

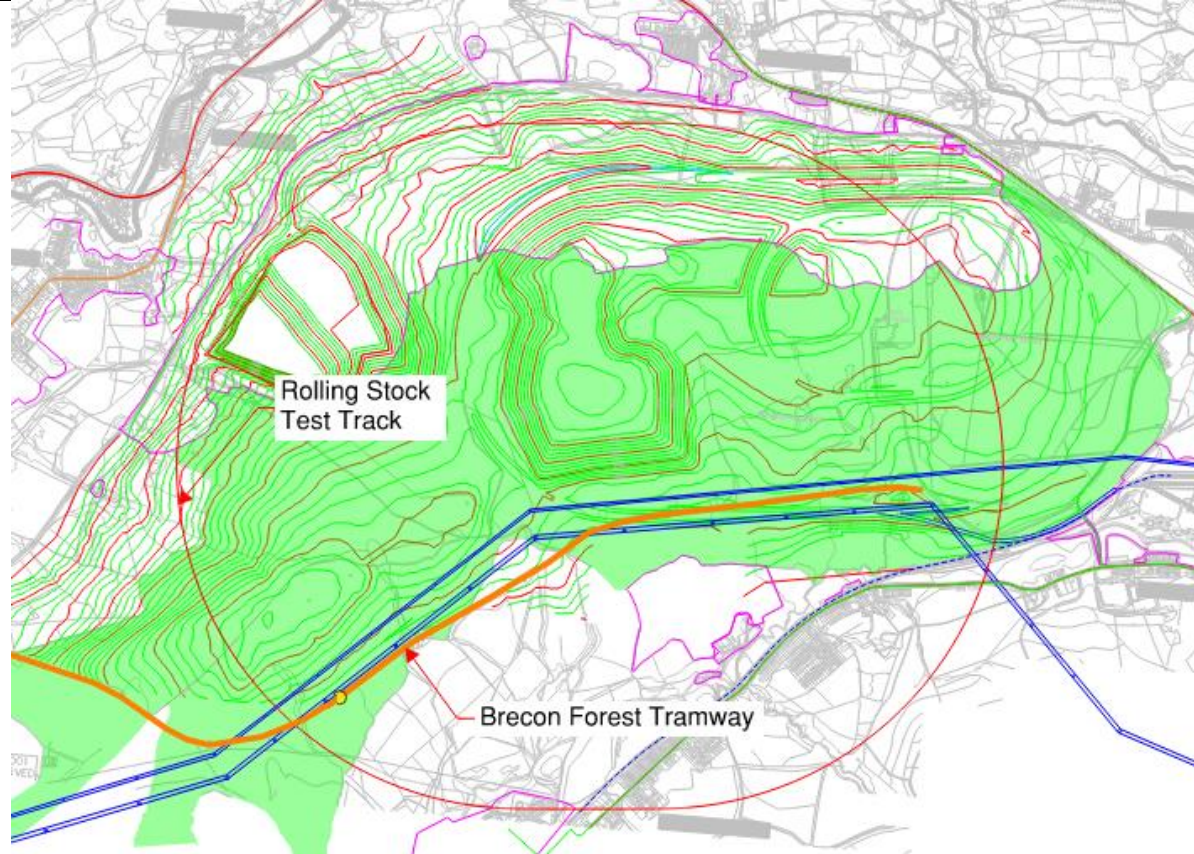
Appendix 4A

Design Iterations

GCRE – Track Layout Options Assessment

Note: when referring to line speeds within this assessment, the quoted speeds are for non-tilting trains, in accordance with NR/L3/TRK/2102.

Design Iteration 1 – 08/11/2018



The purpose of the initial design options was to demonstrate the spatial requirement for railway test tracks of various speeds. Options were produced for line speeds of 80 – 125mph.

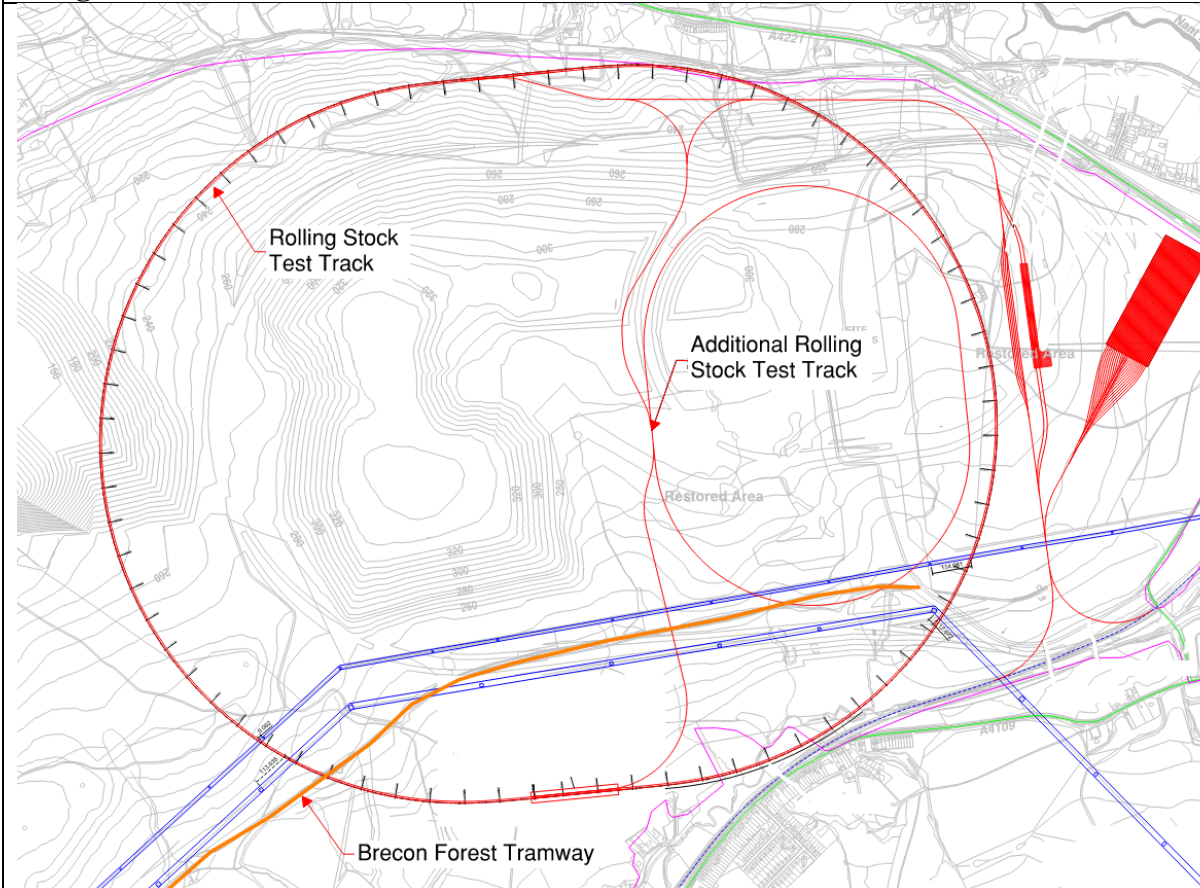
Design Principles:

- Option achieved 125mph, using Exceptional NR design values.
- Welsh Government stressed their desire to maximise line speeds.
- Bi-symmetrical loop with 1450m radius curves with 180mm cant.

Limiting Factors:

- Clashes with multiple residential clusters (Seven Sisters, Dyffryn Cellwen, Caehopkin).
- Enormous infrastructure costs associated with proposal.
- Clashes with WPD & National Grid overhead lines.

Design Iteration 2 – 22/11/2018



Formalised drawings produced for initial steering group meetings. Additional ancillary facilities shown for context. Suite of options produced for track line speeds between 80 - 125mph (105mph shown above). Options were taken to a constraints workshop held 11/12/2018, which was used to refine the feasible options for further development to the 80, 95 & 105mph loops.

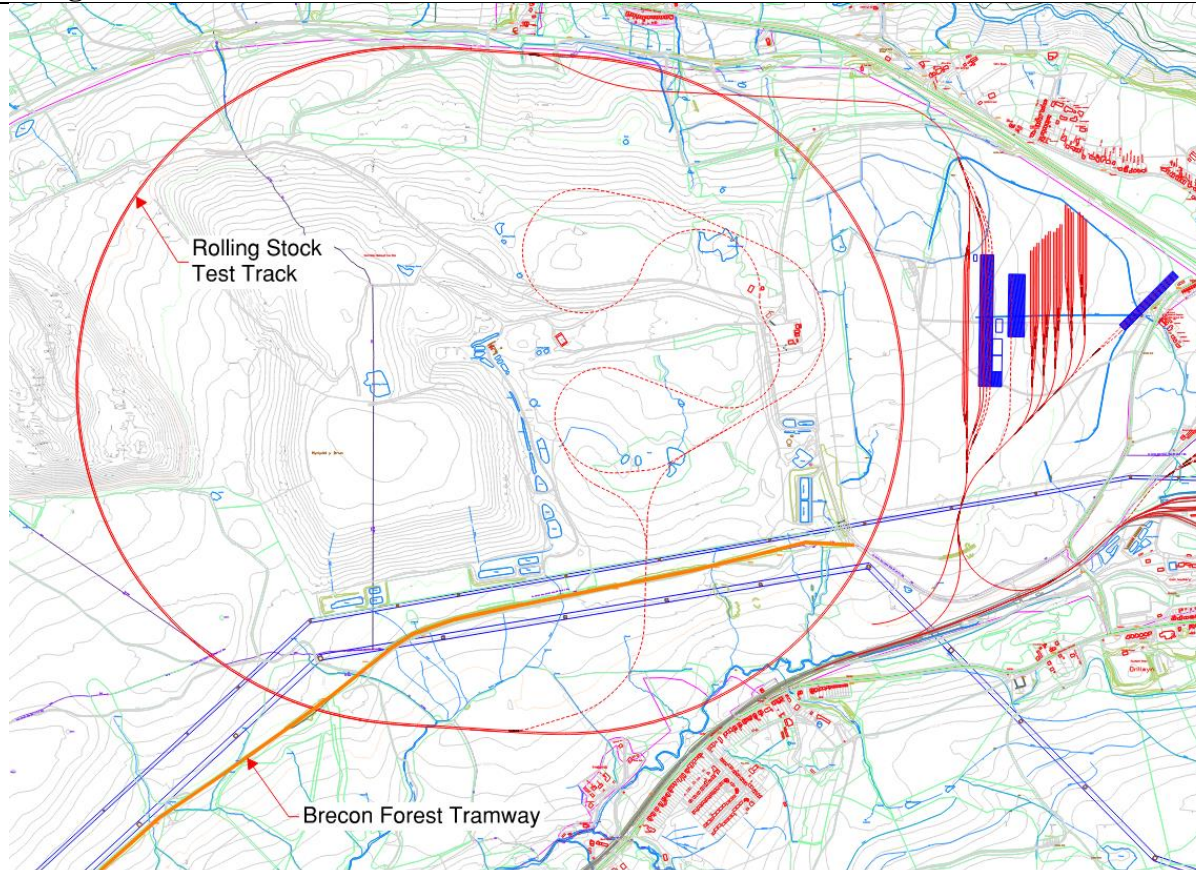
Design Principles:

- Option achieved 105mph, using Exceptional NR design values.
- Welsh Government wished to maximise line speeds as much as practicable.
- Bi-symmetrical loop with 1030m radius curves with 180mm cant.
- Additional internal loop with 60mph line speed for additional rolling stock testing.
- Ancillary features (reception sidings, branch line connection, stabling sidings and maintenance shed) shown.

Limiting Factors:

- Encroaches on multiple residential clusters (Seven Sisters, Dyffryn Cellwen, Caehopkin). Required track level means for significant earthworks, affecting said clusters.
- Enormous infrastructure costs associated with proposal.
- Clashes with WPD & National Grid overhead lines.
- Single-directional access onto loop limits operational flexibility.
- Largest options are too constrained / intrusive for future design consideration.

Design Iteration 3 – 17/01/2019



A result of the constraints workshop held 11/12/2018 was that Welsh Government wanted to maximise the achievable line speed of the test track. Subsequently, the 80mph option was dropped, leaving 95 and 105mph. Additional emphasis on potential business case around separate storage facility for Angel Trains fleet. Next suite of sketches shows additional sidings north of Onllwyn Distribution Centre and loops within the loop (conception of the ‘Squeal track’). This stage saw the initial development of earthworks models to show extents of embankments / cuttings.

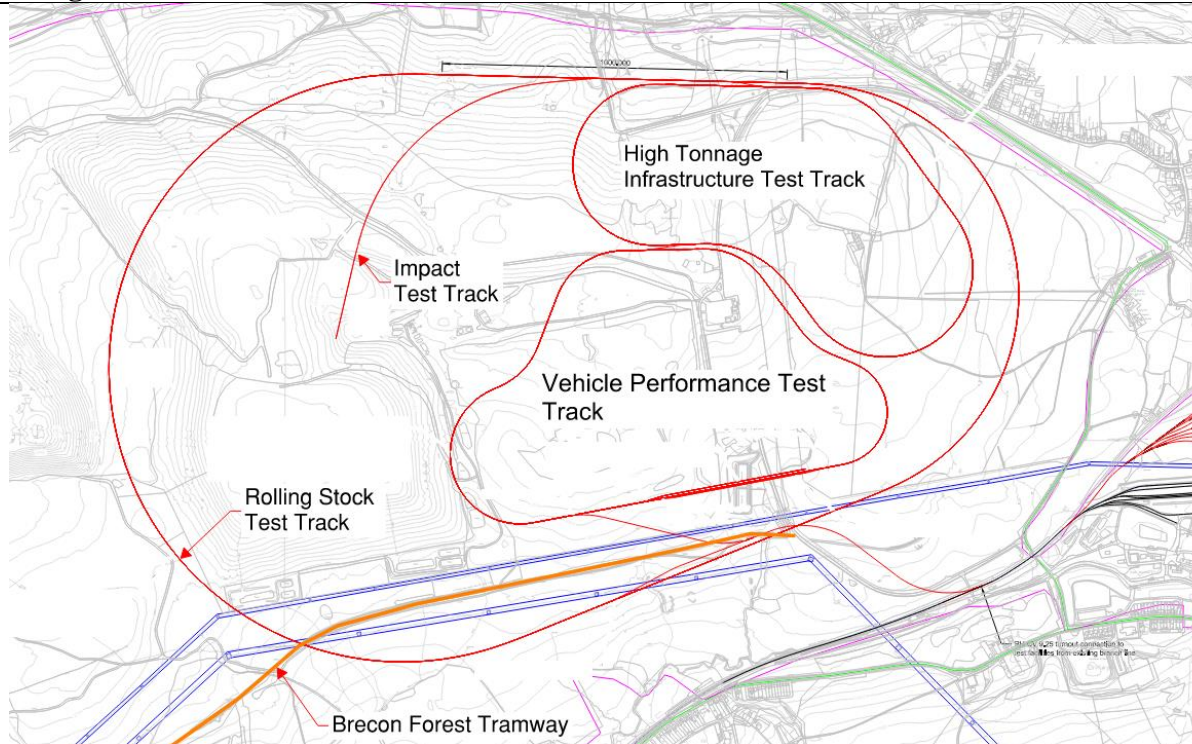
Design Principles:

- Option achieved 105mph, using Exceptional NR design values.
- Welsh Government wished to maximise line speeds as much as practicable.
- Bi-symmetrical loop with 1030m radius curves with 180mm cant.
- Internal ‘squeal track’ developed with extreme track geometry for testing of rolling stock in limiting conditions (high gradients / tight curves etc).
- Additional warm storage sidings provided for the storage of Angel Trains fleet – as per Welsh Government’s request. Circa. 300 vehicle capacity.

Limiting Factors:

- Encroaches on multiple residential clusters (Seven Sisters, Dyffryn Cellwen, Caehopkin). Required track level means for significant earthworks, affecting said clusters.
- Enormous infrastructure costs associated with proposal.
- Clashes with WPD & National Grid overhead lines.
- Single-directional access onto loop limits operational flexibility.
- Location of sidings North of Onllwyn Distribution Centre is unsuitable and beyond agreed project red-line boundary.

Design Iteration 4 – 20/02/2019



Following multiple industry engagement sessions held January 2019, the most pertinent feedback was that maximising the line speed was not a necessity for the viability of the scheme. The 105mph option was dropped because of the earthwork implications and impacts on surrounding communities. Industry engagement provided clarity over importance of various facilities. Inclusion of multiple additional tracks within rolling stock test track.

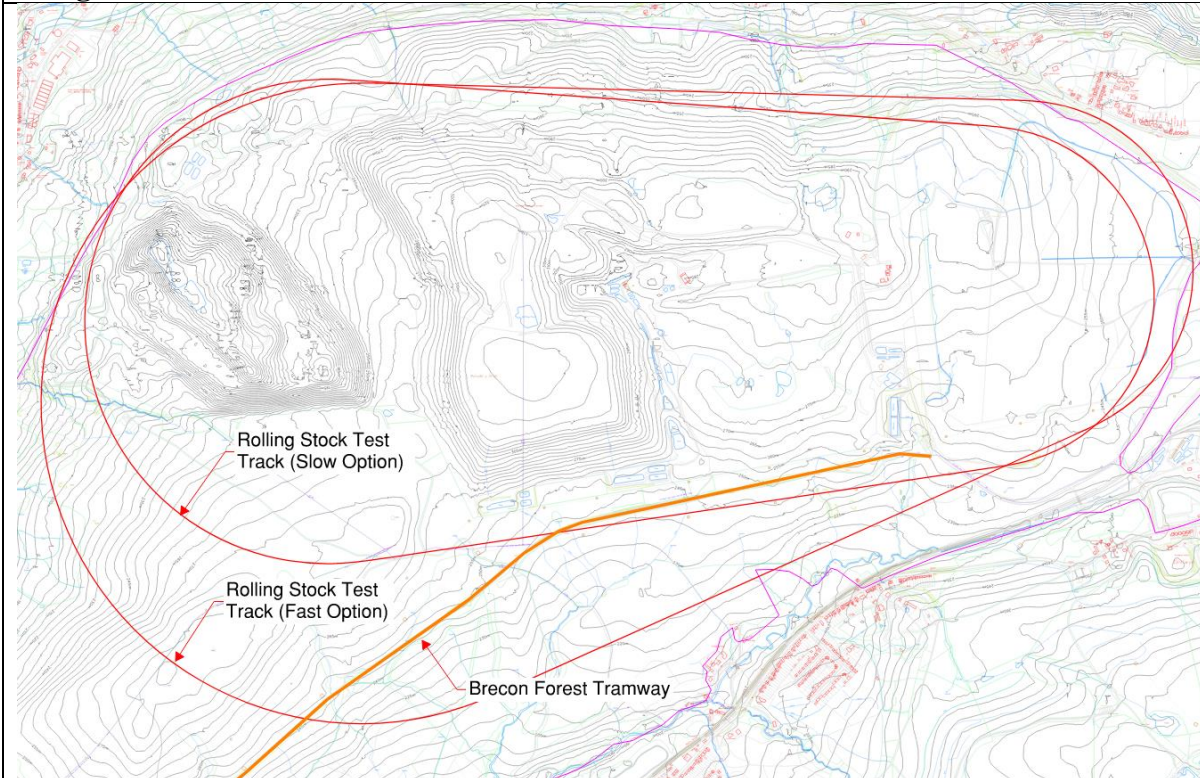
Design Principles:

- Position / size of track a combination of maximising rail performance capacity and earthworks cut / fill balance.
- Rolling stock test track with 1000m straight lengths for brake testing.
- Curves of 840m and 600m – eastern curve reduced to limit cut / fill earthworks imbalance.
- Achieves line speeds of 95mph and 80mph through curves.
- Additional impact testing track – resultant of industry engagement.
- Additional infrastructure testing track – resultant of discussion with Network Rail.
- Additional facilities provided in washery area as a result of industry engagement – rolling stock decommissioning and R&D centres.

Limiting Factors:

- Clashes with WPD & National Grid overhead lines.
- Single track connection onto test tracks limits operational flexibility (not possible to provide delta junction onto rolling stock test track).
- Connecting track required to pass beneath rolling stock test track – unviable level difference and associated track gradients of connecting track.
- Location of sidings North of Onllwyn Distribution Centre is unsuitable and beyond agreed project red-line boundary.
- Varied topography at North (infrastructure test track location) means for unfeasible cut / fill.

Design Iteration 5 – 15/03/2019



Following discussion with Siemens, Welsh Government instructed Arup to investigate the feasibility of providing straights of minimum 2140m. This is the length required to undertake brake testing on the entire Siemens fleet.

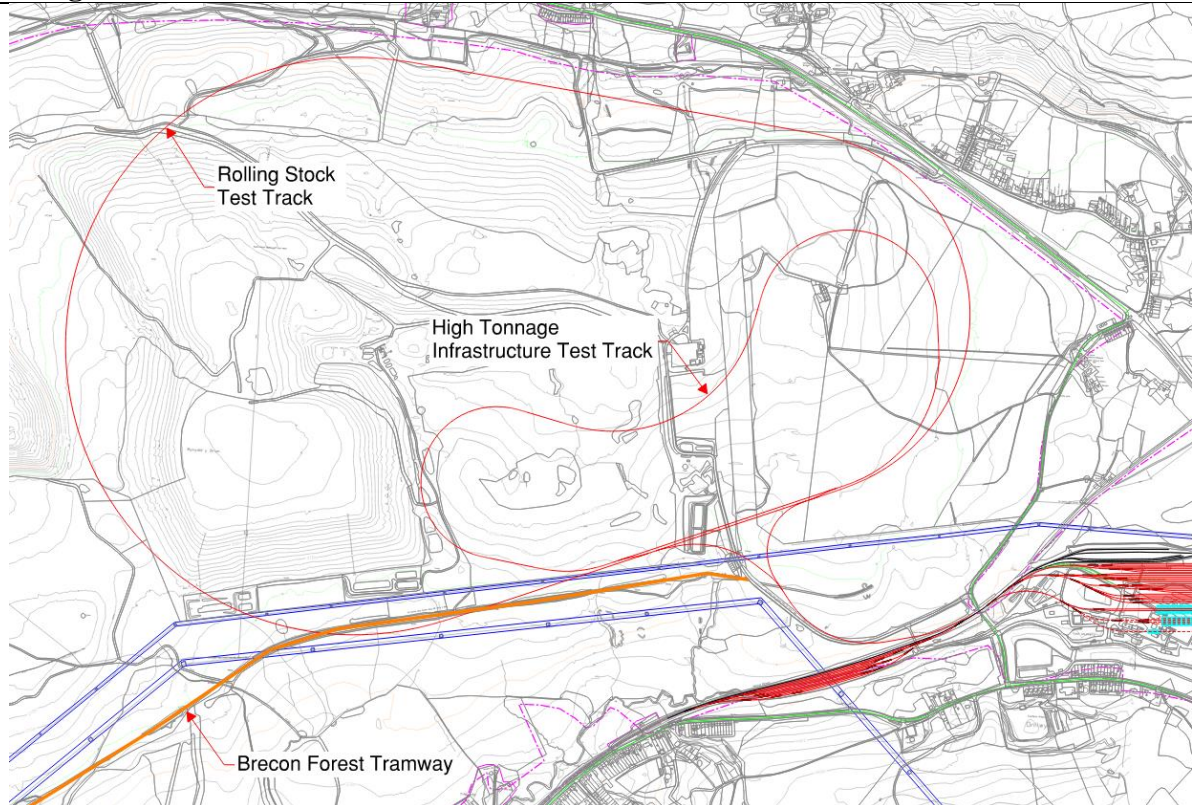
Design Principles:

- Provision of sufficiently long straights for the testing of Siemens trains.
- Test tracks of varying geometry – one track has curves of 840m & 600m radii (as per design iteration 4) and the other has curves of radii 600m & 680m.

Limiting Factors:

- Encroaches on multiple residential clusters (Seven Sisters, Dyffryn Cellwen, Caehopkin). Required track level means for significant earthworks, affecting said clusters.
- Enormous infrastructure costs associated with proposal.
- Clashes with WPD & National Grid overhead lines.
- Single-directional access onto loop limits operational flexibility.
- Options are too constrained / intrusive for future design consideration.

Design Iteration 6 – 04/04/2019



Introduction of the phased construction principles. Both the vehicle performance test track and impact test tracks were omitted. The eastern curve radius was reduced for operational and earthworks purposes. Relocation of washery facilities and inclusion of additional features in the area, based on conversations with multiple stakeholders (TrenItalia & Deutsche Bahn).

Design Principles:

- Orientation of rolling stock test track adjusted for betterment of cut / fill balance.
- Radius of eastern curve reduced to 530m, reducing the line speed through the curve to 75mph – this reduction had multiple benefits:
 - Gained the ability to provide a delta junction onto the rolling stock test track, improving operational flexibility;
 - Allows the connecting track from the branch line to avoid clashing with the overhead lines.
- Branch line connecting track length maximised by moving connecting S&C to Onllwyn Rd overbridge, improving achievable track level and subsequent cut / fill balance. This was

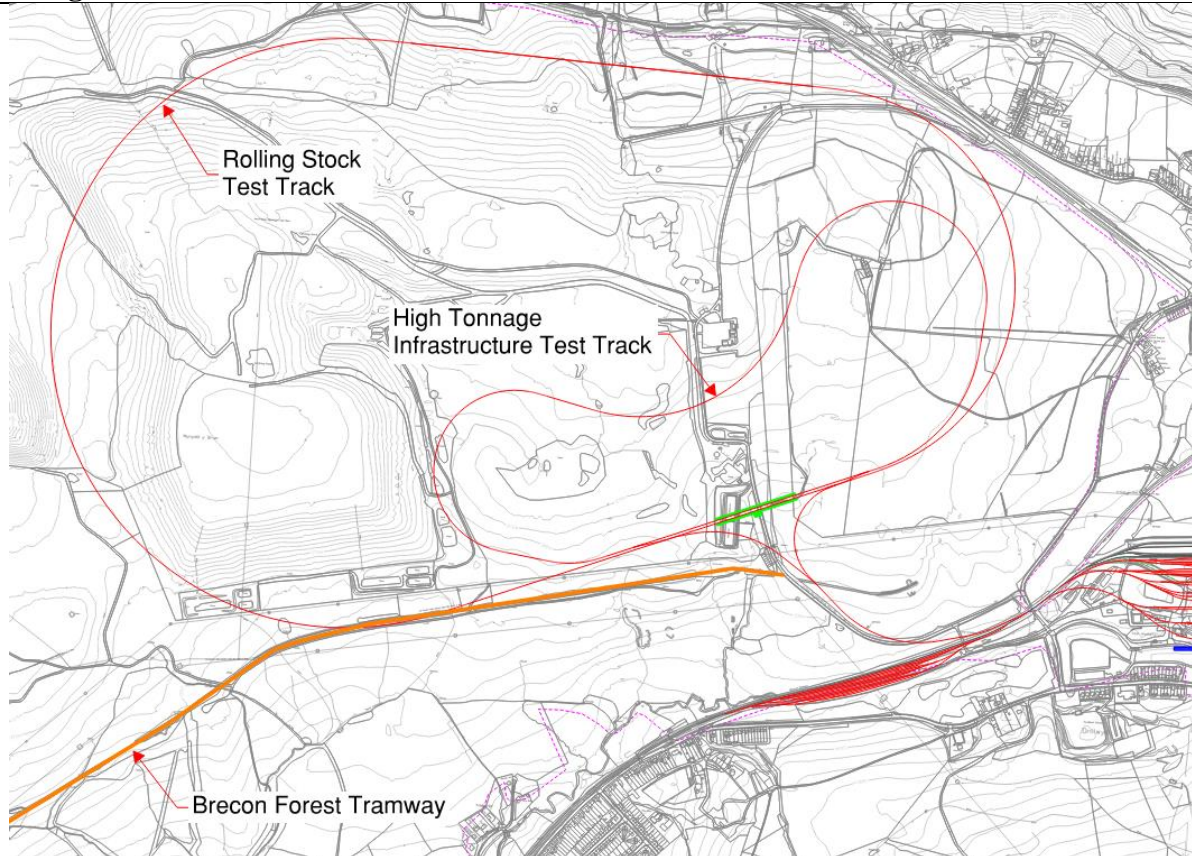
Limiting Factors:

- Further reduction of rolling stock test track line speed.
- Rolling stock test track line speeds based on 180mm of applied cant, which is atypical of the UK rail network. Typically, 150mm is the highest designed value.
- Limited flexibility of movement for trains within washery area. Single-directional access to / from maintenance shed could be limiting.

also aided by the eastern curve radius reduction.

- Relocation of all washery facilities to South of existing sidings.
- Increased length of maintenance shed to provide capacity for 400m trains.
- Additional warm storage sidings provided South of branch line in currently unused area of land (which has historic rail-freight use).
- Inclusion of carriage wash facility.
- Removal of impact test track and vehicle performance test because of inviable existing topography and limited business case. Relocation of infrastructure test track to improve cut / fill balance.

Design Iteration 7 – 19/09/2019



Further development based on construction phasing. Inclusion of winch-propelled test track. Further manoeuvring of rolling stock test track. Additional connecting track in washery area.

Design Principles:

- Rolling stock test track rotated to improve cut / fill, by matching topography along the northern straight as much as possible. Geometry consistent with design iteration 6.
- Winch-propelled facility added as a means of infrastructure testing during / prior to construction of main test tracks.
- Additional headshunt provided to rear of maintenance shed for improved flexibility of movement between washery facilities.
- Maintenance shed rationalised to provide 400m servicing length on 2 roads, and 230m on alternate 2 roads, based on the likelihood of having 4x 400m trains at the facility simultaneously.

Limiting Factors:

- Headshunt location potentially problematic for vehicle access into the site. Location also clashes with multiple animal habitats.
- Connecting track onto test tracks is of significant gradient (1:50) which could be problematic for long trains, in particular freight locos accessing the infrastructure test track.
- Rolling stock test track line speeds based on 180mm of applied cant, which is atypical of the UK rail network. Typically, 150mm is the highest designed value.

Design Iteration 8 – 05/08/2020



Refinement of multiple aspects based on internal discussion with Arup Geotechnical, Civil and Environmental teams. Construction phasing updated – Phase 1: Infrastructure Testing, Phase 2: Rolling Stock Testing, Phase 3: Aspirational Inclusions.

Design Principles:

- All test track geometry is as per previous design iteration.
- Connecting track length maximised to increase test track levels as much as possible, to best-suit existing topography.
- Winch-propelled facility omitted in-line with updated phasing approach.
- Headshunt alignment adjusted to avoid existing water courses and animal habitats. Alignment follows trace of historic railway.

Limiting Factors:

- Current design.
- Multiple clashes with existing watercourses and habitats.
- Proposed connecting track onto test tracks is of a significant gradient.

