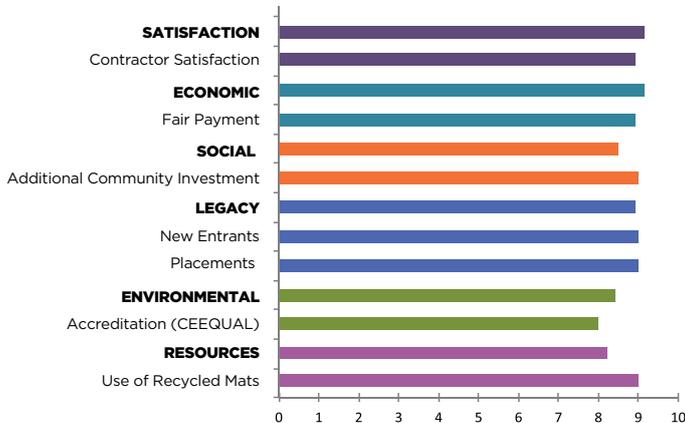


## A465 Heads of the Valleys Section 2 Gilwern to Brynmawr

### DESIGN STAGE



The A465 is recognised in the Welsh Governments National Transport Plan as a strategically important route. The dualling scheme extends for 8.1km from Brynmawr in the West to Gilwern in the East. This will connect the previously completed Section 1 (Abergavenny to Gilwern) and Section 3 (Brynmawr to Tredegar) schemes.

The scheme includes the construction of 14 major structures, over 12.5km of various types of retaining walls as well as excavation of over 1.2 million m<sup>3</sup> of earthworks. All this through an extremely narrow rock gorge with a river on one side while maintaining current traffic flows on the existing route.

Many of these are elements which are pushing the boundaries of standard construction techniques including the largest span precast concrete arch in the UK, along with installing a fully precast deck to the Saleyard River Crossing structure in order to reduce working at height and the risks associated with it.

The aim of the scheme is to upgrade the existing three-lane carriageway to a dual carriageway to improve the safety of a notoriously dangerous road and to help stimulate the local economy of Brynmawr. The vast majority of the scheme is online (5.8km) with just 2.3km off-line.

### PROJECT DETAILS

**Client:** Emyr Davies - Welsh Government  
**PM:** Adam Hughes - Arcadis  
**Contractor:** Bruce Richards - Costain  
**Supervisor:** Jacobs  
**Designer:** Paul Sandford - CH2M/Atkins  
**Environmental Designer:** RPS - Karen Roberts  
**Value:** Total project costs £223m  
**Project size:** 8.1km Dualling  
**Contract:** ECI NEC Option C  
**Duration:** Start date: End 2014 - End date: Late 2018



### KEY CONTACTS

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**Bruce Richards**  
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The existing single three-lane carriageway was constructed in the 1960s with generally two lanes in the uphill direction through the Clydach Gorge. Traffic flow and speed are restricted by the road width, gradients, the at-grade nature of the junctions and the limited opportunities for safe overtaking. Due to the constrained nature of the gorge, the hardstrips and verges are narrower than would normally be expected for a road of this type.

The geometry of the road includes elements such as horizontal curves, vertical curves and forward visibility, which are appropriate for vehicles travelling at 50mph. This layout combined with the need to minimise the air quality impacts of the road on the surrounding ecological sites requires that the whole length of the scheme to be subject to a 50mph speed limit. The carriageways will be split level from west of

Brynmawr Junction for 2.2km through to Blackrock with the eastbound carriageway up to a maximum height of 6m above the westbound carriageway.

The team also have considerable environmental challenges to deal with including special areas of conservation, several sites of special scientific interest and scheduled ancient monuments.

The project was awarded by the Welsh Government to Costain in June 2011. This marked the commencement of the Early Contractor Involvement (ECI) phase. Key successes to note are the completion of the preliminary design leading up to the publication of draft orders in October 2013 and a successful public local inquiry in March/April 2014. Construction commenced in December 2014 with completion aimed for Late 2018.

## What is an Exemplar project?

An Exemplar is defined as **‘something worthy of being copied’**. The Exemplar programme has been developed to help identify the reasons why certain projects are successful in a standardised, quantifiable way and to share with the industry what enabled these successes.

An Exemplar considers all aspects of sustainability, including economic, social and environmental, demonstrating that

the scheme is well rounded and has incorporated best practice and collaboration.

## Case studies are prepared at 3 Key Stages Design Stage; Construction Phase; Post Occupation

This ensures that lessons learnt can be demonstrated throughout the development of the project.

## What Makes this Project Exemplar?

**1 Environmental Assessment & Design:** The A465 Section 2 is one of the most environmentally challenging schemes the WG has had to deliver. It passes through the European designated Usk Bats Sites Special Conservation Area (SAC) an Assessment of Implications on European sites (AIES) was required. An overriding need for the scheme and the lack of any reasonable alternative to the scheme had to be proven and agreed by the Welsh Ministers. The key issues were the effects on the Lesser Horseshoe Bat population and a habitat known as Tilio Acerion Woodland.

Design options were rapidly modelled in 3D and assessed using WelTAG; with the best performing option being taken forward to preliminary design. The highway alignment negotiated the significant environmental constraints accommodate the severe topography of the River Clydach Gorge and the 300m change in altitude from Gilwern to Brynmawr. In order to satisfy European Legislation we demonstrate how we minimised the scheme's effect on the European sites.

Two fundamental mitigation measures were agreed with WG during the preliminary highway design: a reduced dual carriageway cross section width and a reduced design speed. Agreeing these departures from standard early on in the design process permitted a sympathetic alignment which minimised environmental effects and reduced land take. The split level carriageway stepped into the northern gorge face was a key strategy in minimising the scheme's environmental impact, reducing land take and improving the scheme's earthworks balance.

**2 Environmental Management:** The scheme is within the Brecon Beacons National Park (BBNP) and includes three SSSI's, a National Nature Reserve (NNR), three Schedule Monuments (SAM's) and listed buildings. In order to protect these sites, the scheme was subject to an Environmental Impact Assessment reported in an Environmental Statement (ES) in 2013.

The commitment register records commitments made at Public Local Inquiry (PLI) that shall be incorporated within the development of the design. A key commitment

was the establishment of a "Finishes Protocol" which is a framework developed in consultation with BBNP and NRW to ensure that the project provides a final appearance that is sympathetic to the surrounding area and environment.

We also established a protocol NRW's geologist to manage the scheme's impact with the Geological SSSI. The site will be geologically mapped before, during and post construction to record the geological data. This enabled design solutions that were sympathetic to the Geological SSSI to be developed and provides visible rock exposures that can be viewed for years to come.

As a further level of protection for the existing sensitive sites, and species an environmental permit system was developed in advance of construction. This ensures the ecological and archaeological surveys, vegetation protection and species protection is put in place in every area of the site prior to any site clearance or excavation works being commenced.

**3 Consultation:** A major scheme achievement; on such an environmentally sensitive project, was the successful PLI; which lasted only three weeks and had no statutory consultee objections, which was largely down to excellent consultation. Several groups have been regularly consulted with such as: Environmental Liaison Group and Heritage Protection Action Group. Developing a close working relationship with these groups and organisations and developing protocols has been essential in enabling the consents and agreements to be in place and for the scheme to proceed on programme. This has continued into the detail design stage with the creation of the innovative Design Change log.

During the preliminary design public consultation was greatly enhanced by adopting Augmented Reality as an approach, this allowed us to clearly explain the complexity of the project to the wider audience. During the early public exhibitions and the PLI, the scheme layout was presented using AR, this allowed the project team to focus in on key areas such as the Brynmawr and Saleyard interchanges. This enabled us to bring conventional 2D drawings to life for the benefit of residents and road users.



In several cases we were able to alleviate the concerns of residents by simply showing them how their properties interfaced with the project using 3D models to give personal perspectives of the scheme from individuals' properties.

- 4 Innovative Design:** The most imposing structure will be the Brynmawr Gateway Bridge which is a 70m span skewed bowstring arch bridge which crosses the gorge with the split-level carriageway 25m below. The bridge foundations, on either side of the River Clydach Gorge, required major grouting works to treat historic iron and coal mine workings beneath. The extensive environmental, topographical and geotechnical constraints throughout the scheme's length has necessitated an exceptional level of engineering intervention to achieve delivery of this highway project. The 8.1km scheme requires over 80 retaining walls or geotechnically engineered slopes with a total length of 12.5km. The largest soil nailed slope is 14.5m high and the tallest rock cut is 26m high.

The scheme includes 14 major new structures and incorporates 45 significant existing structures.

The split level carriageway runs for 2.25km requiring a central reserve retaining wall which is on average 6m high. Part of this length is a back-to-back reinforced earth wall has been constructed which in turn is founded on sheetpiles driven into solid rock, in order to avoid culverting the River Clydach and important woodland habitat. The Giken sheet piling 'supercrush' method, has been employed allowing construction to continue whilst maintaining two lanes of mainline traffic flowing.

- 5 Employment & Training:** The project has created a workforce that is highly qualified, innovative, motivated and committed. Our investment to training and upskilling the workforce is managed and directed through our National Skills Academy that is fully supported by CITB and Welsh Government.

The project team has endeavoured to promote challenging yet realistic targets, which align with the principles of Welsh Government's procurement strategy 'Delivering Maximum Value for the Welsh Pound'. Along with providing other educational and community benefits, the training requirements of the scheme are extensive and extend to all employees including our supply chain. Initial targets set for the academy: 160 new employment opportunities and 60 new apprentices.

- 6 Community Benefits:** With a dedicated Public Liaison Officer working with a number of stakeholders the A465 is building a long term legacy within the communities along the Clydach Gorge and further afield. Business in the Community, Careers Wales, Brynmawr Foundation School and Costain with other partners pioneered the first business class cluster in Wales.

This initiative builds strong links with the pupils, school and the community developing STEM interventions, Welsh Baccalaureate assistance and extracurricular activities. Less formal links with high schools and primary schools in the vicinity has already seen in excess of 5,500 pupils interacting with the construction team.

## Notable Aspects **Improving Design and Delivery**

- The use of BIM and 3D models has been an essential tool to achieve the complex statutory utility diversions throughout the scheme such as the inter-related pumped foul sewer and very high-pressure gas main diversions that cross the grade-separated Brynmawr Junction and the BT, foul sewer and water main diversions at Gilwern Junction. 3D model information was exchanged between statutory utility designers and the DJV to produce coordinated, integrated design proposals.
- At Pont Harri Isaac Footbridge several major interconnected design elements had to be coordinated: verge retaining walls (both sides of the carriageway) both immediately adjacent to the River Clydach; central reserve retaining wall; extension to the existing river culvert; conversion and extension of an existing pedestrian subway to a bat crossing; the construction of a the new footbridge crossing, and another very high pressure gas main diversion across the steep-sided gorge.
- The combined (federated) model and individual design models are used by the design and construction team on a daily basis to communicate issues and describe problems with 3D PDFs being a popular way to exchange information.
- The CDM hazard log used produced by the DJV and the construction team identifies all construction teams, operation and demolition risks associated with the project. The residual risks have also been identified by a symbol within the federated 3D model which will assist the maintaining agent after handover of the scheme.



## STRATEGY

**Due to the complexities of this project it was evident from an early stage that we would need to adopt a more collaborative approach to delivering this project successfully. The construction team co-located to offices in Cardiff with all the design team to ensure we maximised the team integration and made communication between all team members easy and efficient.**

A number of workshops were held throughout the process to enable all members to gain an understanding of the objectives and concerns. A project strategy was then developed and condensed onto one document that captured the outcomes from these workshops with associated owners.

These main focus included health & safety, cost, people, technical / statutory process, quality and process, supply chain, environment, legacy, engagement (stakeholder & community) and time.

It was always the intention that the team that successfully delivered the project through KS3, KS4 and the Public Local Inquiry would then be the same team that went onto to deliver the construction phase (KS6) of the project. This would ensure that the vital knowledge and experience of the scheme was not lost by staff transfers.

With the leadership remaining consistent throughout the various stages of the process it was decided that we would also continue with the co-locating strategy and the main site compound offices were designed to enable the customer, the construction team, the designers and the supply chain to be located in one site building thus enabling full team interaction and achieving the one team mentality for this extremely complex project.

In order to ensure this strategy is both implemented and remained effective there are a number of control measures in place. One example would be the Key Performance Indicators (KPI's) developed with the customer.

We have been involved early on in the project in determining both the type of KPI's and the wording of these KPI's to ensure they are relevant for this project and can be measured. These KPI's are reviewed at a meeting with the customer every quarter with evidence provided and feedback given.

## IMPROVING THE PROCESS

**For our monthly client progress meetings a report is produced detailing the main issues and progress to date. We have now also developed new dashboards which contain graphical / visual representations of targets achieved, progress against measureable baselines and commercial data. These monthly dashboards are also displayed around the site office to enable the whole of the site team and supply chain to understand how the project is performing.**

Lessons learnt documents have been produced for the early KS3 and KS4 stages and the PLI. These have been distributed with the aim of improving the process for the customer on future projects. Further reports will be produced at the Client end of the construction phase (KS6).

To improve the design and delivery process we have embraced BIM technology. The use of Bentley ProjectWise as the Common Data Environment (CDE) has allowed project information to be managed, controlled and shared between all members of the Design Joint Venture (DJV) - CH2M and Atkins in accordance with BS1192 - Collaborative production of architectural, engineering and construction information - code of practice.

The use of 3D models has been an essential tool to achieve the complex statutory utility diversions throughout the scheme such as the inter-related pumped foul sewer and very high-pressure gas main diversions that cross the grade-separated Brynmawr Junction. The A465 carriageways are also split in level at this junction and are congested with other highways infrastructure and structures. 3D model information was exchanged between statutory utility designers and the DJV to produce an integrated design proposals.





## CONTINUOUS IMPROVEMENT

**Costain are passionate about driving continuous improvement within all levels of the project. This helps drive objectives and behaviours at a personal level through annual performance reviews. The main aim of the lean implementation strategy is to ‘change our way of thinking at all levels to create positive synergies and minimise waste’.**

Welsh Government and Costain have pioneered a comprehensive key performance indicator measurement system, which is scored quarterly on this project over the seven main headings. We operate as a fully integrated project team with the client, designers, DJV, supply chain partners and main contractor all working under the same roof. The collaborative approach ensures efficient communication between all parties.

Collaborative planning sessions focusing on improved construction sequences also enhance the soft skills of trust and teamwork. Key milestones are extracted and each blocker assigned an action owner to provide a accountability and resolution. The project team run a Lean Focus Group that co-ordinate all continuous improvement plans. This forum, including strategic supply chain and client representatives, follows the six sigma DMAIC (Define, Measure, Analyze, Improve and Control) process for capturing and improving processes. Key successes to date include an increased earthworks process, improved soil nailing solution and efficient procurement of re-bar.



## SUPPLY CHAIN STRATEGY

**The project strategy identified areas of key supply chain involvement at the commencement of KS3. These included design, earthworks and geotechnical solutions. We therefore setup supply chain agreements and professional services contracts to ensure these key members of the supply chain were fully involved from the beginning in both providing solutions and contributing to the statutory process.**

The supply chain continue to be involved in the collaborative planning process and feed into how the project is planned and sequenced.

We worked closely with our strategic earthworks partner Walters UK to develop a sustainable and safe earthworks strategy for the project that included minimising plant movements on local roads by building a temporary bridge over the existing A465 to take earthworks plant and equipment.

RPS provided invaluable advice and input relating to the numerous, complex environmental and ecological issues effecting this stretch of the A465. They were heavily involved from the beginning in liaising with the various stakeholders (BBNPA, BGCBC, NRW, MCC) to develop a designed scheme that sympathetically addresses the concerns of all affected by the project.

In terms of the design of the scheme this is being facilitated through co-location of designers, contractors and sub-contractors alike through most of the design process. In particular the Design Joint Venture of CH2M and Atkins are working in partnership with the Reinforced Earth Company and Phi Keller to develop integrated designs for the very large number of complex reinforced earth retaining walls and slopes along the scheme.

In addition further close collaboration with CAN and BAM Ritchies on site during the construction of the soil nailed walls/slopes, enabled rapid design changes/remedial works to be specified and constructed following the exposure of unexpected ground and groundwater conditions which is a common occurrence on the scheme.

We have also enhanced our performance review process on the A465 project and have identified strategic supply chain packages and adapted the normal performance review process to incorporate more project specific measuring tools - we have called this “Costain Blue”.

## Community Engagement, Community Enhancement, Community Benefits Delivered

Higher Education providers are engaged with the project with a direct link with Coleg Gwent and presentations and visits to all the South Wales Universities. Wider community interest in the project has seen the development of a programme of general and specialist talks and site visits for community groups including University of the Third Age, Rotary, Probus and W.I. with over 60 presentations made to date, this network sees local people engaged in the project and the interest and understanding spread across the community.

Local community projects are supported by donations and volunteer time with in excess of £10,000 contributed to date in a range of community and educational projects. The demolition of the Primitive Methodist Chapel and exhumation of the remains provided a challenge for the team, following the application and granting of a Ministry of Justice licence to remove and rebury the expected 15 remains an extremely sensitive operation was undertaken. A service of memorial was held with the local Methodist congregation on the site. The exhumation was undertaken by hand behind screens with each individual provided with a casket and transported by ambulance to a chapel of rest, all 62 individual remains were recovered. A reburial service was then held at a local cemetery with Methodist and local dignitaries present to lay to rest all 62 alongside the remains reburied as part of the original Heads of the Valley Scheme.

## SUSTAINABILITY

**The scheme has targeted CEEQUAL Whole Project Award at Excellence (>75%) and is also targeting Considerate Constructors Scheme Gold award. Costain have appointed a trained CEEQUAL assessor to be fully based on the scheme throughout the construction phase. Individuals responsible for the delivery and management of key aspects have been appointed champions of CEEQUAL sections, i.e. Community Liaison Officer appointed champion for relations with local community and stakeholders. Regular CEEQUAL 'away days' are scheduled between the section leads and project assessor to track progress and upload evidence.**

The scheme presents significant water management challenges. Located in a particularly wet climate, within a steep sided gorge, challenging geology and very little space for attenuation the scheme has to manage hugely fluctuating water volumes over short discharge periods. Working in partnership with Natural Resources Wales (NRW) and a specialist water treatment company the scheme has developed a range of treatment capabilities to manage fluctuating flows and suspended solid loading. Innovative monitoring agreed with NRW allows for in field monitoring to be undertaken to establish if discharges are in line with the schemes agreements without waiting for laboratory analysis.

Low energy and low carbon initiatives of the scheme have been at the forefront of the projects development. Low energy solutions have been procured during the construction phase in line with Costain's sustainable procurement policy. For example, every tower light sourced for the scheme is equipped with LED bulbs and hybrid technology. Low carbon initiatives have been considered throughout the project from design and into construction, designing out the need for large concrete pours where possible, utilising 'cyclopene concrete' if suitable and reusing sustainably sourced materials (recycled glass) to offset virgin quarried aggregates.

Additionally, working in close relationship with local suppliers for reinforced steel bars and rod, the scheme has limited the amount of carbon generated significantly. All reinforced steels delivered to site are produced through the Electric Arc method, utilising a significant volume of recycled steels (>90%) when compared with the traditional basic oxygen steelmaking process (~30%).

Furthermore, sourcing the steel locally means that from scrap to the delivered product, the material travels a maximum of just 44.4 miles. Comparing this to steels sourced on the international market the scheme calculates that just 590kgs/t of carbon is generated when compared to a potential 2.2t/t of carbon for steel sourced from the global market.

AIES: As the A465 passes through the European designated Usk Bats Sites Special Conservation Area (SAC) an Assessment

of Implications on European sites AIES was required under the Conservation of Habitats and Species Regulations 2010. An assessment of the effects of the scheme including the additional land taken, construction and operation of the dual carriageway on the qualifying features of the SAC had to be undertaken.

Following a screening process the key issues were effects on the Lesser Horseshoe Bat population and their habitat known as "Tilio Acerion" woodland. The scheme has already incorporated:

- Extension of existing underground bat crossings; erection of bat boxes and hibernacula (bat roosts); new underground bat crossings; and temporary screens are being erected to protect existing flight lines and connectivity to under road crossings
- Additional land in the gorge has been acquired and the planting of 148,000m<sup>2</sup> (approx. 36 acres) of woodland to mitigate for woodland and bat foraging areas lost to the scheme
- A significant new maternity roost building has been constructed within an area of the new planting and there is already evidence of bats using this new roost
- Ongoing monitoring of roosts and the activity of the bats at crossings is being undertaken to understand the effects on the local population and enable further temporary measures to be put in place as necessary to protect the bat flight lines during construction.

Survey evidence to date has shown the bat population being conserved and activity levels and maternity roost numbers are doing well. As well as passing through the SAC, the scheme is within the Brecon Beacons National Park and the site includes three Sites of Special Scientific Interest (SSSI's), a National Nature Reserve (NNR), three Schedule Monuments (SAM's) and listed buildings.

Site Specific Environmental Mitigation works for the scheme have included:

- Environmental Impact Assessment reported in an Environmental Statement (ES) in 2013
- Environmental permit system in place for surveys to occur prior to works.
- Acquisition and management of former Coal Authority Land for a Lapwing breeding area to mitigate for Ben Ward's Fields which are being used for earthworks depositions during construction;
- The translocation and replanting of a rare Welsh Whitebeam tree;
- The use of hundreds of beech seedlings transplanted from the NNR (managed by NRW) for the new bat mitigation woodland planting areas to ensure the local provenance of these imported trees to the Clydach Gorge.

DESIGN STAGE EVENT 08/06/2017

