing Details	CPA-HAL-NR-XX-PL-6000	P01
Appendix 13.6 – Construction Access Option 2 – Traffic Calculations		
Appendix 13.7 – Construction Access Option 2 – Modelling Results		

Appendix B – Problem Locations


Problem 3.6
Problem 3.8
Problem 3.7
General Problem 3.1
General Problem 3.2
General Problem 3.3
General Problem 3.4
General Problem 3.5
Problem 3.9

APPENDIX 17.1

ENVIRONMENTAL RISK ASSESSMENT

COMAH SUPPORT FOR PROJECT COOLPOWRA

Project Coolpowra Environmental Risk Assessment

Halston Environmental and Planning Limited

Report No.: 2, Rev. 2
Document No.: 2246099
Date: 2026-02-02

Project name:	COMAH SUPPORT FOR PROJECT COOLPOWRA	DNV Services UK Limited
Report title:	Project Coolpowra Environmental Risk Assessment	Applicon House,
Customer:	Halston Environmental and Planning Limited,	Exchange St.
	IHub Building	Stockport SK3 0EY
	Westport Road	United Kingdom
	Castlebar	Tel:
	F23 K162	GB 440 60 13 95
	Co. Mayo	
	Ireland	
Customer contact:	Colm Staunton	
Date of issue:	2026-02-02	
Project No.:	10510406	
Organisation unit:	Manchester Risk Advisory	
Report No.:	2, Rev. 2	
Document No.:	2246099	

Applicable contract(s) governing the provision of this Report: 1236811

Objective:

To carry out an environmental risk assessment of the Project Coolpowra planning application stage

Prepared by:	Verified by:	Approved by:
John Fraser Senior Consultant	Tomi Owolabi Principal Consultant	A Hynds Head of Section

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Keywords:
ERA, CDOIF, Environmental, COMAH

Rev. No	Date	Reason for Issue	Prepared by	Verified by	Approved by
0	2024-05-20	First issue	J Fraser	M Simms	M Simms
1	2024-05-24	Draft Second issue incorporating update to hydrology information	J Fraser		
2	2026-01-30	Incorporation of TLUP Guidance	J Fraser	T Owolabi	A Hynds

DNV

Table of contents

1 EXECUTIVE SUMMARY

This report presents the Environmental Risk Assessment for the Project Coolpowra planning application stage.

The ERA methodology follows the Source-Pathway-Receptor model outlined in the Chemical and Downstream Oil Industries Forum (CDOIF) Guideline on Environmental Risk Tolerability for COMAH Establishments. The source of environmental risk identified was diesel from three liquid fuel tanks with a capacity of 7333m^3 each.

One Source-Pathway-Receptor trio with MATTE potential was identified as the release of approximately 6196 tonnes of diesel stored in 7333m^3 liquid fuel tank capacity impacting on the Kilcrow River

The overall unmitigated level of risk posed by the establishment from the release of diesel to the Kilcrow River was found to be in the tolerable if ALARP (TifALARP) on the CDOIF risk matrix. Following the identification of the control measures in place and their probability of failure on demand, it was found that the level of mitigated risk posed by the establishment to the Kilcrow River falls into the Broadly Acceptable region.

2 INTRODUCTION

Project Coolpowra is a proposed Reserve Gas-Fired Power Generator, GIS Electrical Substation and Energy Storage System.

Halston Environmental and Planning Limited (Halston) is to produce an environmental risk assessment (ERA) as part of its COMAH HSE submission on behalf of Coolpowra Flex Gen Limited (the Applicant). The Health and Safety Authority (HSA) can request it to see the ERA. DNV has been subcontracted by Halston Environmental and Planning Limited to carry out the ERA in support of the Environmental Impact Assessment Report (EIAR) and Land Use Planning application. The EIAR contains 3 planning applications as follows:

- Project 1: a Reserve Gas-Fired Generator, which was lodged with the Commission on 04 July 2024 (Case Ref.: PA07.320095) under Section 37A of the Planning and Development Act 2000 (as amended) (hereafter referred to as "the P&D Act"),
- Project 2: An Energy storage system (ESS) facility, which was lodged with Galway County Council (GCC) on 08 July 2024 (GCC Case Ref. 2460845) under Section 34 of the P&D Act. An appeal to the Commission (Case Ref. PL07.320916) was lodged by the applicant on 26 September 2024 following the decision of GCC to refuse permission for the development, and
- Project 3: a 400kV Gas Insulated Switchgear (GIS) substation, which was lodged with the Commission on 04 July 2024 (Case Ref. PA07.320094) under Section 182A of the P&D Act.

The Chemicals Act (Control of Major Accident Hazards involving Dangerous Substances) Regulations 2015 (S.I. No. 209 of 2015) (the "COMAH Regulations") (Ref. /1/), implement the Seveso III Directive (2012/18/EU) and aim to prevent and mitigate the effects of major accidents involving dangerous substances which can cause serious harm to people and/or the environment, with the overall objective of providing a high level of protection in a consistent and effective manner. The site development qualifies as a "lower tier" site under the COMAH Regulations 2015 as it holds quantities of dangerous substances above threshold quantities specified in Schedule 1 of the COMAH Regulations 2015 (Ref. /1/).

The ERA outlined in this document has been undertaken in accordance with the Chemical and Downstream Oil Industries Forum (CDOIF) Guideline on Environmental Risk Tolerability for COMAH Establishments (Ref. /2/), the Guide to the Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015 (S.I. No. 209 of 2015) (Ref. /3/) and the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Enforcement Regulations, 2008 (Ref. /4/). The CDOIF guideline for carrying out ERAs is an industry wide accepted methodology.

3 RISK ASSESSMENT METHODOLOGY

3.1 What is a Major Accident to the Environment?

It is not possible to provide a scientific definition of changes in the environment caused by an event at an establishment that would constitute a major accident to the environment. However, the more extensive the areas and quantities of natural and semi-natural resource damaged, the longer the effects are likely to last, and the more intense or severe these effects, then the more likely it is that the event will be regarded as a major accident to the environment by the competent authority. Moreover, if the event affects national or international sites designated for nature conservation purposes then the event is likely to be regarded as a major accident at lower thresholds than those that apply to other designated areas, amenity areas, the wider countryside or the more common types of agricultural land. As a general rule, the specific threshold levels that apply to other designated sites, scarce habitats and more widespread habitats vary in relation to the importance of the particular type of site.

In the most general terms, major accident hazards to the environment will be those where events have the potential to: (i) pose knock-on threats to human health by contamination of food or drinking water or impacts on sewage treatment regimes; (ii) affect large areas of land designated for conservation, amenity or planning purposes. Note that large in an ecological sense may include extensive agglomerations of fragmented habitats; (iii) be long-term or persistent and/or inhibit natural processes of regeneration; (iv) be severe by causing significant permanent or long-term damage to the ecosystem (direct, indirect, or knock-on), such as reduced breeding success of protected species, or reduced biodiversity of protected habitats (including local or national extinctions of protected species), or destruction/reduction in quality of a significant proportion of the area of a rare habitat (Ref. /5/).

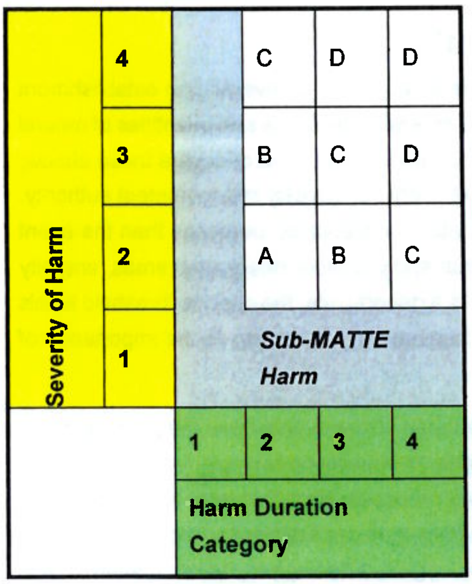
3.2 Environmental Risk Assessment Approach

DNV's environmental risk assessment methodology follows the Source-Pathway-Receptor model that is outlined in the CDOIF (Ref. /2/) and DETR Guidelines (Ref. /5/). The assessment involves the following steps which are described below:

1. **Source-pathway-receptor assessment -** The first stage involves a detailed assessment of the materials stored on site, identification of the natural and man-made receptors surrounding the site and the pathways leading from the site to these receptors.

2. **Determination of the severity and duration of harm to receptors –** to determine the consequence level for each unmitigated liquid, gaseous and ignited release event, the severity levels, S1, S2, S3 and S4 for significant, severe, major and catastrophic respectively were established.

Three approaches are used to determine the severity of harm caused by liquid releases. These include an oil slick approach and an LC_{50} approach for releases on water and analysis of a representative pool diameter for releases on land. These are described later in Section 3.2.1. For particular species, the severity of harm is based on an estimate of the proportion of the national population which is affected, if a release impacts the receptor where the species is resident. Once established, these severity levels are then compared with the likely duration of harm D1, D2, D3 and D4 for short term, medium term, long term and very long term respectively to establish a consequence level between A and D as shown in the matrix presented in Figure 3-1. The reference tables from the CDOIF guidelines (Ref. /2/) used to establish the consequence levels and the duration of harm categories associated with each MAH scenario are shown in Appendix A. The method used for predicting the duration of harm caused by the release scenarios to the environmental receptors is presented in Section 3.2.2.



Frequency at which the CDOIF consequence level is reached or exceeded	Frequency per receptor per establishment per year	
	Intolerable (greater than)	Broadly Acceptable (less than)
A	1.0 E-02	1.0 E-04
B	1.0 E-03	1.0 E-05
C	1.0 E-04	1.0 E-06
D	1.0 E-05	1.0 E-07

Figure 3-1: Method and matrix for determining MATTE consequence level and corresponding receptor frequency tolerability thresholds

3. **Quantification of unmitigated risk to receptors** – the frequencies of the unmitigated occurrences of any scenarios qualifying as MATTEs are determined using site specific or generic quantitative risk assessment (QRA) data. This includes similar releases of the material which could follow the same pathway to the receptor. These frequencies are aggregated to determine the total unmitigated risk posed to each receptor by the establishment. A comparison of the unmitigated risk posed to each receptor against the criteria in the risk matrix presented in Figure 3-2 to establish whether the risk is intolerable, tolerable if as low as reasonably practicable (TifALARP) or broadly acceptable.

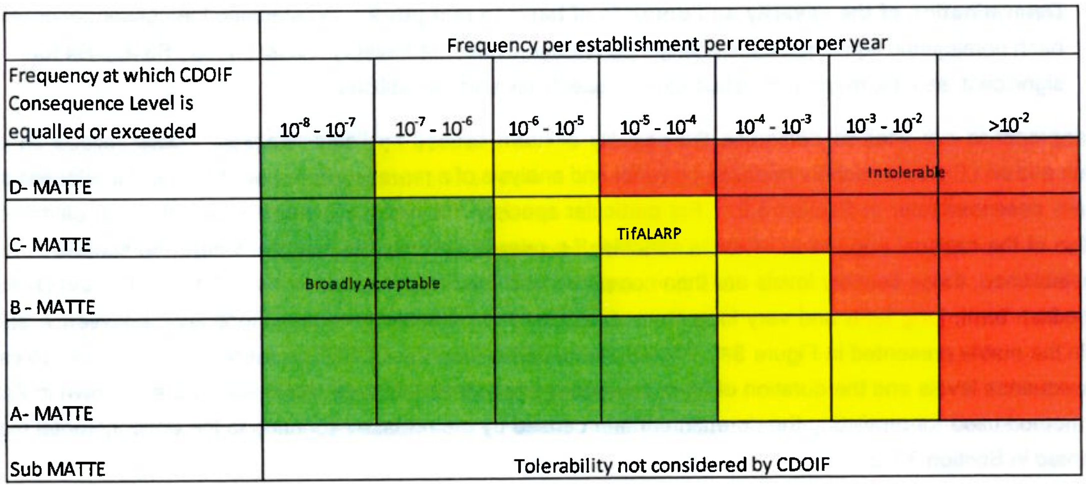


Figure 3-2: CDOIF Risk Matrix

4. **Quantification of mitigated risk to receptors –** the frequencies of the unmitigated MATTE scenarios are multiplied by the probability of failure on demand (PFD) of any relevant protection layers on the site. These mitigated frequencies are aggregated to determine the total mitigated risk posed to each receptor by the establishment. The mitigated risks posed to each receptor are again compared to the criteria in the risk matrix presented in Figure 3-2 to establish whether the risk is intolerable, TifALARP or broadly acceptable.

5. **ALARP demonstrations if necessary -** Operators may be required to conduct a ALARP demonstration if the mitigated level of risk posed by the establishment to any of the surrounding receptors is found to be intolerable or TifALARP.

3.2.1 Determining Severity of Harm to Receptors

Harm to Water Receptors

Two approaches are used to determine the severity of harm caused by a liquid release to a water based environmental receptor. These are based on a lethal concentration (LC_{50}) of material in the receptor and the critical thickness of an oil slick. The type of approach applied depends on the properties of the material being released. For releases onto land, an approach based on a representative diameter for liquid pool is used.

If a release can reach a receptor where particular species can be found, the severity of harm is assessed using the MATTE tolerability tables in Appendix A.

1. LC_{50} Approach

An LC_{50} approach can be used to determine the severity of harm caused by water soluble substances which can exert toxic effects on aquatic life. The median lethal concentration, LC_{50} (lethal concentration, 50%) is the concentration of a substance required to kill half of the members of a tested population after a specified test duration. The value may be obtained by direct observation or from interpolation. LC_{50} values are a useful indicator of the substance's ecotoxicity with lower values indicative of increased toxicity. LC_{50} values can therefore define maximum allowable toxicant concentrations. As a general rule the longer the exposure time for a particular species, the lower the LC_{50} value. The reason for this observation is that it takes time for the compound to penetrate the bodies of test organisms to affect harm.

The following simple equation is then used to determine the minimum amount of material which could credibly cause a MATTE scenario:

$$\text{Mass of material for MATTE potential} = \text{Area of receptor} \times \text{Water depth} \times LC_{50}\ \text{value} \qquad (1)$$

2. Oil Slick Approach

The fate and behaviour of oil in the marine environment depends on many processes including dissolution, emulsification, oxidation and destruction, physical transport and the marine environment. According to "Offshore Environment" (Ref. /6/), it is stated that an oil slick with a thickness of less than 0.1 mm in the marine environment will tend to disintegrate into separate fragments and spread over larger and more distant areas. It is therefore assumed that a critical thickness greater than or equal to 0.1 mm is feasible for an oil slick that has the potential to cause a MATTE.

To calculate the minimum volume of material required to cause a MATTE to a receptor, the critical thickness of 0.1 mm is multiplied by the defined minimum threshold area for a MATTE in the receptor (Ref. /2/).

In addition, the way in which an oil slick breaks up and dissipates depends largely on how persistent the oil is. Light products such as kerosene tend to evaporate, dissipate quickly and naturally and rarely need cleaning up. Such products are termed non-persistent oils. Persistent oils, such as many crude oils, break up and dissipate more slowly and usually require a clean-up response. An oil slick usually drifts in the same direction as the wind, and as it does, it dissipates and thins.

Harm to Land Receptors

Liquid spills on land surfaces will spread to form pools, the extent of which will depend on a number of factors such as the ground surface and topography.

Low viscosity liquids (e.g. light distillates) spilt on concrete are assumed to spread to form pools with a uniform thickness of 5 mm. DNV's Safeti software is used for quantified risk assessment and sets this thickness value as a default for pools. This value is used for releases to areas of made ground within the site area. Liquids with higher viscosities (e.g. middle distillates and crude / heavy oils) that are spilt on concrete are assumed to spread to form pools with a uniform thickness of 20 mm. If liquid hydrocarbons are spilt onto unmade ground that is covered with vegetation they will form pools with significantly greater thicknesses due to the liquid hold-up provided by the vegetation. A value of 50 mm has been assumed in the case where crude oil is spilt onto unmade ground.

Harm to Soil and Groundwater Receptors

Liquids which are released to permeable ground will migrate downwards through the soil and potentially into groundwater layers due to the effect of gravity and capillary forces. For hydrocarbon releases, the depth and size of the plume depends on (Ref. /7/):

1. Properties of the hydrocarbon material – heavier hydrocarbons show lower rates of permeation through the soil due to their higher viscosity and tendency to adsorb to soil particles. On the other hand, BTEX (benzene, toluene, ethylbenzene and xylene) have lowest soil sorption coefficients and move quickly through the soil;
2. Properties of the soil – porosity and permeability are the two most important factors which influence liquid flow through the ground. Soils such as sand with high porosities and permeabilities allow for the fastest rates of permeation.

Hydrocarbons that have been released into the ground break down over time due to vaporisation and the action of bacteria in the soil. The length of time that the hydrocarbons remain in the ground depends on the molecular weight of the compound, with heavier hydrocarbons being more resistant to degradation than lighter ones. Hydrocarbons also degrade more quickly in hot and humid climates. In general, sub-surface hydrocarbon releases tend to degrade quite quickly – a field study of a crude oil spill site in India indicated that up to 75% of the hydrocarbons could be degraded within a year (Ref. /7/).

Accurately predicting the subsurface spread of hydrocarbons is difficult even with complex modelling solutions. DNV will employ a simplified semi-quantitative approach to determine the severity and duration of harm of releases. This approach will involve the following steps:

1. Determine if the released hydrocarbons have the potential to permeate through the soil layer and enter the groundwater layer depending on the properties of the released material and the properties and thickness of the soil layer.
2. If the hydrocarbon release can permeate into the groundwater layer, any BTX components and light hydrocarbons present in the material will be assumed to be able to spread indefinitely in the groundwater until they occupy a volume with a concentration greater than the legal or recommended concentration of the pollutant in question. It will be assumed that middle distillates and heavy hydrocarbons will not be able to spread easily within the groundwater layers due to their higher viscosities. The following simple equation is then used to determine the minimum amount of material which could credibly cause a MATTE scenario:

$$\text{Mass of material for MATTE potential} = \text{Groundwater area} \times \text{Groundwater table depth} \times \text{Legal limit of pollutant} \quad (2)$$

3.2.2 Determining Duration of Harm

The overall receptor tolerability for MATTE, as defined in Figure 3-1, is dependent on the level of harm caused by the incident and also the duration of that harm. A supporting document to the CDOIF guidance has been produced by ENVIRON titled 'Environmental Recovery Guide' - Supporting Guide to the Environmental Risk Tolerability for COMAH Establishments Guideline' (Ref. /8/). This document lays out a straightforward method for determining harm duration for any environmental release based on the chemical and receptor type under analysis. The guidance in the document is based on a review of around 300 case studies of environmental incidents in the CDOIF related industries and a review of monitoring studies of the Exxon Valdez incident.

The environmental recovery guidance document provides two flow charts, which are based on water habitats and land habitats, allowing the assessor to determine the harm duration. The flowcharts contain all 60 of the chemicals listed in the COMAH Regulations and split these substances by their ability to be broken down or dispersed in the natural environment. The flowchart then splits up different habitat (receptor) types by their ability to regenerate and their environmental sensitivity i.e. a river is classed as a different type of habitat to a coral reef. A harm duration category is then selected, for each potential MATTE event, based on the categories of chemical and habitat.

The recovery flowchart for water and land receptors is provided in Figure 3-3 and Figure 3-4 respectively. The method presented in Figure 3-3 is not applicable for firewater, so engineering judgement was used to determine the harm duration category.

The recovery time for each particular species is taken as the breeding lifecycle. The harm duration category is selected based on the relevant water or land habitat flowchart provided in Figure 3-3 or Figure 3-4.

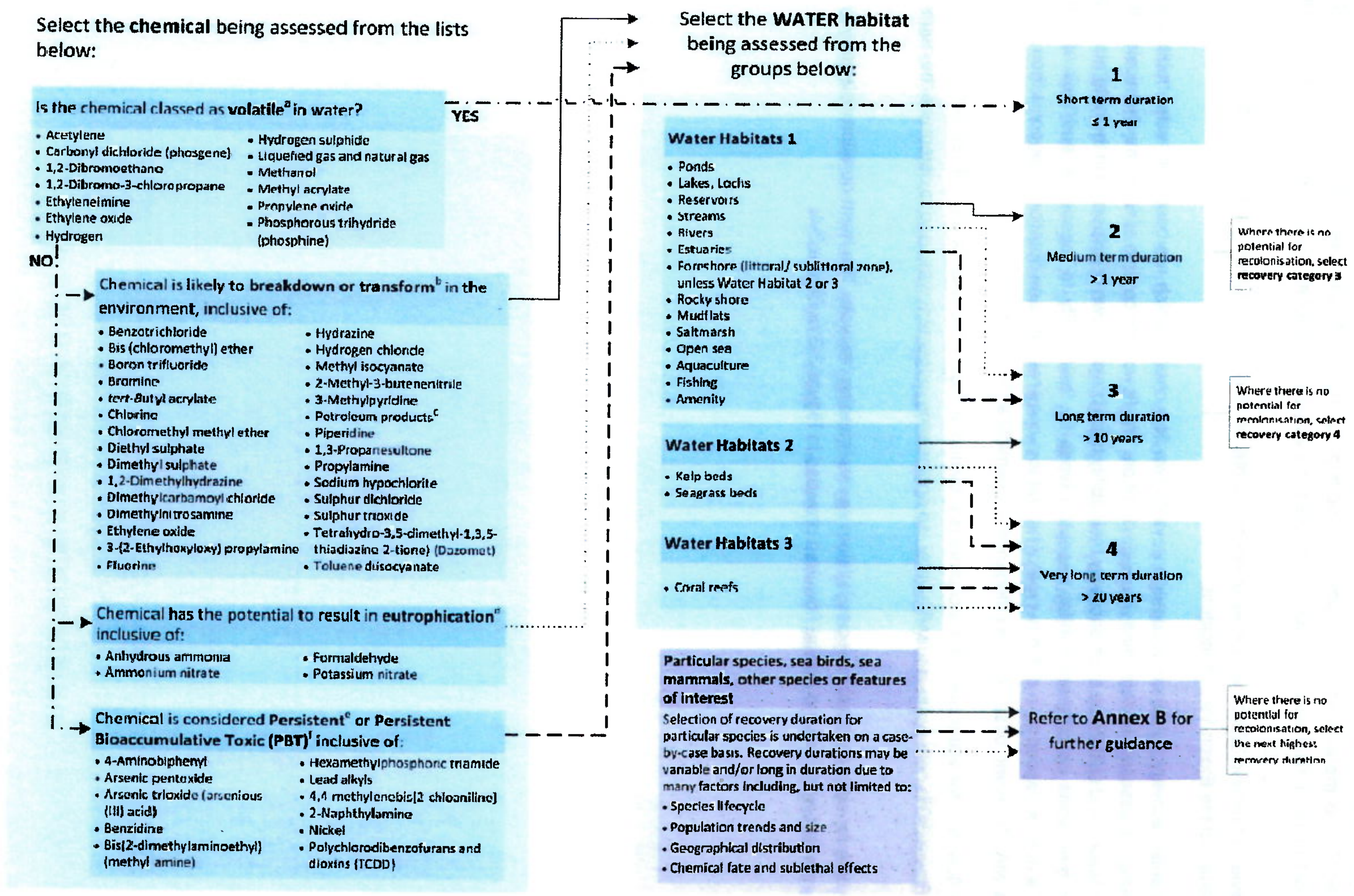


Figure 3-3: Recovery flowchart for water receptors (Ref. /8/)

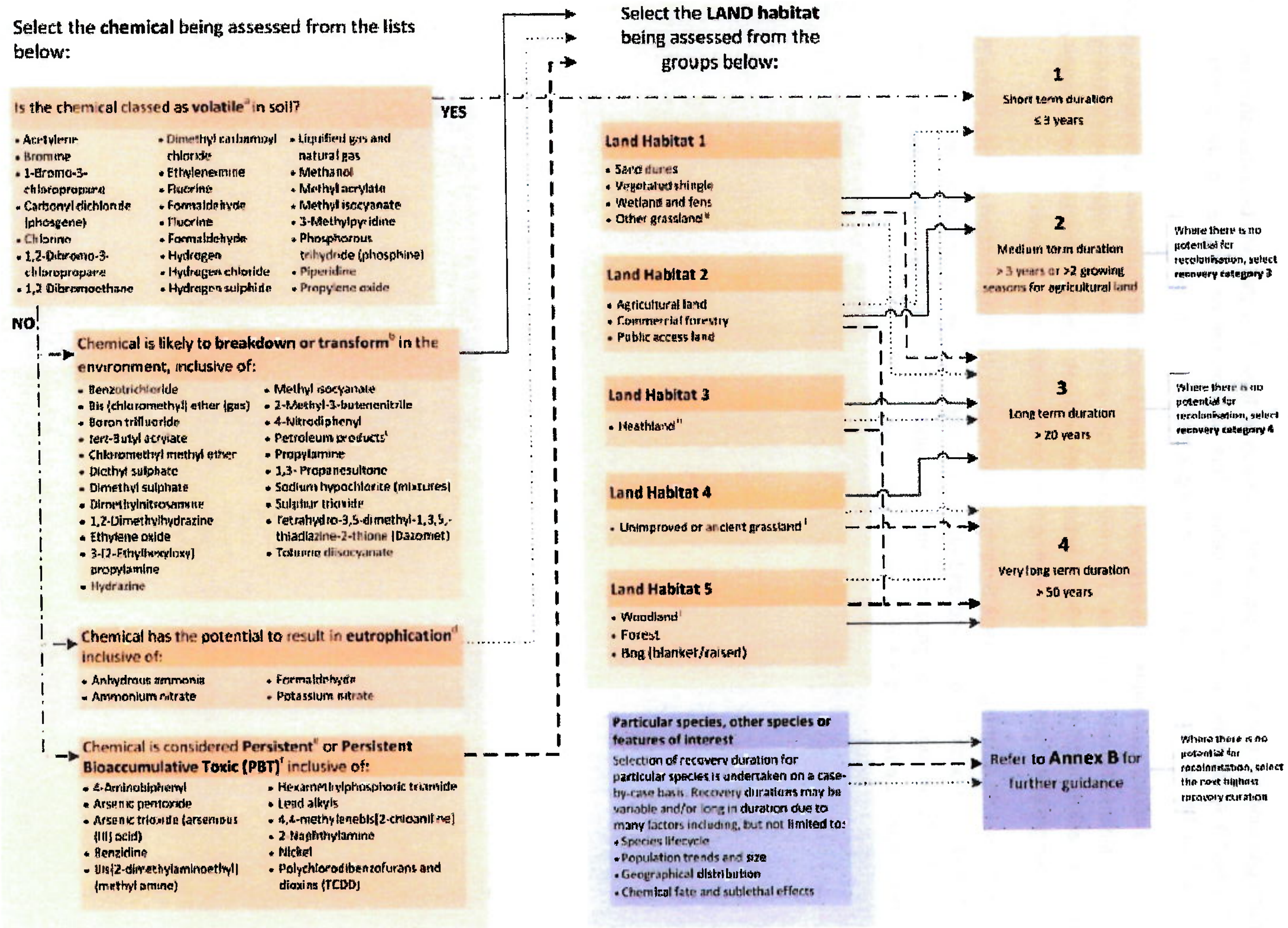


Figure 3-4: Recovery flowchart for land receptors (Ref. /8/)

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4 SITE DESCRIPTION

The proposed development is located in the townlands of Coolpowra, Cooldorragha, Ballynaheskeragh, Gortlusky and Sheeaunrush, County Galway, and is located approximately 4km north of Portumna and 3.1km south of Killimor. See Figure 4-1 for site location and Figure 4-2 for site layout plan.

The project includes a Reserve Gas-Fired Generator which comprises three opencycle gas-fired generator (OCGT) units located within a turbine hall, accompanied by auxiliary equipment, with secondary fuel (gas oil) stored in a bunded structure outside the turbine hall, alongside cooling equipment and other electrical plant items (e.g. transformers). The Reserve Gas-Fired Generator will include an above ground installation (AGI) compound.

An underground gas pipeline, designed to operate at pressures of 16bar or higher, will be established by Gas Networks Ireland (GNI) through a separate planning application. This pipeline will be directed to the proposed AGI at the development site from the nearest connection point on the gas transmission network.

The project includes a 400kV Gas Insulated Switchgear (GIS) Substation comprising a two-storey building positioned and secured within a palisade fenced compound. The proposed GIS will upgrade and replace the existing air insulated switchgear (AIS) substation with a new gas GIS substation at Oldstreet. The GIS substation will facilitate connection of the reserve gas fired generator and ESS to the existing node on the transmission network.

Finally, the project includes an energy Storage System which includes: (i) a long duration energy storage (LDES) battery (200MW) positioned in an outdoor compound and (ii) a synchronous condenser (400MVA electrical rating) positioned within a building. The technology is designed to complement and support the reserve gas fired generator by providing zero carbon, instantaneous power and balancing power to the grid.

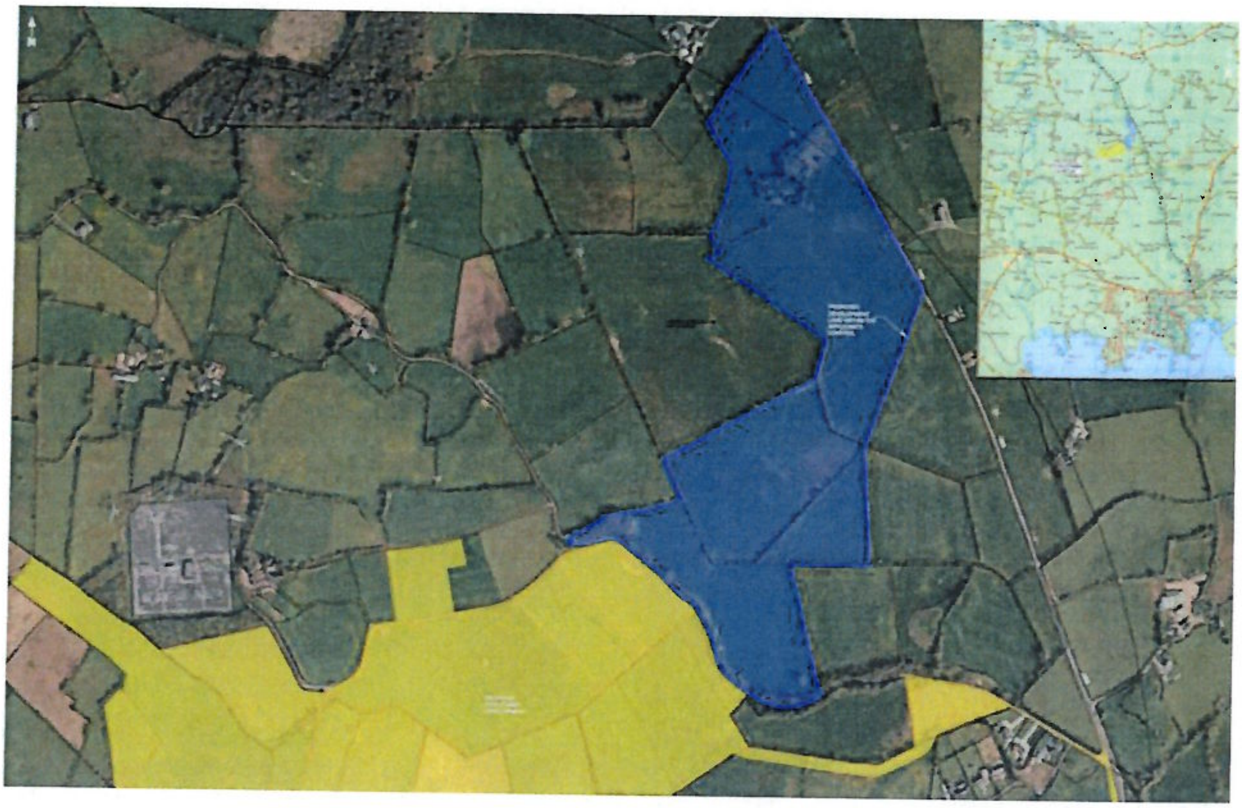

Figure 4-1 Site Location Plan

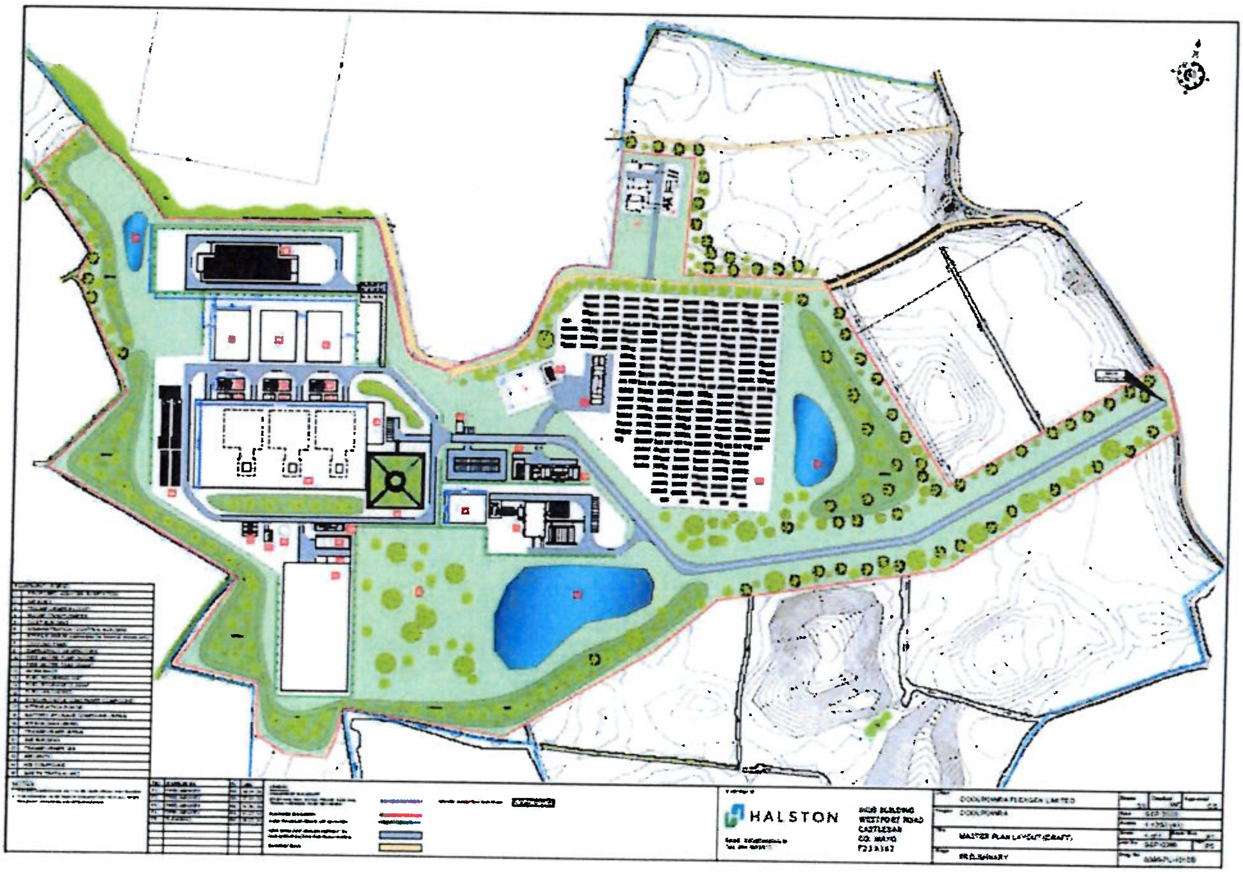

Figure 4-2 Site Layout Plan

5 BASELINE DESCRIPTION OF THE LOCAL ENVIRONMENT

The site setting descriptions are detailed in the Summary Description of Receiving Environment (Ref. /9/) and summarised in the following sections.

5.1 Topography

Lands within the development site boundary are in agricultural use and include a farmhouse and outbuildings which will be demolished. The proposed lands are situated at an elevation of c. 51-54m.

5.2 Geology

Bedrock Formation Beneath the site is Visean basinal limestone "Calp" described as Dark-grey argillaceous & cherty limestone & shale. Soils on the site are described as Mullabane (Teagasc Code 1100q) and described as mostly Brown Earths and Calcareous Brown Eaths on drift with limestones, associated with Luvisols and some inclusions of Rendzinas and peat.

5.3 Soil and Sediment

The soils are classed as well drained (Type BminSW). The Killimor Esker (Code GY078), a moderate-sized ridge comprised of esker sands and gravels, deposited under the ice sheet and trends east west is located 2.6km north of the site at its nearest point.

5.4 Groundwater

The bedrock aquifer beneath the site is a locally important aquifer with bedrock which is moderately productive only in local zones (Aquifer Category Ll). Aquifer vulnerability is classed as moderate mainly with the exemption of the south-western corner of the site where vulnerability is classed as high with some outcropping rock /rock near the surface,

There are no karst features (including Turloughs) within the boundary of the proposed development lands; the closest karst feature being Pollnabreeka Spring, an enclosed depression approximately 2.8km south of the site. There are no known (recorded by GSI) groundwater abstraction wells within 4km of the site.

5.5 Hydrology

The site is within the Lower Shannon Hydrometric Area (River Basin District IEGBNISH), which has an area of 5,032km^2. The application site is primarily within the Lower Shannon catchment (catchment ID 25B) with the western part of the site bordering Lower Shannon catchment ID 25B. Desktop studies show that the proposed development lands are contained in the Gortaha_010 and Kilcrow_070 WFD River subbasins. There are a number of field ditches and streams within the proposed development site. The main watercourse within the development land is the Ballynaheskeragh stream (also known as GORTAHA_010) which is shown (see Figure 5-1) to be flowing generally in a north western and discharges to the Kilcrow River.

The Kilcrow River is located approximately 1.8km west of the development land boundary and it flows generally in a southern direction and through Barroughter Bog SAC approximately 9km downstream of the site, before flowing into Lough Derg (Shannon) SPA (Code 004058) /Lough Derg, North-east Shore SAC (Code 002241) a further 1.1km downstream of Barroughter Bog SAC.

Figure 5-1: Ballynaheskeragh Stream and Kilcrow River Flow Path

5.5.1 Flooding

The application site boundary is located within (fluvial) Flood Zone C (low probability of flooding) as confirmed by a review of Office of Public Works(OPW) available flood mapping. Historical flood events are recorded by OPW. A review of the online historical data indicates that there is no record of past flooding events mapped within a 2km radius of the application site. The application site is located on lands with clear drainage paths away from the site, so the risk of pluvial flooding is categorised as low. There is no groundwater flood risk as identified from a review of Groundwater Flood Probability Maps prepared by Geological Survey Ireland. No Areas of Further Assessment (AFA) are identified at the proposed site in the Strategic Flood Risk Assessment (SFRA) for the Galway CDP 2022-2028.

5.6 Cultural Heritage

There are no listed or known architectural heritage, archaeological monuments or geological heritage sites within the proposed development site.

5.7 Biodiversity, Flora and Fauna

There are no protected sites within the development land. Capira/Derrew Bog NHA (Site code 001240) is 1.3km east of the site and is the closest designed site. Ardgraigue Bog SAC (Site Code 002356)/pNHA (Site Code 01224) is 3.7km northwest of the site and Middle Shannon Callows SPA (Site Code 004096) /River Shannon Callows SAC/pNHA (Site Code 000216) is 5.2km at its closest point southeast of the site.

A map showing the location of European Sites (SAC, SPA) within a 15km radius of the proposed development lands is presented in Figure 5-2.

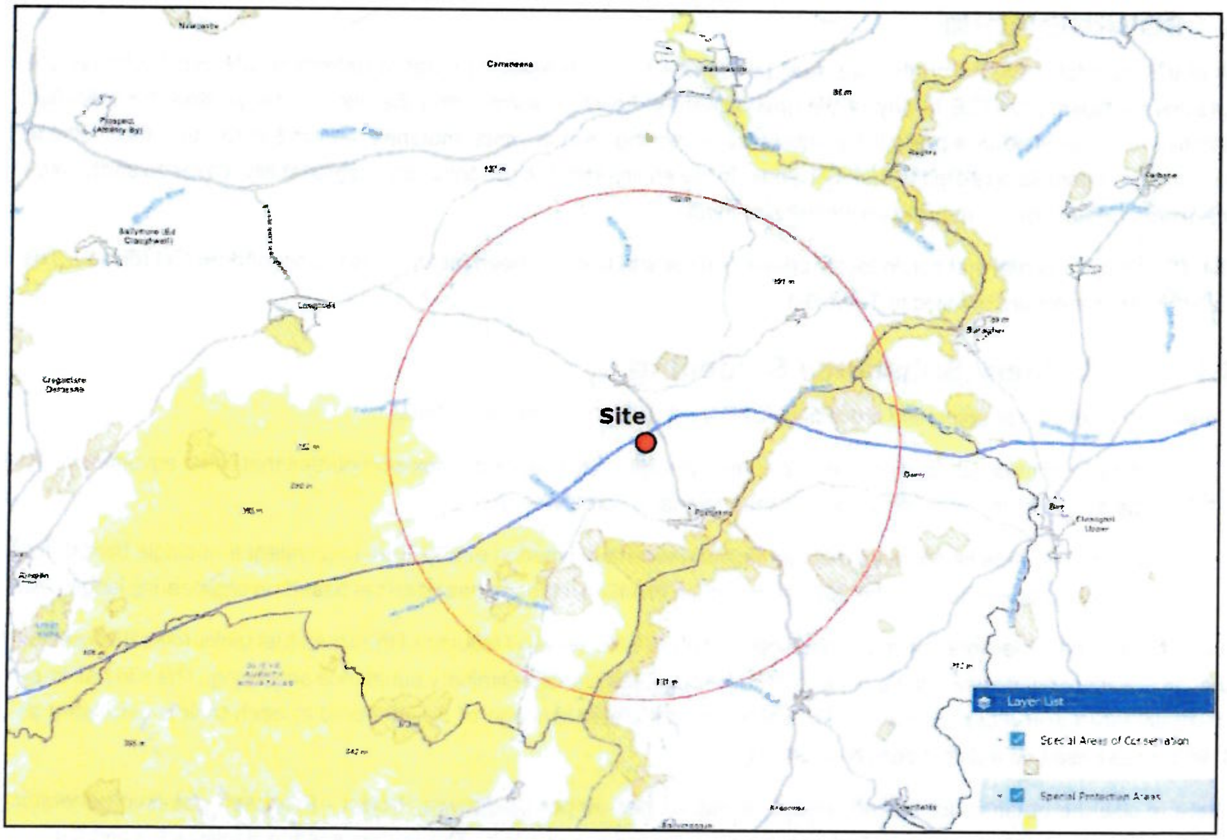

Figure 5-2 European Sites (15km radius from the site presented) along with the 400kV power line

5.8 Landscape and Visual

The proposed development is located within the 'Eastern Plains Region', which 'derives most of its character from the covering blanket of glacial soils that give rise to extensive, level plains of grasslands, with many areas of bog in the north'. Within this landscape region, the site is within the 'Central Galway Complex Landscape' Type, described as 'Level plain of productive grassland containing many settlements and dwellings'. The site sensitivity is classed as 'Low', the lowest degree of sensitivity, and defined as 'unlikely to be adversely affected by change'. Whilst a considerable number of designated scenic routes are located throughout County Galway, according to the Galway CDP 2022-2028 none of these occur within the 2km study area. The area in which the proposed development site is located is typical productive rural landscape that is not considered rare or distinctive at national or regional level.

The proposed development will be located adjacent to, and south of, the existing operational 400kV AIS electricity substation (Oldstreet). The proposed site was chosen as the preferred site following analysis of sites along the two 400kV transmission lines which runs from Moneypoint to the east coast of Ireland. The site adjoins the 400kV line which routes from Moneypoint to Oldstreet (an intermediate substation) and then to Woodland, where there is a connection to the East West Interconnector (EWIC)1. Oldstreet is the only substation along the HV line between Moneypoint and Woodland.

5.9 Air Quality and Climate

The site is located in Air Zone D (rural Ireland, i.e. remainder of the state excluding Zones A, B and C). According to the Environmental Protection Agency (EPA), the Air Quality Index is classed as 3 (Good).

6 SOURCE TERM

All of the materials handled on the site must be identified and assessed in order to determine whether they have the potential to cause a MATTE to any of the environmental receptors surrounding the site. In this section, the identified materials are assessed in a preliminary substance screening step in which materials are screened out if their release quantities or parameters related to their behaviour in the environment (e.g. ecotoxicity, degradability, water solubility, etc.) are deemed insufficient to result in environmental harm.

The only dangerous material continuously present on the site that has been identified is the secondary fuel (diesel). The material parameters are detailed in Table 6-1.

6.1 Preliminary Substance Screening

A preliminary substance screening process is conducted using the following criteria:

1. Where the material does not have any physical, chemical, toxic or eco-toxic properties that could adversely affect the environment following a release, the material is screened out.
2. Where the material does not meet a minimum inventory criterion of 250 litres (equivalent to a single barrel), the material is screened out. The 250 litre minimum inventory criterion has been set based on engineering judgement.

The ERA considers the worst-case unignited catastrophic (full-inventory) failures of the liquid fuel tanks (diesel) stored on site. All releases are assumed to be unignited for the purposes of the preliminary substance screening. The site has three liquid fuel tanks with a capacity of 7333m^3 each. The calculated tonnage of diesel stored in each tank is calculated as 6196 tonnes based on a diesel density of 845 kg/m^3.

There is also the potential for ignited release of natural gas as per Coolpowra Project - Proposed gas-fired generator which will combust natural gas supplied from the GNI transmission system. This is discussed in Sections 9.3 and 9.4.

The proposed 400kV Gas Insulated Switchgear (GIS) Electrical Substation may contain a greenhouse gas such as sulphur hexafluoride which is identified as a non-flammable and non-toxic gas and unlikely to cause a MATTE.

Finally, thermal runaway of the of the LDES batteries is likely to result in the evolution of toxic gases particularly Hydrogen Fluoride. Other gases such as Hydrogen, Methane, Ethylene and Carbon Monoxide may also be produced. Based on Classification, Labelling and Packaging (CLP) none of these are formally classified as hazardous to the environment. However, Hydrogen fluoride readily dissolves in water or moisture to form corrosive hydrofluoric acid. Hydrofluoric acid, whilst not formally classified as hazardous to the environment can result in damage through soil acidification, groundwater contamination, and harm to aquatic/terrestrial life. Therefore, firewater runoff from a LDES battery fire is considered a Source Term and is discussed in Section 9.2.

6.2 Summary of Representative MATTE Scenarios

The representative scenario is the release of approximately 6196 tonnes of diesel stored in one of the liquid fuel tanks or road tanker on the site. This is the worst-case unignited catastrophic (full-inventory) release scenario. The release of diesel representative scenario will be assessed to determine whether it has the potential to cause a MATTE to one of the identified environmental receptors surrounding the site.

Table 6-1 List of Materials Held on Site with Chemical Properties

Material	CAS No.	Composition	Solubility in Water	Other Physical and Chemical Properties	Toxicity	Aquatic Toxicity	Degradability	Bioaccumulation	Comment
Diesel		Mixture of C9-C25 hydrocarbons	Insoluble	State (ambient conditions): liquid Boiling point: 170-390 °C Flash point: 55-75 °C Density: 820-845 kg/m^3 Flammability: flammable	Rat (inhalation): LC_{50} 4.1 mg/L (4 h)	Invertebrates: *Daphnia magna* (water flea): EL_{50} (48 h) 68 mg/l Fish: LL_{50} (96 h) 65 mg/l	Biodegradable	Not expected to bioaccumulate	Spillages may penetrate the soil and accumulate in sediments.

7 PATHWAY TERM

The pathways describe how unignited and ignited releases can potentially make their way offsite and into the surrounding environment via air, water and land pathways. At this stage of the assessment, it is assumed that no mitigation measures (for example bunds and tertiary containment) are in place.

7.1 Releases to Atmosphere

For substances that are released to atmosphere, the pathway of dispersion through air and subsequent deposition is viable. Atmospheric release scenarios include:

1. Transmission of thermal radiation, flame and overpressure through the atmosphere.
2. Dispersion and subsequent deposition of gaseous/vapour releases (including fire plume gases) through the atmosphere.
3. Atmospheric deposition of solids/liquids (for example from boilover events).

7.2 Releases to Water

There is potential for a release to the Ballynaheskeragh stream which flows within the proposed development land. Any release into this water course then has potential to continue to the Kilcrow River

7.3 Releases to Ground

For scenarios that result in releases with the potential for environmental damage that are transported by land, the existence of a complete source-pathway-receptor linkage is more complex and the pathway component of the linkage may be scenario location specific. The following land pathways have been considered:

1. Overland flow of the substance from point of release to receptor. This is more likely to occur where the ground at the point of release is impermeable, either through the presence of made ground or natural conditions.
2. Throughflow of material through the ground – the substance is released onto permeable ground and then flows laterally through the sub-surface over a short distance to surrounding environmental receptors. In this case, the soil layer would be considered to be both a receptor and a pathway.
3. Groundwater flow – the substance is released onto permeable ground and percolates through the surface layers into groundwater. Further dispersion through the groundwater may then occur, potentially leading to the exposure of more distant environmental receptors. In these cases, the groundwater can be both a receptor and a pathway.
4. Flow of released material offsite via the drainage system.

A discussion on whether the abovementioned land pathways present credible pathways that can result in the transportation of released material from specific points of release on site to any of the surrounding environmental receptors is given in the subsections below.

7.3.1 Overland Flow

Released liquids will be able to reach the surrounding environmental receptors via overland flow if the gradient of the land slopes in the direction of the receptors, the flow pathway is not excessively long and there are no significant impediments to flow (e.g. vegetation).

The site development is within agricultural pastures and the overall topography of the site has been considered to be flat. Any liquid releases are therefore expected to spread out form circular pools around their point of release.

DNV

7.3.2 Throughflow and Groundwater Flow

The three liquid fuel tanks storing diesel have a bund. Which is designed to contain at least 110% capacity of a single tank within. Pumping of water from bunds can only be manually initiated by an operator following inspection of the water within the bund. In the event of a spillage from an unloading fuel tanker the liquid will runoff into a central gully. The spill will be detected by a below ground forecourt oil separator which will contain and store the liquid for removal off site. The retention separator will be capable of retaining the maximum spillage likely to occur for road tanker delivery. The below ground separator is designed to accommodate 150% of this volume.

However, there are areas outside of the tank bunds through which liquids can permeate. Where bund overtopping may occur, diesel is not expected to percolate quickly through the ground due to the viscosity dependence on outside temperature.

7.3.3 Releases via Site Drainage System

The structure of the site's drainage system is assessed to determine if there is a potential for collected material to be discharged offsite and into any of the surrounding receptors.

The drainage system is incorporates below-ground oil interceptors, a firewater retention tank, stormwater attenuation pond, silt sumps (at gully positions) and infiltration trenches. Large external areas/compounds at the site will be surfaced with stone /grassed areas to allow rainwater to percolate to the underlying soils (e.g., AIS compound, AGI and areas beyond the main compound areas but within the development site boundary).

The access roads to the site are to be drained utilising filter drains. These are to run longitudinally along the road and allow the stormwater to filter directly to ground /soils via infiltration trenches. Surface water collected from impermeable areas will be delivered to the site stormwater drainage system. Surface water will be routed via the fire wastewater retention tank and an oil/water interceptor prior to entering an attenuation pond. The outfall from the attenuation pond will be controlled using a hydrobrake which will limit the discharge of stormwater to the receiving watercourse to 9.4l/s (4l/s per hectare).

During times when chemicals are handled, isolation valves in the drainage system will be closed. This is to assure that accidently spilled chemicals do not enter the storm water drain. The isolation valves will only be opened again once it has been assured that contamination of the downstream system can be excluded.

Any overwhelming which occurs will follow the flow path discussed in Section 7.3.1 and 7.3.2. It is assumed that a flow pathway from the site to the Kilcrow River via the drainage system therefore exists.

8 RECEPTOR TERM

The receptors which are located nearest to the site development are considered to be at the highest risk of harm from unignited and ignited releases. An overview of the sensitive features that are found in the receptors that have been identified to be at the highest risk of harm from the site are given in the subsections below.

8.1 Kilcrow River

The Kilcrow flows from north to south, before joining the Duniry River which subsequently joins Lough Derg/River Shannon. The River Shannon empties into the Atlantic Ocean through the Shannon Estuary. The Kilcrow River is located approximately 1.8km which then flows for about 9km and meets Duniry River approximately 1km upstream of Lough Derg. Lough Derg is approximately 11km from the site.

8.2 Agricultural Land

The site development is within agricultural pastures and releases from the site may impact the agricultural pastures assumed to 200 ha of land surrounding the site.

8.3 Soil

The soil located below the site area within agricultural pastures is considered as a separate environmental receptor as per the CDOIF Guidelines (Ref./3/). This receptor group refers to the material at the earth's surface to a depth of 1 m.

8.4 Groundwater

The site development is located above an aquifer classed as being of moderate vulnerability and located within a locally important aquifer. The bedrock is moderately productive in local zones.

The flow of groundwater in the area is assumed to be from north to south, in line with the Kilcrow River flow direction. There are no groundwater drinking water protection areas within, or close to, the proposed site development lands.

For the purposes of this assessment, a single groundwater receptor with a depth of 12 m will be considered with properties equivalent to the Dinantian Pure Unbedded Limestone – Waulsortian Limestone aquifer.

8.5 Heritage Sites

There are no listed or known architectural heritage, archaeological monuments or geological heritage sites within the proposed development site.

8.6 Designated Areas

There are no protected sites within the development lands. Capira/Derrew Bog NHA (Site code 001240) is 1.3km east of the site and is the closest designed site. Ardgraigue Bog SAC (Site Code 002356)/pNHA (Site Code 01224) is 3.7km northwest of the site and Middle Shannon Callows SPA (Site Code 004096) /River Shannon Callows SAC/pNHA (Site Code 000216) is 5.2km at its closest point southeast of the site.

8.7 Summary of Receptors at Risk of Harm from Site

The environmental receptors that have been deemed to be at potential risk of harm from operations at the site are listed in Table 8-1 below. Details on the size and CDOIF designation of each receptor are also provided.

Table 8-1: Environmental receptors which may potentially be affected by Site Development

Receptor ID	Receptor Name	Size	CDOIF Designation
R1	Kilcrow River / Lough Derg	Kilcrow River - 22 km length, (9km under consideration) Lough Derg – 118km^2	Fresh and estuarine water habitats
R2	Agricultural Land	200 ha	Widespread Habitat – non-designated Land
R3	Soil	N/A	Soil or sediment
R4	Dinantian Pure Unbedded Limestone – Waulsortian Limestone aquifer	12 m depth	Not a groundwater source of drinking water
R5	Capira/Derrew Bog NHA	119 ha	Designated Area
R6	Ardgraigue Bog SAC	24.3 ha	Designated Area
R7	Middle Shannon Callows SPA	3750 ha	Designated Area
R8	River Shannon Callows SAC	5856 ha	Designated Area

9 DETERMINING MATTE POTENTIAL

The MATTE potentials of the unmitigated liquid and unignited gaseous release scenarios are determined in this section. The first step taken was to establish which of the surrounding receptors can be affected and then it was checked whether the quantity of material that is predicted to reach the receptor is sufficient to cause a MATTE. If the potential for a MATTE exists, the level of harm caused to the affected receptor is determined by establishing the severity of harm caused and the likely duration of harm of the effects of the release on the impacted receptor.

9.1 Unignited Liquid Scenario

The first step taken was to determine whether the released liquid have the potential to affect the surrounding environmental receptors by establishing whether flow pathways exist between the sources and receptors. The severity of harm caused to the affected receptors by the released material was then determined using the approaches described in Section 3.2.1 (LC_{50} approach, oil slick approach, etc.). The duration of harm caused to the affected receptors was then determined using the approach outlined in Section 3.2.2. The severity and duration of harm were then used to establish the MATTE consequence level to each receptor between A and D as shown in the matrix presented in Figure 3-1.

The representative unignited liquid scenario is the release of approximately 6196 tonnes of diesel stored in 7333m^3 liquid fuel tank capacity identified in the preliminary screening stage. The scenario is assessed to determine if there is a potential for a MATTE to any of the surrounding receptors. This scenario examines the release of diesel following a catastrophic failure of a 7333m^3 tank and represents the largest worst case single release of diesel. Details of the maximum releasable inventory and pool radius are presented in Table 9-1 below.

Table 9-1: Scenario of Diesel Release Details

Scenario Description	Release Location	Worst Case Quantity Released		Pool Radius (m)
		m^3	Tonnes	
Catastrophic failure of a diesel tank	Fuel Tank Bund Area	7333	6196	683
Failure over 10 minutes from diesel tank *				
10mm leak over 30minutes from diesel tank*				
Catastrophic failure of a diesel road tanker	Road Tanker Area	40	34	4
Leak from the largest connection of diesel road tanker				
Rupture of loading/unloading hose diesel road tanker				
Leak of loading/unloading hose of diesel road tanker				

* Worst case quantity released is assumed for both these scenarios for conservatism.

The diesel storage tanks are located in a bund with at least 110% capacity of a single storage tank; therefore overtopping is not considered a credible scenario.

The surface of the site is considered to be flat and the release is expected to spread out in a circular pool with an assumed thickness of 20 mm from its point of origin. A conservative assumption has been made for the purposes of simplification that there will be no flash-off of any of the light components in the released material and there will be no reduction in the mass of liquid. The released material may potentially impact the following environmental receptors:

- **R1 Kilcrow River / Lough Derg** – in the absence of containment measures i.e., the bund, the released diesel is expected to either:
    - Spread across the surface until it flows into the Ballynaheskeragh stream which flows within the proposed development land. Any release into this water course then has potential to continue to Kilcrow River. No direct flow of the released material into the Kilcrow River is expected to occur due to the distance of the site to the river itself.
    - Spread across the surface of the site until it is infiltrated to the below ground fire wastewater retention tank or intercepted via upgradient of infiltration. The diesel, if it is not infiltrated into the below ground wastewater retention tank or intercepted there, will be routed into the Ballynaheskeragh stream which flows within the proposed development land. Any release into this water course then has potential to continue to the Kilcrow River . No direct flow of the released material into the Kilcrow River is expected to occur due to the distance of the site to the river itself.
- **R2 Agricultural Land and R3 Soil** – the released diesel is not expected to flow far enough to impact the agricultural land or its soil. Therefore, no significant environmental harm to these receptors is expected to occur.
- **R4 Groundwater** – some of the released diesel will spread to areas of unmade ground and the well on the site. However, the material is expected to permeate into the ground slowly. This will allow the majority of the spill to be cleaned up before a significant volume can permeate into the ground. A small percentage of the released diesel will enter the sub-surface but this is expected to remain above the groundwater layer due to the low solubility of its components in water. Therefore, no significant environmental harm to this receptor is expected to occur.

The potential environmental harm to the Kilcrow River (R1) is discussed in the following sub-section and the findings are summarised in Table 9-2.

9.1.1 Potential Impacts on R1 – Kilcrow / Lough Derg

A release of diesel into the waters of the Kilcrow River may potentially cause harm via the formation of an oil slick on the surface of the water. Thus, the oil slick approach has been used to assess the potential level of environmental harm. The length of the Kilcrow River that would be covered if a slick of slop oil spread evenly across the width of the river with a thickness of 0.1 mm and an assumed average width of 5m was calculated as:

$$Length\ of\ river\ affected\ (m) = \frac{Volume\ released\ (m^3)}{Slick\ thickness\ (m) \times Width\ of\ River\ (m)} \quad (9.1)$$

The calculations show that a release of 7333m^3 of diesel will cover the entire 9km length of the Kilcrow River under consideration with a 0.1 mm slick. The slick will therefore continue into Lough Derg where the remain diesel will cover a 14.6km length of Lough Derg. This is the equivalent to approximately 63% of Lough Derg, which constitutes a severity level of 3 (Major) as per Table A-1. It is expected that it will be possible to remove the majority of the released oil from the water in the river/lough within a year. However, it is expected that due to the very high release volume, a significant quantity of the released oil may mix with sediments and vegetation on the banks of the river and create effects which last longer than 1 year. A medium-term duration of harm (>1 year) was therefore selected as per Table A-2. The overall consequence level is therefore a level B MATTE.

A release from a road tanker is predicted to only cover <1% of Lough Derg and therefore is judged to have a severity level of 1. As with a release from the storage tanks, a medium-term duration of harm (>1 year) was selected. The overall consequence level for a road tanker release is therefore a level sub-MATTE and no longer considered in this analysis

Table 9-2: MATTE Assessment results for Release of Diesel Scenario

Receptor	Minimum Area Required for MATTE	Min. Release Quantity Required for MATTE	Area Affected by Full Inventory Release	Severity Rating	Duration Category	MATTE Consequence Level
R1 – Kilcrow River (oil slick approach)	2 km	8.45 te	9km of Kilcrow River 14.6km length of Lough Derg	3	2	B
			80m of Kilcrow River	1	2	Sub-MATTE

9.2 Releases of Firewater

Firewater systems present on site will provide an immediate response to events that involve fires. The release of firewater will be assumed to only occur following releases of flammable materials or occurrences of fires on the site, e.g. LDES fire.

Firewater itself does not have the potential to cause environmental harm. However, firewater run-off from the site can contain combusted and un-combusted forms of the substances involved in the fire. Therefore, in the event of a fire, any fire wastewater generated will drain through the system and be held in a below ground tank (fire wastewater holding tank), which will accord with EPA requirements (3,690m3 capacity). An actuated penstock valve will be positioned on the outlet of the below ground tank which will be activated to close upon the activation of the fire alarm within the development. The contaminated water will be subsequently tested and appropriately disposed of. Gaseous extinguishing systems will also be provided for use on electrical systems.

The application of firewater can increase the potential for the release of diesel to reach the surrounding receptors via run-off from the site and it is assumed that the flow pathways will remain the same. It is difficult to estimate exactly how much further release of diesel will spread if firewater is applied simultaneously. It is expected that the spill radii will increase slightly but will not increase in the MATTE levels determined previously.

The BESS Compound includes one proprietary fire water storage tank with a capacity of 500 cubic metres (500m3), located adjacent to the IPP building to ensure an adequate firefighting water supply. Surface finishes within the LDES compound comprise clean permeable stone fill. Firewater collected from impervious areas such as the IPP building and limited bitumen macadam roads will be collected and routed through a below ground interceptor.The firewater supply system provides a cooling of nearby structures only in the event of a fire thus limiting the contaminants within the firewater as it will not be applied directly to a battery that is on fire. Therefore the level of harm caused is not likely to be significant enough to result in a MATTE. Furthermore, any contamination of water or ground sources due to firewater the harm will have a short recovery time thus is not considered a MATTE.

Further details of the firewater and drainage systems are provided within the Fire Risk Assessment (Ref. /14/) and Environmental Impact Assessment Report Addendum (EIAR Addendum) (Ref. /15/).

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9.3 Ignited Scenarios

Environmental receptors can be harmed by ignited events, either as a result of direct flame engulfment or, outside the flame, by short or long-term exposure to elevated levels of thermal radiation transmitted through the atmosphere. Overpressure generated by an explosion can also result in environmental impacts.

A variety of consequence types are considered including jet fire, flash fire, fireball, pool fire and vapour cloud explosion. The consequence types and the potentially affected receptors are presented in Table 9-3.

The assessment show that the only ignited consequence types that have the potential to impact the surrounding environmental receptors are:

- Flash fires – flash fires may impact the Agricultural Land (R2). However, any land or vegetation which is burnt is expected to recover within a year which will avoid the potential for a MATTE being realised;
- Overpressure events – an overpressure of 0.1 bar is typically strong enough to break glass on buildings but is not strong enough to cause harm to flora and fauna and generally predict that stronger overpressure levels are not expected to extend for significant distances.

It should be noted that diesel is difficult to ignite. In general diesel needs a sustained naked flame with a heat source to ignite. Therefore ignited events from the site are therefore not expected to result in any MATTEs to the surrounding receptors.

Table 9-3: Receptors potentially impacted by ignited events

Consequence Type	Receptors Potentially Affected	Notes
Jet fire	-	Consequence effects not expected to impact any of the surrounding receptors.
Flash fire	R2	Affected receptors are expected to recover in <1 year. No potential for MATTE.
Fireball	-	Consequence effects not expected to impact any of the surrounding receptors.
Pool fire	-	Consequence effects not expected to impact any of the surrounding receptors.
Vapour cloud expansion (0.1 bar)	R2	No harm to flora or fauna expected to be caused by an overpressure of 0.1 bar.

9.4 Combustion Products

Combustion products are the materials produced as a result of the decomposition of the material involved in a fire including intermediate breakdown products, smoke and particulates. The likely fall-out products following a fire or explosion will mainly be limited to CO, CO_2, H_2O and a number of partially oxidised products such as soot and smoke etc. Polycyclic Aromatic Hydrocarbons (PAHs) may also be produced during the combustion of natural gas. Thermal runaway of the of the LDES batteries is likely to result in the evolution of toxic gases particularly Hydrogen Fluoride.

Soot formation is expected to be an issue with fires involving solid or liquid fuels such as crude oil. Soot is generated by the incomplete combustion of hydrocarbons and it can be transported as fine particulates through the air. Particulate matter is also expected to be produced if the fire from an ignited event burns the ground, vegetation or other structures on or off the site.

There is a wide spectrum of particle sizes released during a fire. Smaller sized particles tend to travel further distances than the larger sized particles. In general, within a few kilometres of the site, material with diameters of a few millimetres to even centimetres will settle. Particles with diameters of a few to tens of micrometres may be transported up to ten kilometres away from the source (Ref. /11/). Particles may be deposited directly on to land or surface water sources, or washed out of the atmosphere by precipitation and indirectly deposited. The extent of environmental damage will depend on the meteorological conditions (e.g. the wind direction, wind speed, atmospheric stability and rainfall) and generally decreases non-linearly with distance from the site of the release.

Wind direction will influence the likely environmental receptors; the wind speed will influence the dispersion rate and the extent that a material is carried downwind. Similarly, rainfall can have differing impacts on an atmospheric release. The reactivity and solubility of a material will influence whether it is likely to undergo hydrolysis or deposition through precipitation. Deposition onto land could result in soil contamination or percolation into groundwater causing contamination. The properties of the material, such as its persistence and ecotoxicity will also influence the extent of environmental damage. Soot can also impact surface water receptors either via direct deposition or via land run-off.

Any combuston fall-out, which reaches the surrounding receptors, may result in some short-term impacts but particle degradation is likely to occur relatively quickly. Therefore, a release of combustion products via the atmosphere is unlikely to result in a MATTE.

10 FREQUENCY ASSESSMENT OF UNMITIGATED CONSEQUENCES

The frequency assessment follows the approach defined in Section 6.2 of the CDOIF guidance (Ref. /2/). It is undertaken by assigning an unmitigated event frequency to the release of diesel scenario that has the potential to cause a MATTE to the Kilcrow River/Lough Derg. The unmitigated event frequency for the release of diesel is used to establish the unmitigated risk posed by the establishment to the identified receptor.

10.1 Unmitigated Scenario Frequency and Risk Summary

The unmitigated event frequency for the release of diesel scenario identified to have the potential to cause a MATTE is summarised in Table 10-1. The sources of the frequency data used is also stated in the table.

Table 10-1: Unmitigated event frequencies for each potential MATTE scenario

Scenario Description	Receptor	MATTE Consequence Level	Frequency (event per year)	Source of Frequency data
Catastrophic failure of a diesel tank	R1 – Kilcrow River / Lough Derg	B	5×10^{-6}	HSA Guidance on technical land-use planning advice Table 48, Rev 2.
Failure over 10 minutes from diesel tank *			5×10^{-6}	
10mm leak over 30minutes from diesel tank*			1×10^{-4}	
Release of Diesel Total Frequency for all 3 tanks			$1.1 \times 10^{-4} \times 3 =$ **3.3×10^{-4}**	

The unmitigated event frequency is the total unmitigated risk posed by the establishment to the receptor identified. The establishment risk to the receptor is plotted against the CDOIF tolerability criteria for event frequency per receptor per year in Figure 10-1 and found to be in the tolerable if ALARP (TifALARP) on the CDOIF risk matrix.

	Frequency per establishment per receptor per year (unmitigated)						
Frequency at which CDOIF Consequence Level is equalised or exceeded (events/year)	10^{-8} - 10^{-7}	10^{-7} - 10^{-6}	10^{-6} - 10^{-5}	10^{-5} - 10^{-4}	10^{-4} - 10^{-3}	10^{-3} - 10^{-2}	$>10^{-2}$
D - MATTE							
C - MATTE							
B - MATTE					**R1**		
A - MATTE							
Sub-MATTE	Tolerability not considered by CDOIF						

Figure 10-1: Unmitigated frequency per establishment per receptor per year

11 MITIGATED FREQUENCIES

The layers of protection in place to prevent the release scenario from reaching the surrounding environmental receptors are considered, in order to determine the mitigated levels of risk from the site. The mitigated frequency of harm caused to the surrounding environmental receptors is calculated by multiplying the unmitigated frequency by the probability of failure on demand (PFD) values of any layers of protection which may potentially stop the release from making its way to the receptor.

A description of the relevant layers of protection in place to prevent the scenario identified as having the potential to cause a MATTE to the surrounding receptor is given below.

11.1 Release Impacting R1 – Kilcrow River/ Lough Derg

The layers of protection relevant to releases from the site which have been identified to have the potential to cause MATTEs to the Kilcrow River / Lough Derg are:

- Tank bund.
- Fire wastewater retention tank.

A description and the PFD values allocated to each of these layers of protection are provided in the table below.

Table 11-1: Layers of protection relevant to preventing releases to the Kilcrow River / Lough Derg

Layer of Protection	Description	PFD
Tank bund	The diesel fuel tanks surrounded by a concrete bund which provide capacity for at least 110% of the contents of the tanks. Tank releases may breach the containment provided by the bund following a structural failure of the bund walls, overtopping of the bund walls or if the bund drain valve has been left open. Tank is fitted with level monitoring and CCTV coverage.	0.01 (Ref. /13/)
Fire wastewater retention tank	The catastrophic failure of one of the diesel fuel tanks will result in the release of a very large volume of diesel which has the potential to spread and form a pool from the release point. Collection and infiltration to the below ground fire wastewater retention tank occurs around the site. In addition, there are a number of interceptors (oil/water separators) upgradient of the infiltration points which are also routed to the fire wastewater retention tank.	0.3 (Ref. /13/)

The event tree which illustrates the layers of protection that are in place to prevent the release of diesel from causing a MATTE in the Lough Derg are shown in Figure 11-1. The event tree is used to calculate the risk reduction factors that the layers of protection expected to provide to reduce the unmitigated frequencies of the scenarios.

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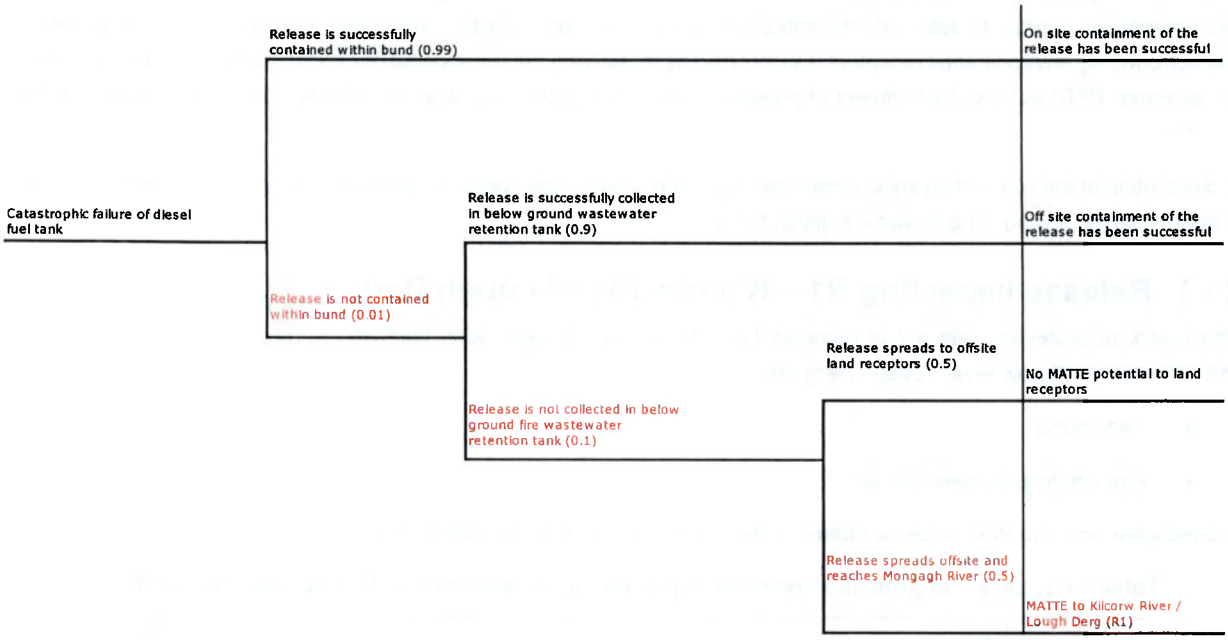

Figure 11-1: Event tree for catastrophic failure of diesel tank in bunded area

11.2 Mitigated Event Frequency Calculations

The mitigated event frequency for the MATTE scenario was calculated by multiplying the unmitigated event frequency by the risk reduction factor associated with the layers of protection in place for the scenario.

Table 11-2: Mitigated event frequencies for each potential MATTE scenario

Receptor	Scenario Description	MATTE Consequence Level	Unmitigated Frequency (per year)	Risk Reduction Factor	Mitigated Frequency (per year)
R1 – Kilcrow River / Lough Derg	Release of Diesel	B	3.3E-04	5.00E-04	1.65E-07

11.3 Mitigated Risk Summary

The mitigated event frequency for release of diesel scenario as reported in Table 11-2 is used to establish the mitigated risk posed by the establishment to the identified receptor.

The mitigated establishment risk per receptor per consequence level is summarised in

Table **11-3**. The establishment risk to the identified receptor was then plotted against the CDOIF tolerability criteria for event frequency per receptor per year in Figure 11-2 and found to be in the Broadly Acceptable Region of the CDOIF risk matrix.

Table 11-3: Mitigated establishment risk

Receptor	MATTE Consequence Level	Total Mitigated MATTE Frequency (events/year)
R1 – Kilcrow River / Lough Derg	B	1 65E-07

	Frequency per establishment per receptor per year (mitigated)						
Frequency at which CDOIF Consequence Level is equalised or exceeded (events/year)	10^{-8} - 10^{-7}	10^{-7} - 10^{-6}	10^{-6} - 10^{-5}	10^{-5} - 10^{-4}	10^{-4} - 10^{-3}	10^{-3} - 10^{-2}	>10^{-2}
D - MATTE							
C - MATTE							
B - MATTE		R1					
A - MATTE							
Sub-MATTE	Tolerability not considered by CDOIF						

Figure 11-2: Mitigated frequency per establishment per receptor per year

12 CONCLUSIONS

One Source-Pathway-Receptor trio with MATTE potential was identified as the release of approximately 6196 tonnes of diesel stored in 7333m^3 liquid fuel tank capacity impacting on the Kilcrow River / Lough Derg

The overall unmitigated level of risk posed by the establishment from the release of diesel to the Kilcrow River / Lough Derg was found to be in the tolerable if ALARP (TifALARP) on the CDOIF risk matrix. Following the identification of the control measures in place and their probability of failure on demand, it was found that the level of mitigated risk posed by the establishment to Kilcrow River / Lough Derg falls into the Broadly Acceptable region.

13 REFERENCES

/1/ The Chemicals Act (Control of Major Accident Hazards involving Dangerous Substances) Regulations 2015 (S.I. No. 209 of 2015) (the "COMAH Regulations"), Health and Safety Authority, 2015

/2/ Guideline – Environmental Risk Tolerability for COMAH Establishments, Version 2.0, Chemical and Downstream Oil Industries Forum.

/3/ A Guide to the Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015 (S.I. No. 209 of 2015

/4/ The REACH Enforcement Regulations 2008, European Parliament No. 1906/2006.

/5/ Guidance on the Interpretation of Major Accident to the Environment for the Purpose of the COMAH Regulations 1999, Department of the Environment, Transport and the Region (DETR), 1999.

/6/ Oil Spills in the Sea, Offshore Environment, S. Patin. Available at: http://www.offshore-environment.com/oil.html.

/7/ Behaviour of Hydrocarbons in the Subsurface, Pennsylvania Department of Environmental Protection. Available at: http://files.dep.state.pa.us/EnvironmentalCleanupBrownfields/LandRecyclingProgram/LandRecyclingProgramPortalFiles/CSSAB/2004/fprg_chap3.pdf

/8/ Supporting Guide to the Environmental Risk Tolerability for COMAH Establishments Guideline - Environmental Recovery Guide, ENVIRON, 2015.

/9/ Halston, Environmental Planning, Project Coolpowra Summary Description of Receiving Environment, February 2024

/10/ https://www.epa.ie/our-services/licensing/air/

/11/ Using Science to Create a Better Place – Review of Emission Factors for Incident Fires, Environment Agency, 2009.

/12/ OGP Risk Assessment Data Directory, Storage Incident Frequencies, Report No 434-3, March 2010

/13/ CCPS LOPA guidance by DNV, 2010

/14/ Halston Environmental, Fire Risk Assessment (FRA), Version 1 January 2026

/15/ Halston Environmental, Environmental Impact Assessment Report Addendum (EIAR Addendum). Version 4, January 2026

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APPENDIX A
MATTE Tolerability Tables

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Table A-1: Severity of harm criteria for environmental receptors (Ref. /2/)

Row	Receptor Type	Severity of Harm				Reference to	Comments
		Significant *While this level of harm might be significant pollution, it is not considered a MATTE.*	**Severe** *DETR Criteria – the lowest level of harm that might be considered MATTE.*	**Major**	**Catastrophic**	*Corresponding Harm/Duration/ Recovery row in Table A-2*	*The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident.* *Receptors include:*
	Severity Level →	**1**	**2**	**3**	**4**		
1	Designated Land/Water Sites (Nationally important)	<0.5ha or <10%	>0.5ha or 10-50% of site area, associated linear feature or population	>50% of site area, associated linear feature population	*N/A*	Land or Surface Water	NNR, SSSI, MNR
2	Designated Land/Water Sites (Internationally important)	<0.5ha or <5% (<5% LF/Pop)	>0.5ha or 5-25% of site area or 5-25% of associated linear feature or population	25-50% of site area, associated linear feature or population	>50% of site area, associated linear feature or population	Land or Surface Water	SAC, SPA, RAMSAR
3	Other Designated Land	<10ha or <10%	10-100ha or 10-50% of land	>100ha or >50% of land	*N/A*	Land	ESA, AONB, National Park, etc.
4	Scarce Habitat	<2ha or <10%	2-20ha or 10-50% of habitat	>20ha or >50% of habitat	*N/A*	Land or Surface Water	BAP habitats, geological features

Row	Receptor Type	Severity of Harm				Reference to	Comments
		Significant *While this level of harm might be significant pollution, it is not considered a MATTE.*	**Severe** *DETR Criteria – the lowest level of harm that might be considered MATTE.*	**Major**	**Catastrophic**	*Corresponding Harm/Duration/ Recovery row in Table A-2*	*The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident.* *Receptors include:*
	Severity Level →	**1**	**2**	**3**	**4**		
5	Widespread Habitat – Non-designated Land	<10ha	Contamination of 10-100ha of land, preventing growing of crops, grazing of domestic animals or renders the area inaccessible to the public because of possible skin contact with dangerous substances. Alternatively, contamination of 10ha or more of vacant land.	100 – 1000ha (applied as per text under 'Severe')	>1000ha (applied as per text under 'Severe')	Land	Land/water used for agriculture, forestry, fishing or aquaculture
6	Widespread Habitat – Non-designated Water		Contamination of aquatic habitat which prevents fishing or aquaculture or renders is inaccessible to the public.	*N/A*	*N/A*	Surface Water	Land/water used for agriculture, forestry, fishing or aquaculture

Row	Receptor Type	Severity of Harm				Reference to	Comments
		Significant *While this level of harm might be significant pollution, it is not considered a MATTE.*	**Severe** *DETR Criteria – the lowest level of harm that might be considered MATTE.*	**Major**	**Catastrophic**	*Corresponding Harm/Duration/ Recovery row in Table A-2*	*The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident.* *Receptors include:*
	Severity Level →	**1**	**2**	**3**	**4**		
7	Source of Public or Private Drinking Water (Groundwater or Surface Water)	Interruption of drinking water supply <1000 person-hours or For England & Wales only <1ha SPZ	Interruption of drinking water supplied from a ground or surface source (where persons affected x duration in hours [at least 2] >1,000) or For England & Wales only 1-10ha of SPZ where drinking water standards are breached	>1 x 10^7 person-hours interruption of drinking water (a town of ~100,000 people losing supply for month) or For England & Wales only 10-100ha SPZ drinking water standards breached	>1 x 10^9 person-hours interruption of drinking (~1 million people losing supply for 1 month) or For England & Wales only >100ha SPZ drinking water standards breached	Groundwater body or Surface Water Public Drinking Water Source	In England the area of groundwater, used for public drinking water, at risk from pollution is mapped using Source Protection Zones (SPZs). In Scotland, there is not an equivalent mapping of SPZs and only the interruption criteria should be used.

Row	Receptor Type	Severity of Harm				Reference to	Comments
		Significant *While this level of harm might be significant pollution, it is not considered a MATTE.*	**Severe** *DETR Criteria – the lowest level of harm that might be considered MATTE.*	**Major**	**Catastrophic**	*Corresponding Harm/Duration/ Recovery row in Table A-2*	*The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident.* *Receptors include:*
	Severity Level →	**1**	**2**	**3**	**4**		
8	Groundwater Body (non-Drinking Water Source)	<1ha	1-100ha of groundwater body where the WFD status has been lowered	100-10,000ha	>10,000ha	Groundwater body or Surface Water Public Drinking Water Source	UKTAG has determined that to qualify as a body of groundwater, an aquifer must be capable of supplying 10m³ per day or 50 people (on a continuous basis) and that such aquifers/groundwater bodies have future resource value which must be protected. Groundwater Bodies have been identified and mapped in accordance with guidance under the Water Framework Directive – see 3.2.3 and Appendix 3 for further information
9	Other Groundwater (outside of groundwater bodies)	Groundwater not a pathway to another receptor.	*Where the groundwater is a pathway for another receptor assess against relevant criteria for the receptor.*			*N/A*	

Row	Receptor Type	Severity of Harm				Reference to	Comments
		Significant *While this level of harm might be significant pollution, it is not considered a MATTE.*	**Severe** *DETR Criteria – the lowest level of harm that might be considered MATTE.*	**Major**	**Catastrophic**	*Corresponding Harm/Duration/ Recovery row in Table A-2*	*The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident.* *Receptors include:*
	Severity Level →	**1**	**2**	**3**	**4**		
10	Soil or sediment (i.e. as receptor rather than purely a pathway)	Contamination not leading to environmental damage (as per ELD), or not significantly, affecting overlying water quality.	Contamination of 10-100ha of land etc. as per Widespread Habitat; Contamination sufficient to be deemed environmental damage (Environmental Liability Directive)	Contamination of 100-1000ha of land, as per Widespread Habitat; Contamination rendering the soil immediately hazardous to humans (e.g. skin contact) or the living environment, but remediation available.	Contamination of >1000ha of land, as per Widespread Habitat; Contamination rendering the soil immediately hazardous to humans (e.g. skin contact) or the living environment and remediation difficult or impossible.	Land	
11	Built environment	Damage below a level at which designation of importance would be withdrawn.	Damage sufficient for designation of importance to be withdrawn.	Feature of built environment subject to designation of importance entirely destroyed.	*N/A*	Built environment	This is limited to Grade 1 / Cat A Listed buildings, scheduled ancient monuments, conservation area, etc.
12	Various receptors. Should not be used to identify and assess MATTE.	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	Refer to DETR. Standards relating to continuous emissions, contained in other EU legislation.

Row	Receptor Type	Severity of Harm				Reference to	Comments
		Significant *While this level of harm might be significant pollution, it is not considered a MATTE.*	**Severe** *DETR Criteria – the lowest level of harm that might be considered MATTE.*	**Major**	**Catastrophic**	*Corresponding Harm/Duration/ Recovery row in Table A-2*	*The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident.* *Receptors include:*
	Severity Level →	**1**	**2**	**3**	**4**		
12	Particular species (Note – these criteria apply nationally – i.e. England, Wales, Scotland)	Loss of <1% of animal or <5% of plant ground cover in a habitat.	Loss of 1-10% of animal or 5-50% of plant ground cover.	Loss of 10-90% of animal or 50-90% of plant ground cover.	Total loss (>90%) of animal or plant ground cover.	Land	
14	Marine	<2ha littoral or sub-littoral zone, <100ha of open sea benthic community, <100 dead sea birds (<500 gulls), <5 dead/significantly impaired sea mammals.	2-20ha littoral or sub-littoral zone, 100-1000ha of open sea benthic community, 100-1000 dead sea birds (500-5000 gulls), 5-50 dead/significantly impaired sea mammals.	20-200ha littoral or sub-littoral zone, 100-10,000ha of open sea benthic community, 1000-10,000 dead sea birds (5,000-50,000 gulls), 50-500 dead/significantly impaired sea mammals.	>200ha littoral and sub-littoral zone, >1000ha of open sea benthic community, >1000 0 dead sea birds (>50000 gulls), >500 dead/significantly impaired sea mammals.	Surface Water	

Row	Receptor Type	Severity of Harm				Reference to	Comments
		Significant *While this level of harm might be significant pollution, it is not considered a MATTE.*	**Severe** *DETR Criteria – the lowest level of harm that might be considered MATTE.*	**Major**	**Catastrophic**	*Corresponding Harm/Duration/ Recovery row in Table A-2*	*The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident.* *Receptors include:*
	Severity Level →	**1**	**2**	**3**	**4**		
15	Fresh and estuarine water habitats	Impact below that of Severity level 2	WFD Chemical or ecological status lowered by one class for 2-10km of watercourse or 2-20ha or 10-50% area of estuaries or ponds. Plus interruption of drinking supplies, as per DETR Table 6.	WFD Chemical ecological status lowered by one class for 10-200km of watercourse or 20-200ha or 50-90% area of estuaries and ponds. Plus interruption of drinking water supplies, as per DETR Table 6.	WFD Chemical or ecological status lowered by one class for >200km of watercourse or >200ha or >90% area of estuaries and ponds. Plus interruption of drinking water supplies, as per DETR Table 6.	Surface Water	

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Table A-2: Duration / recovery criteria (based on unmitigated consequence) (Ref. /2/)

Description	Short term	Medium term	Long term	Very long term
	Harm with such short recovery is not considered a MATTE.			
Harm Duration Category →	**1**	**2**	**3**	**4**
LAND	≤ 3 years	> 3 years or > 2 growing seasons for agricultural land	> 20 years	> 50 years
SURFACE WATER (ALL EXCEPT PUBLIC OR PRIVATE DRINKING WATER SOURCE)	≤ 1 year	> 1 year	> 10 years	> 20 years
GROUNDWATER BODY OR SURFACE WATER PUBLIC OF PRIVATE DRINKING WATER SOURCE	*N/A*	Harm affecting non-public drinking water source.	Harm affecting public drinking water source or SPZ.	*N/A*
BUILT ENVIRONMENT	Can be repaired in < 3 years, such that its designation can be reinstated.	Can be repaired in > 3 years, such that its designation can be reinstated.	Feature destroyed, cannot be rebuilt, all features except world heritage site.	Feature destroyed, cannot be rebuilt, world heritage site

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Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.

APPENDIX 17.2

CONSEQUENCE AND TLUP ASSESSMENT REPORT

COMAH SUPPORT FOR PROJECT COOLPOWRA

Consequence Study and TLUP Assessment Report

Halston Environmental and Planning Limited

Rev. 2
Document no.: 2246462
Date: 2026-02-02

Project name:	COMAH Support for Project Coolpowra	
Report title:	Consequence Study and TLUP Assessment Report	
Customer:	Halston Environmental and Planning Limited, IHub Building Westport Road Castlebar F23 K162 Co. Mayo Ireland	
Customer contact:	Colm Staunton	
Date of issue:	2026-02-02	
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2	2026-02-02	Update to include TLUP Assessment	JF	TO	AH

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Table of contents

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Abbreviations

AGI	Above Ground Installation
AIS	Air Insulated Switchgear
ALARP	As Low as Reasonably Practicable
CFD	Computational Fluid Dynamics
CIA	Chemical Industries Association
DAL	Dimensioning Accidental Load
FBR	Full Bore Rupture
GIS	Gas Insulated Switchgear
GNI	Gas Networks Ireland
HCRD	Hydrocarbon Leak Frequency Database
HSA	Health and Safety Authority
HSE	Health and Safety Executive
IOGP	International Association of Oil and Gas Producers
LDES	Long Duration Energy Storage
LFL	Lower Flammability Limit
MATTE	Major Accident to the Environment
OCGT	Open Cycle Gas-Fired Generators
PFD	Process Flow Diagram
QRA	Quantitative Risk Assessment
TLUP	Technical Land Use Planning
UG	Underground

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1 EXECUTIVE SUMMARY

1.1 Background

The aim of Project Coolpowra is to design, develop, and expand Ireland's 400kV transmission system to improve the reliability, resilience, and efficiency of the electricity supply, supporting the transition to greener energy. It facilitates the integration of renewable energy sources, aligning with Ireland's goals to reduce greenhouse gas emissions and combat climate change.

This study originally conducted a preliminary consequence modelling, which by its nature, results in typically **worst-case hazard contours**. In order to provide context to the results, a semi-quantitative risk assessment has been carried out based on DNVs experience in assessing similar industrial facilities.

The original consequence study covers:

- Quantitatively model a set of identified major accident hazards, at a level of detail commensurate with the design data currently available.
- Both full bore pipework ruptures and catastrophic vessel ruptures are modelled, as well as smaller (5mm diameter) leaks, giving an indication as to the likely extent of hazard ranges associated with the project.
- Risk to people and asset in terms of flammable leak major accident hazards (i.e. potential fire and explosion loads to the plant itself and surrounding facilities) will be assessed at a high level to give an early indication of the risk profile of the facility.

Subsequently, the study has been updated to include a Technical Land Use Planning (TLUP) Assessment where LUP zones are determined based on individual risk. The TLUP Assessment approach aligns with the Guidance on Technical Land-Use Planning Advice Version 2.

The TLUP assessment builds upon the original consequence modelling study to:

- Include event frequencies and ignition probabilities.
- Alignment of failure cases, vulnerability and exposure criteria with Guidance on Technical Land-Use Planning Advice Version 2.
- Production of LUP zones as contours overlayed on a map of the local area.

1.2 Conclusions

1.2.1 Consequence Model

The consequences derived have been both for small 5 mm releases and full bore/catastrophic releases. There are no notable consequences for any small leak scenario, except for the firewater tanker locations. Given the high flash point of diesel, it is difficult to ignite and this is reflected by the low likelihoods associated with the ignited diesel scenarios in the risk assessment.

The following conclusions are made from this study:

- **Risk**: None of the risks associated with the facility are considered intolerable. A high-level semi-quantitative risk assessment has not highlighted any serious concerns at this point, and given that further risk assessment studies are planned for further stages of the project (detailed design), it is likely that all risks will be demonstrated to be tolerable.

- **Off-site risk:** No natural gas or diesel hazards have been identified with the potential to impact off-site populations. Given the proposed safeguards and control measures associated with the long duration energy storage (LDES) compound (including fire water application, spacing, and inert gas application), a full scale LDES compound fire, which may have the potential to result in smoke passing the site boundary, is considered unlikely.

- **Consequence Results:** Consequence modelling results are considered representative of worst-case scenarios. Still, no off-site impacts have been identified during the consequence modelling. Furthermore, a full risk-based study (such as a quantitative risk assessment, QRA, to be undertaken in detailed design) is likely to demonstrate that the safety risk from the proposed facility is tolerable both on and off-site.
  - **Pool Fires:** In the highly unlikely event of a catastrophic rupture of a diesel road tanker resulting in a pool fire, the thermal radiation intensity is at levels sufficient to cause multiple fatalities at the administration/control building. Furthermore, there is potential for fuel tank pool fires to escalate to the adjacent tanks, or to cause catastrophic damage to the fire water tanks.
  - **Jet Fires:** There is potential for the 37.5 kW/m^2 contours to extend across a large section of the facility, which suggests that there is potential for escalation due to jet fires associated with the natural gas system on-site. There is also potential for personnel situated outside (e.g. walking between areas of the site) to be fatally injured from natural gas jet fires. There is also potential (based on unmitigated risk) for escalation of jet fires originating in the AGI (Above Ground Installation) or on-site pipeline to the LDES compound, however given the protective systems at the LDES compound, a compound-wide fire is considered unlikely.
  - **Fireballs:** The hazard contours associated with fireballs are relatively large, however these are short lived events and therefore do not contribute greatly to escalation, and the likelihood of a fireball has been deemed improbable over the lifetime of the facility.
  - **Flash Fires:** Flash fires can have far reaching effects; however, cloud shapes can be seen to be much smaller than the entire cloud envelope. The ½ LFL cloud can impact the majority of the site such that muster points could be considered compromised.
  - **LDES System:** The safety risk posed by LDES systems must not be underestimated, and there is potential for very large fires should propagation between containers occur. Should an LDES fire be contained to a single container (as is likely the case given the protective measures proposed for the facility), there is potential for localised asset damage and safety risk to first responders.
  - **Off-site impacts:** Natural gas and fuel oil consequence modelling has highlighted no particular concerns to third-party buildings or properties outside of the site boundary. In the unlikely event that a large-scale LDES compound fire occurs, with the fire propagating across multiple containers, there is potential for off-site impacts from smoke and evolved gases.

1.2.2 TLUP Assessment

- No LUP Zone contours are expected to impact on local populations. Both the
  - maximum tolerable risk of fatality to a member of the public of 1 x 10^{-6} per year, and
  - maximum tolerable risk of fatality to a person at an offsite work location of 5 x10^{-6} per year.

  is not foreseen to be exceeded.
- No Level 1, 2, 3 or 4 developments are located within the LUP zones.
- No offsite populations, nor the neighbouring existing substation are within the 1 x 10^{-9} per year risk contour.
- The development aims to prevent MATTEs due to a loss of containment of diesel through the use of an appropriate diesel storage tank designed in accordance with all relevant codes and standards, a dedicated

bund with a minimum capacity of 110% of a single tank, and a wastewater retention tank with oil/water interceptors which would collect any diesel not contained within the bund (i.e. due to bund failure/leak).

- The ERA (Ref. /14/) demonstrates that appropriate measures are in place to prevent a MATTE and reduce the risk to 'Broadly Acceptable' levels.

1.3 Recommendations

The following recommendations are made:

1. Consider fire protection strategies for the tanker unloading and fuel oil storage areas, which could include separate bunds for each storage tank, deluge (sprinkler) systems, and/or foam application on confirmation of a fire. Also consider relocation of the fire water tanks to a location away from all flammable inventories to ensure they are not impacted by fire events.
2. There is currently potential two occupied buildings (security and administration/control building) to be within the 37.5 kW/m^2 hazard ranges associated with jet fires and pool fires. If possible, Halston Lumcloom should consider relocating these buildings to an area outside all hazard contours – which would be considered an inherently safe solution.
3. Ensure any muster points are located outside of the ½ LFL clouds, as shown in Section 5.4.
4. If possible, the spacing between the natural gas-containing systems and the LDES compound should be increased to reduce the likelihood of a natural gas jet fire escalating to a large-scale battery fire, which could potentially have off-site impacts.
5. Undertake further risk assessments in later design stages and review the input data and assumptions. This should primarily address any uncertainties or assumptions in process information, as these will be more accurately defined as the design progresses. Particular attention should be given to fire and explosion risk within the LDES compound - ensuring and demonstrating that all applicable design standards have been followed to minimise the risk associated with stored electrical energy.

Note, these recommendations aim to further reduce any risk associated with Project Coolpowra, however other risk reduction measures may be deemed more appropriate as the design develops

2 INTRODUCTION

Halston Lumcloon Energy is designing, developing, and expanding Ireland's 400kV transmission system to improve the reliability, resilience, and efficiency of the electricity supply, supporting the transition to greener energy. It facilitates the integration of renewable energy sources, aligning with Ireland's goals to reduce greenhouse gas emissions and combat climate change.

Halston have developed a proposal, which consists of units such as reserve gas-fired generators, Gas Insulated Switchgear Substations, long duration energy storage batteries and more. The first site for application of the plant concept is a facility in Ireland, and the modules and components are designed for use with gas oil. Natural gas is present in the underground pipelines and equipment associated with integration into Gas Network Ireland's network.

This document has bene prepared by DNV for Halston Environmental & Planning Limited (Halston) on behalf of Coolpowra Flex Gen Limited. Environmental Impact Assessment Report (EIAR) and Land Use Planning application. The EIAR contains 3 planning applications as follows:

- Project 1: a Reserve Gas-Fired Generator, which was lodged with the Commission on 04 July 2024 (Case Ref.: PA07.320095) under Section 37A of the Planning and Development Act 2000 (as amended) (hereafter referred to as "the P&D Act"),
- Project 2: An Energy storage system (ESS) facility, which was lodged with Galway County Council (GCC) on 08 July 2024 (GCC Case Ref. 2460845) under Section 34 of the P&D Act. An appeal to the Commission (Case Ref. PL07.320916) was lodged by the applicant on 26 September 2024 following the decision of GCC to refuse permission for the development, and
- Project 3: a 400kV Gas Insulated Switchgear (GIS) substation, which was lodged with the Commission on 04 July 2024 (Case Ref. PA07.320094) under Section 182A of the P&D Act.

2.1 Study Scope

The scope of the studies within this document can be split into two distinct parts:

1. Original consequence modelling to inform on the layout and design, with determination of worst-case hazard contours. This was conducted in 2024 by DNV.
2. 2026 update to include a Technical Land Use Planning (TLUP) Assessment.

The original consequence study covers:

- Quantitatively model a set of identified major accident hazards, at a level of detail commensurate with the design data currently available.
- Both full bore pipework ruptures and catastrophic vessel ruptures are modelled, as well as smaller (5mm diameter) leaks, giving an indication as to the likely extent of hazard ranges associated with the project.
- Risk to people and asset in terms of flammable leak major accident hazards (i.e. potential fire and explosion loads to the plant itself and surrounding facilities) will be assessed at a high level to give an early indication of the risk profile of the facility.

The following aspects were excluded from the original study scope:

- Risk during construction, commissioning or other phases not representing normal operation of the facilities.
- Risks to the environment and of business interruption / remediation / reputation.

The original Study Scope is presented in Section 4 to 6, with conclusions in Section 8.

2.1.1 Technical Land Use Planning (TLUP) Assessment

The TLUP assessment builds upon the original consequence modelling study to:

- Include event frequencies and ignition probabilities
- Alignment of failure cases, vulnerability and exposure criteria with Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/
- Production of LUP zones as contours overlayed on a map of the local area.

Approximation of individual risk, societal risk and risk to nearby buildings/sites. The TLUP assessment is presented in Section 7, with conclusions in Section 8.

2.2 Study Objectives

The objectives of the report are:

- Conduct a high-level risk study (consequence modelling and semi-quantitative risk assessment) to highlight any preliminary siting or layout concerns for the facility based on the current layout.
- To understand the potential risk exposure of site personnel, key buildings, offsite populations, and other siting aspects.
- Determine extent of LUP zones.
- Alignment with Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/).

3 DESCRIPTION AND STUDY BASIS

The assumptions for this study were derived from the project description and discussion with project team members, which are summarised below:

The key inputs defining the design as modelled in this study are:

- Process details are given by the Project Description document /1/ and discussion with the project team
- The overall process structure and major equipment items are given by the Project Description /1/.

Other data provided by Halston, and public information sources provide underlying basis for the study modelling as discussed in the remainder of this section.

3.1 Site Location

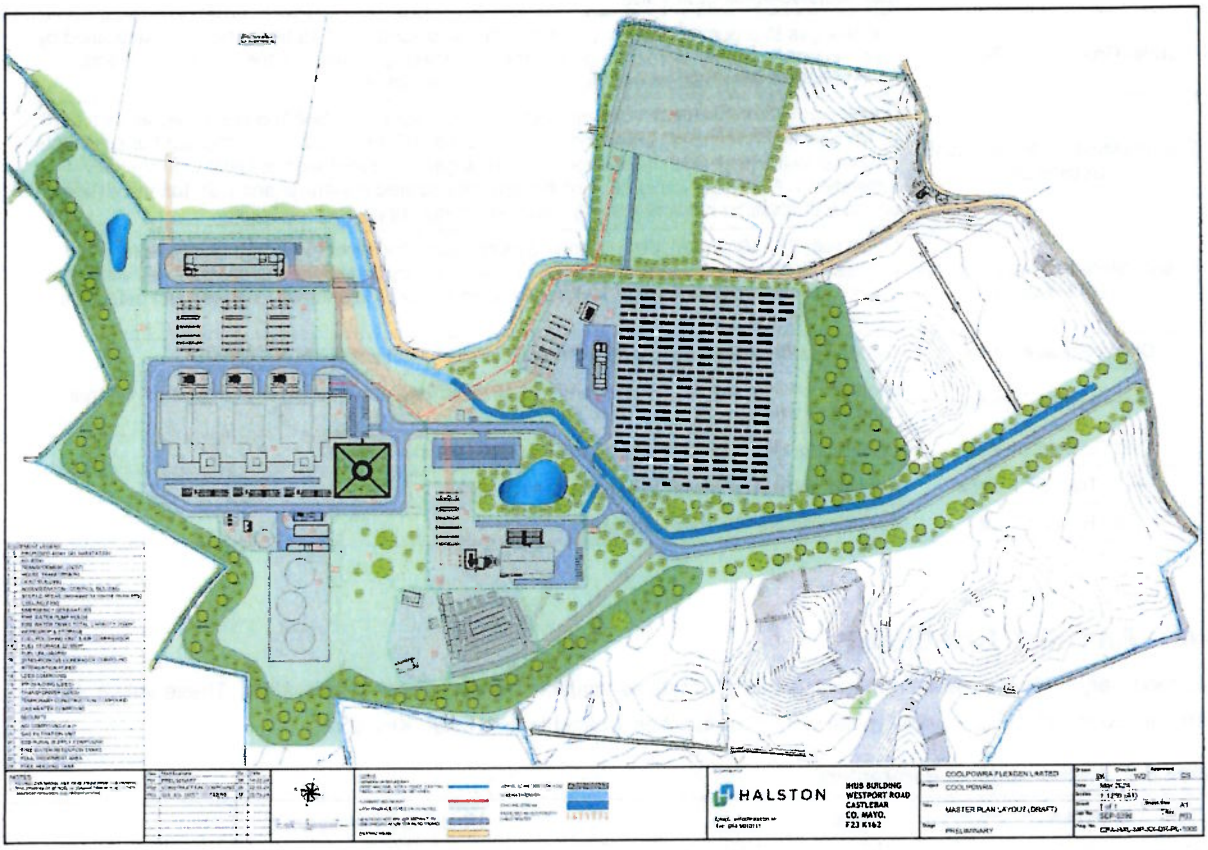
The proposed development is located approximately 4km north of Portumna and 3.1km south of Killimor. Lands within the development site boundary are in agricultural use and include a farmhouse and outbuildings which will be demolished. The proposed lands are situated at an elevation of c. 51-54m AOD and are accessed by road via the N65 (National Road) and the L8763 (local road). The N65 connects the towns of Loughrea and Portumna. The proposed development will be located adjacent to, and south of, the existing operational 400kV AIS electricity substation (Oldstreet).

Figure 3-1 Location of the Halston Plant

3.2 Site Layout

The facility layout shown in Figure 3-2 is used as the basis for this study.

Figure 3-2 Layout of the Halston Site



3.3 Process Description

The plant processing equipment within the scope of this study is defined within Table 3-1. Note that not all of these items present hazards that form part of the consequence modelling.

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Table 3-1 Summary of The Plant Processing Equipment and Systems

System	Description
Reserve Gas-Fired Generator	Three OCGT units, 1,125 MW (3 x 375 MW) Output will connect to the electricity system via the gas insulated switchgear (GIS).
Under Ground Gas Pipeline	Delivers gas to proposed AGI on site. Operating at pressures of 16 bar or higher, established by Gas Networks Ireland (GNI) through separate planning application at the time of this report. Around 400m run-length across the site in zig-zag formation.
Gas Insulated Switchgear (GIS) Substation	Forms part of the Electricity Transmission System. Two-storey building positioned and secured within a palisaded fenced compound. The proposed GIS will upgrade and replace the existing air insulated switchgear (AIS) substation with a new gas GIS substation at Oldstreet. The GIS substation will facilitate connection of the reserve gas fired generator and ESS to the existing node on the transmission network thereby securing energy supply into the future
Energy Storage System Energy – Grid Stability	LDES with 200 MW / 800 MWh Output. Synchronous Condenser with 400 MVA output. Both connect to electricity system via the GIS. The technology is designed to complement and support the reserve gas fired generator by providing zero carbon, instantaneous power and balancing power to the grid.
Diesel Storage Tanks	Three vessels containing gas oil, with a gross maximum inventory of 22,000 m^3.
Diesel Road Tanker	Located between the OCGT units and the diesel storage tanks, assumed to have an internal capacity of 40m^3
Grid Connection AGI	Connects to the main gas pipeline run by Gas Networks Ireland
Diesel Transfer Pumps	For safe delivery of diesel from tanks to process.
Foul Holding Tank	For use with the foul treatment area

3.4 Ambient Conditions

It is necessary to define certain meteorological constants as inputs to the consequence modelling. These values are summarised in Table 3-2, based typical values for facilities located in the United Kingdom.

Table 3-2 Meteorological Parameters

Parameter	Value	Notes and References
Atmospheric Temperature	10°C	Based on average annual temperatures.
Relative Humidity	70%	Typical annual average for Ireland.
Surface Temperature	10°C	Taken to be the same as atmospheric temperature

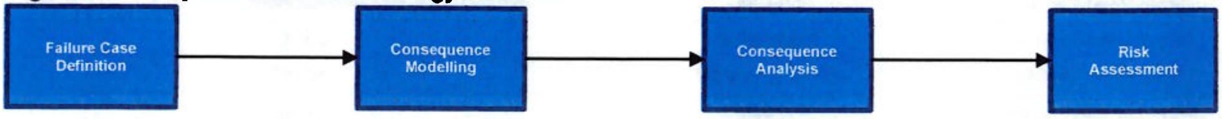
The contribution of solar flux to thermal radiation is not accounted for risks from fires (as is typical for these studies).

Those parameters above which are not based on any available site/ project specific data source are assumed values, selected based on experience or using model defaults, with the intention of providing the most appropriate modelling results whilst still taking a conservative approach so as not to underestimate any of the risk levels.

4 CONSEQUENCE MODEL METHODOLOGY

The outline methodology to be adopted for this preliminary consequence modelling is shown in Figure 4-1 and is described in more detail in in the following sections.

Figure 4-1 Simplified QRA Methodology Flowchart



4.1 Software

DNV Phast software v9.0 is used to carry out the study. A summary of global modelling parameters to be applied in the study are provided in Table 4-1. Other values not mentioned in this document can be assumed to remain as default settings in the software.

Table 4-1 General Phast Parameters to be Used for Modelling

Parameter	Value	Notes
Software version	V9.0	Latest version
Height of interest	1 m	Population is assumed to be located at ground level with a receptor height of 1 m (equal to release height); this applies to the whole population identified for the study.
Default leak direction for above-ground releases	Horizontal	Releases from any containerised equipment are considered as impinged. Modelling all releases as horizontal is somewhat conservative, however is typical practice for QRA studies.
Default release elevation	1.5 m	Typical standard value representing 'head height'
Surface Type	Concrete	
Surface Roughness	183 mm	Affects the turbulence in the air reaching the release source and is related to effective average obstacle height over the terrain. 183 mm is the Phast default and is suitable for occasional large obstacles, and is selected as the site has neither open, flat terrain (typically assigned a value of 30 mm), nor a significantly built-up area (typically assigned a value of 500 mm or more) in close proximity to the site.
Flammable averaging time	18.75 sec	Phast default value for flammable dispersion.
Flammable vapour cloud extent allowing ignition	Lower Flammability Limit (LFL)	Effects are calculated at effect height rather than the default cloud centreline height (affects buoyant cloud delayed ignition risk)

4.2 Failure Cases

Normal operating conditions for each failure case have been assumed, namely pressure, temperature, and operating flowrate.

Table 4-2 Operating parameters and parameters assumed for modelling.

Vessel/Equipment	Parameter	Value used
Diesel Storage Tanks	Temperature	20 °C
Diesel Storage Tanks	Volume inventory (per tank)	7333.3 m3
Diesel Road Tanker	Pressure	Atmospheric
Diesel Road Tanker	Temperature	20 °C
Diesel Road Tanker	Volume inventory	40 m^3
Diesel Transfer Pumps	Pressure	2 barg
Diesel Transfer Pumps	Temperature	20 °C
Diesel Transfer Pumps	Maximum Diameter	6 inches (full bore)
Diesel Transfer Pumps	Flow Rate	0.5 kg/s
Grid Connection AGI	Pressure	25 barg
Grid Connection AGI	Temperature	20 °C
Grid Connection AGI	Maximum Diameter	6 inches (full bore)
Gas Pipeline	Pressure	16 barg
Gas Pipeline	Temperature	20 °C

4.2.1 Leak Sizes

A range of representative leak sizes has been modelled as shown in Table 4-3.

Table 4-3 Representative Leak Sizes Modelled

Leak Size Name	Representative Hole Diameter (mm)	Hole Size Range for Frequency Analysis (mm)
Medium Leak	5	3-10
Full-Bore Rupture (FBR)	Line Size	Residual from total frequency for component

Additionally, catastrophic rupture of all vessels has been modelled, which is representative of vessel failure e.g. due to vehicle impact of mechanical defects.

4.2.2 Locations

A single representative leak location is defined per failure case, based on the plot plans and information provided.

The gas pipeline was modelled as an extended line source with potential leak locations along the pipeline length, however only the worst-case results are reported in this document.

4.3 Consequence Analysis

This section outlines the approach to be used for consequence modelling analysis.

4.3.1 Process Fluid Compositions

Some key assumptions have been made when defining the process fluid compositions to be modelled:

- The natural gas feed is assumed to be 100% methane.
- Secondary fuel oil (gas oil) is modelled as diesel.

4.3.2 Discharge

The discharge parameters have been determined within Phast on the basis of the defined failure case parameters (pressure, temperature). Where releases occur downstream of equipment such as a pump or compressor, the release rate will typically be driven by the normal flow rate of the section in forward flow. Therefore, the release rates are capped at a maximum of 150% of the inflow rate.

Detection and isolation are not modelled at this stage.

4.3.3 Dispersion

Releases have been modelled with a "horizontal" release direction, accounting for the open nature of the facility, with limited opportunity for direct impingement to adjacent equipment.

A default representative release height of 1.5 m applies for all failure cases, as is typical QRA practice.

4.3.4 Fire Modelling

Standard Phast models for flash fires and fireballs are used.

4.3.5 Explosion Modelling

Explosions are assumed to have the potential to occur where a vapour cloud with concentration within the flammable range is ignited and there is simultaneously a mechanism to accelerate the flame front. Such explosion scenarios require delayed ignition of the vapour cloud.

The potential detonation of natural gas in the open (i.e. outside areas of congestion/confinement) is not considered credible, and therefore a single area of congestion has been defined in the model, this being the Transformers shown by location 20 in Figure 3-2.

The approach to modelling a vapour cloud explosion (VCE) associated with a flammable cloud interacting with these transformers is to calculate the mass of methane associated with filling the transformer area with a stoichiometric mixture of methane in air, in this case approximately 80 kg of methane, and assuming ignition in the centre of this location. All explosion results outlined in this report are based on an explosion in this transformer compound.

4.3.6 Ignition Modelling

For the sake of consequence modelling, it is always assumed that the natural gas and secondary fuel (diesel) are ignited and the worst-case results are presented in Section 5. In reality, diesel is difficult to ignite - having a flash point of between 52 and 96°C, it is classified as 'combustible' rather than 'flammable'. This means that diesel is not readily ignited with a naked flame and requires sustained energy input (or atomisation) for it to ignite.

As a result, although the consequences of a diesel fire can appear severe, the likelihood of this event occurring can be considered less than for a more readily ignitable fluid (such as petrol or gases such as natural gas). This is reflected in the high-level risk assessment presented in Section 6.

4.3.7 Long Duration Energy Storage Modelling

At the time of conducting the consequence modelling, DNV were unable to model fires associated with battery energy storage systems (BESSs), however a qualitative assessment was undertaken for the likely impacts of BESS fires, based on DNVs experience in risk assessment of these systems.

4.4 Vulnerability Criteria

This section covers the integration of the consequence and frequency modelling to provide risk estimates for human receptors. The vulnerability criteria in Table 4-4 are for information only and provide context to the choice of hazard levels reported in this document.

The vulnerability criteria within this section were used for the original consequence study only. For the specific TLUP Assessment criteria, see Section 7.2.

Table 4-4 Vulnerability Criteria

Hazard	Effect Threshold (model ≥ threshold)	Fatality Probability				Notes
		Outdoor	Indoor CIA 4*	Indoor CIA 3*	Indoor CIA 2*	
Flash fire	LFL	100%	50%	20%	20%	DNV internal guidance.
Jet fire	4.7 kW/m²	0%	0%	0%	0%	4.7 kW/m² is considered the 'safe limit' for on-site personnel. 6.3 kW/m² is considered the point at which escape routes are considered impaired. 37.5 kW/m² is considered the point at which process equipment can sustain damage.
	6.3 kW/m²	0%	0%	0%	0%	
	12.5 kW/m²	50%	25%	25%	25%	
	37.5 kW/m²	100%	100%	50%	50%	
Fireball	4 kW/m²	0%	0%	0%	0%	0% at lower radiation thresholds to account for the short exposure duration.
	12.5 kW/m²	0%	0%	0%	0%	
	37.5 kW/m²	100%	100%	50%	50%	
Pool fire	4 kW/m²	0%	0%	0%	0%	4.7 kW/m² is considered the 'safe limit' for on-site personnel. 6.3 kW/m² is considered the point at which escape routes are considered impaired. 37.5 kW/m² is considered the point at which process equipment can sustain damage.
	12.5 kW/m²	50%	25%	25%	25%	
	37.5 kW/m²	100%	100%	50%	50%	
Explosion overpressure (side-on)	0.07 bar	0%	3%	2%	0%	Linearly interpolated between thresholds. 0% below lowest threshold. Outdoors represents people adjacent to buildings. Indoors from IOGP /11/ based on Chemical Industries Association (CIA) guidance.
	0.14 bar	0%	15%	8%	3%	
	0.35 bar	30%	90%	55%	70%	
	0.5 bar	100%	100%	65%	80%	
Toxicity	-	-	-	-	-	No toxic components have been identified for this study.

Note*: CIA4: 'Portacabin' type timber construction, single storey, CIA3: Typical domestic building: two-storey, brick, walls, timber floors, CIA2: Typical office block: four storey, concrete frame and roof, brick block wall panels.

4.5 Tolerability of Risk

The Health and Safety Authority (HSA) in Ireland follow a similar approach to the Health and Safety Executive (HSE) in the United Kingdom in respect to tolerability of risk, and the ALARP principle (Ref /12/). Risks can be designated into one of three categories:

a) **Broadly Acceptable**, whereby the individual risk is calculated to be below $1x10^{-6}$ per year. As long as it can be demonstrated that good practice has been followed in terms of management of these risks, no further action is required.

b) **Tolerable if ALARP.** Individual risk calculated to lie between $1x10^{-6}$ and $1x10^{-3}$/$1x10^{-4}$ for on-site and off-site populations respectively are considered tolerable if it can be demonstrated that further risk reductions are not

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practicable. In practice, this would mean demonstrating that further risk mitigation measures could not be justified in terms of cost (monetary or time/effort) against the level of risk reduction gained.

c) **Intolerable**. If the risk is found to exceed $1x10^{-3}$ /$1x10^{-4}$ for on-site and off-site populations respectively, risk reduction measures must be implemented regardless of cost, to bring the risk into the Tolerable if ALARP region before operation can continue.

Note, the quantitative figures outlined above are typically the outcome of a full QRA. This is outside the scope of the scope of this document given the early stage of the project however a QRA is planned for detailed design. The risk ranking matrix used in this semi-quantitative assessment aims to map the identified hazards across the three categories listed above.

DNV

5 CONSEQUENCE ASSESSMENT

Note, these results are for consequences only and do not consider the likelihood of the initial release, ignition probability, or any other conditional modifiers such as occupancy. They are necessarily coarse given the relatively early design maturity, and it is likely that any risk results derived during detailed design will give less severe contours.

5.1 Pool Fire Thermal Radiation

The thermal radiation consequence contours representing all diesel pool fires (irrespective of duration) are shown in Figure 5-1 to Figure 5-6. It can be seen from the shape of the contours that:

- The control room is located outside of all pool fire contours for all scenarios except for the catastrophic rupture of the Diesel Road Tanker where it lies within the 6.3 kW/m^2 contour, but this only impairs escape routes and leads to no fatalities.
- The radiative flux of 37.5 kW/m^2 is the key thermal load in terms of escalation and the risk effects. Any pool fire could escalate to any of the adjacent equipment (i.e. a single pool fire from any storage tank would cause all of the other storage tanks, the diesel road tanker and diesel transfer pump, and vice versa).
- Catastrophic rupture of the road tanker with subsequent pool ignition could result in high thermal loads on the OCGT building, however the effects of drainage in mitigating pool formation have not been modelled.
- The fire water retention tanks lay within the pool fire contours at 12.5 kW/m^2 for all catastrophic ruptures of any fuel storage tanks, road tanker and diesel transfer pumps, however this level of thermal flux is unlikely to cause damage to the fire water tanks.
- Given that all three fuel storage tanks currently share a bund, it is possible that catastrophic failure of one vessel could escalate to a large fire resulting in catastrophic damage to all three tanks. Furthermore, the integrity of the firewater tanks could be compromised in such an event which would result in loss of a key protective safeguard.

Recommendation – Assess the potential to relocate the fire water tanks to an area where they are unlikely to sustain damage in the event of a fire.

Figure 5-1: Contours for Pool Fire Radiation at category 5/D for Diesel Storage Tank (Southern) Catastrophic Rupture in kW/m^2

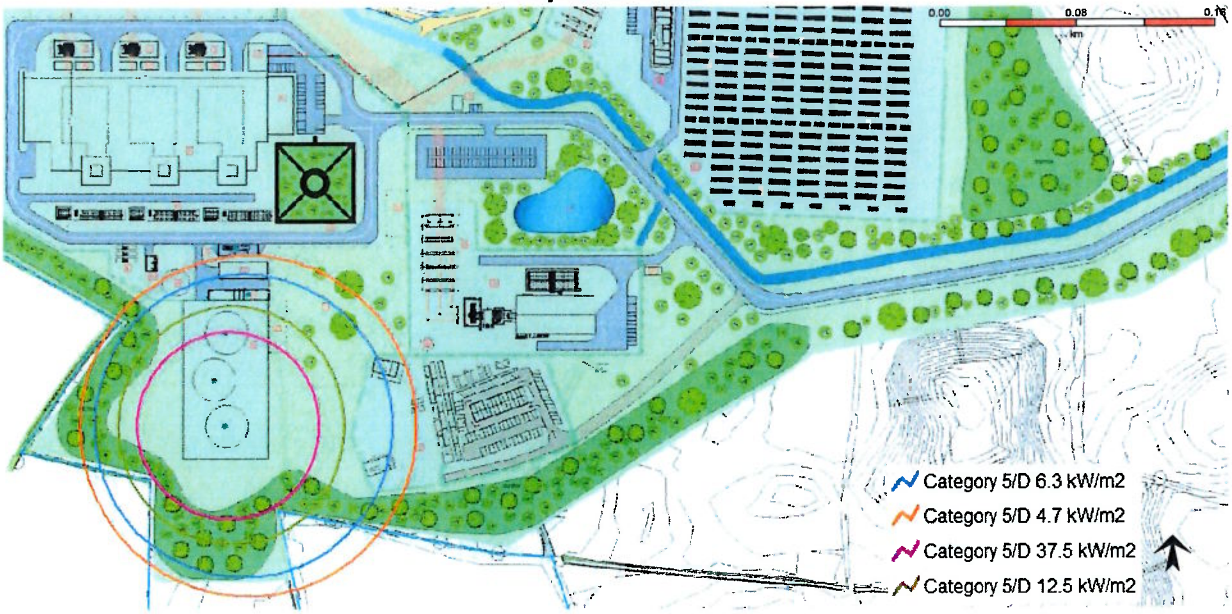

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Figure 5-2: Contours for Pool Fire Radiation at category 5/D for Diesel Storage Tank (Central) Catastrophic Rupture in kW/m²

Figure 5-3: Contours for Pool Fire Radiation at category 5/D for Diesel Storage Tank (Northern) Catastrophic Rupture in kW/m²

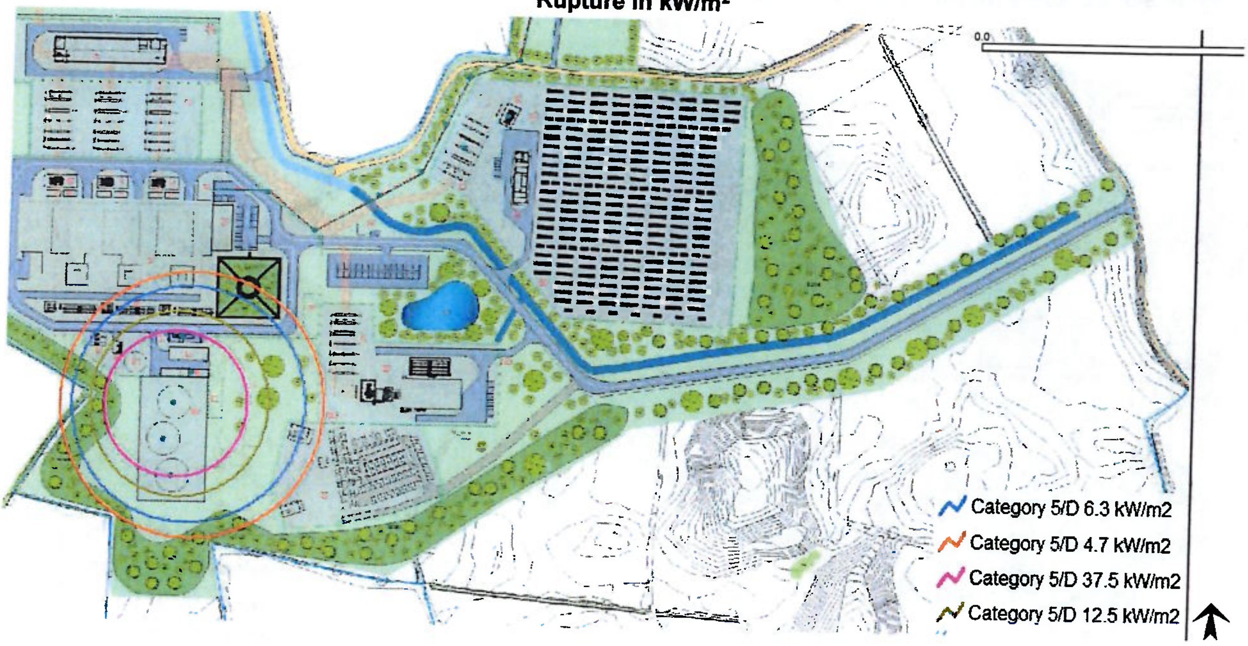


Figure 5-4: Contours for Pool Fire Radiation at category 5/D for Diesel Storage Tank (Northern) for a small 5mm hole size leak in kW/m²

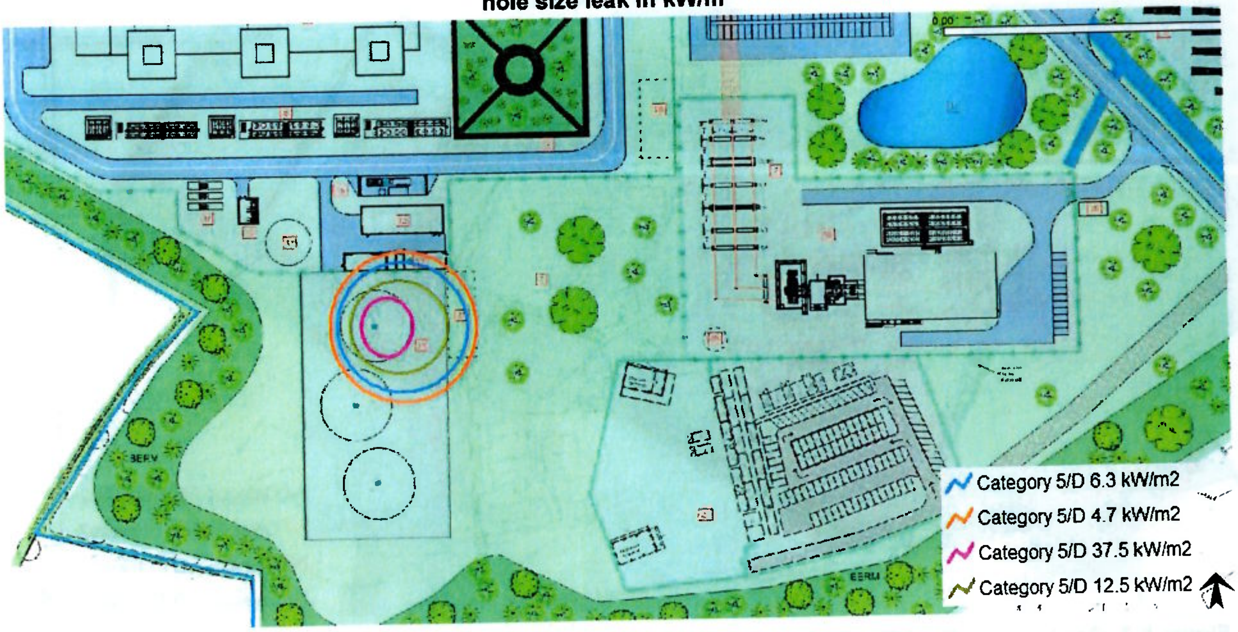


Figure 5-5: Contours for Pool Fire Radiation at category 5/D for Diesel Road Tanker Catastrophic Rupture in kW/m²

Figure 5-6: Contours for Pool Fire Radiation at category 5/D for Diesel Transfer Pump Full Bore Rupture in kW/m²

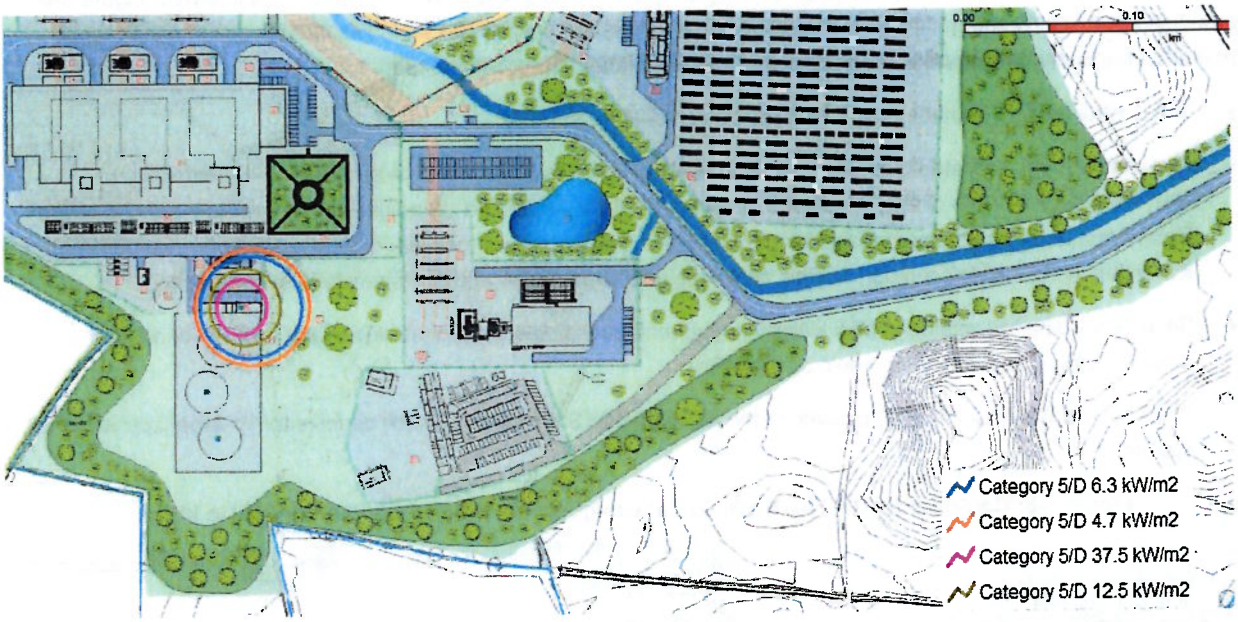
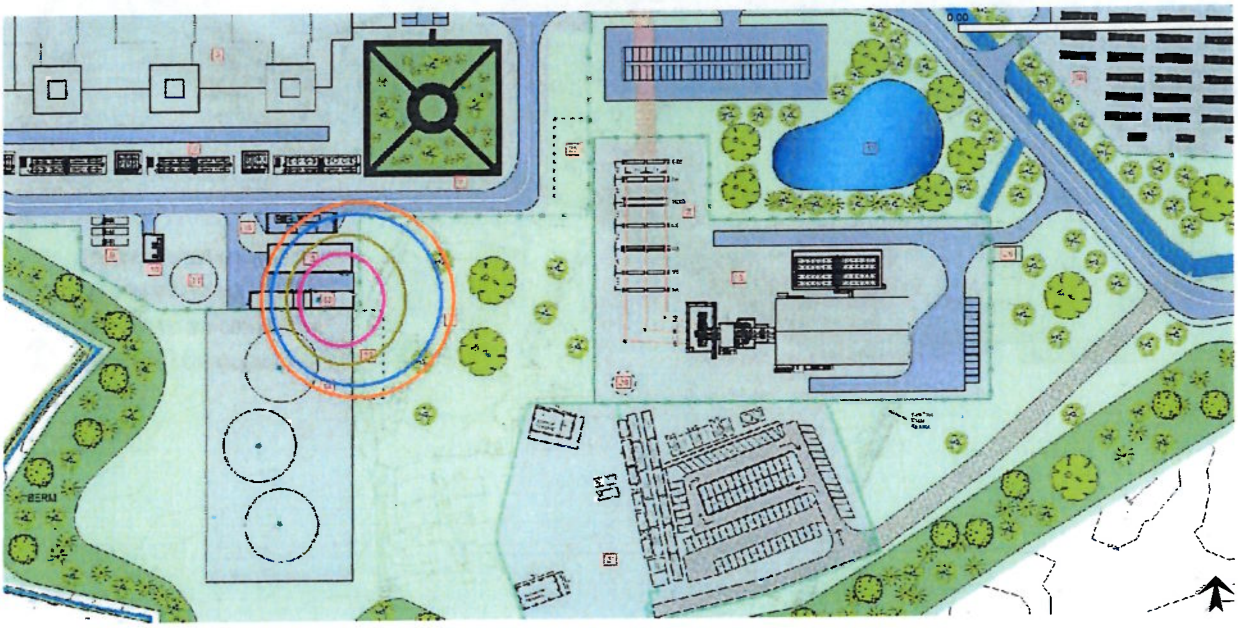


Figure 5-7: Contours for Pool Fire Radiation at category 5/D for Diesel Transfer Pump small 5mm hole leak in kW/m²



5.2 Jet Fire Thermal Radiation

The thermal radiation consequence contours representing all jet fires (irrespective of duration) are shown in Figure 5-8 and Figure 5-9. Jet fires form following ignition of a high momentum natural gas leak, assumed to occur at the facility AGI or on the buried gas pipeline. It can be seen from the shape of the contours that:

- The control room is located outside of all jet fire contours for the AGI.
- The control room is located outside of the long pipeline rupture's 37.5 kW/m^2 hazard frequency contours (corresponding to 100% chance of fatality for occupants for a portakabin style building) and outside the 12.5 kW/m^2 hazard frequency contours (corresponding to 25% chance of fatality for occupants for a portakabin style building). It is within the 6.3 kW/m^2 contour, but this only impairs escape routes and is unlikely to lead to fatalities.
- Security building lies within the 37.5 kW/m^2 contour of the long pipeline rupture and thus if any personnel are present during this event, there could be fatalities.
- There is potential for jet fires to escalate to the adjacent LDES compound, which could result in large fires within the system.

Figure 5-8: Contours for Jet Fire Radiation at category 5/D for Grid Connection AGI in kW/m^2

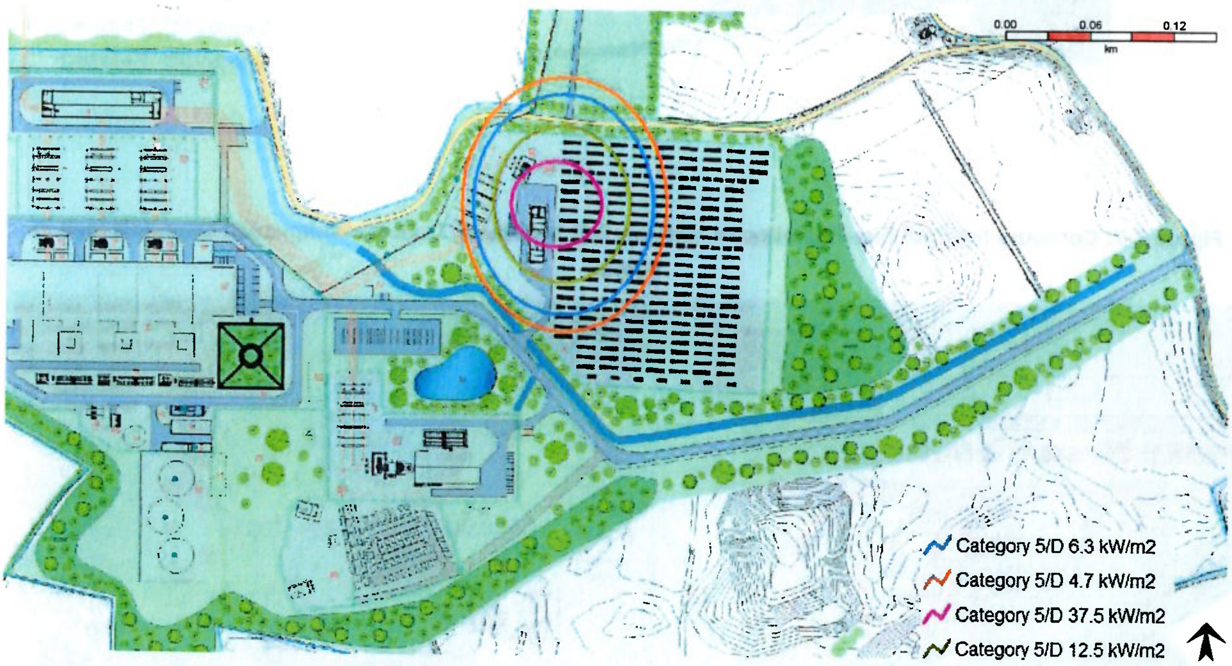


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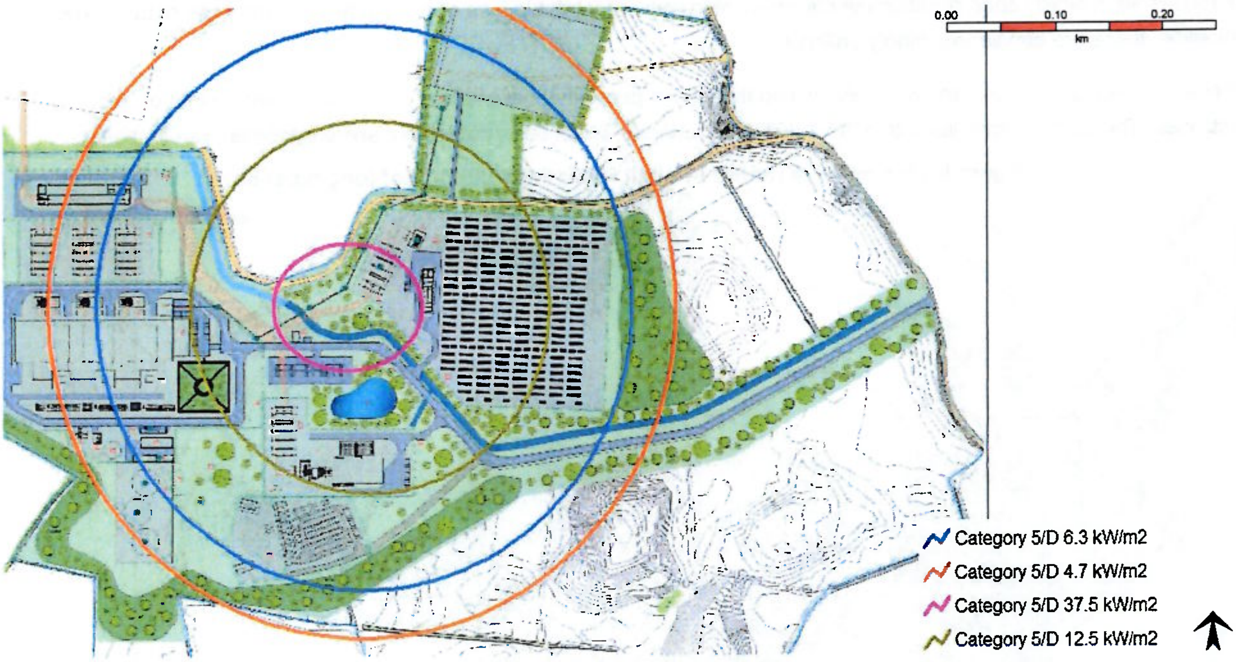
Figure 5-9: Contours for Jet Fire Radiation at category 5/D for Long Pipeline Full Bore in kW/m²



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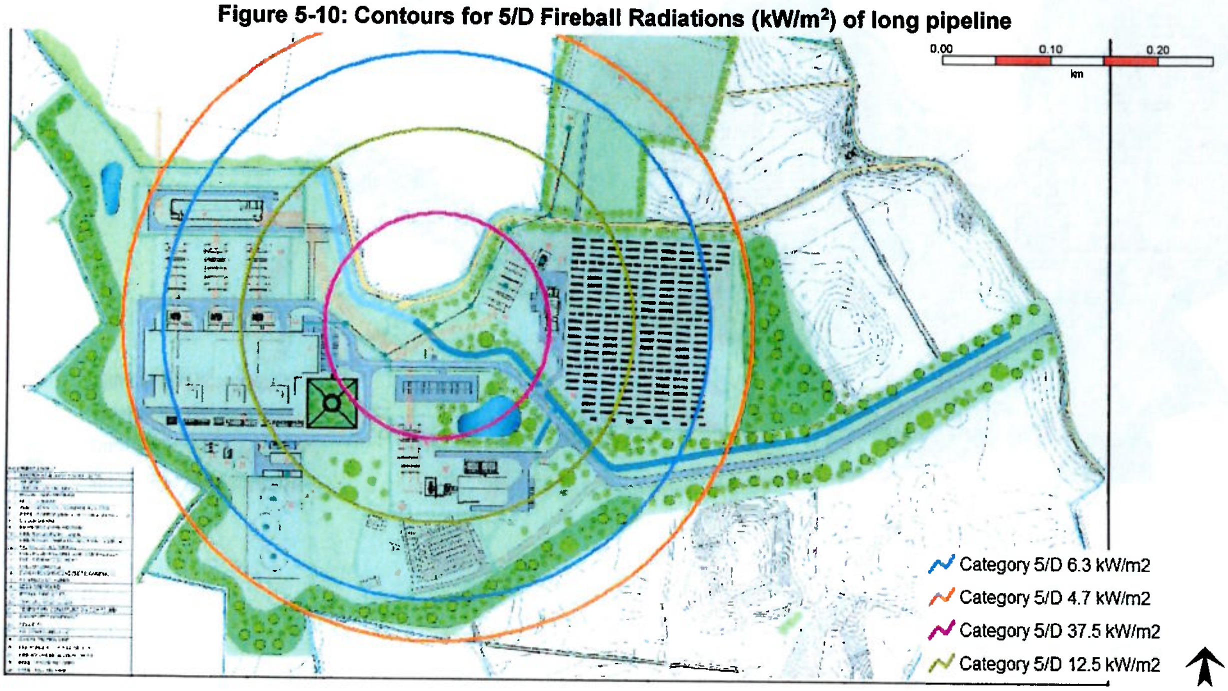
5.3 Fireball Thermal Radiation

The thermal radiation hazard frequency contours representing thermal loading from fireballs is shown in Figure 5-10. Fireballs are typically short duration events associated with catastrophic loss of containment. In the case of the buried pipeline, these are considered highly unlikely.

Security building lies within the 37.5 kW/m^2 and thus if any personnel are present during this event, there could be fatalities. The control room lies within the 12.5 kW/m^2 contour which does not lead to any causalities from fireballs

Figure 5-10: Contours for 5/D Fireball Radiations (kW/m^2) of long pipeline



5.4 Flash Fires

The vapour dispersion / flash fire to LFL hazard contours are shown in Figure 5-11 to Figure 5-16. These provide an indication of the flammable dispersion extents from the plant.

Flash fires associated with the fuel storage systems generally remain very localised, this is due to the fluid being a liquid at ambient temperature with a relatively high flash point. The flash fires associated with releases upstream of the AGI appear to have the potential to engulf the majority of the site within the 1/2LFL envelope, however the shape of the cloud is extremely thin, as shown in Figure 5-15, and the overall risk is consequently reduced.

Figure 5-11: Flash Fire at 5/D for both 3500 and 7000 ppm for catastrophic rupture of Diesel Storage Tank (northern)

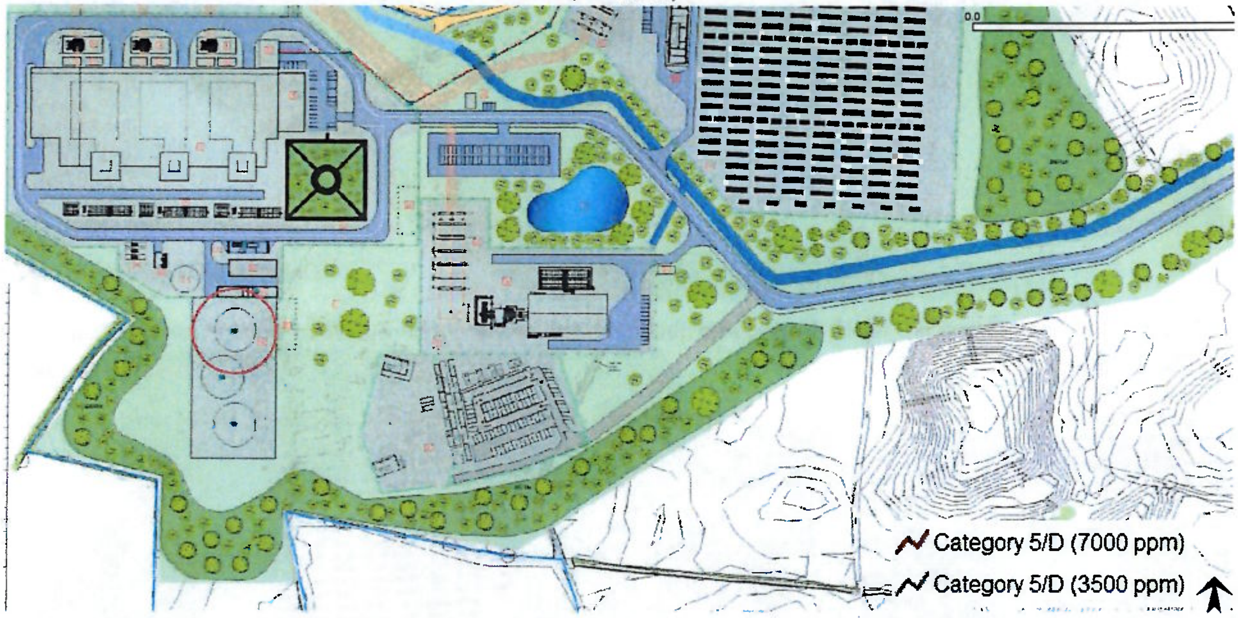


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Figure 5-12: Flash Fire at 5/D for both 2500 and 5000 ppm for catastrophic rupture of Diesel Road Tanker

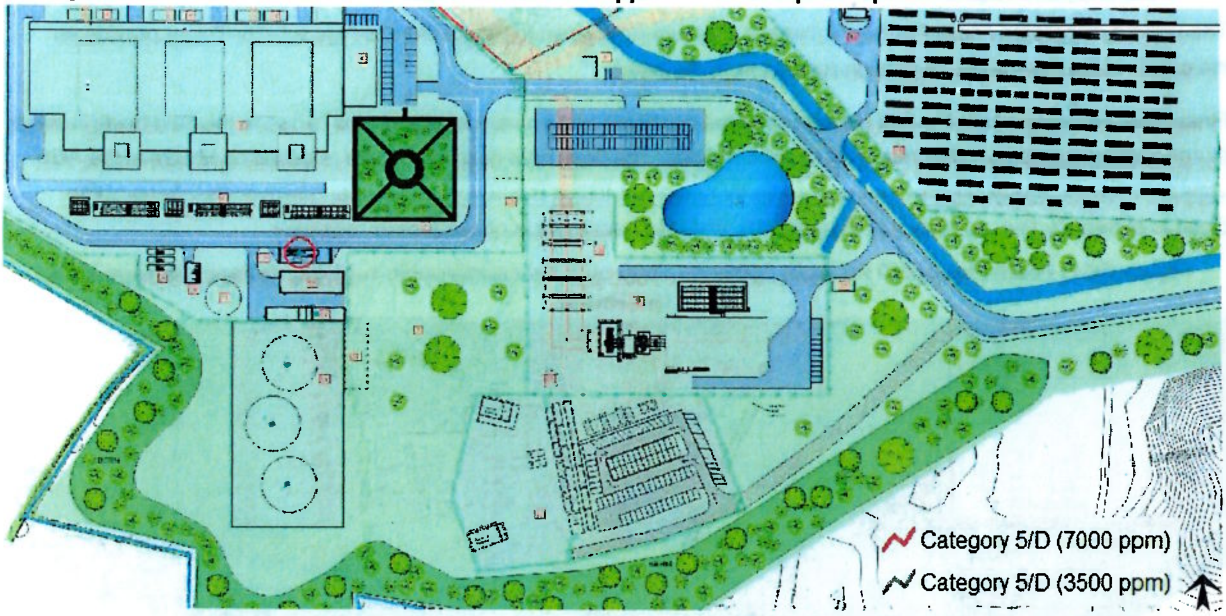


Figure 5-13: Flash Fire at 5/D for both 2500 and 5000 ppm for catastrophic rupture of Diesel Transfer Pump

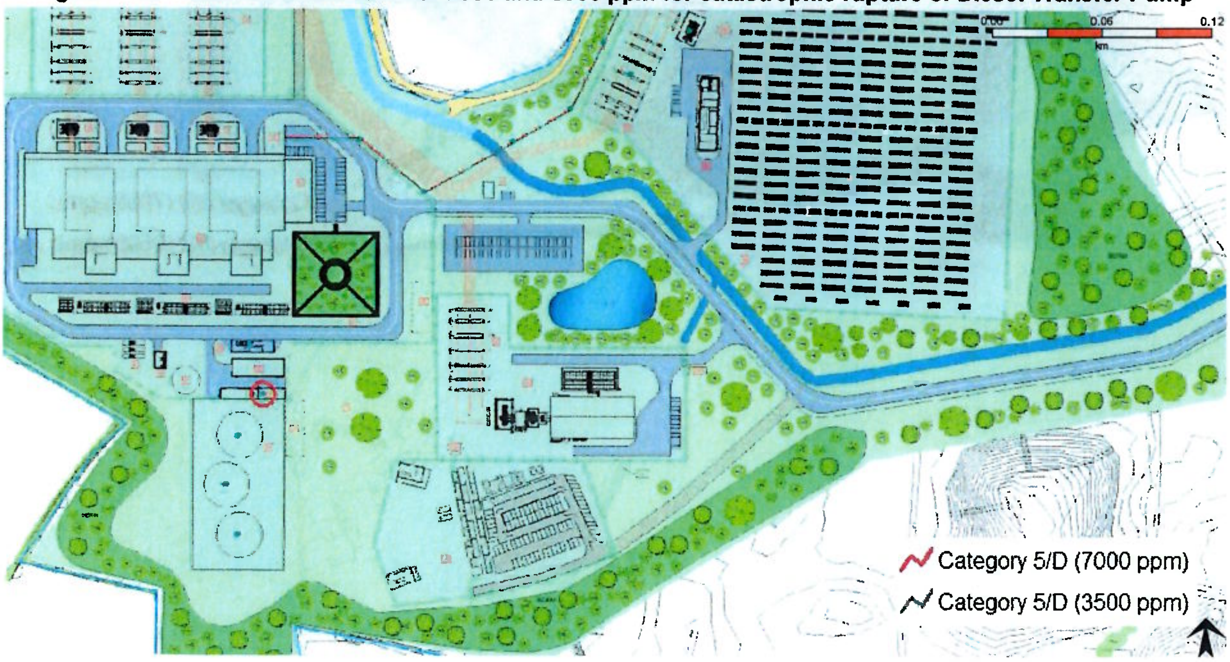


Figure 5-14: Flash Fire at 5/D for both 25000 and 50000 ppm for full bore (6 inch) of AGI grid connection

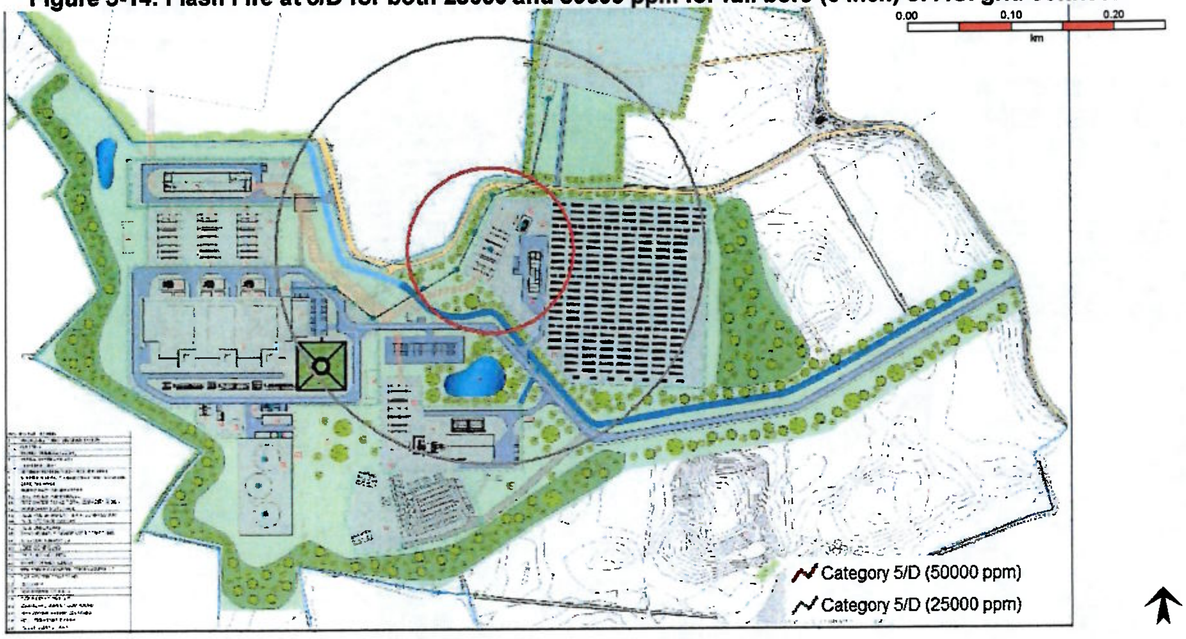


Figure 5-15: Shape of LFL and ½ LFL cloud shown for a release at the AGI.

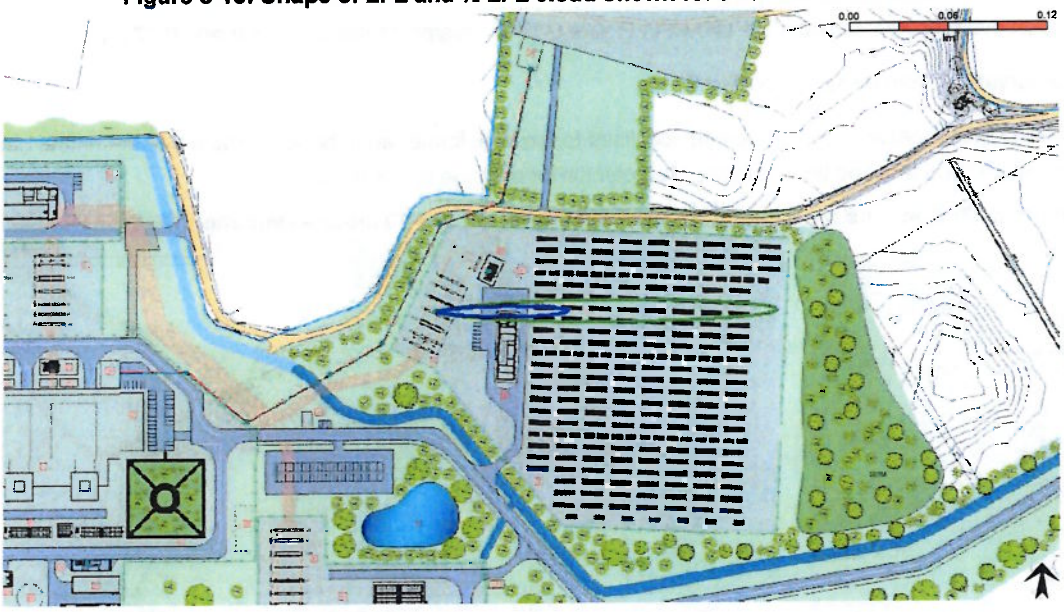
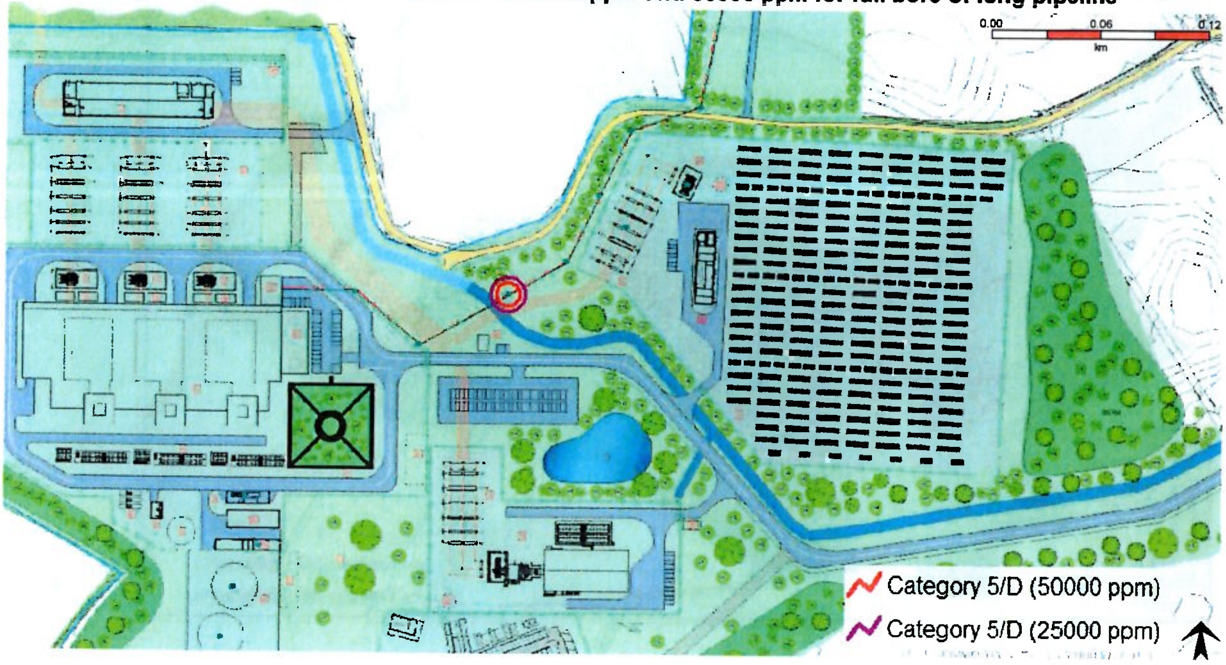


Figure 5-16 Flash Fire at 5/D for both 25000ppm and 50000 ppm for full bore of long pipeline



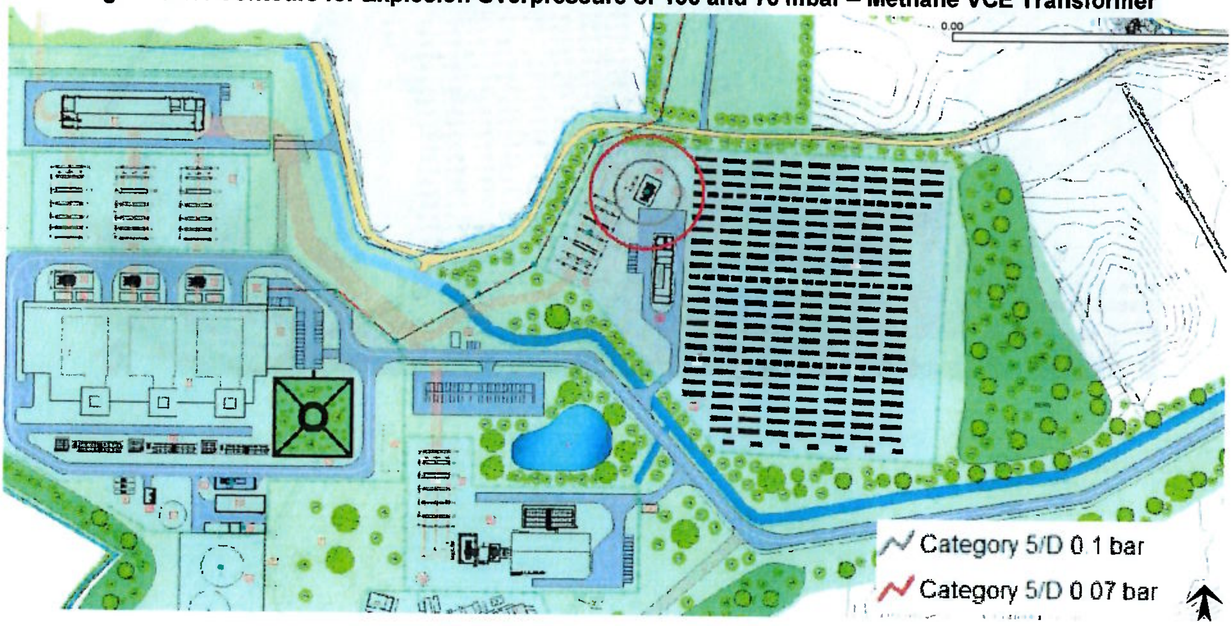
5.5 Explosion Overpressures

The explosion overpressure contours are shown in Figure 5-17 for overpressures of 0.1 bar and 0.07 bar.

The key observations from these contours are:

- The overpressure hazard contours remain localised to the transformer area, however the 0.07 bar contour does reach the IPP building, and there is therefore potential for damage to this building.

Figure 5-17: Contours for Explosion Overpressure of 100 and 70 mbar – Methane VCE Transformer



5.6 Long Duration Energy Storage (LDES) Battery System

Battery Energy Storage Systems (BESS) present significant safety risks through fire and explosion (thermal runaway). In case of the proposed development, the aggregate stored energy will likely exceed 1 GWh (assuming 400 MW with at least 5 hours of capacity); making it one of the largest installations under development globally.

Should a fire occur in one of the LDES battery containers, there is potential that the fire propagates through the entire system, which would have catastrophic consequences in terms of asset loss and potential risk to personnel and first responders. Proper fire management design should be followed during the design of the LDES system such that the potential for a fire to propagate from one container to the next is reduced to ALARP. It is likely that the LDES system will be of particular interest to regulators and insurers, and as such, DNV recommend specific risk assessment for the system when the design is sufficiently mature.

6 PRELIMINARY RISK ASSESSMENT

Given the early stage of this project, and the resulting lack of engineering design detail, a full quantitative risk assessment (QRA) cannot be undertaken. However, based on engineering judgement and experience of assessing other similar industrial facilities, DNV have conducted a preliminary risk assessment using the consequence results reported above to allow for prioritisation of risk as High, Medium and Low.

The following basis is taken for assessing the severity (S) of the modelled scenarios:

Table 6-1: Severity ranking categories.

Severity Category	Criteria
S5	Multiple Fatalities or one off-site fatality
S4	Multiple serious injuries or one fatality
S3	Serious (life altering) Injury
S2	Serious (non-life altering) injury
S1	Minor injury

The following basis is used for assessing the likelihood (L) of the modelled scenarios:

Table 6-2: Likelihood ranking categories.

Likelihood Category	Criteria
L5	Can occur multiple times per year
L4	Can occur once in a year
L3	Can occur once during the lifetime of the facility
L2	Potential to occur once in 100 years
L1	Unlikely to occur once in 100 years

And the following risk matrix is proposed to rank risks at this stage.

Figure 6-1: Proposed risk matrix

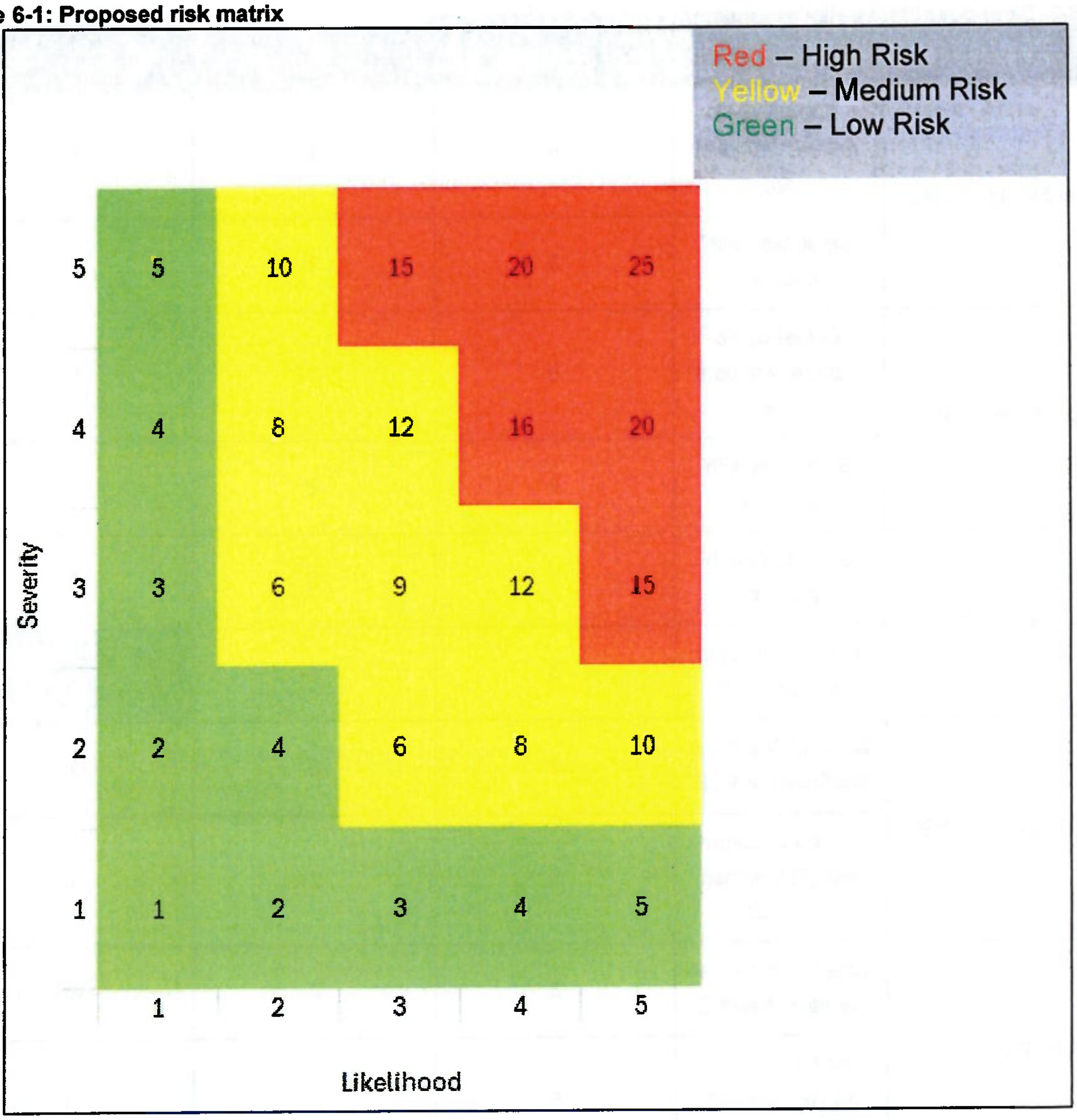


Table 6-3: Semi-quantitative risk assessment of modelled scenarios.

System	Scenario	Severity	Likelihood	Risk
Diesel Storage Tanks	Catastrophic rupture with pool fire	5	1	5
	Small leak with pool fire	3	2	6
Diesel Road Tanker	Catastrophic rupture with pool fire	5	1	5
	Small leak with pool fire	3	2	6
Diesel Transfer Pumps	Small leak with pool fire	3	2	6
	Full bore rupture with pool fire	3	1	3
Grid Connection AGI	Small leak with jet fire/flash fire/VCE	3	3	9
	Full bore rupture with jet fire/flash fire/VCE	5	2	10
Long Pipeline	Small leak with jet fire/flash fire/VCE	3	2	6
	Full bore rupture with jet fire/flash fire/VCE	5	2	10
VCE	Explosion	4	2	8
LDES Battery	Single container fire	4	3	12
	Multi-container fire	5	2	10

At this stage, no High risks have been identified. However, the facility operator will be required to demonstrate that all risks have been managed and that all reasonably practicable measures have been implemented to reduce the risk. The ALARP demonstration principle is a key feature of the Control of Major Accident Hazards (COMAH) regulations, and further risk assessments will be required as the design of the facility matures, such that the control of risk can be adequately demonstrated in accordance with the HSA guidance related risk tolerability Ref. /12/.

7 TLUP ASSESSMENT

"The Seveso-III Directive (2012/18/EU) requires that the objectives of preventing major accidents and limiting their consequences should be taken into account in land use policy. As implemented by the COMAH Regulations 2015, the objectives are to be achieved through controls on:

- the siting and development of new establishments,
- modifications to existing establishments,
- development in the vicinity of establishments" (Ref. /13/).

To ensure that the requirements of the Seveso-III Directive (2012/18/EU) are met, the Health and Safety Authority (HSA) developed a risk-based TLUP advice methodology to be used for TLUP advice required by the Seveso Directive, and for development of LUP zones around COMAH (Seveso) establishments.

Therefore, Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/) provides a consistent methodology that can be followed to demonstrate that risks are at an acceptable level for a new COMAH site. This Section details that demonstration.

7.1 LUP Risk Criteria

7.1.1 Individual Risk

Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/) sets out two criteria for new establishments:

- A maximum tolerable risk of fatality to a member of the public of 1 x 10^{-6} per year.
- A maximum tolerable risk of fatality to a person at an offsite work location of 5 x10^{-6} per year.

Further to these criteria, consultation distances (CD) around establishments, that correspond to three zones of risk are also defined:

- Zone 1 – risk of fatality for inner zone of 1 x10^{-5} per year.
- Zone 2 – risk of fatality of middle zone of 1 x10^{-6} per year.
- Zone 3 – risk of fatality of outer zone of 1 x10^{-7} per year.

Associated with these zones are then four levels of development, which have an increasing sensitivity to major hazards as follows:

- Level 1 – Workplaces and car parks, e.g. offices, factories, farm buildings, builder's yards, etc.
- Level 2 – Developments for use by the general public e.g. housing, hotels, restaurants, roads, etc.
- Level 3 – Developments for use by vulnerable people e.g. hospitals, schools, nursing homes, sheltered housing, etc.
- Level 4 – very large and/or sensitive developments e.g. very large development of the above examples, sports stadiums, arenas, etc.

These zones and levels are then combined (Table 7-1) to determine whether the Competent Authority 'Advises Against (AA)' or 'Does Not Advise Against (DAA)' an establishment.

Table 7-1: TLUP Advice for Each Zone

	Zone 1	Zone 2	Zone 3
Level 1	DAA	DAA	DAA
Level 2	AA	DAA	DAA
Level 3	AA	AA	DAA
Level 4	AA	AA	AA

7.1.2 Societal Risk

Societal risk is the relationship between frequency and the number of people from a given population who may be affected (to a specified level of harm) by major accidents from specified hazards. It is used to demonstrate the potential for certain, rare major hazard events to affect large numbers of people and can be used to target different types of risk reduction measures.

Both the individual and societal risk criteria must be satisfied when considering a new development. If the individual risk criterion is met, then the societal risk level has to be considered. Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/) provides the criteria for societal risk as follows:

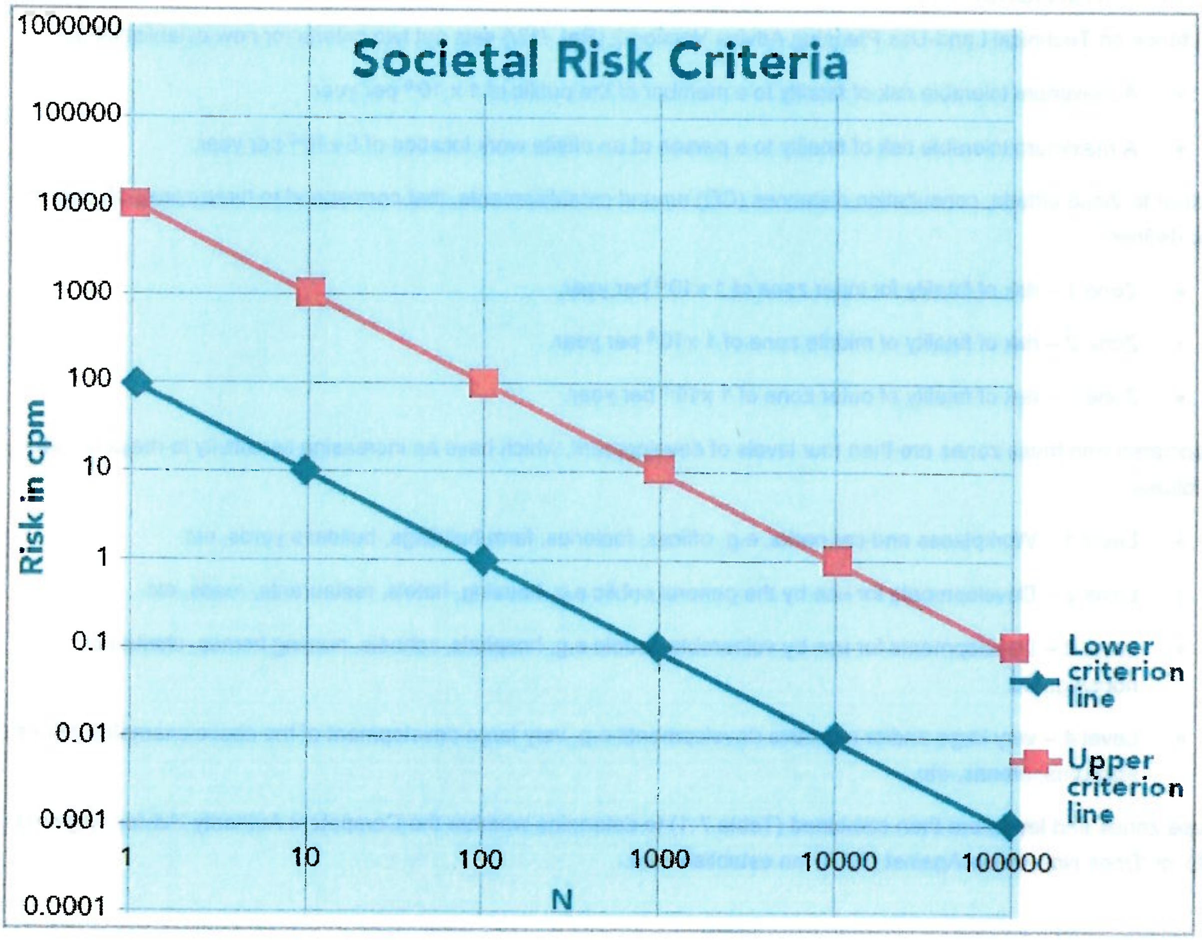


Figure 7-1: Societal Risk Criteria (Ref. /13/)

7.2 Vulnerability Criteria

Vulnerability criteria based on established literature and engineering good practice are already defined in Section 4.4. However, in some instances these do not correspond to those used within the Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/). Therefore, to ensure alignment with the guidance, the vulnerabilities stated within this section were used for the TLUP Assessment.

Table 7-2: TLUP Vulnerability Criteria

Hazard	Effect Threshold (model ≥ threshold)	Fatality Probability		Notes
		Outdoor	Indoor	
Flash fire	LFL	100%	10%	
Jet and Pool fire	8.02 kW/m^2	1%	0%[1]	1. People are assumed to be protected, and therefore there is a 0% fatality probability for radiative heat flux below 12.7 kW/m^2. 2. People are assumed to have escaped outdoors, and therefore have a risk of fatality corresponding to that of people outdoors for radiative hat flux below 25.6 kW/m^2
	10.09 kW/m^2	10%	0%[1]	
	15.9 kW/m^2	50%	50%[2]	
	25.6 kW/m^2	N/A	100%	
Fireball	N//A			Due to the dominating effects of fireballs, it is used exclusively in determining BLEVE effects for TLUP. No BLEVEs are considered within this TLUP assessment.
Explosion overpressure (side-on)	0.07 bar	N/A	2%	Indoors from IOGP /11/ based on a Category 3 Building in Chemical Industries Association (CIA) guidance. Category 3 building used as conservative estimate.
	0.14 bar	N/A	8%	
	0.168	1%	N/A	
	0.35 bar	N/A	55%	
	0.365	0.1	N/A	
	0.5 bar	N/A	65%	
	0.942	0.5	N/A	
Toxicity	N/A			No toxic components have been identified for this TLUP Assessment
Risk to Buildings				

7.3 Model Assumptions

In addition to the vulnerability criteria, other modelling assumptions were also adjusted to ensure alignment with the Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/).

Table 7-3: Parameters Used in TLUP Assessment

Parameter	Value	Notes
Software version	V9.0	Same version as consequence model
Height of interest	1 m	Population is assumed to be located at ground level with a receptor height of 1 m (equal to release height); this applies to the whole population identified for the study.
Default leak direction for above-ground releases	Horizontal impinged	Releases from any containerised equipment are considered as impinged. Modelling all releases as horizontal is somewhat conservative, however is typical practice for QRA studies.
Default release elevation	1.5 m	Typical standard value representing 'head height'
Surface Type	Concrete	
Surface Roughness	100 mm	Chosen as conservative approach
Flammable averaging time	18.75 sec	Phast default value for flammable dispersion.
Flammable vapour cloud extent allowing ignition	Lower Flammability Limit (LFL)	Effects are calculated at effect height rather than the default cloud centreline height (affects buoyant cloud delayed ignition risk)
Wind Direction Probability	See	Derived from simulated wind data for Coolpowra (Ref. /17/).
Wind Speeds	2m/s 5m/s	
Ambient temperature	15°C for 5D weather conditions 10°C for 2F weather conditions	
Fraction of Time indoors	90%	
Domino effects	-	No domino effects to neighbouring sites, or between the diesel inventory and natural gas line have been identified for this TLUP Assessment. However, it is deemed possible for a domino impact from a tanker pool fire resulting in escalation to the northern diesel storage tank.
Maximum Pool Size	100m	
Surface Emissive Power	Methane – 265 kW/m^2 Diesel – 140 kW/m^2	Note that Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/) sates 130 kW/m^2 for diesel, therefore the 140 kW/m^2 is seen a more conservative. All pool fire s are modelled using a two-zone model to determine an average surface emitted flux based on the fluxes from the lower and upper layer of the pool fire.

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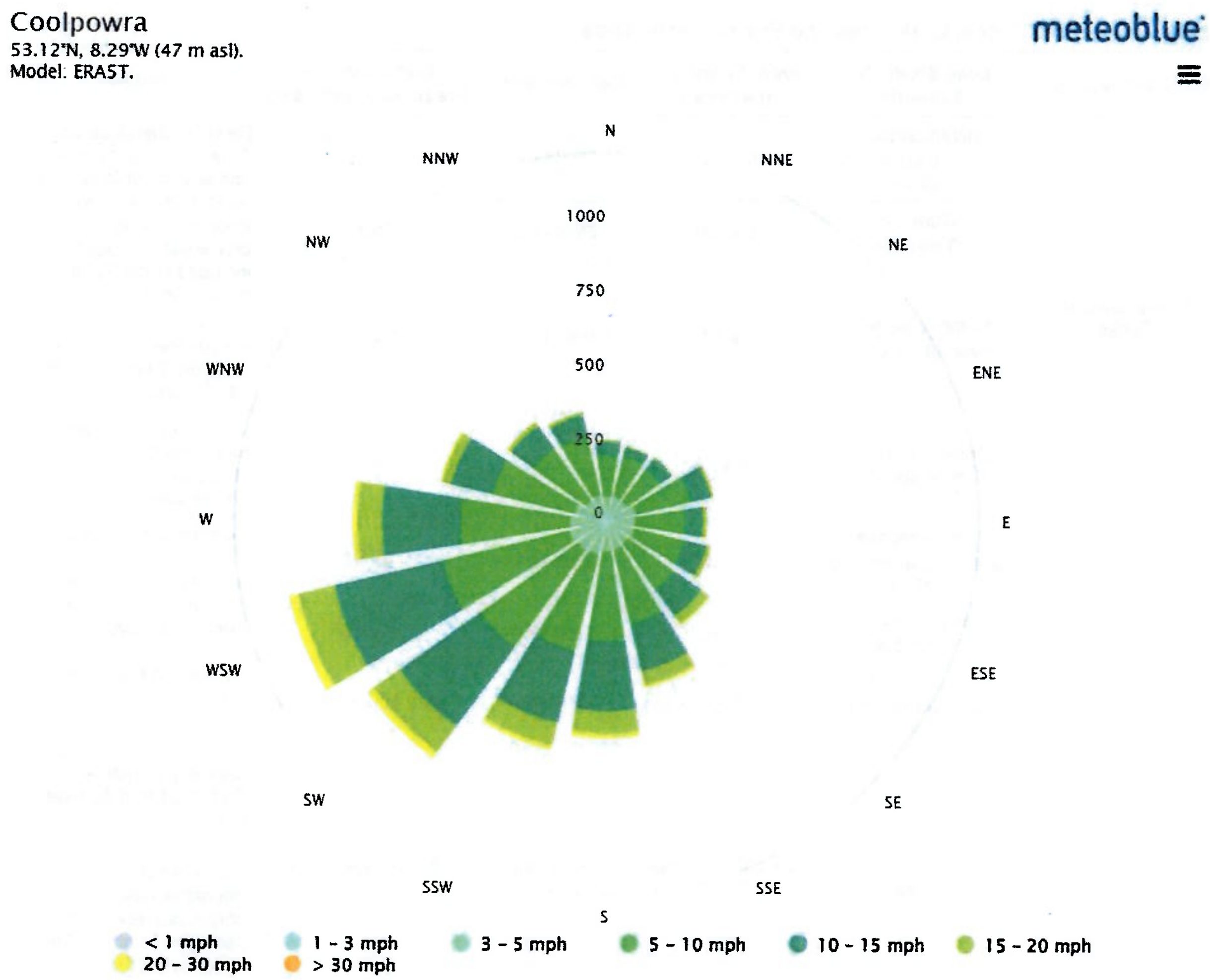

Figure 7-2: Coolpowra Wind Rose (Ref. /17/).

7.4 Failure Cases and Frequency Analysis

Section 4.2 describes the normal operating conditions for each failure case that has been assumed, namely pressure, temperature, and operating flowrate. These conditions remain valid for the TLUP assessment with the exception of temperature which has been adjusted as per Table 7-3.

A range of representative leak sizes has been modelled as shown in Table 4-3. Again, to ensure alignment with the Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/) these have been adjusted as follows:

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Table 7-4 Failure Cases, Leak sizes and Event Frequencies

Vessel/Equipment	Leak Size/LOC Scenario	Event Frequency (per year)	Consequence	Consequence Frequency (per year)	Notes
Diesel Storage Tanks	Instantaneous Failure / Catastrophic rupture	5×10^{-6}	Pool Fire	5×10^{-8}	Diesel is classified as a Category 3 substance and any credible spill will remain on-site, however Pool Fires have conservatively been included in the TLUP assessment. Frequencies are as per a category 2 liquid – Table 48 (Ref. /13/)
	Failure over 10 minutes	5×10^{-6}	Pool Fire	5×10^{-8}	
	10 mm pipe leak over 30 minutes	1×10^{-4}	Pool Fire	1×10^{-6}	
	Domino Event – Tanker pool fire	5.8×10^{-8}			This frequency is applied to all Diesel storage tank consequences frequencies
Diesel Road Tanker	Instantaneous Failure / Catastrophic rupture	1×10^{-5}	Pool Fire	1×10^{-7}	Diesel is classified as a Category 3 substance and any credible spill will remain on-site, however Pool Fires have conservatively been included in the TLUP assessment. Frequencies are as per a category 2 liquid – Tables 51 and 52 (Ref. /13/) A 24-hour a day operation has conservatively been assumed for the TLUP assessment
	Leak from largest connection	5×10^{-7}	Pool Fire	5×10^{-9}	
	Rupture of loading/unloading hose	3×10^{-8} (per hour)	Pool Fire	3×10^{-10} (per hour)	
	Leak of loading/unloading hose	3×10^{-7} (per hour)	Pool Fire	3×10^{-9} (per hour)	
Grid Connection AGI	Above ground Pipeline Rupture	1×10^{-7} (per metre)	Jet Fire/Fireball	1×10^{-8} (per metre)	Frequencies for an above ground pipeline with diameter greater than 150mm. Total pipeline length on the site is 381m. Probability of consequences determined as per table 42 (Ref. /13/).
			Flash Fire	3.6×10^{-8} (per metre)	
			Explosion	5.4×10^{-8} (per metre)	
Grid Connection AGI	Above ground Pipeline Leak	5×10^{-7} (per metre)	Jet Fire/Fireball	5×10^{-8} (per metre)	
			Flash Fire	1.8×10^{-7} (per metre)	
			Explosion	2.7×10^{-7} (per metre)	
Gas Pipeline	Below ground Pipeline Rupture	1×10^{-8} (per metre)	Jet Fire/Fireball	1×10^{-9} (per metre)	Frequencies for a below ground pipeline with diameter greater than 150mm. Total pipeline length on the site is 381m. Probability of consequences determined as per table 42 (Ref. /13/).
			Flash Fire	3.6×10^{-9} (per metre)	
			Explosion	5.4×10^{-9} (per metre)	
Gas Pipeline	Below ground Pipeline Leak	5×10^{-8} (per metre)	Jet Fire/Fireball	5×10^{-9} (per metre)	
			Flash Fire	1.8×10^{-8} (per metre)	
			Explosion	2.7×10^{-8} (per metre)	

A single representative leak location is defined per failure case, based on the plot plans and information provided. The gas pipeline was modelled as an extended line source with potential leak locations along the pipeline length.

The diesel transfer pumps have been excluded from the TLUP assessment as no data is available for their assessment within the Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/). Based on the results of the original consequence assessment, it is not anticipated that events associated with the Diesel Transfer Pumps would noticeably alter the determined LUP zones, and results in Section 7.5

7.5 TLUP Assessment Results

This section details the risk results and extent of LUP zones. The detailed consequences to the thresholds specified in by Section 2 of the Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/) are presented in Appendix F.

7.5.1 Individual Risk

Figure 7-3 shows the calculated LUP Zone risk contours for the development. No contours are expected to impact on local populations. Both the following criteria are not foreseen to be exceeded.

- maximum tolerable risk of fatality to a member of the public of 1 x 10^{-6} per year, and
- maximum tolerable risk of fatality to a person at an offsite work location of 5 x10^{-6} per year.

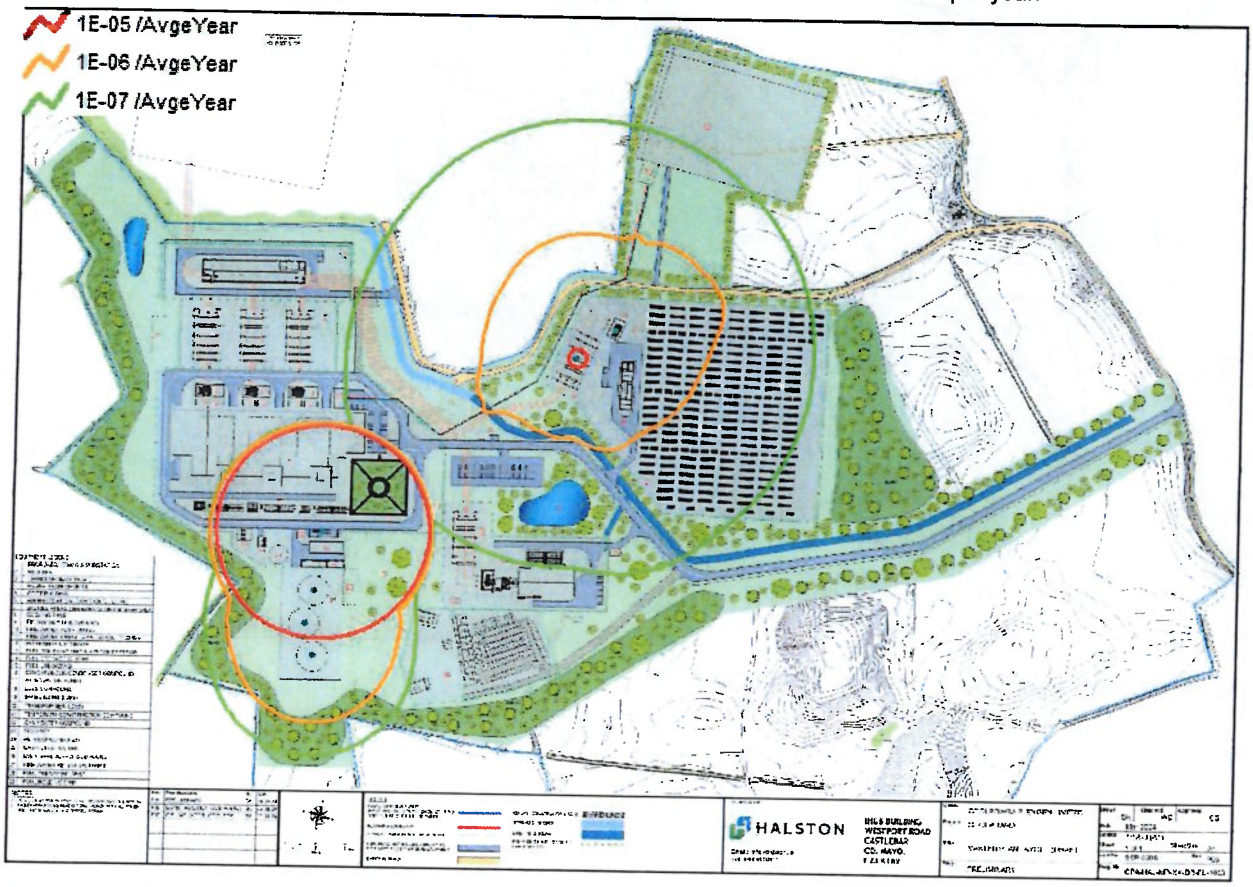

Figure 7-3: LUP Zones

Consultation distances (CD) around establishment, that correspond to three zones of risk are also defined:

- Zone 1 – risk of fatality for inner zone of 1 x10^{-5} per year does not extend beyond the site boundary and is centred around the pipeline AGI and the tanker loading area.
- Zone 2 – risk of fatality of middle zone of 1 x10^{-6} per year extends beyond the site boundary in the vicinity of the pipeline AGI, however it is unlikely to impact on local populations.
- Zone 3 – risk of fatality of outer zone of 1 x10^{-7} per year extends beyond the site boundary in the vicinity of the pipeline AGI and the diesel storage area, however unlikely to impact on local populations.

No Level 1, 2, 3 or 4 developments are located within the contours.

7.5.1.1 One in a Billion Chance of Fatality

When establishing new CDs, the Guidance on Technical Land-Use Planning Advice Version 2 (Ref. /13/) also requires the 1 x 10^{-9} (1 in a billion) fatality risk contour to be determined. This is presented in Figure 7-4 and shows that no offsite populations, nor the neighbouring existing substation are within the contour.

As no there are no buildings or sites within the 1 x 10^{-9} contour, no analysis to the impact on offsite buildings or structures has been deemed necessary as part of the TLUP assessment.

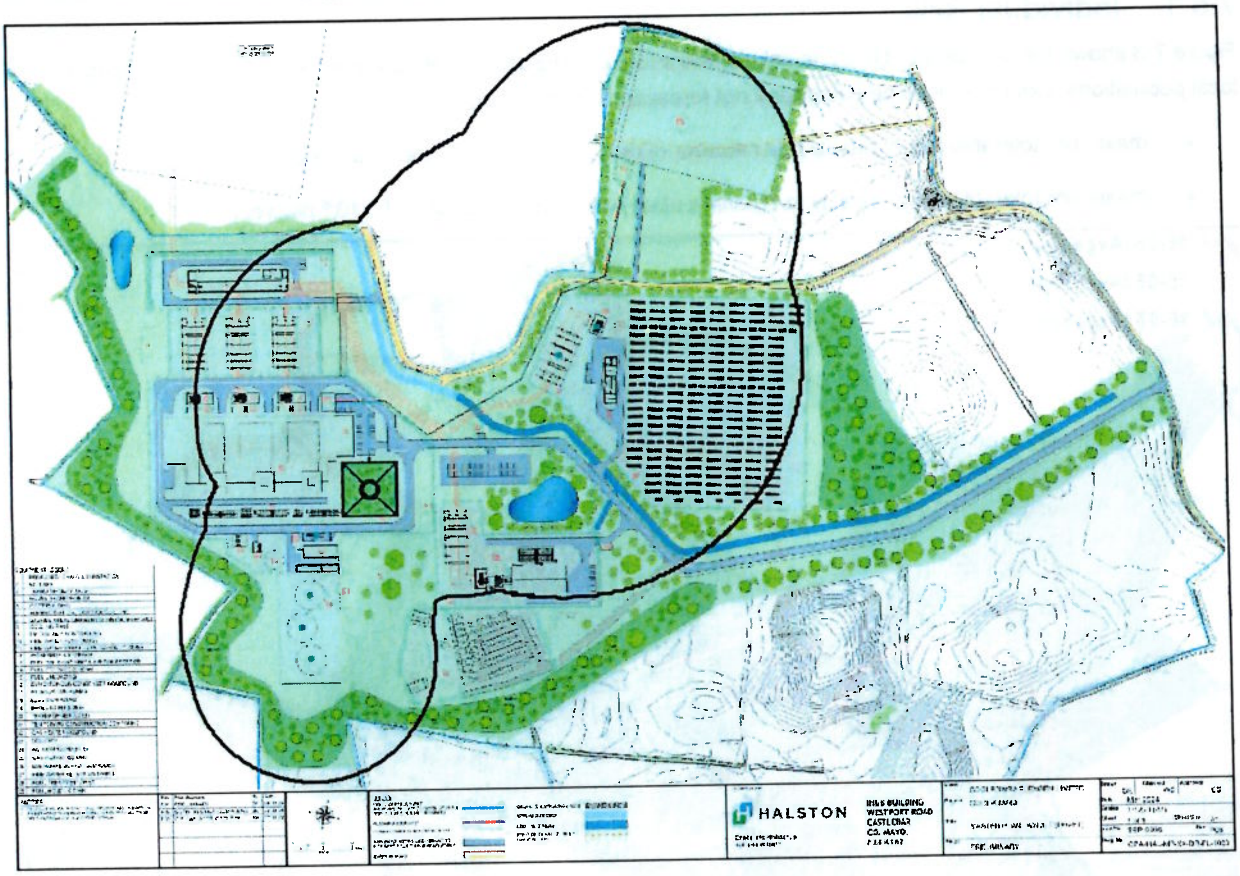

Figure 7-4: One in a Billion Chance of Fatality Contour

7.5.2 Societal Risk

The Societal Risk was determined based on census data for the local area (Ref. /16/), using an onsite population of 20 that is equally distributed around the site and offsite population of 52 people per km^2. No individual dwellings or populations were noted within the immediate vicinity of the development.

The FN Curve for the establishment is presented in Figure 7-5. This includes risk to all populations identified on and off-site. This chart highlights no intolerable risks, with fatalities of 1 to 2 onsite personnel being within the tolerable if ALARP regions. Fatalities of 3 or more onsite personnel is within the broadly acceptable region. No offsite fatalities are anticipated.

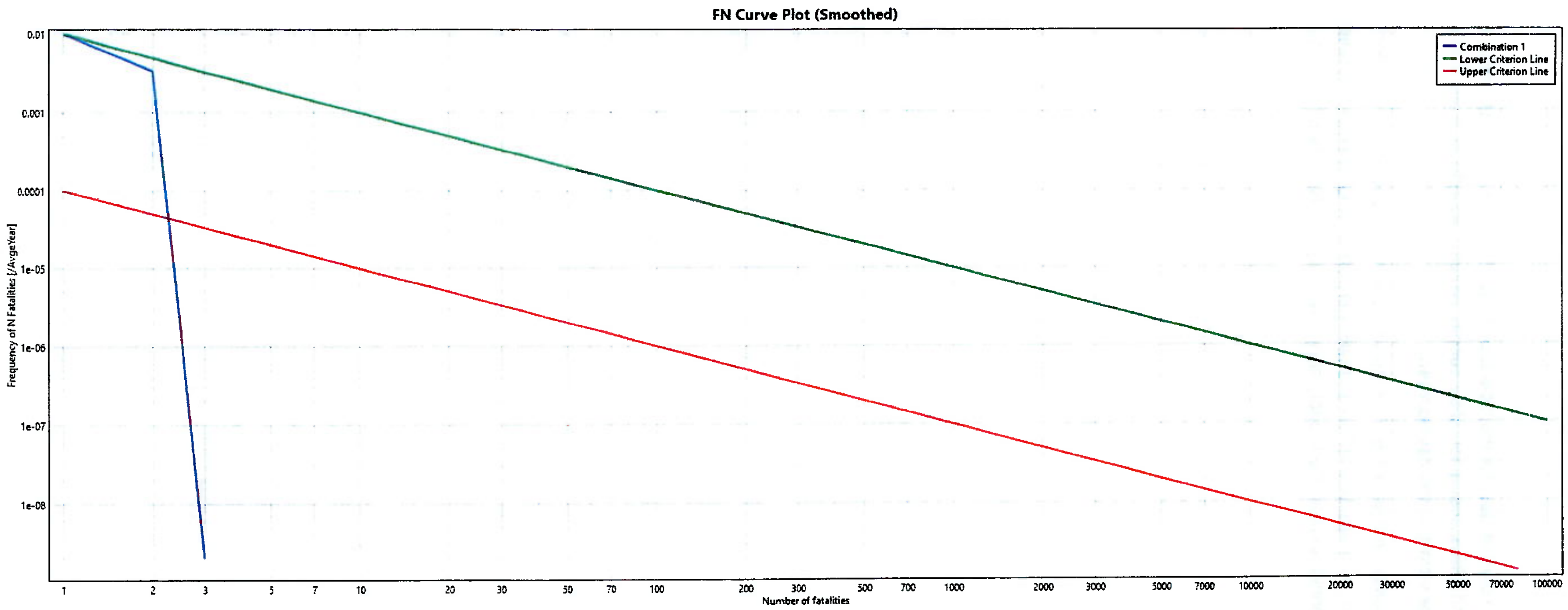

Figure 7-5: Societal Risk FN Curve

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7.6 Environmental TLUP Assessment

In the context of LUP, the prevention of Major Accidents to the Environment (MATTEs) is the primary objective and it is expected that accident pathways will be prevented. The assessment of major accidents to the environment focuses on the specific risks to sensitive receptors within the local environment, the extent of consequences to such receptors and the ability of such receptors to recover.

For new establishments, the focus is on the removal of accident pathways to receptors (i.e. through the use of additional technical measures: e.g. appropriate containment, within the confines of current good practice and ALARP, etc.). To support the demonstration that the accident pathway to receptors has been adequately removed, an Environmental Risk Assessment (Ref. /14/) has been conducted in accordance with risk-based approach developed by the Chemical and Downstream Oil Industries Forum (CDOIF) (Ref. /15/).

The potential MATTE identified to the site is a Catastrophic failure of a diesel tank which reaches the Kilcrow River (MATTE Type B). The ERA demonstrates that the risk levels for the development are below the risk criteria for new COMAH establishments in relation to MATTEs:

Table 7-5: Broadly Acceptable Levels for MATTEs

MATTE Type	Broadly Acceptable Risk Less than
A	1.0 $\times 10^{-4}$ per year
B	1.0 $\times 10^{-5}$ per year
C	1.0 $\times 10^{-6}$ per year
D	1.0 $\times 10^{-7}$ per year

The calculated risk for a Catastrophic failure of a diesel tank which reaches the Kilcrow River is 1.65 $\times 10^{-7}$ per year.

The development aims to prevent such events from occurring through the use of an appropriate diesel storage tank designed in accordance with all relevant codes and standards, and a dedicated bund with capacity of 150% of a single tank. The bund is also fitted with level monitoring. There is a wastewater retention tank designed to collect any diesel not contained within the bund (i.e. due to bund failure/leak). An oil/water interceptor will also be installed to prevent any diesel entering an attenuation pond.

The ERA (Ref. /14/) demonstrates that appropriate measures are in place to prevent a MATTE and reduce the risk to 'Broadly Acceptable' levels, as such double containment tanks are not required and any benefit gained would be grossly disproportionate to the cost. As the bund contains at least 110% of a single tank's contents overtopping of the bund is not deemed a credible event to cause a MATTE.

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8 CONCLUSIONS & RECOMMENDATIONS

8.1 Conclusions

8.1.1 Consequence Model

The consequences derived have been both for small 5 mm releases and full bore/catastrophic releases. Despite there being no notable consequences for any small leaks except for the firewater tank locations.

The following conclusions are made from this study:

- **Risk**: All facility risks are, at this point in time, considered tolerable if ALARP. Halston Lumcloom energy will be required to demonstrate that all risks have been controlled as low as reasonably practicable before the facility can be operational.
- **Pool Fire Radiation:** In the event of a catastrophic rupture of a diesel road tanker resulting in a pool fire, the thermal radiation intensity is at levels sufficient to cause multiple fatalities at the administration/control building. Furthermore, there is potential for fuel tank pool fires to escalate to the adjacent tanks, or to cause catastrophic damage to the fire water tanks.
- **Jet Fires:** There is potential for the 37.5 kW/m^2 contours to extend across a large section of the facility, which suggests that there is potential for escalation due to jet fires associated with the natural gas system on-site. There is also potential for personnel situated outside (e.g. walking between areas of the site) to be fatally injured from natural gas jet fires. There is also potential for escalation of jet fires originating in the AGI or on-site pipeline to the LDES compound.
- **Fireballs:** The hazard contours associated with fireballs are relatively large, however these are short lived events and therefore do not contribute greatly to escalation, and the likelihood of a fireball has been deemed improbably over the lifetime of the facility.
- **Flash Fires:** Flash fires can have far reaching effects, as seen in Figure 5-14, however Figure 5-15 provides an indication as to the shape of the flammable cloud which can be seen to be much smaller than the entire cloud envelope. However, the ½ LFL cloud can impact the majority of the site such that any muster points could be considered compromised.
- **LDES System:** The safety risk posed by LDES systems must not be underestimated, and there is potential for very large fires should propagation between containers occur. Should an LDES fire be contained to a single container (as should be the case for properly designed systems), there is potential for localised asset damage and safety risk to first responders.
- **Off-site impacts:** Natural gas and fuel oil consequence modelling has highlighted no particular concerns to third-party buildings or properties outside of the site boundary. In the unlikely event that a large-scale LDES compound fire occurs, with the fire propagating across multiple containers, there is potential for off-site impacts from smoke and evolved gases.

8.1.2 TLUP Assessment

- No LUP Zone contours are expected to impact on local populations. Both the
  - maximum tolerable risk of fatality to a member of the public of 1 x 10^{-6} per year, and
  - maximum tolerable risk of fatality to a person at an offsite work location of 5 x10^{-6} per year.

  is not foreseen to be exceeded.
- No Level 1, 2, 3 or 4 developments are located within the contours.
- No offsite populations, nor the neighbouring existing substation are within the 1 x 10^{-9} contour.

- The development aims to prevent MATTEs due to a loss of containment of diesel through the use of an appropriate diesel storage tank designed in accordance with all relevant codes and standards, a dedicated bund with a minimum capacity of 110% of a single tank, and a wastewater retention tank with oil/water interceptors which would collect any diesel not contained within the bund (i.e. due to bund failure/leak).
- The ERA (Ref. /14/) demonstrates that appropriate measures are in place to prevent a MATTE and reduce the risk to 'Broadly Acceptable' levels.

8.2 Recommendations

The following recommendations are made:

1. Consider fire protection strategies for the tanker unloading and fuel oil storage areas, which could include separate bunds for each storage tank, and deluge (sprinkler) systems, and/or foam application on confirmation of a fire. Also consider relocation of the fire water tanks to a location away from all flammable inventories to ensure they are not impacted by fire events.
2. There is currently potential for occupied buildings (security and administration/control building) to be within the 37.5 kW/m^2 hazard ranges associated with jet fires and pool fires. If possible, Halston Lumcloom should consider relocating these buildings to an area outside all hazard contours – which would be considered an inherently safe solution.
3. Ensure any muster points are located outside of the ½ LFL clouds, as shown in Section 5.4.
4. If possible, the spacing between the natural gas-containing systems and the LDES compound should be increased to reduce the likelihood of a natural gas jet fire escalating to a large-scale battery fire, which could potentially have off-site impacts.
5. Undertake further risk assessments in later design stages and review the input data and assumptions. This should primarily address any uncertainties or assumptions in process information, as these will be more accurately defined as the design progresses. Particular attention should be given to fire and explosion risk within the LDES compound - ensuring that all applicable design standards have been followed to minimise the risk associated with stored electrical energy.

Note, these recommendations aim to further reduce any risk associated with Project Coolpowra, however other risk reduction measures may be deemed more appropriate as the design develops.

9 REFERENCES

/1/ Project Coolpowra, Proposed Reserve Gas-Fired Power Generator, GIS Electrical Substation and Energy Storage System, Project Description SEP-0398, February 2024, Rev 01.

/2/ CPA-HAL-OC-XX-DR-PL-1000, Proposed Site Location, March 2024, Rev P01.

/3/ CPA-HAL-MP-XX-DR-PL-1000,.Master Plan Layout, March 2024, Rev P03

/4/ Summary description of receiving environment, SEP-0398, February 2024, Rev 01

/5/ UK HSE, "Reducing risks, protecting people", ISBN 0 7176 2151 0, 2001.

/6/ UK HSE, "HSE's Land Use Planning Methodology", https://www.hse.gov.uk/landuseplanning/methodology.htm, accessed February 2024.

/7/ IOGP, "Risk Assessment Data Directory – Process Release Frequencies", 434-01, Version 3.0, September 2019.

/8/ TNO, "Guidelines for Quantitative Risk Assessment – 'Purple Book", CPR 18E, 2005.

/9/ UK HSE Failure Rate and Event Data (FRED) report.

/10/ IOGP, "Risk Assessment Data Directory – Ignition Probabilities", 434-06, Version 1.0, September 2019.

/11/ IOGP, "Risk Assessment Data Directory – Vulnerability of Humans", 434-14, Version 1.0, July 2023.

/12/ Guidance to Inspectors on the Assessment of Safety Reports under the COMAH Regulations 2015, HSA, Rev 4, 2017.

/13/ Health and Safety Authority (HSA), Guidance on technical land-use planning advice. For planning authorities and COMAH establishment operators. Version 2, February 2023.

/14/ DNV, Project Coolpowra Environmental Risk Assessment, Rev 1, May 2024.

/15/ Guideline – Environmental Risk Tolerability for COMAH Establishments, Version 2.0, Chemical and Downstream Oil Industries Forum.

/16/ https://www.cso.ie/en/releasesandpublications/ep/p-cpp1/censusofpopulation2022profile1-populationdistributionandmovements/populationdistribution/. Last accessed January 2026.

/17/ https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/coolpowra_ireland_3313051.Last accessed January 2026

APPENDIX A
Flammable Dispersion Results

Scenario	Weather	Hole size (mm)	Distance to LFL fraction (m)	Distance to LFL (m)
Diesel Storage (central) - Catastrophic rupture	Category 1.5/F	Full rupture	22	22
Diesel Storage (central) - Catastrophic rupture	Category 1.5/D	Full rupture	22	22
Diesel Storage (central) - Catastrophic rupture	Category 5/D	Full rupture	25	25
Diesel Storage (central) - leak	Category 1.5/F	5	Not reached at height of interest	Not reached at height of interest
Diesel Storage (central) - leak	Category 1.5/D	5	Not reached at height of interest	Not reached at height of interest
Diesel Storage (central) - leak	Category 5/D	5	Not reached at height of interest	Not reached at height of interest
Road tanker - Catastrophic rupture	Category 1.5/F	Full rupture	6	6
Road tanker - Catastrophic rupture	Category 1.5/D	Full rupture	6	6
Road tanker - Catastrophic rupture	Category 5/D	Full rupture	7	7
Road tanker - Leak	Category 1.5/F	5	Not reached at height of interest	Not reached at height of interest
Road tanker - Leak	Category 1.5/D	5	Not reached at height of interest	Not reached at height of interest
Road tanker - Leak	Category 5/D	5	Not reached at height of interest	Not reached at height of interest
Diesel Transfer Pumps - Leak	Category 1.5/F	5	Not reached at height of interest	Not reached at height of interest
Diesel Transfer Pumps - Leak	Category 1.5/D	5	Not reached at height of interest	Not reached at height of interest
Diesel Transfer Pumps - Leak	Category 5/D	5	Not reached at height of interest	Not reached at height of interest
Diesel Transfer Pumps - Catastrophic rupture	Category 1.5/F	Full rupture	5	5
Diesel Transfer Pumps - Catastrophic rupture	Category 1.5/D	Full rupture	5	5
Diesel Transfer Pumps - Catastrophic rupture	Category 5/D	Full rupture	6	6
Grid Connection AGI - Leak	Category 1.5/F	5	Not reached at height of interest	Not reached at height of interest

Scenario	Weather	Hole size (mm)	Distance to LFL fraction (m)	Distance to LFL (m)
Grid Connection AGI - Leak	Category 1.5/D	5	Not reached at height of interest	Not reached at height of interest
Grid Connection AGI - Leak	Category 5/D	5	Not reached at height of interest	Not reached at height of interest
Grid Connection AGI - Full bore rupture	Category 1.5/F	152	187	83
Grid Connection AGI - Full bore rupture	Category 1.5/D	152	182	77
Grid Connection AGI - Full bore rupture	Category 5/D	152	205	80
Long pipeline (single point) - 5mm	Category 1.5/F	5	1	1
Long pipeline (single point) - 5mm	Category 1.5/D	5	1	1
Long pipeline (single point) - 5mm	Category 5/D	5	Not reached at height of interest	Not reached at height of interest
Long pipeline (single point) - Full bore	Category 1.5/F	914	Not reached at height of interest	Not reached at height of interest
Long pipeline (single point) - Full bore	Category 1.5/D	914	6	5
Long pipeline (single point) - Full bore	Category 5/D	914	9	6

APPENDIX B
Jet fire results

Scenario	Weather	Hole size (mm)	Flame emissive power (kW/m2)	Distance downwind to intensity level 1 (4.7 kW/m2) (m)	Distance downwind to intensity level 2 (6.3 kW/m2) (m)	Distance downwind to intensity level 3 (12.5 kW/m2) (m)	Distance downwind to intensity level 4 (37.5 kW/m2) (m)	Ellipse area at intensity level 1 (4.7 kW/m2) (m2)
Diesel Storage (central) - leak	Category 1.5/F	5	33	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Diesel Storage (central) - leak	Category 1.5/D	5	33	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Diesel Storage (central) - leak	Category 5/D	5	64	1	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	1
Road tanker - Leak	Category 1.5/F	5	21	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Road tanker - Leak	Category 1.5/D	5	22	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Road tanker - Leak	Category 5/D	5	50	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Diesel Transfer Pumps - Leak	Category 1.5/F	5	39	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Diesel Transfer Pumps - Leak	Category 1.5/D	5	40	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest
Diesel Transfer Pumps - Leak	Category 5/D	5	78	1	Not reached at height of interest	Not reached at height of interest	Not reached at height of interest	1
Grid Connection AGI - Leak	Category 1.5/F	5	40	4	4	Not reached at height of interest	Not reached at height of interest	3
Grid Connection AGI - Leak	Category 1.5/D	5	40	4	4	Not reached at height of interest	Not reached at height of interest	3
Grid Connection AGI - Leak	Category 5/D	5	37	4	4	Not reached at height of interest	Not reached at height of interest	2
Grid Connection AGI - Full bore rupture	Category 1.5/F	152	350	134	124	106	82	20943
Grid Connection AGI - Full bore rupture	Category 1.5/D	152	350	134	124	106	82	20943
Grid Connection AGI - Full bore rupture	Category 5/D	152	350	135	126	108	88	20639
Long pipeline (single point) - 5mm	Category 1.5/F	5	42	4	4	2	1	29
Long pipeline (single point) - 5mm	Category 1.5/D	5	42	4	4	2	1	29
Long pipeline (single point) - 5mm	Category 5/D	5	70	6	5	4	4	34
Long pipeline (single point) - Full bore	Category 1.5/F	914	184	300	248	132	15	232841
Long pipeline (single point) - Full bore	Category 1.5/D	914	184	300	248	132	15	232841
Long pipeline (single point) - Full bore	Category 5/D	914	286	335	295	219	102	274608

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APPENDIX C
Pool fire results

Scenario	Weather	Hole size (mm)	Pool diameter (m)	Distance downwind to intensity level 1 (4.7 kW/m2) (m)	Distance downwind to intensity level 2 (6.3 kW/m2) (m)	Distance downwind to intensity level 3 (12.5 kW/m2) (m)	Distance downwind to intensity level 4 (37.5 kW/m2) (m)
Diesel Storage (central) - Catastrophic rupture	Category 1.5/F	Full rupture	94	104	91	69	54
Diesel Storage (central) - Catastrophic rupture	Category 1.5/D	Full rupture	94	104	91	69	54
Diesel Storage (central) - Catastrophic rupture	Category 5/D	Full rupture	94	112	98	71	55
Diesel Storage (central) - leak	Category 1.5/F	5	14	34	30	22	13
Diesel Storage (central) - leak	Category 1.5/D	5	14	34	30	22	13
Diesel Storage (central) - leak	Category 5/D	5	14	36	33	25	13
Road tanker - Catastrophic rupture	Category 1.5/F	Full rupture	101	107	94	71	57
Road tanker - Catastrophic rupture	Category 1.5/D	Full rupture	101	107	94	72	57
Road tanker - Catastrophic rupture	Category 5/D	Full rupture	101	117	103	74	59
Road tanker - Leak	Category 1.5/F	5	11	28	25	19	10
Road tanker - Leak	Category 1.5/D	5	11	28	25	19	10
Road tanker - Leak	Category 5/D	5	11	30	27	22	10
Diesel Transfer Pumps - Leak	Category 1.5/F	5	17	35	32	23	15
Diesel Transfer Pumps - Leak	Category 1.5/D	5	17	36	32	24	15
Diesel Transfer Pumps - Leak	Category 5/D	5	17	38	35	26	16
Diesel Transfer Pumps - Catastrophic rupture	Category 1.5/F	Full rupture	50	60	53	39	30
Diesel Transfer Pumps - Catastrophic rupture	Category 1.5/D	Full rupture	50	60	53	39	30
Diesel Transfer Pumps - Catastrophic rupture	Category 5/D	Full rupture	50	66	58	40	31

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APPENDIX D
Fireball results

Scenario	Weather	Hole size (mm)	Distance downwind to intensity level 1 (4.7 kW/m2) (m)	Distance downwind to intensity level 2 (6.3 kW/m2) (m)	Distance downwind to intensity level 3 (12.5 kW/m2) (m)	Distance downwind to intensity level 4 (37.5 kW/m2) (m)
Long pipeline (single point) - Full bore	Category 1.5/F	914	292	254	182	104
Long pipeline (single point) - Full bore	Category 1.5/D	914	292	254	182	104
Long pipeline (single point) - Full bore	Category 5/D	914	292	254	182	104

APPENDIX E
Explosion results

Scenario	Weather	Material	Distance downwind to overpressure 1 (0.07 bar) (m)	Distance downwind to overpressure 2 (0.1 bar) (m)	Distance downwind to overpressure 3 (0.35 bar) (m)
Methane VCE - Transformer	Category 1.5/F	METHANE	33	19	Not reachable
Methane VCE - Transformer	Category 1.5/D	METHANE	33	19	Not reachable
Methane VCE - Transformer	Category 5/D	METHANE	33	19	Not reachable

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APPENDIX F
TLUP Assessment Consequence Results

This appendix details the consequence results relevant to the TLUP Assessment only. The distances downwind presented are the maximum values, irrespective of weather conditions.

Vessel/Equipment	Leak Size/LOC Scenario	Pool Fire Results				Jet Fire Results				Flash Fire Results	Explosion Results					
		8.02kW/m²	10.9kW/m²	15.9kW/m²	25.6kW/m²	8.02kW/m²	10.9kW/m²	15.9kW/m²	25.6kW/m²	Distance to LFL (m)	0.07 bar	0.14 bar	0.168 bar	0.35 bar	0.365 bar	0.5 bar
Diesel Storage Tanks	Instantaneous Failure / Catastrophic rupture	94m	82m	72m	66m	N/A				N/A	N/A					
	Failure over 10 minutes	105m	94m	84m	78m	N/A				N/A	N/A					
	10 mm pipe leak over 30 minutes	37m	32m	28m	25m	N/A				N/A	N/A					
Diesel Road Tanker	Instantaneous Failure / Catastrophic rupture	89m	77m	67m	62m	N/A				N/A	N/A					
	Leak from largest connection	91m	80m	70m	65m	N/A				N/A	N/A					
	Rupture of loading/unloading hose	91m	80m	70m	65m	N/A				N/A	N/A					
	Leak of loading/unloading hose	29m	25m	18m	15m	N/A				N/A	N/A					
Grid Connection AGI	Above ground Pipeline Rupture	N/A				119m	111m	103m	94m	78	33m	18m	17m	Not reached	Not reached	Not reached
Grid Connection AGI	Above ground Pipeline Leak	N/A				11m	11m	10m	9m	Not reached	33m	18m	17m	Not reached	Not reached	Not reached
Gas Pipeline	Below ground Pipeline Rupture	N/A				97m	91m	85m	77m	59m	33m	18m	17m	Not reached	Not reached	Not reached
Gas Pipeline	Below ground Pipeline Leak	N/A				9m	8m	8m	Not reached	Not reached	33m	18m	17m	Not reached	Not reached	Not reached

About DNV

DNV is the independent expert in risk management and assurance, operating in more than 100 countries. Through its broad experience and deep expertise DNV advances safety and sustainable performance, sets industry benchmarks, and inspires and invents solutions.

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Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.

APPENDIX 17.3

FIRE RISK ASSESSMENT AND EMERGENCY RESPONSE PLAN

COOLPOWRA BESS
FIRE RISK ASSESSMENT

Version 1
JANUARY 2026

LUMCLOONENERGY

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Table of Contents

1 INTRODUCTION

1.1 The Author

Lumcloon Energy was founded in 2008 as a project development company focused on flexible power and energy assets. Lumcloon Energy identified flexibility as a key component to address the changing needs of the evolving power systems, which are transitioning from fossil-based generation to renewable-based generation.

Lumcloon Energy is highly experienced in energy project development and continues to maintain an interest in assets that have been successfully delivered, from early development and ongoing commercial operation. Lumcloon Energy developed several grid scale Battery Energy Storage Systems, the first of which has been in operation since 2021.

1.2 Purpose

This Fire Risk Assessment (FRA) has been prepared for the proposed Battery Energy Storage System (BESS) facility on lands located in the townlands of Coolpowra, Cooldorragha, Ballynaheskeragh, Gortlusky and Sheeaunrush, County Galway. The primary purpose of this assessment is to identify and evaluate potential fire hazards associated with the design, installation, and operation of the facility and to propose appropriate fire risk mitigation measures.

The FRA aims to ensure that fire safety is achieved to the highest practical standard, minimising risk to life, property, and the environment, in accordance with good engineering practice and the requirements of relevant Irish and international standards. This document will also support the client's due diligence obligations and facilitate compliance with planning and local fire authority requirements.

1.3 Document Use

This Fire Risk Assessment is intended for use by the client, their contractors, and relevant regulatory or emergency services personnel. It will form a key component of the facility's safety case, planning permit documentation, and ongoing safety management framework.

1.4 Document Review

A review of this Fire Risk Assessment shall be conducted and documented at minimum on an annual basis by site operator. The document shall also be reviewed and amended whenever there is a change in facility design, construction, operation, or maintenance that affects emergency response planning. When outside resources are changed or modified the document shall be reviewed and updated to reflect the changes that may affect this plan.

1.5 Scope

The scope of this Fire Risk Assessment encompasses all site infrastructure and equipment associated with the Coolpowra BESS, including but not limited to:

- One hundred and thirty-eight (138) battery storage containers arranged in a configured layout.
- One hundred and thirty-eight (138) Medium Voltage Power Stations (MVPS) serving as the grid interface units.
- One Independent Power Producer (IPP) building housing control, protection, metering, and communications equipment.
- BESS compound fire water storage tank and hydrants.
- Vehicle access roads, turning areas, and perimeter fencing.
- equipment such as fire detection, alarm, and suppression systems, as well as ventilation and explosion relief features.

This assessment considers fire hazards relating to battery electrochemistry (including thermal runaway), electrical faults, site-specific operational and environmental factors, and the potential impact on the surrounding community and environment.

1.6 Location and Setting

The proposed development as amended is located on a 46 hectares (ha) site in the townlands of Coolpowra, Cooldorragha, Ballynaheskeragh, Gortlusky and Sheeaunrush, County Galway. The site is located approximately 5km north of the town of Portumna and 3.7km south of Killimor.

Lands within the development site boundary are in agricultural use and include a farmhouse and outbuildings which will be demolished as part of development works. The proposed lands are situated at an elevation of c. 51-54m AOD and are accessed by public road via the N65 (National Road) and the L8763 (local road). The proposed development is located adjacent to, and south of, the existing operational 400kV AIS electricity substation (Oldstreet). The proposed site was chosen as the preferred site following analysis of alternative sites along the two 400kV transmission lines, which traverse the country from west to east. The are a limited number of residential properties within the surrounding rural area and these are described as one-off housing with a total of 40 recorded within 1km offset from the main development with the proposed development lands. The closest residential dwelling to the proposed BESS compound boundary is approximately 500m to the north.

1.7 Standards and Guidance Referenced

This assessment has been developed with reference to a comprehensive suite of national and international codes, standards, and best-practice guidance, including but not limited to:

- NSAI I.S. 10101 – National Rules for Electrical Installations in Ireland
- NFPA 855 (2026) – Standard for the Installation of Stationary Energy Storage Systems
- UL 9540A – Standard Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
- FPA Zurich RE1 – Battery Storage Fire Safety Guidance
- ESB Networks Grid Code and Connection Standards relevant to medium-voltage infrastructure
- Local and regional fire authority regulations and planning conditions
- NFCC: Grid Scale Battery Energy Storage System Planning – Guidance for FRS

2 BESS DESCRIPTION

2.1 Battery Enclosures

The Coolpowra BESS site comprises one hundred and thirty-eight battery enclosures (containers) and one hundred and thirty-eight MVPS enclosures (containers) in twenty-five rows and nine columns, covering an approximate footprint of 178.5 meters by 156.5 meters. Each battery measures approximately 12.272 meters in length, 2.487 meters in width, and 4.032 meters in height, with an estimated total weight of 48.8 tonnes including battery modules and enclosure.

Each enclosure houses approximately eighteen battery racks, delivering a total energy capacity of approximately 4.9 MWh per container. The battery systems operate within ambient temperature ranges of -25 °C to +45 °C and incorporate thermal insulation designed to mitigate thermal runaway propagation between cells. The enclosures are equipped with an HVAC cooling system consisting of six wall-mounted units providing a total cooling capacity of approximately 61.2 kW to maintain safe operating temperatures. Fire safety features include integrated smoke, heat, and carbon monoxide detectors; manual fire alarm pull stations; horn and strobe alarms; and a solid aerosol fire suppression system supplemented by deflagration relief panels and active ventilation to evacuate hazardous gases during fire events.

Spacings between battery enclosures are consistent with fire safety guidelines and insurance requirements, with columns spaced 4.5 meters apart on centres of 6.9 meters and rows spaced 4.5 meters apart. This spacing supports adequate fire separation distances and emergency vehicle access throughout the battery storage area.

Surface finishes within the BESS compound will comprise clean permeable stone fill. Stormwater collected from impervious areas such as the IPP building and limited bitumen macadam roads will be directed to a below ground oil interceptor and attenuation /infiltration structure (volume of c.90m^3) before being discharged via a hydrobrake (which will limit flow to 1l/s (4l/s per hectare)) to the open drain /stream which runs to the south of the compound. Foul wastewater generated from welfare facilities within the BESS compound will be discharged to a sealed foul holding tank. The holding tank will be emptied and suitably disposed of periodically by a local waste permitted contractor. A foul holding tank is recommended due to low occupancy of the facility once operational. There is no requirement for the use of water in the process.

2.2 Medium Voltage Power Stations (MVPS)

One hundred and thirty-eight battery enclosures Medium Voltage Power Stations (MVPS) enclosures are installed on site as modular containerised substations to serve as the interface between the battery system and the medium-voltage grid.

These MVPS units are approximately 6.06 meters wide, 2.90 meters high, and 2.44 meters deep, weighing less than 18 tonnes. They are rated for DC input voltages up to 1,500 V and deliver AC medium-voltage output typically ranging between 10 kV and 35 kV with nominal power ratings between 4,000 kVA and 4,200 kVA.

Key electrical safety features include arc-fault resistant switchgear compliant with IEC 62271-202, vacuum circuit breakers, surge protection devices, galvanic isolation, and integrated oil spill containment systems with filtration and early detection capabilities. Strict installation and maintenance procedures are followed to mitigate fire and electrical hazards, including adherence to precise torque specifications for live bolted connections, establishing arc-fault exclusion zones during maintenance, and employing personal protective equipment (PPE) protocols to avoid shock and burn injuries.

2.3 IPP Building

The IPP building is a purpose-built facility serving as the primary control and grid interface centre of the BESS site. The building footprint measures approximately 40.0 meters in length and 10meters in width, housing the medium voltage switchgear, protection panel, meters, SCADA and communications equipment, and auxiliary power systems.

The internal layout is divided into functional compartments including the Control Room (x3), Switchgear Room, Communications Room, ESB Room, Store Rooms (x2), Mess Room. a small WC. The building is constructed with insulated block cavity walls offering robust fire compartmentalisation, finished externally with non-combustible plaster and a timber truss roof clad with synthetic slate tiles.

Electrical systems within the IPP building operate at voltages up to 20kV for the medium voltage equipment and 230V for building systems such as lighting and control devices. The facility incorporates fire detection and suppression systems designed to protect critical electrical infrastructure and personnel safety.

2.4 Storm water Drainage

The proposed design separates the site into distinct drainage/containment zones, as follows:

- BESS compound (container/enclosure area): Full infiltration strategy using a clean, open-graded stone compound surface (SuDS source control). No point source outfall from this area.
- Impervious areas (IPP building roof and paved road /parking): Managed collection and controlled discharge of stormwater from these limited impervious areas via underground drainage incorporating an underground petrol /oil interceptor to I.S. EN 858 performance expectations (Class I full retention, as appropriate to the discharge sensitivity).
- MVPS (transformer-containing equipment): Local containment at source for transformer oil hazards (bunding and controlled dewatering /oil separation), consistent with Irish utility substation practice and relevant standards.
- AIS - transformer-containing equipment): Local containment at source for transformer oil hazards (bunding and controlled dewatering /oil separation), consistent with Irish utility substation practice and relevant standards.

2.4.1 <u>SuDS surface water management rationale</u>

Rainfall is managed in accordance with Sustainable Drainage Systems (SuDS) principles, prioritising source control, runoff reduction, and water quality protection. The primary design basis is CIRIA C753 (The SuDS Manual), supported by relevant Irish planning guidance on flood risk and surface water runoff management.

2.4.1.1 BESS compound – clean stone infiltration surface

The BESS enclosure compound will be finished in clean, open-graded stone over an engineered granular sub-base. This provides a stable, non-ponding surface suitable for electrical compounds and promotes infiltration of normal rainfall. The infiltration-led approach reduces the frequency and volume of surface runoff, limits the need for piped drainage, and avoids standing water in proximity to electrical equipment and access routes.

2.4.1.2 Impervious areas – controlled collection and discharge via interceptor

Stormwater from the limited impervious areas (IPP roof drainage and the paved road /parking around the IPP) will be collected via conventional underground drainage and discharged in a controlled manner. To protect water quality, the system will incorporate an underground petrol/oil interceptor designed and installed to recognised separator standards (I.S. EN 858).

This targeted approach applies enhanced treatment where traffic /plant-related hydrocarbons could credibly arise, while avoiding unnecessary treatment of rainfall falling on the BESS infiltration compound where routine contamination sources are not present.

2.4.1.3 Local containment for MVPS transformer oil hazards

MVPS units contain oil-filled transformers and local containment is provided at source. This comprises a proprietary self-bunded enclosure (or equivalent containment arrangement) sized to retain the relevant oil volume.

This is consistent with Irish transmission/substation civil standards that specify oil-sensitive bund dewatering systems and Class I full retention oil separators certified to I.S. EN 858 for external transformer bund drainage. The purpose is to prevent oil releases from completing a pollution linkage to soil, groundwater or surface waters.

2.4.2 Firewater

The BESS Compound includes one proprietary fire water storage tank with a capacity of 500 cubic metres (500m3), located adjacent to the IPP building to ensure an adequate firefighting water supply. A fire hydrant is positioned to the north and south of the IPP building enabling fire service intervention.

Vehicle access is provided to the compound in the southwestern area of the BESS compound and turning areas are located adjacent to the IPP building. Access roads and vehicle paths are maintained at a minimum width of 4.5 meters to accommodate emergency vehicles. The entire battery storage area is enclosed by a 2.65-meter-high palisade fence.

The design recognises that, in the unlikely event of a BESS fire incident, water may be used by the fire service for defensive operations such as exposure cooling and boundary protection. Firefighting water that becomes contaminated is an emergency-condition effluent and is not treated as a routine discharge stream.

Accordingly, the development does not rely on full-compound containment and managed release of all stormwater as the primary control. Instead, it relies on the suite of controls set out in the Fire Risk Assessment and Emergency Response Plan, developed with reference to NFPA 855 (2026) and associated recognised guidance. These controls are incorporated and design embedded to prevent escalation /propagation, support safe incident management, and provide practicable environmental protection measures that can be deployed under incident command.

The Fire Risk Assessment /management plan controls relevant to firewater risk include, as applicable:

- Design and layout measures to reduce escalation and limit event size (e.g., separation, thermal barriers where required, and listed equipment).
- Detection, monitoring and system safety features, and documented site operating procedures.
- Emergency Response Plan information for the which will be discussed and agreed with the local fire authority, including contact protocols, site access, and isolation arrangements.
- Temporary containment capability (portable bunding/berms, absorbent booms, drain covers where relevant) and procedures to collect and remove contaminated liquids via authorised contractors.

3 HAZARD IDENTIFICATION

This section identifies and describes the key fire-related hazards associated with the Coolpowra BESS facility components, operational activities, and site context. It provides the foundation for risk assessment and mitigation planning.

3.1 Fire Hazards in Battery Enclosures

3.1.1 Thermal Runaway in Lithium-ion Batteries

Lithium-ion battery cells inherently carry the risk of thermal runaway, a rapid, uncontrolled release of heat and gas caused by internal cell failure or external damage. This may lead to smoke, fire, and potentially explosions within battery modules.

3.1.2 Propagation Risk:

Without adequate thermal insulation and fire suppression, thermal runaway propagation between cells or modules can escalate a localized fire into a container-wide or site-wide incident.

3.1.3 Gas Emissions:

Venting of flammable and toxic gases such as hydrogen and electrolyte vapors during thermal runaway events creates explosion and health hazards, necessitating active ventilation and gas detection systems.

3.1.4 Electrical Faults:

Internal electrical faults—including short circuits, over-temperature conditions, and arc faults—may trigger or amplify fire incidents.

3.1.5 Cooling System Failures:

HVAC failure or blockage may cause abnormal temperature increases, elevating the risk of cell thermal incidents.

3.2 Electrical and Fire Hazards in Medium Voltage Power Stations (MVPS)

3.2.1 Arcing Faults:

Arc faults occurring in high-voltage compartments can generate intense localized heat, pressure waves, and ignition sources for fires. Proper maintenance procedures, arc-resistant switchgear, and exclusion zones mitigate these risks.

3.2.2 Thermal Overloads and Overheating:

Transformers and switchgear may overheat due to overload, component failure, or inadequate cooling, potentially causing oil or insulation fires.

3.2.3 Oil Spill and Fire Risk:

MV transformers containing mineral or ester-based insulating fluids introduce fire hazards; oil containment systems reduce spill and fire propagation risks.

3.2.4 Electrical Shock Hazards:

High voltages (up to 33 kV) create shock and arc flash risks, necessitating strict PPE use and lockout/tagout procedures.

3.2.5 Maintenance and Operational Procedure Risks:

Incorrect torquing of live electrical connections or foreign objects left in live compartments amplify fire hazard potential.

3.3 Fire Risks Associated with IPP Building

3.3.1 High-Voltage Electrical Equipment:

Switchgear, protection panels, and metering devices operating at up to 33 kV can generate electrical faults, arc flashes, or overheating incidents.

3.3.2 Combustible Building Components:

The timber truss roof assembly poses a structural fire risk unless appropriately fire-treated or protected by suppression systems.

3.3.3 Internal Compartmentation:

Absence of adequate compartmentation between functional areas (Switch Room, Control Room, Comms Room, and Store) could facilitate fire spread if doors are left open or unsealed.

3.3.4 HVAC and Auxiliary Systems:

Malfunctions or failures could provide ignition sources or hinder smoke and heat removal.

3.4 Environmental Risks and Impact on Local Community

3.4.1 Proximity to Sensitive Receptors:

The are a limited number of residential properties within the surrounding rural area and these are described as one-off housing with a total of 40 recorded within 1km offset from the overall Coolpowra development. The closest residential dwelling to the proposed development boundary is approximately 500m north of the BESS site. Firewater runoff, smoke plumes, or toxic gas releases pose environmental and health concerns.

The closest watercourse to the BESS facility is the Treananearla stream which flows southwest of the compound. The Treananearla stream flows northwest from the site and enters the Kilcrow River (1.9km west of the development lands at Coolpowra). The Kilcrow River flows generally south for approximately 11km, discharging into Lough Derg at Stonyisland Bay.

3.4.2 Firewater Runoff Management:

Firefighting water is provided for the purposes of cooling (in the event of a fire) only. The drainage /containment strategy of the BESS facility has been developed to be commensurate with risk using a source-pathway-receptor (SPR) model, consistent with Irish environmental risk assessment practice for discharges to groundwater. Under the SPR concept, an adverse effect requires a credible contaminant source, a migration pathway, and a sensitive receptor.

Applying the SPR model to the proposed development:

- Routine rainfall on the BESS compound: A credible contaminant source is not expected during normal operation; therefore, the appropriate control is SuDS source control and infiltration (subject to groundwater protection checks), rather than treating all rainfall as contaminated effluent.
- Transformer oil at MVPS: A credible pollutant source exists (hydrocarbon oil). The design therefore provides local containment and controlled bund drainage to prevent completion of a pathway to receptors.
- Stormwater from impervious /traffic-influenced areas around the IPP: A limited credible hydrocarbon source may exist (vehicle/plant leakage). The design therefore provides targeted collection and treatment via an interceptor prior to controlled discharge.
- Emergency-condition firewater: There is a potential for contamination soil and water by firefighting water mixed with electrolyte but this is a low-frequency, abnormal event. It is managed primarily through prevention /mitigation measures and emergency procedures within the Fire Risk Assessment and Emergency Response Plan, rather than by permanently bunding the entire compound.

3.4.3 Airborne Emissions:

Smoke and gases released during a fire may include hazardous substances requiring monitoring and notification protocols for nearby residents and emergency responders.

4 RISK ASSESSMENT AND ANALYSIS

4.1 Likelihood and Consequence of Fire Events

The potential fire scenarios at the BESS facility range from localised cell failures in battery modules to large-scale site-wide fires involving multiple containers and associated electrical infrastructure.

4.1.1 Localised Thermal Runaway:

A failure of a single battery cell or module can initiate a thermal runaway event. The likelihood of occurrence is low due to robust cell manufacturing standards, battery management systems (BMS), and thermal insulation. However, if initiated, the consequences include heat generation, toxic gas release, and potential spread to adjacent cells or racks.

4.1.2 Enclosure /Container-Level Fire:

Inadequate detection or suppression inside a container could allow a fire to escalate to a full container event. The presence of aerosol suppression and active ventilation significantly reduces this risk. Consequences include damage to battery modules, container structure, and potential gas emissions affecting adjacent containers.

4.1.3 Inter-Container Fire Propagation:

Insufficient spacing or failure of fire barriers may permit fire spread between containers, risking a multi-container incident. The site's layout and fire compartmentalisation measures reduce this likelihood.

4.1.4 MVPS and IPP Electrical Fires:

Electrical faults such as arc faults, short circuits, or transformer overheating within MVPS or IPP building have moderate likelihood due to high-voltage operation and complex electrical systems. Consequences may involve equipment damage, fire spread in enclosed spaces, and electrical hazards to staff.

4.1.5 Environmental and Community Impact:

Fires releasing smoke, toxic gases, or firewater runoff pose potential consequences to nearby residents, local ecosystems and site workers.

4.2 Risk Rating

The risk profile is calculated considering both the likelihood of each event and its potential consequences, following a qualitative matrix approach consistent with industry guidance.

Risk Scenario	Likelihood	Consequence	Risk Rating	Comments
Single Cell Thermal Runaway	Low	Moderate	Medium	Mitigated by BMS, insulation, and suppression systems.
Full Container Fire	Very Low	High	Medium-High	Aerosol suppression and detection reduce event escalation
Fire Between Containers	Very Low	Very High	Medium-High	Fire separation and spacing designed to prevent propagation.
MVPS Electrical Fault	Low to Medium	High	Medium-High	Maintenance and engineering controls

Fire				mitigate occurrence and impact.
IPP Building Electrical Fire	Low	High	Medium	Fire compartmentalisation and detection reduce impact.
Environmental Contamination	Very Low	Moderate	Low	Firewater containment systems limit environmental risks.

4.3 Summary of Key Risk Drivers

- Battery cell chemical and thermal instability during fault conditions.
- Potential failure or delay in activation of fire detection and suppression systems.
- Electrical fault potential within medium and low voltage infrastructure.
- Site layout limitations including spacing and access for emergency response.
- Environmental exposure risks from firewater runoff and gas emissions

4.4 Risk Mitigation Effectiveness

Proposed design and operational controls; including thermal insulation, aerosol suppression, HVAC cooling systems, arc-resistant switchgear, oil containment, and comprehensive fire detection—substantially reduce the inherent fire risks. Regular operational maintenance, inspections, and emergency preparedness training further ensure risks are managed to ALARP (As Low As Reasonably Practicable) levels.

5 PROPOSED FIRE PREVENTION AND PROTECTIVE MEASURES

5.1 Structural Fire Protection and Compartmentalisation

- The battery containers feature fire-resistant enclosure materials with mineral wool insulation designed to prevent thermal propagation between cells and modules.
- Container spacing and site layout adhere to fire safety guidelines to maintain adequate separation distances, minimizing fire spread risk between battery units.
- The Independent Power Producer (IPP) building is constructed using insulated block cavity walls providing robust compartmentalisation between rooms, limiting fire spread within critical high-voltage and control areas.
- Steel insulated doors, presumed fire-rated, will provide further fire separation between building compartments and to the external environment.

5.2 Fire Detection Systems

- Early warning systems encompass smoke, heat, and carbon monoxide detectors installed inside battery containers, MVPS enclosures, and the IPP building.
- Hydrogen gas detectors are incorporated for early detection of electrolyte off-gassing during cell failure events.
- Manual fire alarm pull stations are located strategically within operational areas, supplemented by audible horn and visual strobe alarms to alert onsite personnel.

5.3 Fire Suppression Systems

- Solid aerosol fire suppression systems are installed inside the battery containers and modular steel houses to rapidly suppress incipient fires before spread.
- MVPS containers are equipped with arc-fault resistant switchgear and may be fitted with gaseous or water mist suppression systems to protect electrical components.
- The IPP building is designed for appropriate fire suppression, likely including gaseous or sprinkler systems, protecting MV switchgear and control equipment.

5.4 Ventilation and Explosion Relief

- Active inlet and exhaust ventilation systems in battery containers manage ambient temperature and rapidly expel smoke, explosive, and toxic gases during fire events.
- Deflagration panels provide safe overpressure relief for containers during rapid gas expansion or explosion scenarios, positioned to vent gases away from personnel and critical infrastructure.

5.5 Firewater Storage and Hydrant Provision

The Coolpowra BESS facility's firewater supply infrastructure has been designed and installed to meet recognised Fire & Rescue Service (FRS) guidance and to support effective firefighting operations:

- One proprietary firewater storage tank with a capacity of 500 cubic meters (totaling 500,000 litres), is sited adjacent to the Independent Power Producer (IPP) building to ensure sufficient water availability.
- Fire hydrants are positioned close to the IPP (north and south) near the vehicle turning area which will provide reliable water delivery points. These hydrants have been designed and maintained to supply a minimum flow rate of 1,900 liters per minute for at least two hours, consistent with NFCC recommendations for grid-scale Battery Energy Storage Systems.

- The location and accessibility of hydrants and water tanks have been coordinated with local fire and rescue services to facilitate unimpeded vehicle access and operational deployment.
- Mechanical protection, such as bollards, will be installed around hydrants and outlets to reduce risk of accidental damage.
- Surface finishes within the BESS compound comprise clean permeable stone fill. Stormwater collected from impervious areas such as the IPP building and limited bitumen macadam roads will be collected and routed through a below ground interceptor (Klargester NSBP004 AquaOil Bypass MDPE & Full Retention GRP Separator) in the vicinity of the IPP building, MVPS units are self contained (bunded to prevent transformer oil losses to ground).

The water supply system provides a robust and compliant firefighting resource (cooling of nearby structures only in the event of a fire), ensuring readiness for emergency fire response.

5.6 Emergency Vehicle Access and Site Design

- The site provides vehicle access and turning areas enabling fire service entry and manoeuvrability.
- Access roads maintain minimum widths of 4.5 meters, free of obstructions and compatible with emergency vehicles.
- Vegetation control around battery containers and critical infrastructures maintains clear, fire-resistant zones.

5.7 Operational Procedures and Training

- Strict maintenance protocols for battery and electrical equipment installation, including torque specifications and exclusion zones during live work, reduce fire initiation risks.
- Onsite personnel will be trained in fire detection system operation, alarm response, and emergency fire procedures.
- Regular fire drills, system testing, and active monitoring will be employed to ensure readiness and safety compliance.

5.8 Emergency Response Plan Overview

The Coolpowra BESS facility will implement a detailed Emergency Response Plan (ERP) that addresses prevention, preparedness, response, and recovery from fire and other emergency situations. The ERP is designed to protect life, minimize property and environmental damage, and ensure rapid, effective response by onsite personnel and offsite emergency services. The full Emergency Response Plan (ERP) is included in Appendix E of this document.

The ERP includes clearly defined roles and responsibilities, communication protocols, and procedures for evacuation, fire suppression, and incident management. It is developed in collaboration with local fire authorities, emergency services, and other stakeholders to ensure coordinated and efficient response.

5.9 Access and Egress for Emergency Services

Site design provides extensive access for emergency vehicles, along with designated turning areas near battery container rows and critical infrastructure buildings such as the IPP.

Clear signage and site maps will be posted at entry points and critical locations to guide first responders. The location of firewater storage tanks, hydrants, electrical isolation points, and hazardous areas will be clearly identified.

Emergency egress routes for personnel will be maintained free from obstruction, with adequately marked escape paths within all containers, buildings, and site areas.

5.10 Staff Training, Communication, and Alarm Systems

All site personnel will receive comprehensive training covering fire hazard recognition, detection system operation, initial incident response procedures, and evacuation protocols. Regular fire drills and safety exercises will be conducted to build competency and preparedness.

The integrated fire detection and alarm systems; including smoke, heat, and gas detectors alongside signalling via horns and strobes; ensure rapid notification to onsite staff and remote monitoring centres. Manual pull stations provide additional alert capacity for personnel.

Continuous communication lines between onsite operators, emergency coordinators, and local fire services will be established, including provision of facility schematics, hazard information, and contact details for subject matter experts.

5.11 Coordination with Local Fire and Emergency Services

Proactive engagement and collaboration with local fire brigades and emergency responders are core to the ERP. This includes:

- Pre-incident site familiarization visits and training sessions for first responders.
- Sharing hazard analyses, Standard Operating Procedures (SOPs), and Emergency Response Plans.
- Coordinated incident command structures during emergencies to ensure safety and operational efficiency.
- During a fire or other emergency, responding personnel will use thermal imaging, gas detectors, and incident monitoring tools to assess hazards and manage the situation with full situational awareness.

5.12 Incident Management and Post-Incident Procedures

The ERP establishes an Incident Command System (ICS) structure for managing emergencies methodically from arrival through resolution. Life safety is prioritized, followed by containment and mitigation of damage.

After extinguishment or incident stabilization, the ERP calls for a fire watch of no less than 24 hours to monitor for reignition or hazardous conditions. Incident investigation and root cause analysis will follow to inform any required operational or design improvements.

6 SUMMARY AND RECOMMENDATIONS

6.1 Summary

This Fire Risk Assessment has comprehensively evaluated fire hazards, risks, and mitigation measures associated with the proposed Coolpowra Battery Energy Storage System (BESS) facility. The assessment covers the battery enclosures, Medium Voltage Power Station (MVPS) enclosures, Independent Power Producer (IPP) building, fire water infrastructure, and site access provisions.

Key findings include:

- The inherent fire risks primarily stem from lithium-ion battery thermal runaway, electrical faults in high-voltage equipment, and their potential for fire propagation if uncontrolled.
- Proposed mitigation measures—such as robust container insulation, solid aerosol suppression, arc-fault resistant MV switchgear, ventilation with deflagration relief, and comprehensive fire detection—reduce risks to an acceptable level consistent with recognised safety standards.
- Site layout, spacing, and compartmentalisation strategies further minimise fire spread potential and support emergency access.
- Environmental and community risks around toxic gas emissions and firewater

runoff have been addressed through containment, detection, and coordination with local authorities.

- An Emergency Response Plan tailored to site-specific hazards and operational scenarios will ensure readiness and effective incident management.

7 RECOMMENDATIONS

To maintain and enhance fire safety at the facility, the following actions are recommended

- Design and Construction:

Complete installation of all proposed fire prevention and protection systems as specified, including fire-rated enclosure materials, suppression systems, and ventilation controls.

- Maintenance and Testing:

Establish rigorous maintenance schedules for all fire detection and suppression equipment, electrical systems, and ventilation infrastructure. Include periodic simulation exercises and functional tests.

- Training and Drills:

Conduct regular training programs for on-site personnel focusing on fire hazard awareness, emergency response procedures, and use of fire safety equipment. Regular fire drills should be implemented to maintain high preparedness.

- Coordination with Emergency Services:

Maintain active engagement with local fire and emergency services through familiarization sessions, sharing of site plans and hazard information, and joint exercises.

- Monitoring and Review:

Implement continuous monitoring of fire risk factors such as battery conditions, electrical system status, and environmental parameters. Review and update the Fire Risk Assessment and Emergency Response Plan at least annually or following any significant changes.

- Environmental Controls:

Ensure firewater containment and drainage systems remain fully functional and compliant with environmental protection standards to prevent contamination. By adhering to these recommendations, the Coolpowra BESS will uphold a robust fire safety posture, protecting personnel, assets, and the local community while aligning with statutory and best-practice requirements.

8 APPENDICES

8.1 Appendix A: Site Layout Plan and Battery Container Arrangement

- Detailed site layout plans showing the configuration of battery containers, MVPS units, IPP building, fire water tank, hydrants, access roads, and fencing.
- Spacing dimensions and access pathways for emergency vehicle circulation.
- Location of fire detection and suppression system components.

Figure 8.1 Coolpowra BESS Layout

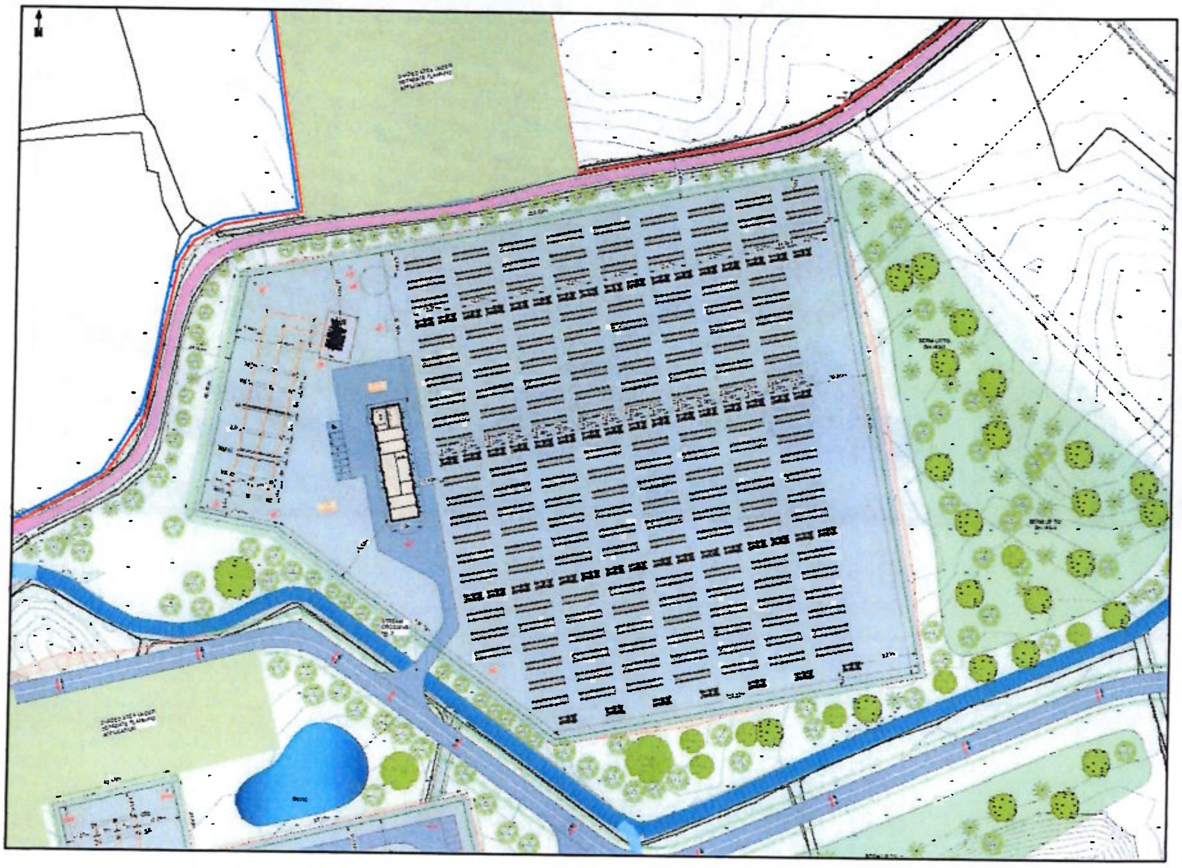
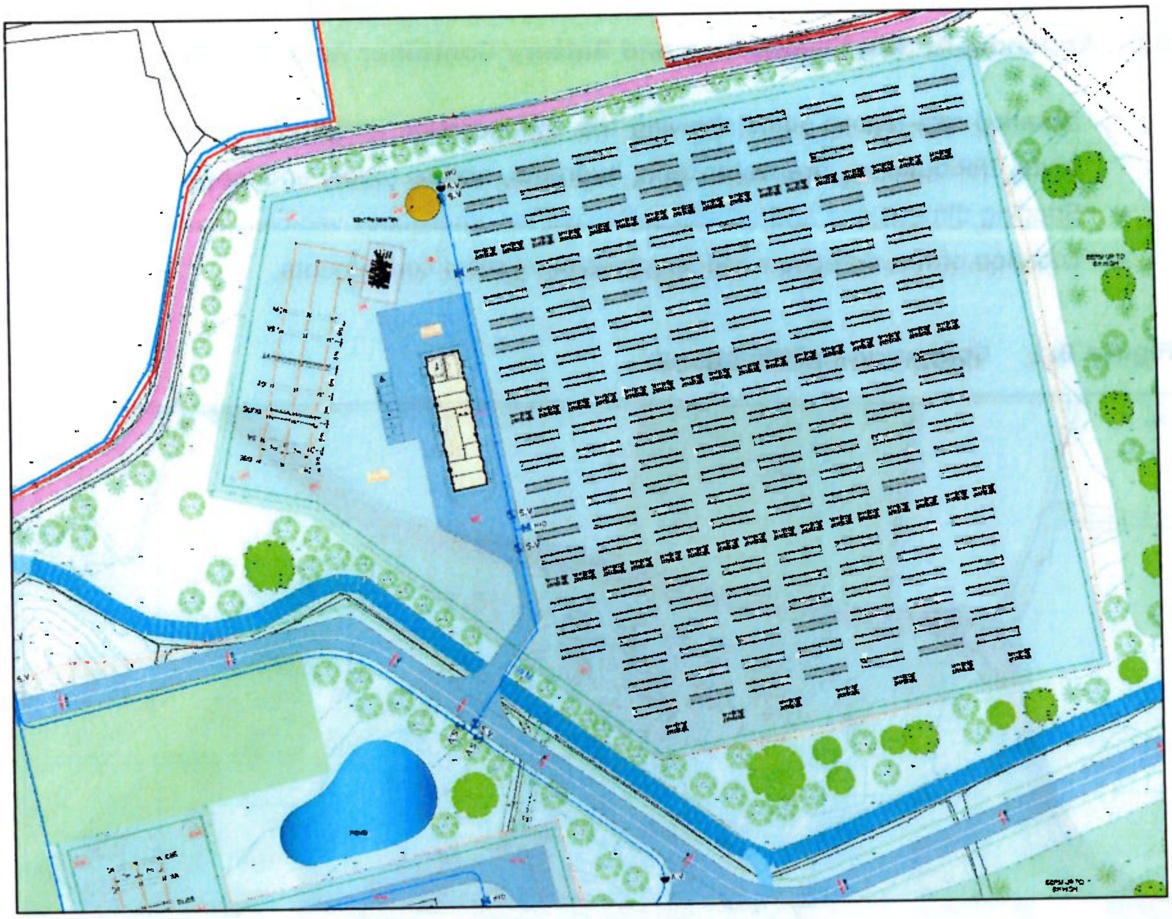


Figure 8.2 Water Main Layout



8.2 Appendix B: Technical Specifications for Equipment

- Manufacturer datasheets and technical details for:
  - Battery storage containers including battery module composition and HVAC system.
  - SMA Medium Voltage Power Stations (MVPS) models with electrical and fire safety features.
  - Independent Power Producer (IPP) building design, electrical system architecture, and fire safety installations.

AVAILABLE AND PROVIDED UPON REQUEST

8.3 Appendix C: Fire Detection and Suppression System Details

- Descriptions and design basis for all fire detection devices (smoke, heat, CO, hydrogen sensors).
- Solid aerosol fire suppression system specifications, including coverage, discharge mechanisms, and testing protocols.
- Ventilation system schematics, including deflagration panel placement and flow direction.

8.4 Appendix D: Relevant Standards and Guidance Documents

List of referenced standards, codes, and guidelines utilized in this FRA including:

- NSAI I.S. 10101:2020 + Amendment 1:2024 (National Rules for Electrical Installations, Ireland)

The latest edition, incorporating updates through 2024, this standard governs the design, erection, and verification of low-voltage electrical installations in Ireland including require ments relevant for BESS electrical infrastructure.

- NFPA 855 (2020) – Standard for the Installation of Stationary Energy Storage Systems

  Recognised international standard defining fire risk management, detection, suppression, and emergency response criteria specific to stationary battery energy storage installations.
- UL 9540A – Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

  Defines laboratory testing procedures to characterize thermal runaway propagation and aids the design of fire suppression and containment systems.

- FPA Zurich RE1 – Battery Storage Fire Safety Guidance
  Practical guidance on risk management and insurance considerations for battery storage facilities.
- ESB Networks Grid Code and Connection Standards
  National grid operator requirements relevant to MV and LV infrastructure interfacing with the utility grid.
- Local Fire Authority Regulations and Planning Conditions
  Requirements from local authorities and An Bord Pleanála mandating fire risk assessments, fire prevention measures, and emergency planning as conditions of development consent.

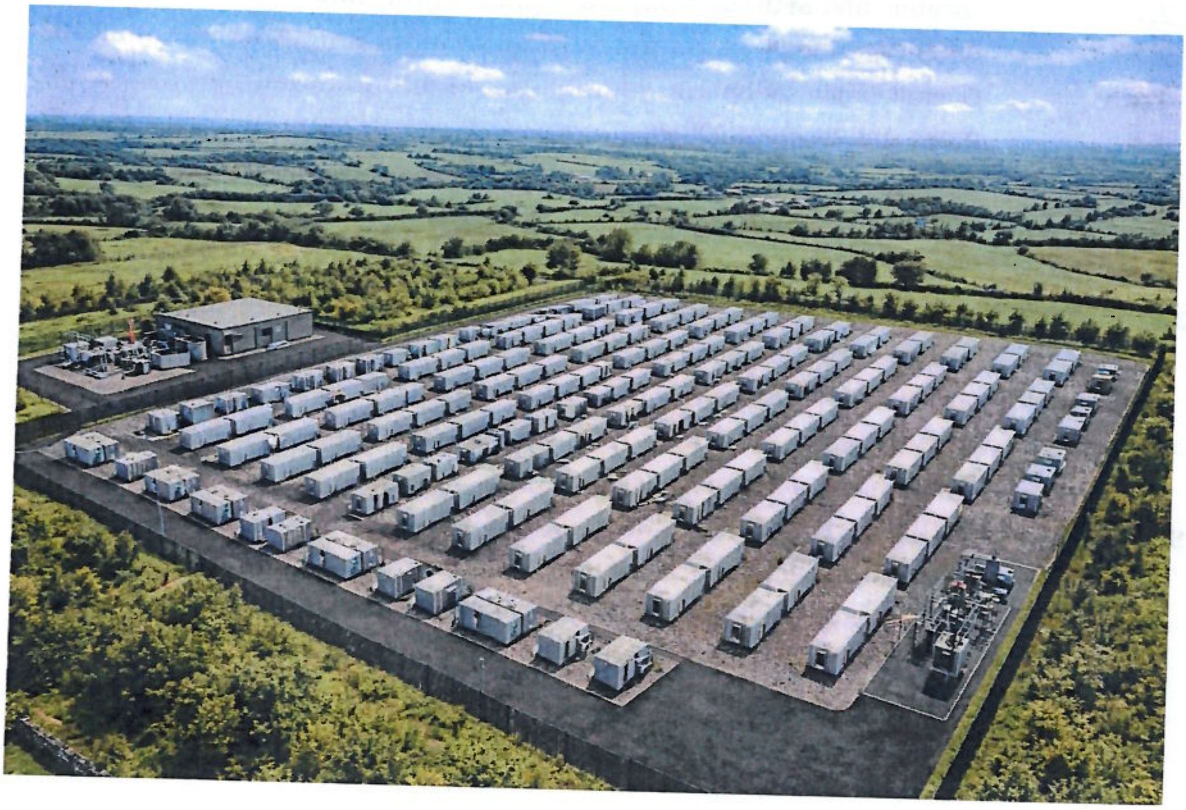
8.5 Appendix E: Emergency Response Plan (ERP)

This appendix contains the comprehensive Emergency Response Plan for the facility, detailing all aspects critical to effective emergency management. It includes clearly defined roles and responsibilities, communication protocols, and comprehensive evacuation procedures supported by detailed site maps. Emergency contact information is provided to ensure rapid coordination with external responders.

Additionally, this section covers site access and egress routes designed to facilitate safe and efficient emergency service response. It also documents staff training programs and records of emergency drills and exercises conducted to maintain readiness and continual improvement of response capabilities.

COOLPOWRA BESS

EMERGENCY RESPONSE PLAN



EMERGENCY RESPONSE PLAN
Version 1
JANUARY 2026

LUMCLOONENERGY

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Table of Contents

1 INTRODUCTION

This Emergency Response Plan (ERP) has been prepared for the proposed Coolpowra Battery Energy Storage System (BESS) facility on lands located in the townlands of Coolpowra, Cooldorragha, Ballynaheskeragh, Gortlusky and Sheeaunrush, County Galway.

The purpose of this ERP is to establish procedures and responsibilities for the effective management of emergencies occurring within the BESS facility. This plan aims to protect life, minimise damage to property and the environment, and ensure timely notification and efficient response by site personnel and external emergency services.

The following emergency response procedures are provided so that all personnel understand the practices that are to be followed to be prepared for and to provide immediate and effective response to emergencies that might arise at the facility. Because the safety of employees is of primary concern, the Emergency Response Coordinator and each member of the staff are committed to providing a safe, healthy work environment and are responsible for ensuring implementation of these procedures. Life safety of personnel shall be the highest priority during any event.

1.1 The Author

Lumcloon Energy was founded in 2008 as a project development company focused on flexible power and energy assets. Lumcloon Energy identified flexibility as a key component to address the changing needs of the evolving power systems, which are transitioning from fossil-based generation to renewable-based generation.

Lumcloon Energy is highly experienced in energy project development and continues to maintain an interest in assets that have been successfully delivered, from early development and ongoing commercial operation. Lumcloon Energy developed several grid scale Battery Energy Storage Systems, the first of which has been in operation since 2021.

1.2 Document Use

This ERP is intended for use by the client, their contractors, and relevant regulatory or emergency services personnel. It will form a key component of the facility's safety case, planning permit documentation, and ongoing safety management framework. The FRA should be reviewed and updated periodically or following any significant changes to facility design, equipment, or operational procedures.

1.3 Document Review

A review of this ERP shall be conducted and documented at minimum on an annual basis by site operator. The document shall also be reviewed and amended whenever there is a change in facility design, construction, operation, or maintenance that affects emergency response planning. When outside resources are changed or modified the document shall be reviewed and updated to reflect the changes that may affect this plan.

2 COOLPOWRA BESS

2.1 Location and Setting

The proposed development as amended is located on a 46 hectares (ha) site in the townlands of Coolpowra, Cooldorragha, Ballynaheskeragh, Gortlusky and Sheeaunrush, County Galway. The site is located approximately 5km north of the town of Portumna and 3.7km south of Killimor.

Lands within the development site boundary are in agricultural use and include a farmhouse and outbuildings which will be demolished as part of development works. The proposed lands are situated at an elevation of c. 51-54m AOD and are accessed by public road via the N65 (National Road) and the L8763 (local road). The proposed development is located adjacent to, and south of, the existing operational 400kV AIS electricity substation (Oldstreet). The proposed site was chosen as the preferred site following analysis of alternative sites along the two 400kV transmission lines, which traverse the country from west to east. The are a limited number of residential properties within the surrounding rural area and these are described as one-off housing with a total of 40 recorded within 1km offset from the main development with the proposed development lands. The closest residential dwelling to the proposed BESS compound boundary is approximately 500m to the north.

2.2 BESS Description

2.2.1 Battery Enclosures

The Coolpowra BESS site comprises one hundred and thirty-eight battery enclosures (containers) and one hundred and thirty-eight MVPS enclosures (containers) in twenty-five rows and nine columns, covering an approximate footprint of 178.5 meters by 156.5 meters. Each battery measures approximately 12.272 meters in length, 2.487 meters in width, and 4.032 meters in height, with an estimated total weight of 48.8 tonnes including battery modules and enclosure.

Each enclosure houses approximately eighteen battery racks, delivering a total energy capacity of approximately 4.9 MWh per container. The battery systems operate within ambient temperature ranges of -25 °C to +45 °C and incorporate thermal insulation designed to mitigate thermal runaway propagation between cells. The enclosures are equipped with an HVAC cooling system consisting of six wall-mounted units providing a total cooling capacity of approximately 61.2 kW to maintain safe operating temperatures. Fire safety features include integrated smoke, heat, and carbon monoxide detectors; manual fire alarm pull stations; horn and strobe alarms; and a solid aerosol fire suppression system supplemented by deflagration relief panels and active ventilation to evacuate hazardous gases during fire events.

Spacings between battery enclosures are consistent with fire safety guidelines and insurance requirements, with columns spaced 4.5 meters apart on centres of 6.9 meters and rows spaced 4.5 meters apart. This spacing supports adequate fire separation distances and emergency vehicle access throughout the battery storage area.

Surface finishes within the BESS compound will comprise clean permeable stone fill. Stormwater collected from impervious areas such as the IPP building and limited bitumen macadam roads will be directed to a below ground oil interceptor and attenuation /infiltration structure (volume of c.90m^3) before being discharged via a hydrobrake (which will limit flow to 1l/s (4l/s per hectare)) to the open drain /stream which runs to the south of the compound. Foul wastewater generated from welfare facilities within the BESS compound will be discharged to a sealed foul holding tank. The holding tank will be emptied and suitably disposed of periodically by a local waste permitted contractor. A foul holding tank is recommended due to low occupancy of the facility once operational. There is no requirement for the use of water in the process.

2.2.2 Medium Voltage Power Stations (MVPS)

One hundred and thirty-eight battery enclosures Medium Voltage Power Stations (MVPS) enclosures are installed on site as modular containerised substations to serve as the interface between the battery system and the medium-voltage grid.

These MVPS units are approximately 6.06 meters wide, 2.90 meters high, and 2.44 meters deep, weighing less than 18 tonnes. They are rated for DC input voltages up to 1,500 V and deliver AC medium-voltage output typically ranging between 10 kV and 35 kV with nominal power ratings between 4,000 kVA and 4,200 kVA.

Key electrical safety features include arc-fault resistant switchgear compliant with IEC 62271-202, vacuum circuit breakers, surge protection devices, galvanic isolation, and integrated oil spill containment systems with filtration and early detection capabilities. Strict installation and maintenance procedures are followed to mitigate fire and electrical hazards, including adherence to precise torque specifications for live bolted connections, establishing arc-fault exclusion zones during maintenance, and employing personal protective equipment (PPE) protocols to avoid shock and burn injuries.

2.2.3 IPP Building

The IPP building is a purpose-built facility serving as the primary control and grid interface centre of the BESS site. The building footprint measures approximately 40.0 meters in length and 10meters in width, housing the medium voltage switchgear, protection panel, meters, SCADA and communications equipment, and auxiliary power systems.

The internal layout is divided into functional compartments including the Control Room (x3), Switchgear Room, Communications Room, ESB Room, Store Rooms (x2), Mess Room. a small WC. The building is constructed with insulated block cavity walls offering robust fire compartmentalisation, finished externally with non-combustible plaster and a timber truss roof clad with synthetic slate tiles.

Electrical systems within the IPP building operate at voltages up to 20kV for the medium voltage equipment and 230V for building systems such as lighting and control devices. The facility incorporates fire detection and suppression systems designed to protect critical electrical infrastructure and personnel safety.

2.2.4 Fire Water Infrastructure

The BESS Compound includes one proprietary fire water storage tank with a capacity of 500 cubic metres (500m3), located adjacent to the IPP building to ensure an adequate firefighting water supply. A fire hydrant is positioned to the north and south of the IPP building enabling fire service intervention.

Vehicle access is provided to the compound in the southwestern area of the BESS compound and turning areas are located adjacent to the IPP building. Access roads and vehicle paths are maintained at a minimum width of 4.5 meters to accommodate emergency vehicles. The entire battery storage area is enclosed by a 2.65-meter-high pa lisade fence.

2.3 Overall Organisation

Overall responsibility for the Emergency Response Plan (ERP) lies with the Emergency Response Coordinator. The Emergency Response Coordinator or their designee is responsible for program implementation, including designating evacuation routes and employee assembly points, coordinating severe weather activities, communicating emergency response procedures to site personnel, contracting with emergency response organizations, and contractor coordination.

2.4 Roles and Responsibilities

Specific management personnel will assume leadership roles for emergency responses. The Emergency Response Coordinator, Site Manager, and/or Lead Technicians will assist in the implementation of this plan by knowing and communicating evacuation routes to workers during emergency evacuation and reporting the status of the evacuation to the

Fire Department. The Emergency Response Coordinator is responsible for seeing that this plan is implemented and will appoint an adequate number of personnel to enforce the plan, assure everyone is familiar with this plan and act as a liaison with the local Fire Department(s).

All facility personnel have a responsibility to immediately report emergency situations to the Lead Technician on duty or local emergency responder personnel when appropriate. There shall be no delay to report emergency events that require the local emergency responders.

A subject matter expert (SME) shall be contactable at all times by telephone. This person and a designated secondary SME contact should be readily available to first responders in the case of emergency situations. The SME shall be versed in the battery's failure modes and hazards. A working knowledge of incident command systems will allow the SME to integrate into the emergency response operations when needed.

2.5 Emergency Routes

A evacuation sheet shall be posted and orally communicated to site personnel. These procedures shall be discussed at periodic safety meetings in addition to being covered during new employee orientation. Personnel are to know at least two exits whenever possible and be familiar with the evacuation routes posted in the location indicated on the site map.

Depending upon the degree of emergency, weather and/or site conditions, roadways as designated on the site map will be used for routes of evacuation. In the event of an evacuation, all personnel will meet at the designated muster point for further information. If the primary muster point is inaccessible or hazardous, personnel shall gather at the secondary muster point and inform the emergency coordinator (if not present) by radio or telephone. The emergency response coordinator shall inform personnel of a diversion to the secondary muster point by such mean as are available, to include radio or loud hailer. If personnel are unable to make it to the designated muster points, they should seek shelter wherever possible and contact their supervisor for further instructions. Accountability of personnel shall be of the upmost importance and be conducted in a timely manner. Responder access points shall be kept unobstructed at all times so first responders will not be hindered in their operations when responding to emergencies within the site.

2.6 Operator Safety & Equipment

2.6.1 General recommendations for operator safety

- Inspect equipment daily for unsafe conditions.
- Keep hands away from exposed electrical connections.
- Keep hands away from hot surfaces.
- Observe all high voltage warnings.
- Any outstanding observations shall be reported to their supervisor immediately and documented.

2.6.2 Personal Protective Equipment

The operation or maintenance of specific equipment may have different safety requirements. There are different levels of PPE that must be checked and maintained. All personnel who wear levels of protection above and beyond their normal everyday attire must be trained in that PPE. All training of PPE shall be conducted by a competent person and documented. Some PPE have a SCAM (selection, care and maintenance) document that will instruct the end user on the limitations of the PPE and the proper maintenance of the PPE. Always be aware of individual equipment operational requirements and hazards as well as out of service dates. For example,

- Safety glasses with side shields (no dark glasses are permitted except those approved for welding or cutting)
- Face shields for cutting & grinding
- Approved safety toe shoes
- Approved hearing protection
- Approved hardhat
- Approved gloves
- Long sleeve shirt
- Long pants

All PPE is required to be worn at all times for the working being conducted. Any PPE that is compromised or no longer considered viable for protection shall be discarded and replaced. Any PPE that comes in contact with hazardous material shall be properly decontaminated and inspected for functionality before being returned to service.

2.7 Safety Training

Initial training for all site personnel with respect to the contents of this ERP shall be undertaken upon the start of employment or substantial changes in duties. Refresher training of the ERP to site personnel shall be conducted at least annually. Documentation of ERP training is to be maintained in site files.

A variety of emergency response drills are to be held at minimum on a quarterly basis and shall be documented. Table-top exercises are encouraged to familiarize relevant response personnel with procedures for different types of emergencies that could be encountered at the site.

The site Emergency Response Coordinator and Lead Technicians are trained in their specific duties upon being assigned these roles or beginning their employment. All building occupants have been instructed in actions to take in case of an emergency through their copies of procedures and training, as needed.

Operator personnel should receive supplier / manufacturer approved training on the specific characteristics of the energy storage system. Applicable common standards (e.g. on electrical safety) should be taken into account.

All personnel who wear levels of protection above and beyond their normal everyday attire must be trained in that PPE. All training of PPE shall be conducted by a competent person and documented.

All hazardous materials incident emergency responders and workers at hazardous materials facilities, transport companies, waste treatment facilities, storage facilities and disposal facilities will be provided training which meets federal and state standards. Such training will be commensurate with their employer's or organization's plan and policies.

Initial and refresher training regarding warning systems and alarms shall be conducted at least annually. Documentation of training is to be maintained in site files.

3 EMERGENCY RESPONSE

3.1 Analyse, Plan, Implement, Evaluate

The phases of emergency response may be categorized under the 'APIE' scheme for handling an emergency: Analyse, Plan, Implement, Evaluate.

- Analyse: Analysing the response is the phase in which the notification takes place to emergency responders.
- Plan: Planning the response is the phase in which the proper resources and equipment are called to the emergency scene and a plan is developed to mitigate the emergency.
- Implement: Once a plan is developed and the proper resources and equipment are there, then the Emergency Response Coordinator will make the determination to implement the plan.
- Evaluate: Once the plan is implemented, it shall be evaluated for safety and effectiveness. If the plan is not safe or effective, then the process should start over again with Analyse, Plan, Implement, and Evaluate.

No employee is required or permitted to place himself or herself in harm's way in order to facilitate extinguishment, evacuation, or rescue. All rescue operations will be performed by trained professionals upon their arrival. Rescue operations will only be conducted after a risk-reward analysis is done and proper PPE is used to protect against any adverse hazards that may be encountered.

Incidents where local fire department personnel are involved will be managed under a system established by the fire department, called 'Incident Command System.' This establishes a primary incident commander and a liaison to or for the Emergency Response Coordinator.

3.1.1 Analyse

Without entering an immediate hazard area, the employee who first discovers an emergency should identify the following:

- Is there a fire, spill, explosion, or other incident happening?
- Does medical assistance appear to be needed?
- Who/what is at risk: people, the environment, or property?
- What are the weather and terrain conditions and risks?

The employee will also isolate the area to keep people away from the scene until trained responders arrive, as long as it is safe to do so. An employee who has not received training in emergency response should take no actions beyond notification, isolation of the area, and personal safety precautions. Any efforts made to rescue persons, protect property, or protect the environment must be weighed against the possibility of becoming part of the problem. Attempts to rescue others shall only be attempted with proper PPE, proper training, and in a manner that does not create significant risk to rescuer or others. Persons at the scene must not contact spilled material or inhale fumes, smoke, or vapours.

3.1.2 Plan

After all life hazards are no longer a threat, a plan of operation shall be devised for remediation of the event. The plan shall be communicated to all responders and safety of all responders shall be paramount. A staging area, if needed, shall be identified for extra personnel and equipment that may be needed to accomplish the plan's objectives. All responders that will enter the hot zone (affected area) must be made aware of any decontaminated area upon their exit of the hot zone. Trained responders will be called to the scene by the O&M Manager and/or Lead Technicians to begin the process of hazard assessment and to establish objectives and priorities. The hot zone shall be identified, and all non-essential personnel shall not be permitted to enter this area without proper training and permission of the Emergency Response Coordinator.

3.1.3 Implement

The initial response phase starts with notification, which activates the emergency response system. Anyone who observes or receives information regarding an emergency at BESS should immediately notify available personnel using the radio network or their issued cell phones. The Emergency Response Coordinator and/or Lead Technician will then ensure fire department is notified. At BESS plant, employees are notified of emergencies by cell phone/radio and word of mouth from the Emergency Response Coordinator and/or Lead Technicians. Appendix 4 provides a list of emergency notification information for BESS plant personnel.

If an event has the potential to impact the local community, BESS plant will contact local fire/police to make community notifications. The Emergency Response Coordinator and/or Lead Technicians will coordinate any media efforts through the BESS plant Asset Manager and Company Legal Department.

The incident command post will be set up in a location free of contaminants and located upwind uphill and upstream. The Emergency Response Coordinator or designee shall remain at the incident command post to serve as a liaison to the Incident Commander designated by emergency responders. Trained responders may enter a 'hot zone' only when wearing appropriate protective equipment. Personnel entering the hot zone shall be briefed on the plan before entering. All communication devices shall be tested prior to entry into the hot zone. A decontamination corridor shall be established prior to entry into the hot zone. There shall be accountability taken of all personnel entering and leaving the hot zone. A back up team that has the same PPE shall be at the ready in the event of the entry team needs quick assistance. A decontamination team shall be ready to for after exiting the location (warm zone). There shall be a doffing station that is set up immediately at the end of the decontamination section that will allow the responders a safe place to remove their PPE. Only trained responders are authorized to risk exposure to chemicals for purposes of containing or stopping the material release.

The Emergency Response Coordinator or a designee will be responsible for notifying the appropriate regulatory agencies and, if necessary, the Emergency Response Contractor or mutual aid groups. The incident will be documented and kept on file.

3.1.4 Evaluate

During the implementation phase of the emergency, response, action and progress shall be analysed by the Emergency Response Coordinator constantly. If the plan seems to be ineffective or unsafe the responders shall be removed from the hot zone and the plan shall be revised. The new plan shall be implemented, and that revised plan shall be analyzed for safety effectiveness again.

3.2 Evacuation Procedures

When notified to evacuate, site personnel shall do so in a calm and orderly fashion, keeping the following instructions in mind:

- Walk, don't run. Help others who need assistance as long as doing so does not put you at greater risk.
- Stay upwind, upstream, and uphill whenever possible.
- Watch for other traffic and equipment on access roads and roadways.
- Be aware of ice/snow and loose gravel conditions.
- Drive safely.

Site personnel shall go to the primary designated muster area as identified.

If employees are unable to make it to the muster area, they should divert to the secondary muster area and immediately contact their supervisor for further instructions.

During evacuation, the Emergency Response Coordinator and/or Lead Technicians should ensure that every person on his/her crew has been notified and that evacuation routes are clear. Any person with a disability (mobility, hearing, sight, etc.) who requires assistance to evacuate is responsible for pre-arranging with someone in their immediate work area to assist them in the event of an emergency. Anyone knowing of a person with a disability or injury who was not able to evacuate will report this fact immediately to their supervisor. This information shall be communicated to emergency responders immediately upon their arrival if the disabled person has not been evacuated.

Once an evacuation is complete, the Emergency Response Coordinator or Lead Technician should account for all personnel. This accountability information shall be communicated to the emergency responders immediately upon their arrival. When a person is unaccounted for, the following information shall be communicated to the emergency responders:

- Name of the individual
- Disabled or not disabled
- Work location
- Last known location

4 FIRE INCIDENTS

All personnel working at BESS plant are to be trained and should know how to prevent and respond to a fire emergency. All on-site personnel shall:

- Complete an on-site training program identifying the fire risks at BESS plant.
- Understand the protocol and follow emergency procedures should an event occur.
- Review and report potential fire hazards to the Emergency Response Coordinator.

No employee is required or permitted to place himself or herself in harm's way in order to facilitate extinguishment, evacuation, or rescue. All rescue operations will be performed by trained professionals upon their arrival.

4.1 Response to a Fire Incident

In the event of an incipient stage (beginning, small) fire, employees should notify adjacent individuals of this situation and exit the area. Only employees trained in the use of fire extinguishers or other manual fire suppression systems should attempt to use an extinguisher or system. Employees are not expected or authorized to respond to fires beyond the incipient stage (i.e., fires that are beyond the beginning stage and which cannot be extinguished using a hand-held, portable fire extinguisher). The fire department should be immediately notified by dialing fire department when any type of unintended fire has taken place. Site management shall also be immediately notified of any emergency.

4.1.1 Fire Internal/External to Battery Container

- Call fire department and report as an 'ETHANE' message, the followings:
  - E - Exact location: The precise location of the incident,
  - T - Type: The nature of the incident, including how many vehicles, buildings and so on are involved,
  - H - Hazards: Both present and potential,
  - A - Access: Best route for emergency services to access the site, or obstructions and bottlenecks to avoid.
  - N - Numbers: Numbers of casualties, dead and uninjured on scene
  - E - Emergency services: Which services are already on scene, and which others are required
- Make sure the immediate area of the fire is clear of personnel.
- Account for all employees, contractors, and visitors who were working in the immediate area of the fire. If any personnel are unaccounted for from the immediate fire area, a communication shall be made through out the facility in attempt to locate the person(s) missing. If the person(s) is equipped with a facility radio then an emergency transmission shall be communicated in attempt to locate the person(s).
- Contact the O&M Manager (if present) and Emergency Response Coordinator (if not the O&M Manager) immediately.
- Remove any obstructions (vehicles, material, etc.) that might impede response to the scene.
- Station available personnel at road intersections to stop traffic flow into the fire scene.
- Evacuate the energy storage system area immediately if the fire warning alarm sounds or fire warning lights illuminate.
- Proceed to the designated muster point for head count.

- If onsite, the designated Emergency Response Coordinator will do a head count and relay any information/instructions.
- If you encounter heavy smoke, stay low and breathe through a handkerchief or other fabric; move away from the area.
- Assist anyone having trouble leaving the area so long as doing so does not put the assistor at additional risk.
- Attempt to extinguish the fire ONLY if you have had the appropriate training and proper firefighting agent for the type of fire.
- The energy storage system is not to be accessed until the O&M Manager or designated Emergency Response Coordinator gives authorization.

4.1.2 After a Fire

Hazards after a fire should be identified at the time of installation such that recommendations for personal protective equipment (PPE) are available for clean-up crews and hazardous materials (HAZMAT) teams. This may include respirators to protect personnel from toxic gas that continues to be generated from hot cells. Firewater retention and cleanup measures may be required by local regulations.

In addition to the gas generation risk, cells that remain hot also pose a delayed ignition risk, whereby heat in the cell may transfer to undamaged adjacent cells or remaining active material and reignite the fire. As such, fire-damaged equipment must remain monitored for a period identified in consultation with equipment manufacturer.

Care should be taken to ensure that damaged batteries containing energy have been safety de-energized in accordance with disposal procedures, if possible, before handling and disposal. If unable to completely de-energize batteries involved in a fire, care should be taken with handling or dismantling battery systems involved in fires as they may still contain hazardous energy levels.

5 APPENDICES

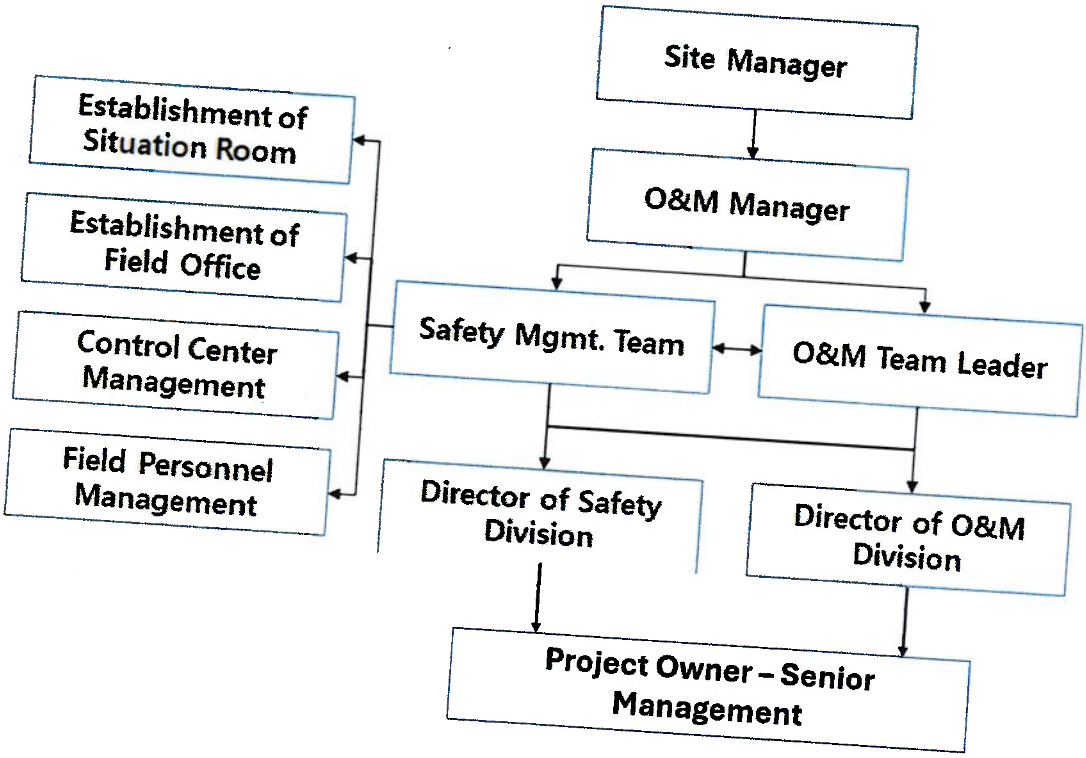
5.1 Appendix 1: Emergency Contacts (T.B.D)

TITLE	COMPANY	INDIVIDUAL	TELEPHONE	EMAIL
Project Owner				
Project Owner				
O&M Manager (Main)				
O&M Manager (Sub)				
Site Manager (Main)				
Site Manager (Sub)				
Trading Agent				
EPC Contractor (PM)				
EPC Contractor (Lead Engineer)				
EPC Owners Engineer				
Construction Contractor				
BESS Supplier				
Battery Supplier				

5.2 Appendix 2: Emergency Services & Contractors (T.B.D)

TITLE	TEL /EMAIL
Fire Office (Emergency)	
Fire Department (Non-Emergency)	
Police (Emergency)	
Police Department (Non-Emergency)	
Ambulance (Emergency)	
Hospital / (Name)	
Hazardous Material Safety Administration	
Equipment Assistance	

5.3 Appendix 3: Emergency Reporting Procedure



5.4 Appendix 4: Escape Routes (T.B.D)