

## Highway Link

### An introduction to the case study

*Which is more important: saving people's jobs, providing hospitals, keeping cars off village streets or saving time for motorists? You have to create the route of a bypass for a small village, make decisions about priorities, and discuss the strengths and weaknesses of others' routes.*

#### Overview

Challenge your pupils to design and agree on an optimal route for a village bypass, subject to the Highways Agency constraints for road design. Pupils use the provided software or suggested physical resources and measure lengths and curves, fine tune cost-benefit trade offs, interpret data, convert units; and balance their mathematical findings against stakeholder interests. You can use the case study to introduce or develop mathematical concepts in a real-world setting that emphasises Key Concepts and Key Processes in the Key Stage 3 National Curriculum for mathematics. Alternatively, use it to build on previous maths lessons.

#### Mathematical content

Measurement, ratio and proportion, unit conversion, and speed-time-distance calculations are needed to design the bypass. The emphasis is on learners using mathematical findings and reasoning to convince others. There are no 'right' answers; routes are presented to the class and put to a vote.

The case study has strong direct links with the National Curriculum. Mathematics is a tool for designing bypasses (1.3*b* 4*cd*). Data from the Highways Agency is interpreted (2.1*abc* 2.3*be*), and other pupils' routes considered (2.3*fg* 2.4*bc* 4*f*). Pupils draw creatively upon their knowledge and skills (1.2*abc*) to estimate and measure bypasses (3.1*d*), to make proportional comparisons of alternative routes (3.1*c*), and to convert units of time and distance (3.1*g* 3.2*g* 4*abe*). There is significant use of ICT and other hands-on resources (4*g*).

The case study is designed for pupils to discover how useful and necessary mathematical ideas can be when solving real-world problems. Spreadsheet calculators and converters are provided to support pupils if needed. You may also choose to review or introduce some of these skills (measuring, converting units, percentages and decimals, working out speed, time and distance) prior to beginning the case study.

#### Organisation and pedagogy

The case study is flexible and adaptable to all year groups and abilities across Key Stage 3. The pupils mostly work in groups of three or four, with some whole class teacher led discussions. The role of the teacher during group work is similar to assisting pupils with work during mathematics lessons: circulating, intervening to help, and so on. Homework opportunities are research based, such as finding the definitions of words, and you can decide the degree of structure to provide.

#### Resources

A map is provided and pupils design their bypass using the provided *ByPass* software, or alternatively using pin-boards and curtain wire. Road design data from the Highways agency is presented as graphs and tables, including speed limits and cost estimates. Stakeholder interests, including those of commuters, local residents and public services, are also presented. You can also decide which printed resources to distribute to pupils, and when to do so.

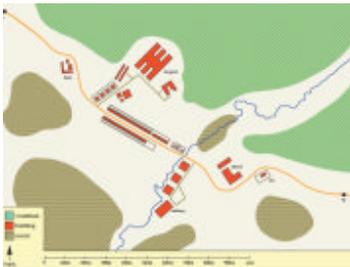
## Contents

### What this case study contains, and other things you might use.

For teachers, the case study contains this document as well as the Lesson Plans. It also contains various printable resources and ICT products, as set out below.

#### Bypass making resources

Pupils use the supplied *ByPass* software or suggested physical resources for making bypasses.



##### Map

The map is the central resource of the case study. It can be printed A4 size for drawing on and A3 size for pin-board work. It can also be used on a whiteboard, and appears in the *ByPass* software. You need not use the map supplied with the case study. Alternate maps can readily be generated by you or your pupils (see **GoogleEarth Guide**, below).



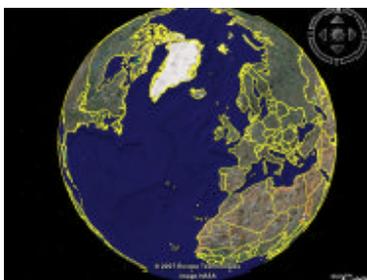
##### ByPass Software

The *ByPass* software is provided with the case study. It enables pupils to construct and measure bypasses. It can be used alone, to supplement non-ICT resources, or not at all. The software is small and simple but will need installing on the school network or locally on the pupils' machines. Provide a shared space for pupils to save their work, as well as access to office software (e.g. *Word*) in order to paste images. A **ByPass Software Guide** is provided, and is suitable for both teachers and pupils.



##### Pin-boards

Pin-boards and curtain wire may be used as an alternative or complement to the *ByPass* software. Physical resources can make maths lessons more engaging, and pupils will need to work out how to make measurements of their bypass. The **Pin-Boards Guide** provides an overview that is suitable for both teachers and pupils.



##### GoogleEarth

*GoogleEarth* can be used by you or your pupils to make maps rather than using the one supplied. You might make a map of a local area for pupils to design a bypass. Pupils might use *GoogleEarth* after completing the case study to find and measure real bypasses. A **GoogleEarth Guide** is provided, and is suitable for both teachers and pupils.

## Handouts

Handouts are printable discussion prompts and references for use in the classroom. They include information about speed limits and costs. There are 9 of them, labeled HL1 to HL9.

Some of these resources are optional. You might allow free access by providing a bank of print or electronic copies to all pupils. Alternatively, you might stagger the distributions to provide a new 'twist' to the 'plot' each lesson.

### **Handout HL1: Stakeholders**

Optional prompt for stimulating discussion in Lesson 1, and for reference in later lessons. It raises issues of safety, pollution, traffic flow, expense, conservation and the environment.

### **Handout HL2: Bypasses in the news**

Optional prompt for stimulating discussion in Lesson 1. Includes a link to a BBC news video of the famous Newbury bypass battle.

### **Handout HL3: Glossary**

Optional prompt for Lesson 1 illustrating key words from the case study (T-junction, refinery etc). A blank version is also provided that can be given out for homework.

### **Handout HL4: Junctions**

Mandatory reference for Lesson 2 onwards. The costs of various types of junction are set out.

### **Handout HL5: Costs**

Mandatory reference for Lesson 2 onwards. Costing data is repeated in tabulated and graphical form. Each form has strengths and weaknesses, and some are more appropriate than others. You might use only one representation of the data; alternatively multiple presentations of the same data might be used to stimulate discussion about the most appropriate form.

### **Handout HL6: Speed Limits**

Optional prompt and reference for Lesson 2 onwards. Details the legal national speed limits for straight stretches of road in the UK.

### **Handout HL7: Speed Signs**

Optional prompt or homework for Lesson 1. Displays speed limit signs, some realistic, others not.

### **Handouts HL8 and HL9: Curves and Speed Limits**

Mandatory reference for Lesson 2 onwards. Provides Highways Agency data on the safe maximum speed limits for curved stretches of roads. Two versions are supplied so you can decide whether pupils need to convert units (HL8) or not (HL9).

## Other resources

Other resources should be used to support pupils in their work. One of these is supplied with the case study, the others are typically found in maths classrooms.

### **Spread calculators and converters**

If pupils need support with calculating speed, distance and time, or with converting units, then the optional spreadsheet supplied with the case study can be used.

### **Calculators**

Handheld calculators are likely to come in handy when converting units, and working with speed, distance and time.

### **Paper, pencils and mathematical instruments**

Make sure pupils have plenty of paper, pens and pencils, and mathematical instruments to hand from Lesson 2 onwards.

### **Posters**

Posters provide a useful aid for structuring group work in Lessons 2 and 3, and presenting ideas in Lesson 4. They can also provide you with a classroom display about the case study. A large piece of sugar paper should be provided to each group. Pupils work on plain paper, and trim and glue contributions on to their group posters. In this way group members can work collaboratively and concurrently.

### **PowerPoint**

*PowerPoint* can be used for the presentations in Lesson 4. *PowerPoint* allows slides made by pupils working concurrently at different computers to be pasted into a single presentation. It could therefore also be used as a focus for structuring group work in Lessons 2 and 3, just like Posters (above).

### **Voting Handsets**

Some schools have a set of voting handsets, such as Promethean's *ACTIVote*. This technology displays results on a whiteboard as the votes come in. It also records how each pupil voted (displaying this information to the class can have amusing consequences!) If available, voting handsets might enliven choosing a winning bypass in Lesson 4.