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WATER FRAMEWORK DIRECTIVE

AQUIFER CLASSIFICATION SCHEME FOR NORTHERN IRELAND

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TITLE: WATER FRAMEWORK DIRECTIVE (2000/60/EC)

**AQUIFER CLASSIFICATION SCHEME FOR
NORTHERN IRELAND**

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SUMMARY

A new aquifer classification scheme has been devised for Northern Ireland. It is proposed for use initially for Water Framework Directive groundwater characterisation.

In devising the scheme, consideration has been given to a number of factors including:

- Aquifer definitions and objectives for groundwater in the Water Framework Directive (2000/60/EC);
- Compatibility with the existing Republic of Ireland aquifer classification system;
- The existing British Geological Survey aquifer classification scheme for Northern Ireland and
- Availability of hydrogeological data.

The classification comprises eight classes of aquifers based upon geological strata type, relative resource productivity and flow type.

The proposed classification scheme is shown in the table below.

Aquifer Category	Symbol	Description
<i>Bedrock</i>		
High Productivity Fracture Flow	Bh (f)	High to moderate yields probable, however dependence on fracture flow makes poorer yields possible. Generally includes element of regional flow (km's).
High Productivity Fracture/Intergranular Flow	Bh (I-f)	High to moderate yields probable, however part dependence on fracture flow makes poorer yields possible. Dual porosity. Generally includes element of regional flow.
High Productivity Fracture flow with karstic element	Bh (f-k)	High to moderate yields probable, however dependence on fracture flow makes poorer yields possible. Evidence of karstic flow. Generally includes element of regional flow.
Moderate Productivity Fracture Flow	Bm (f)	High to moderate yields possible in places however dependence on fracture flow makes poorer yields possible. Potential element of regional flow, but local flow significant.
Limited Productivity Fracture Flow	Bl (f)	Moderate yields unusual. Low yields more common. Regional flow limited. Mainly shallow, local flow.
Poor Productivity Fracture Flow	Bp (f)	Small supplies may be possible but strata rarely exploited. Negligible regional flow. Limited local flow
<i>Superficials</i>		
High Productivity Intergranular Flow	Sh (I)	High to moderate yields probable in most areas. Permeability high.
Moderate Productivity Intergranular Flow	Sm (I)	Moderate yields possible. Permeability moderate.

WATER FRAMEWORK DIRECTIVE (2000/60/EC)

AQUIFER CLASSIFICATION SCHEME FOR NORTHERN IRELAND

1.0 INTRODUCTION

The Water Framework Directive (2000/60/EC) requires Member States to assess and manage all waters within their boundaries in a unified manner. For groundwater, *groundwater bodies* have to be delineated and characterised using guidance outlined in the Directive.

The Water Framework Directive (WFD) describes a groundwater body as a ‘*distinct volume of water within an aquifer or aquifers*’.

Similarly, ‘*aquifer*’ means a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater.

This definition of aquifer can be further qualified by the following statement from the directive:

‘Aquifers are defined on the basis of the groundwater bodies contained within them supplying more than 10 m³/day or providing significant flow to surface water bodies or terrestrial ecosystems’.

From the above, prior to delineating groundwater bodies, there is an obvious requirement to define and describe aquifers across Northern Ireland (NI) in the context of WFD guidance and objectives.

2.0 PREVIOUS NORTHERN IRELAND AQUIFER CLASSIFICATION SCHEME

Following on from a baseline hydrogeological survey of NI, carried out in the early 1990’s, an aquifer classification of bedrock and superficials deposits was produced by the British Geological Survey (BGS). This classification of aquifers in NI is depicted and described on the ‘*Hydrogeological Map of Northern Ireland*’, (BGS, 1994). Further details can be found in the publication ‘*Hydrogeology of Northern Ireland*’ (Robins, 1996). Using a variety of stratigraphic, lithostratigraphic and lithological nomenclature, units or regions of bedrock and superficial deposits were assigned to one of three main groups. Each of the three main groups was further subdivided into two categories as summarised in Table 1.

Aquifer Type		Sub-type
1	Aquifers in which intergranular flow is significant	a. Highly productive aquifers (not extensive)
		b. Locally important aquifers
2	Aquifers in which flow is dominantly in fissures and other discontinuities	a. Highly productive aquifers (not extensive)
		b. Locally important aquifers
3	Aquifers of limited potential, regions without significant groundwater	a. Aquifers with limited or local potential
		b. Regions underlain by impermeable rocks: generally without groundwater except at shallow depth

Table 1 BGS Aquifer classification scheme

All bedrock and certain, more permeable, superficial deposits were assigned to one of these sub-groups

The classification is based on the UNESCO international legend for hydrogeological maps (UNESCO, 1983) and gives information on the predominant type of flow (intergranular/fissure) and the relative resource potential of an aquifer unit. The classification categories and subsequent assigning of rock units to them partly reflected the general understanding of the UK hydrogeological community at that time regarding what constituted an aquifer and non-aquifer and the perceived significance and scale with respect to major aquifer systems across the UK.

The hydrogeological map produced was mainly based upon the existing geological divisions and boundaries as defined on the 1:250 000 geological bedrock map (GSNI, 1977), available at the time, but included modifications to Palaeogene and Devonian/Carboniferous boundaries. Since then, a revised and updated 1:250 000 bedrock geological map (GSNI, 1997) has been published. This map revised geological boundaries based upon more recent mapping and used an updated lithostratigraphical framework. As part of the map production process, extensive liaison was undertaken with the Geological Survey of Ireland (GSI) to review and agree cross-border geological boundaries and formation descriptions.

It is considered that this existing aquifer classification scheme is not directly appropriate for the characterisation work required under the WFD. In addition to the above issues relating to the out-dated base geological data used, the terminology employed and the assigning of particular strata to certain aquifer categories requires updating to reflect the definitions and objectives of the WFD. Nevertheless the hydrogeological map and aquifer classification scheme used provides a good starting point for the development of an updated scheme.

3.0 NORTHERN IRELAND WFD AQUIFER CLASSIFICATION SCHEME

A new aquifer classification scheme has been developed to meet the requirements of the WFD. The WFD emphasises the relative importance of materials supplying even small supplies of water in addition to acknowledging the key contribution groundwater plays in

supporting flows and ecological communities in rivers and wetlands. Given the objectives of the WFD, it was considered necessary to develop an appropriate aquifer classification scheme.

The WFD requires particularly close assessment of water bodies that extend across Member States territorial borders. Such bodies will be assigned to an International River Basin District. For this and other practical reasons, a compatible approach for classifying aquifers is desirable within NI and the Republic of Ireland (RoI) to help ensure a consistent approach is taken in implementing the WFD across the border areas.

For the purposes of the WFD analysis, the aquifer classification scheme has considered the following elements in defining aquifer type/category:

- 1) Strata type (Bedrock or Superficial);
- 2) Relative 'productivity' with respect to exploitation history/well yields (where data available): and
- 3) Flow type (intergranular, fractured, karstic or combination).

The classification scheme is shown in Table 2 below.

Aquifer Category	Symbol	Description
<i>Bedrock</i>		
High Productivity Fracture Flow	Bh (f)	High to moderate yields probable, however dependence on fracture flow makes poorer yields possible. Generally includes element of regional flow (km's).
High Productivity Fracture/Intergranular Flow	Bh (I-f)	High to moderate yields probable, however part dependence on fracture flow makes poorer yields possible. Dual porosity. Generally includes element of regional flow.
High Productivity Fracture flow with karstic element	Bh (f-k)	High to moderate yields probable however dependence on fracture flow makes poorer yields possible. Evidence of karstic flow. Generally includes element of regional flow.
Moderate Productivity Fracture Flow	Bm (f)	High to moderate yields possible in places however dependence on fracture flow makes poorer yields possible. Potential element of regional flow, but local flow significant.
Limited Productivity Fracture Flow	Bl (f)	Moderate yields unusual. Low yields more common. Regional flow limited. Mainly shallow, local flow.
Poor Productivity Fracture Flow	Bp (f)	Small supplies may be possible but strata rarely exploited. Negligible regional flow. Limited local flow
<i>Superficials</i>		
High Productivity Intergranular Flow	Sh (I)	High to moderate yields probable in most areas. Permeability high.
Moderate Productivity Intergranular Flow	Sm (I)	Moderate yields possible. Permeability moderate.

Aquifer type *B - Bedrock* *S - Superficial*
Productivity *h - high* *m - moderate* *l - limited* *p - poor*
Flow Type *f - fracture* *I - Intergranular*

Table 2 Aquifer categories and descriptions

This classification does not explicitly make any reference to whether an aquifer area is local or regional with respect to overall size and importance of resource. Given the relatively small size of NI ‘regional’ aquifers compared to the UK and even RoI and the de minimus quantities of water that could be considered ‘significant’ under the WFD, it is not thought important to define this element. However the descriptions do indicate whether regional **flow** (kms) is likely to be operating. Only the Sherwood Sandstone aquifer in the Lagan and Enler Valleys could be considered a regional aquifer in an Irish or UK context. On some summary maps for the island of Ireland, the Palaeogene Basalt has been defined as a ‘major’ aquifer probably due to the significant aerial extent of this rock unit. However, the nature of the aquifer is such that yields are generally only moderate at best and local groundwater flow systems are likely to predominate.

4.0 BEDROCK AQUIFER MAP PRODUCTION

Each rock unit, formation or group as defined on the 1:250 000 bedrock geological map (GSNI, 1997) has been assigned to one of the aquifer classes listed in Table 2. During this process, consideration has been given to the aquifer classification of similar units in the RoI to ensure compatibility. Where possible, published and unpublished data have been reviewed and reference made to previous hydrogeological work when assigning rock formations to a particular class. However, it must be recognised that detailed and systematic collection and analysis of hydrogeological data for a substantial area of Northern Ireland has yet to be undertaken. It is intended that this classification will show which are the ‘better’ aquifers and which are the ‘poorest’. As characterisation progresses and knowledge improves, it would be expected that some reassignment to a higher or lower aquifer class might be appropriate for a minority of rock formations. The aquifer classification for rock units as displayed on the 1:250 000 bedrock geological map (GSNI, 1997), used for WFD initial characterisation in 2004, is shown in Appendix 1.

Aquifer classes and typical rock units/formations falling within each class are shown in Table 3. The distribution of these bedrock aquifer classes across NI is shown in Figure 1. It should be noted that the scheme allows particular formations to be assigned to different aquifer classes in different areas where their hydrogeological characteristics justifies this.

Aquifer Category	Symbol	Typical Rock Units / Formations
High productivity Fracture Flow	Bh (f)	Certain Carboniferous basal formations
High Productivity Fracture/Intergranular Flow	Bh (I-f)	Permo-Triassic Sandstones
High Productivity Fracture flow with karstic element	Bh (f-k)	Carboniferous Darty Limestone with Knockmore Limestone Member (in places) Carboniferous Ballyshannon Limestone Formation Ulster White Limestone Formation (Chalk)
Moderate Productivity Fracture Flow	Bm (f)	Palaeogene Basalts Certain Carboniferous Dinatian Sandstones
Limited Productivity Fracture Flow	Bl (f)	Ordovician/Silurian strata Dalradian strata Devonian strata Granites and Intrusives
Poor Productivity Fracture Flow	Bp (f)	Lough Neagh Clay Group Mercia Mudstone Group Waterloo Mudstone Formation

Table 3 Aquifer classes and example rock formations

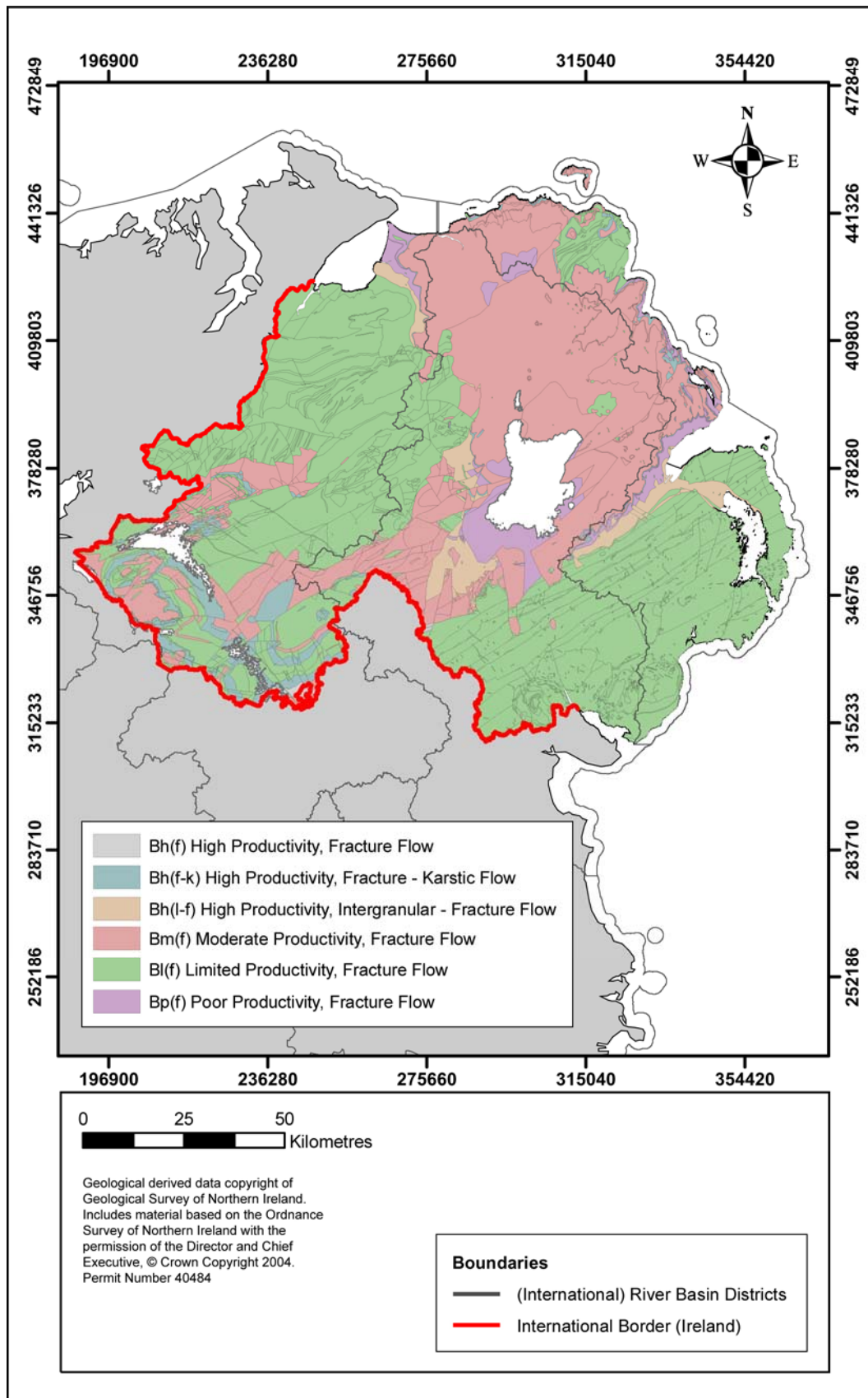


Figure 1 WFD Bedrock aquifer classes

5.0 CROSS-REFERENCING OF NORTHERN IRELAND AND REPUBLIC OF IRELAND SCHEMES

Significant areas of NI fall within International River Basin Districts, with aquifers extending across the political boundary and local surface water catchments into the RoI. Therefore there is a clear need to ensure a degree of compatibility in aquifer classification to ensure a common understanding is developed and a similar approach to characterisation followed.

The GSI has produced a scheme for aquifer classification based upon knowledge of a particular rock unit with respect to its extent, productivity and key hydrogeological features (GSI, 2003). This classification has been used in particular for the Groundwater Protection Schemes produced for local councils. Rules have been developed which guide the determination of which category a particular rock unit falls into. The classification is split into bedrock and sand/gravel aquifers and the categories are shown below in Table 4.

Class	Sub-class	Code
Bedrock Aquifers		
Regionally Important Aquifer	Karst, Good development potential	Rk
	Karst conduit	Rkc
	Karst diffuse	Rkd
Locally Important Aquifer	Fissured bedrock, Good development potential	Rf
	Generally moderately productive	Lm
Poor Aquifer	Moderately productive only in local zones	Ll
	Generally unproductive except for local zones	Pl
	Generally unproductive	Pu
Sand and Gravel Aquifers		
Regionally Important Aquifer	Sand/gravel	Rg
Locally Important Aquifer	Sand/gravel	Lg

Table 4 RoI aquifer classification scheme

GSI consider, for the RoI, all bedrock will qualify as a WFD aquifer along with sand/gravel deposits meeting certain minimum aerial size and saturated thickness criteria. In NI a similar approach has been taken such that all bedrock qualifies as a WFD aquifer unless proven otherwise. However, due to the different geological settings between NI and RoI, in NI a very small number of lithostratigraphic units will potentially be considered as not qualifying as WFD aquifers (e.g. Lough Neagh Group). Within superficial deposits, sand/gravel deposits are generally classified as aquifers similar to the Republic of Ireland. In Scotland and England and Wales, alluvium and even sandy glacial till deposits have been regarded as aquifers in certain localities.

For the purposes of the WFD, RoI are grouping their aquifer types into four main groups as shown in Table 5:

Description	Aquifer types
Regionally Important Karstic aquifers	Rk, Rkc, Rkd
Gravel aquifers	Rg and Lg
Productive Fractured Bedrock aquifers	Rf and Lm
Poorly Productive Bedrock aquifers	Ll, Pl and Pu

Table 5 RoI aquifer groups

The grouping is based upon similarities in a) hydrogeological properties; b) resource value; c) likely monitoring approaches and d) likely influence of surface water characterisation (Groundwater Working Group, 2001). The groups will be considered as general groundwater body types.

It is noted that in the RoI, depending on factors such as structural setting, well-yield data, aerial extent etc., specific rock formations can be classed differently in different areas.

It is considered that the following cross-reference can broadly be made between the scheme for NI and the existing RoI scheme (Table 5).

Aquifer Category	NI	RoI	Comments
Bedrock			
High productivity Fracture Flow	Bh (f)	Rf	
High Productivity Fracture/Intergranular Flow	Bh (I-f)		No bedrock units in RoI contain any significant intergranular porosity
High Productivity Fracture flow with karstic element	Bh (f-k)	Rk, Rkc, Rkd	Differentiation of karstic flow not undertaken in NI at 1:250 000 scale.
Moderate Productivity Fracture Flow	Bm (f)	Lm	
Limited Productivity Fracture Flow	Bl (f)	Ll, Pl	
Poor Productivity Fracture Flow	Bp (f)	Pu	
Superficials			
High Productivity Intergranular Flow	Sh (I)	Rg, Lg	
Moderate Productivity Intergranular Flow	Sm (I)		No equivalent category in RoI.

Table 6 Cross-referencing of NI and RoI schemes

6.0 CONCLUSION

A new aquifer classification system has been defined for NI to meet the requirements for the WFD. In designing the classification, consideration has been given to:

- 1) Aquifer definitions and objectives for groundwater in the WFD;
- 2) Compatibility with the RoI aquifer classification system;
- 3) Previous BGS aquifer classification for NI; and
- 4) Limitations of current hydrogeological data availability.

The classification will allow representation of NI geology with respect to its considered relative importance for water supply, dominant flow mechanism and type (bedrock/superficial). Based upon this classification, certain assumptions can be made regarding the relative importance with respect to surface water interaction. This work will assist with ensuring that a consistent approach is taken to the delineation and description of groundwater bodies, as required by the WFD and should also help assess the degree of risk from 'potential pressures' identified as part of the characterisation process.

As more detailed hydrogeological assessment of specific areas and rock formations is undertaken it is considered that demotion or promotion of individual rock units to a higher or lower aquifer category may be necessary. Additional aquifer categories (e.g. Bm (I-f)) may also be required upon application of the classification scheme to 1:50 000 geological data layers. At present, use of this classification scheme is intended primarily for WFD initial and further characterisation work. It is recommended that any application of the classification for other purposes should only proceed following consultation with GSNI or Environment and Heritage Service (EHS).

The classification used has similarities with the RoI classification and as such will allow a broadly common understanding of aquifer descriptions in cross-border river basins to be achieved.

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Appendix 1

Aquifer classification of 1:250 000 solid geology map rock unit formations/groups used for WFD initial characterisation, 2004.

NB: Modifications to this classification may occur as the result of ongoing assessment and GSNI should be contacted for updates where necessary. Direct application to 1:50 000 solid geology map layers will require additional modifications/adaptation.

Rock Unit (1:250k Solid Geology Digital Layer)	Rock Unit Group	Aquifer Category
Cooldaragh Formation	Dinantian (early) Sandstones, Shales and Limestones	Bh(f)
Ulster Canal Formation	Dinantian (early) Sandstones, Shales and Limestones	Bh(f)
Ballysteen Formation	Dinantian Lower Impure Limestones	Bh(f)
Fearnaght Formation	Dinantian Sandstones	Bh(f)
Ballyshannon Limestone Formation	Dinantian Pure Bedded Limestones	Bh(f-k)
Dartry Limestone Formation	Dinantian Pure Bedded Limestones	Bh(f-k)
Ballyshannon Limestone Formation	Dinantian Pure Unbedded Limestones	Bh(f-k)
Knockmore Limestone Member	Dinantian Pure Unbedded Limestones	Bh(f-k)
Hibernian Greensands & Ulster White Limestone Formations	Upper Cretaceous chalk & greensand	Bh(f-k) ⁽¹⁾
Euler Group	Permo-Triassic Sandstones	Bh(l-f)
Sherwood Sandstone Group	Permo-Triassic Sandstones	Bh(l-f)
Clogher Valley Formation	Dinantian (early) Sandstones, Shales and Limestones	Bm(f)
Meenymore Formation	Dinantian Mixed Sandstones, Shales and Limestones	Bm(f) ⁽²⁾
Blackwater Limestone Formation	Dinantian Pure Bedded Limestones	Bm(f)
Ballyness Formation	Dinantian Sandstones	Bm(f)
Ballyreagh Conglomerate Formation	Dinantian Sandstones	Bm(f)
Carnmore Sandstone Member	Dinantian Sandstones	Bm(f)
Carrickaness Sandstone Formation	Dinantian Sandstones	Bm(f)
Claragh Sandstone Formation	Dinantian Sandstones	Bm(f)
Derryloran Formation	Dinantian Sandstones	Bm(f)
Glenade Sandstone/Bellavalley Formations	Dinantian Sandstones	Bm(f)
Mullaghmore Sandstone Formation	Dinantian Sandstones	Bm(f)
Omagh Sandstone Group	Dinantian Sandstones	Bm(f)
Topped Mountain Sandstone Formation	Dinantian Sandstones	Bm(f)
Armagh Group	Dinantian Shales and Limestones	Bm(f)
Carboniferous Limestone Supergroup (undivided)	Dinantian Shales and Limestones	Bm(f)
Drumgesh Shale Formation	Dinantian Shales and Limestones	Bm(f)
Maydown Limestone Formation	Dinantian Shales and Limestones	Bm(f)

Rockdale Limestone Formation	Dinantian Shales and Limestones	Bm(f)
Desertmartin Limestone Formation	Dinantian Upper Impure Limestones	Bm(f)
Ballylagan Member	Palaeogene basalts & other volcanic rocks	Bm(f)
Causeway Tholeiite Member	Palaeogene basalts & other volcanic rocks	Bm(f)
Coagh Conglomerate Member	Palaeogene basalts & other volcanic rocks	Bm(f)
Interbasaltic Formation	Palaeogene basalts & other volcanic rocks	Bm(f)
Lower Basalt Formation	Palaeogene basalts & other volcanic rocks	Bm(f)
Port na Spaniagh Member	Palaeogene basalts & other volcanic rocks	Bm(f)
Upper Basalt Formation	Palaeogene basalts & other volcanic rocks	Bm(f)
Barrack Hill Andesite Member	Basalts & other Volcanic rocks	Bl(f)
Shanmullagh Formation	Basalts & other Volcanic rocks	Bl(f)
Carboniferous Limestone Supergroup (undivided)	Basalts & other Volcanic rocks	Bl(f)
Cross Slieve Group	Devonian Old Red Sandstones	Bl(f)
Gortfinbar Conglomerate Formation	Devonian Old Red Sandstones	Bl(f)
Raveagh Sandstone Formation	Devonian Old Red Sandstones	Bl(f)
Red Arch Formation	Devonian Old Red Sandstones	Bl(f)
Shanmaghera Sandstone Formation	Devonian Old Red Sandstones	Bl(f)
Tedd Formation	Devonian Old Red Sandstones	Bl(f)
Altagoan Formation	Dinantian (early) Sandstones, Shales and Limestones	Bl(f)
Annaclare Group	Dinantian (early) Sandstones, Shales and Limestones	Bl(f)
Barony Glen Formation	Dinantian (early) Sandstones, Shales and Limestones	Bl(f)
Hollywood Group	Dinantian (early) Sandstones, Shales and Limestones	Bl(f)
Meenymore Formation	Dinantian Mixed Sandstones, Shales and Limestones	Bl(f)
Ballydurnian Breccia Formation	Dinantian Sandstones	Bl(f)
Drumman More Sandstone Formation	Dinantian Sandstones	Bl(f)
Iniscarn Formation	Dinantian Sandstones	Bl(f)
Owenkillew Sandstone Group	Dinantian Sandstones	Bl(f)
Quarry Sandstone Member	Dinantian Sandstones	Bl(f)
Alderwood Mudstone	Dinantian Shales and Limestones	Bl(f)
Benbulbin Shale Formation	Dinantian Shales and Limestones	Bl(f)
Bundoran Shale Formation	Dinantian Shales and Limestones	Bl(f)
Castle Espie Group	Dinantian Shales and Limestones	Bl(f)
Keenaghan Shale Formation	Dinantian Shales and Limestones	Bl(f)

Rossmore Mudstone Formation	Dinantian Shales and Limestones	Bl(f)
Glencar Limestone Formation	Dinantian Upper Impure Limestones	Bl(f)
Ballyrainey Sill	Granites & other Igneous Intrusive rocks	Bl(f)
Beragh Granite	Granites & other Igneous Intrusive rocks	Bl(f)
Carrickmore Granite	Granites & other Igneous Intrusive rocks	Bl(f)
Craigbardahessiagh Granodiorite	Granites & other Igneous Intrusive rocks	Bl(f)
Dundonald Sill	Granites & other Igneous Intrusive rocks	Bl(f)
Fair Head Sill	Granites & other Igneous Intrusive rocks	Bl(f)
Garrison Sill	Granites & other Igneous Intrusive rocks	Bl(f)
Laght Hill Tonalite	Granites & other Igneous Intrusive rocks	Bl(f)
Magilligan Sill	Granites & other Igneous Intrusive rocks	Bl(f)
Mourne Mountains Granite G1	Granites & other Igneous Intrusive rocks	Bl(f)
Mourne Mountains Granite G2	Granites & other Igneous Intrusive rocks	Bl(f)
Mourne Mountains Granite G3	Granites & other Igneous Intrusive rocks	Bl(f)
Mourne Mountains Granite G4	Granites & other Igneous Intrusive rocks	Bl(f)
Mourne Mountains Granite G5	Granites & other Igneous Intrusive rocks	Bl(f)
Newry Granodiorite Complex	Granites & other Igneous Intrusive rocks	Bl(f)
Newry Granodiorite Complex Phase 1	Granites & other Igneous Intrusive rocks	Bl(f)
Newry Granodiorite Complex Phase 2	Granites & other Igneous Intrusive rocks	Bl(f)
Newry Granodiorite Complex Phase 3	Granites & other Igneous Intrusive rocks	Bl(f)
Pomeroy Granite	Granites & other Igneous Intrusive rocks	Bl(f)
Portrush Sill	Granites & other Igneous Intrusive rocks	Bl(f)
Scrabo Sill	Granites & other Igneous Intrusive rocks	Bl(f)
Shane's Hill Rhyodacite	Granites & other Igneous Intrusive rocks	Bl(f)
Slieve Gallion Granite	Granites & other Igneous Intrusive rocks	Bl(f)
Slieve Gullion Complex	Granites & other Igneous Intrusive rocks	Bl(f)
Tardree Rhyolite Complex	Granites & other Igneous Intrusive rocks	Bl(f)
Tremoge Glen Granite	Granites & other Igneous Intrusive rocks	Bl(f)
Tyrone Plutonic Group	Granites & other Igneous Intrusive rocks	Bl(f)
Un-named dyke, Palaeogene	Granites & other Igneous Intrusive rocks	Bl(f)
Un-named intrusion, early Caledonian	Granites & other Igneous Intrusive rocks	Bl(f)
Un-named intrusion, late Caledonian	Granites & other Igneous Intrusive rocks	Bl(f)
Un-named intrusion, Palaeogene	Granites & other Igneous Intrusive rocks	Bl(f)
Un-named intrusion, Pre-Caledonian	Granites & other Igneous Intrusive rocks	Bl(f)

Un-named sill, Palaeogene	Granites & other Igneous Intrusive rocks	Bl(f)
Briscloonagh Sandstone Formation	Namurian Sandstones	Bl(f)
Greenan Sandstone Formation	Namurian Sandstones	Bl(f)
Millstone Grit Group	Namurian Sandstones	Bl(f)
Ballinamallard Mudstone Formation	Namurian Shales	Bl(f)
Desertcreat Group	Ordovician Metasediments	Bl(f)
Gilnahirk Group	Ordovician Metasediments	Bl(f)
Moffat Shale Group	Ordovician Metasediments	Bl(f)
Strokestown Group	Ordovician Metasediments	Bl(f)
Copney Pillow Lava Formation	Ordovician Volcanics	Bl(f)
Helen's Bay Formation	Ordovician Volcanics	Bl(f)
Tyrone Volcanic Group	Ordovician Volcanics	Bl(f)
Belfast Group	Permo-Triassic Mudstones and Gypsum	Bl(f)
Aghyaran Formation	Precambrian Marbles	Bl(f)
Dungiven Formation	Precambrian Marbles	Bl(f)
Torr Head Limestone Formation	Precambrian Marbles	Bl(f)
Aghyaran Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Altmore Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Ballykelly Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Claudy Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Corvanaghan Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Croaghgarrow Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Dart Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Dungiven Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Glendun Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Glenelly Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Glengawna Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Killeter Quartzite Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Londonderry Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Lough Derg Group	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Lough Esk Psammities	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Lough Mourne Grit	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Mullaghcarn Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Mullyfa Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)

Murlough Bay Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Newtownstewart Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Owencam Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Runabay Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Shanaghy Green Bed Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Torr Head Limestone Formation	Precambrian Quartzites, Gneisses & Schists	Bl(f)
Gala Group	Silurian Metasediments and Volcanics	Bl(f)
Hawick Group	Silurian Metasediments and Volcanics	Bl(f)
Lisbellaw Formation	Silurian Metasediments and Volcanics	Bl(f)
Little River Group	Silurian Metasediments and Volcanics	Bl(f)
Slievebane Group	Westphalian Sandstones	Bl(f)
Coal Measures Group	Westphalian Shales	Bl(f)
Dunaghy Formation	Oligocene mudstones	Bp(f)
Lough Neagh Group	Oligocene mudstones	Bp(f)
Mercia Mudstone Group	Permo-Triassic Mudstones and Gypsum	Bp(f)
Penarth Group	Permo-Triassic Mudstones and Gypsum	Bp(f)
Waterloo Mudstone Formation	Permo-Triassic Mudstones and Gypsum	Bp(f)

(1) – These two formations have been combined on the 1:250 000 solid geology map and overall, fracture and karstic flow considered dominant. However the Hibernian Greensands also have a component of intergranular flow.

(2) – Within NI, generally taken as Bl(f), however one area taken as Bm(f) where it extends into RoI and where local investigations indicate this higher productivity potential locally.



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Your views on this
document are welcome.

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