ZOOM Rail
Speed and connectivity

INSTRUCTIONS

Route options project — Sheet 1

Welcome to the Zoom Rail route options project! It should take around 10 hours to complete. Your teacher will explain how long each activity should take.

You will play the part of the Zoom Rail project team, choosing one of four possible routes between Birmingham and London.

What you need

To complete the challenge, you will need:

- an introduction to high speed rail (sheet 2).
- four route option sheets, including a map and a description of each route's key features (RA-RD).
- three expert advice sheets, giving you valuable decision-making help on engineering, economics and the environment (E1-E3).
- six job profile sheets: these explain some of the many careers in high speed rail; they also give you advice on the skills, qualifications and experience you would gain and use (J1-J6).
- an evaluation sheet for recording your findings.

By applying the expert advice to each of the options, you will identify the relative strengths and weaknesses of each route. You will need to provide evidence that your preferred route offers the best balance of engineering feasibility, economic benefits and environmental impacts.

How it works

1. Complete the pre-project questionnaire.
2. Do some research into high speed rail. As well as the HS2 website (www.hs2.org.uk), you could look at:
   - local and national newspaper articles;
   - the Department for Transport website; and
   - professional publications, such as Construction Enquirer.
3. Discuss and review each route, considering its engineering feasibility.
4. Discuss and review each route, considering its environmental impacts.
5. Discuss and review each route, considering its economic impacts.
6. Assess all the evidence you have gathered. Work as a group to debate your preferred route. Once you make your choice, how will you justify it? What arguments will you face? What will your counter-arguments be?
7. High speed rail offers the chance to use a wide variety of skills. Discuss the professional roles in your groups: which of these careers appeals to you? What other jobs might a high speed rail company offer?
8. Prepare a presentation to give to the Secretary of State, using Microsoft Powerpoint. You should explain which is your preferred route and why you chose it. What were the strengths and weaknesses? How did you balance these conflicting factors? Be ready to answer questions from other groups.
9. Your teacher will decide which group made the most persuasive argument. He/she will also reveal which of the routes is the preferred route – and why.
10. Complete the post-project questionnaire (Q2).

The project will help you to develop some or all of these seven employability skills:

- self-management;
- teamwork;
- business and customer awareness;
- problem solving;
- communication and literacy;
- application of numeracy; and
- application of information technology.

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INTRODUCTION

Route options project — Sheet 2

What is high speed rail?

High speed rail is the latest innovation in train travel. It isn't that new – the 'bullet train' in Japan has been running for nearly 50 years – but it has only become common in Europe more recently. In Britain, we only have a short stretch of high speed rail. This train line, in the south of England, is called High Speed One; It has been very successful and its passengers can get from London to cities in Europe quickly and in a more environmentally friendly way than flying or driving. The large crowds of people that came to the Olympics in London were also able to use it. The UK government has decided to build another high speed network.

Why do we need it?

- The railways in the rest of the country are crowded and are becoming even busier.
- More people use trains for travelling to business meetings, visiting friends and family, or going on holiday.
- The Government wants to improve train travel, but just adding more trains doesn't create enough extra room.
- This is a big problem at busy times and on the most popular routes. It also means that if one train breaks down, it affects many more.

How would it help?

- The Government wants more high speed rail in Britain to make train travel easier, less crowded and more convenient.
- A new, super-fast railway between cities would help the passengers on the new trains, and those passengers wouldn't be taking up space on the smaller trains that stop at the towns in between.
- There would be more space for everyone. Journeys would be faster and more comfortable. And people and businesses would be more likely to earn and spend money in the areas with new stations and better connections.

Keep waiting: *the number of journeys we make is rising, but our rail lines are nearly full and delays are a problem.*

Keep moving: *a high-capacity service for long-distance passengers will free up space for local journeys too.*

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Your task

The Government wants to build a new high speed line to connect Birmingham with London. And that's where you come in.

You are a group of transport experts working on the project. The government has four routes in mind for the new rail line, but wants your company – Zoom Rail – to choose the best.

Your responsibilities

Your job is to achieve as many benefits as possible from the new high-speed line, while also thinking about the many challenges in building such a large railway. You should be able to explain the reasons for your choice of route according to the different specialist positions that you will learn about.

To explain this, the Secretary of State for Rail has written you a letter. You will need to meet all the goals set for you in this document (called a 'remit'). The remit letter will be given to you separately (sheet 3).

Consider: *the environmental effects*

Consider: *the engineering feasibility*

Consider: *the economic effects*

A new railway: big advantages…

The new network has many potential advantages. People who travel as part of their job will have better conditions in which to work on the train; they will also have greater choice in where they live and what kind of job they can do.

Companies like to locate in places with convenient links to motorways, railways and airports, so they can attract the best employees and easily keep in touch with their customers and suppliers.

If cities are easy to get to, they become more attractive places in which to live and work. If more people move to a city because it has really good travel links, they will be likely to spend money on living in that city's houses and flats, and on buying things in the shops. This means the cities will become wealthier because they do not seem far away from other parts of the country.

…but also some big challenges

However, the new network needs to be carefully planned. Building a rail line close to homes, businesses and community facilities (such as parks and schools) can cause problems; so can building near protected natural habitats. Some areas of countryside are protected by UK and European laws. High speed trains cannot run around tight corners, or steeply downhill or uphill. So you must consider the landscape and environment through which your new train line will run.

In choosing your route, you must consider positive and negative effects. Then you need to find the right balance between the effects on the community, the economy and the environment.

Sheet 3

Secretary of State for Rail

101 Station Road
London
SW99 4DT

August 2013

Dear Zoom Rail,

Re: High speed rail options

Following the Government's decision to proceed with a high speed rail network for Britain, I am writing to record the work I would like you to take forward. Our research and background work to this point has produced four possible routes for the railway to take in order to connect London and the West Midlands. I would request that you study and review these options and decide upon a preferred line of route that I can submit to Parliament for decision.

In particular, your work should include considerations of:

- **Cost** – we must find a route that meets our objectives of connecting the cities in question, but one that does not cost a lot of money to construct. For example, the route cannot be entirely in tunnel as this would be too expensive;

- **Sustainability** – we must also find a route that affects the fewest homes, businesses and communities as it passes through the country, and has the least impact on the natural environment and areas protected for heritage or scientific reasons. Bear in mind, however, that measures to reduce the environmental effects of trains cost money and may involve a longer route;

- **Journey times** – the extra convenience of high speed rail will be negated if we cannot find a route that offers passengers faster journeys between the areas it connects. But we must remain aware that a straight line through towns, villages and the natural environment can never be allowed;

- **Benefits** – consider things such as the location of stations, which will affect the ways in which we can provide benefits to cities and the people that live in and around them. For example, there may be better opportunities to link to other modes of transport from areas just outside cities, rather than running the train straight into the city centre.

I am relying on you to provide a fair and measured assessment of the routes we have put forward. You will present your finding to a panel who will decide if your recommendations achieve the balance we are looking for. Further information will be provided with this letter. I look forward to hearing your conclusions.

Sincerely,

Secretary of State for Rail

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ROUTE FINDINGS

Route options project — Sheet 4

Use the grid below to record your findings for each of the routes. Which scored highest in each category (on a scale of 4 for the best, down to 1), and why? This information will help you to form a reasoned conclusion on your preferred option, based on the best balance of community, environmental and economic impacts.

	Route A	Route B	Route C	Route D
Engineering feasibility				
Cost				
Environmental impact: urban				
Environmental impact: rural				
Job creation				
Passenger journey times				
Other economic benefits				
What other criteria do you think are important in assessing the four routes?				

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EXPERT ADVICE ON... ENGINEERING

Route options project — Sheet E1

Comparing the options

When engineers examine 'engineering feasibility', they are looking at how easy or difficult it would be to build a particular route. Here is your expert's advice on how to make the right choice.

You need to build a fast route, but you also need to think about its cost and environmental effects.

It's important to consider:

- how the route fits the shape of the landscape (or 'topography');
- how close the route runs to towns, waterways, roads and other railways; and
- how many stations to build, and where to build them.

Planning a high performance route

High speed trains can't run around tight corners, or steeply up or downhill. For example, a route which crosses a very hilly area may need tunnels and viaducts to keep the railway flat and straight. However, this will be more expensive than a route built on flatter ground.

Choosing the best locations

Stations need around 1km of straight, level railway.

When deciding where your station should be, you need to consider:

- the buildings nearby;
- whether a deep tunnel is needed – this may be too expensive; and
- the space available to extend the station – could you add extra platforms in future?

You also need to know about the local transport connections. People won't use your station if it is inconvenient to get there. Is it a 'parkway' station that most people will drive to? Or is it a city-centre station that can be more easily reached on foot or by different kinds of public transport?

Remember: your task is to find the best balance of community, environmental and economic impacts. Use the station and tunnel information, and the questions on the next page, to help you.

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Key questions 1 to 4

You need to discuss, compare and evaluate each of the four routes, using some or all of the issues below.

Can you think of any other issues to consider?

1. **Is part of your route in a tunnel? Does it run under any houses?**
   Routes that pass under houses are more complex to design and build. Although today's advanced tunnelling techniques are unlikely to affect properties, residents are often concerned as they fear that their houses may collapse or be damaged by vibration. You can find out more about tunnelling in the section on the right.

2. **Does your route affect main roads, motorways or railways?**
   You may need to modify the road or railway if your route runs over or under it. Bridges are expensive and can affect how an area looks. They should be constructed only where they are really needed. Road changes and closures can cause serious disruption for communities.

Tunnels are generally used for passing through higher ground and avoiding densely populated areas.

However, tunnels won't work everywhere. They may be unsafe in low-lying areas or flood plains. They are up to six times more expensive than surface track. Lots of excavated earth needs to be transported and re-used. And long tunnels need ventilation shafts every 2km-3km, housed in a 4m-high building on the surface. In long tunnels, high speed trains can use nearly double the normal amount of energy, and would not always be able to run at top speed.

Some tunnels are drilled (or 'bored') with a machine. Where the route is shallower, engineers dig a cutting, construct a box-like structure in it, then put the earth back on its roof.

Green tunnels also use the box method. They are called 'green' because they are topped with a mound that can be covered with grass or other plants. They hide the railway and make it quieter; they are also better for preserving natural habitat.

3. **Does your route affect rivers or canals?**
   You may need to build a bridge or a viaduct. These are expensive and can affect how an area looks: build them only if you need them. It may be possible to divert a stream or canal, but this complicates construction.

   A flood plain is an area that is at risk of flooding when the level of a nearby river rises. If your route crosses a flood plain, it will need to be protected from flooding.

4. **Does your route affect a motorway junction?**
   This may cause more disruption than crossing a road or motorway. You may need a long bridge or tunnel. Either will add to the engineering complexity and cost. Building the route could disrupt the motorway network too, increasing costs and risks.

Key questions 5 to 7

5. **What is the route's topography like?**
   Think about how the following features will affect the route design:
   - *Hills and valleys*
     High speed trains can't run steeply up or downhill. You would need to build embankments or cuttings.
   - *Towns and villages*
     If the railway passes near a town, it may upset people who live there. Creating noise barriers, cuttings and earthworks will make the railway less noticeable, but will also increase the building cost.
   - *Flood plains*
     If the railway crosses a flood plain, you must protect it from flooding.

6. Does the route include geotechnical hazards?

The ground under the route may have some dangerous surprises. Your geotechnical engineer needs to check for:

- *Areas with a long industrial history*
  Old factories, mines and other developments can leave behind pollution. Cleaning up contaminated ground is costly and may be dangerous. The law sets out regulations on how to clean up land, and who should do it.
- *Subsidence of natural cavities*
  Over time, certain minerals can dissolve, leaving holes (or 'cavities') underground. If these collapse, they make the ground above them sink, damaging buildings above them. Look out for gypsum and salt deposits.
- *Areas of unstable or compressible ground*
  In areas with a history of landslides, building embankments or cuttings can be dangerous. Other types of 'soft' ground can be compressed when a new, heavy structure is built on them, causing damage to buildings.
- *Minewater*
  Disused mines sometimes fill up with water. Creating cuttings or tunnels may release this heavily acidic water, which requires a special drainage system – this means more costs and delays.

7. Where will the infrastructure maintenance depot be?

An infrastructure maintenance depot (IMD) is a base for maintaining the track, the signalling equipment, cuttings and embankments, and other things that keep the railway running smoothly. You need at least one.

The depot must have access to a road, but access to the existing rail network is vital too. This will allow heavy rail machinery and supplies to be delivered without using local roads (which would affect nearby communities) or the high speed line itself (which would affect passenger services). Ideally, the depot should be halfway between London and the West Midlands, minimising travel distances.

Need more information?

To find out more about building and running high speed rail, and about the careers within the sector, take a look at:

Institution of Civil Engineers
http://www.ice.org.uk/Education

Tomorrow's Engineers
http://www.tomorrowsengineers.org.uk/home.cfm

Women in Science & Engineering
http://www.wisecampaign.org.uk/women

National Skills Academy for Railway Engineering
http://www.nsare.org/

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Group activity

Before you start, consider the example below and discuss your responses with your team.

Abdul is Zoom Rail's route engineer. He chooses a route that crosses a long section of an Area of Outstanding Natural Beauty. Most of his route runs along the surface, rather than using long tunnels.

How might Abdul justify his choice?

Use the space below to make notes for this exercise.

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EXPERT ADVICE ON... ECONOMICS

Route options project — Sheet E2

Comparing the options

A new high speed rail network could benefit Britain's economy in many different ways – if it is planned well. Here is your expert's advice on what to consider.

The new railway means that many of our important cities would be linked by quicker connections. This would allow businesses to be more productive. It would also give people greater choice in how, when and where they work, and the kinds of job they can do.

Many advantages, such as jobs and the regeneration of cities, will begin before the first Zoom Rail trains start running and will continue to develop for decades.

What's it worth? Using a benefit-cost ratio (BCR)

All big projects use a benefit-cost ratio (BCR). This is a calculation that weighs the money to be spent on a project against the benefits we receive in return. If the BCR is more than 1, that's positive: we get more out than we put in. For example, if a project is expected to make £2 for every £1 it costs, the ratio is written as 2:1 (two-to-one), which economists then refer to simply as '2'. Similarly, if a project was to make £1.50 back from every £1, the BCR would be 1.5.

However, using just a BCR doesn't tell us whether a project is worth funding, since it misses out some positive spin-offs that are difficult to measure. But it is a useful indicator of value and part of an economist's job is to compare the BCRs of different routes. Their work becomes part of what is called the 'economic case' for the project – which means working out whether, overall, it is good value for money.

Each of the four routes has key factors for you to consider, including:

- the frequency and position of stations;
- the operating speeds and journey times;
- the length of tunnelling required; and
- the number of jobs created.

Deciding which factors are most important will directly affect the BCR.

Remember: your task is to find the best balance of community, environmental and economic impacts. Use the station and tunnel information, and the questions on the next page, to help you.

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Key questions 1 to 3

Describe and record the impact of each factor for each route. Does it strengthen or weaken the economic case?

1. **Does the route have interchange stations (stations that connect to other rail main lines)?**
   Interchange stations are less convenient for passengers travelling to and from city centres. However, with the right public transport links and good road access, they can serve a bigger area, spreading the benefits more widely.

   Usually, trains can approach and leave interchange stations at high speed; this reduces the overall journey time for onward travellers.

   However, interchange stations tend to have lower-value businesses around them, or no business development at all. It is harder to judge how this kind of station could contribute to economic growth.

   If an interchange station is built in open countryside, you must consider its effect on the environment.

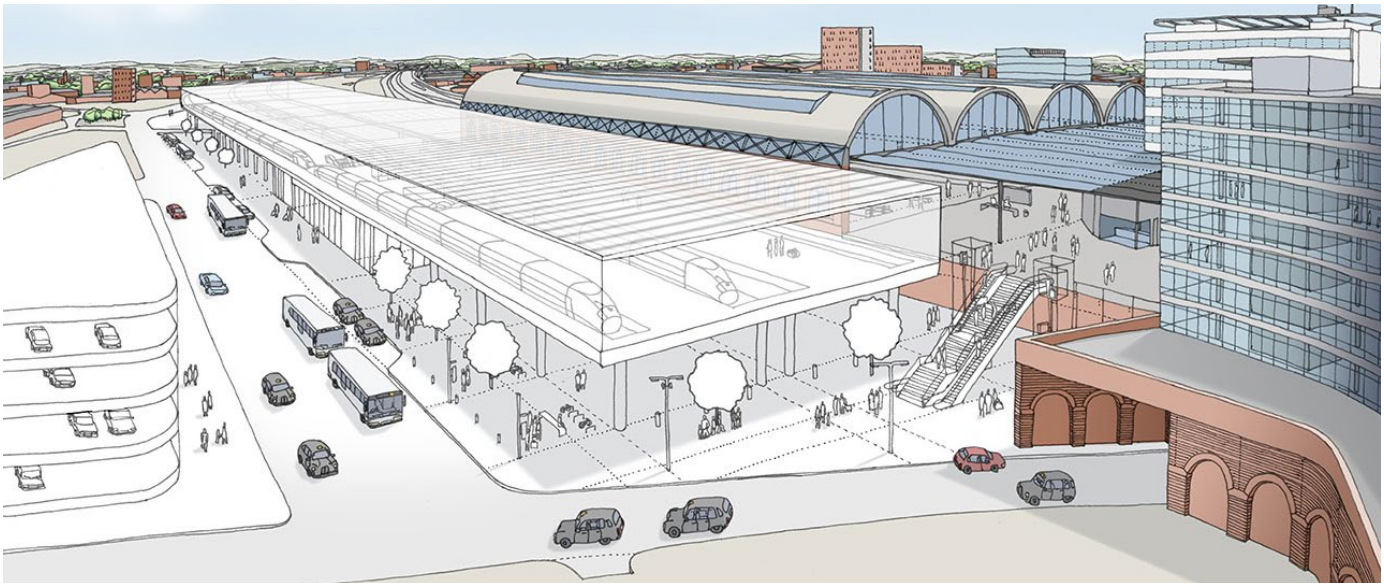
2. **How many city-centre stations does the route have?**
   City centres tend to have a high concentration of business and commerce. These locations offer high-value development opportunities, so stations on Zoom Rail's new route could support much more economic growth.

   However, trains approach and leave city-centre stations at lower speeds, so onward journeys take longer. Building in a city centre involves extra cost and sustainability impacts, because the route needs to pass through parts of cities with a large number of houses and buildings in a relatively small area.

3. **What about the journey times?**
   Saving time is one of the key benefits of high speed rail. Faster journeys also encourage more frequent travel because it is easier to attend business meetings, go for a day trip or even work in a different city.

   However, the routes with the fastest journey times are usually the most expensive, as the railway must be designed to cope with faster speeds. They are also the most direct, though this can mean that sensitive areas are not as easily avoided and therefore that the route has more negative environmental effects.

   The fastest journeys have the fewest stops. However, stopping at fewer stations makes the route less accessible, so fewer people benefit from it.



Key questions 4 to 6

4. What is the capacity of the route?

Creating extra space for passengers ('capacity') is a crucial benefit of a new rail line. Capacity is not just about having enough seats, but about having enough track on which to run the trains frequently and reliably.

Demand for rail travel is rising, but a lack of capacity limits the ability to meet that demand. The result? Higher ticket prices and overcrowding.

Faster journey times mean that a train can make more trips in a day, which generally means higher capacity. However, high capacity trains are expensive to run: you will lose money unless you have passengers to fill the seats. Find out more about capacity in the box on the right.

When they were first built, Britain's railways were a breakthrough in transport technology. But by the time the full Zoom Rail train service is running, parts of our original network will be nearly 200 years old.

In 20 years, the number of passenger journeys has doubled to over 1.5 billion, and demand for long-distance rail travel is still growing. Soon, many key rail routes will be full, and Britain's economy will start to suffer.

A crowded railway also makes delays worse: a fault on one train can disrupt the service on the whole line for hours.

The new network will be just for travelling between cities, and would carry up to 350,000 people every day. This would take pressure off the existing rail lines, freeing up space for people's local journeys and for moving goods and freight.

More capacity would make rail a more convenient, environmentally friendly alternative to travelling by car and plane.

5. How much of the route is in a tunnel?

Tunnels avoid much of the economic disruption caused by demolishing housing and offices along the route. They also avoid damage to natural environments that are sensitive, scientifically important or very beautiful. However, tunnels can be up to six times more expensive than track that is built on the surface. They can also reduce line speeds, which in turn increases journey times.

6. Will the route run close to major population centres?

A route stopping in a city can be a big advantage, as large numbers of people can use the service (see question 2).

However, running a route through a densely populated area poses problems during construction and operation. Demolishing buildings to make room for the railway causes more disruption in a city than in sparsely populated areas. Similarly, the environmental impacts on noise and air quality will affect more people. Members of a community may find themselves cut off from their neighbours by the new rail line. One way to reduce negative impacts may be to tunnel under the area (see question 5).

Need more information?

If you would like to find out more about building and running high speed railways, and about the careers within the sector, take a look at:

HS2 facts and figures
http://www.hs2.org.uk/about-hs2/facts-figures

HS2: the economic case
http://www.hs2.org.uk/news-resources/publications/economic-documents

The Construction Industry Training Board
http://www.citb.co.uk/en-GB/Careers-in-Construction/

Built environment careers route map
http://careers.cicskills.org.uk/

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Group activity

Before you start, consider the example below and discuss your responses with your team.

Kim is a community and regeneration manager with Zoom Rail. She opts for a route which has three additional stations. The stations will encourage regeneration and job creation in these three areas.

Compared to a route with just one additional station, Kim's option extends the journey time from London to Birmingham by seven minutes (a 14% increase).

How could Kim justify her choice?

Use the space below to make notes for this exercise.

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EXPERT ADVICE ON... SUSTAINABILITY

Route options project | Sheet E3

Environmental factors

Ensuring sustainability means thinking about the railway and its effects in the long term. It should be built and run in a way that makes good use of resources, while limiting any negative impacts - on our homes, businesses and communities, but also on our local and national heritage and the natural world. Sustainability should also make it possible to maximise the railway's benefits. Here is your expert's advice.

When you identify an environmental issue, you need to adopt a strict approach. The starting point is to try to avoid all environmental impacts. However, if an impact cannot be avoided, you should minimise and mitigate or 'abate' it (reduce its consequences). For remaining impacts, you should be prepared to repair or compensate (see below).

If part of a route would have an environmental impact, follow this checklist. Remember, your aim is to AVOID any effects. Only move down to the following option if this is not feasible.

- Can you **AVOID** it? — For example, by rejecting damaging options, moving the route away from a sensitive area, or tunnelling under the area.
- Can you **ABATE** it? — For example, by creating barriers (or 'bunds') to reduce noise and visual impact, or freezing the ground during tunnelling to prevent groundwater from becoming contaminated.
- Can you **REPAIR** it? — For example, by restoring a feature after an impact has occurred. This is often a good solution during construction if something needs to be removed temporarily, then replaced.
- Can you **COMPENSATE**? — For example, by creating and managing new woodland, creating new open space or providing financial compensation.

Work through each proposed route, identifying the environmental effects. Once you have the identified the effects, think about how these could be reduced or managed.

Remember: your task is to find the best balance of community, environmental and economic impacts. Use the checklist above and questions on the next two pages to help you.

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Key questions 1 and 2

Describe and record the impact of each factor for each route. Can you suggest any other questions to ask?

1. **What environmental mitigations could each route require?**
   'Environmental mitigations' are steps taken to avoid or minimise negative environmental effects. Remember that these mitigations will all add to the cost of the project. For example:

   - **earthworks** – landscaping and embankments can be used to screen noise and keep the railway out of sight.
   - **bunding** – a 'bund' is an embankment that screens noise, keeps the railway out of sight, or controls spills of liquid in the event of an accident.
   - **barriers** or fences can also be used to to limit noise and visual impacts.
   - **planting** – new areas of woodland and local shrubs can be used as a visual or noise screen or to provide new or replacement habitat for certain species of plant or animal (this is called 'ecological mitigation').
   - **balancing ponds** – these are part of a drainage system; they can be used for temporarily storing flood waters that run off from the railway.
   - **replacement facilities** – if a facility such as a school or community centre needs to be demolished for the railway, a new facility can be built to replace it.
   - **habitat enhancement** – changes to existing areas can improve their ecological value, making them better homes for a range of species.
   - **species translocation** – moving protected species from an existing habitat to a new replacement habitat.

2. **What are the noise effects along the route?**
   Noise can be caused by:

   - equipment: construction sites, construction vehicles on haul roads and local roads, and demolitions.
   - operational noise generated from trains, stations and depots.

   In rural areas, you can reduce noise by keeping the route low in the landscape – in a cutting, for example – and by avoiding towns and villages, where it is practical to do so.

   Where the route is on an embankment or viaduct, it is impossible to avoid noise by keeping the route low. Other measures must be taken, such as noise barriers near the source and insulation for homes and other buildings affected by noise.

Key questions 3 and 4

3. **Does the route require demolitions?**
   Buildings for demolition could include residential, commercial or business properties, community facilities or even nationally listed buildings of special interest. Will a demolition create job loses? Will it displace people from their homes? Does it reduce the area of open space or parkland that a community can enjoy?

4. **Does the route affect plants, animals and their habitats?**
   Construction works and the additional trains may disturb wildlife, habitats and ecosystems.

   Does the route cut through protected habitats? Look at the definitions in the box on the right. These areas all have some degree of protection. Avoid these areas if you can: in some cases, even tunnelling under them may be harmful.

   Does the route displace protected species or damage their habitat? Some species are protected by law, making it an offence to disturb them or damage their habitat. They include:

   - bats
   - great crested newts
   - reptiles
   - badgers
   - otters
   - water voles
   - hazel dormice

   Studies and field surveys give ecologists a picture of the existing habitats and species along the route. This helps in designing the route and indicating what type of mitigation will be necessary.

The UK's Protected Areas

Site of Special Scientific Interest – An area of land notified by Natural England under section 28 of the Wildlife and Countryside Act 1981 as being of special interest due to its flora, fauna or geological or physiological features.

Special Area of Conservation – An area strictly protected under the EC Habitats Directive that provides increased protected to a variety of wild animals, plants and habitats.

Special Protection Area – An area of land, water or sea which has been identified as being of international importance for the breeding, feeding, wintering or migration of rare and vulnerable species of birds found within the European Union.

Local Nature Reserve – An area that offers people special opportunities to study or learn about nature, or simply to enjoy it.

National Nature Reserve – A site for exceptional wildlife and/or geology. Such areas are open to the public and provide great opportunities for people to experience nature.

Area of Outstanding Natural Beauty – An area designated under section 82(1) of the Countryside and Rights of Way Act 2000 for the purpose of conserving and enhancing its natural beauty.

Ancient Woodland – Land that has been continually wooded since the year 1600 or before.

Need more information?

To find out more about building and running high speed rail, and about the careers within the sector, take a look at:

HS2 Draft Environmental Statement – non-technical summary
http://hs2.org.uk/draft-environmental-statement/document-library

HS2 on noise and construction
http://www.hs2.org.uk/developing-hs2/environment

National Careers Service
https://nationalcareersservice.direct.gov.uk/Pages/Home.aspx

Group activity

Before you start, consider the example below and discuss your responses with your team.

Environmental manager Joe opts for a route which disturbs a rare bird habitat, instead of a route which would mean that 50 local residents experience high levels of noise during the two years of construction.

How might Joe justify his choice?

Use the space below to make notes for this exercise.

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JOB PROFILE: TRANSPORT MODELLER

Route options project | Sheet J1

Why is it important?

Over time, towns and cities evolve, populations shift and new houses and facilities are built. A transport modeller predicts the effects that this will have on our future need for transport.

Rail transport modellers have two roles. Firstly, they forecast how, when and where the people of a city, region or country will need to travel. Secondly, they consider how the railway should operate once it is built, so that it provides a useful service and offers value for money.

Transport modellers are working on the future of Britain's high speed rail. In less than 20 years, the number of rail journeys has doubled to over 1.5 billion a year, but route length – the actual distance of railway track – has remained almost unchanged. Transport modellers predict that by 2020, a further 400 million journeys will be made.

What do they do?

- Transport models are highly sophisticated, mathematically based tools. They provide data which helps to make decisions about the future of transport. Using them, modellers can take general principles about how transport works and apply them to a particular time and place.
- Transport modellers create, update and use these models. They provide technical information and make sure it is used accurately.

What should I study?

- A Maths or Economics A-level, plus Geography or Computing, will build up your numerical skills.
- Most transport modellers have a degree in a subject like Physics, Economics, Civil Engineering or Mathematics. You can add more specialist knowledge with a Master of Science degree (MSc) in Transportation Planning or Economics.

What skills do I need?

A good transport modeller can:

- understand the strengths and weaknesses of different kinds of data;
- use evidence from different sources to identify problems and find solutions;
- use models to examine new transport ideas – working out whether they fit with the government's policy and whether they offer good value for money;
- explain complex issues simply and persuade people using facts and evidence;
- work with different groups of people to achieve common goals and deal with different priorities; and
- take the lead on projects – working out what needs to be done, reporting on progress and identifying risks.

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ZOOM Rail
Speed and connectivity

JOB PROFILE: ECONOMIC ANALYST

Route options project | Sheet J2

Why is it important?

How will a new rail network have a positive effect on people, companies and the UK economy? Why does the location of a station affect the number of jobs, houses and new shops and businesses it might support? Will we get more money back from the project than we spend on it? Before anyone starts building a new railway, economist analysts are required to ask – and answer – all of these questions, and more.

Analysts make sure that the project is supported by reliable economic evidence, particularly as big transport projects come with a mix of costs and benefits – and some have effects that are not immediately obvious. Economic analysts take account of the full range of a project's impacts and provide information to the chief executives, government ministers and others. The information they provide helps make decisions that get the most out of the proposed routes and stations.

What should I study?

- Maths or Economics to A-level standard would be a useful start, as you will need a degree in Economics, Mathematics or another subject which uses numerical skills.

What do they do?

- Economic analysts work with statisticians, researchers and transport modellers, as well as analysts and policy experts in various government departments.
- They examine costs and financial assumptions: the economic work of the project needs to be carried out from an accurate starting point.
- They develop new financing and revenue models: the best ways to put money into the railway and to get money out.
- They study and explain the economic risks of the project.

What skills do I need?

A good economic analyst can:

- study evidence and use it to make decisions;
- explain complex ideas simply, but without leaving out important details;
- think strategically: how does one particular task help to achieve the project's goal?;
- write and speak about his or her findings to the project's leaders and answer their questions; and
- make sure a project gets finished on time, while also focusing on risk management, quality assurance and delivering value for money.

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JOB PROFILE: ROUTE ENGINEER

Route options project | Sheet J3

Why is it important?

Civil engineers design and develop a huge range of projects around the world: from roads and railways to Olympic stadiums. Engineers study the needs of people and the environment. The solutions that they create are sometimes spectacular, sometimes cleverly simple – often, they're both.

Route engineers plan where the railway could run and where stations could be. Projects need to be built safely, on time, and with good use of resources. Engineers discuss with their clients about how they will plan, design and supervise construction. They work with consultants who are experts in particular areas. As engineering projects affect communities, route engineers play a role in public consultations too.

What do they do?

- Decisions about routes and stations are closely connected, so route engineers develop them together, as a package.
- They help to ensure that the different parts of the railway meet the right specifications, so the parts work properly when they are put together.
- Engineers work with colleagues on cost, risks and environmental effects, to make sure that their plans meet the right standards.

What skills do I need?

A good route engineer:

- understands how to plan routes and stations, and how to choose between different options;
- enjoys working with other people, and communicates his or her ideas by speaking and writing well, particularly on technical subjects;
- pays attention to detail;
- works flexibly and meets tough deadlines; and
- enjoys solving problems.

What should I study?

- If you enjoy maths and physics, as well as design technology, you should consider applying for a civil engineering degree at university. After your course, you will need to impress at further training and some hands-on experience, while working towards your professional exams, to join the Institution of Civil Engineers. It's not easy, but it opens doors to a prestigious career around the world.
- Another pathway into engineering is a Level 3 Technician Apprenticeship, where you have a job, but also study one day a week.

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JOB PROFILE: GEOTECHNICAL ENGINEER

Route options project

Sheet J4

Why is it important?

Massive structures. Immense, invisible forces. Tiny margins for error. Geotechnology is where earth science meets construction. It is vital for the safety of underground projects, such as tunnelling, but structures such as bridges and viaducts depend on it too.

Geotechnical engineers need to be experts several times over. They apply soil and rock mechanics, geology and other disciplines to design and construction, while working to protect the physical environment.

Along the route of a railway, geotechnical engineers examine the soil, rock, underground water and other natural conditions. They then help engineers to choose the most suitable building materials and the safest methods. Where land has been contaminated, or was previously used for mining, geotechnical engineers need to understand the problem.

What do they do?

- Geotechnical engineers gather data and use specialised computer software to investigate the earth's structure and spot possible dangers.
- They analyse construction problems by creating two- and three-dimensional models, and calculating whether engineering structures will work.

What should I study?

- If you enjoy Maths and Physics at A-level, why not consider applying for a civil engineering degree? Geology and Geography will give you a headstart.
- After your degree, you'll add to your skills with training and hands-on experience, while working towards exams to join the Institution of Civil Engineers. A BSc/MSc in Engineering Geology and Geotechnics, or Civil Engineering with Geotechnics units will provide you with the expertise you'll need.

What skills do I need?

A good geotechnical engineer can:

- design earthworks, slopes and foundations;
- investigate rocks and soils, and work out whether the engineers' structures can go under, over or through them;
- understand complicated numerical information;
- understand how major projects are developed, designed and built;
- understand environmental issues;
- work well with a range of different people and teams;
- communicate important information by speaking and writing well; and
- make a plan and complete it on time.

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JOB PROFILE: ENVIRONMENT MANAGER

Route options project — Sheet J5

Why is it important?

All big projects affect their surroundings, but smarter design and construction can minimise impacts.

An environment manager examines the potential impacts on the natural world, and how these will affect people and places. He or she talks to people who may be affected. The role also involves work with organisations that specialise in protecting natural resources, keeping them up-to-date on the project and giving them opportunities to provide opinions and advice.

Environment managers need experience of issues surrounding infrastructure projects at home and abroad. If the law states that a special environmental assessment is needed, the environmental manager makes sure this is done properly.

What do they do?

- Environment managers consult people and organisations with an interest in the natural world.
- They provide environmental advice to the government, so it can consider this alongside other factors in the project.
- They report on environmental impacts, and on plans to develop projects in a sustainable way.

What should I study?

- You will probably need at least one science A-level, but Geography, Environmental Studies, Maths or Economics would all be useful too.
- You will need a degree in an environmental or built environment subject. A qualification in project management is also useful, to help you plan, monitor and complete projects which involve many people from different teams or organisations.

What skills do I need?

A good environment manager can:

- Lead sustainability and environmental appraisals. These are studies into the project's environmental effects, and into running the project in a 'green', well-managed way in future;
- Work well with environmental organisations at local, regional and national level;
- talk to the local community about sensitive issues and listen to their views;
- work well with people;
- manage contracts and projects, making sure that people and companies do what is asked of them; and
- get things done on time and keep track of a number of different tasks.

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JOB PROFILE: G.I.S. MANAGER

Route options project | Sheet J6

Why is it important?

Building a railway takes huge amounts of information. Geographical information systems (GIS) help us to see this information clearly, creating maps and images of the project's future. GIS managers turn data about populations, economies and landscapes into sophisticated diagrams that evolve as data changes.

Environmental GIS managers organise the IT experts who produce geographical data using computer systems. They work with cartographers (map-makers), analysts, programmers and data managers.

Geographical information systems combine social and economic data, plus information about the landscape, which will be used in planning the new rail project.

Environmental GIS Managers provide information for Environmental Impact Assessments and Environmental Statements.

What do they do?

- Environmental GIS managers design, edit and maintain environmental GIS data.
- They create maps and manage spatial databases.
- They manage budgets and project costs, making sure that projects are finished on time.

What should I study?

- Start with A-levels in Geography, Computing, Maths or other numerical and analytical disciplines. The next step is a single honours degree in GIS or a combined degree with Geography and IT/IS/Computing. Some establishments offer a Higher National Diploma in GIS or a closely related subject.

What skills do I need?

A good Environmental GIS manager can:

- put together spatial information from many different sources, using different types of data;
- use expert map-making skills;
- manage, encourage and help people;
- use specialist software;
- understand a range of environmental issues and different aspects of a project; and
- work with motivation and enthusiasm, without giving up easily.

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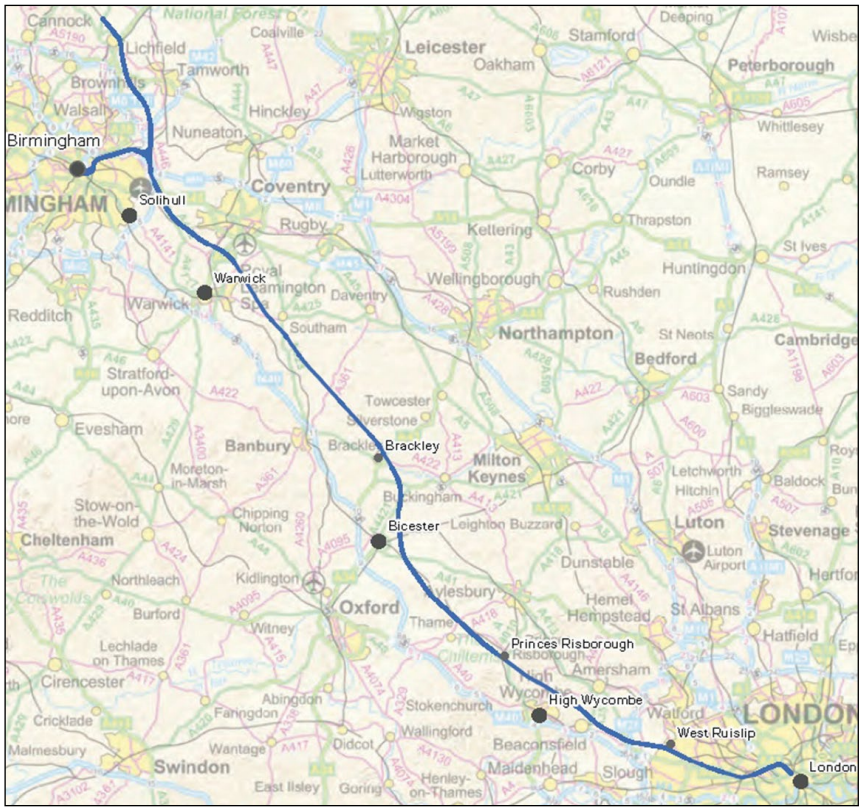
ROUTE OPTION A

Route options project | Sheet RA

Map and description

Route A is one of four options for the railway. Below is a map and a brief description of the route; use the more detailed information on pages 2 and 3 to help you make your decision.



- The route would run from an expanded London Euston station to a new station in central Birmingham. It would also connect to the West Coast Main Line (WCML) near Lichfield. From Euston, trains would run to an interchange station at New Ash Heath. They would follow the existing Central line and Chiltern line corridor, on the surface.
- The route would pass Beaconsfield and High Wycombe, entering an Area of Outstanding Natural Beauty (AONB) near Seer Green and continuing at surface level, including a number of short viaducts.
- The route would run partly in tunnel in the AONB, returning to the surface outside it to the west of Princes Risborough. It would then curve northwards, continuing mainly at surface level past Brackley and approaching the West Midlands between Kenilworth and Coventry.
- The route would serve city-centre stations in Bicester and Warwick, as well as the Birmingham Interchange and New Ash Heath stations.

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Speed and connectivity

Studying the route

Here is some more route information. Consider each point carefully. Is it an engineering problem? Which of the three factors does it affect: (1) environment, (2) community or (3) economy? Does the information make a big or a small difference to your decision? Is the difference negative or positive? Use expert advice to help you.

Land, highways and waterways

- The land on this route is relatively flat, with some gentle hills and valleys.
- Along the proposed route, a landslide was last recorded in 2008.
- The route largely avoids major waterways.
- This route encounters several major roads. Extensive modification to existing highways would be required and an additional bridge would need to be built to avoid a motorway junction.

Towns, residential dwellings and tunnels

- The proposed route encounters eight towns, with a total population of 242,000.
- The closest properties to the route are 500m away. Trains would be running at surface at this point. The track and the houses would be separated by dense woodland.
- The route passes under 100 dwellings. It would require 7.5km of tunnels.
- You could reduce the length of tunnelling by demolishing 50 dwellings. This would halve your tunnelling costs.

- You could reduce the length of tunnelling by demolishing a number of industrial buildings, including logistics factories which employ over 250 people.

Other local effects

- The route would run through the pitches and clubhouse of a junior football club – these facilities would be lost permanently. There are similar facilities locally, but the site is well established and is used regularly by its members. The loss would have a major adverse effect and is considered locally significant.

Countryside and wildlife

- Building on this route would mean permanently acquiring 200 hectares of agricultural land, which is currently used by a large, profitable dairy farm.
- The route would entail 9.5km of tunnel in the AONB. It would pass at surface in the AONB for 10.5km.
- Local populations of bats would be affected. Parts of their woodland roosting habitat could be lost. In addition, the loss of other woodland and grassland habitats would leave them with a smaller area for feeding. There could be a permanent adverse effect on the conservation status of local bat populations.

Stations and depots

- The route starts in London and ends in Birmingham. There would be interchange stations at New Ash Heath and Birmingham Interchange, and city-centre stations at Bicester and Warwick.
- New Ash Heath would connect with Crossrail, Great Western mainline services and the Heathrow Express.
- Birmingham Interchange would be near the National Exhibition Centre and Birmingham Airport.
- Birmingham Interchange would be a parkway station – people would travel to it by car or public transport. It would be built in countryside. New Ash Heath would be built on land that was mainly used for light industry. Building the station here would encourage other companies to invest in houses, shops and offices.
- The infrastructure maintenance depot would be near Tidmouth. You would need to construct a new freight line to connect it. This line could run alongside the high speed route, but would increase the width of the rail corridor by eight metres in this area. The depot is not in the middle of the route; it is surrounded by higher land, would be visible from local viewpoints, and is three miles from a registered park. The depot would cost around £120 million.

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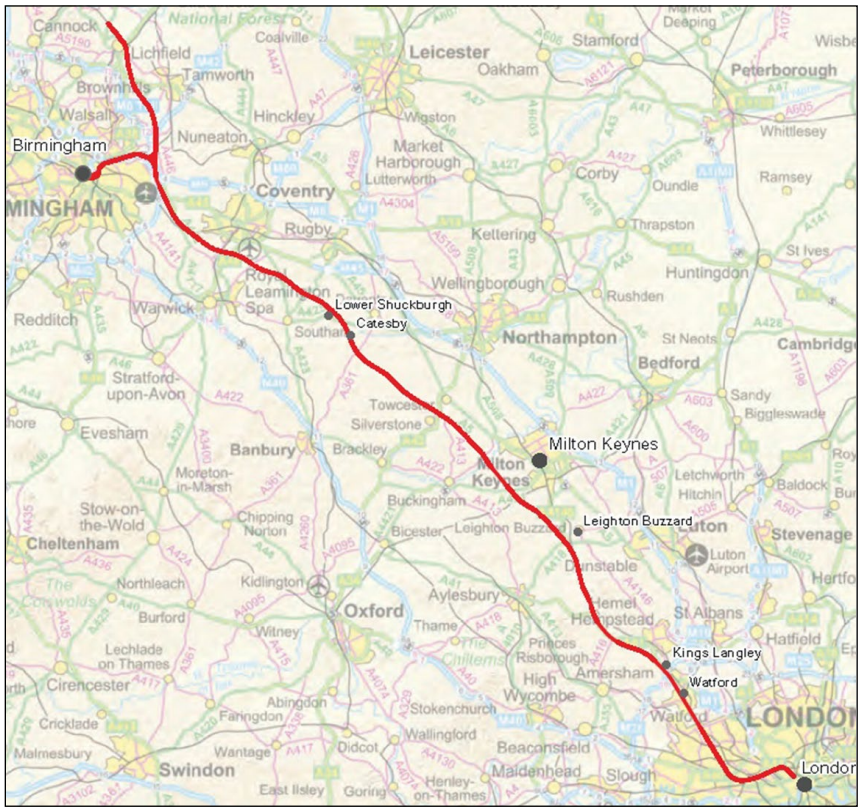
Speed and connectivity

ROUTE OPTION B

Route options project | Sheet RB

Map and description

Route B is one of four options for the railway. Below is a map and a brief description of the route; use the more detailed information on pages 2 and 3 to help you make your decision.



- The route would run from an expanded London Euston station to a new station in central Birmingham. It would also connect to the West Coast Main Line (WCML) near Lichfield.
- From the New Ash Heath area, the route would run north-west in a tunnel for almost 27km to a point near Kings Langley, close to the M25. It would run through relatively open countryside in a series of cuttings and embankments, passing close to Berkhamsted before entering an Area of Outstanding Natural Beauty (AONB).
- It would then head across country to pass over the WCML on a viaduct, before leaving the AONB and crossing open countryside to the west of Milton Keynes, away from the WCML corridor.
- The route would continue towards Kenilworth on a new route through open countryside. The line would include two more tunnels (near Catesby) and a mix of embankments, cuttings and a number of low viaducts.
- There would be two intermediate stations at Milton Keynes and Birmingham Interchange.

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Speed and connectivity

Studying the route

Here is some more route information. Consider each point carefully. Is it an engineering problem? Which of the three factors does it affect: (1) environment, (2) community or (3) economy? Does the information make a big or a small difference to your decision? Is the difference negative or positive? Use expert advice to help you.

Land, highways and waterways

- The route encounters a number of hills and valleys. One small waterway could be crossed by a small bridge.
- The route encounters several major highways. The route could be built without constructing new bridges, but work would result in road closures lasting 18 months. Your route engineers tell you that local residents would experience major congestion. Vehicles delivering materials to the construction site could also face delays.
- Around 20% of the route is on former industrial land. This includes land that was once used for mining.

Towns, residential dwellings and tunnels

- The proposed route encounters five towns, with a total population of 200,000.
- The nearest buildings are 200m away. They are all industrial buildings, not residential dwellings.
- The route would pass under 80 dwellings. This would require 6km of tunnels.
- You could reduce the length of tunnelling by demolishing 40 dwellings. This would reduce the cost of tunnelling by one-third.
- You could reduce the length of tunnelling by demolishing a number of industrial buildings. This would include a warehouse that distributes nuclear protection suits for the police and the military. It employs 100 people with disabilities.

Countryside and wildlife

- The route would require 4km of tunnel through the AONB. It would run at surface through the AONB for 16km.
- In order to carry out construction work, you would need land for storing building equipment and materials. Your best option would be to lease the land for two years. The area in question is 80 hectares of fertile arable land.

Countryside and wildlife (continued)

- You would have to build a haulage route to a work site. This is a route used by lorries to transport construction materials. Building it would result in the temporary loss of three-quarters of an area of broad-leaved, semi-natural woodland. This site – 2.5 hectares in total – would be restored following construction. There would be no significant effect once the restoration work was done.

Other local effects

- A site used by a Gliding Club would be lost permanently. The site is used daily by its members and there are few viable local alternatives.

Stations and depots

- The infrastructure maintenance depot would be one mile to the east of Knapford. New railway lines would need to be built to connect the depot to the railway line. The depot would cost around £80 million. Its location is not in the middle of the route and is surrounded by higher land, meaning that it can be seen in the Aylesbury Vale landscape.
- The route includes two intermediate stations. Birmingham Interchange would be near the National Exhibition Centre and Birmingham Airport. It would be a parkway station, not a city-centre station: people would travel to it by car or public transport. The station would be built in the countryside.
- Another intermediate station, Milton Keynes Parkway, would be built 6km to the west of Milton Keynes city centre. The land needed for the new station would prevent the development of a new business park, which was planned to attract large, blue-chip companies to the area.

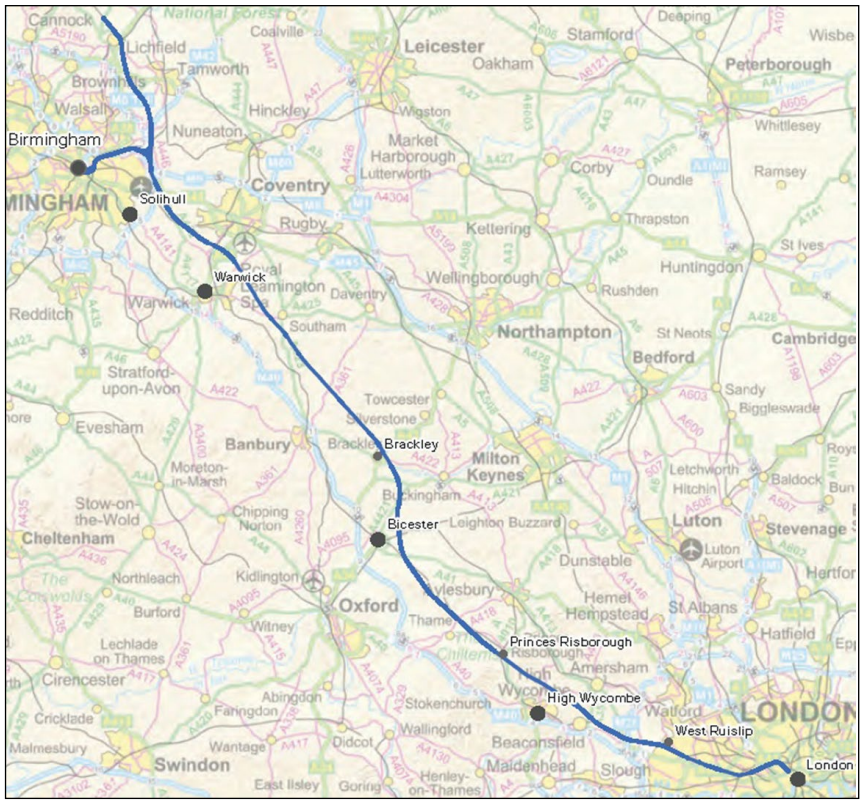
ZOOM Rail
Speed and connectivity

ROUTE OPTION C

Route options project | Sheet RC

Map and description

Route C is one of four options for the railway. Below is a map and a brief description of the route; use the more detailed information on pages 2 and 3 to help you make your decision.



- The route would run from an expanded London Euston station to a new station in central Birmingham. It would also connect to the West Coast Main Line near Lichfield.
- From Euston to New Ash Heath in West London, it would follow the existing Central line and Chiltern line corridor.
- The route would diverge from the corridor to pass Beaconsfield and High Wycombe, entering an Area of Outstanding Natural Beauty (AONB) near Seer Green and continuing at surface level. This section would include a number of short viaducts, as well as a length of tunnel.
- The route would surface outside the AONB to the west of Princes Risborough, then curve northwards, continuing mainly at surface level past Brackley and passing between Kenilworth and Coventry.
- The route would include an interchange station at New Ash Heath and a city-centre station at Bicester.

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Studying the route

Here is some more route information. Consider each point carefully. Is it an engineering problem? Which of the three factors does it affect: (1) environment, (2) community or (3) economy? Does the information make a big or a small difference to your decision? Is the difference negative or positive? Use expert advice to help you.

Land, highways and waterways

- The route runs through an area of floodplains. This route runs above underground areas of gypsum and salt – sometimes a sign of subsidence risk. Some ground may be prone to compression.
- There are two rivers on the route. The second does not meet the route at a right angle, meaning that a long bridge would be needed.
- This route encounters some major A-roads. However, you would not need to build new bridges. Instead, the highways could be modified in stages. Your route engineers tell you that the roads would be more congested during the construction of the railway, but that the congestion would be manageable for local residents.

Towns, residential dwellings and tunnels

- The proposed route encounters three towns with a total population of 48,000.
- At the route's closest point, there are properties 100 metres away. The trains would pass by in a deep cutting.
- The route would pass under 60 dwellings. This would require 4.5km of tunnels.
- You could reduce the need for tunnels by demolishing 30 dwellings. This would reduce tunnelling costs by 25%.
- You could reduce the length of tunnelling by demolishing an industrial building: 30 people work here in a furniture workshop. The business has been on this site for 70 years.
- In order to carry out construction work, you would need some land for storing building equipment and materials. Your best option would be to lease the land for two years. The land is a brownfield site, not a greenfield site.

Countryside and wildlife

- The route would require 9.5km of tunnel through the AONB. For 6.5km, the route would be on the surface of the AONB.
- The route would cross part of a nature reserve. A small area of land would be permanently lost. During construction, a larger area would be lost for about four years – a construction site would be built there temporarily. Most of the nature reserve could remain open to visitors.

Other local effects

- The route would be close to a country park used by pedestrians, cyclists and horse-riders. The park would be parallel to the area needed for construction.

Stations and depots

- The route starts in London and ends in Birmingham. It would have one interchange station at New Ash Heath in West London, where rail passengers would connect to Crossrail, the Great Western Main Line and Heathrow Express.
- New Ash Heath station would be built on land that was mainly used for light industry. Building a station here would encourage other businesses to invest in new houses, shops and offices.
- The infrastructure maintenance depot would be at Great Waterton: halfway between London and Birmingham. It would be alongside the route, just north of the existing Oxford to Bletchley railway line. It would cost around £40 million to build. The land around the area is relatively flat, so the visual impact would be comparatively small.
- An intermediate station would be built at Bicester city centre, to serve Oxford.

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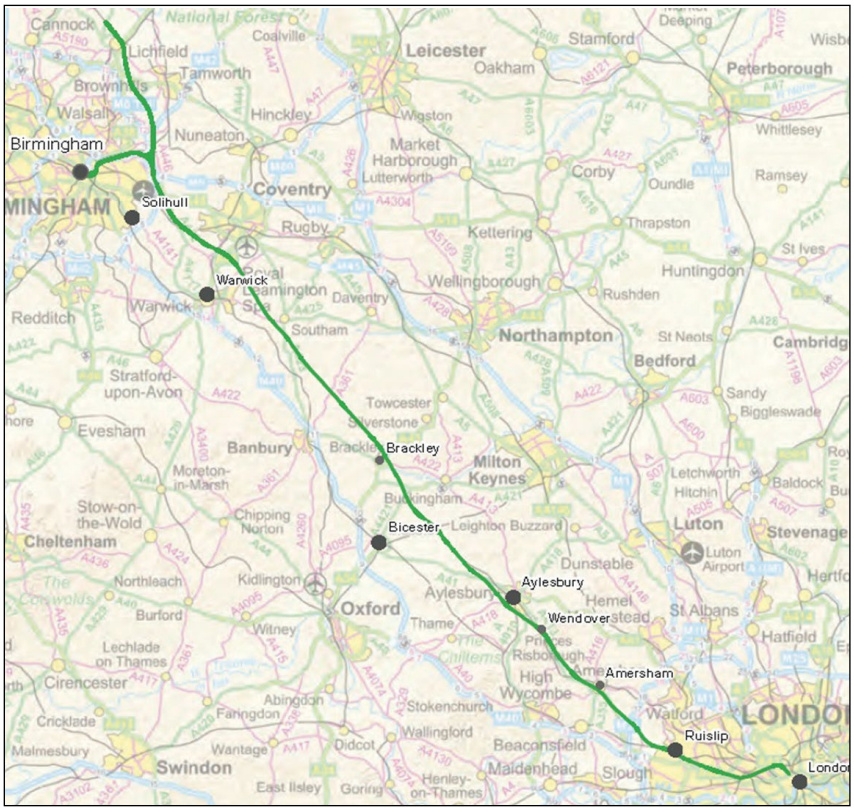
ROUTE OPTION D

Route options project | Sheet RD

Map and description

Route D is one of four options for the railway. Below is a map and a brief description of the route; use the more detailed information on pages 2 and 3 to help you make your decision.



- The route would run from an expanded London Euston station to a new station in central Birmingham. It would also connect to the West Coast Main Line (WCML) near Lichfield.
- There would be a new station at New Ash Heath, in West London. The route would then run via the New Ash Heath to the West Ruislip corridor, before passing through an Area of Outstanding Natural Beauty (AONB) near Great Missenden and Wendover. It would then pass to the south-west of Aylesbury and east of Brackley, before passing between Kenilworth and Coventry.
- The route would pass east of Birmingham, with a new interchange station near Birmingham International. The route would continue north to join the WCML.
- A 'spur' from this route, in the Coleshill/Water Orton area, would run towards central Birmingham.
- There would be two intermediate stations at New Ash Heath and Birmingham Interchange.

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Studying the route

Here is some more route information. Consider each point carefully. Is it an engineering problem? Which of the three factors does it affect: (1) environment, (2) community or (3) economy? Does the information make a big or a small difference to your decision? Is the difference negative or positive? Use expert advice to help you.

Land, highways and waterways

- This route largely avoids major highways.
- There are two major waterways on the route. One of them is in the AONB: a bridge would change the landscape too much, so you need to find another solution.
- The route has a high natural occurrence of gypsum and salt, indicating a risk of subsidence. However, the route is flat, with very few hills or valleys.

Towns, residential dwellings and tunnels

- The proposed route passes near four towns: their total population is 179,000.
- At the closest point, the track would be 500 metres away from houses. They would be separated from the track by a dense, evergreen woodland.
- The route would need to pass under 40 dwellings. This would require 3km of tunnelling.
- You could reduce the length of tunnelling by demolishing 20 dwellings. This would reduce tunnelling costs by 10%.
- Aside from the cases mentioned above and the proposed rail corridor, no additional land acquisitions would be required.

- The proposed route would require 4.5km of tunnel running through the AONB. It would be on the surface of the AONB for 10.5km.

Countryside and wildlife

- At one point, the rail line would cross a waterway on a viaduct. This is not expected to have any negative effects on river/waterside habitats. There would be no significant effects on the otter, brown trout or European eel which live in the river.
- This route includes a part of a long-distance walking route, approximately 160km in length. A small section of the walking route would be temporarily affected, reducing the size of the recreational route for walking and cycling for approximately 18 months.

Stations and depots

- The route starts in London and ends in Birmingham, with no city-centre stops along the way. There would be two interchange stations: New Ash Heath and Birmingham Interchange.
- New Ash Heath would connect passengers to Crossrail, the Great Western Main Line and the Heathrow Express.
- New Ash Heath station would be on land that was mainly used for light industry. Building a station here would encourage other businesses to invest in new houses, shops and offices.
- Birmingham Interchange would be near the National Exhibition Centre and Birmingham Airport. It would be a parkway station, not a city-centre station: people would travel to it by car or public transport.
- Birmingham Interchange station would be built in the countryside.
- The infrastructure maintenance depot would be at Great Waterton: halfway between London and Birmingham. It would be alongside the route, just north of the existing Oxford to Bletchley railway line. It would cost around £40 million to build. The land around the area is relatively flat, so the visual impact would be comparatively small.

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GLOSSARY

Route options project Sheet G1

abate – to reduce or lessen something unwanted (such as a negative effect on the environment).

adverse – negative or damaging.

Area of Outstanding Natural Beauty (AONB) – an area of countryside that is protected by law to preserve its natural characteristics.

benefit-cost ratio (BCR) – a way of calculating the value for money of a project. A ratio of over 1 suggests that the project will have more benefits than costs.

bored tunnel – a tunnel constructed by using a tunnel-boring machine: the normal process for long, deep tunnels.

brownfield site – an area of previously built-on land; often an old commercial or industrial site. It may raise contamination problems.

bund – an earth mound, sometimes used to deflect noise or partly hide the railway from view. They can be planted with grass, shrubs and flowers.

business park – an area of commercial buildings: it may attract companies that benefit from being near other companies that do similar or complementary work. Like any commercial development, it potentially creates jobs.

cavity – an underground hole that may cause the earth above it to subside

community facility – a building or other place that local people come together to use. Schools, hospitals and parks are all community facilities.

contamination – man-made pollution, often caused when an industrial site stops operating, but no one cleans up dangerous materials. Building roads and railways through former industrial areas sometimes reveals areas of contamination, which then need treatment.

cutting – a part of the route where earth is dug out. Cuttings are used where the ground is sloping upwards, but the route needs to stay level.

depot – A building in which trains are checked, cleaned and repaired.

embankment – Artificially raised ground, usually made of earth or stone, for a railway to run along.

Environmental Impact Assessment – a study of a project's positive and negative effects on a particular area.

Environmental Statement –

flood plain – Land adjacent to a river or stream over which water flows (or would flow, except for man-made defences) in times of flood.

greenfield site – land that has not been built on before.

green tunnel – This is constructed by cutting a trench and building the tunnel in the trench. The top of the tunnel can then be covered with grass or other plants. A good method for short, shallow tunnels.

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habitat – the type of area in which a particular species of animal prefers to live.

haulage route – a route used by lorries to transport construction materials to a work site.

interchange station – a station that connects to other major rail lines.

intermediate station – a city centre station, serving a destination somewhere between the two ends of the route.

mitigate – to reduce a negative effect.

noise barrier – A fence or an earth mound that reduces the effect of noise from a railway.

parkway station – a station outside a city centre, usually reached by public transport or car.

public right of way (PRoW) – these are roads, paths or tracks that must be kept open and well maintained for everyone - even if the land through which they run is privately owned. The route of a PRoW can be changed temporarily or permanently - but only if the new route is just as convenient.

rail corridor – The strip of land needed for the track, the overhead line equipment, track drainage, electricity cables and lineside paths.

regeneration – economic redevelopment for a local area.

remit letter – A letter from a government minister to a government department or agency. It normally explains the scope of a task, the terms on which it must be done, and the powers for completing it.

sett – a network of holes and tunnels in which badgers live.

topography – landscape, including all its natural and artificial features (and the science of studying and mapping it).

tunnel vent – A large tube (also called a ventilation shaft) that connects the tunnel to ground level. It keeps air flowing and reduces the effects of sudden changes in pressure when a train enters the tunnel. In an emergency, it can be used to remove smoke from the tunnel. Tunnel vents need to be constructed every 2km-3km.

viaduct – a long rail bridge, normally at least 45 metres long. Viaducts can be used to cross motorways, other railways, canals and rivers, and flood plains and other areas of lower ground level.

wider economic benefit – a positive effect that leaves people, businesses or the country better off, but is not limited to the operation of the railway, or to the area in which it runs.