DART+ Coastal North

Public Consultation No.2

Annex 3.2 I: Drogheda Station Canopies Report

NTA Údarás Náisiúnta Iompair National Transport Authority
Rialtas na hÉireann Government of Ireland | Tionscadal Éireann Project Ireland 2040
Iarnród Éireann Irish Rail

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ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
ARL	Average Run Length
CAF	Common Assessment Framework
CWH	Contact Wire Height
DART	Dublin Area Rapid Transit
DC	Direct Current
IÉ	Iarnród Éireann
MCA	Multi-Criteria Analysis
OHLE	Overhead Line Electrification
TSS	Train Service Specification
BC	Bottom Chord
CAF	Common Assessment Framework
CCE	Chief Civil Engineer
CWH	Contact Wire Height
DART	Dublin Area Rapid Transit
DC	Direct Current
IÉ	Iarnród Éireann
MCA	Multi-Criteria Analysis
NTS	Not To Scale
OHLE	Overhead Line Electrification
PRM	Persons with reduced mobility
SET	Signalling, Electrification, Telecommunications
TC	Top Chord
TCT	Track Construction Tolerance
TLA	Track Maintenance Tamping Allowance
TMT	Track Maintenance Tolerance
TSS	Train Service Specification
TSI	Technical Specification for Interoperability

1. INTRODUCTION

The purpose of the report is to provide the technical input into the Preferred Option Report. This document covers the option selection process for necessary clearance improvement works to Drogheda Station Canopies as a result of the introduction of overhead line electrification equipment (OHLE).

Sufficient clearance must be achieved at platform canopies such that live parts, such as overhead wires, overhead equipment and the pantograph gauge can be placed at the minimum required electrical clearances from the canopies, along with provision of necessary allowances for tolerance, adjustment and electrical isolation.

This report provides a technical assessment of the impact on the existing canopy as a result of the introduction of overhead line electrification equipment (OHLE) between Malahide and Drogheda, taking into account its heritage status. Drogheda (MacBride) Station is a protected structure: this includes various structures around the station as well as the canopies on the platforms.

The report includes:

- An introduction and description of the study;
- A summary of the option assessment approach undertaken;
- A description of the existing situation;
- The requirements;
- The technical options available, along with comparison;
- Recommendations.

1.1 Packages of Work

The scope of work for DART+ Coastal North covers a wide range of interventions on the Northern Line needed in order to meet the Train Service Specification (TSS) requirements. To appropriately assess options against each other, the works have been split into separate work packages, as detailed in the Preferred Option report. Where appropriate, the works have then been further split down into ‘sections’ which define the system which has been subject to the optioneering and design process.

1.2 References

This report should be read in conjunction with reports listed in the Option Selection Preferred Option Report.

1.3 Options Assessment Approach

The options described in this report have not been subject to a Multi-Criteria analysis (MCA) process as the solutions are developed based upon technical requirements set out within this document.

2. EXISTING SITUATION

2.1 Overview

As part of the DART+ Coastal project, the Northern Line between Malahide and Drogheda is to be electrified with 1.5kV DC overhead line electrification. A study has been undertaken to determine the impact of electrification on station canopies. The study has identified that only the station canopy at Drogheda MacBride Station on Platform 1 will be affected and, as such, is the only canopy covered in this report. It is important to note that Drogheda (MacBride) Station is a protected structure which includes its canopies on the platforms.

2.2 Structure

The canopy at Drogheda Station Platform 1 is situated along the length of track which is to be electrified. This is a historic structure and was constructed in 1853 without cognisance of necessary clearances for OHLE.

Figure 2-1: Drogheda Platform 1 Canopy

A drawing showing the edge of the canopy and the required electrical clearance can be found in section 6.1 of this report.

The canopy also encloses various items including signage, CCTV cameras, cable conduits, Public Address loudspeakers, a station clock and platform lighting. Refurbishment of the canopy arising from the need for alterations will include removal and refitting of the relevant items. As a consequence, some items may need to be renewed.

2.3 Permanent Way

Generally, all areas that are to be electrified have two tracks which are continuous welded rail on ballast. The exception is at Drogheda depot and overbridge OBB80.

2.4 Other Railway Facilities

As the canopy at Drogheda Platform 1 is within a station platform area, the OHLE wire height needs to be cognisant of the requirements to have increased separation between the public and electrical equipment.

2.5 Utilities

Utility service records have been obtained from the providers in the area. Most services are located within the existing road network surrounding the railway and in bridge and underpass crossings of the railway. There are also lineside services running parallel to the railway and some major utilities crossing perpendicularly under the railway. All records should be considered indicative only and the most up to date information must be obtained and verified prior to any intrusive works occurring.

The records received and findings of a July 2022 site visit indicate that there are no services located on or near the canopies.

2.6 Services supported by the canopy structure

The services that are located within or supported by the canopy structure includes:

- PA Speakers
- Lighting
- CCTV
- Clock

These must be taken into account when considering the various options.

3. REQUIREMENTS

The main project requirements relevant to this report subsection are as follows:

- Electrification of the line from the end of the current electrified section at Malahide to Drogheda with 1500V DC overhead;
- Undertake necessary infrastructure change to achieve the clearances required for electrification at bridges and structures;
- Undertake safety improvements resulting from the introduction of 1500V DC overhead.

3.1 Specific Requirements

In achieving the clearances required for electrification at bridges and structures, a predefined approach for electrical clearance design is to be adopted as per DART+ Electricity Functional Specifications System-Wide (MAY-MDC-ELE-DART-SP-E-0002) Section 5.6.7. This lists relevant electrical equipment configurations and their hierarchy for adoption and is explained further in Section 6.1 of this report.

Additionally, the standard CME-TMS-327 – Vehicle Gauging provides reference profiles for the pantographs, which have been developed from CME-TMS-306. The maximum sway of the pantograph is limited in CME-TMS-306 to 130mm in still air at a reference height of 4300mm ARL. An increase of 40mm sway per additional 1000mm increase in wire height is also to be allowed for.

The required electrical clearances from live parts of OHLE and pantographs to structures for 1.5 kV d.c. are:

- Static clearance of 150mm: the safe distance between the earthed material of any structure and the live parts of the OHLE;
- Passing clearance of 100mm: the safe distance between the earthed material of a structure or rail vehicle and the live part of the OHLE.

I-PWY-1101 Requirements for Track and Structures Clearances should be adhered to for Track and Structure Clearances.

3.2 Systems Infrastructure and Integration

No further systems integration is envisioned to be required at this stage.

3.3 Design Standards

Table 3 contains the key applicable standards that will be used to develop the design. Please note that this is not intended as an exhaustive list.

Table 3-1: Relevant design standards for OHLE bridge clearance works

Source	Description	Comments
European Norm	EN50122-1	Protective provisions against electric shock
European Norm	EN50119	Electric traction overhead contact lines
Irish Rail	I-ETR-4101	Maintenance Parameters for 1500Vdc OHLE
Irish Rail	I-ETR-4004	Clearance Requirements for DC 1500V Electrified Lines
Irish Rail	CCE-TMS-300	Track Construction Requirements and Tolerances
Irish Rail	CME-TMS-306	OHLE Interface for IÉ Rolling Stock
Irish Rail	CCE-TMS-321	Track Maintenance Requirements and Tolerances
Irish Rail	CME-TMS-327	Vehicle gauging
Irish Rail	CCE-TMS-410	Civil Engineering Structures Design Standard
Irish Rail	I-PWY-1101	Requirements for Track and Structures Clearances
Irish Rail	SET-AMS-002-012 Iss1.0	Derogation from SET Technical Standards

4. CONSTRAINTS

4.1 Technical

4.1.1 Electrical system

The study of the impact of electrification on station canopies shall consider the following parameters which define the OHLE, pantograph and canopy positions and the tolerances and allowances for OHLE clearance assessment, as indicated in the DART+ Functional System Requirements specification (MAY-MDC-ELE-DART-SP-E-0002):

- The contact wire height;
- The track maintenance tamping allowance;
- The track construction tolerance if track reconstruction/modification is required;
- The track maintenance tolerance;
- The OHLE construction tolerance;
- The OHLE maintenance tolerance;
- The structural construction tolerance if canopy reconstruction/modification is required;
- An allowance for contact wire and pantograph wear;
- The OHLE system height or allowance for OHLE support;
- The uplift caused to wires by a passing train;
- The required electrical clearances;
- The survey tolerance.

4.1.1.1 Contact wire height

The nominal height of the contact wire (from which the train pantograph draws its power) is defined by the DART+ Functional System Requirements specification (MAY-MDC-ELE-DART-SP-E-0002) as 4.7m. This can also be reduced to a minimum height of 4.4m before a derogation from standards is required, with a risk assessment and approval from IÉ SET (and CCE depending on values for allowances, tolerances and clearances). The absolute minimum is 4.27m (which would require a derogation).

In Drogheda Station, footbridge OBB81, placed just at the south side of the canopies area, constrains the contact wire height up to 4.4m, considering a contenary with zero encumbrance arrangement and the required tolerances and allowances according to the preferred arrangement for the proposed overbridge modification indicated in the optioneering report D+WP56-ARP-P3-NL-RP-CB-000056 (Overbridge OBB81 Options Report) and shown in the picture below.

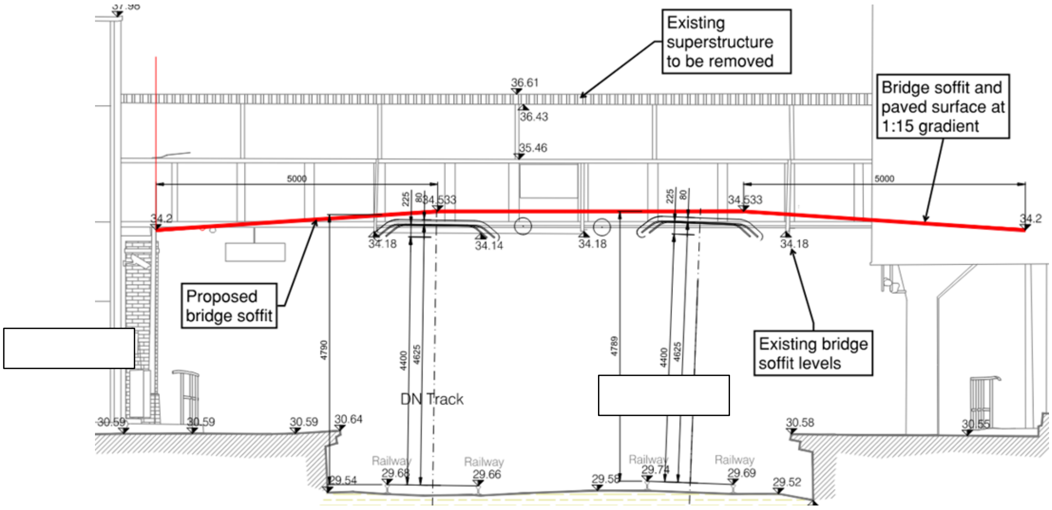


Figure 4-1: Elevation of proposed superstructure replacement at OBB81

The contact wire height considered along the platforms in Drogheda Station will therefore also be 4.4m.

4.1.1.2 Track maintenance tamping allowance

Track tamping is the regular maintenance process of correcting geometry and creating a uniform rail bed via adjustments to the ballast. This is generally achieved by a rail-mounted tamping machine. The target maintenance allowance is 100mm although this can be reduced to a minimum of 50mm for ballasted track. Alternatively, the rails can be mounted directly to a concrete slab (referred to as slab track) to remove the need for tamping (i.e. 0mm allowance).

4.1.1.3 Track maintenance tolerance

Track Maintenance Tolerance of 25mm for ballast track is considered in the required clear height.

4.1.1.4 Track and OHLE construction tolerance

Track and OHLE construction tolerances are 5mm and 20mm respectively.

4.1.1.5 OHLE maintenance tolerance

During the service lifetime of the OHLE, maintenance operations and adjustments require a tolerance of 30mm, regardless of electrical arrangement selected.

4.1.1.6 Contact wire and pantograph wear

An allowance of 25mm is required to account for wear to the pantograph and contact wire affecting the dynamic behaviour of the system.

4.1.1.7 System height

The system height is the distance between the highest point of the catenary wire and the contact wire. Typically, support is provided to the contact wire from the catenary wire with ‘droppers’.

As previously indicated, the proposed OHLE arrangement within the area underneath footbridge OBB81 is a contenary with zero encumbrance arrangement, with the OHLE supported in OHLE structures at each side of the footbridge, to maintain maximum span of 13 m for this arrangement, as per DART+ Functional System Requirements specification (MAY-MDC-ELE-DART-SP-E-0002).

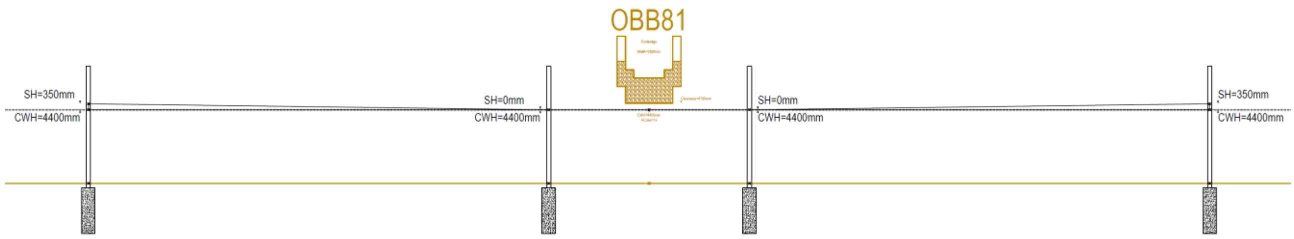


Figure 4-2:OHLE schematic arrangement, passing under OBB81

From these OHLE structures, the system height is increasing according to the DART+ Functional System Requirements specification drawing MAY-MDC-ELE-DART-DR-E-0004. For the following spans, along the area where canopies are placed, the system height can change between 0.26m and 0.5m, depending on the span length, which can change between 20m and 40m.

4.1.1.8 Uplift

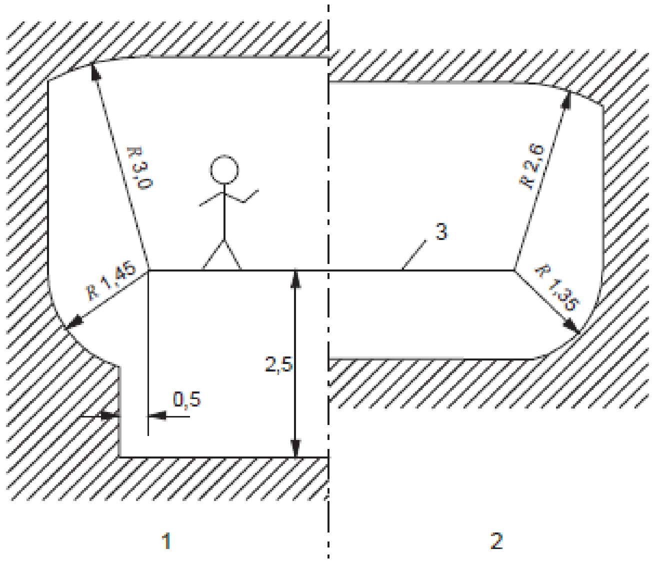
Passing trains cause movement on the overhead wires. This is relevant when considering dynamic electrical clearance required. For a catenary system, the required dynamic uplift allowance is 110mm. For a contenary system this is typically 70mm. The maximum speed of trains through Drogheda Platform 1 is 30 mph.

4.1.1.9 Electrical clearance

Enhanced electrical clearance (the preferred option) between live parts of OHLE and pantograph and the earthed structures is 150mm under static conditions or 100mm under dynamic for 1.5 kV d.c. Note that the dynamic case governs as this requires the inclusion of uplift allowance. Reduced electrical clearances are 100mm and 80mm under static and dynamic conditions respectively.

In case of modifications or reconstruction of the canopy, passive provision for 25kV a.c. electrification will be considered, so in this case, electrical clearances are 270mm and 150mm under static and dynamic conditions respectively.

In addition, the electrical safety distances between standing surfaces and live parts must be respected to avoid any direct contact, following EN 50122-1 (see figure below for low voltages). These distances constrain the OHLE height and mast position at stations and must be checked to ensure personal safety.



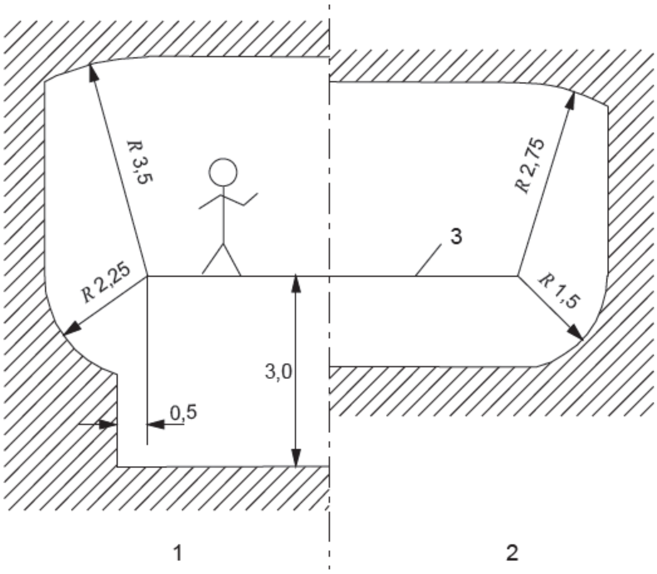
Key

1 public areas

2 restricted areas

3 standing surface

Figure 4-3: Minimum clearances to accessible live parts on the outside of vehicles as well as to live parts of overhead contact line systems from standing surfaces accessible to persons for low voltages (EN 50122-1)



Key

1 public areas

2 restricted areas

3 standing surface

Figure 4-4: Minimum clearances to accessible live parts on the outside of vehicles as well as to live parts of overhead contact line systems from standing surfaces accessible to persons for high voltages (EN 50122-1)

These clearances are minimum values which shall be maintained at all temperatures and in the full range of electrical and mechanical loads of the conductors.

4.1.1.10 Surveying

An allowance of 5mm for survey inaccuracies is required.

4.1.2 Gauging

The necessary changes to electric rolling stock on this section of the route requires consideration of gauging (physical clearances) as well as the previously discussed electrical clearances. This is particularly relevant to the pantograph and its interaction with the canopy at Drogheda Platform 1.

The reference profile for the pantograph gauge is provided in the standard CME-TMS-327 – Vehicle Gauging. The maximum sway of the pantograph is limited in CME-TMS-306 to 130mm in still air at a reference height of 4300mm ARL. An increase of 40mm sway per additional 1000mm increase in wire height is also allowed for.

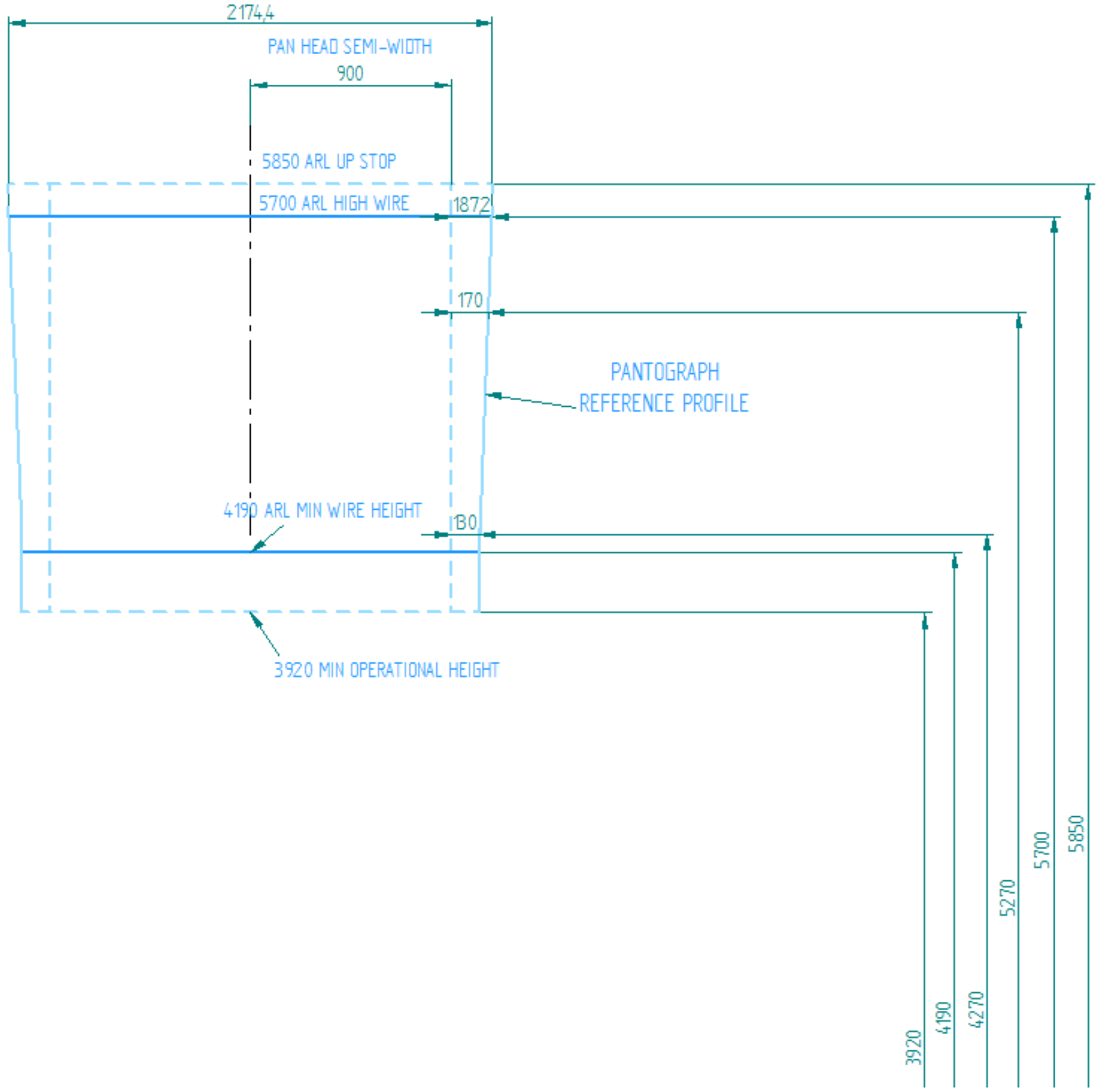


Figure 4-5:Reference profile for pantograph gauge given in the standard CME-TMS-327 – Vehicle Gauging

4.1.3 Track level

Track lowering is an option to improve the electrical clearance and enable a more favourable electrical arrangement. Track lowering can be achieved in two ways:

Removal of some of the ballast depth – skim dig;

Adjustment of formation level.

A skim dig can be achieved in some conditions by temporarily supporting rails and digging out some of the ballast from underneath sleepers. This is a relatively simple task with limited construction impact but can only achieve minor reductions to track levels (less than ~ 75mm).

For lowering greater than 75mm, the potential construction operations will be more disruptive. Where enough ballast depth exists, this may be possible via alterations to the overall ballast depth. In cases with minimal ballast depth, the formation may need to be lowered, comprising significantly disruptive construction activities, including removal of track and ballast before the formation can be dug down, followed by reinstatement. It should be noted that further investigation into the existing ballast depth at such locations will be required at subsequent design stages.

Due to gradient limits on track alignment, any lowering operation is likely to impact extensive lengths of rail. Consideration must be given to the interaction with other assets such as station platforms.

Lowering of track is also constrained by impacts on existing drainage, utilities and bridge substructure. There is a further constraint relating to the compliance for step heights between the train and platform. It is not generally permissible to deviate from standard platform heights in order to comply with TSI PRM requirements. Therefore, any track lowering will require corresponding lowering of the platform surface.

Additionally, it will also be constrained by impacts on the electrical safety distances between standing surfaces and live parts described in section 5.1.1.9 of this document.

4.1.4 Canopy Modification

As an alternative to track lowering, canopy modification can be considered to achieve additional clearance where alternative solutions prove too constrictive. This can either take the form of raising the canopy or adopting a more substantial modification/reconstruction of the canopy to achieve the required clearance.

4.2 Environmental

For a more detailed overview of the existing environmental constraints for DART+ Coastal North refer to Annex 3.1 Constraints Report.

4.2.1 Traffic and transportation

Traffic and transportation will not have a material impact on the solutions proposed at Drogheda Platform 1 canopy.

4.2.2 Landscape and visual impact

Whilst the introduction of OHLE on the bridges will have an impact on the structure the impact will be largely similar for all electrical solutions.

4.2.3 Architectural heritage

There are six Protected Structures in Drogheda MacBride Station. They are: Drogheda MacBride Station (LCC RPS DB-055); Engine Shed LCC RPS DB-395,; Water Tower LCC RPS DB-397; Parcel Office LCC RPS DB-396; Boiler House LCC RPS DB-398; and a toilet block LCC RPS DB-399. All of these structures are also included in the NIAH. Their settings or curtilages include the whole station complex. The canopy on platform 1 is not a specifically listed protected structure, however it would fall under the protection of the station curtilage.

There is a protected structure of note to the north of the station, St. James's House (LCC RPS DB-148), within whose setting the station is situated, and one protected structure to the south west, Bayview House (LCC RPS DB-301). Similarly, UBB82 (Boyne Viaduct) is a protected structure (LCC RPS DB-176).

The station does not fall within an Architectural Conservation Area (ACA) and there are no historic gardens included in the NIAH Garden Survey, in the vicinity of it.

Historic Map analysis identifies a number of additional features which require further investigation to determine their architectural interest. These include a double arched cut stone bridge across Newtown Lane, and the Dublin Road Bridge. A terrace of six houses marked Railway Terrace is noted on the 1870 town map, with later workers houses added to the south of these by 1907. The former Union Workhouse and Fever Hospital to the west of the station is a significant complex of buildings likely to be of architectural, technical, social and historical interest. There were substantial gardens to the north of the station as Wierhope and St. James which may retain landscape features of interest.

Drogheda Railway Station including the canopy on Platform 1 is listed under the National Inventory of Architectural Heritage registration number 13902404 and is listed under Record of Protected Structures under DB-055 and was built in 1853. As such it is afforded all of the protections given to protected structures as listed under Part IV of the Planning and Development Act 2000.

4.2.4 Noise and Vibration

Noise and vibration will not have a material impact on the solutions proposed at the Drogheda Platform 1 canopy.

4.2.5 Air quality and climate

Air quality and climate will not have a material impact on the electrical solutions proposed at the Drogheda Platform 1 canopy.

4.2.6 Agricultural and Non-agricultural

Surrounding land use will not have a material impact on the electrical solutions proposed at the Drogheda Platform 1 canopy.

4.2.7 Water Resources

Water resources will not have a material impact on the solutions proposed at the Drogheda Platform 1 canopy.

4.2.8 Biodiversity

There are several potential ecological constraints, however these are similar across all options all electrical options and do not differentiate the preference between options. These include:

- The Overhead line equipment masts (OHLE) pose a potential hazard for birds, through electrocution from the powerlines by causing a short circuit either by touching two live wires or a live and an earthed component;
- Displacement of bats. If there are bat roosts within the existing structure, renovation works would reduce the potential satellite roosts within this well-connected habitat network for wildlife;
- All options involve some level of works on the existing tracks. Railway lines can often support interesting flora species and habitats due to the calcareous nature of the ballast and their often relatively undisturbed nature. If any such habitat is present the level of impact is likely to be similar across all options and might not be a significant differentiator between options.

4.2.9 Geology and Soils

Geotechnical/Geology and soil constraints will not have a material impact on the electrical solutions proposed at the Drogheda Platform 1 canopy.

4.3 Planning

It is envisaged that the planning permission in order to modify the canopy on platform 1 could potentially be challenging due to the protected nature of the structure. It is suspected that considerable effort will have to be put in order to keep the character and essence of the structure unchanged post modification.

5. SOLUTIONS

This section outlines the proposed electrical solution at Drogheda Station Platform 1.

5.1 Proposed electrical solution

As detailed in section 4.1.1, a variety of electrical arrangements exist to cater for different available clearances. These are given a hierarchy of preference as provided and detailed further in section 5.6.7 of the Electricity Functional Specifications System-Wide document (MAY-MDC-ELE-DART-SP-E-0002).

A nominal contact wire height of at least 4700mm is preferred at overbridge locations. Where this cannot be achieved, a minimum contact wire height (CWH) of 4400mm can be considered provided the associated risks are suitably addressed. Contact wire heights less than 4400mm will require a derogation. This is summarised as follows:

- Contact wire height ≥ 4700mm: Represents nominal contact wire height. No risk assessment or derogation required.
- Contact wire height < 4700mm but ≥ 4400mm: Electrical solutions with contact wire heights in this range require a risk assessment to be undertaken.
- Contact wire height < 4400mm but >4200mm: Electrical solutions with contact wire heights less than 4400mm require a risk assessment and a derogation.

The electrical solution given in the specification favours the contact wire height over the system height. Where possible, the contact wire height is increased, resulting in contenary systems being favoured since increasing the system height typically requires more clearance than that required to increase the system height to a more favourable hierarchy case.

As indicated previously in section 5.1.1.1 of this document, footbridge OBB81 will be modified in order to achieve a minimum contact wire height of 4.4m and as a result, a derogation is not needed for the electrification in Drogheda. The same minimum contact wire height is to be adopted along the platform area in the station.

A lower contact wire height could be adopted; however, this would lower the contact wire at OBB81 and it would require a derogation and impact the proposed modification of the footbridge.

A higher contact wire height cannot be adopted because it would require additional clearance for the footbridge.

A contact wire height of 4.4m has therefore been considered to check the clearance of the canopies and the following tolerances and allowances values, according to the parameters given in the DART+ Functional System Requirements specification (MAY-MDC-ELE-DART-SP-E-0002).

Table 5-1: Parameters adopted for checking the canopies clearance

Parameter	Value
Static Clearance (Csc) - 1500Vdc	150
Dynamic Clearance (Cdc) - 1500Vdc	100
Minimum Position of the Contact Wire (considering tamping)	4226
Actual Design Contact Wire Height (Cdcl) (After Tamping)	4400
Maximum Design Contact Wire Height [Pre-Tamping]	4450
OHLE System Depth (Csd)	500
OHLE Uplift (Cwu)	110
OHLE Construction/ Installation (Cct) + Maintenance Tolerance (Cmt)	50
Structure Construction Tolerance (St)	0
Track Maintenance Tamping Allowance (Tla)	50
Track Construction Tolerance (Tct)	0
Track Maintenance Tolerance (Tmt)	25
Considered OHLE span along the canopy area	30
Sag and Ice Load	74
Survey Tolerance	5
Loading Gauge	4064

According to these parameters, the pantograph gauge and the contact wire have been located in cross sections obtained from the topography survey of Drogheda Station, as shown in the following figures.

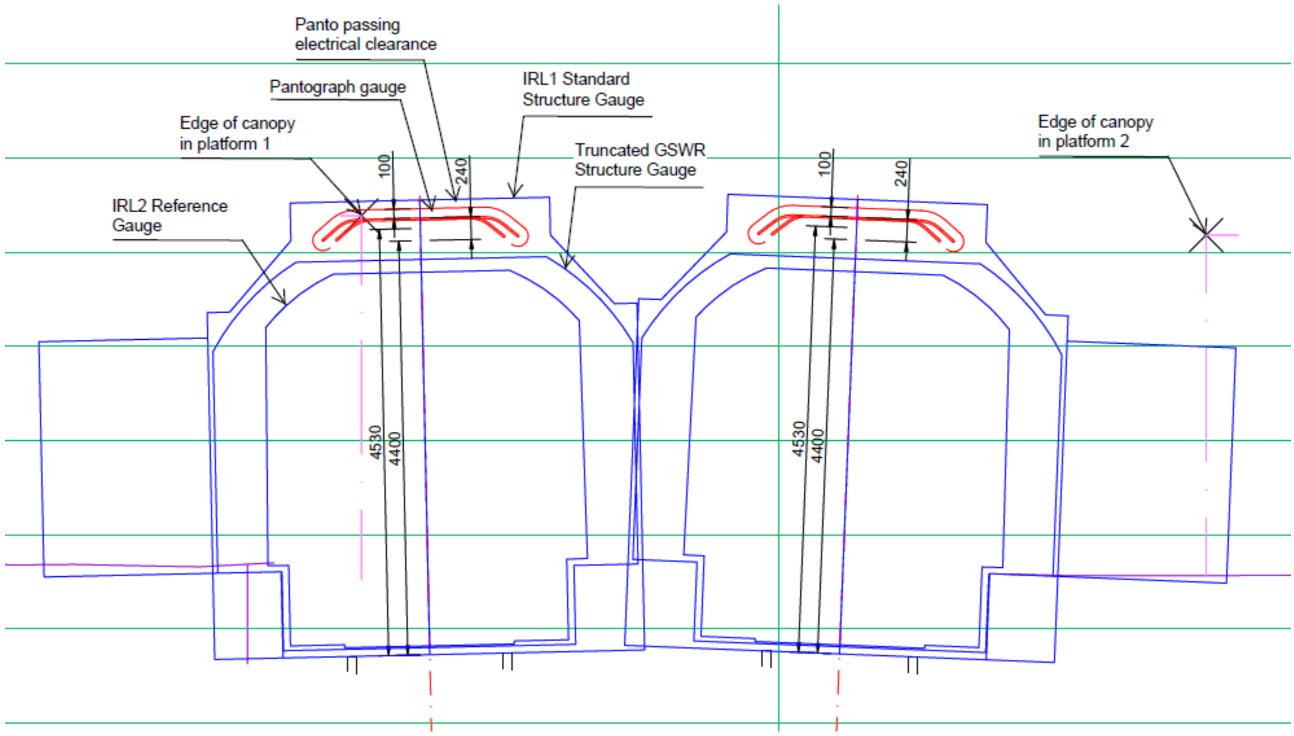


Figure 5-1: Cross section through the north end of the platform canopy

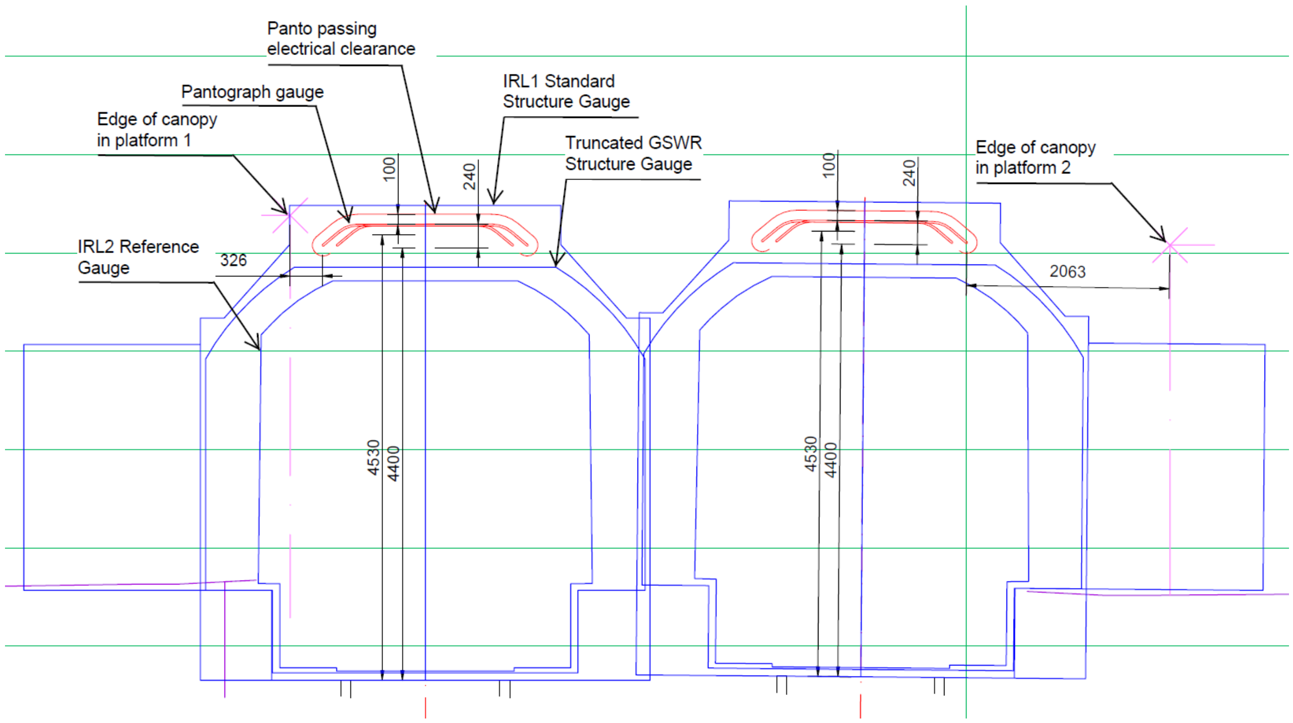


Figure 5-2: Cross section through the south end of the canopy

As shown in the figures, the canopy in Platform 1 will clash with the pantograph gauge with the contact wire height at 4.4m considering the tolerances and allowances values as per the DART+ Functional System Requirements specification (MAY-MDC-ELE-DART-SP-E-0002) if no modifications are carried out. A purely electrical solution cannot therefore be implemented.

5.1.1 Risk Assessment

As far as the contact wire height is less than 4.7m, a risk assessment must be carried out and presented to the IÉ Signalling, Electrification and Telecoms (SET) department. Site specific risks will be evaluated in subsequent design stages however, general risks associated with reduced contact wire heights have been captured in the figure below. The mitigation measures are also listed in the figure.

			EVALUATION				EVALUATION		
Hazard Cause	**Hazard -** The unsafe act or condition.	**Hazard Event** Description of the Hazard Event (the RISK) and the consequence.	**F**	**C**	**Result**	**Safety Measures - mitigation description**	**F**	**C**	**Result**
Contact wire height < 4700 mm	Contact wire located closed to rolling stock than minimum required	Touch potential, Electrocution	4	4	8	In the canopy area, proposed CWH is 4400 mm and maximum spans to be considered are lower than 30 m, so minimum CWH will be 4226 mm according to the allowances and sag considered in the FRS and therefore higher than absolute minimum (4190 mm) given in the CME- TMS-327 Vehicle Gauging and in the FRS.	1	4	5
Contact wire height < 4700 mm	Steep transition between nominal CWH and required CWH in the overbridge	Bad dynamic behaviour and quality of current collection. Increase of pantograph and contact wire wear.	5	2	7	Transition between different contact wire height will respect values given in the FRS. These values are according to values indicated in Table 11 of EN50119 for required design speed. As far as the 4.4 m contact wire height is also required for OBB81, the transition between nominal contact wire height and the 4.4m will required to be placed before the station, taking into account the other existing constraints in the area (OBB80, turnouts, etc).	3	2	5
Contact wire height < 4700 mm	Live parts of the OHLE or pantograph are closer to platform standing surface than minimum required	Electrocution	4	4	8	In this area of station the proposed adjacent spans are lower than 30 m, so considering CWH is 4400 mm, the minimum CWH will be 4276 mm. Pantograph depth is 210 mm and therefore minimum height for live parts is 4066 mm from ToR. Worst point along the platforms has 40 mm cant towards the platform and platform height of 1030 mm, so minimum height of live parts from platform standing surface is 3029 mm. Therefore it fulfils the distance required in the EN50122-1 for 1500 V d.c. Cant and platform height values have been obtained from Drogheda station survey	2	4	6

Figure 5-3: Hazard associated with reduced contact wire height

5.2 Track Lowering Solution

Lowering of the track in the vicinity of the existing platforms presents a significant undertaking with respect to the works required and maintaining the operational functionality of the station. Lowering the tracks to achieve a rail to wire height clearance of 4.7m will require track lowering along the extent of the existing operation platforms of approximately 300mm. Since this track lowering is undertake in a confined area, the existing platforms will require partial or full demolition to achieve this, with remodelling of the public platform areas also required.

The extent of the lowering will be required for a minimum of 300m to the south of the existing platform to ensure the maximum gradient of 1% is not exceeded.

Due to the interlinked nature the mainlines, the Navan Branch and the Depot, coupled with the close proximity of the existing switches and crossings arrangement in this area, all the existing switches will need to be removed and lowered.

In order to undertake these works a phased shut down or complete shutdown will be required at Drogheda Station.

With respect to minor lowering of the track, similar difficulties exist with respect to the lowering of the existing platform copings and run out to existing switch and crossing units currently installed.

5.3 Canopy Modification

In this section, an overview of the canopy structure, comments on the current condition of the canopy structure, and possible alternatives to achieve the required electrical clearance requirements are presented.

5.3.1 Overview

As shown in Figure 5-1 of this report, the Platform 1 Canopy at Drogheda Station will clash with the proposed overhead line equipment. It will therefore need to be modified as part of the DART+ Coastal project. As shown in Figure 5-4, the canopy truss (red) intersects with the exclusion zone (blue hatch) of the rail car and will thus need to be modified.

The station platform is curved and therefore the end profile of the canopy will have to follow, thus each modification will differ to miss the exclusion zone, or all the trusses need to be modified (shortened) for the worst case to keep them uniform.

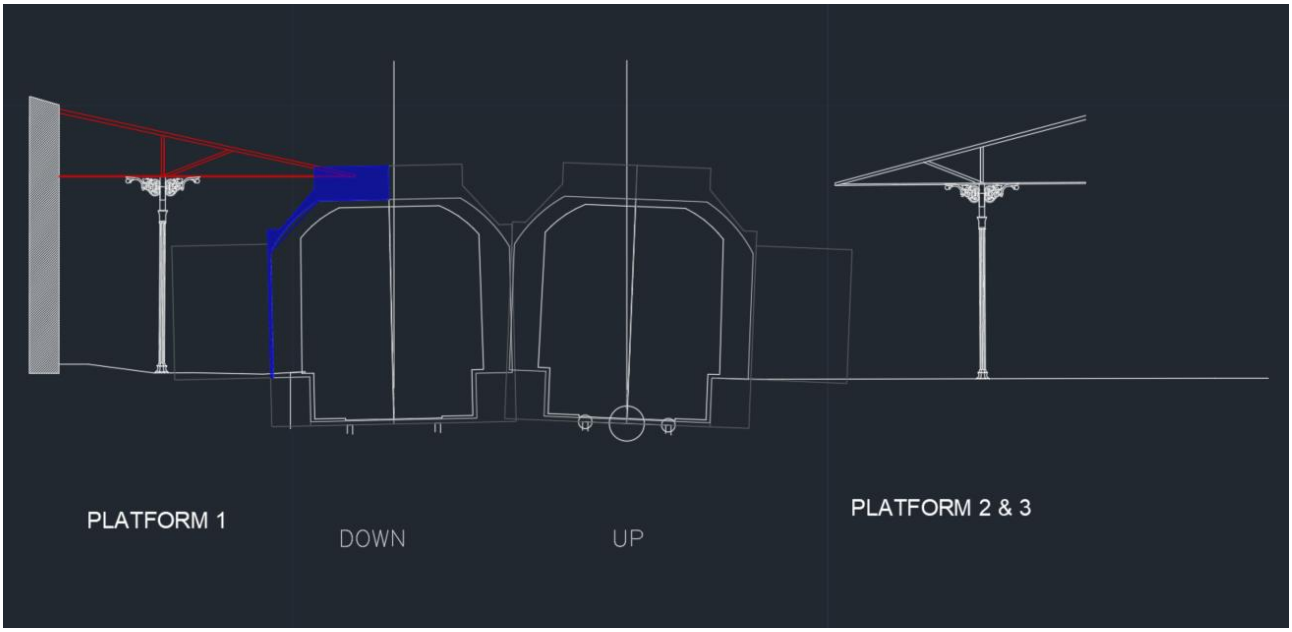


Figure 5-4: Platform 1 canopy and exclusion zone intersection

5.3.2 Site Inspection

Arup conducted a site visit to Drogheda Station on 15 July 2022 to inspect the Platform 1 canopy. The canopy comprises of a clear sheeting, possibly Perspex or glass, supported on timber purlins. The purlins span between trusses that span from the station wall and onto a column approximately 2.15m away from the wall. The truss has an overhang of approximately 3.75m. The trusses have been labelled as T1 -T10 starting from the north in the figure that follows. Spacing between the typical trusses is approximately 5m. The spacing is halved by the intermediate trusses T3 and T5. Lattice trusses span between columns and are perpendicular to the trusses. The lattice trusses have been named L12 (lattice truss between trusses T1 and T2) to L910 (lattice truss between trusses T9 and T10). Figure 5-5 below shows the naming of the trusses on a plan view of Drogheda Station.

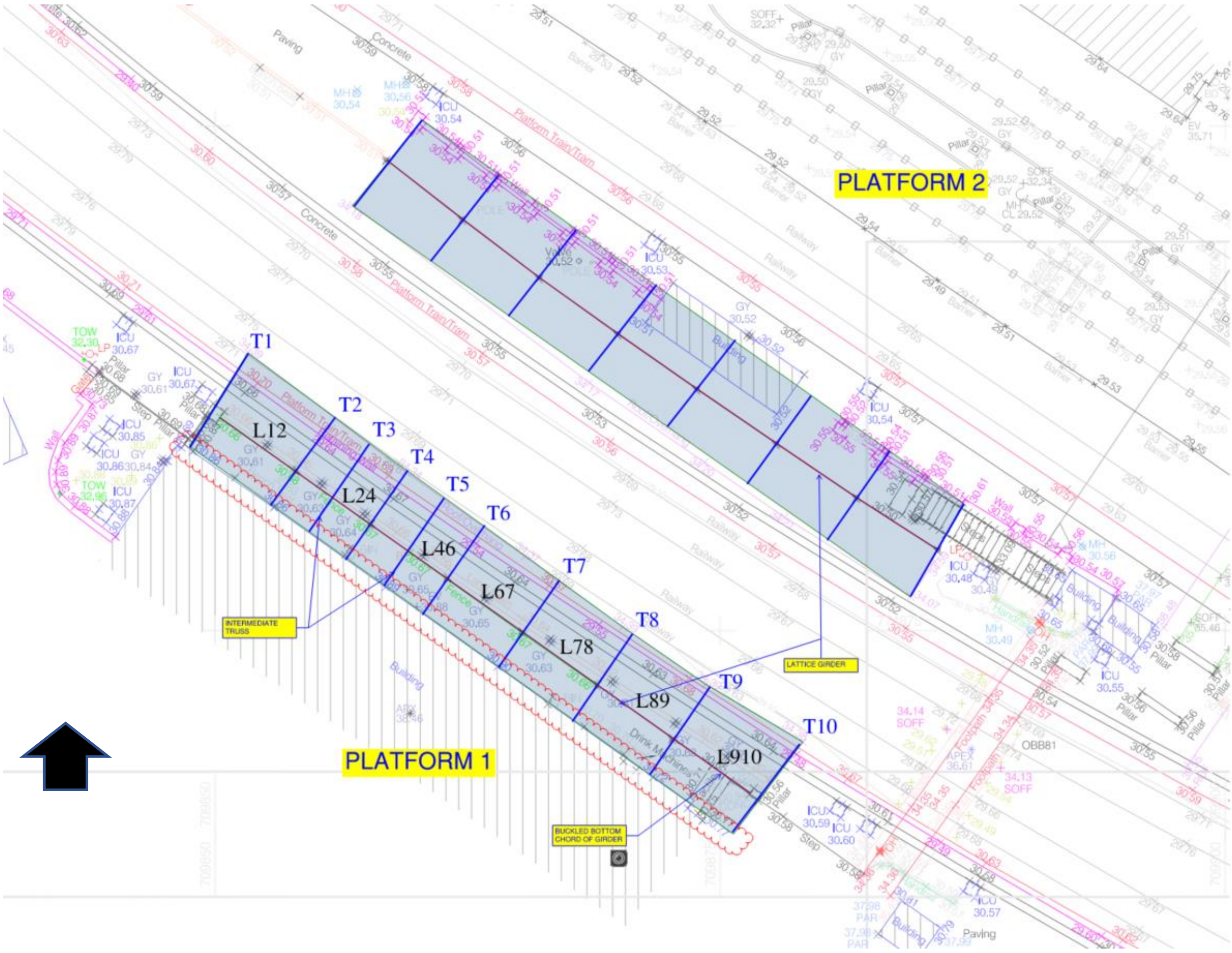


Figure 5-5: Platform 1 Truss name allocation

Lattice trusses span between columns that also support trusses T1, T2, T4, T6 – T10. Trusses typically span between the wall and the columns, however, trusses T3 and T5 are intermediate trusses and are supported by the lattice trusses L24 and L46 respectively rather than a column. The main observations from the site visit are summarised in Table 5-2 below. A full list of site observations can be found in Appendix A.

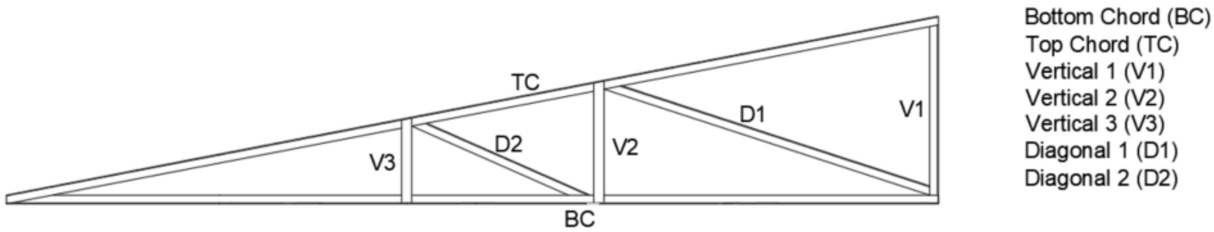


Figure 5-6: Truss annotation (NTS)

A basic description of the trusses can be seen below:

Typical Truss: All trusses are made from steel (and/or possibly wrought or cast iron) members connected together with rivets – see Figure 5-7 below. The top and bottom chord (TC and BC respectively) are T-sections continuous from the wall to the tip where the chords meet. Where the two chords meet, rivets connect the webs of the two chords: this connection induces a slight eccentricity or skewing of the top/bottom chord. Where the truss connects to the wall the web of the t-section has been cut and the flange has been bent up and fixed to the wall with a single anchor or bolts. The bottom chord seems to be bearing on a corbel; no anchors or bolts have been observed. There are 3 vertical members in the truss (refer to Figure 5-6). The first vertical (V1) is a T-section against the wall. V1 is connected to the TC and BC by a gusset plate either side of the web and two rivets in each web. Vertical 2 (V2) is directly above the column and consists of two flat bars, each connected to either side of the web of the TC and BC. One of the flat bars have been bent away from the truss in order to rivet it to the lattice truss. There is also a single rivet connecting the two flat bars midspan. Vertical 3 (V3) is similar to V2 - just shorter. There are 2 diagonals (D1 and D2) within the truss, both of which have T-sections. D1 is connected to the gusset plate at V1 and BC with a rivet, and the opposite end the web of D1 is connected to the web of TC. Diagonal 2 (D2) is between V2 and V3 and the web of D2 is connected to the webs of Tc and BC respectively with 1 rivet each side.

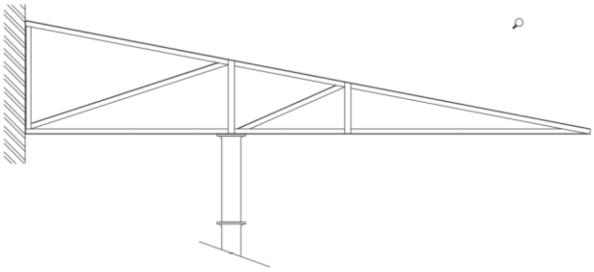


Figure 5-7: Typical Truss (nts)

Intermediate Truss: The intermediate trusses (T3 and T5) are similar to the typical truss described above, but with some slight differences. The TC flange of the intermediate truss appears to be wider than that of the typical truss. The intermediate trusses are not supported by a column - rather the lattice truss spanning between the columns. The gusset plates between V1 and BC also differ from the typical truss. The angle of D1 is thus slightly different from the typical truss. Where the chords meet at the end the number of rivets at the connection differ from the typical truss.

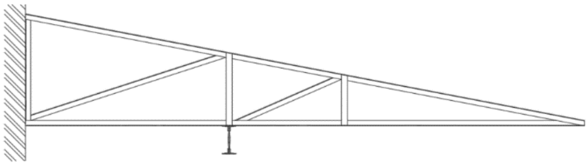


Figure 5-8: Intermediate Truss (nts)

Lattice Truss: The lattice trusses span between the columns. The top and bottom chord consist of horizontal flat bars connected to two back-to-back unequal angles. The cross bracing between the top and bottom chords consists of flat bars. They are slotted in between the back-to-back angles and connected with 1 rivet at each end. There is also a rivet connecting the 2 cross bracing members where they intersect. The lattice trusses typically only have their self-weight as vertical load, apart from lattice trusses L24 and L46 that support the intermediate trusses.

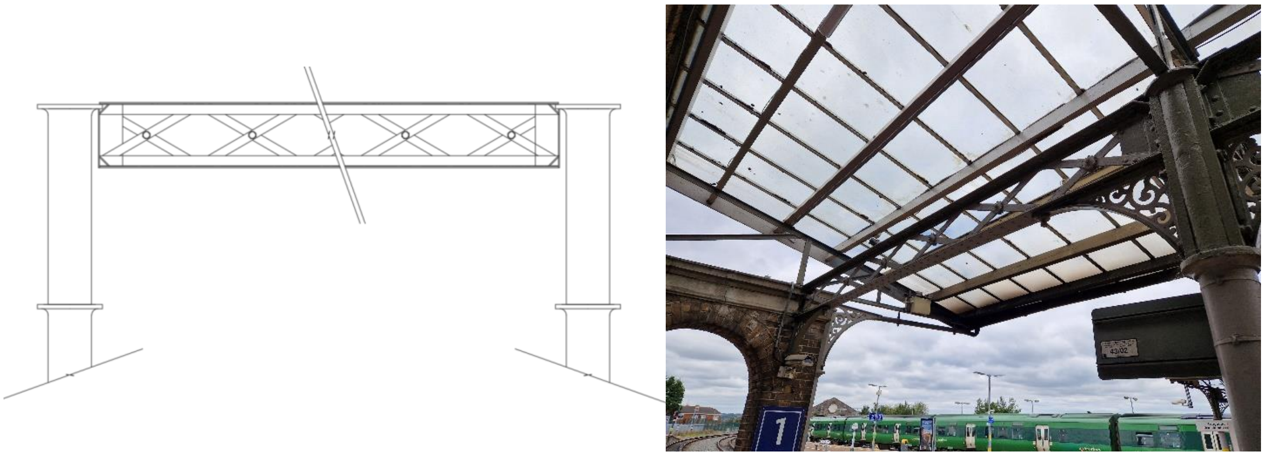


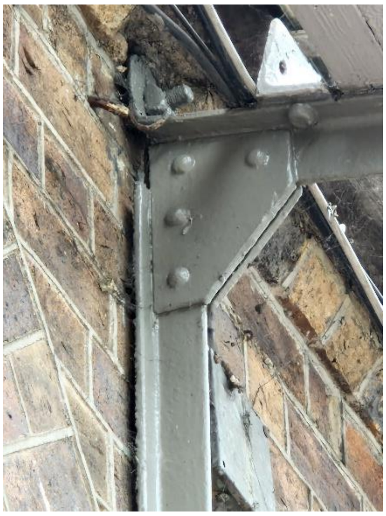
Figure 5-9: Lattice Truss (nts)

The lattice truss provides lateral stability to the top of the columns by mobilizing a frame action. However, the typical and intermediate trusses are not restrained laterally or stabilised by the lattice truss. For the typical and intermediate trusses, the single bolt/anchor in the wall provides some lateral stability to the top chord of the trusses. However, it seems that the majority of the lateral stability of the trusses is provided by the roofing acting as a membrane. The current lateral stability system of the canopy does not appear to be able to provide the strength and stiffness necessary for such systems, which is typical of structures from that era.

Material tests of structural elements will be carried out at the detailed design stage to verify composition.

Paint testing could potentially be required depending on the canopy modification approach ultimately used. If the canopy is completely dismantled, then all members should be stripped, repaired, and then repainted with a new paint system. However, if a "kept-in-place" canopy modification is undertaken, then paint system testing is necessary so that a new compatible system can be used.

Table 5-2 Main Site Observations

Image	Observation	Trusses affected
	Truss is pulling away from the wall. Connection appears to be bending open. Anchor bolt head appears to be rusted.	All typical trusses
	Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.	All typical trusses
	Flange of the top chord has been corroded away.	T6

	Lattice girder shows corrosion where it joins to the column.	L12, L910
	Stone corbel at the top of the column is badly cracked.	L910

5.3.3 Raising the Canopy

Looking at the general arrangement of the canopy as it interfaces with the proposed development, the canopy needs to be raised by significant distance to be clear of the exclusion zone - see Figure 5-10: Platform 1 Cross Section Canopy. The top chord of the canopy truss is supported by the station wall at the top end of the wall - see Figure 5-11: Platform 1 Canopy Side View and Figure 5-12: Platform 1 Canopy view from Underneath. In addition, the bottom chord of the trusses is supported on a pedestal off the same wall. Whilst it is possible to move the canopy up, the amount of such movement is quite large and would require significant changes to the canopy supports. The top chord support will require the station wall, or parts of it, to extend up to provide the required support to the canopy trusses at their raised position. The pedestal support of the bottom chord needs to be extended up in a similar way. Furthermore, the columns need to move up by the same amount - possibly by adding new stone, cast iron, or reinforced concrete pedestals.

In conclusion, the canopy could be raised, but this will require significant changes to its supporting walls and columns and as such it has been ruled out as a possible option.

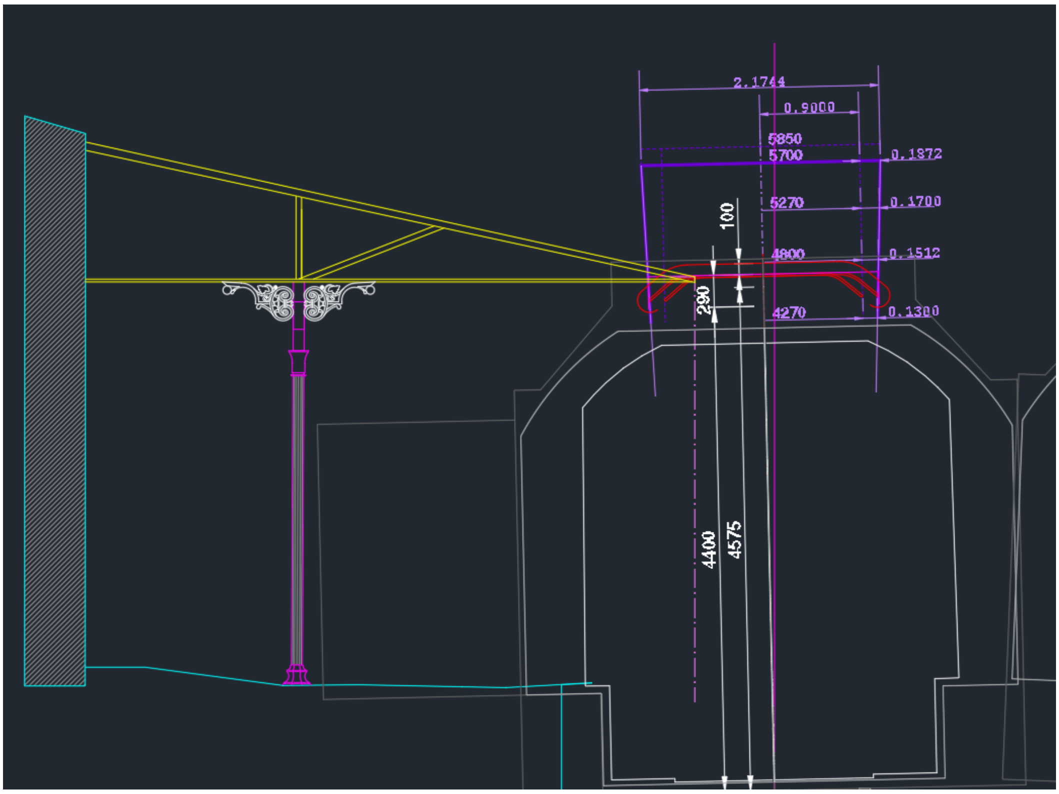


Figure 5-10: Platform 1 Cross Section Canopy compared to Pantograph reference profile

Figure 5-11: Platform 1 Canopy Side View

Figure 5-12: Platform 1 Canopy view from Underneath

5.3.4 Proposed Modification

The proposed modification is shown in Figure 5-13 below. Figure 5-13 is only indicative and the modification will need to be designed accordingly. It is proposed that the section of the overhang that intersects with the rail car exclusion zone be cut back, and an endplate is bolted to join the top and bottom chords.

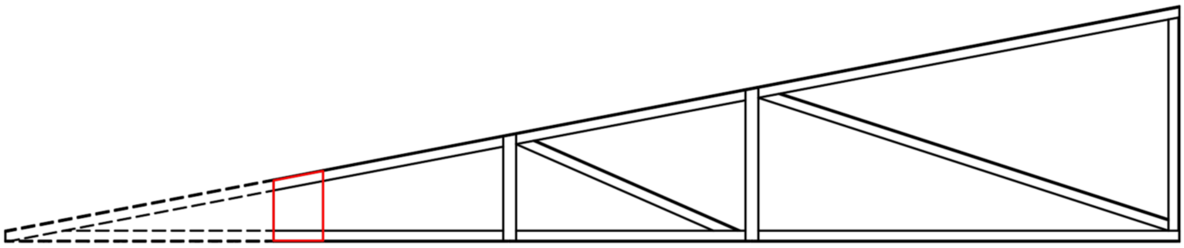


Figure 5-13: Truss modification (Indicative)

The best approach (approach-1) to apply the proposed modifications is to completely dismantle the canopy, then apply the modifications and other remediations such as straightening of members, corrosion repairs, corrosion protection, etc., before assembling again. However, such approach is expected to cause significant disruption to the functioning of the platform. Another option is to apply the proposed modifications while the canopy is kept in-place (approach-2). This approach can be designed to limit the modifications to a small part of the canopy at any one time, hence reduce the potential disruption. This option will require the preparation of a detailed modification and remediation sequence, preparation of detailed health and safety procedure, risk assessment, etc. Any of the two options described above seem to be possible with the final decision to be based on a full comparison considering safety, functionality, constructability, and financial aspects.

The following details are based on the assumption that approach-2 is used. For the modification to take place and the truss to be cut back, the relevant purlins and roof covering will need to be removed as well. The trusses will need to be propped while the modification takes place. While the remedial work takes place it is proposed that additional remedial works be done to the trusses. To solve the concern of lateral stability, it is recommended that a V-brace be installed at 2 trusses. The V-brace will be connected to the truss at the 2nd vertical (V2) near the top chord and again at the lattice truss. Along with the V-brace a stiff angle will need to be installed at purlin level to connect all the trusses to the ones that have been laterally restrained with the V-brace, see Figure 5-14 below. Any other damage, misalignment, and corrosion needs to be repaired. The trusses will also need to be painted to replace the rust protection that is currently peeling from the steel.

All modification and repair work to the canopy must be carried out in a manner sensitive to its heritage and protected structure status.

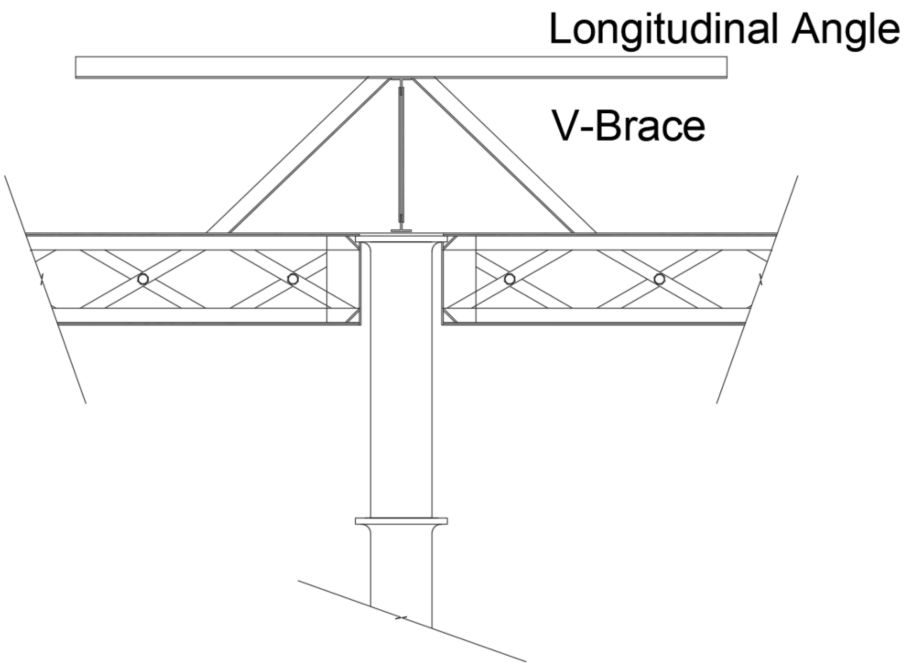


Figure 5-14: Proposed V-brace(nts)

It is noted that the required canopy modifications will affect the glazing, guttering, and purlins which will require alteration to match the revised general arrangement. It should also be assessed during the modification process of the canopy structure whether the canopy structure originally included daggerboard fascia and if that is the case it should also then be assessed whether it could be reinstated as part of the modification works.

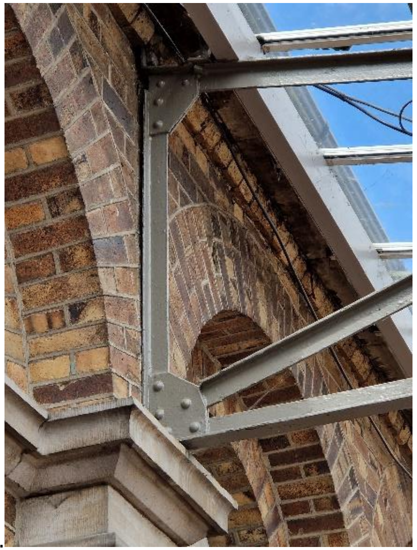
6. CONCLUSIONS

The required electrical clearances cannot be met with the Platform 1 canopy in its current form. A track lowering or raising of the canopy is not desirable or economically viable. The preferred viable solution is to modify the existing canopy in a way that is sensitive to its heritage structure status and allows for passive provision for 25kV. The modifications can be carried out by completely dismantling the canopy, then applying the modifications and other remediations such as straightening of members, corrosion repairs, corrosion protection, etc., before assembling again, or to modify the canopy whilst it is kept in-place. This must be done in a way that is sensitive to its heritage structure status to allow the required clearances around the canopy for the electrification of the line to be achieved.

APPENDIX A

Site visit observations

Truss	Photo	Observation
T1		Truss is pulling away from the wall. Connection appears to be bending open.
		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.

Truss	Photo	Observation
T2		Truss is pulling away from the wall.
		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.

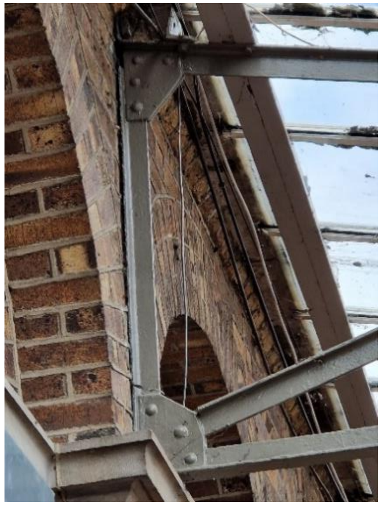
Truss	Photo	Observation
T3		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.
		Due to the webs being connected there is a slight eccentricity between the centre lines of the top and bottom chord.

Truss	Photo	Observation
T4	 	Truss is pulling away from the wall. Connection appears to be bending open.
		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.

Truss	Photo	Observation
T5		Truss is pulling away from the wall.
		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.

Truss	Photo	Observation
		Last purlin at the end is not fixed to the bracket provided.
		Due to the webs being connected there is a slight eccentricity between the centre lines of the top and bottom chord.

Truss	Photo	Observation
T6		Truss is pulling away from the wall. Connection appears to be bending open.
		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.

Truss	Photo	Observation
		Flange of the top chord has corroded away.
T7		Truss is pulling away from the wall.

Truss	Photo	Observation
		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.
T8		Truss is pulling away from the wall. Connection appears to be bending open.

Truss	Photo	Observation
		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.
T9		Truss is pulling away from the wall. Connection appears to be bending open

Truss	Photo	Observation
		Paint is peeling from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.

Truss	Photo	Observation
T10		Truss is pulling away from the wall. Connection appears to be bending open. Anchor bolt head appears to be rusted.

Truss	Photo	Observation
		Paint is starting to peel from the steel. Assuming this is rust protection the steel will be susceptible to rust in future.
		Corbel at the top of the column is badly cracked.

Truss	Photo	Observation
L12		Lattice girder shows weathering where it joins to the column.