

Learner Resources and Research Pack

Grangemouth Flood Protection Scheme

Prezi Video Guide

Presented by Adele Jaccon, a Jacobs Engineer working on the Grangemouth Flood Protection Scheme, the videos below provide additional information to learners about the different methods of flood protection available, where and when you would use them and some additional information to get young people started. They can be used in addition to, or instead of, the Learner Worksheets and/or Learner Research or Assessment PowerPoint.

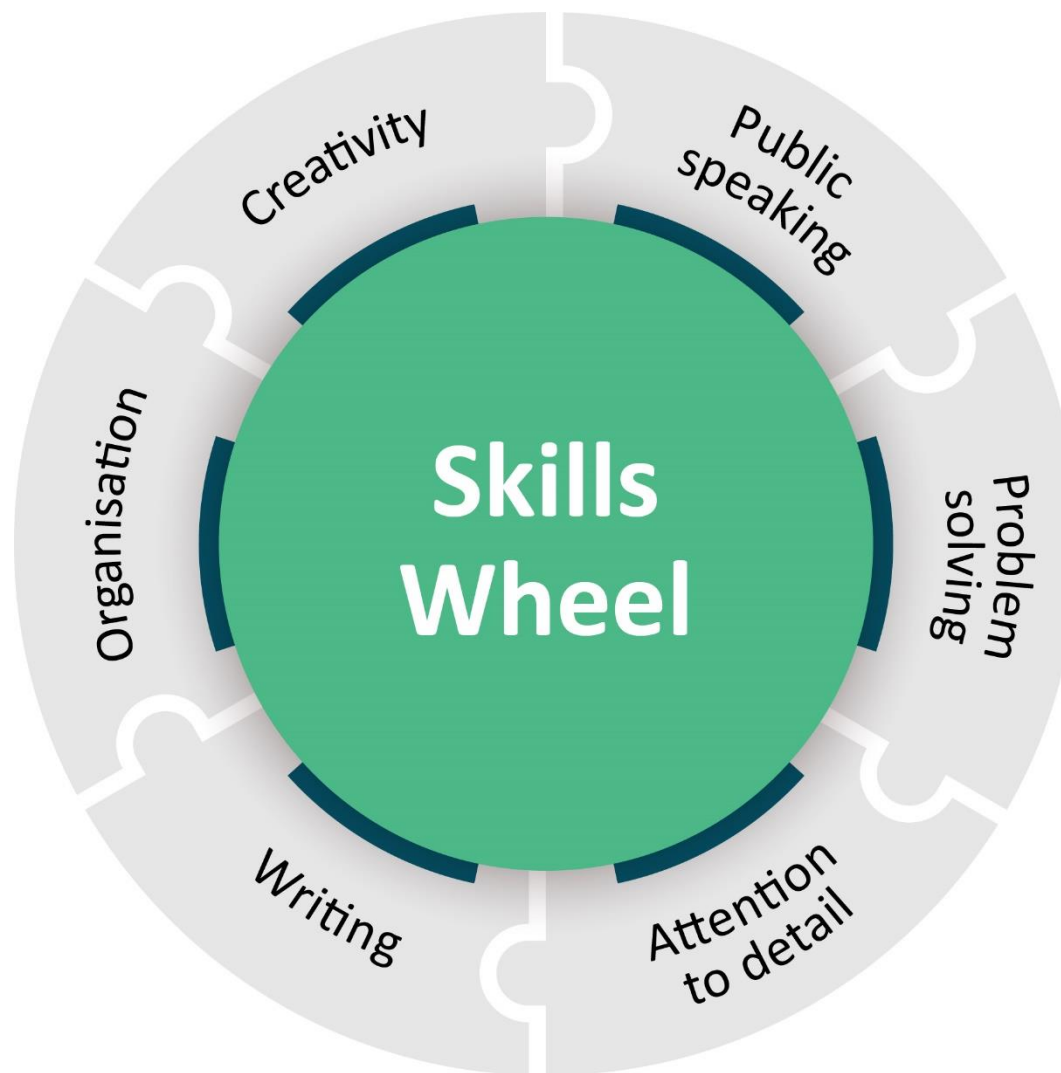
Video	Length	Link
Introduction	42s	Introduction by Adele Jaccon on Prezi Video
Flood Walls	2min 52s	Flood Walls by Adele Jaccon on Prezi Video
Embankments	2min 4s	Flood Embankments / Levees by Adele Jaccon on Prezi Video
Flood Gates	2min 19s	Flood Gates by Adele Jaccon on Prezi Video
Flood Storage Areas	2min 7s	FSAs by Adele Jaccon on Prezi Video
Flood Relief Channels	1min 52s	FRCs by Adele Jaccon on Prezi Video
Culverts	1min 55s	Culverts by Adele Jaccon on Prezi Video
Top Tips	1min 32s	Top Tips by Adele Jaccon on Prezi Video



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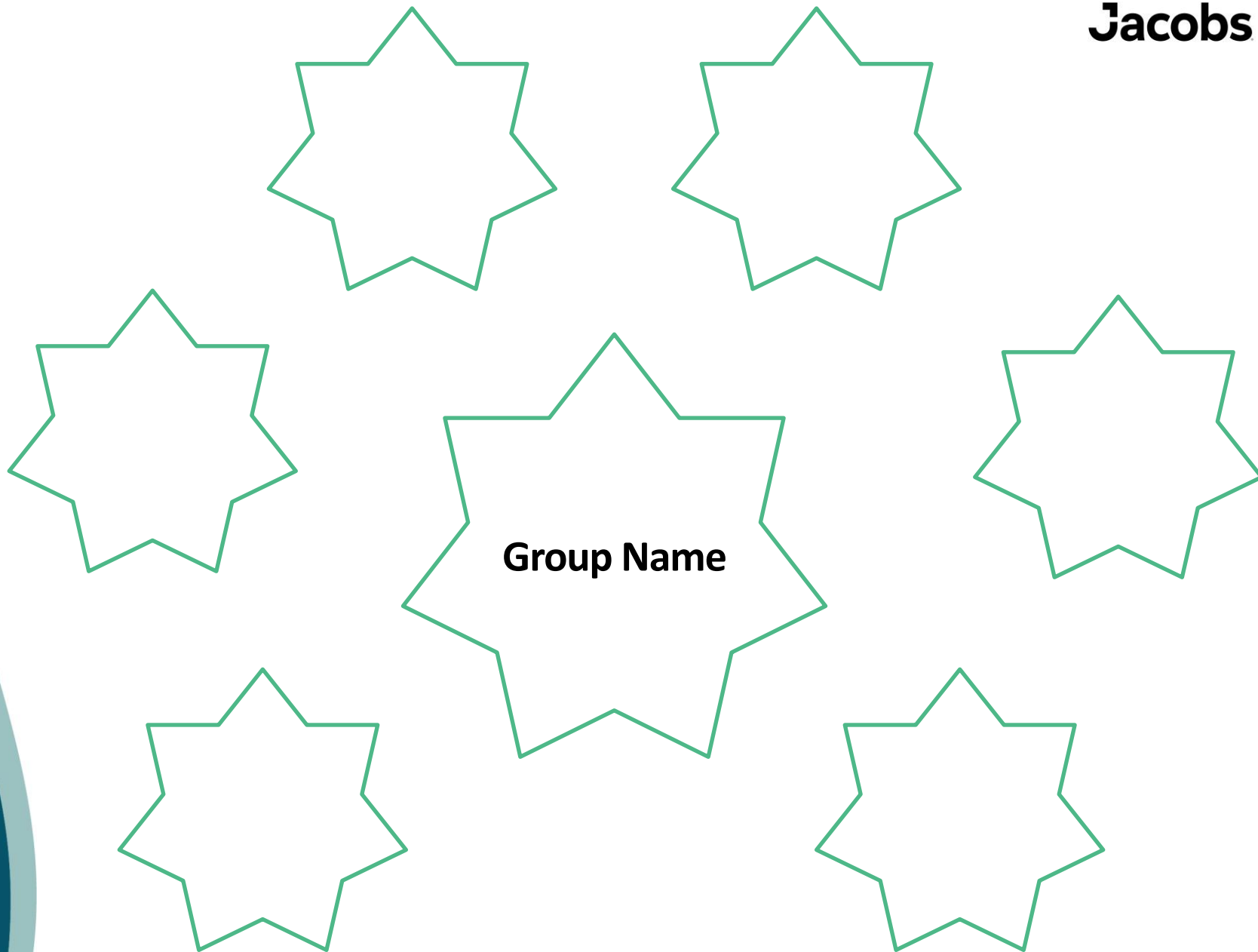
Skills Wheel

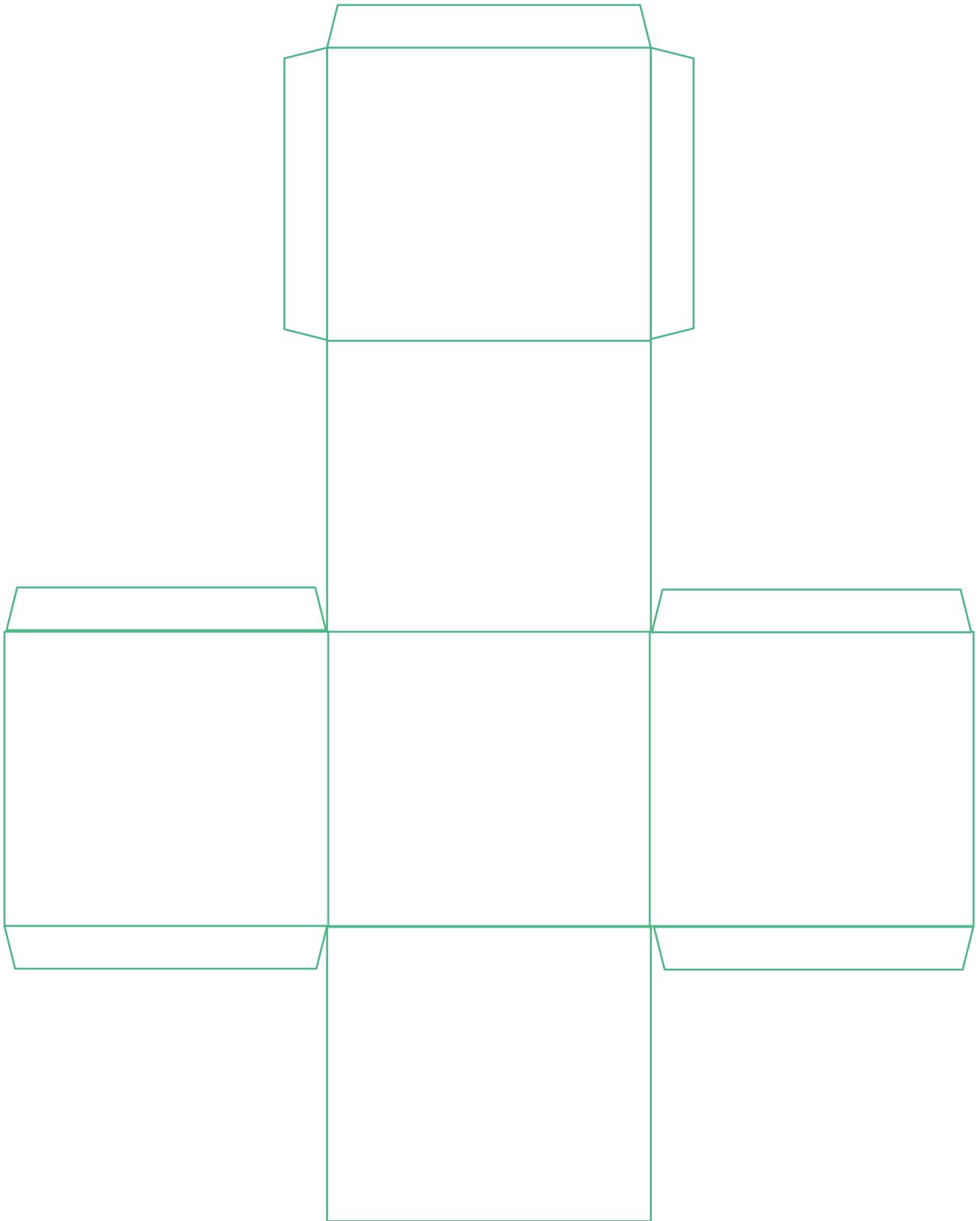


Protecting the heart of our communities

Project Job Roles

Role	Skill	Description
Project Manager	Organisation	In charge of the whole project, setting goals for the team and making sure these are met
Lead Designer/Engineer	Problem Solving	Coming up with design solutions and suggesting how the design can be changed to solve any issues/challenges encountered
Environmental Scientist	Writing	In charge of ensuring all the elements of the project and design are as sustainable and environmentally friendly as possible
PR/Communications Officer	Public Speaking/Presenting	Presenting the final design to the judges and answering any questions posed/directing the question to the best person to answer it
Landscape Architect	Creativity	In charge of ensuring the design looks good and fits in with the landscape/area around it
Administration Officer	Attention to detail	In charge of ensuring all paperwork is correctly kept and stored, all notes are maintained and the information about the design is clearly shown





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Name of Measure: _____

Where it would usually be used: Areas with _____ to build (for example on the banks of a river with houses along it)

Cost: £££

Benefits:

- Doesn't require much _____ to be built
- Can be made to look _____ (stone/brick clad)
- Can have _____ on top to allow people to look through if the view is blocked by the structure (This can significantly add to the costs)
- _____ to build
- Buildings close by are not disturbed during _____
- Can be made to be _____ (more expensive)

Issues:

- Can _____ the view
- Doesn't allow _____ or animal passage through/over them
- _____ design life since materials might need replacing after a while (design life of concrete is 50-100 years only)
- Must account for local _____ (for example what would happen if rainwater started pooling against a wall instead of flowing into the river, or what would happen downstream to other towns if more water is forced towards them)
- If made to be removable they need to be installed _____ before a flood (This process can be very risky)
-

Example of when this defence was well-used:

<https://interestingengineering.com/mobile-flood-walls-keeps-austrian-town-safe>

Website to Begin Research:

<https://acicorporation.com/blog/2018/04/20/the-4-types-of-floodwalls-and-what-they-could-do-for-you/>

<https://coastal-management.eu/measure/flood-embankments-and-floodwalls>

Word Bank

limited space | glass panels | removable | floodwalls | easy | block | space | attractive | human | manually | construction | shorter | drainage



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Name of Measure: Flood _____/ levees

Where it would usually be used: Areas with a lot of _____ to build due to the width of the embankment (e.g. next to the banks of a _____ in a field or in large open spaces away from the river)

Cost: ££

Benefits:

- Can be made to blend in with _____ if covered in grass
- A path can be constructed _____ to allow people to walk/cycle on it
- _____ to build
- Allows _____ or animal passage over them if access ramps are built
- Can provide natural habitat for _____ animals if built with earth

Issues:

- Requires regular _____ (For example cutting the grass, reforming them after a flood in case any of the material was washed away)
- Needs a lot of space to be _____
- Needs to account for local _____ (for example what would happen downstream to other towns if more water is forced _____ them)

Example of when this defence was well-used:

Flood defences in the Netherlands. Their use of embankments and other defences has protected most of the country from being underwater permanently: https://en.wikipedia.org/wiki/Flood_control_in_the_Netherlands

Note: Although it is not generally recommended, this Wikipedia page does give some clear information without being too complicated)

Website to Begin Research:

<https://coastal-management.eu/measure/flood-embankments-and-floodwalls>

Word Bank

space | river | drainage | nature | on top | built | embankments | riverbed | towards | easy | human | maintenance



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Name of Measure: Vehicular or _____ Flood gates (Note: these are different from dam flood gates)

Where it would usually be used: Across _____ or access paths where flood walls are needed but need to allow _____ or cars to pass through (For example on either side of a bridge)

Cost: £

Benefits:

- Demountable (meaning it can be removed and stored somewhere); this can be useful if _____ to the other side of the _____ is needed
- _____
- Easy to _____
- A lot of colours/finishes/_____ available so can blend in with the local landscape

Issues:

- The gate must be completely secure against the _____ for the seal to work
- Might need to be closed manually every time a _____ is announced (more expensive models are automated now)
- Must be stored somewhere _____ when not in use (only if it is a manual gate)

Example of when this defense was well-used:

This is a very commonly used defense so here are just a selection of examples. Note: the gates don't work if the ground behind them hasn't stayed dry.

Some examples: <http://huntonengineering.co.uk/flood-gates/>

Website to Begin Research:

<https://floodcontrolinternational.com/flood-gates/>

Word Bank

pedestrian | access | people | safe | roads | walls | replace | flood | inexpensive | sizes | ground



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Name of Measure: Flood _____ Areas (FSAs)

Where it would usually be used: _____ of the area to protect, in fields or large open areas with low-lying land which can be entirely flooded and left underwater while _____ for the storm/flood to pass

Cost: £££££

Benefits:

- _____ the need to build defenses against floods further downstream
- Don't need to account for _____ drainage since the water can be released back into the river at a controlled safe pace
- Can be _____ into the scenery (ex a football field or a park can become a storage area during a flood and can then be used normally once the water dissipates)

Issues:

- _____ to build and maintain
- High risk if anything goes _____ so must be constantly surveyed
- Floods a large area to hold the water which means the _____ cannot be used until the flood is over

Example of when this defense was well-used:

Wigan Flood Storage Area (as part of a larger flood protection scheme): <https://hydro-int.com/en/case-studies/hydro-brake%C2%AE-flood-protects-over-600-properties-wigan-0>

<https://www.youtube.com/watch?v=41oSLkb7dmY>

Note: it's normal for water to pour on top of the dam in this situation since this is what allows for a controlled release of the water into the river and avoids extensive flooding (this is more about spreading out the volume of water coming down the river across time) - The area where water is allowed to spill over the top of and down the dam is called a spillway

Website to Begin Research:

https://www.therrc.co.uk/MOT/References/EA_Achieving_more_Operational_flood_storage_areas.pdf

Note: Pages 7-15 give the official definition of a FSA, how it can be used and some examples.

Word Bank

upstream | reduces | waiting | expensive | land | wrong | storage | local | incorporated



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Name of Measure: Flood relief _____

Where it would usually be used: Used to create an _____ channel that links one river to another or to the sea to divert water out of the river and away from the area at risk

Cost: ££££

Benefits:

- Reduces the need to build _____ against floods further downstream
- Don't need to account for local _____ or the river losing water
- New aquatic _____ are created
- Can be used for _____ (walking, fishing, boating if also built to allow for boat traffic)
- Doesn't affect people living _____ to where defences would have originally been built

Issues:

- _____
- Requires constant _____ (For example regular cleaning)
- Needs a lot of _____
- Could lead to extra costs if it crosses _____ (which then has to be turned into a bridge)
- Should be _____ to ensure it won't cause flooding along the new channel
- Need to _____ local drainage if it brings water into another river (this can then increase the flood risk from this river)

Example of when this defence was well-used:

River Exe flood relief channel: <https://www.ceca.co.uk/wp-content/uploads/legacy-media/247607/exeter-fds-presentation-30th-nov-16.pdf>

Website to Begin Research:

<https://getrevising.co.uk/grids/flood-relief-channels-flood-management-strategies>

Word Bank

defences | drainage | expensive | designed | artificial | recreation | close | space | consider | channels | habitats | maintenance | roads



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Name of Measure: _____

Where it would usually be used:

Used to create an _____ channel (often a pipe or "tunnel") that is used to allow water to go under roads or houses (very similar to a bridge)

Cost: ££

Benefits:

- Prevents _____ (gradual destruction) of the river and its banks if designed correctly
- Ensures _____ does not flow over ground (for example through people's gardens or over roads)
- Can be used to divert water for _____ or engineering purposes
- _____ to install and inexpensive

Issues:

- Must be correctly _____ to avoid scouring (destruction of the riverbed) and corrosion
- Needs to include something to allow _____ animals to pass through (for example fish passages)
- Needs constant _____ (cleaning it of any debris or sediment, replacing fish brushes etc)
- Can be _____ to design due to all the things that need to be accounted for

Example of when this defence was well-used:

Grange Burn where it passes under the M9 near Rannoch Park – This is a local site so might be worth a look in-person.

Website to Begin Research:

<https://practical.engineering/blog/2020/5/5/what-is-a-culvert>

Note: This is a video which explains in simple terms what a culvert is

Word Bank

artificial | water | easy | maintenance | culverts | erosion | designed | farming | aquatic | complicated



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Name of Measure: Floodwalls

Where it would usually be used:

Cost: £££

Benefits:

Issues:

Example of when this defence was well-used:

<https://interestingengineering.com/mobile-flood-walls-keeps-austrian-town-safe>

Website to Begin Research:

<https://acicorporation.com/blog/2018/04/20/the-4-types-of-floodwalls-and-what-they-could-do-for-you/>

<https://coastal-management.eu/measure/flood-embankments-and-floodwalls>



Falkirk Council



Name of Measure: Flood embankments / levees

Where it would usually be used:

Cost: ££

Benefits:

Issues:

Example of when this defence was well-used:

Flood defences in the Netherlands. Their use of embankments and other defences has protected most of the country from being underwater permanently: https://en.wikipedia.org/wiki/Flood_control_in_the_Netherlands

Note: Although it is not generally recommended, this Wikipedia page does give some clear information without being too complicated)

Website to Begin Research:

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Falkirk Council



Name of Measure: Vehicular or Pedestrian Flood gates (Note: these are different from dam flood gates)

Where it would usually be used:

Cost: £

Benefits:

Issues:

Example of when this defence was well-used:

This is a very commonly used defence so here are just a selection of examples.

Note: the gates don't work if the ground behind them hasn't stayed dry.

Some examples: <http://huntonengineering.co.uk/flood-gates/>

Website to Begin Research:

<https://floodcontrolinternational.com/flood-gates/>



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Name of Measure: Flood Storage Areas (FSAs)

Where it would usually be used:

Cost: £££££

Benefits:

Issues:

Example of when this defence was well-used:

Wigan Flood Storage Area (as part of a larger flood protection scheme): <https://hydro-int.com/en/case-studies/hydro-brake%C2%AE-flood-protects-over-600-properties-wigan-0>

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Note: it's normal for water to pour on top of the dam in this situation since this is what allows for a controlled release of the water into the river and avoids extensive flooding (this is more about spreading out the volume of water coming down the river across time) - The area where water is allowed to spill over the top of and down the dam is called a spillway

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Note: Pages 7-15 give the official definition of a FSA, how it can be used and some examples.



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Name of Measure: Flood relief channels

Where it would usually be used:

Cost: ££££

Benefits:

Issues:

Example of when this defence was well-used:

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Flood Protection Scheme
Protecting the heart of our communities

Name of Measure: Culverts

Where it would usually be used:

Cost: ££

Benefits:

Issues:

Example of when this defence was well-used:

Grange Burn where it passes under the M9 near Rannoch Park – This is a local site so might be worth a look in-person!

Website to Begin Research:

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Name of Measure: Floodwalls

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Name of Measure: Flood embankments / levees

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Name of Measure: Vehicular or Pedestrian Flood gates (Note: these are different from dam flood gates)

Example of when this defence was well-used:

This is a very commonly used defence so here are just a selection of examples.

Note: the gates don't work if the ground behind them hasn't stayed dry.

Some examples: <http://huntonengineering.co.uk/flood-gates/>

Website to Begin Research:

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Name of Measure: Flood Storage Areas (FSAs)

Example of when this defence was well-used:

Wigan Flood Storage Area (as part of a larger flood protection scheme): <https://hydro-int.com/en/case-studies/hydro-brake%C2%AE-flood-protects-over-600-properties-wigan-0>

<https://www.youtube.com/watch?v=41oSLkb7dmY>

Note: it's normal for water to pour on top of the dam in this situation since this is what allows for a controlled release of the water into the river and avoids extensive flooding (this is more about spreading out the volume of water coming down the river across time) - The area where water is allowed to spill over the top of and down the dam is called a spillway

Website to Begin Research:

https://www.therrc.co.uk/MOT/References/EA_Achieving_more_Operational_flood_storage_areas.pdf

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Name of Measure: Flood relief channels

Example of when this defence was well-used:

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Website to Begin Research:

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Flood Protection Scheme
Protecting the heart of our communities

Name of Measure: Culverts

Example of when this defence was well-used:

Grange Burn where it passes under the M9 near Rannoch Park – This is a local site so might be worth a look in-person!

Website to Begin Research:

<https://practical.engineering/blog/2020/5/5/what-is-a-culvert>

Note: This is a video which explains in simple terms what a culvert is



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Grangemouth Flood Protection

Research Starter Pack

Below please find some research starter cards to help the pupils begin and inform their research.

Can be:

- Printed
- Shared digitally
- Used for whole-class teaching
- Given to groups or individuals for their research
- By the teacher to strategically assist pupils in their research

Costs have been summarised by giving a number from £-£££££. Number £ means this defence is inexpensive and £££££ means it can be highly expensive.

Answers from the Pupil Worksheet (Easy) are highlighted in **yellow**.



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Name of Measure: Floodwalls

Where it would usually be used: Areas with limited space to build (for example on the banks of a river with houses along it)

Cost: £££

Benefits:

- Doesn't require much space to be built
- Can be made to look attractive (stone/brick clad)
- Can have glass panels on top to allow people to look through if the view is blocked by the structure (this can significantly add to the costs though)
- Easy to build
- Buildings close by are not disturbed during construction
- Can be made to be removable (more expensive)

Issues:

- Can block the view
- Doesn't allow human or animal passage through/over them
- Shorter design life since materials might need replacing after a while (design life of concrete is 50-100 years only)
- Must account for local drainage (for example what would happen if rainwater started pooling against a wall instead of flowing into the river, or what would happen downstream to other towns if more water is forced towards them)
- If made to be removable they need to be installed manually before a flood (this process can be very risky)

Example of when this defence was well-used:

<https://interestingengineering.com/mobile-flood-walls-keeps-austrian-town-safe>

Website to Begin Research:

<https://acicorporation.com/blog/2018/04/20/the-4-types-of-floodwalls-and-what-they-could-do-for-you/>

<https://coastal-management.eu/measure/flood-embankments-and-floodwalls>



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Name of Measure: Flood **embankments** / Levees

Where it would usually be used: Areas with a lot of **space** to build due to the width of the embankment (e.g. next to the banks of a **river** in a field or in large open spaces away from the river)

Cost: ££

Benefits:

- Can be made to blend in with **nature** if covered in grass
- A path can be constructed **on top** to allow people to walk/cycle on it
- **Easy** to build
- Allows **human** or animal passage over them if access ramps are built
- Can provide natural habitat for **riverbed** animals if built with earth

Issues:

- Requires regular **maintenance** (for example cutting the grass, reforming them after a flood in case any of the material was washed away)
- Needs a lot of space to be **built**
- Needs to account for local **drainage** (for example what would happen downstream to other towns if more water is forced **towards** them)

Example of when this defence was well-used:

Flood defences in the Netherlands. Their use of embankments and other defences has protected most of the country from being underwater permanently: https://en.wikipedia.org/wiki/Flood_control_in_the_Netherlands

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Name of Measure: Vehicular or **Pedestrian** Flood gates (Note: these are different from dam flood gates)

Where it would usually be used: Across **roads** or access paths where flood walls are needed but need to allow **people** or cars to pass through (for example on either side of a bridge)

Cost: £

Benefits:

- Demountable (meaning it can be removed and stored somewhere); this can be useful if **access** to the other side of the **walls** is needed
- **Inexpensive**
- Easy to **replace**
- A lot of colours/finishes/**sizes** available so can blend in with the local landscape

Issues:

- The gate must be completely secure against the **ground** for the seal to work
- Might need to be closed manually every time a **flood** is announced (more expensive models are automated now)
- Must be stored somewhere **safe** when not in use (only if it is a manual gate)

Example of when this defence was well-used:

This is a very commonly used defence so here are just a selection of examples. Note: the gates don't work if the ground behind them hasn't stayed dry.

Some examples: <http://huntonengineering.co.uk/flood-gates/>

Website to Begin Research:

<https://floodcontrolinternational.com/flood-gates/>



Falkirk Council



Name of Measure: Flood Storage Areas (FSAs)

Where it would usually be used: Upstream of the area to protect, in fields or large open areas with low-lying land which can be entirely flooded and left underwater while waiting for the storm/flood to pass

Cost: £££££

Benefits:

- Reduces the need to build defences against floods further downstream
- Don't need to account for local drainage since the water can be released back into the river at a controlled safe pace
- Can be incorporated into the scenery (e.g. a football field or a park can become a storage area during a flood and can then be used normally once the water dissipates)

Issues:

- Expensive to build and maintain
- High risk if anything goes wrong so must be constantly surveyed
- Floods a large area to hold the water which means the land cannot be used until the flood is over

Example of when this defence was well-used:

Wigan Flood Storage Area (as part of a larger flood protection scheme): <https://hydro-int.com/en/case-studies/hydro-brake%C2%AE-flood-protects-over-600-properties-wigan-0>

<https://www.youtube.com/watch?v=41oSLkb7dmY>

Note: it's normal for water to pour on top of the dam in this situation since this is what allows for a controlled release of the water into the river and avoids extensive flooding (this is more about spreading out the volume of water coming down the river across time) - The area where water is allowed to spill over the top of and down the dam is called a spillway

Website to Begin Research:

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Note: Pages 7-15 give the official definition of a FSA, how it can be used and some examples.



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Name of Measure: Flood relief channels

Where it would usually be used: Used to create an artificial channel that links one river to another or to the sea to divert water out of the river and away from the area at risk

Cost: ££££

Benefits:

- Reduces the need to build defences against floods further downstream
- Don't need to account for local drainage or the river losing water
- New aquatic habitats are created
- Can be used for recreation (walking, fishing, boating if also built to allow for boat traffic)
- Doesn't affect people living close to where defences would have originally been built

Issues:

- Expensive
- Requires constant maintenance (For example regular cleaning)
- Needs a lot of space
- Could lead to extra costs if it crosses roads (which then has to be turned into a bridge)
- Should be designed to ensure it won't cause flooding along the new channel
- Need to consider local drainage if it brings water into another river (this can then increase the flood risk from this river)

Example of when this defence was well-used:

River Exe flood relief channel: <https://www.ceca.co.uk/wp-content/uploads/legacy-media/247607/exeter-fds-presentation-30th-nov-16.pdf>

Website to Begin Research:

<https://getrevising.co.uk/grids/flood-relief-channels-flood-management-strategies>



Falkirk Council



Name of Measure: Culverts

Where it would usually be used: Used to create an artificial channel (often a pipe or "tunnel") that is used to allow water to go under roads or houses (very similar to a bridge)

Cost: ££

Benefits:

- Prevents erosion (gradual destruction) of the river and its banks if designed correctly
- Ensures water does not flow over ground (for example through people's gardens or over roads)
- Can be used to divert water for farming or engineering purposes
- Easy to install and inexpensive

Issues:

- Must be correctly designed to avoid scouring (destruction of the riverbed) and corrosion
- Needs to include something to allow aquatic animals to pass through (for example fish passages)
- Needs constant maintenance (cleaning it of any debris or sediment, replacing fish brushes etc)
- Can be complicated to design due to all the things that need to be accounted for

Example of when this defence was well-used:

Grange Burn where it passes under the M9 near Rannoch Park – This is a local site so might be worth a look in-person.

Website to Begin Research:

<https://practical.engineering/blog/2020/5/5/what-is-a-culvert>

Note: This is a video which explains in simple terms what a culvert is



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