Sustainable infiltration: A national map

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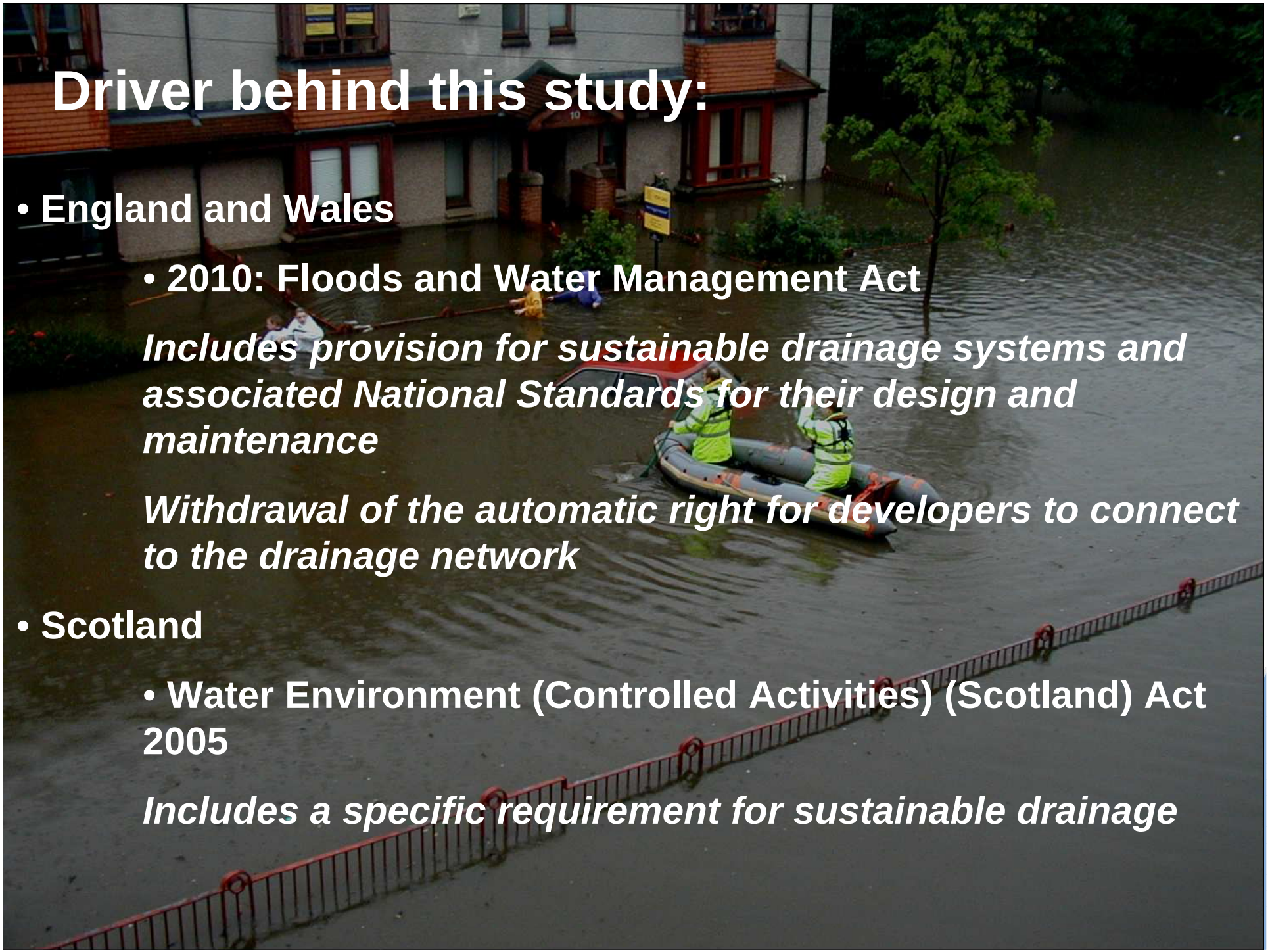
Aim and objectives

AIM: To develop a UK national dataset that will provide data necessary to enable preliminary decision-making on the suitability of the ground for the installation of infiltration-based SuDS

OBJECTIVES:

- Create a GIS-based product that:
  - guides the user through the relevant subsurface considerations
  - provides data necessary for site-specific decision-making
  - provides an overview of infiltration-suitability over wide spatial areas
  - communicates opportunities for a wide variety of infiltration-based SuDS techniques



Driver behind this study:

- **England and Wales**
  - **2010: Floods and Water Management Act**

    Includes provision for sustainable drainage systems and associated National Standards for their design and maintenance

    Withdrawal of the automatic right for developers to connect to the drainage network
- **Scotland**
  - **Water Environment (Controlled Activities) (Scotland) Act 2005**

    Includes a specific requirement for sustainable drainage

SuDS National Standards

- The new SuDS National Standards for England and Wales cover:
  - design
  - construction
  - operation
  - maintenance
- We anticipate that the selection of SuDS techniques, will be guided by the surface water drainage hierarchy, as per current guidance (Approved Document H – Drainage and Waste Disposal):

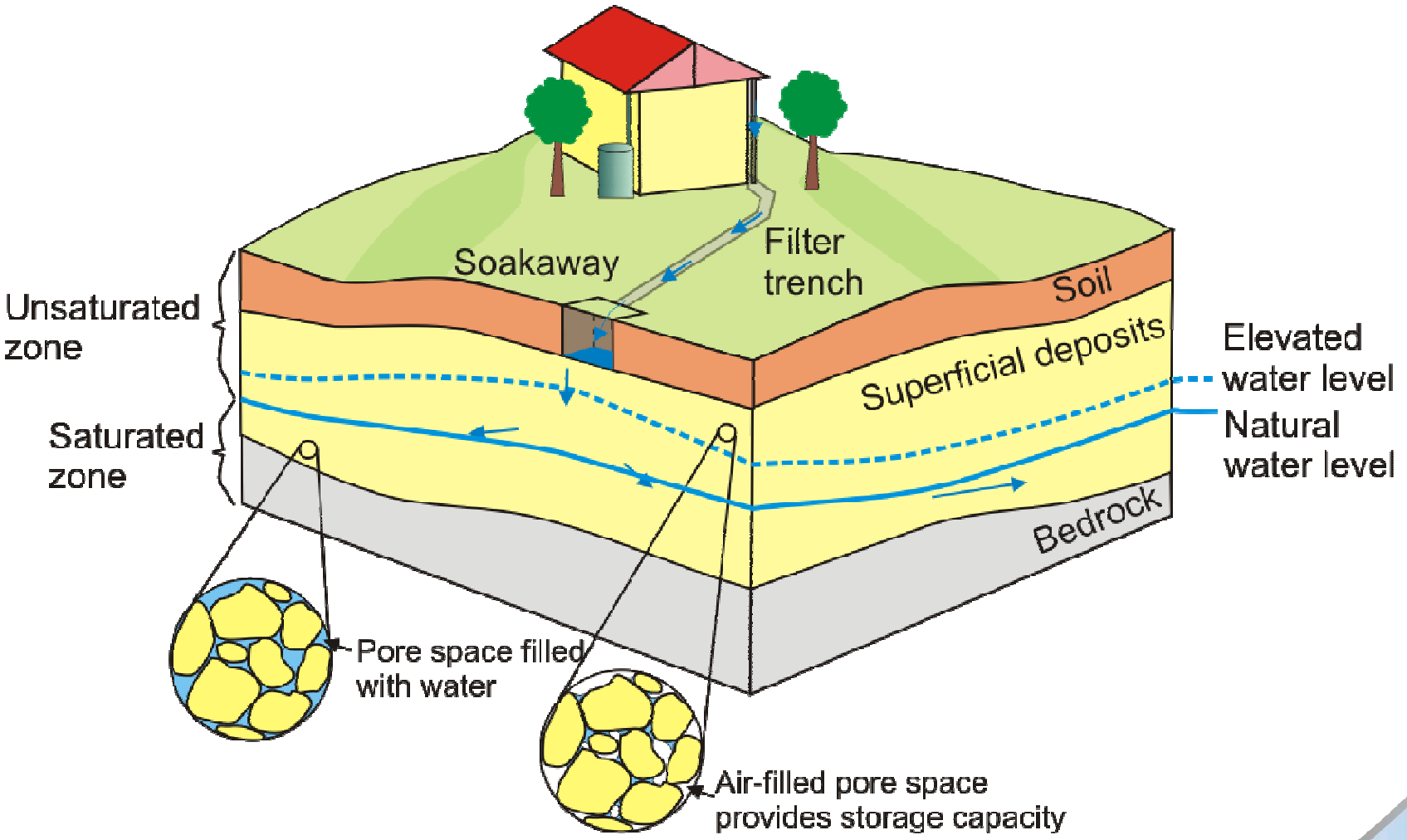
Approved Document H – Drainage and Waste Disposal:

1.Infiltration on site

2.Discharge to watercourses

3.Connection to sewer

How do infiltration SuDS work?



Infiltration SuDS

Soakaway

Permeable paving

Infiltration basin

Infiltration trench

Wetland

Which type of system is applicable?

What type of system is applicable?

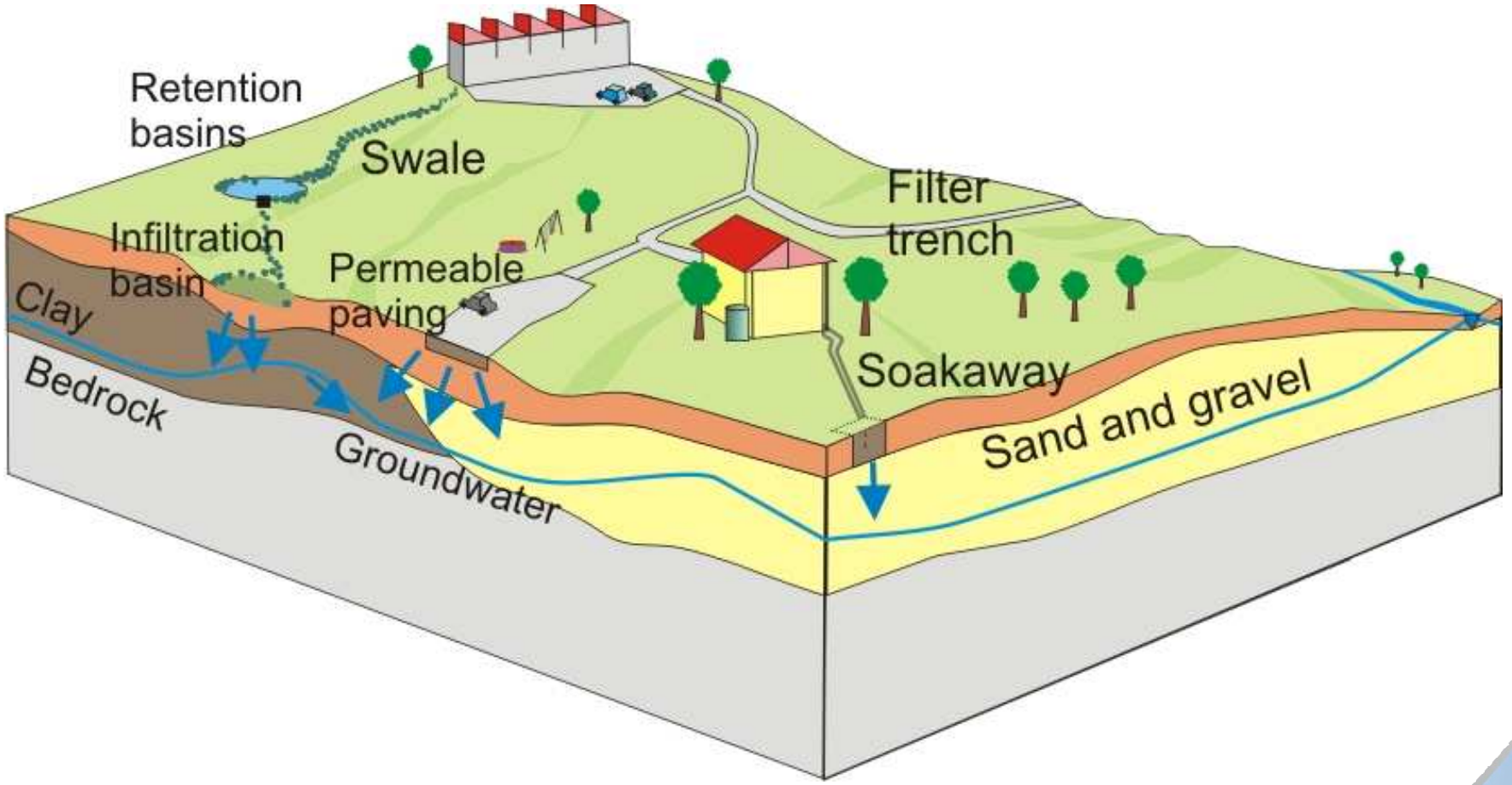
Soakaways: Focuses recharge over a small surface area. Deposits must be free-draining and groundwater level relatively deep

Permeable paving: Allows recharge over an extensive surface area. Required infiltration rate is lower than above and hence systems can be installed in moderately free-draining deposits

Infiltration basin: Allows recharge over a fairly extensive surface area, but also provides sufficient capacity to store water whilst infiltration occurs, hence applicable in low permeability deposits

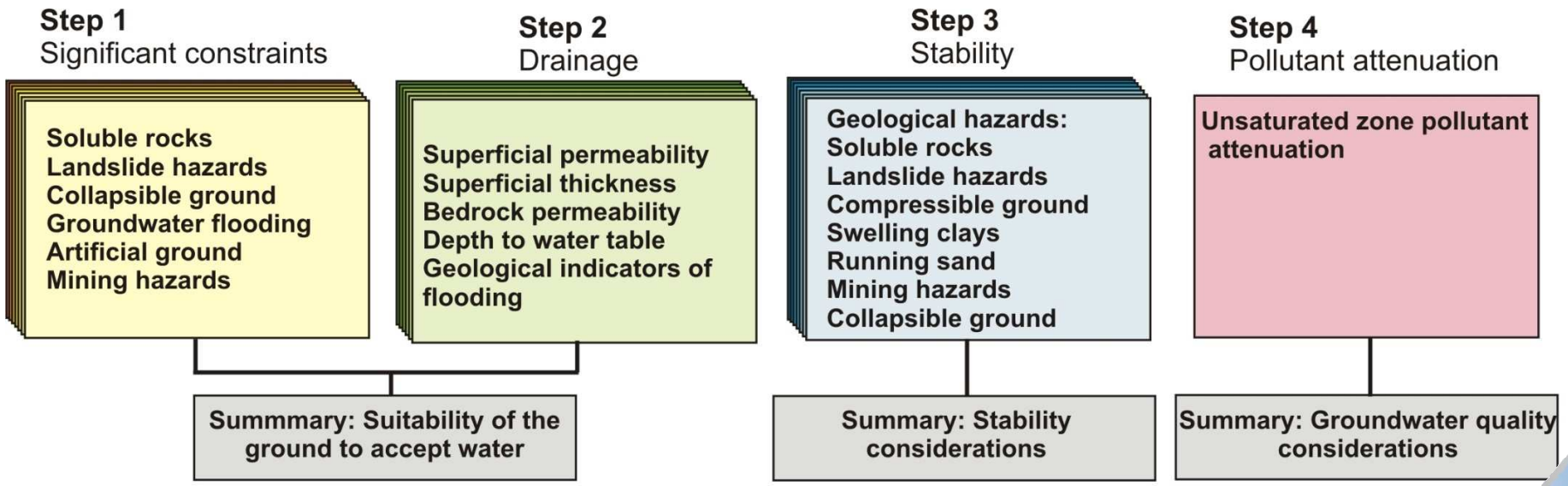
Wetland: Recharge occurs through wetland, which must remain saturated throughout the year, thereby hydraulic continuity with the groundwater is required.

Ground compatibility



National infiltration suitability map

- The national infiltration suitability map aims to:
  - guide the user through the decision making process
  - provide data necessary for preliminary site-specific decision-making
  - provide an overview of infiltration-suitability over wide spatial areas



Framework for site-specific decision-making

- BGS have developed a decision-making framework that guides the user (planner, consultant, developer or SuDS approval body) to determine suitable infiltration SuDS for a specific location.
- The framework comprises four steps:
  - **Step 1**: Consider whether there are any significant constraints that mean an infiltration system should not be installed.
  - **Step 2**: Consider the extent to which the ground will drain.
  - **Step 3**: Consider whether the addition of water to the ground may potentially result in ground instability.
  - **Step 4**: Consider whether the infiltration of surface water is likely to impact groundwater quality.

Step 1: Consider whether there are any significant constraints that mean an infiltration system should not be installed.

- Possible constraints include:

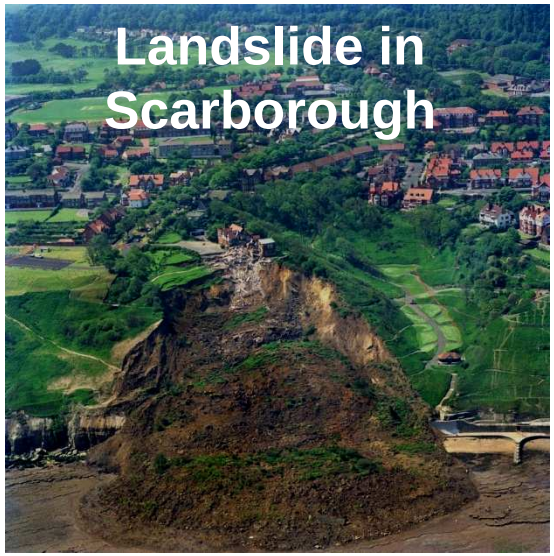
  - Rocks that have a very significant potential to become unstable when water is added, for example, rocks that may dissolve, landslide, collapse or are affected by shallow mining.

  - Areas susceptible to groundwater flooding

  - Areas covered by artificial ground that has unknown chemical and physical properties

  - Locality of Environment Agency (EA) groundwater source protection zones

Burst water main impacts soluble rocks in Surrey



Landslide in Scarborough

Shrink-swell clays

Groundwater flooding in Oxford

Collapses around a soakaway in Kentucky

Step 2: Consider the extent to which the ground will drain.

- Drainage considerations include:
  - Depth to water table and potential for perched water tables
  - Permeability of superficial deposits
  - Permeability of underlying bedrock deposits, where superficial deposits are absent or thin.
  - Slope and its impact on subsurface lateral flows

Step 3: Consider whether the addition of water to the ground may potentially result in ground instability.

- Stability considerations include:
  - Instability hazards that may not preclude infiltration, but that should be considered during the design phase including rocks and deposits that are potentially susceptible to dissolution, landslide, running sand, swelling clays, collapse and compression
  - Instability hazards resulting from shallow mining

Step 4: Consider whether the infiltration of surface water is likely to impact groundwater quality.

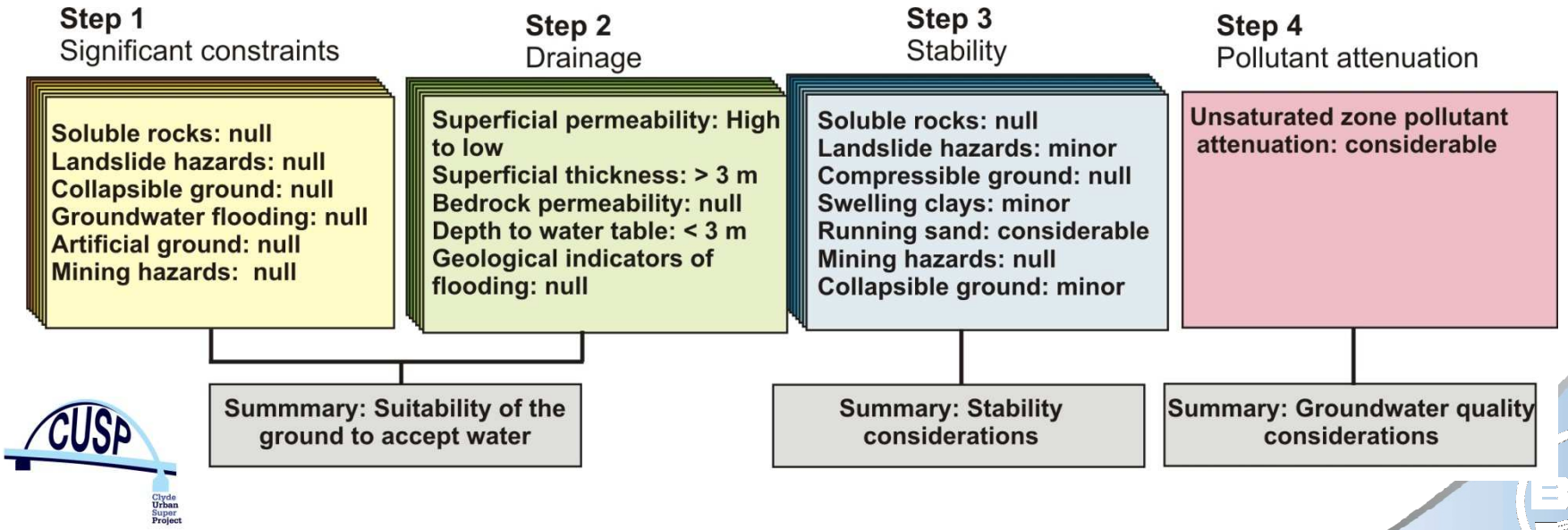
- Groundwater quality considerations include:
  - Quality of surface water, upstream of the infiltration system
  - Mobilisation of surface and subsurface contaminants
  - Attenuation potential of the unsaturated zone deposits
  - Possible pre-treatment requirements
  - Locality of groundwater source protection zones (EA)

Data sources

Dataset	Component datasets
Geohazards (soluble rocks, landslides, compressibles, swelling clays, running sand, mining hazards, collapsible deposits)	Geology, slope, superficial thickness, depth from surface, expert judgement
Groundwater flooding	Geology, permeability, depth to water table
Artificial ground	Geology
Superficial permeability	Geology, literature data, expert judgement
Superficial thickness	Geology, borehole data
Bedrock permeability	Geology, literature data, expert judgement
Depth to water table	Geology, borehole data, river levels
Floodplains	Geology
Aquifer predominant flow mechanism	Geology, literature data, expert judgement

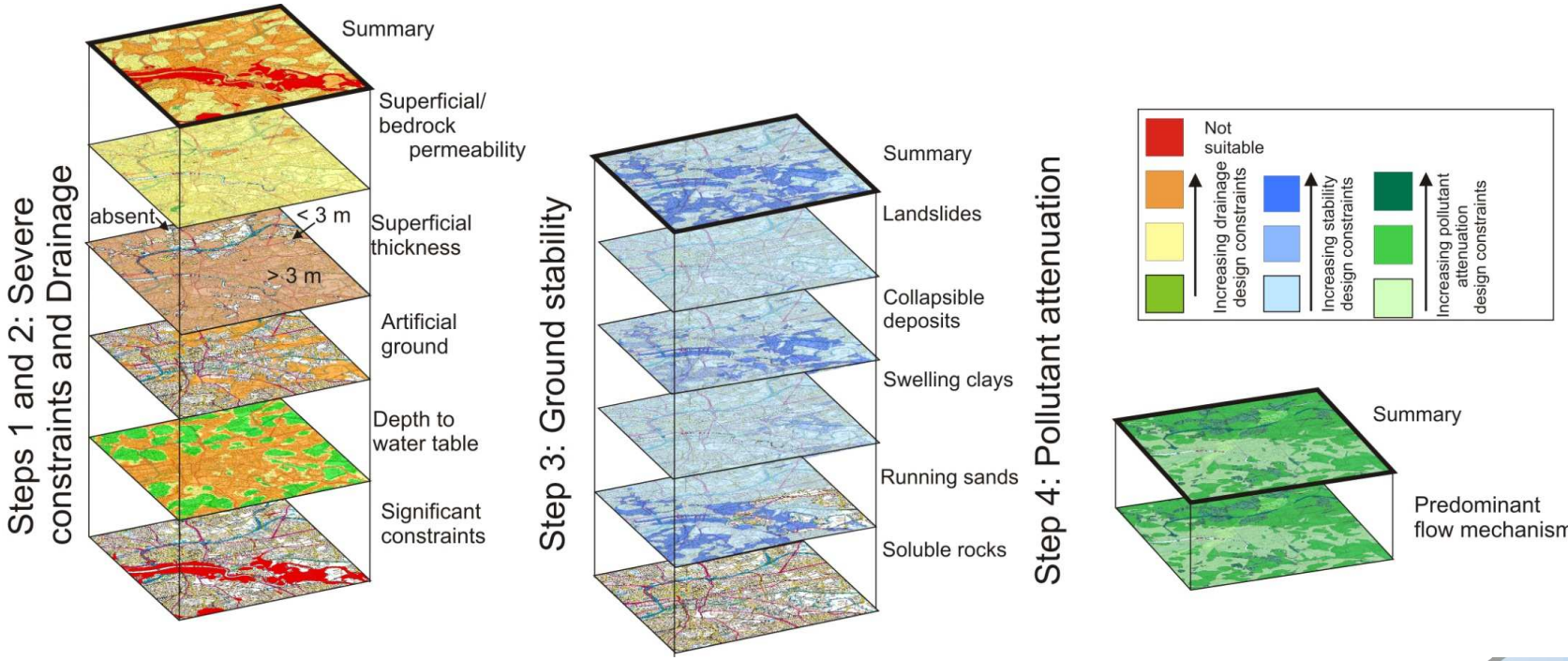
Provision of site-specific data

- Site-specific data download
- Provides sufficient data for preliminary decision-making

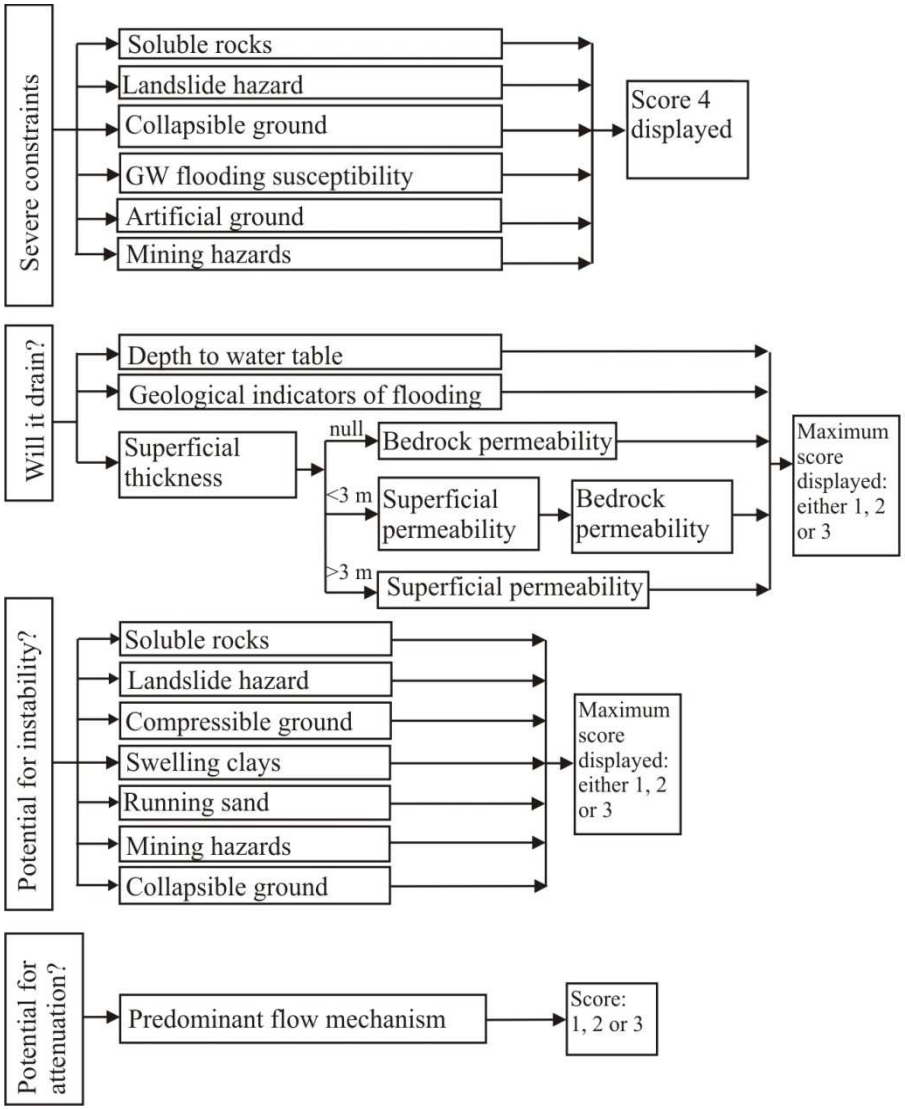


Provision of spatial suitability maps

- Provides a rapid method by which to assess larger spatial areas
- Data from component datasets is used to create summary maps for Steps 1 and 2, Step 3 and Step 4.



Spatial suitability mapping: methodology



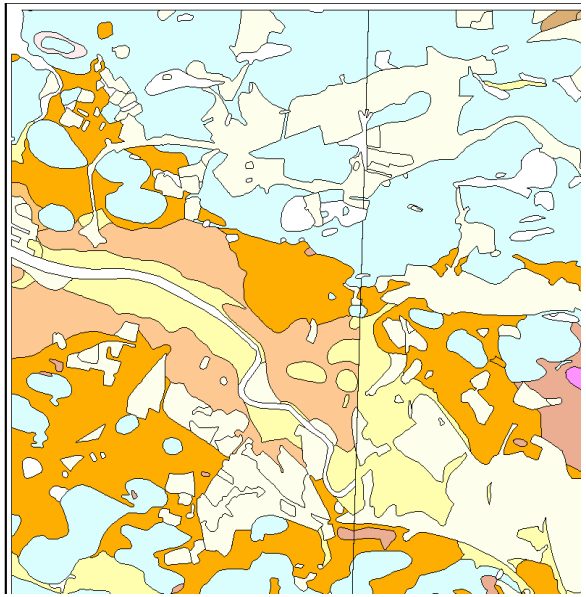
- Datasets are reclassified from 1 to 4:

Score	Likely design constraints
1	Minimal
2	Moderate
3	Considerable
4	Infiltration not recommended

- Within each summary map, the highest score for each polygon part is presented, thereby representing the maximum likely design constraints.

Glasgow -Geology

Superficial deposits



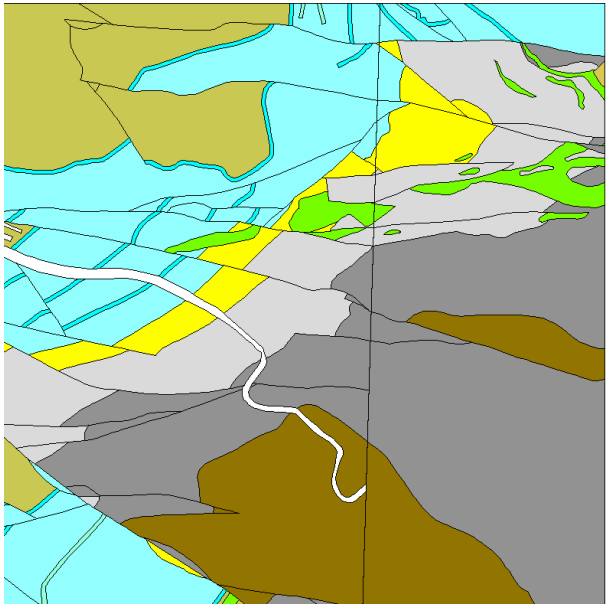
Alluvium

Marine silts and clays

River terrace

Till

Bedrock

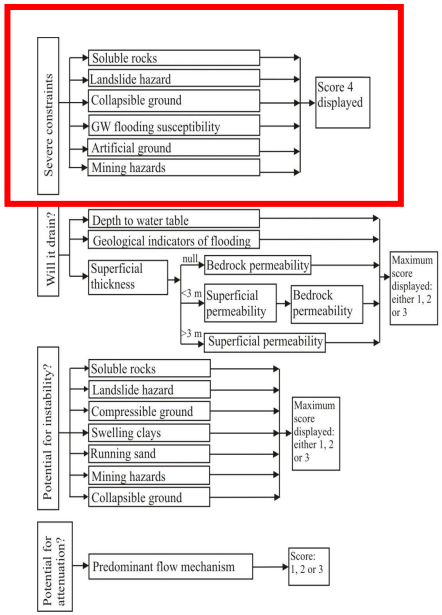


Coal Measures

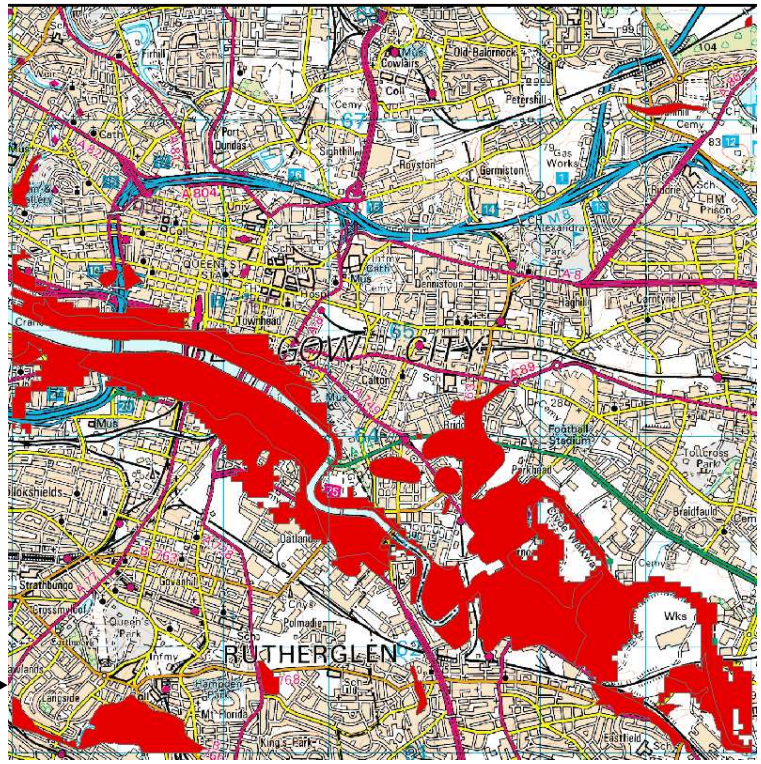
Limestone

Step 1: Severe constraints

Glasgow



Soluble rocks
Landslides
Collapsible ground
Groundwater flooding
Mining hazards



Step 2: Drainage

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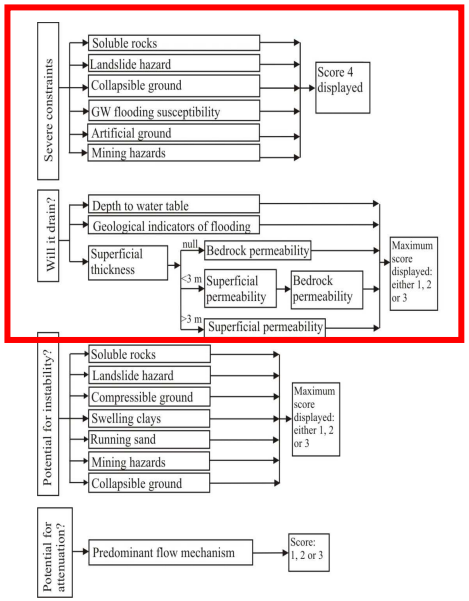
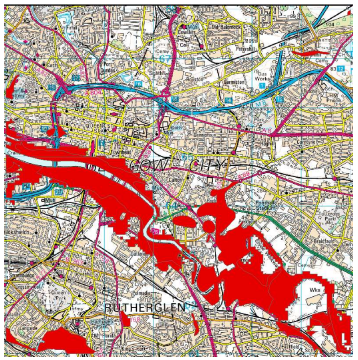
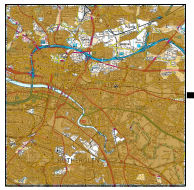


Severe constraints

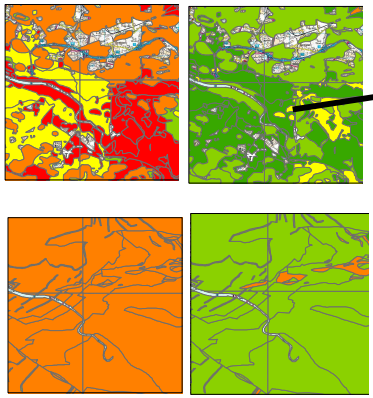


Groundwater level

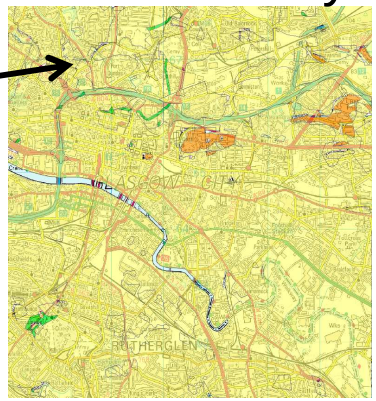
Superficial thickness



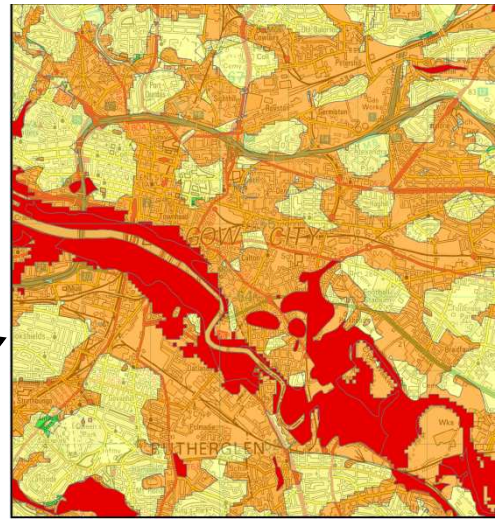
Min and max. permeability



Permeability

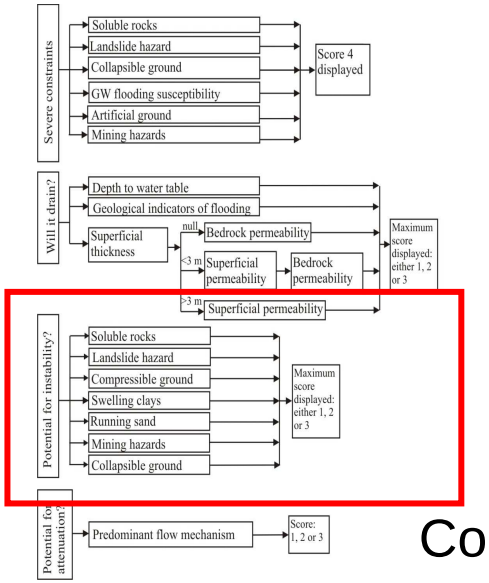


Summary

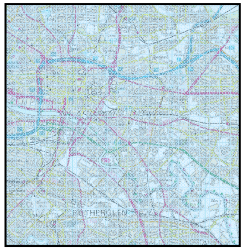


Step 3: Ground stability

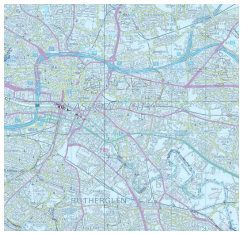
Glasgow



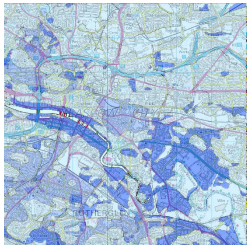
Soluble rocks



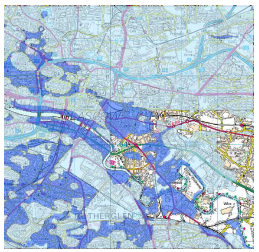
Landslides



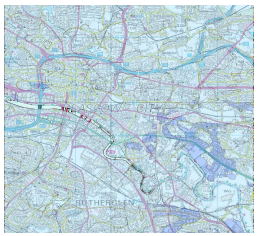
Compressible ground



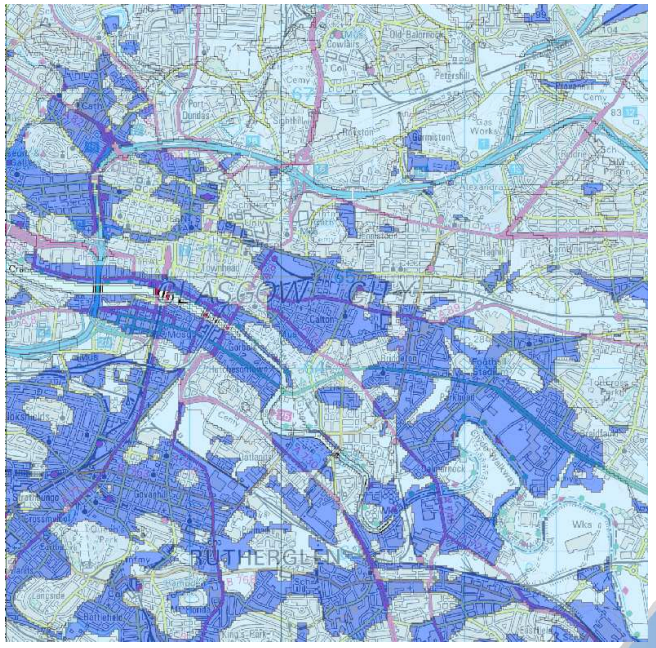
Running sands



Shrink-swell clays

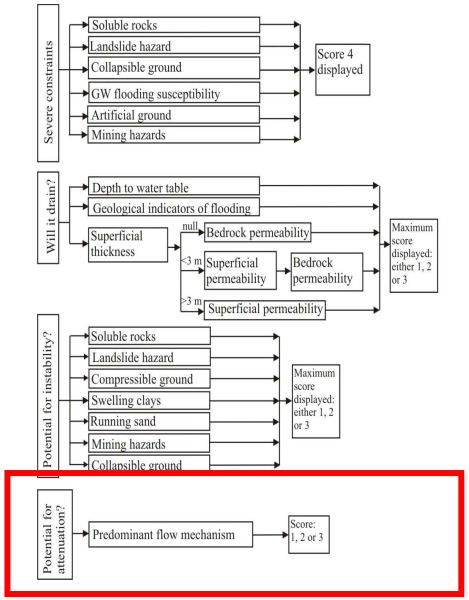


Summary

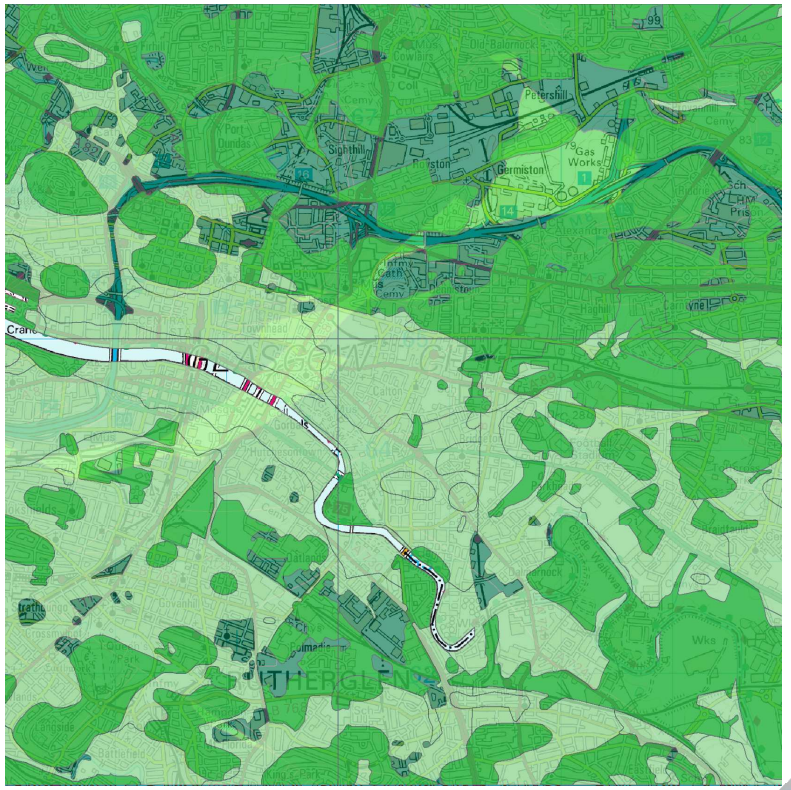


Step 4: Pollutant attenuation

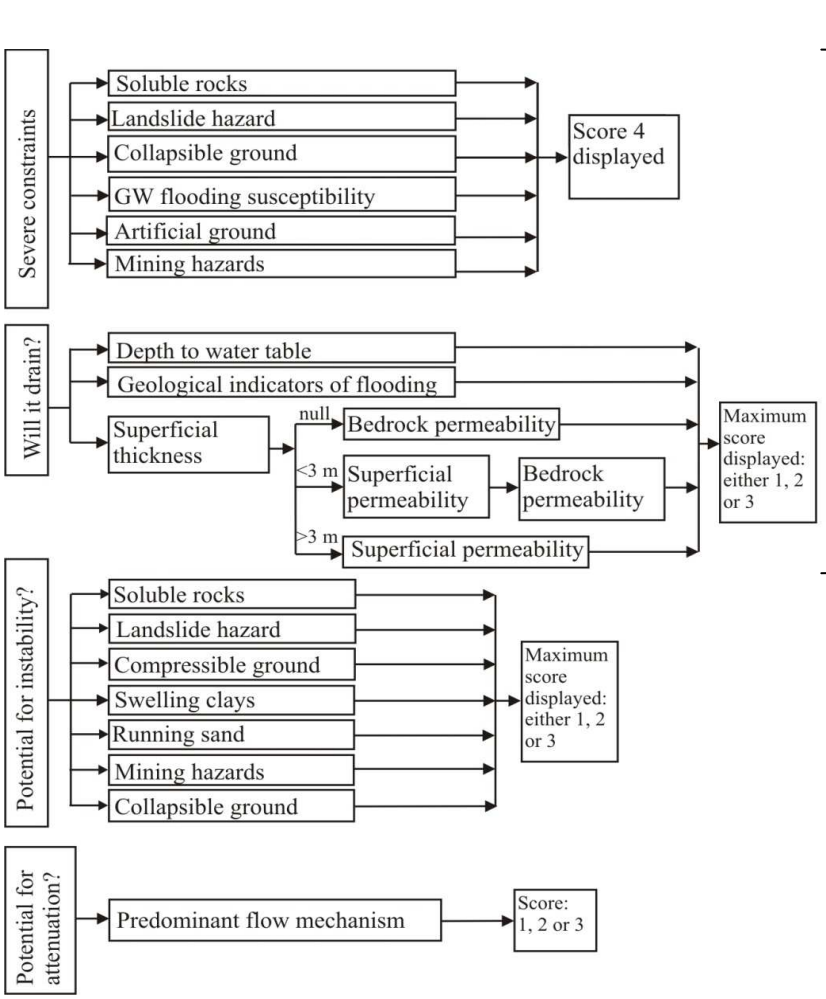
Glasgow

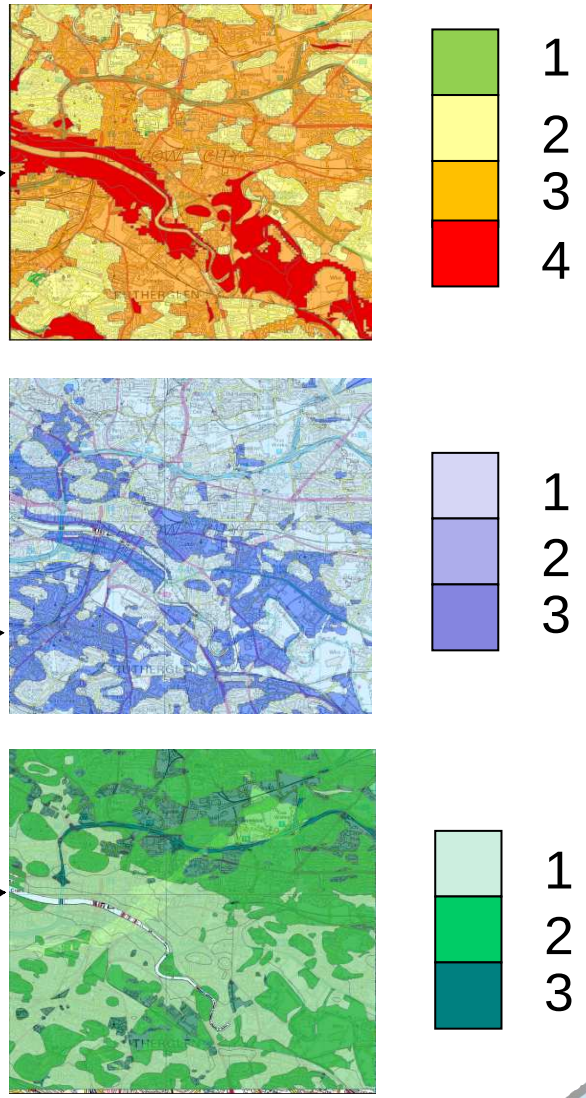


Predominant unsaturated zone flow mechanism →



Spatial suitability mapping: example





Example 1

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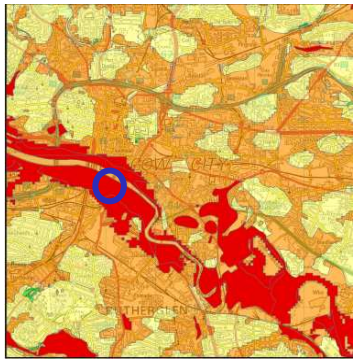
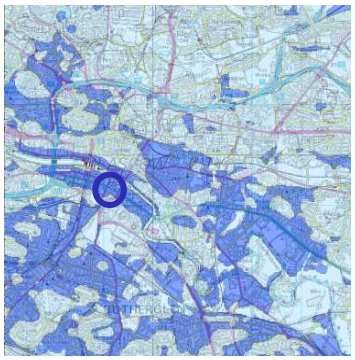
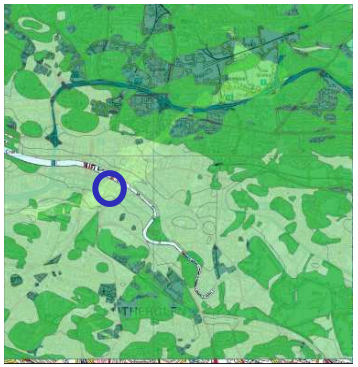






Step 1

Soluble rocks	Null
Landslides	Null
Collapsible ground	Null
Groundwater flooding	Yes
Artificial ground	Null
Mining hazards	Null

Step 2

Superficial permeability	Very low to high
Superficial thickness	~30 m
Bedrock permeability	Low to high
Depth to water table	< 1 m
Geological indicators of flooding	Yes

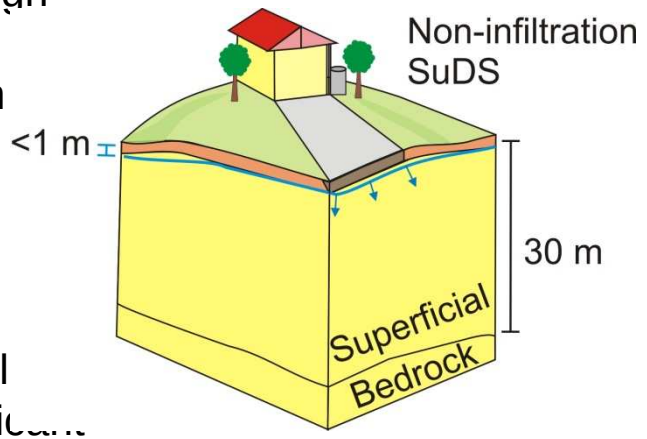
Step 3

Soluble rocks	Null
Landslides	Insignifi...
Compressible deposits	Considerable constraints
Swelling clays	Insignificant
Running sands	Considerable constraints
Collapsible ground	Insignificant
Mining hazards	Null (non-coal)

Step 4

Predominant flow mechanism	Intergranular

Conceptual model



Example 2

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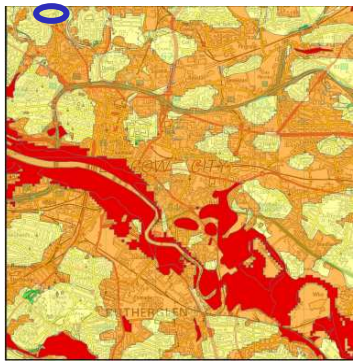
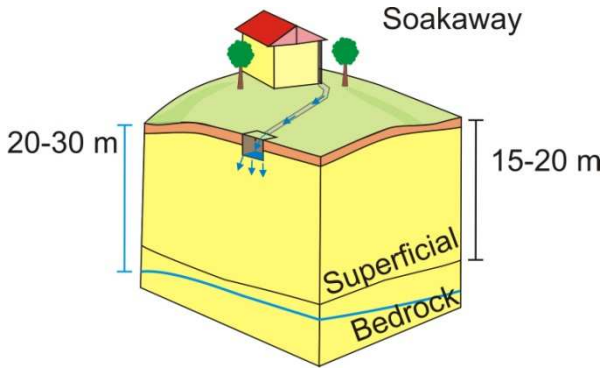
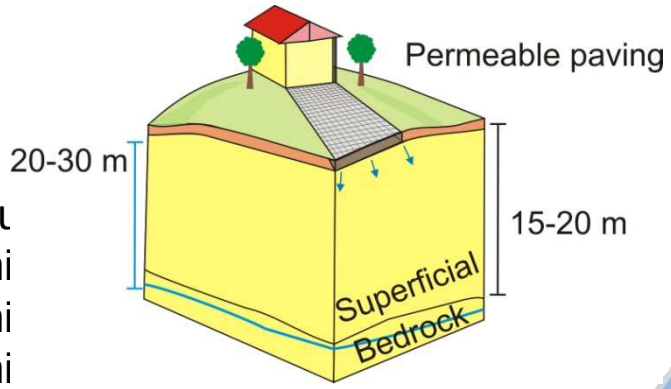


Step 1	
Soluble rocks	Null
Landslides	Null
Collapsible ground	Null
Groundwater flooding	Null
Artificial ground	Null
Mining hazards	Null
Step 2	
Superficial permeability	Low to high
Superficial thickness	15-20 m
Bedrock permeability	Low to high
Depth to water table	20-30 m
Geological indicators of flooding	Null
Step 3	
Soluble rocks	Nu
Landslides	Insigni
Compressible deposits	Insigni
Swelling clays	Insigni
Running sands	Minor constraint
Collapsible ground	Moderate constraint
Mining hazards	Null (non-coal)
Step 4	
Predominant flow mechanism	Mixed

Conceptual model





Example 3

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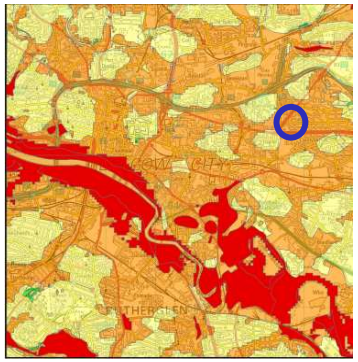
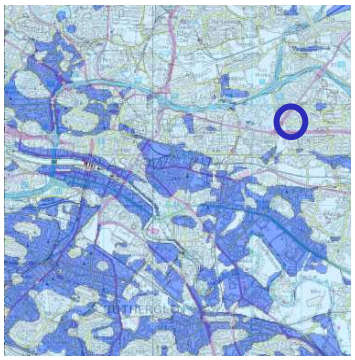




Step 1

Soluble rocks	Null
Landslides	Null
Collapsible ground	Null
Groundwater flooding	Null
Artificial ground	Null
Mining hazards	Null

Step 2

Superficial permeability	Very low to high
Superficial thickness	12 m
Bedrock permeability	Low to high
Depth to water table	1-3 m
Geological indicators of flooding	No

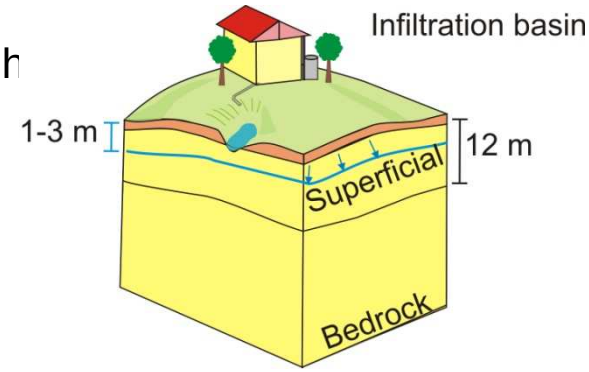
Step 3

Soluble rocks	Insignificant
Landslides	Insignificant
Compressible deposits	Insignificant
Swelling clays	Insignificant
Running sands	Insignificant
Collapsible ground	Insignificant
Mining hazards	Null (non-coal)

Step 4

Predominant flow mechanism	Intergranular

Conceptual model



Caveats

- The methodology described is under development
- The intention is that the data is used for preliminary decision-making and for guidance during the assessment of SuDS proposals
- The data does not replace a site investigation or soakaway test

Future work

- Implement the suitability GIS methodology for national coverage [ongoing]
- Validation of the national map [ongoing]

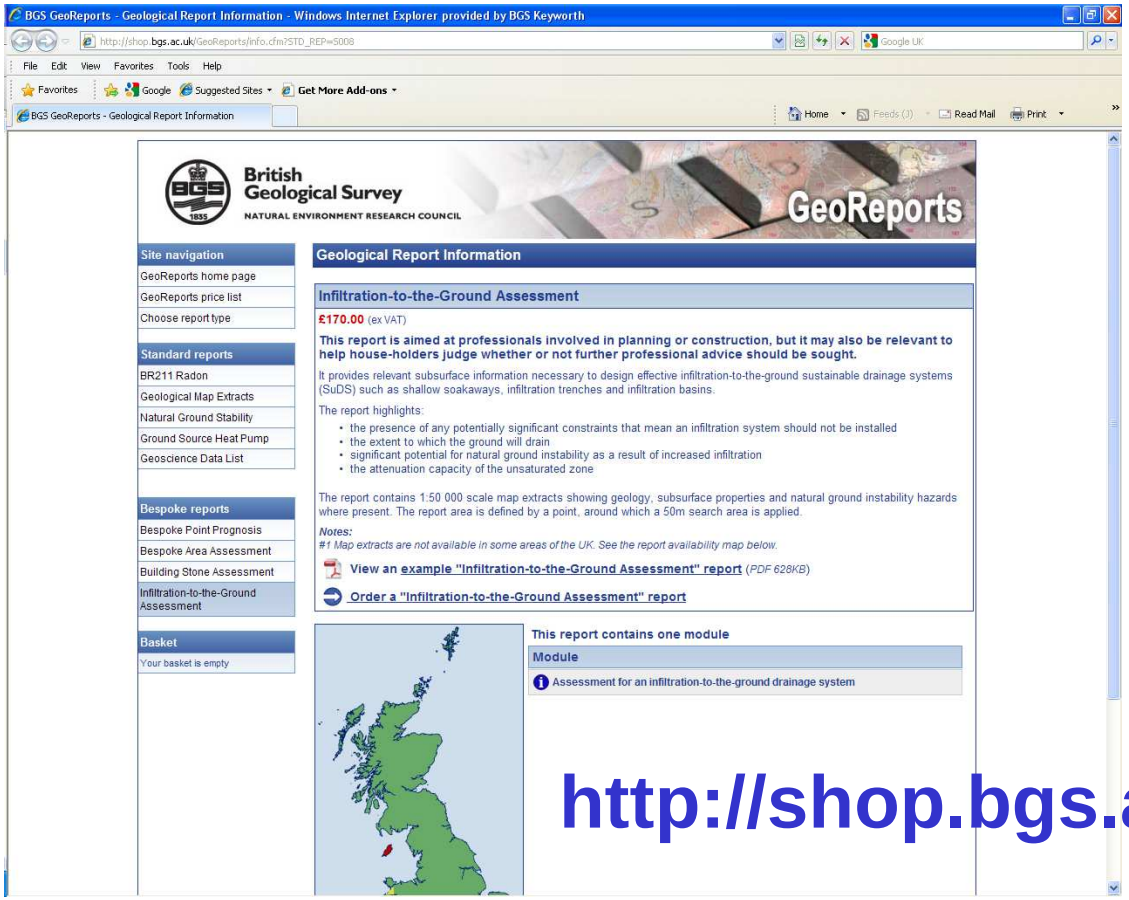
Data request: We are interested in obtaining:
- details of effective and ineffective infiltration SuDS
- Soakaway and infiltration testing data

- Engagement with potential users with the aim of designing an effective user-interface

Participation request: We are interested in discussing requirements with any potential users

In the meantime…

BGS have recently launched an "Infiltration-to-the-ground GeoReport"



- Implements the 4-step decision-making framework and provides site-specific data discussed herein.

http://shop.bgs.ac.uk/GeoReports/