

The Welbeck Estates Company Limited

A9 Trunk Road: Berriedale Braes

An overview of the options for improvement

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A9 Trunk Road: Berriedale Braes

1. BACKGROUND

Mr Anson MacAuslan, Factor to the Welbeck Estates Company Limited requested Colin JT Mackenzie to carry out an overview of the options available for improving the A9 Trunk Road at Berriedale in Caithness.

The background to this request was the Estate's concern that vague proposals for major improvements at Berriedale had been hanging over the estate and community at Berriedale for 20 years or more. The Estate was concerned at the impact this was having not just on the locality but on the wider Caithness community and economy. Despite the Estate having fully cooperated with investigations in the 1980's, the delivery of firm proposals for essential improvements to the road seemed as far away as ever.

The Delivery Plan prepared by The Highlands and Islands Transport Partnership (HITRANS) in support of their Strategy published in 2007 included a strategic network proposal for Berriedale Braes Crossing, provisionally programmed for 2013-2017. No details of this proposal are available at present although such a project will have to be assessed and prioritized by the major projects review currently being carried out by Transport Scotland. More recently, in September 2007, The Highland Council has expressed support for the construction of a 'flyover' at Berriedale, although again details are not available.

Given this background the Estate Company was keen to be advised of the range of alternatives that might be available for improving the road at Berriedale, not restricted to costly options that may never be built.

That is the brief for this overview.

2. THE OVERVIEW PROCEDURE

It is important to state at the outset that this report is based on desk study. It does not purport to provide preliminary designs but aims to set out a range of scheme options that may be available and to put these in context, enabling some valid comparison to be made. It has used OS digital photography and mapping in the corridor of the existing road and OS 1:25000 scale mapping in the wider area.

The traditional approach to a transport problem such as the Berriedale Braes was to devise a range of engineering schemes and then to compare the economic benefits of these to determine which was best. However transport projects in Scotland now require to be assessed differently, using the Scottish Transport Appraisal Guidance (STAG). This guidance ensures that proposals are ‘objective led’ and require much greater thought to go into the process of deciding what the project aims to achieve.

For example, a worthy objective might be to ‘Reduce the time taken to travel between Caithness and Inverness’. This reduction can be achieved by many different means, not just by improving the A9 and not just by improving it at Berriedale. The intention of this open-minded approach is to ensure that a wide range of options are considered, not just restricted to road improvements, and that the appraisal process is seen to be more than a justification of a previously determined engineering solution.

This has particular resonance at Berriedale where the proposal to construct a costly flyover has been discussed for over 20 years, as if that were the only option available. There are other ways to resolve the delays and unreliability of the existing A9 link and this report hopes to outline some of these.

3. TOPOGRAPHY AND GEOMORPHOLOGY

The topography at Berriedale provides one of the most challenging obstacles to travel on the East coast of Scotland. Once across the Dornoch Bridge, the A9 generally follows the undulating land close to the coast until at Helmsdale it is forced to climb steeply to a height of 250m to the Ord of Caithness to avoid the 150m high coastal cliffs. It then follows the plateau of Granite and Old Red Sandstone from there to Dunbeath, generally at an altitude of 150m.

The problem is that the Langwell and Berriedale rivers run in valleys, deeply incised in this plateau, and must be crossed somewhere. The confluence of the rivers is at the village of Berriedale, just inland from the coast, and this provides the benefit of a single crossing point, rather than crossing both valleys separately.



Fig 1 Wm Roy's Military Map

It is clear that this has always been the traditional preferred route, as shown on William Roy's Military Survey Map of 1747-55. The route was upgraded by Thomas Telford some 50 years later. Little changed in the following 150 years until increased traffic required widening, realignment and construction of new bridges in 1963.



Fig 2 Landslip below A9

Overlying the Old Red Sandstone and Granite rocks are extensive deposits of glacial and other origin. These deposits show clear signs of instability and erosion, particularly on the steep sides of the Langwell valley.

Some of this is obviously historic but other slips are more recent. One major slip has occurred near the top of the South Brae and requires monitoring to ensure that it does not encroach further towards the road.

Given this background it is essential that a full investigation of the ground conditions is required to underpin the choice of any of the preferred engineering option.

4. ENVIRONMENT

The environmental setting of the Berriedale Braes is exceptionally beautiful and a noted feature of the journey into Caithness. Indeed, and despite the engineering problems, it is viewed by many as one of the ‘classic’ sections of road in Scotland.

To protect this natural setting there are a number of formal environmental designations in place covering the rivers Berriedale and Langwell, the adjacent sea cliffs and the 130ha of policies of Langwell House and Gardens.

These designations have significant implications for any proposals which might impact directly or indirectly on these areas. The European SAC designation is in respect of Atlantic Salmon in the rivers and is extremely onerous. It would obviously pose a major constraint on proposals deviating from the existing road corridor and potentially affecting the rivers.



Fig 3 The Walled Gardens at Langwell

Title	Formal Designation
Langwell Lodge	Gardens and Designated Landscapes
Langwell Water	Site of Special Scientific Interest
Berriedale Cliffs	Site of Special Scientific Interest
Berriedale and Langwell Waters	Special Area of Conservation

Table 1 Environmental Designations

5. TRAFFIC VOLUMES

Traffic volumes have a major influence on the design and justification of road improvements. The A9 at Berriedale is fitted with a traffic counter and is routinely monitored together with 36 other motorway and trunk road sites in Scotland. The following table shows the Annual Average Daily Flow (AADF) at Berriedale compared to other monitored sites carrying below 12,000 vehicles per day AADF. The information is reproduced from Scottish Transport Statistics 2007.

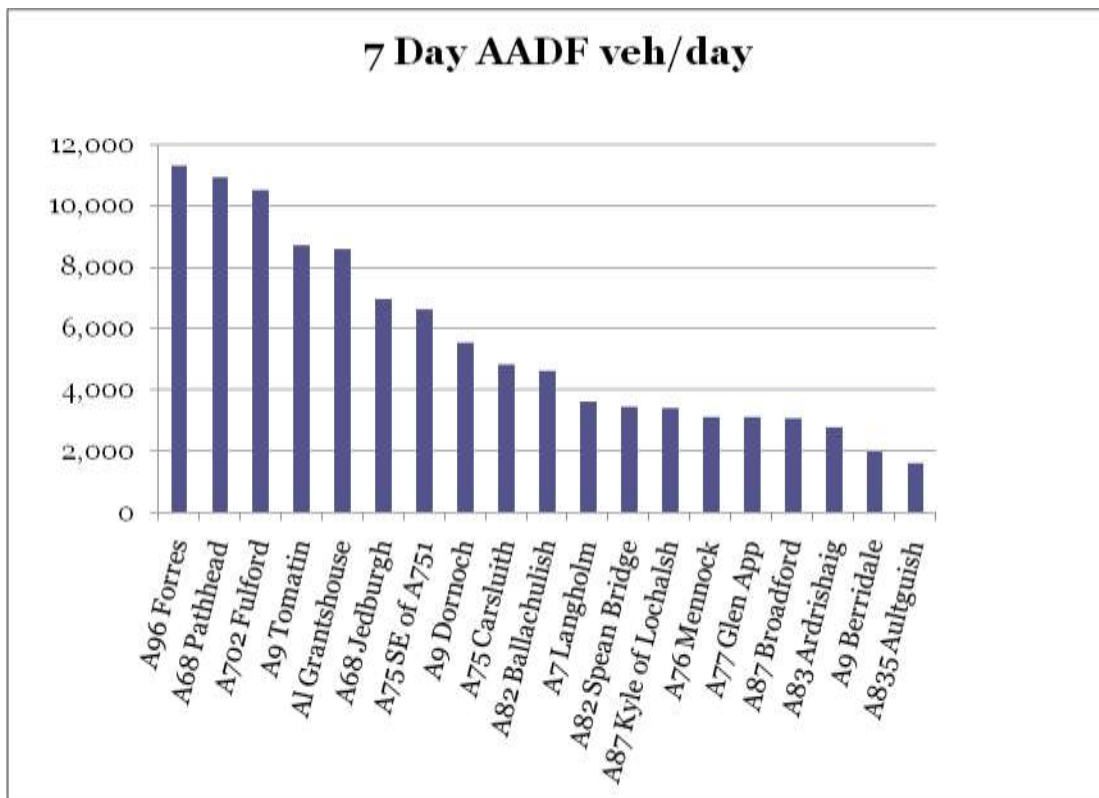


Fig 4 Graph showing Trunk Road flows at monitoring sites <12,000vpd

This graph shows that the traffic flow at Berriedale is the second lowest of the recording sites, although there are likely to be other trunk road links with lesser flows not covered by this data.

The following chart shows how the Annual Average Daily Flow of traffic at Berriedale have changed over the last 18 years, with flows at Dornoch for comparison. The information is based on Scottish Transport Statistics 2007, with the addition of historic information for 1988 and 1990.

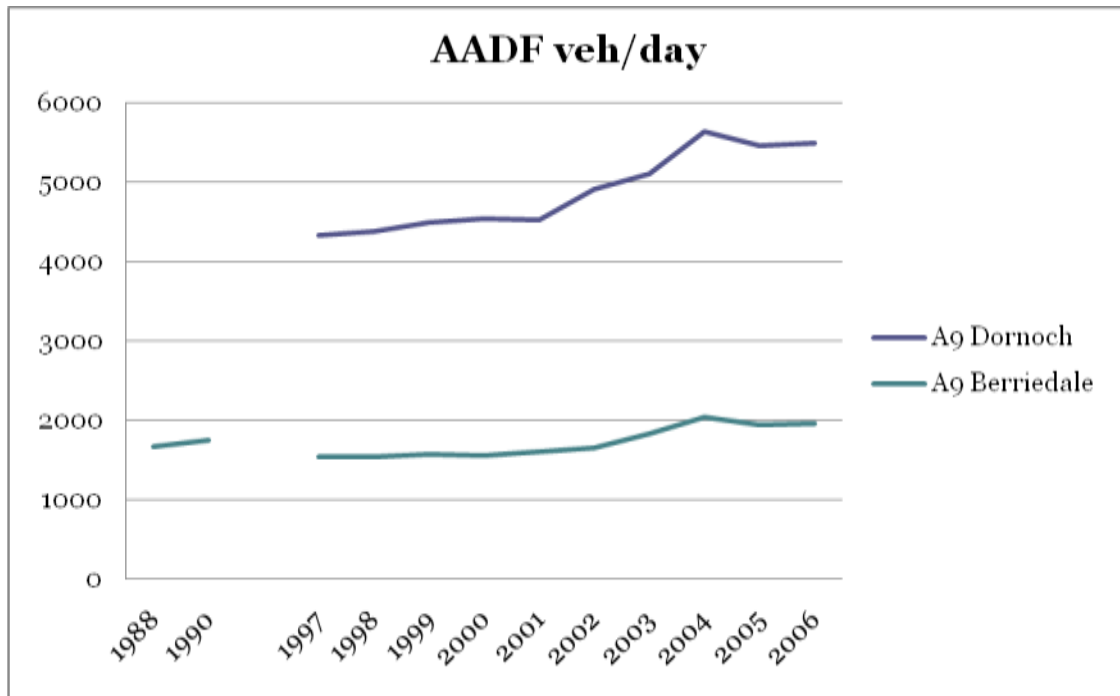


Fig 5 Graph showing A9 flows at Dornoch and Berriedale

It can be seen that the flows at Berriedale have only increased by an average of 1% per annum over this period, compared to the 3% per annum at Dornoch. This difference can be ascribed to the increase in commuter traffic and economic links between East Sutherland to Inverness and the Inner Moray Firth in recent years.

Looking to the future, the volumes on the A9 at Berriedale can be expected to increase but will always be constrained by the peripheral location and limited population base. Unless more freight is diverted to rail it can be speculated that heavy goods traffic might increase disproportionately as haulage of timber, onshore oil and traffic related to Scrabster Harbour increase.

Increasing traffic volumes are only part of the justification for improvements at Berriedale. The A9 is a vital community and economic link and increasing concern has been expressed about the manner in which it can be disrupted, particularly by vehicles blocking the North Hairpin at Berriedale. When this arises the only feasible diversion is via the single track A897 Helmsdale to Melvich route which is totally unsuited to heavy vehicles. With major retailers and key industries relying heavily on 'just in time' deliveries, this type of disruption can have major knock on effects and must be eliminated if the economy is not to suffer.

6. THE VIADUCT OPTIONS

The lack of available plans of the viaduct options has been mentioned above and this overview has had to start from the beginning. It is clear that there are three broad options for viaduct solutions, although these will have many potential variants. These options considered are:

- High level viaducts (shown yellow on plan below)
- Lower level inland viaducts (shown red on plan below)
- Online viaduct

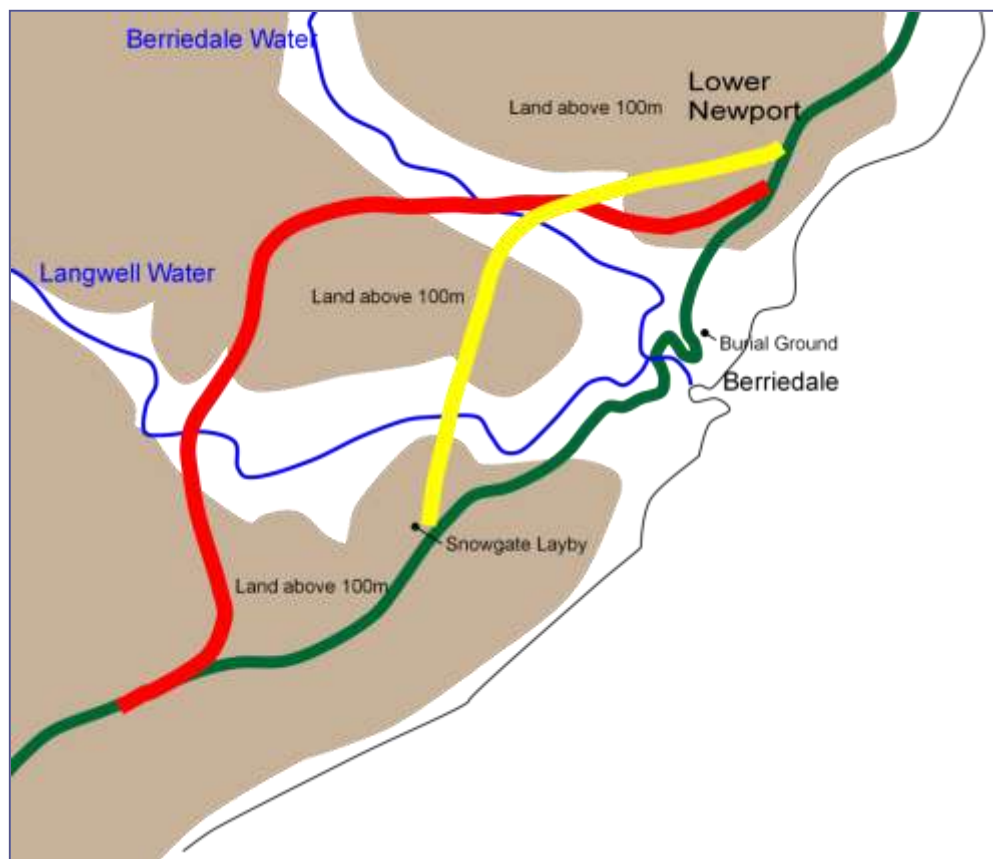


Fig 6 Plan showing corridors of High Level and Inland Viaducts (existing road shown green)

6.1 HIGH LEVEL VIADUCTS

The purpose of a high level viaduct would be to minimize the effect of topography on traffic by spanning between the high ground north and south of Berriedale, avoiding the need for 150m of descent and subsequent ascent. It is assumed that this option is what the public widely perceive as the ‘flyover’ option.

To span the single valley from the Snowgate layby to Lower Newport would require a structure of over 2km which can realistically be ruled out on grounds of cost. By way of comparison, this structure would need to be more than twice the length of the Dornoch Bridge, and many times as high.

A more realistic line for a high level viaduct would be to cross the Langwell valley from the Snowgate layby to the ridge west of Langwell House at a level of 100m. The gap to be crossed would be about 350m, followed by a 600m road link to a second viaduct to cross the Berriedale Water. Unfortunately this viaduct would have to be even longer, some 4-500m, if the level was to be sustained at 100m.

This raises a number of challenging issues:

- With the bridges totalling some 800m in length these would be major structures with associated high cost.
- Given the evident instability of the valley sides it would be optimistic to assume foundations would be straightforward
- These bridges would be 70-80m above the valley floors. To put this in context the Erskine and Forth bridges have shipping clearances of 38m and 50m respectively.
- The road decks of these bridges would be among the highest (if not the highest) in Scotland
- Closure to high sided vehicles during windy conditions would be a significant risk.

6.2 LOWER LEVEL INLAND VIADUCTS

To avoid the problems and costs associated with a high level option, lower level structures have also been considered. This option would require the road to be directed inland to lose height.

A key feature of these designs would be the choice of maximum gradient. The existing gradient at Dunbeath is signed at 10% and this has been used for the desk study. However the provision of two low level viaducts would involve four gradients and it can be argued that 10% is excessive

for major new build project. Compared to the existing road these gradients would be more susceptible to icing in winter conditions being inland from the coast. This would be a major factor to be considered.

This route option would swing inland, from a point 150m high 1.5km south of the Snowgate layby and follow the contours down the side of the Langwell valley, crossing the river to the west of the Gardens. The road would then have to climb up to a level of 140m before dropping down again into the Berriedale Water valley, before another long ascent to 130m at Lower Newport.

The final design would be a trade-off between gradient, the amount of earthworks and the cost of the bridges but it is clear that two very major structures would still be required. In lay terms, the viaduct on the Langwell Water would be similar in scale to the Dunbeath viaduct with the Berriedale Water viaduct being considerably larger and higher.

It is beyond the scope of this investigation to carry out more detailed investigation but the challenges faced are clear. These include:

- The evidence of instability mentioned above
- The difficulty providing overtaking opportunities on a curving alignment without the provision of extensive crawler lanes
- The need to avoid winter maintenance problems (north facing slopes, steep gradients, deep cuttings)



Fig 7 The deep valley of Berriedale Water is a major challenge to bridge

6.3 ONLINE VIADUCT

The most difficult section of the existing road is the lower part of the Braes and this could be bypassed by a viaduct following the corridor of the existing road but running over it. This can be compared to the situation at Dunbeath where the former trunk road has been bypassed.

The obvious place for this structure would be to start north of the north hairpin at a level of 55m, spanning over the river valley and the Berriedale village before meeting up with the existing South Brae. The bridge would be in the form of a sag 4-500m long and the lowest point would be 40-50m above the village.

This would be a substantial structure in itself, about twice as long and twice the height of Dunbeath Viaduct. It would be difficult to build in the congested space available and without encroaching on the Special Area of Conservation. It would clearly dominate the village.



Fig 8 Dunbeath viaduct. Viaducts at Berriedale would be very much longer and higher

7. ALTERNATIVE SOLUTIONS

In considering the alternative solutions that might be available, it is helpful to identify and address the key deficiencies of the existing alignment. These are considered to be:

- The north Hairpin Bend
- The gradient
- The lack of overtaking opportunities

7.1 THE NORTH HAIRPIN BEND

The North Hairpin Bend is the biggest single challenge for heavy goods vehicles on this route. The existing road is constrained by a 4m high retaining wall on the downside and a 2-3m high wall on the high side. This upper wall retains an 11m wide slope; at the top of which lies a drystone wall. This wall in turn retains the old burial ground.



Fig 9 4m high retaining wall below North Hairpin Bend

Properly engineered hairpin bends need not cause difficulties and it is the combination of extreme gradient, tight radius and lack of width that cause the problem at Berriedale. This is particularly the case for northbound long and heavy vehicles. The lack of forward visibility means that a driver unfamiliar with the road seeking to follow the tight inside kerb is likely to lose traction, leading to stalling, jack-knifing and road blockage. More experienced drivers routinely overcome this problem by swinging over to the southbound lane although this is not without its hazards for oncoming vehicles.



Fig 10 View of retaining walls and burial ground above North Hairpin Bend

There is an understandable reluctance to encroach on burial grounds when widening a road and other options will almost always be preferred. However, where there are serious topographical constraints or where cost becomes a critical factor, the option has to be considered.

There is legislation in place which deals with this matter, ensuring proper consideration is given and appropriate procedures put in place for carrying out any work in a burial ground. About 25 years ago, the A9 in Golspie was widened by encroaching into the burial ground at St Andrew's Church, without major difficulty.

In carrying out this desk study it is assumed that the burial ground should be avoided. Two separate options have therefore been considered for resolving the hairpin problem. These are:

- A 100m minor improvement involving widening and realigning the existing road, on front of the burial ground.
- A 350m diversionary alignment, to the north of the burial ground.

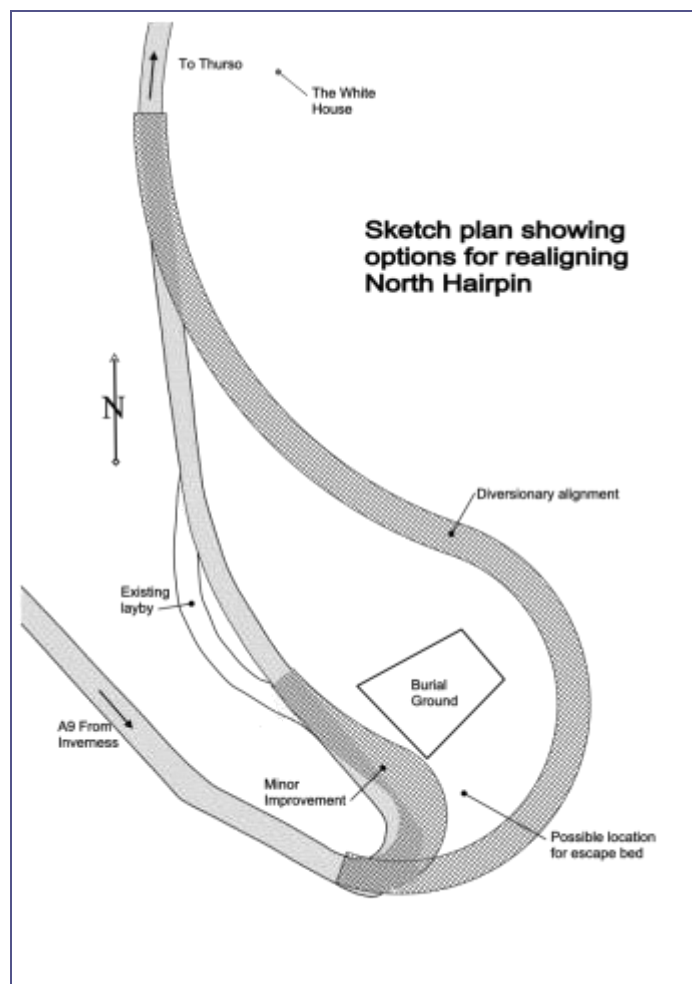


Fig 11 Sketch Plan showing options for realigning North Hairpin

7.1.1 North Hairpin Bend Minor Improvement

The options available for widening are restricted by the retaining walls mentioned above and the steep sidelong ground. There is little doubt that these factors would have weighed heavily in the design of the improvement scheme in 1963, given the difficulty of building the walls whilst ensuring traffic flow was maintained.

Modern plant and construction techniques mean that there are now other options and it would seem possible to widen the road either by constructing a higher retaining wall on the down side or moving the topside retaining wall back towards the burial ground.

On balance, and in the absence of any soils information, the latter option appears the best, although a preliminary design exercise would look at both options or a combination of the two.

This proposal would involve constructing a new retaining wall immediately on front of the existing burial ground wall, about 10m behind the existing wall. The method of construction will depend on the underlying ground conditions, although it is interesting to note that rock outcrops in the roadside ditch some 50m to the north. Constructing this wall and keeping traffic flowing will be a challenge but if access can be gained from the Estate land to the east it may well be possible to carry out much of the work behind and with the existing wall still in place.

This would roughly double the road width ensuring two long vehicles can pass, as well as easing the inside radius and gradient. The effectiveness of this solution can be gauged from observation of existing northbound trucks which cope well provided they cross to the southbound lane.

A further advantage of this option is that it would lend itself to the installation of an escape bed at the hairpin in the 'straight on' position where it is most needed.



Fig 12 A well driven truck can stay within the southbound lane



Fig 13 A heavily laden Northbound truck has to swing wide to take the bend

7.1.2 North Hairpin Bend: Diversionary Alignment

A diversionary alignment bypassing the hairpin has been included as an alternative. This might be a potentially superior, if more costly option. The key benefit of this option would be that the better alignment would enable trucks to keep up forward momentum on a consistent gradient.

This option would require a major cutting some 200m long and up to 15m deep round the north side of the burial ground. Forward visibility may be substandard without encroachment on the burial ground itself and this would require more detailed study. In addition, a soils investigation is essential as the route crosses what appears to be the upper limit of a historic coastal landslip and this would also require detailed assessment.

The cutting would result in the excavation of 50,000 cubic metres of material, some of which is likely to be rock. This material would have to be disposed of as taxable waste unless a beneficial use can be found. The logical option would be to use the material directly on planned road improvements, for example by widening and realigning the trunk road further north at the Borgue. This would improve safety and facilitate overtaking in a highly cost effective manner.

7.2 THE GRADIENT

The gradients of up to 13% at Berriedale are very much a function of the difficult topography and apart from constructing high level viaducts there is not a lot that can be done to eliminate them. Their impact is greatest on heavily laden vehicles going both uphill and downhill. As a result light vehicles and passenger cars are held up and form into ‘platoons’ trying to overtake.

The effect of this is exacerbated by the lack of overtaking opportunities which is covered in the next section.



Fig 14 A platoon of cars starting to form on the South Brae

7.3 THE LACK OF OVERTAKING OPPORTUNITIES

Whilst the A9 from Perth to the Dornoch Bridge has been constructed to modern standards, much of the road to the north is unimproved and suffers from a serious lack of overtaking opportunities. This is particularly the case from Brora to Latheron. In this 47km (30miles) there are currently only two overtaking opportunities providing the full visibility to comply with modern design standards.

As a result of this, any bunching of traffic caused by the Berriedale Braes cannot be quickly dispersed and this leads to increased frustration and risk of accidents. The majority of traffic on this section of the A9 is long distance heading to and from the Inner Moray Firth and beyond and these delays and frustration must be seen in the light of missed hospital and business appointments, rail and air connections.

This study has considered the opportunities that might be available to improve overtaking in the area.

7.3.1 North Brae.

Unfortunately the North Brae does not immediately lend itself to the addition of a low cost overtaking lane because of the number of private accesses requiring right turn provision. It might be possible to restrict right turning by providing alternative facilities and this would merit further investigation. Otherwise it would seem to be more cost effective to provide overtaking opportunities further north by carrying out a major project of realignment in the Borgue-Ramscaigs area.

7.3.2 South Brae

Two options have been considered for improving overtaking provision on the South Brae:

- Improving visibility to enable uphill overtaking
- Provision of a climbing lane

The top 600m of the South Brae comprises a right hand curve heading South. Forward visibility is currently restricted by tree growth on the inside of the bend and if this was able to be removed it would provide a valuable and low cost overtaking opportunity. It must be emphasised that this growth currently provides significant visual screening and noise attenuation for the Estate Policies. This would have to be carefully considered and mitigated but may not be acceptable to the Estate.

The provision of a climbing lane on the South Brae is relatively straightforward. Given the length of the Brae and the low traffic volumes a short climbing lane starting at the bottom bend might be adequate in the medium term. A climbing lane the full length of the Brae would generate a considerable volume of fill material and would best be programmed with other works which could use it. In addition the provision of a full length climbing lane would ensure the road was secured in the case of further landslips by providing extra width and benching into the hillside.

7.3.3 Overtaking opportunities elsewhere

There are several situations north and south of Berriedale where overtaking opportunities are compromised by roadside growth or other obstacles. In these situations, benefits can be gained out of all proportion to the modest expenditure required. Examples of these at Ousdale and Ramsbraigs are shown on the following photos.



Fig 15 Ousdale. Some bank clearance would enable 600m visibility.



Fig 16 Ramsraigs. Good visibility but a minor narrow bridge prevents overtaking

8. THE ROUTE IN WINTER CONDITIONS

The higher parts of the A9 in Caithness have always been susceptible to blockage in snow and ice conditions and it is important that this factor is included in any STAG assessment of the options. There can be little doubt that the road is blocked for many more hours each year by snow and ice than it ever is by trucks stuck at the North Hairpin.

Concern has been expressed above about the impact of wind on high level viaducts, and the risks of moving the road with steep gradients inland, away from the warming effect of the sea.

Following the exceptional blizzard in February 1978, the Estate co-operated fully with the then Scottish Office in the planting of extensive shelter belts on the road between the Ord of Caithness and Berriedale. These have proved highly successful and it is worth noting that the road inevitably blocks now to the north of Berriedale, where drystone walls and cuttings close to the road encourage drifting. Dealing with these problems in a comprehensive manner would be highly cost effective in terms of improving the security of the route.

9. A HISTORY OF DELAY

In order to objectively assess the likelihood of major improvements happening at Berriedale it is important to have an understanding of the history of this and other projects on the A9 north of the Dornoch Bridge.

Despite approaches to Transport Scotland, HITRANS and The Highland Council it has not been possible to obtain plans of the ‘flyover’ proposed for Berriedale. It is understood that some preliminary work was done for the former Scottish Office by consultants in the 1980’s but the extent of this work is unclear.

The Secretary of State for Scotland is reported in Hansard in 1990 as advising that a 5km scheme at Berriedale was at the stage of ‘economic assessment not yet available’.

A Route Action Plan for the A9 north of the Dornoch Bridge was proposed by the Highland Regional Council in 1991. Four years later in 1995 the Secretary of State confirmed that ‘the case for improvements at Berriedale Braes will be examined as part of the A9 Route Action Plan’. When this plan was eventually produced in 1996 it only made mention of the need for examination of larger scale improvements at the Berriedale Braes in ‘the medium term’. It appears that this has yet to be done, despite 20 years having passed since the scheme was first proposed.

It is interesting to note that the 1990 report by the Secretary of State also confirmed that five other major projects were then at the same stage as the Berriedale proposal. These are shown in the table below:

Project	Location	Length (km)	Current status (2008)
Windyhouse-Borgue Bridge	Caithness	2.8	Project not advanced
Crackaig-Culgower	Sutherland	1.8	Project not advanced
Portgower-Greenpark	Sutherland	1.6	Project not advanced
Brora Bypass	Sutherland	2.5	Project not advanced
Helmsdale-County Boundary	Sutherland	5.2	Phase 1 completed, Phase 2 under construction

Table 2 A9 Major Improvement Programme in 1990

In addition to the above projects, which were at least included in the then programme, a number of other major projects on the A9 north of the Dornoch Bridge have been proposed such as the Cambusavie Bends and Golspie Bypass. The total cost of these unfulfilled projects, is of the order of £30-40M.

10. ASSESSING THE OPTIONS

It may be concluded from the above history that whilst the Berriedale project is viewed locally as a high priority, it is still some way from being realized. Looking at the matter objectively, it is clear that a trunk road carrying 2000 vehicles a day will always have to struggle to justify high expenditure against competing priorities from other parts of Scotland. The review that the Scottish Government is currently carrying out of major transport proposals will not just compare the user benefits of a Berriedale project against road projects elsewhere but against different modes of transport across Scotland.

Putting this in perspective, is a £30M+ Berriedale project likely to come out of this process above dualling the A9 Perth to Inverness or bypasses for Keith, Elgin and Nairn on the A96? Even closer is it more beneficial to motorists from Caithness and Orkney than improvements at Cambusavie Bends or a climbing lane over the Black Isle between Tore and the Cromarty Bridge? Is it more desirable than improvements to the Far North Railway line? These are the challenging questions and comparisons that the STAG assessment will tease out and on which politicians will eventually decide.

Another problem that must be faced is the possibility of a costly Berriedale project actually being placed in a medium to long term programme, such as it has been in the HITRANS strategy document. This might be viewed as a success but the evidence of history is that the project would then run the risk of being overtaken by other more pressing priorities, resulting in uncertainty for decades. A local example of this process is the Helmsdale-County Boundary project which was first mooted by Sutherland County Council in 1971 and is only now being completed 37 years later.

10. SUMMARY

Taking into account all the above factors the following table lists the scheme options discussed above and considers their likelihood of gaining a place in an early programme. Given all the unknown factors discussed above, particularly the lack of soils information, it is impractical for this report to give estimates for the options other in the most general sense. The indications of cost are given on that basis.

	Alternative	Cost Indication	Remarks
Viaducts	High Level viaducts	£30M+	None of the viaduct options is likely to find a place in a five year programme. They are costly, complex and will have significant environmental impact in an area of high sensitivity. They are unlikely to represent best value for money
	Low level viaducts	£30M+	
	Online viaduct	£20M+	
Other Options	Hairpin widening	£250k-£500k	Highly cost effective and highest priority for further investigation
	Hairpin Diversion	£500k-£1.5M	A cost effective option in parallel with other road improvements
	North Brae Overtaking Provision	£1.5M+	Would need detailed investigation. Improvements further north may be better value
	South Brae Visibility Improvements	£20k-50k	Highly cost effective but impact on Estate policies would require mitigation and may not be acceptable to the Estate
	South Brae Climbing Lane	£250k-1.5M	A cost effective option which could be built in phases. Use of excavated material could justify other projects
	Provision of overtaking opportunities elsewhere	£20k-£100k	Highly cost effective

Table 3 Option summary and comparison

It is clear that there is a wide gulf in cost between the viaduct schemes and the alternatives, but the reason for this is straightforward. Apart from the deficiencies noted, the existing trunk road across the Berriedale Braes functions reasonably well. It is structurally sound, has been constructed to modern standards and includes two significant bridges. The viaduct options

require this valuable infrastructure to be relegated to local use, at a very high cost of replacement.

In contrast, the other options build on the infrastructure already in place, saving substantially in the process. A further advantage of these options is that they can be built together or in phases, as funds permit.

11. CONCLUSION AND RECOMMENDATIONS

For the last 20 years consideration has been given to the provision of a flyover to replace the Berriedale Braes. It is the conclusion of this overview that concentration on this singular and costly project has prevented proper consideration being given to cheaper alternatives which have a higher likelihood of being constructed in the near future.

A number of low cost options have now been suggested to address the key deficiencies of the existing road. These vary in cost from £20,000 to £1.5M. With the co-operation of the Estate as the major landowner these could be built without delay as funds permit.

The Estates Company is recommended to:

- Consider the impact of all these options on its policies, the environment and the wider community
- Press the Scottish Government for immediate action to ensure that an appropriate selection of low cost options are properly investigated and costed
- Press the Scottish Government to include such options in the STAG appraisal process currently underway