



## Civil and Infrastructure Engineering Projects – An Overview (SCQF level 4)

Teacher Guide





# TABLE OF CONTENTS

<b>1.0 INTRODUCTION</b>	4
<b>2.0 WHAT IS A CIVIL AND INFRASTRUCTURE ENGINEERING PROJECT?</b>	4
<b>3.0 BACKGROUND TO THE A9 DUALLING PROGRAMME</b>	5
<b>4.0 CHALLENGES WITH THE CURRENT A9</b>	6
<b>5.0 OBJECTIVES OF UPGRADING TO DUAL CARRIAGEWAY</b>	6
<b>6.0 THE ANTICIPATED BENEFITS OF UPGRADING</b>	7
<b>7.0 PROFESSIONALS WORKING ON THE A9</b>	8
7.1 JOB ROLES ON THE A9	8
7.2 FACTS ABOUT JOB ROLES	10
7.3 PROFESSIONALS WORKING COLLABORATIVELY	15
<b>8.0 RISKS AND CONSTRAINTS ASSOCIATED WITH UPGRADING</b>	15
<b>9.0 OPTIONS APPRAISAL</b>	17
<b>10.0 DESIGN/MITIGATION WORKSHOPS</b>	17
<b>11.0 SUSTAINABLE DESIGN</b>	18
<b>12.0 CONSTRUCTION</b>	19
<b>13.0 FURTHER RESOURCES</b>	20
<b>14.0 MARKING CRITERIA</b>	21

# 1.0 Introduction

This Guide has been produced to assist teachers delivering the SQA Unit – “Civil and Infrastructure Engineering Projects – An Overview” (SCQF Level 4).

The information contained in this Guide is not intended to be prescriptive, rather, it is provided to help inform and guide teachers to appropriate resources which could be used in conjunction with delivering the Unit.

The information contained in this Guide is based on the A9 Dualling Programme. The A9 Dualling Programme is one example of a project background that could be used in the delivery of the Unit. However, it should be noted that any similar infrastructure project could also be used as an alternative to the dualling of the A9.

The Award is aimed at S3, S4 and S5 pupils and involves approximately 20 hours of learning and teaching.

In this Unit, pupils use Transport Scotland’s A9 Dualling Programme as a case study, exploring the nature of civil and infrastructure engineering projects. They investigate some of the main job roles and some of the main challenges encountered in such a project. They may also look at other civil and infrastructure engineering projects.

Three Learning Outcomes (LOs) need to be successfully completed to gain the Award. It is possible for schools to deliver all three LOs. However, at times, professionals from industry such as engineers, environmental scientists and geologists, can collaborate with schools to contribute towards the delivery of LO 2. Appendix 1 provides information and advice on the marking criteria for each LO.

# 2.0 What is a civil and infrastructure engineering project?

The purpose of an infrastructure project is to provide a service that meets the needs of owners and users, not only to deliver a physical structure. Infrastructure is the architecture that connects communities and grows economies. Great infrastructure transforms communities. Roads, rail, communications, airports and energy projects are a gateway to a modern prosperous world and improve the quality of people’s lives, create greater resilience to natural disasters and ensure sustainable growth and affordable access to services. Civil and infrastructure engineering projects are made up of multiple physical, digital and human components. A new tunnel, for example, exists to support a system such as a railway that includes physical trains,

stations and track; digital signalling, safety and communications as well as human components such as the procedures followed by drivers. In the case of an airport, by contrast, this would include the terminal structures, air traffic control facilities and baggage handling systems.

In addition, while some infrastructure projects inevitably include amazing feats of civil engineering, they are of little use without a host of other supporting elements working to create an integrated and functioning system – a railway line is of little use without signalling, trains or stations. And so, systems provide the mobility, sanitation, energy and all other infrastructure services on which we rely.

## 3.0 Background to the A9 Dualling Programme

Scottish Government Ministers are committed to dualling 129 km (80 miles) of road between Perth and Inverness. This forms part of the Scottish Government's plan to connect all Scotland's cities with a high-quality transport system in the future. The A9 Dualling Programme is a complex and challenging civil engineering project and is the largest transport investment in Scotland's history to date. The A9 is the longest trunk road

in Scotland, with the Perth to Inverness section forming 177km (110 miles) of the 433km (269 miles) total.

The A9 Dualling Programme aims to deliver economic growth through improved road safety and reliable and quicker journey times. In addition, the Programme will deliver better links for pedestrian, cycling and public transport facilities.

### This Guide will help you understand:

- ✓ The rationale for upgrading the road to dual carriageway
- ✓ Some of the current issues with single carriageway sections of the A9
- ✓ The main objectives of upgrading the A9 road to dual carriageway
- ✓ Some of the benefits of dualling the A9 road
- ✓ Some of the risks and constraints associated with the upgrade of the A9
- ✓ How some of these risks and constraints might be managed and mitigated
- ✓ Some of the job roles found on the project
- ✓ How different professionals work collaboratively.

### How do you find information?

In addition to the information contained in this Guide, a dedicated website has been developed by Transport Scotland, hosting resources to help teachers and pupils find information for the learning outcomes. The URL for this website is [bit.ly/academy9](https://bit.ly/academy9)

On the website, you will find A9 resources in the form of e.g., short video blogs (vlogs), examples

of presentations, hyperlinks to other sites, photographs, and documents.

It is suggested you begin by watching the 'A9 Dualling Programme Overview Video' on the homepage [bit.ly/academy9](https://bit.ly/academy9)

Note that the website also serves as a school resource, e.g., for lesson planning.

## 4.0 Challenges with the current A9

- ! The road is used by HGVs, agricultural vehicles, commercial vehicles, tourists, residents, etc. Some of this traffic includes slow-moving vehicles which can often lead to traffic build-ups. At times, this can lead to driver frustration and stress, and also impacts on journey times.
- ! Parts of the A9 between Perth and Inverness are single carriageway, while other parts are already dual carriageway which can create several issues.
- ! Driver frustration can lead to the temptation to overtake, which could be unsafe as some parts of the single carriageway sections are not suitable for overtaking.
- ! Weather in this part of Scotland can be severe, especially in winter, creating hazardous driving conditions and slow-moving traffic situations.
- ! In the spring and summer months, traffic volumes increase due to high numbers of tourists travelling on the road, again creating slow-moving traffic.

## 5.0 Objectives of upgrading to dual carriageway

**The A9 Dualling Programme has four key objectives:**

- 1. To improve the operational performance of the A9 by:**
  - Reducing journey times; and
  - Improving journey time reliability.
- 2. To improve safety for motorised and non-motorised users by:**
  - Reducing rates of fatality and severity of accidents; and
  - Reducing driver frustration and stress.
- 3. To facilitate active travel within the A9 corridor; and**
- 4. To improve integration with public transport.**

## 6.0 The anticipated benefits of upgrading

### Upgrading the full extent of the A9 to dual carriageway will:

- Reduce journey times;
- Improve journey reliability;
- Encourage more economic development (e.g. for business & tourism sectors) by improving access to and from the Highlands;
- Improve safety for all road users;
- Increase access to tourist sites, local towns and villages;
- Increase the diversity of the local population in the Highlands due to improved access and mobility; and
- Bring economic and cultural benefits to the region.



## 7.0 Professionals working on the A9

### 7.1 Job roles on the A9

Job roles on the A9 vary depending on lots of different factors and can include:

ENGINEERING/PLANNING/DESIGN RELATED	
Roads and Infrastructure Engineer	Intelligent Technology Specialist
Rail Engineer	Contracts and Commercial Specialist
Structural Engineer	Geographical Information Systems (GIS) Specialist
Drainage Engineer	Archaeologist
Geotechnical Engineer	Acoustic Consultant
Geologist	Air Quality Consultant
CAD Technician	Cultural Heritage Consultant
Transport Planner	Ecologist
Topographic Surveyor	Landscape Architect
Architect	Sustainability Consultant
Planner	Hydrologist
Economist	Geomorphologist
Project Manager	Document Controller
Health and Safety Manager	Stakeholder Engagement Consultant
Education Liaison Officer	Videographer
Bridge Engineer	Water Engineer
Highways Engineer	Ground Investigation Supervisor
Civil Engineer	Geotechnical Engineer
Environmental Consultant	Environmental Scientist
Intelligent Traffic Systems (ITS)	

CONSTRUCTION RELATED	
Engineer	Quantity Surveyor
Community Benefits Adviser	Laboratory Assistant
Health and Safety Manager	Temporary Works Designer
Ganger	Foreman
Joiner	Steel Fixer
Materials Buyer	Plant Operator
Environmental Clerk of Works	Labourer/Tradesperson



## 7.2 Facts about job roles

In the table below, three facts are outlined about a range of the different job roles:

JOB TITLE	THREE FACTS
<b>Bridge Engineer</b>	<ol style="list-style-type: none"> <li>1. Provides practical design solutions that bring communities together by enabling all types of road users and pedestrians to cross roads, rivers and railways.</li> <li>2. Understands and can design structures that use a wide range of materials including concrete, steel, timber and stone.</li> <li>3. Understands the particular design requirements of any structure and prepares detailed designs necessary for the project.</li> </ol>
<b>Engineer</b>	<ol style="list-style-type: none"> <li>1. Usually, a civil engineer who is early in his/her career will involve “setting out” where engineering drawings are used to help mark out locations to define the position and level of the construction works.</li> <li>2. Works closely with Section Foreman on details required.</li> <li>3. Works with temporary works designer.</li> </ol>
<b>Highways Engineer</b>	<ol style="list-style-type: none"> <li>1. Creates drawings that contractors use to construct roads.</li> <li>2. Designs roads and road related features to the relevant design standards.</li> <li>3. Liaises with a range of disciplines to ensure best practice, including e.g., Client, Project Manager, Health &amp; Safety and Environment Teams.</li> </ol>
<b>Water Engineer</b>	<ol style="list-style-type: none"> <li>1. Creates models which predict flows and water levels of rivers.</li> <li>2. Accountable to the Client for delivering the work required to time, cost, quality and safety targets.</li> <li>3. Final checker of reports or work produced by the team before it is issued to the client.</li> </ol>
<b>Project Manager</b>	<ol style="list-style-type: none"> <li>1. Responsible for making sure that the team has the necessary resources.</li> <li>2. Understands and can design structures that use a wide range of materials including concrete, steel, timber and stone.</li> <li>3. Understands the particular design requirements of any structure and prepares detailed designs necessary for the project.</li> </ol>



JOB TITLE	THREE FACTS
<b>GIS Specialist</b>	<ol style="list-style-type: none"> <li>1. Manages geographical and survey data and produces and provides accurate mapping that includes the latest information.</li> <li>2. Translates data into a readable and useful format for use in the scheme proposals and designs.</li> <li>3. Liaises with engineers and the environmental teams to ensure the most up to date information is available.</li> </ol>
<b>Landscape Architect</b>	<ol style="list-style-type: none"> <li>1. Designs public spaces, including cycle paths, parks and outdoor open spaces.</li> <li>2. Designs spaces using trees and plants. Undertakes a mix of design requirements in urban areas and more sensitive design in rural areas.</li> <li>3. Liaises with the designer of structures and bridges to make sure these fit into the overall design requirements.</li> </ol>
<b>Geologist</b>	<ol style="list-style-type: none"> <li>1. Responsible for planning and designing site investigations, assessing contaminated land and the need for remediation (clean-up) of a site.</li> <li>2. Provides technical input to Environmental Impact Assessments.</li> <li>3. Carries out field surveys of soil and peat and oversees ground investigation works.</li> </ol>
<b>Ground Investigation Supervisor</b>	<ol style="list-style-type: none"> <li>1. Manages the site team supervising the ground investigation and decides on safe working methods.</li> <li>2. Examines soil and rock samples and schedules laboratory testing to determine their engineering properties.</li> <li>3. Keeps records of progress and costs of investigations to keep the project on time and on budget.</li> </ol>
<b>Environmental Scientist</b>	<ol style="list-style-type: none"> <li>1. Responsible for ensuring all environmental surveys, mapping and environmental impact assessments are completed and properly reviewed.</li> <li>2. Makes sure all environmental topic leads (e.g., ecologist or geologist) understand the project requirements.</li> <li>3. Makes sure team is aware of deadlines to meet in order to make sure statutory process including planning permission can be obtained.</li> </ol>



JOB TITLE	THREE FACTS
<b>Transport Planner</b>	<ol style="list-style-type: none"> <li>1. Carries out modelling of traffic flows to current requirements and for future projections.</li> <li>2. Designs static and electronic traffic signs and safe access points for future maintenance.</li> <li>3. Liaises with local authorities and landowners on future power supply requirements to ensure the electricity network provides what is required.</li> </ol>
<b>Temporary Works Designer</b>	<ol style="list-style-type: none"> <li>1. Responsible for the design of temporary works such as revised traffic flows to allow the road to be built.</li> <li>2. Works with Sub Agent and Section Engineer on specific proposals.</li> <li>3. Works with subcontractors and suppliers to ensure the design of temporary works includes any specific requirements.</li> </ol>
<b>Quantity Surveyor</b>	<ol style="list-style-type: none"> <li>1. Responsible for reviewing and preparing quantities of materials used on the construction site. This includes materials used but also things like materials moved i.e., earthworks.</li> <li>2. Prepares payments for suppliers, subcontractors and plant suppliers.</li> <li>3. Undertakes reconciliation of materials.</li> </ol>
<b>Laboratory Assistant</b>	<ol style="list-style-type: none"> <li>1. Take samples of materials, such as freshly poured concrete or soil for testing in laboratory.</li> <li>2. Carries out all testing of site materials in laboratory.</li> <li>3. Certifies all approved or rejected materials.</li> </ol>
<b>Community Benefits Adviser</b>	<ol style="list-style-type: none"> <li>1. Assists Community Benefits Manager on delivery of all Social Value Commitments which are part of the contract agreement.</li> <li>2. Provides point of contact with local community.</li> <li>3. Arranges local meetings and community involvement.</li> </ol>



JOB TITLE	THREE FACTS
<b>Health and Safety Manager</b>	<ol style="list-style-type: none"> <li>1. Responsible for all contract health and safety management which includes ensuring the correct practices are undertaken by reviewing risk assessment and method statements. These detail how construction activities will be undertaken and identify the risk involved so those carrying out the work are aware.</li> <li>2. Responsible for delivery of all health and safety training including subcontractors, suppliers and plant suppliers.</li> <li>3. Responsible for all health and safety briefings and communication with third party landowners and stakeholders.</li> </ol>
<b>Foreman</b>	<ol style="list-style-type: none"> <li>1. Responsible for the operatives working on a specific element of the contract.</li> <li>2. Ensuring the timely delivery of all resources and materials required to construct a part of the contract.</li> <li>3. Making sure all health and safety requirements are observed.</li> </ol>
<b>Ganger</b>	<ol style="list-style-type: none"> <li>1. Person in charge of a squad or team of operatives or items of plant, e.g., drainage team.</li> <li>2. Working under the foreman's supervision to ensure the work is carried out on time and to specification.</li> <li>3. Making sure the correct materials and plant are available as required.</li> </ol>
<b>Steel Fixer</b>	<ol style="list-style-type: none"> <li>1. Working under foreman's supervision, working specifically to ensure steel reinforcement which is found within certain types of structures.</li> <li>2. Must have all the necessary certification and training for the task.</li> <li>3. Must work with and follow instruction from the engineer and foreman to make sure that task is correctly undertaken.</li> </ol>
<b>Joiner</b>	<ol style="list-style-type: none"> <li>1. Works specifically with formwork which is used to create the structures themselves. Formwork acts like a mould for concrete to be poured into and create shapes, like bridges.</li> <li>2. Must have all the necessary certification and training for the task.</li> <li>3. Must work with and follow instruction from the engineer and foreman to make sure that task is correctly undertaken.</li> </ol>



JOB TITLE	THREE FACTS
<b>Plant Operator</b>	<ol style="list-style-type: none"> <li>1. Fully trained operator of a specific item of plant or equipment. On roads projects they will usually be responsible for shifting earthworks around the site but can also be used for smaller work like fitting drainage channels or laying asphalt.</li> <li>2. Must have the necessary certification and training to operate a specific item of plant or equipment.</li> <li>3. Is responsible for the health and safety of the particular item of plant or equipment.</li> </ol>
<b>Materials Buyer</b>	<ol style="list-style-type: none"> <li>1. Responsible for the purchase of all materials required by the contract or part of the contract.</li> <li>2. Ensuring the contract specification requirements are maintained.</li> <li>3. Ensuring the materials are delivered on time and in the correct place and or order.</li> </ol>
<b>Labourer/Tradesperson</b>	<ol style="list-style-type: none"> <li>1. Works across various aspects of a construction site, helping out where needed and carrying out specific tasks such as laying piping.</li> <li>2. Works with particular materials and equipment to undertake the specific task.</li> <li>3. Ensuring all health and safety procedures are followed.</li> </ol>
<b>Environmental Clerk of Works</b>	<ol style="list-style-type: none"> <li>1. Monitors on-going contractor compliance with environmental regulations and contractual requirements (including commitments and mitigation set out in the Environmental Impact Assessment and Environmental Management Plans).</li> <li>2. Provides specialist knowledge if any environmental issues arise, such as pollution incidents.</li> <li>3. Liaises with regulatory authorities, for example SEPA, NatureScot and Historic Environment Scotland and Local Authorities (through Planning Monitoring Officers)</li> </ol>



### 7.3 Professionals working collaboratively

Teams working on the A9 Dualling Programme are “multi-disciplinary”. This means that people with different job roles work collaboratively together in order to get the best outcome. Working collaboratively means that a balance must be reached between different professionals about what is desirable and what is achievable. This requires that each professional has an understanding of, and geologists and environmental consultants to advise them about, suitable or unsuitable soil conditions, dangers of landslip and rock falls. This links into the need to preserve protected wildlife habitats or Sites of Special Scientific Interest (SSSI).

By working collaboratively, different professional input helps ensure the optimal design and

appreciation of the roles and responsibilities of other professionals on the project.

Highways Engineers depend on Landscape Architects, Site Surveyors, Geologists, Hydrologists and Environmental Consultants to advise them about the specifics of existing environmental constraints. Geotechnical Engineers rely on information from construction of the road. Each professional provides expertise, passing on information to others so that existing conditions, risks and constraints can be established, which allows for suitable management and mitigation of these. Collaboration involves a willingness to negotiate and compromise so that solutions can be reached.

## 8.0 Risks and constraints associated with upgrading

In attempting to mitigate the effects of the new road on existing landscape features, Transport Scotland must consult, negotiate and, at times, compromise, with a range of group stakeholders, each of which has their own concerns and interests.

**Designing and building the dual carriageway is complex. The location and design of the new dual carriageway takes into account a variety of engineering constraints, such as:**

-  The location of the existing road
-  Other roads
-  Cycle routes
-  Power lines
-  Utility and cable pipelines
-  Railway tracks
-  Buildings – residential, commercial and industrial
-  Topography (the physical appearance of natural features of an area of land)
-  Rivers and lochs
-  Floodplains
-  Types of ground – rock or very soft ground (such as peat) would be difficult to build on.

**There are also environmental constraints, many of which are protected by law. These are at risk of being affected by the construction or operation of the new road and include:**

-  Wildlife, for example, birds, bats and fish
-  Plants and habitats, for example, peatland or heathlands
-  Ancient woodland
-  Heritage sites (including listed buildings)
-  Designated environmental sites, such as important habitats or scientifically important geological sites
-  National parks
-  Rivers and lochs
-  Groundwater
-  Private water supplies (from wells or rivers)
-  Landscape character
-  Farms and plantations; and
-  Air and noise quality.

These risks and constraints must be managed and/or mitigated. The table below provides examples of some possible risks and potential mitigation to reduce the risk:

RISK	EXAMPLE OF MITIGATION
<b>Removal of trees</b>	Replantation of trees in specially selected areas
<b>Removal of a section of important habitat</b>	Habitat restoration in an appropriate area
<b>Increased noise during construction</b>	Specific timings of construction works in highly populated areas or near sensitive wildlife
<b>Reduction in water quality in a river, due to chemicals or changes to flows</b>	Monitoring of water quality during construction
<b>Unknown ground conditions</b>	Ground investigations carried out ahead of the design being finalised

## Design process

Below are some specific examples of other constraints which have had to be considered in the upgrading of the A9.

National cycle paths and right of way tracks exist on the A9 which are likely to be impacted by the upgrade resulting in some having to be closed or diverted during construction work. One of the aims of the dualling programme is to ensure the safety and continued access of non-motorised users (NMUs). Access to these paths and trails must be managed carefully and may involve the creation of new underpasses (to avoid NMUs having to cross the A9), thus enhancing their safety.

Several rivers are affected by the dualling programme and the points at which the new dual carriageway intersects with these rivers may require the construction of bridges for vehicular traffic or new tunnels for rivers to flow through underneath the A9 carriageway.

One of the aims of the dualling programme is to accommodate and facilitate the integration of public transport, which includes the major railway line running north from Perth to Inverness. The design of the new dual carriageway must take account of rail tracks and associated facilities. This may result in the re-routing of the road or the construction of road bridges over the railway lines.

Protected environmental, archaeological and heritage sites may be impacted by increased noise and air pollution during construction and/or by an increase in volume of traffic when the new road is complete. Mitigating measures can be taken and constant monitoring and recording of pollution levels is essential. Examples of mitigation measures which can be implemented include minimising noise by restricting work to daylight hours or placing restrictions on HGV traffic during evening, weekend and night-time hours.

## 9.0 Options appraisal

A major part of the design for a road infrastructure scheme is an 'options appraisal'. For this, Highways Engineers will create a variety of possible options - in the case of the A9, this was different corridor/route options (where the road could go). All teams involved in the road design (including Geotechnical Engineers, Environmental Scientists and Highways

Engineers etc.) will look at the design and assess the pros and cons for each option. A final design, which may be a compromise taking account of all possible constraints, is produced following detailed assessment and feedback from all the professionals involved.

## 10.0 Design/mitigation workshops

Design/mitigation workshops are where professionals working on a project come together to discuss aspects of the proposed route design. Depending on the key issues in a project, those typically involved would include Highways Engineers, Geotechnical Engineers,

Landscape Architects, Ecologists, Hydrologists and Environmental Consultants. Professionals involved will discuss design issues and constraints before agreeing appropriate solutions or mitigation options for the majority of constraints.

# 11.0 Sustainable design

**Sustainability can be defined as “meeting our own needs without compromising the ability of future generations to meet their own needs”. Sustainability is now ingrained in the design of large infrastructure projects. Sustainability refers to the use of:**

- 1.** Natural resources from the environment
- 2.** Social resources such as education, connecting towns and cities
- 3.** Economic resources such as providing employment opportunities for communities and supporting local businesses and suppliers.

Together, the environment, social and economic resources are the three pillars/mainstays of sustainability. Full descriptions on these mainstays/ pillars and what is included in each can be found under the **United Nations Sustainable Development Goals** (a set of 17 goals to drive

forward global sustainability by 2030). Commonly, large infrastructure projects create sustainability objectives for the project to achieve environmental, social and economic targets. Project teams are continuously assessing whether they are meeting these objectives.



## Examples of implementation of the A9 sustainability objectives on the A9 Dualling Programme includes:

- Balancing the amount of cut (soil dug up from the ground) and fill (soil put into the ground) to reduce wastage
- Encouragement of car sharing or using public transportation when site work is being undertaken to minimise carbon emissions
- The contribution to education and skill building within the corridor through Academy9
- Consideration of access for communities
- Inclusion of Non-Motorised User (NMU) routes, such as cycleways and footpaths

The design of the A9 was undertaken using an “environmentally-led approach”, which means the impact of the road on the environment was considered throughout the design process. This approach to design is now relatively standard for large infrastructure projects, however this was not always the case.

Sustainability is also considered in the design standards (legal requirements for the design of infrastructure) that are required to be used on projects. One example would be to design to increased flood levels due to climate change and incorporating this into the design to ensure there is no flooding.

## 12.0 Construction

Once the design has been agreed and the public have had the chance to comment on the proposed scheme, the design is finalised in detail. Contractors will use the designs created by the design team to build the road. Members of the design team will be on site to represent the client and help resolve any issues. There will also be specialists, such as an Environmental

Clerk of Works on site to monitor and ensure that environmental commitments are met and that mitigation measures are applied, where necessary. All members of the site team will work together to ensure the road is built to a high standard and safely. Safety is extremely important on a construction site and everyone is responsible for reporting anything which may be unsafe.

## 13.0 Further resources

In order to further inform and assist teachers delivering the Unit, a list of resources is provided below.

### **A9 Dualling Programme overview video**

[bit.ly/academy9](https://bit.ly/academy9)

### **Overview of the A9 Dualling upgrade Perth to Inverness**

[transport.gov.scot/projects/a9-dualling-perth-to-inverness/](https://transport.gov.scot/projects/a9-dualling-perth-to-inverness/)

### **List of the 11 projects making up the A9 Dualling upgrade**

[blogs.glowscotland.org.uk/glowblogs/academy9/about/projects/](https://blogs.glowscotland.org.uk/glowblogs/academy9/about/projects/)

### **A Day in the life of an Aquatic Ecologist (see p.5)**

[transport.gov.scot/media/35826/ts-a9-dualling-update-newsletter-march-2017.pdf](https://transport.gov.scot/media/35826/ts-a9-dualling-update-newsletter-march-2017.pdf)

### **Video blogs of professionals working on the A9 Dualling upgrade**

[blogs.glowscotland.org.uk/glowblogs/academy9/gallery/video-blogs/](https://blogs.glowscotland.org.uk/glowblogs/academy9/gallery/video-blogs/)

### **More information on careers and job roles**

[blogs.glowscotland.org.uk/glowblogs/academy9/careers/](https://blogs.glowscotland.org.uk/glowblogs/academy9/careers/)



# 14.0 Civil infrastructure engineering project marking criteria and advice

## Learning Outcome 1

Describe the objectives and likely benefits of a civil and infrastructure engineering project.

SUCCESS CRITERIA	EXAMPLE A	EXAMPLE B
Gives an accurate description in general terms of what a civil and infrastructure engineering project is, giving 3 simple facts about it.	What 3 facts would you use to define a civil and infrastructure engineering project?	How would you describe to someone else what a civil and infrastructure engineering project is, using 3 simple facts about it?

### MARKING GUIDANCE 3 [1]

The candidate's response should give 3 different facts about a civil and infrastructure engineering project. The response should show an understanding that civil and infrastructure engineering is concerned with work on e.g. roads, bridges, railways, tunnels, hospitals, canals, etc. (i.e. civil structures and facilities that support human activity, involving utilities, communication networks, housing, transport, etc.) as distinct from e.g. military engineering [2]

### FACTS INCLUDE

- a focus on public/social facilities of the built environment that support human activity
- examples of the types of facilities/structures involved (i.e. roads, bridges, housing, etc., as indicated above)
- a reference to public funding e.g. by national government or local authority
- a reference to distinguish it from e.g. other types of engineering projects
- reference to the involvement of both small companies or larger, national/international/transnational corporations

SUCCESS CRITERIA	EXAMPLE A	EXAMPLE B
Gives an accurate description of 2 objectives of a civil and infrastructure engineering project (such as the upgrade of the A9).	What are 2 of the main objectives of a particular civil and infrastructure engineering project that you have learned about?	Describe 2 of the main objectives of a chosen civil and infrastructure engineering project.

### MARKING GUIDANCE 2 [3]

The candidate's response should give 2 different objectives of the project. The aim is for the candidate to show that he/she understands the main purpose/aim of the project and what it is designed to achieve. [4]

### FACTS INCLUDE

**These objectives may have been defined, for example, by –**

- a national government (e.g. UK, Scottish) or local authority
  - a managing agency (e.g. Transport Scotland)
- For the objectives of the A9 Dualling Programme, please see the following –  
[blogs.glowscotland.org.uk/glowblogs/academy9/](https://blogs.glowscotland.org.uk/glowblogs/academy9/)  
[transport.gov.scot/projects/a9-dualling-perth-to-inverness/](https://transport.gov.scot/projects/a9-dualling-perth-to-inverness/)

## Learning Outcome 1 - continued

Describe the objectives and likely benefits of a civil and infrastructure engineering project.

SUCCESS CRITERIA	EXAMPLE A	EXAMPLE B
Gives an accurate description of 2 likely benefits of the chosen civil and infrastructure engineering project.	What might be 2 of the likely benefits of the project you have learned about and who might benefit from it?	Describe 2 of the likely benefits of your chosen civil and infrastructure engineering project and who might benefit from it.
<b>MARKING GUIDANCE 3 [5]</b>		
The candidate's response should give 2 different likely benefits of the project and show some understanding of who might benefit. The aim is to show that he/she understands how the project might help bring improvements e.g. to a particular group, community, region, stakeholder, etc. <b>[6]</b>		
<b>FACTS INCLUDE</b>		
<p><b>For benefits associated with the upgrade of the A9, please see the following –</b>  <a href="https://blogs.glowscotland.org.uk/glowblogs/academy9/">blogs.glowscotland.org.uk/glowblogs/academy9/</a>  <a href="https://transport.gov.scot/projects/a9-dualling-perth-to-inverness/">transport.gov.scot/projects/a9-dualling-perth-to-inverness/</a>  <a href="https://blogs.glowscotland.org.uk/glowblogs/public/academy9/uploads/sites/3601/2016/06/a9_-_general_IntroductionPresentation_StALL.pdf">blogs.glowscotland.org.uk/glowblogs/public/academy9/uploads/sites/3601/2016/06/a9_-_general_IntroductionPresentation_StALL.pdf</a></p> <p><b>A candidate's response might include -</b></p> <ul style="list-style-type: none"> <li>• General benefits - e.g. creating jobs, bringing more tourism, helping businesses, reducing travel times, reducing accidents, etc.</li> <li>• Local or specific benefits - e.g. improving access to a particular area, connecting areas not previously connected, improving trade links between areas, removing traffic from a town centre, etc.</li> <li>• National benefits – e.g. upgrading/improving national (road, rail, communication networks, etc.)</li> <li>• International benefits – e.g. attracting more foreign investment, foreign visitors, foreign trade, etc.</li> </ul>		
<b>Total possible marks 8 [7]</b>		

RESOURCE	WEBSITE
LO1 <b>A9 Dualling Programme Overview Video</b>	<a href="https://blogs.glowscotland.org.uk/glowblogs/academy9/">blogs.glowscotland.org.uk/glowblogs/academy9/</a> <a href="https://transport.gov.scot/projects/a9-dualling-perth-to-inverness/">transport.gov.scot/projects/a9-dualling-perth-to-inverness/</a> <a href="https://blogs.glowscotland.org.uk/glowblogs/public/academy9/uploads/sites/3601/2016/06/a9_-_general_IntroductionPresentation_StALL.pdf">blogs.glowscotland.org.uk/glowblogs/public/academy9/uploads/sites/3601/2016/06/a9_-_general_IntroductionPresentation_StALL.pdf</a>

# Civil infrastructure engineering project marking criteria and advice (continued)

## Learning Outcome 2

Describe the work of different professionals involved in a civil and infrastructure engineering project.

SUCCESS CRITERIA	EXAMPLE A	EXAMPLE B
Gives examples of the kind of professionals who work on this type of project - correctly identify 2 examples of professional job roles found on a civil and infrastructure engineering project.	What kind of professional jobs would you find on a civil and infrastructure engineering project?	Identify 2 different types of professional jobs that you might find on a civil and infrastructure engineering project.

## MARKING GUIDANCE 2 [8]

The candidate's response must identify 2 different examples of professional job roles found on this type of project. The examples can be given in simple terms e.g. geologist, ecologist, engineer, archaeologist, surveyor, etc. or can be given in a more specific way, for example, as a job title, e.g. Senior Engineering Geologist, Landscape Architect, Contract Manager, Archaeologist, etc. [9]

## FACTS INCLUDE

**For professional jobs associated with the upgrade of the A9, please see section 7 of this Guide, and the following -**

[blogs.glowscotland.org.uk/glowblogs/academy9/gallery/video-blogs/](https://blogs.glowscotland.org.uk/glowblogs/academy9/gallery/video-blogs/)

[blogs.glowscotland.org.uk/glowblogs/academy9/about/](https://blogs.glowscotland.org.uk/glowblogs/academy9/about/)

## Learning Outcome 2 - continued

Describe the work of different professionals involved in a civil and infrastructure engineering project.

SUCCESS CRITERIA	EXAMPLE A	EXAMPLE B
Gives an accurate description of the work of 2 professionals on the chosen civil and infrastructure engineering project, using 3 facts about each (i.e. 6 facts must be included for a complete answer).	Describe the work of 2 professionals who can be found on a civil and infrastructure engineering project. Give 3 facts about each person's work.	Describe the work of both these jobs by giving at least 3 facts about each of them.

### MARKING GUIDANCE 6 [10]

The candidate's response must describe the work of 2 different professionals, giving at least 3 facts or making at least 3 different points about each (i.e. 6 in total for full marks). Normally, the candidate should describe the work of the 2 jobs chosen previously, but no penalty should be imposed if different examples are used. **[11]**

### FACTS INCLUDE

**For the work of professionals on the A9 Dualling Programme, see section 7 of this Guide, the web links above, and the following video blogs -**

[blogs.glowscotland.org.uk/glowblogs/academy9/gallery/video-blogs/](https://blogs.glowscotland.org.uk/glowblogs/academy9/gallery/video-blogs/)

**The candidate's response might include facts or examples from the following -**

- Area(s) of professional specialism for the job
- Aims and purpose of the job (e.g. to ensure that the project meets legal and/or health and safety, etc. regulations; to prevent specific problems arising e.g. subsidence, flooding, accidents, collapse, etc.; to ensure that other professionals can carry out their own tasks effectively; to ensure that overall project objectives are met; to avoid damage to e.g. wildlife habitats, heritage sites, etc.)
- Types of activity carried out on the job (e.g. carrying out on-site surveying, taking soil samples, writing reports, measuring distances, mapping landscape features, taking photos, recording habitat information, making presentations, etc.)
- Where the work is carried out (e.g. on site, in an office, both)
- What equipment / tools are used to carry out the job, etc.

**Total possible marks 8 [12]**

RESOURCE	WEBSITE
LO2 <b>A9 Careers</b>	<a href="https://transport.gov.scot/media/35826/ts-a9-dualling-update-newsletter-march-2017.pdf">transport.gov.scot/media/35826/ts-a9-dualling-update-newsletter-march-2017.pdf</a> <a href="https://blogs.glowscotland.org.uk/glowblogs/academy9/careers/">blogs.glowscotland.org.uk/glowblogs/academy9/careers/</a> <a href="https://blogs.glowscotland.org.uk/glowblogs/academy9/gallery/video-blogs/">blogs.glowscotland.org.uk/glowblogs/academy9/gallery/video-blogs/</a>

# Civil infrastructure engineering project marking criteria and advice (continued)

## Learning Outcome 3

Explain non-routine elements (or challenges) in the work of professionals on a civil and infrastructure engineering project.

SUCCESS CRITERIA	EXAMPLE A	EXAMPLE B
Correctly describe in general terms one example of a non-routine element (or challenge) that professionals might face when working on a civil and infrastructure engineering project.	What kind of challenges (i.e. non-routine or unexpected element or experience of the job) might professionals face while working on a civil and engineering and infrastructure project? Describe one example.	Describe in general terms one example of a challenge (i.e. a non-routine or unexpected element or experience) that might be found on a civil and infrastructure engineering project.
<b>MARKING GUIDANCE 3 [13]</b>  The candidate's response must describe one example of a 'challenge' that might be faced by professionals on this type of project. The term 'challenge' has been used here to mean a non-routine or unexpected element of work or experience on the project. The aim is for the candidate to gain a broader perspective, a general understanding (using an example) that the work of professionals on such a project is not always straightforward and/or that such work may sometimes involve dealing with difficult situations. [14]		
<b>FACTS INCLUDE</b>  <b>The following link provides examples relating to constraints within construction projects -</b> <a href="http://designingbuildings.co.uk/wiki/Constraints_on_construction_projects">designingbuildings.co.uk/wiki/Constraints_on_construction_projects</a>  <b>Additional examples can be found by exploring the latest news on the A9 Dualling Programme from Transport Scotland -</b> <a href="http://blogs.glowscotland.org.uk/glowblogs/academy9/about/projects/">blogs.glowscotland.org.uk/glowblogs/academy9/about/projects/</a>  <b>Examples of a 'challenge' might be included under any of the following -</b> <ul style="list-style-type: none"> <li>on-the-job findings that are unexpected, unforeseen or that may pose difficulty for the project (e.g. ecology findings showing evidence of habitat for a rare or protected species; landscape or cultural heritage features requiring specific engineering solutions; etc.)</li> <li>changes in government policy or priorities that might impact on the project (e.g. a decision to promote 'electrification' of the A9, involving the installation of car charging points, additional access points or cabling, etc. along the route)</li> </ul>		

### Learning Outcome 3 - continued

Explain non-routine elements (or challenges) in the work of professionals on a civil and infrastructure engineering project.

SUCCESS CRITERIA	EXAMPLE A	EXAMPLE B
Give an accurate explanation of what the possible consequence(s) or impact(s) (negative or positive, or both) of such a challenge might be on a civil and infrastructure engineering project.	What impact or consequence(s) might this challenge have on the project? Explain in your own words.	Explain in your own words how or in what way(s) this challenge might impact on the project.

#### MARKING GUIDANCE 3 [15]

The candidate's response must explain the possible impact(s) or consequence(s) such a challenge might have on the project. The candidate is expected to show an understanding – in very general terms - of how, or in what way(s), such a challenge might affect the project. The aim here is to give candidates an understanding that projects sometimes have to change and adapt to ongoing/everyday situations. **[16]**

#### FACTS INCLUDE

To achieve this part of the learning outcome, the candidate is not expected to discuss solutions (or 'mitigation'), simply to show a basic appreciation of some of the ways in which a project might be affected. For example, the candidate might refer to any/some of the following, depending on the challenge she/he has described -

- the project might become more (or less) expensive
- deadlines/timescales for the project might be delayed or extended (or shortened)
- overall designs/technical drawings for the project might have to be altered and updated
- additional (e.g. unanticipated) work may have to be carried out
- one or more of the project objectives might be more difficult to achieve
- clearer, more detailed/up to date information might have to be provided to stakeholders

**Total possible marks 6 [17]**

**Total UNIT marks 22 [18]**

RESOURCE	WEBSITE
LO3 <b>Constraints</b>	<a href="https://designingbuildings.co.uk/wiki/Constraints_on_construction_projects">designingbuildings.co.uk/wiki/Constraints_on_construction_projects</a> <a href="https://blogs.glowscotland.org.uk/glowblogs/academy9/about/projects">/blogs.glowscotland.org.uk/glowblogs/academy9/about/projects</a>

# Civil infrastructure engineering project marking criteria and advice (continued)

## Learning Outcome 1

Describe the objectives and likely benefits of a civil and infrastructure engineering project.

### SUCCESS CRITERIA

Gives an accurate description in general terms of what a civil and infrastructure engineering project is, giving 3 simple facts about it.

### MARKING GUIDANCE 3 [20]

Have they given 3 different facts about a civil and infrastructure engineering project? Is there an understanding that civil and infrastructure engineering is concerned with work on e.g. roads, bridges, railways, tunnels, hospitals, canals, etc. (i.e. civil structures and facilities that support human activity, involving utilities, communication networks, housing, transport, etc.)? [19]

### SUCCESS CRITERIA

Gives an accurate description of 2 objectives of a civil and infrastructure engineering project (such as the upgrade of the A9).

### MARKING GUIDANCE 2 [22]

Have they given 2 different objectives of the project? Do they understand the main purpose/aim of the project and what it is designed to achieve. [21]

### SUCCESS CRITERIA

Gives an accurate description of 2 likely benefits of the chosen civil and infrastructure engineering project.

### MARKING GUIDANCE 3 [24]

Have they given 2 different likely benefits of the project and shown some understanding of who might benefit? Do they understand how the project might help bring improvements e.g. to a particular group, community, region, stakeholder, etc. [23]

**Total possible marks 8 [25]**

## Learning Outcome 2

Describe the work of different professionals involved in a civil and infrastructure engineering project.

### SUCCESS CRITERIA

Gives examples of the kind of professionals who work on this type of project - correctly identify 2 examples of professional job roles found on a civil and infrastructure engineering project.

### MARKING GUIDANCE 2 [27]

Have they identified 2 different examples of professional job roles found on this type of project (e.g. geologist, ecologist, engineer, archaeologist, surveyor, landscape architect, contract manager, etc.)? **[26]**

### SUCCESS CRITERIA

Gives an accurate description of the work of 2 professionals on the chosen civil and infrastructure engineering project, using 3 facts about each (i.e. 6 facts must be included for a complete answer)

### MARKING GUIDANCE 6 [29]

Have they described the work of 2 different professionals, giving at least 3 facts or making at least 3 different points about each? **[28]**

**Total possible marks 6 [29]**

## Learning Outcome 3

Explain non-routine elements (or challenges) in the work of professionals on a civil and infrastructure engineering project.

### SUCCESS CRITERIA

Correctly describe in general terms one example of a non-routine element (or challenge) that professionals might face when working on a civil and infrastructure engineering project.

### MARKING GUIDANCE 3 [32]

Have they described one example of a 'challenge' that might be faced by professionals on this type of project? **[31]**

## SUCCESS CRITERIA

Give an accurate explanation of what the possible consequence(s) or impact(s) (negative or positive, or both) of such a challenge might be on a civil and infrastructure engineering project.

### MARKING GUIDANCE 3 [34]

Have they explained the possible impact(s) or consequence(s) such a challenge might have on the project? [33]

Total possible marks 6 [35]

Total UNIT marks 22 [36]



# Appendix 1:

## Civil infrastructure engineering project marking criteria and advice

- [1] The candidate must gain at least 1 mark for this part of the learning outcome.
- [2] Although not required for a correct or complete answer, candidates can be encouraged to link their facts to specific examples e.g. about the upgrade of the A9 - so for example, he/she might include examples of the companies involved in working on the A9.
- [3] The candidate must gain at least 1 mark for this part of the learning outcome.
- [4] Each correct example of an objective can be awarded 1 mark, up to a total of 2 marks. The description can be a simple statement (e.g. one or two sentences).
- [5] The candidate must gain at least 1 mark for this part of the learning outcome.
- [6] Each correct or appropriate likely benefit can be awarded 1 mark, up to a total of 2 marks. A further 1 mark can be awarded if the candidate's response includes an example of who might benefit from the project. A maximum of 3 marks can be awarded for this part of the learning outcome.
- [7] To achieve this learning outcome, a candidate must gain at least 1 mark for each question AND at least 4 marks in total (50%).
- [8] The candidate must gain at least 1 mark for this part of the learning outcome.
- [9] Each correct example can be awarded 1 mark, up to a maximum of 2 marks. The candidate's response need only be a simple statement or two.
- [10] The candidate must gain at least 1 mark for this part of the learning outcome.
- [11] Each correct fact or point about the work of the professional can be awarded 1 mark, up to a total of 3 marks. The candidate's response should include a description of 2 professionals, so a maximum of 6 marks can be awarded for this part of the learning outcome.
- [12] To achieve this learning outcome, a candidate must gain at least 1 mark for each question AND at least 4 marks in total (50%).
- [13] The candidate must gain at least 1 mark for this part of the learning outcome.
- [14] The candidate's response should give a description that includes one example of a challenge of the kind suggested above; award 1 mark for identifying an example. Further marks, up to a total of 2, can be awarded for a description which e.g. is clear, relates directly to the work of a professional or to the project as a whole, shows insight into the nature of the difficulty it might pose, etc. Candidates are not expected to discuss solutions (or 'mitigation'), but if information of this type is included this can be considered when allocating marks. A total of up to 3 marks can be awarded for this part of the learning outcome.

- [15]** The candidate must gain at least 1 mark for this part of the learning outcome.
- [16]** Each correct or appropriate point about an impact or consequence can be awarded 1 mark, up to a total of 3 marks.
- Marks can be awarded e.g. for a response which explains whether the impact/consequence is (in the candidate's own words) negative or positive (allocate 1 mark). Marks can also be awarded if a response shows insight into a range of difficulties created by the challenge; or gives more detailed information (e.g. refers to possible solutions/'mitigation'). Total number of marks possible for this part of the learning outcome = 3. The total number of marks possible for learning outcome 3 = 6.
- [17]** To achieve this learning outcome, a candidate must gain at least 1 mark for each question AND at least 3 marks in total (50%).
- [18]** To achieve a Pass in the Unit a candidate must successfully achieve all the learning outcomes and gain at least 11 marks out of 22 (50%).
- [19]** Although not required for a correct or complete answer, candidates can be encouraged to link their facts to specific examples e.g. about the upgrade of the A9 - so for example, he/she might include examples of the companies involved in working on the A9.
- [20]** The candidate must gain at least 1 mark for this part of the learning outcome.
- [21]** Each correct example of an objective can be awarded 1 mark, up to a total of 2 marks. The description can be a simple statement (e.g. one or two sentences).
- [22]** The candidate must gain at least 1 mark for this part of the learning outcome.
- [23]** Each correct or appropriate likely benefit can be awarded 1 mark, up to a total of 2 marks. A further 1 mark can be awarded if the candidate's response includes an example of who might benefit from the project. A maximum of 3 marks can be awarded for this part of the learning outcome.
- [24]** The candidate must gain at least 1 mark for this part of the learning outcome.
- [25]** To achieve this learning outcome, a candidate must gain at least 1 mark for each question AND at least 4 marks in total (50%).
- [26]** Each correct example can be awarded 1 mark, up to a maximum of 2 marks. The candidate's response need only be a simple statement or two.
- [27]** The candidate must gain at least 1 mark for this part of the learning outcome.
- [28]** Each correct fact or point about the work of the professional can be awarded 1 mark, up to a total of 3 marks. The candidate's response should include a description of 2 professionals, so a maximum of 6 marks can be awarded for this part of the learning outcome.

- [29]** The candidate must gain at least 1 mark for this part of the learning outcome.
- [30]** To achieve this learning outcome, a candidate must gain at least 1 mark for each question AND at least 4 marks in total (50%).
- [31]** The candidate's response should give a description that includes one example of a challenge of the kind suggested above; award 1 mark for identifying an example. Further marks, up to a total of 2, can be awarded for a description which e.g. is clear, relates directly to the work of a professional or to the project as a whole, shows insight into the nature of the difficulty it might pose, etc. Candidates are not expected to discuss solutions (or 'mitigation'), but if information of this type is included this can be considered when allocating marks. A total of up to 3 marks can be awarded for this part of the learning outcome.
- [32]** The candidate must gain at least 1 mark for this part of the learning outcome.
- [33]** Each correct or appropriate point about an impact or consequence can be awarded 1 mark, up to a total of 3 marks. Marks can be awarded e.g. for a response which explains whether the impact/consequence is (in the candidate's own words) negative or positive (allocate 1 mark). Marks can also be awarded if a response shows insight into a range of difficulties created by the challenge; or gives more detailed information (e.g. refers to possible solutions/'mitigation'). Total number of marks possible for this part of the learning outcome = 3. The total number of marks possible for learning outcome 3 = 6.
- [34]** The candidate must gain at least 1 mark for this part of the learning outcome.
- [35]** To achieve this learning outcome, a candidate must gain at least 1 mark for each question AND at least 3 marks in total (50%).
- [36]** To achieve a Pass in the Unit a candidate must successfully achieve all the learning outcomes and gain at least 11 marks out of 22 (50%).

# MINDSET

Academy9

Mindset is a set of beliefs that affects how we **think, feel and behave**

Be the best version of you





Civil and Infrastructure Engineering Projects – An Overview (SCQF level 4)  
[bit.ly/academy9](https://bit.ly/academy9)