



BRITANNIA BRIDGE TIDAL FLOW FEASIBILITY STUDY

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1. Background

1.1 Study Purpose

AtkinsRéalis was instructed by North and Mid Wales Trunk Road Agent (NMWTRA) on behalf of the Welsh Government (WG) to undertake a review of previous studies into the feasibility of implementing a 3-lane tidal flow system on Britannia Bridge in North Wales and produce a safety risk appraisal based on this information. This document is a summary of the appraisal that assessed the viability of introducing tidal flow operation on the bridge from a safety perspective. The purpose of the appraisal was to review the potential introduction of narrow lanes and tidal flow operation on Britannia Bridge and determine whether an acceptable level of safety could be demonstrated for all affected populations i.e. everyone travelling across the bridge, those affected by the operation of the bridge and those working on the bridge. The appraisal drew upon previous studies and considered changes in standards, traffic conditions, vehicle composition and available mitigation measures since earlier assessments were undertaken. The appraisal also considered and included the views of key stakeholders who were consulted during the development of the technical report.

1.2 What is Tidal Flow?

A tidal flow system is a traffic management system where one or more traffic lanes can be used in either direction, depending on traffic conditions and the time of day. The direction of travel in the tidal lane is controlled using signs, signals or barriers, allowing additional capacity to be provided in the peak traffic direction to reduce congestion. For example, during the morning peak an extra lane may operate towards a town or city centre, while during the evening peak the same lane may operate in the opposite direction. This approach allows the available road space to be used more efficiently where traffic demand varies significantly between directions throughout the day.

Previous work undertaken has identified that theoretically there is space on the Britannia Bridge for three narrow lanes instead of the current two-lane layout. The appraisal therefore reviewed the proposed three-lane layout on Britannia Bridge, whereby the middle lane would be a tidal flow lane which would operate in an eastbound direction in the AM peak and westbound in the PM peak.

1.3 Study Objectives

The objectives of the appraisal were to:

- Review the findings of previous studies relating to tidal flow operation on Britannia Bridge.
- Consider whether changes in standards, traffic conditions and vehicle types could affect the viability of a tidal flow arrangement.
- Assess whether operation of Britannia Bridge with narrow lanes and tidal flow could achieve an acceptable level of safety.
- Identify potential mitigation measures and assess whether they could reduce any additional safety risks associated with tidal flow operation.
- Consider the potential impacts of tidal flow operation on different groups of bridge users.
- Examine whether any safety benefits during periods of normal operation could offset potential safety disbenefits during tidal flow operation.
- Determine whether there is sufficient evidence to support further investigation of tidal flow as a potential option for reducing congestion on the bridge.

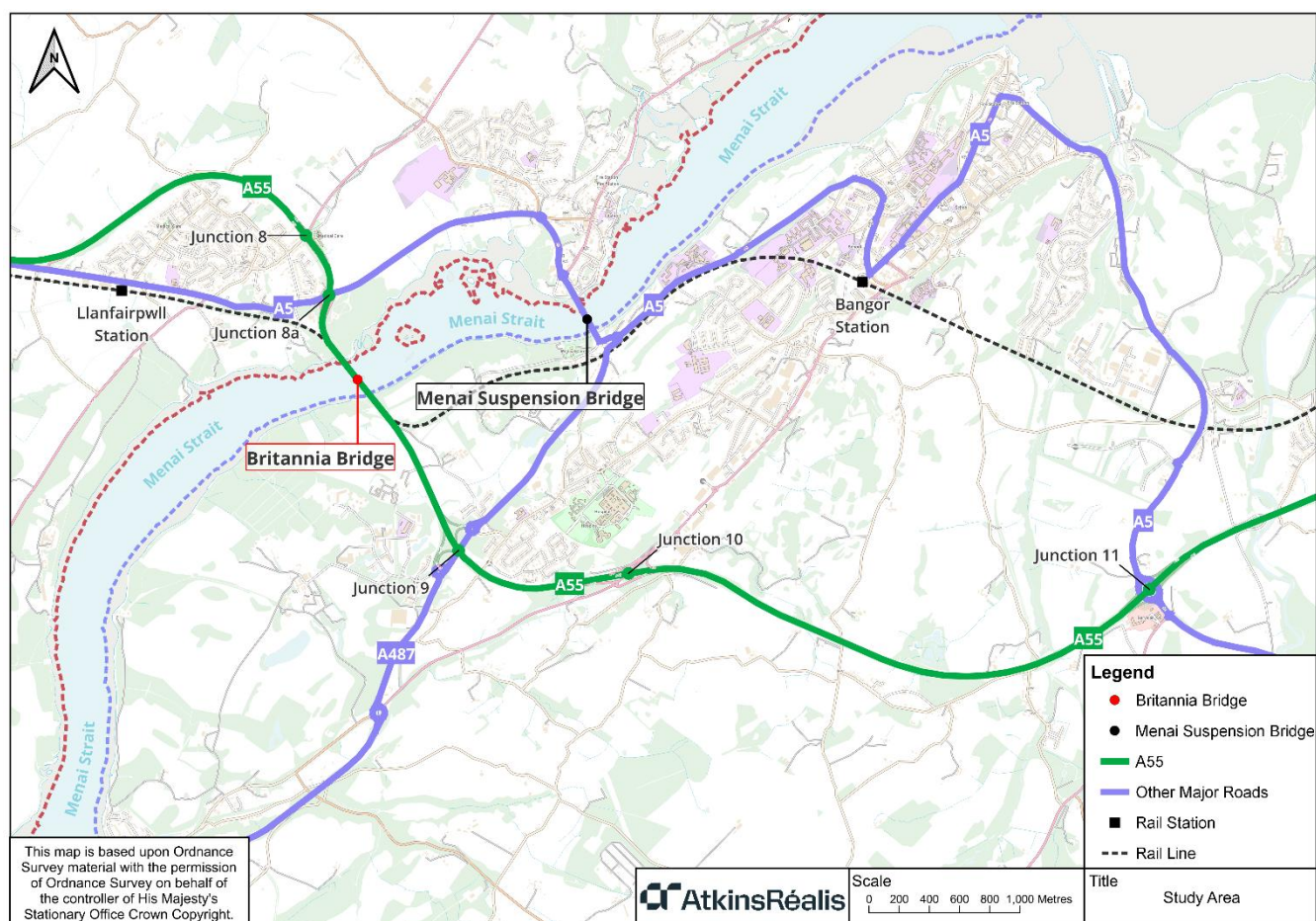


2. Context

The Britannia Bridge is a Grade II listed, two-deck structure spanning the Menai Strait and connecting the Isle of Anglesey with mainland Wales. The upper road deck carries the A55 trunk road between Junctions 8A and 9, while the lower rail deck carries the North Wales Main Line. The A55 carries around three-quarters of the total vehicular traffic crossing the Menai Strait and stretches from Holyhead on the Isle of Anglesey to Chester, near the England-Wales Border. It also forms a key link from Port of Holyhead to the rest of the UK, Ireland, and wider Europe for HGVs carrying freight. The A55 and wider transport network around the Menai Strait is shown in Figure 2-1.

A key challenge on Britannia Bridge and the surrounding road network is the limited capacity for traffic crossing the Menai Strait. Britannia Bridge is a key crossing that experiences high traffic volumes and can be affected by disruption caused by incidents, breakdowns and adverse weather. Table 2-1 shows the key challenges and subsequent issues that these challenges cause. Approximately 34,000 vehicles cross the bridge each day (both directions¹).

Figure 2-1 – Map of Menai Strait



¹ 2023 data

Table 2-1 – Key Resilience Challenges

	Congestion	Rat running	Collisions
Challenge	Regular congestion on both the Eastbound and Westbound carriageways	It has been reported that 'rat running' occurs at 2 locations	Most common type of collision is nose-to-tail suggesting that collisions occur due to congestion
Impact	▪ Delays ▪ Increased collision risk ▪ Economic disbenefit and disruption to local communities	▪ Increased collision risk ▪ Increased traffic volume on these routes ▪ Reduced quality of life in residential areas	▪ Injury to road users ▪ Delays

3. Previous Studies

Several studies have previously been undertaken to investigate opportunities to improve the operation and resilience of the crossing. These studies have informed this safety risk appraisal and are summarised in Table 3-1.

Table 3-1 – Previous Britannia Bridge studies

Date	Study title	Description
2008	A55 Britannia Bridge Improvements Feasibility Study	Assessed options for introducing three-lane running on Britannia Bridge to increase capacity and improve network performance.
2015	A55 Britannia Bridge Narrow Lane Options: Safety Risk Assessment Summary Report	Evaluated the operational safety implications of introducing narrow lanes and tidal flow operation on Britannia Bridge using the trunk road Safety Risk Assessment process.
2025	Menai Resilience Study	Considered how the operational safety of the network could be managed if measures to improve resilience on Britannia Bridge and Menai Bridge were implemented. Assessed whether Intelligent Transport System (ITS) measures could improve resilience on the A55 corridor using available traffic, collision and infrastructure data.

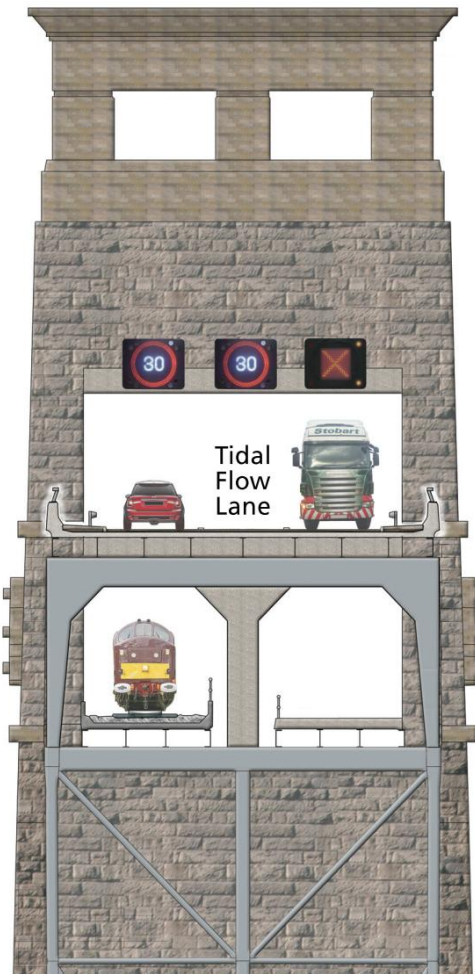
3.1 2008 Study

In 2008, Atkins (now AtkinsRéalis) produced a summary options report for the A55 Britannia Bridge Improvements – Feasibility Study, hereafter referred to as the ‘2008 Study’. This study produced plans for a number of options with road layouts. The proposed tidal flow option showed three running lanes across the bridge:

- Eastbound – 3.5m – outer main running lane
- Westbound – 3.5m – outer main running lane
- Tidal – 3.0m – dynamic, reversible tidal lane

The 2008 Study indicated that there is space to incorporate a central tidal flow lane, and this can be accessed from lane two of the dual carriageway approaching in both directions. The proposal included the use of Automatic Motorway Indicators (AMIs) on the bridge portals to reinforce lane control, as illustrated in Figure 3-1.

Figure 3-1 – Tidal flow cross-section at bridge portal with the tidal flow lane open



The plans indicated four gantries on the approach to the bridge in each direction, designed to manage traffic flow into the tidal flow system. Additionally, the plans show one gantry in each direction after the bridge to signal the end of lane restrictions.

The findings from the study indicated that the most appropriate option to take forward was a new low-level bridge based on Option C, the new multi-span bridge, as it solved the congestion problem, provided greater network resilience, provided positive cost benefits and had the least environmental impacts of the viable option.

3.2 2015 Study

In 2015, Atkins (now AtkinsRéalis) produced a summary report on the A55 Britannia Bridge narrow lane options, hereafter referred to as the '2015 Study'. This report reviewed the options for three lanes running across Britannia Bridge. Building on the previous work and still proposing the same physical layouts as the 2008 Study, including the same lane width dimensions. Three options were considered:

- Option 1: Fixed lane arrangement with two lanes eastbound and one lane westbound.
- Option 2: A full-time tidal flow arrangement, allowing an additional lane to operate in the peak direction of travel throughout the day.
- Option 3: A part-time tidal flow arrangement, with an additional lane operating in the peak direction during busy periods only and the central lane closed during off-peak periods.

The 2015 Study examined the potential safety implications of each option and evaluated how they could affect the operation of the bridge. The findings helped inform the understanding of the risks and benefits associated with introducing narrow lanes and tidal flow operation on the crossing. The findings provided an evidence-based understanding of the safety implications of tidal flow operation and informed subsequent assessments of the proposal.

Key findings from the 2015 Study are as follows:

- The potential misuse of the central lane is one of the key safety risks associated with tidal flow operation.
- Speed limit reduction on the bridge to 30mph could reduce the severity of resultant head-on collisions from fatal to serious or slight.
- The importance of reliable technology and traffic management systems was highlighted.

Following the completion of a Hazard Log, the study concluded that the available evidence suggested that the significant safety concerns raised in previous studies remained. The potential mitigation measures identified did not appear to reduce the level of risk associated with the narrow lane proposal to an acceptable level and thus it was recommended that the proposal should not be progressed further.

3.3 2025 Study

In 2025, a Menai Resilience Study (hereafter referred to as the “2025 Study”) was undertaken to review various measures that could be implemented to improve the resilience of the Menai Strait crossings. As part of this, various traffic management options on Britannia Bridge were considered, one of which being the tidal flow system that is the subject of this appraisal. Other traffic management options included:

- Queue protection on the approaches to Britannia Bridge
- Overarching traffic management system to manage bridge restrictions and closures
- Ramp metering at A55 Junction 8a on-slip, primarily to address local rat-running
- Fixed three-lane option on Britannia Bridge

The fixed three-lane option was put forward in the 2025 Study and was based on an option that was originally explored in 2008. This option proposed two permanent Eastbound lanes on the bridge, given that the benefits obtained from reduced congestion would be greater in the Eastbound direction. A recommendation was made in the 2025 study to further investigate the feasibility of² a fixed three-lane option. However, this appraisal has focussed on the tidal flow at peak times only option as it provides more flexibility and addresses peak flows in both directions rather than just an eastbound direction. Following the 2025 Study, the North Wales Transport Commission published a statement³ detailing its recommendations, one of which was to conduct a risk assessment to assess the safety, suitability and practicality of a three-lane tidal flow system on Britannia Bridge.

² [Written Statement: Menai Resilience Study \(6 November 2025\) | GOV.WALES](#)

4. Safety Risk Appraisal

A Safety Risk Assessment (SRA) was carried out on the tidal flow proposals as part of the 2015 Study. This appraisal reviewed the previous work to determine whether the findings were still relevant and valid. SRAs are carried out in accordance with GG 104 Requirements for Safety Risk Assessment,

The appraisal sought to answer the following question:

“Based on the evidence currently available, is the operation of Britannia Bridge with narrow lanes and tidal flow acceptably safe for affected populations in safety risk terms?”

In layman’s terms, this question can be broken down further into a series of tests to more practically spell out what is meant by “acceptably safe”. These tests are:

- The total level of road user risk of the tidal flow is less than the existing.
- No road user group is disproportionately affected in the risk assessment
- Risks to all populations can be reduced ‘so far as is reasonably practicable’ (SFAIRP)

4.1 Review of Similar Schemes

As part of the 2025 Study, a desktop exercise was carried out to research and review information on tidal flow examples around the world to identify best practises. Several of the schemes reviewed share characteristics with the proposed tidal flow arrangement at Britannia Bridge.

In particular, the Tamar Bridge in Plymouth is considered the closest comparator to the proposed Britannia Bridge tidal flow arrangement because it combines narrow lanes on a bridge with a reversible central lane and no physical barrier. However, several important differences should be noted:

- Unlike the Britannia Bridge, the Tamar Bridge does not have listed status and therefore the tidal flow infrastructure on the bridge was more straightforward to implement.
- An additional segregated traffic lane is provided on the eastbound side of the Tamar Bridge. This lane was added as part of the widening of the Tamar Bridge in 1999-2001 by adding cantilever decks to the sides of the bridge. This additional lane is hence physically separated from the main tidal flow carriageway.
- There are toll booths on the eastbound carriageway after crossing the bridge and average speed cameras in the Saltash Tunnel immediately before/after the bridge, which provide a degree of speed control.

4.2 Constraints

The implementation of tidal flow on Britannia Bridge is physically constrained by the road space available. The width across the bridge and through the towers measures 10m. Considering the recommended lane width of 3.65m and that three lanes are required for a tidal flow layout, narrow lanes and/or non-compliant lane widths across the bridge would have to be adopted for tidal flow to be feasible. As a result, the following lane widths were proposed in both the 2015 and 2025 studies:

- Eastbound – 3.5m – outer main running lane
- Westbound – 3.5m – outer main running lane
- Tidal – 3.0m – dynamic, reversible tidal lane



It should be noted that, due to the nature of the narrow tidal lane, it would need to be restricted to light vehicles only. To allow for such road layout, changes to the central reserve and the main carriageway alignment approaching the bridge would need to be made to make space for the transition into the tidal flow system. However, it has been noted that this will likely incur significant costs.

Additionally, Britannia Bridge is designated as a Grade II listed structure and is therefore recognised as a structure of special interest. The installation of overhead gantries on Britannia Bridge as suggested in previous tidal flow proposals would ultimately change the appearance of the structure and this is a concern highlighted by the Welsh heritage organisation known as CADW.

4.3 Moveable Barrier Option

This appraisal included consideration of the feasibility of operating a moveable barrier on Britannia Bridge to facilitate tidal flow operation by providing physical separation between the tidal flow lane and traffic moving in the opposing direction.

A barrier would need to be moved into place during tidal flow operation to separate opposing traffic flows and then stored on the bridge during off-peak periods. An example of a moveable barrier which is used to facilitate contraflow on the M20 during Operation Brock is shown in Figure 4-1.

Figure 4-1 – Moveable barrier in use on M20

Movable barrier system deployed on the M20, providing physical separation between opposing traffic flows during contraflow operation



Review of examples both in the UK and worldwide identified significant challenges that would impact the feasibility of this option on Britannia Bridge, including but not limited to:

- **Spatial requirements** – the cross-section required for the barrier would mean it is not suitable for deployment on Britannia Bridge, as the barrier itself would be 460mm wide. Allowing for storage/deployment, set back and working width would remove any space for additional lane capacity.
- **Time and cost to deploy/operate?** – this system requires a dedicated team to deploy the barrier and associated traffic management. The cost of deployment may be impractical when deployed on a twice-daily basis as would be required on Britannia Bridge.
- **Safe system of work** – If this system was to be deployed on a live carriageway on Britannia Bridge, the spatial requirements and overall operation of the zipper machine would need to be risk assessed to understand if a safe system of work was possible. Bridge closures would likely be required to allow the barrier to be moved into place between lanes.

The challenges set out above indicate that a moveable barrier system on Britannia Bridge to facilitate tidal flow would not be viable. The bridge's cross-sectional constraints would make the system impractical, and any potential benefits would be outweighed by the operational challenges and costs.

4.4 Collision Data

In appraising the safety of a potential tidal flow system, it was necessary to review the current safety performance of Britannia Bridge and its approaches from Junction 8a and Junction 9 of the A55. The collision data for the period 1 January 2019 to 31 December 2024 was reviewed and summarised in Table 4-1.

Table 4-1 – Collisions on Britannia Bridge – Summary (2019 – 2024)

Total No. of collisions	Killed or Seriously Injured (KSI) %	Dark %	Wet %	Common Factors
13	46	31	15	6 rear-end shunt (4 westbound, 2 eastbound) 3 motorcycle collisions

Thirteen collisions were recorded on Britannia Bridge in the six-year period between Junction 8a and Junction 9 resulting in 21 casualties. Two of the collisions were fatal, 4 were serious and 7 were slight injury collisions.

The most common type of collision on Britannia Bridge was nose-to-tail, suggesting that collisions are occurring because of congestion, particularly in a westbound direction. On the bridge itself, all the collision resulted in slight injury. On the approaches on the bend on the north-western side of the bridge there is a cluster of collisions with one fatal and two serious collisions in that location. This indicates that the main safety concerns are concentrated on the bridge approaches. 23% of collisions involved motorcyclists. Two of the motorcycle collisions resulted in serious injury and in both incidents the motorcyclist was weaving or filtering through traffic. Eleven of the 13 collisions involved multiple vehicles.

As a whole, the injury collision rate on Britannia Bridge between 2019 and 2024 was 0.09 eastbound and 0.06 westbound which both exceed the average rate of 0.02 (2019 to 2024) for A roads in Great Britain. Furthermore, the North Wales Transport Commission note that ‘the collision rate at the A55 Britannia Bridge is around twice as high as other sections of the trunk road network in north Wales’.

4.5 Hazards

For the purpose of this appraisal, the seven hazards that were identified in the 2015 Study as having the highest level of risk have been reviewed to establish the extent to which the proposed tidal flow system would affect the current risk level. These risks are described below:

- **Vehicle encroachment in adjacent lane** (travelling in the same direction) - Narrow lanes can increase the likelihood of vehicles encroaching on the adjacent lane and therefore the risk of a side swipe collision or nose to tail collision as a result of unexpected braking is increased.
- **Vehicle passes close to bridge towers** - Narrow lanes can increase the likelihood of vehicles colliding with the bridge structure and therefore the risk of a collision with the bridge structure is increased.
- **Abnormal loads overhanging lane** - Under tidal flow operation the lanes will be narrow and therefore an abnormal load is more likely to overhang into the oncoming traffic lane during tidal flow operation.
- **Errant vehicle** (vehicle leaving lane) - There is an increased risk of a vehicle leaving the carriageway and colliding with the safety barrier under tidal flow due to reduced lane widths.
- **Driver misinterprets road layout** - When tidal flow is in operation, drivers who are unfamiliar with the bridge may not understand how to navigate the open and closed lanes, increasing the risk of collisions.



- **Misuse of central lane** - As a result of the central lane which will only be in use during tidal flow operation, drivers may deliberately use the lane for overtaking during other time periods and risk a head-on collision with opposing traffic.
- **Technology failure** - If the lane signals were to fail during tidal flow operation, this could result in a head-on collision if opposing traffic in both directions enters the central lane.

4.6 Potential Mitigation Measures

A range of mitigation measures in the current tidal flow design proposals were identified as being potential methods to reduce the risk in relation to the hazards described above. The mitigations measures are:

- Fixed 30mph speed limit
- Average speed enforcement cameras
- Queue protection
- Real time traffic information
- Double white lines to discourage lane changing on the bridge
- Red surfacing in central tidal flow lane
- Closed Circuit TV (CCTV)
- Overhead signal gantries with Advanced Motorway Indications (AMIs) (signals mounted above each lane)

4.7 Risk Analysis

Table 4-2 shows the outcome of the risk analysis of each of the seven high-risk hazards mentioned above, comparing the existing risk of the current bridge layout versus the risk with the tidal flow system in place with appropriate mitigations.

Table 4-2 – Risk analysis of high-risk hazards

Hazard	Risk (existing)	Risk (with tidal flow)
Vehicle encroaching in adjacent lane (in same direction)	Low	Low
Vehicle passes close to bridge towers	Low	Medium
Abnormal loads overhanging lane	Low	Medium
Errant vehicle (vehicle leaves lane)	Low	Medium
Driver misinterprets road layout	Low	Medium
Misuse of central tidal flow lane	Low	Medium
Technology failure	Low	Medium

As shown in Table 4-2, the safety risk increases for six of the seven high-risk hazards identified with a tidal flow system in operation, even with appropriate mitigations in place.

5. Stakeholder Engagement

Prior to finalising the appraisal, the initial findings were presented to the key stakeholders during virtual stakeholder engagement sessions held on Monday 10th August and Thursday 13th August 2026. Stakeholders unable to attend the meetings were also given the opportunity to provide feedback by email. The key stakeholders who were invited to provide feedback on the initial findings of the appraisal are listed below:

- Welsh Government
- Anglesey County Council
- Gwynedd Council
- NMWTRA
- UK Highways
- CADW
- Network Rail
- North Wales Fire & Rescue
- Welsh Ambulance Service
- North Wales Police
- NHS Wales

Feedback provided by the stakeholders during the engagement sessions has been considered in the process of finalising the appraisal. The key discussion points explored during this process and the responses to those points are detailed in Table 5-1.

Table 5-1 – Stakeholder Feedback

Discussion Point	Response
How can the restrictions of use of the tidal flow lane be enforced?	This is one of the key challenges related to a tidal flow system. The risk of misuse of the central lane remains, whether deliberate or accidental.
Given the context of the area being largely rural with generally simple road layouts, is a tidal flow system too complicated for some road users?	The relative complexity of a tidal flow system has been considered in the hazard “Driver misinterprets road layout”.
As the Britannia Bridge carries HGVs to/from Holyhead Port, including international-based drivers, a tidal flow system might be too complicated and increase risk of drivers leaving the bridge on the wrong side of the carriageway.	Yes, foreign HGV drivers are disproportionately affected by a tidal flow system, as this may be an unfamiliar system.
As the bridge is susceptible to high-wind events, have the implications of the proposed narrow lane layout been considered?	During high-wind events, the narrow lane layout would provide less room for manoeuvre and therefore closure of the tidal flow lane during such events would need to be considered.
For vehicles travelling westbound, there might be issues caused by drivers using the tidal flow lane and then cutting across traffic to exit the A55 at Junction 8a.	This appraisal hasn’t considered the specific signage required to mitigate this risk but would need to be considered in more detail.

Discussion Point	Response
Given existing issues regarding the merging of traffic from the on slip at Junction 9 of the A55 travelling westbound, how is this impacted by potential road layout changes before entering the bridge?	This would need to be carefully considered in the overall traffic management if a tidal flow system was considered.
There are challenges around the provision of gantries on the bridge, including the safe access of highway operative staff.	The installation of gantries for the operation of tidal flow has been considered in this appraisal as a significant environmental constraint. Workers on the bridge have been considered as potentially affected users.
How will emergency service vehicles travel across the bridge while the tidal flow lane is being used, particularly if travelling in the opposite direction to the tidal flow lane?	Tidal flow lane might provide emergency vehicles with easier opportunity to pass other vehicles on the bridge, although this is only relevant when the tidal flow lane isn't in operation. The potential for head-on collisions between emergency vehicles and opposing traffic using the tidal flow would need to be considered carefully.
Have the implications of cyclists using the bridge been considered?	Narrow lanes would reduce the space available for vehicles to safely pass cyclists. Cyclists on the bridge have been considered as potentially affected users.
Based on engagement with the team operating the Tamar Bridge tidal flow system, constant monitoring is required, which would necessitate new facilities and dedicated resources.	A control facility has been noted as a risk treatment. The cost of constructing and operating such a facility close to the Britannia Bridge would need to be considered in determining the viability of a tidal flow system.

6. Summary of Findings

The appraisal has provided evidence to determine if the safety “tests” outlined in Section 4 can be satisfied.

Test 1 - The total level of road user risk of the tidal flow is less than the existing.

No, the risk to users would be increased if tidal flow was to be introduced compared to the operation of the bridge now. Whilst this appraisal has explored and detailed new measures compared to the previous work there are no measures, existing or new, that are significant enough in their impact to achieve an acceptable outcome.

Test 2 - No road user group is disproportionately affected in the risk assessment

No, Foreign HGV drivers and motorcyclists have been identified as being disproportionately affected by the tidal flow proposals. This is due to the potentially confusing three lane layout which could be misinterpreted and lead to collisions. The narrow lanes could be a hazard to motorcyclists who would be unable to overtake without entering the tidal flow lane risking head-on collisions with oncoming traffic

Test 3 - Risks to all populations can be reduced SFAIRP.

Given that Tests 1 and 2 have not been passed, this final test is immaterial. However, there are several risk treatments that have been proven to be unpractical or unacceptable to third parties. Even with all of the measures deemed to be required, to demonstrate SFAIRP, the safety objective would still not be met.

This appraisal has concluded, based on the information available, that the introduction and operation of a tidal flow **could not be deemed as acceptably safe**. Further risk assessment activity could provide further rigour of analysis but there are significant hazards with no clear viable or effective risk treatments. As such this appraisal supports the conclusion of the 2015 SRA which stated that the bridge would operate less safely under tidal flow operation than under the existing layout.

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