Gipsy Patch Lane

PWI Briefing

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Permanent Way Institution
The Institution for Rail Infrastructure Engineers

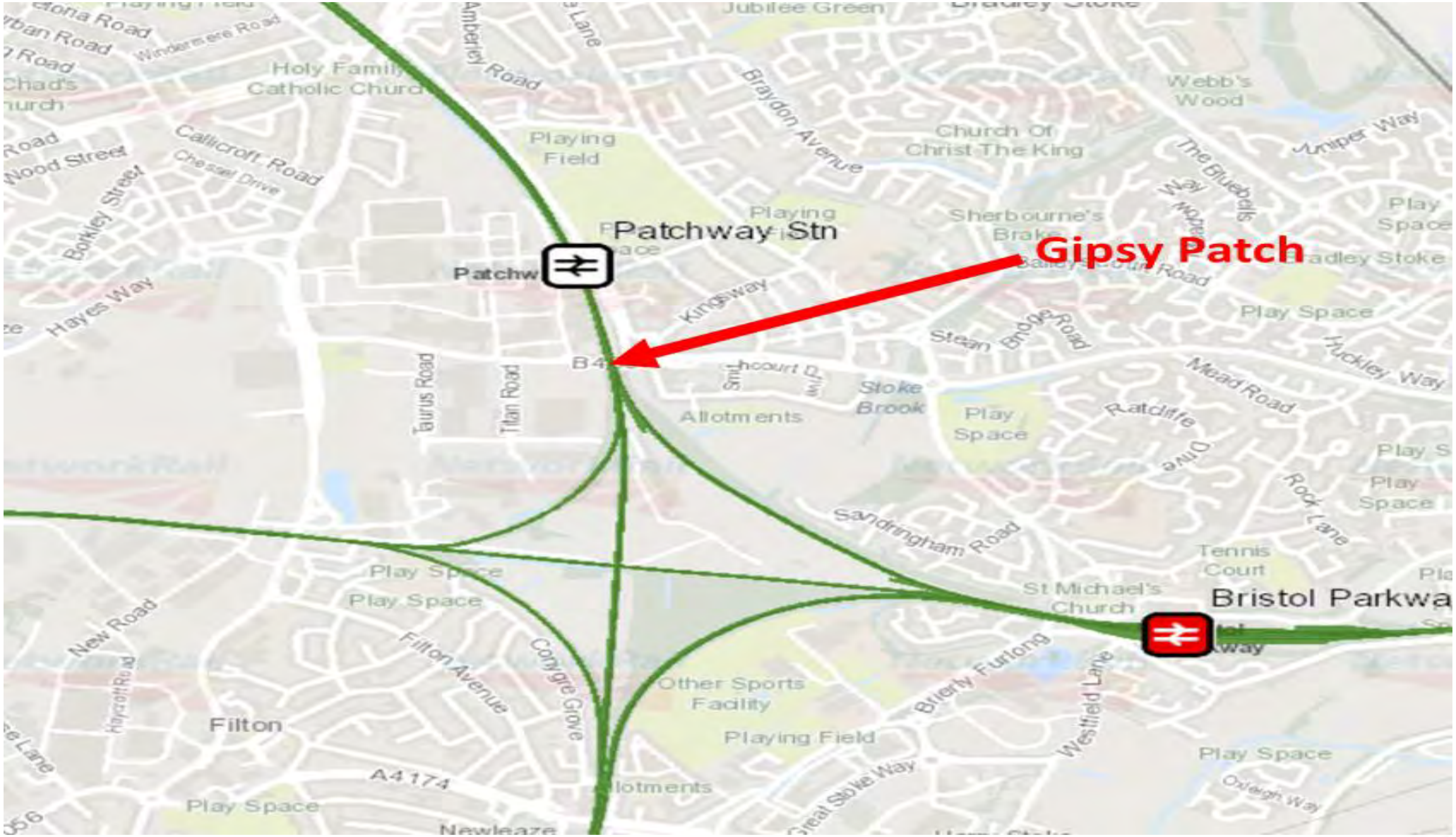
2nd December 2021

Wales and Western


Gypsy Patch
Bridge

Agenda

- Introduction
- Feedback on the lessons learnt from the job
- Permanent Way discussion


Patchway Stn
Gipsy Patch
Bristol Parkway
Filton
Holy Family Catholic Church
Church Of Christ The King
Webb's Wood
Stoke Brook
Allotments
Other Sports Facility
Playing Field
Sandringham Road
Kingsway
Braydon Avenue
Callicroft Road
Hayes Way
Taurus Road
Titan Road
Filton Avenue
Conygre Grove
New Road
A4174
Great Stoke Way
Brierly Furlong
Westfield Lane
St Michael's Church
Tennis Court
Mead Road
Huckley Way
Ratcliffe Drive
Rock Lane
Juniper Way
Jubilee Green
Newleaze

Project Summary

Project Summary

Old vs New Structure Comparison

SPMT Move / Attempt: 1
Option Name: Initial Move
Date 30/10/20

Failed position

Sunken wheels after failed initial move

SPMT Move / Attempt: 2
Option Name: A/B
Date: 31/10/20

Plan A – Using just SPMT
Plan B – Using push / pull aid

Opted to go straight to plan 'B' due to the risk of attempting A and digging all the wheels again
Attempt failed to move

Re-packed 6N and plywood sheets

Pulling using tow trucks and ballast wagons

Pushing using dozers

N.B. landing area excavated and ekki mats installed ahead of attempted move

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Temp Works Installation & Lower Bridge

Option Name: Option 1

Date: 11/11/20

Temporary works put in place to lower the bridge. Combination of ekki mats, plywood sheets (packing), steel beams and steel plates.

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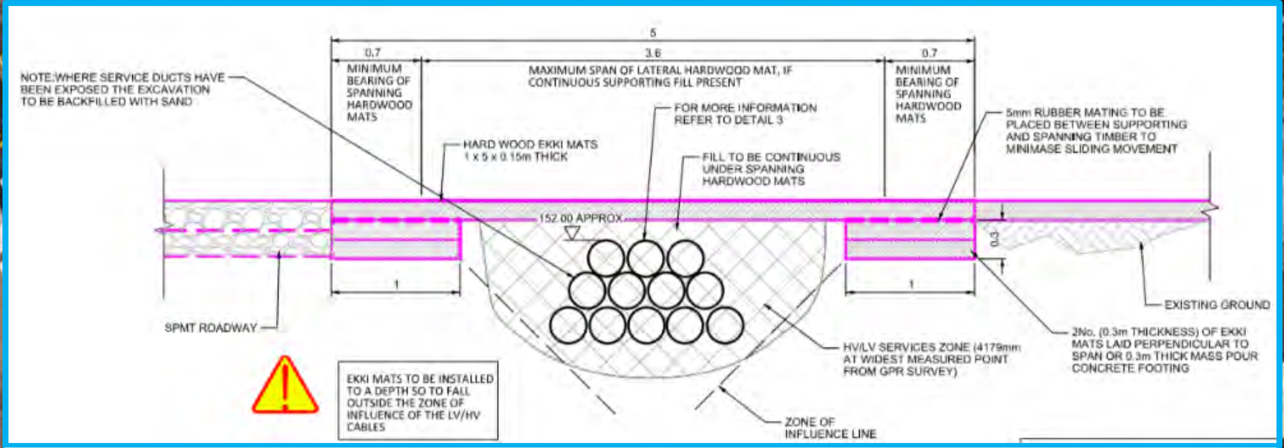
Key Constraints, once moved West:

No clash with pile cap (NE)

Abutment now positioned significantly further over the buried 11kV cables, meaning a new temporary works design was required to lower the bridge (Option 1).



AFC Detail for HV Cable Protection – Ekki Mats and Sand

Buried 11kV Cables – trial pit during blockade

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SPMT Move / Attempt: 9
Option Name: Bridge Install
Date: 14/11/20

SPMT driven into place and lowered onto / attached to the substructure in the four corners (under the wingwalls).

SMPT adjustment required to get the MacAlloy bars to fit into all the screw threads in the pile cap.

MacAlloy Bar Installation (55/56 achieved)

Investigation Remit

We established a team made up of experienced engineers and project managers from across the network and remitted them to review the project under the following headings:

1. **The development and design of the structure**
2. **The management of construction on site**
3. **Roles and responsibilities of Network Rail's engineering, project and construction management teams**
4. **The management during crisis response and recovery**

Key Findings

Summary

- The method of construction adopted and the design selected was correct for use at Gipsy Patch.
- The NR project team principal contractor and specialist subcontractor were experienced in works of this nature. However, this was the heaviest SPMT bridge move in the UK and significantly greater than the typical work.
- The root cause was a failure to construct the temporary works in accordance with specification and design. This included a lack of surface water management, poor quality geogrid installation and not providing a hard surface (asphalt or aluminium trackway). This was exacerbated by the SPMT axle loads being greater than the roadway design specification.
- These issues resulted from inadequate integration and management of risks between the designers (temporary / permanent works) and the principal contractor.
- Network Rail were ‘principal designer’ under CDM regulations but did not properly understand or discharge this duty.
- The risk and contingency reviews held did not reflect the scale and complexity of the work and there was a limited go/no-go process adopted during construction.

Engineering Lessons Learnt Summary

- **The right single option** - The conceptual decision to build a single reinforced concrete structure offline and drive it into place was the right engineering solution to meet the funder’s requirements, particularly noting the desire to minimise railway service disruption. A range of other options were considered by suitably qualified and experienced people and justifiably discounted considering time and cost.
- **Good option development** - Alternative construction methodologies were considered and rejected. These included box jacking, a multi-span structure, piling under the tracks, use of a sacrificial tunnel to create foundations, prestressed beams with reinforced concrete deck and a half trough steel underbridge.
- **What could have been** - A lighter weight, single portal structure using steel girders with composite deck was also considered. Whilst the method of construction would have been the same the reduced weight would have reduced the risk during transportation. This option was rejected by the third-party funder due to planning approval.
- **The use of SPMTS** - This was the heaviest bridge lift attempted in the UK using SPMTs, however it is a tried and tested methodology used all over the world in a range of industries, including lifts heavier than this structure.
- **SPMT Industry Guidance** - The shape of the bridge, combined with its weight, didn’t allow for a lifting solution which would have fallen within industry guidelines in terms of the SPMT’s loading – the designed permanent solution therefore did not fully consider the ‘buildability’.
- **Engineering Integration and Buildability** - the permanent structure and temporary works to facilitate the construction were not integrated enough in communicating design information and risks - this led to an insufficient design for the roadway on which the bridge was driven.

Engineering Design

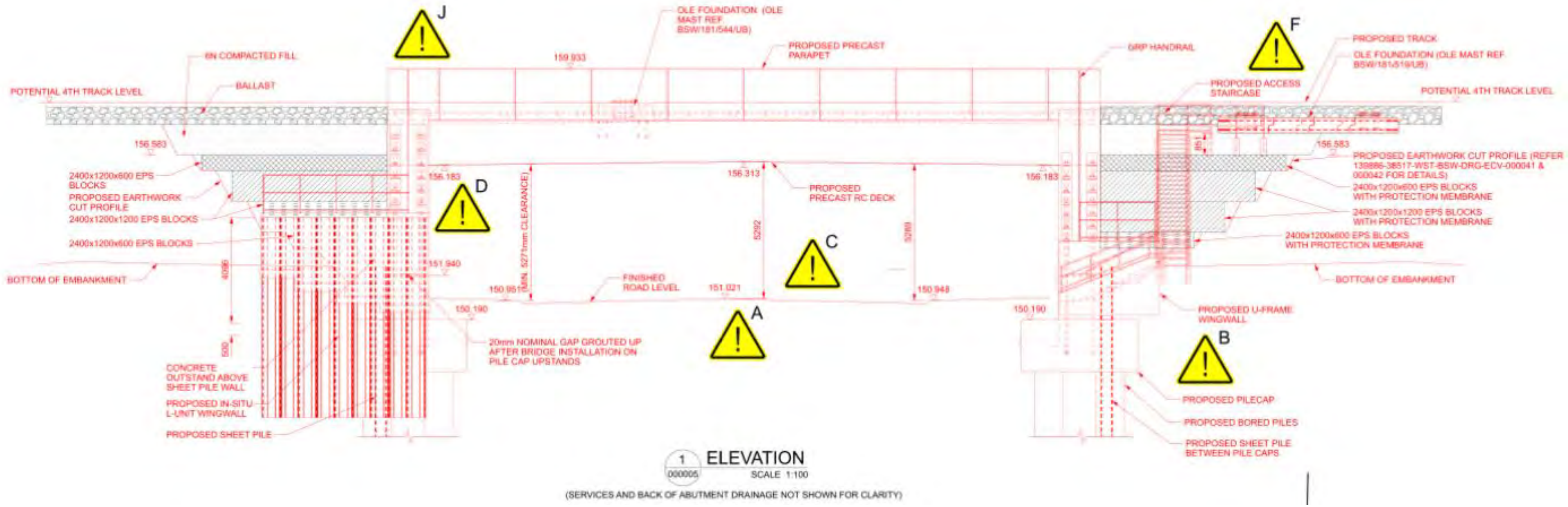
Permanent Works Structure

- Reinforced concrete bridge – deck and abutments / wingwalls with 14No MacAlloy bars in each wingwall section, 56No total, joining the superstructure to the foundations creating an integral bridge
- "L shaped" pre-cast concrete parapet units.
- New overhead line foundations to reinstate the masts – some pre-cast ground bearing units and others cast into the superstructure deck.
- Superstructure foundations – 5No 1.1m diameter 25m long piles in each corner, with pile caps.
- Backfill behind abutments using EPS blocks wrapped in a protection membrane
- Sheet piling beneath abutments to facilitate road lowering.

Main Temporary Works to facilitate the Blockade

- SPMT working platform/roadway for transiting the bridge from the build area to permanent location.
- Steelwork on top of SPMTs to facilitate lift and lateral props for reverse bending during transport. Total Weight 4217 T.
- Temporary catenary structure at high and low level to:
  - Slew OLE and allow removal of existing supports within excavation zone
  - Suspend lineside cables, to provide clearance for the bridge to go under

Engineering Design – Elevation on Span



The use of SPMTs

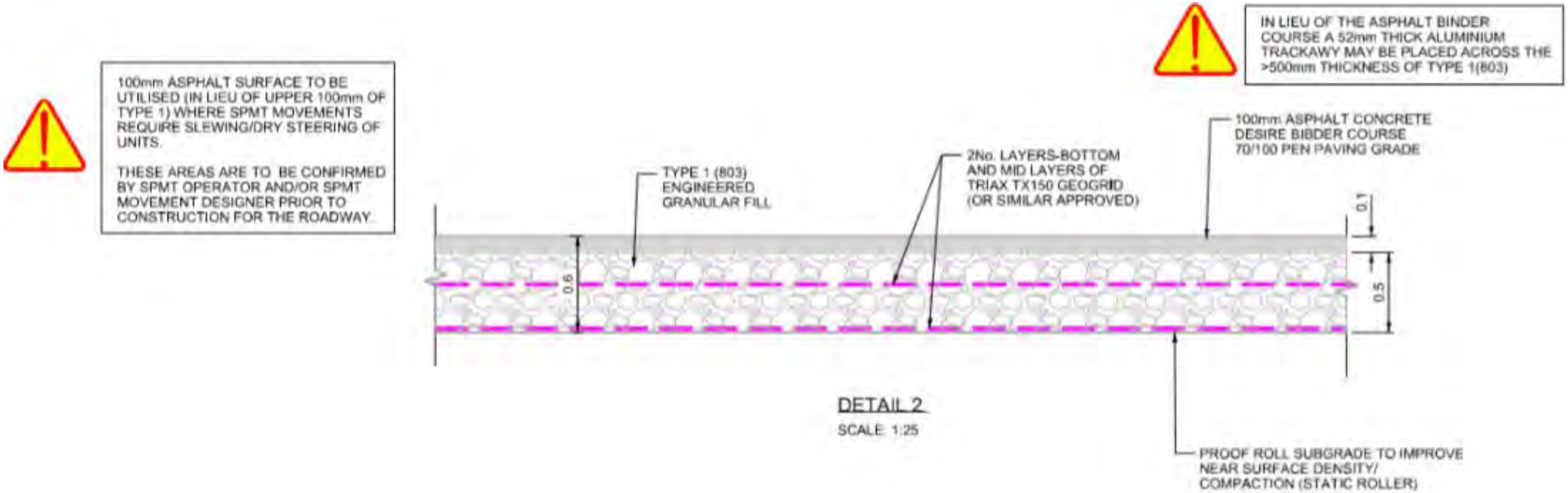
2050T

1850T

3800T

3500T

Engineering Working Platforms



DETAIL 2
SCALE 1:25

No asphalt or trackway was installed for any of the SPMT roadway for construction pre blockade(s) or during the original construction (pre initial move).

Also insufficient surface water management in place

Engineering Working Platforms

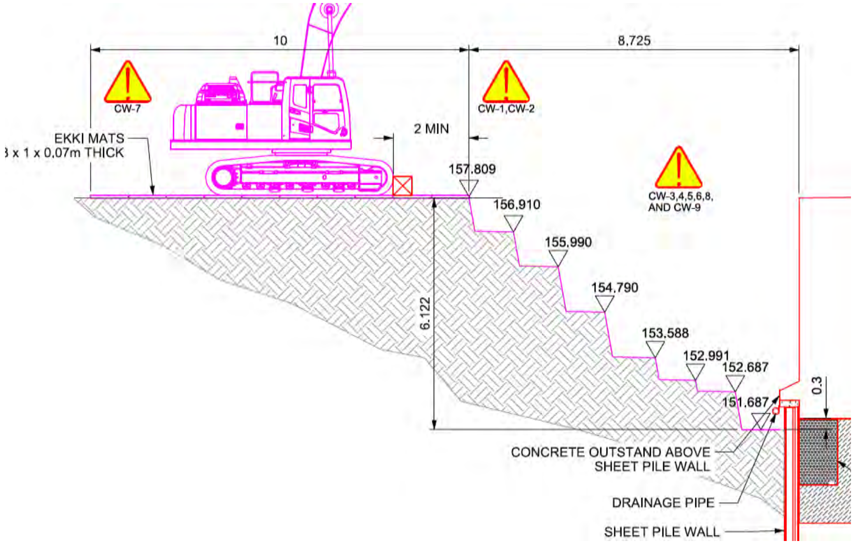
Surface water management and ground water monitoring of working platforms is essential to their performance

1. All unbound surfaces are subject to water ingress and softening, no matter how well compacted.
2. If standing water is allowed on an unbound working platform/haul road/roadway, the material will become saturated and will no longer have the properties required by the design. As such, effective protection, continuous maintenance and proper drainage of any unbound surface is essential to its performance.
3. Crossfalls are to be used on all roadways
4. Surface water runoff is to be captured and disposed of appropriately.
5. After heavy rain, continued use or when rutting/potholing occurs, the surface of the platform should be scraped, proof rolled and topped up with clean stone in accordance with the design.
6. Should pooling/ponding or saturation occur, the designer is to be informed. Areas in question may need to be locally excavated and replaced with clean compacted fill, with appropriate testing.
7. Wheel turns and slewing will break up any unbound surface leading to saturation and the loss of capacity in that surface. Where wheel turns are expected, either a bound surface or surface protection (road-plates/track-mats) should be considered.

Engineering Buildability

EPS blocks should be ideally wrapped prior to any blockade where possible and spare wrapping/jointing capability available if the seal is broken during installation. Noting this has to be typically in dry conditions.

1. Steps were cut in the embankment face to match the EPS block layout.
2. The blocks were not individually wrapped because of programme time constraints for the originally planned blockade.
3. Where we had some fit problems with a step we trimmed the EPS and/or used semi dry concrete.



People, Skills and Experience

Summary

- The Principal Contractor selected to design and build this bridge is a framework contractor for the region with extensive heavy railway civils experience, and recent experience of installing a bridge using SPMTs.
- Network Rail's project team had extensive experience working on railway and civils jobs. However, this job was not identified or treated as extraordinary by the region, and as such the resource wasn't dedicated to the project and wasn't reviewed in terms of project-specific experience.
- There was a change in specialist sub-contractor who operated the SPMT after the contract was awarded – this was agreed by Network Rail. The new company did not have as much experience and had not worked with a structure this heavy before.
- Under 'The Construction (Design and Management) Regulations 2015' (CDM), Network Rail took the role of the 'Principal Designer'. This gives specific duties to liaise and manage risks between all designers and the principal contractor. This was neither fully understood nor implemented by either the project team or the supply chain.

Risk Management

- This job was ranked as 'RED' under Network Rail's DWWP (Delivering Work Within Possessions) standard, meaning it was deemed to have a high risk of overrun and / or a more significant impact in the event of an overrun. However, given the scale of the project and the number of disciplines involved, it was not given the support required by those within the business who could potentially assist – for example specialist input into the reviews of the plan.
- The DWWP and GRIP (Governance for Railway Investment Projects) processes for identifying risks at each stage of the project were followed and the appropriate meetings held.
- There was a failing in identifying the roadway as a potential single point of failure, and as such it was not sufficiently scrutinised or mitigated.
- The contingency plans and risk management documentation was not signed off at director level.
- The roadway failing was a risk that was identified by the Temporary Works designer and they stipulated mitigations including surfacing material and management of water – these were not adhered to by the Principal Contractor.

People, Skills and Experience

Delivery Methodology

- The conceptual plan for the blockade was robust. Installing a bridge in this way is not novel within the rail industry (although the scale of this bridge differentiated it from ordinary bridge renewals).
- **The Principal Contractor made a commercial decision not to build the roadway fully to the temporary works design**. This removed building an asphalt or aluminium trackway where dry steering was to be done. **This was not formally accepted by the designer and nor were Network Rail consulted in this decision being made**.
- SPMTs can travel on a well compacted granular surface. However, had the roadway been surfaced with an asphalt or aluminium track this would have mitigated the failure.
- There was a go/no-go point for the demolition of the old structure, which was outlined in the Project Contingency Plan. This was key, as once demolished, the new structure had to be installed. At the point this decision was made the project was running ahead of the contractor's programme and so this decision was straightforward.
- There was not a formal go/no-go point for the bridge move itself. Assurance of the roadway in the form of testing was done by the contractor, but it was assumed that Network Rail did not need to be involved or informed of the results.
- The change in dates as a result of COVID-19 was not found to have had a significant effect on the works, although some key personnel from both Network Rail and the Principal Contractor were lost from the project during the delay.

Actual Delivery

- The key failure point was the wheels of the SPMT sinking into the roadway and the bridge becoming stuck midway through its transit. The location in which it became stuck added further complication due to the constraints of surrounding infrastructure and services.
- The SPMT roadway was not constructed to specification to mitigate surface water risk. This is the root cause of the failure and consequential overrun. This can be attributed to the fact that holistic risk reviews weren't regularly / robustly undertaken. Furthermore, there was no single driving mind for the risks in design and construction. This all comes down to the discharging of CDM duties from the Principal Designer.
- Other activities undertaken during the railway closure were not completed in the planned durations. One example of this was the backfilling of the embankment using polystyrene blocks. The contractor's timings were not interrogated sufficiently by Network Rail's project team.
- The railway infrastructure works (track, overhead lines, cables etc) which were delivered by sub-contractors were completed successfully and within the planned and re-planned durations.
- Roles and responsibilities were adhered to, with the Principal Contractor being responsible for the decisions being made.
- The over-run was communicated to the route shortly after the SPMT failure. Providing seven days notice allowed passenger and freight services to be re-planned with advance notice and proactive communication.

The role of Network Rail on Site

Summary

- Network Rail were acting on behalf of a 3rd party client who funded the works. This role involved client project management of construction activity and project assurance.
- Network Rail took the role of Principal Designer under CDM legislation However, there was little understanding of the role holder or the individual within Network Rail tasked with discharging these duties, amongst the project team.
- The project team (including engineering and construction staff) were well represented on site prior to and during the blockade, including at the time of the SPMT failure. The NR Team didn't challenge the roadway suitability in advance of the move even though lessons learnt from previous projects were that SPMT's had got stuck before.
- The Principal Designer wasn't necessarily active in any design or construction issues during the Autumn possession.
- Peer Reviews were not appropriate to the task (complexity / scale) and were run at too high a level.
- Endorsement of the project contingency documents was not done at the appropriate level.

- There were errors made in the setting out which the affected the critical path – Network Rail Project Engineers / Construction Managers were not required to check this and weren't consulted by the PC.
- The complexity of the OLE and Track works were considered, but not fully, which resulted in a disjointed approach to some complex OLE and track work – there were 2 sub-contractors who then employed further sub-contractors for Signalling and Points Heating works. This should have been more of a consideration at the procurement stage.

Recommendations

GIPSY PATCH BRIDGE REPLACEMENT – BLOCKADE OVERRUN – CAUSAL TREE & RECOMMENDATIONS

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Regional (W&W) Recommendations — Recommended / Essential / Critical

Contributory Causes | **Root Cause Path** | **Contributory Causes**

National Recommendations — Recommended / Essential / Critical

16 day overrun of planned blockade at Gipsy Patch

Regional (W&W) Recommendations	Contributory Causes	Contributory Causes	National Recommendations
A1 - *National*: Centre of excellence to lead a review of the risk classification process for projects, considering scale, complexity and novelty as well as the impact on the operational railway. A6: Review Project Contingency Plans (PCPs) for all Capital Delivery work types and make recommendations based on best practice.	Contingency planning and risk assessments not in depth enough	Repeated attempt of 'opportunity' option, resulting in broken axles and delay of baseline plan	G2: In crisis situations, specialist plant operators should be involved in decision making and planning.
E3: Consider how project teams can be better equipped to review, scrutinise and challenge programmes.	PC programme not scrutinised for durations / logistics by NR	Principal contractor repeatedly failed to deliver to reported recovery programme for civils work	F4: Principal Contractors should provide contingency management plans before relevant project activity commences G1: Develop a 'Crisis Management Playbook' offering guidance on command / control during recovery.
F3: Principal Contractor to provide adequate planning resource, relevant to the project activity	The PC had no dedicated planner	Buildability challenges of designed solution to deliver within blockade environment	B1: Construction methodology and temporary works design should be considered more by project teams.

Why?

SPMT wheels sank and new bridge got stuck mid-move to the railway corridor

Regional (W&W) Recommendations	Contributory Causes	Contributory Causes	National Recommendations
E2: Review the roles of project, construction and engineering management personnel on projects.	Inspection and Test Plan / Go-No-Go points didn't involve Network Rail and weren't documented	Axle loads higher than recommended by industry guidance due to structure geometry affecting SPMT arrangement (97% capacity)	B5: NR issue a guidance note on Best Practice Guide for SPMTs to inform design and construction.
	Poor geogrid installation quality to design	Trial move didn't test steering, and rutting was not spotted / escalated	
B2: Briefing on buildability and how this should be considered in blockades, particularly external factors including weather.	Heavy rainfall leading up to and during blockade	Lessons learnt from previous projects not harnessed	B3: Project teams to review the lessons learnt database and confirm relevant lessons have been adopted during project reviews B4: All new projects to confirm lessons learn during authority process.

Why?

Principal Contractor did not install surfacing or surface water risk mitigation as per Temporary Works design

Regional (W&W) Recommendations	Contributory Causes	Contributory Causes	National Recommendations
A5: QSRAs and Peer Reviews to be undertaken with appropriately experienced personnel and to a level of detail dependent on the project activity /risks. A2 - *National*: The centre of excellence and regions should review the process of peer review and project risk classification and possession impact at network, region and project level.	Business experts not consulted for review and peer reviews light touch	Network Rail assurance (engineering, project and construction management) were not consulted in the design change and did not independently spot it when informed of methodology	E1: Ensure project teams can draw on suitable industry expertise where there is a specialism involved.
		NR process didn't capture or sufficiently test changes to subcontractors made by the Principal Contractor	F2: Ensure contractors do not change critical sub-contractors after contract award without demonstration that this does not reduce capability to meet technical, scale and complexity requirements.
F1: Review tender selection process to ensure competent contractors meet the technical requirements of the project.	Single point of failure not identified or mitigated sufficiently when considering risks as part of the DWWP process	PC decision to not build to design not agreed with designer or NR engineers – assurance process was not followed	C4: Delivery Directors to ensure that Principal Contractors are aware of, and fulfilling, their responsibility to agree design changes with the designer.

Why?

Principal Contractor did not discharge CDM responsibilities of controlling design change and implementing risk mitigations during construction

Regional (W&W) Recommendations	Contributory Causes	Contributory Causes	National Recommendations
A4: Delivery directors to authorise DWWP Red Ranked sites for project documentation, and run their own reviews prior to peer reviews.	Low level of project director input and ownership / scrutiny of plans	Information not communicated between different designers	C2: Project teams to ensure that an organisation is identified and accountable for design integration.
	Involvement in planning and construction is inconsistent in the business	Project schedule change and changes in NR staff at all levels in almost all project roles (re-org, staff movement, illness etc.)	A3: Capital delivery directors must ensure that the risk classification and review process is re-run after any changes to schedule, design, construction methodology, contractor appointments, weather etc.

Why?

No single driving mind for design & construction risk management

Regional (W&W) Recommendations	Contributory Causes	Contributory Causes	National Recommendations
D1: Guidance note to be produced discussing external client requirements importing risk. Sponsors to be briefed on 3rd party client not importing disproportionate risk to the railway.	Third party scheme drove design decisions and required attention from the project / construction managers	Uncertainty over who the principal designer was, resulting in lack of 'controlling mind' and liaison	C1: Each region should review CDM appointments to each project, ensuring capacity and competence to deliver the role, and this should be confirmed through assurance. This should be reviewed by the regional executive team.
	Project not treated as extraordinary despite scale and complexity & no dedicated project team	Allocation and sign-off of principal designer process was not robustly undertaken	

Why?

Principal Designer did not robustly discharge their duties under CDM

Regional (W&W) Recommendations	National Recommendations
C3: Reinforce understanding within W&W of Network Rail Principal Designer role, specifically the requirement to liaise.	H: Wales and Western and the centre of excellence must brief the findings and recommendations of this report to engineering, commercial and project teams across the network.

Summary of Recommendations

A. Network Rail should review and strengthen the risk assessment process for projects. This must ensure scrutiny and authorisation for all possession work is undertaken at a level relevant to the risk of disruption or other impact to passengers and freight services.

B. All projects must place greater emphasis on design for buildability in a railway environment, whilst considering the lessons from similar projects.

C. Project teams must ensure that all appointments made under ‘The Construction (Design and Management) Regulations 2015’ (CDM) are undertaken by the most appropriate organisation, and that competent individuals with capacity are discharging the duties.

D. Project teams must ensure that the primary requirement of maintaining and operating the railway, communicating with passengers and other stakeholders, is not compromised to meet third party funder’s objectives.

E. The capital delivery director must review the project, construction and engineering management roles on projects, and competency requirements to fulfil them effectively.

F. Contractors and sub-contractors must be technically competent and demonstrate experience and capability to manage the scale and complexity of the work scope.

G. The capital delivery director must develop a contingency management plan and crisis management team capable of leading the response to emergencies and other critical project events.

H. Wales and Western and the centre of excellence must brief the findings and recommendations of this report to engineering, commercial and project teams across the network.

Relevant Permanent way discussions and views welcomed

Before – spot the complexities?

GENERAL VIEW OF POINTS 8743, SHOWING PART OF THE BRIDGE AND CROSSOVER 8744 IN BACKGROUND (LOOKING NORTH)

After showing complexities

NetworkRail

Depth of backfill (+ EPS blocks) under Crossing

NetworkRail

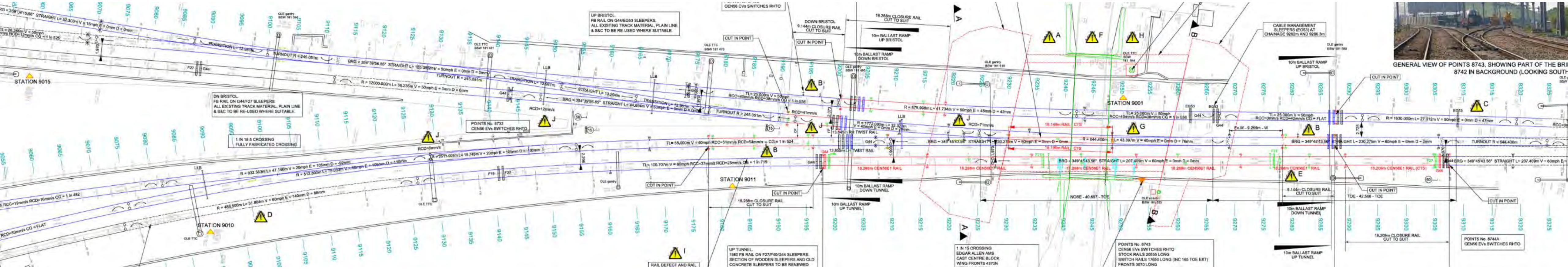
Compacted and tested in layers

NetworkRail

Suspended cables both sides of structure

Parapet installation around cables

Tamping extents – why?



Permanent way points for discussion on this call

1. Complexity and use of 2nd tier P'Way contractor
2. Lack of multi-disciplinary review in detail by discipline experts
3. Tamping of whole layout – why?
4. Crossing location in proximity to structure
5. Safety observations

How did we save some of the time

1. Many iterations of the plan as bridge movement further delayed as discussed
2. More integration & overlap with P'Way, OLE & Signalling
3. Improved communication between 2nd tier – NR took control
4. Track contractor took control of the final bottom ballast levels
5. More detailed hour by hour planning and resource confirmation
6. Reduced the amount of Tamping - did it really need tamping?

Questions