LITHOLOGY	DESCRIPTION (After BS5930:1999)	FOUNDATIONS	EXCAVATION (Excavatability after Pettifer & Fookes 1994)	ENGINEERED FILL (After MCHW Vol. 1. Series 600)	SITE INVESTIGATION
SUPERFICIAL					
Organic Soil	Very soft to firm fibrous to amorphous PEAT. Deposits may be selectively worked to shallow depth in some areas. Very low to moderate permeability; flow dominantly through matrix.	Very poor foundation conditions. Very weak and highly compressible deposits; acidic groundwater may pose a risk to buried steel and concrete. Specialist very low load or 'floating' foundations may be suitable in some cases but, where possible, deposits at surface should be removed or pile foundations to stronger deposits employed.	Easy digging but poor trafficability may require specialist machinery. Requires immediate support and dewatering. Dewatering will lead to surface lowering and oxidation of peat.	Unsuitable for use as fill. May be suitable for reuse as topsoil if mixed with other material.	Important to determine extent and depth of peat deposits. Groundwater acidity should be determined prior to selection of buried concrete.
Coarse Soil	Loose to dense fine to coarse-grained SAND or SAND and GRAVEL with some cobbles. Sandy clay and silt, sometimes laminated, occur locally, especially within terrace deposits which may also contain peat. High to very high permeability; flow is through matrix. Includes glaciofluvial sand and gravel, river terrace deposits, blown sand, coarse marine, coarse alluvium, head and talus deposits.	Generally good foundation conditions. Frost susceptibility of near-surface silt and fine sand lithologies should be considered in design of shallow foundations. Blown sand may prove unsuitable for conventional pad and strip foundations and may require rafts or piling.	Easy digging, occasionally hard digging. Immediate support required. Groundwater control measures will be necessary where deposits are below the water table.	May be suitable as selected granular fill if composition is appropriate or with separation of desired grades; otherwise suitable as general granular fill.	Important to determine lithological variation and deposit geometry, particularly the presence and dimensions of buried channels and characteristics of infilling deposits.
Fine Soil	Very soft to very stiff sometimes sandy CLAY or SILT. Desiccation of top few metres may result in firm to stiff material overlying soft to very soft deposits at depth. Generally very low to moderate permeability; flow dominantly through fissures. Includes lacustrine deposits, glaciolacustrine deposits, fine marine deposits, estuarine alluvium and lowland river alluvium (any of which may contain peat beds or lenses) and loess/loessic soils.	Variable foundation conditions, dependant on shear strength and consolidation characteristics. Settlement rates usually slow but with potentially high total settlements. Possible foundation design considerations may include the potential risk of severe differential settlements in soft, highly compressible zones; the potential for sudden collapse of loessic deposits when saturated under engineering loads; potentially high sulphide contents of some estuarine alluvium; and frost-susceptibility of near surface silty and fine sandy lithologies.	Easy digging. Excavations usually require immediate support but stiff clays may be stable in short-term where groundwater ingress is controlled or absent. Running conditions may occur in silts and sands below the water table; presence of water-bearing sand/silt layers will require groundwater control measures.	May be suitable as selected cohesive fill depending on grading, plasticity, water content and sulphate/sulphide contents where buried concrete and steel are likely to be used; otherwise suitable as general cohesive fill. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet. Material containing a significant proportion of organics, such as some alluvium, are unsuitable as fill.	Important to determine lithological variability and the presence, depth and extent of any soft compressible zones (and depth to sound strata). Assessment of shrink-swell potential and sulphate/sulphide contents in clay deposits and the potential for rapid collapse settlement in loessic deposits is advisable. In situ loading tests advisable to assess bearing strength at selected sites.
Fine and Coarse Soil	Soft to stiff sandy gravelly CLAY or clayey SAND and GRAVEL. Very low to high permeability; flow dominantly through fissures if low and matrix if high. Includes Clay-with-flints and some Head deposits.	Variable foundation conditions, dependant on shear strength, consolidation characteristics and presence of water-bearing sand/silt layers and lenses. Thin deposits may be removed to permit foundations on bedrock. Local problems could arise where deposits occur within solution hollows necessitating deeper excavation, rafting or piling. Possible design considerations as for 'Fine Soils'.	Easy digging. Excavations usually require immediate support, particularly where water-bearing sand/silt layers/lenses are present. In Head deposits presence of relict shear surfaces may cause additional stability problems, particularly in excavations on slopes. Clay-with-flints likely to have irregular base.	May be suitable as general cohesive fill depending on grading, plasticity and water content. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet.	Important to determine deposit variability and thickness and the possible presence of infilled solution hollows in underlying bedrock. In Head deposits, it is also important to identify the possible presence of relict shear surfaces which may adversely affect stability of cuttings in Head-covered slopes. In situ loading tests advisable to assess bearing strength at selected sites.
Fine Till	Firm to very stiff or hard slightly gravelly sandy CLAY with few cobbles and boulders. Occasional medium to extremely widely spaced interbeds and lenses of sand and gravel may be present. Often fissured particularly in the upper few metres. Generally low permeability; flow through fissures and lenses/interbeds of sand and gravel where present.	Generally good foundation conditions but dependant on shear strength, consolidation characteristics and presence of water-bearing sand and silt layers/lenses. Differential settlement possible where foundations overlap fine and coarse soil.	Easy digging. Excavations may be stable in the short term but water-bearing layers/lenses of silt, sand and gravel and the presence of fissures will significantly decrease stability.	Suitable as general cohesive fill depending on grading, plasticity and water content. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet.	Important to determine thickness and lithological variation, particularly the presence of laminated silts and clays and water-bearing sand/silt.
Fine Till (Bouldery)	Firm to very stiff or hard gravelly sandy CLAY with many cobbles and boulders, which may be strong. Often fissured particularly in the upper few metres. Occasional medium to extremely widely spaced interbeds and lenses of sand and gravel may be present. Generally low permeability; flow through fissures and lenses/interbeds of sand and gravel where present.	Variable but generally good foundation conditions, dependant on shear strength, consolidation characteristics and presence of water-bearing sand and silt layers/lenses. Potential for differential settlement associated with the presence of boulders should be accounted for in foundation design.	Easy digging. Large boulders may require hard digging, hydraulic braking tools or possibly blasting. Excavations may be stable in the short term but water-bearing layers/lenses of silt, sand and gravel and fissuring will significantly decrease stability.	May be suitable as general cohesive fill depending upon grading, plasticity and water content. Separation of larger fraction may be necessary to meet grading requirement. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet.	Important to determine deposit thickness and lithological variation, including the presence of laminated silt and clay, water-bearing sand and gravel layers/ lenses and the size, strength and lithology of incorporated boulders.
Fine Till (Layered)	Firm to very stiff or hard slightly gravelly sandy CLAY with interbeds of laminated clay/silt and beds/lenses of sand and gravel. Often fissured, particularly in the upper few metres. Low to high permeability; flow dominantly through lenses/interbeds of sand and gravel.	Variable but generally good foundation conditions dependant on shear strength, consolidation characteristics and presence of water-bearing sand and silt layers/lenses. Differential settlement possible where foundations overlap fine and coarse soils.	Easy digging. Excavations likely to require immediate support due to water-bearing layers/lenses of silt, sand and gravel.	Suitable as general cohesive fill depending on plasticity and water content. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet.	Important to determine deposit thickness and lithological variation, including the presence of laminated silts and clays and water-bearing sand and gravel layers.
Coarse Till	Dense to very dense clayey SAND and GRAVEL with some cobbles and boulders. Low to moderate permeability; flow dominantly through matrix.	Generally good foundation conditions. Frost susceptibility of near-surface silt and fine sand lithologies should be considered in design of shallow foundations.	Generally excavatable by easy digging but dense bouldery deposits may require hard digging and/ or hydraulic breaking tools or possibly blasting. Immediate support generally required; stability dependent on density, particle size distribution and water level.	May be suitable as selected granular fill if composition is appropriate or with separation of desired grades; otherwise suitable as general granular fill.	Important to determine deposit thickness and lithological variation, including the presence, size and lithology of incorporated boulders.
Coarse Till (Layered)	Dense to very dense COBBLES and BOULDERS with medium to very widely spaced thin to very thick interbeds of sand and gravel. Low to high permeability; flow dominantly through lenses/ interbeds of sand and gravel.	Potentially good foundation conditions but large particle sizes may cause difficulties in excavation. Boulders may need to be removed or broken down prior to laying foundations.	Generally excavatable by easy digging but dense bouldery deposits may require hard digging and/ or hydraulic breaking tools or possibly blasting. Generally, immediate support required depending on particle size and density.	May be suitable as general granular fill if composition is suitable or with separation of desired grades.	Important to determine deposit thickness and lithological variation, including the size, strength and lithology of boulders.
BEDROCK					
Coarse Soil	Medium dense to very dense fine to coarse-grained SAND sometimes with medium dense to very dense GRAVEL with some cobbles. Sandy clays and silts, sometimes laminated, occur locally. High to very high permeability; flow is through matrix. Includes calcareous types.	Generally good foundation conditions. Silt and fine sand lithologies may be frost susceptible near to the surface and this should be considered in design of shallow foundations.	Easy digging to hard digging. Immediate trench support required. May be water-bearing with running sand conditions below water table. Groundwater control measures may be required.	Clean sands and gravels suitable as general granular fill. May be suitable as selected granular fill if care taken in selection and abstraction.	Important to determine extent, nature and properties of coarse soil bedrock lithologies and associated groundwater conditions.
Fine Soil	Firm to very stiff sometimes sandy CLAY or SILT. Effectively impermeable to low permeability; flow dominantly through fissures. Includes calcareous types. Considered to be overconsolidated.	Generally good foundation conditions, dependant on shear strength and consolidation characteristics. Settlement rates usually slow; total settlements may be high. Open excavations likely to need protection in wet weather. In some clay strata potentially high sulphate/sulphide contents and/or shrink-swell movements need to be accounted for in foundation design. Frost-susceptibility of near-surface silty and fine sandy lithologies should be considered in design of shallow foundations.	Easy digging to hard digging. Excavations usually require rapid support but stiff clays may be stable in short-term.	May be suitable as selected cohesive fill or as general cohesive fill depending on plasticity, moisture content and sulphate/sulphide content where buried concrete and steel are likely to be used. Compaction properties highly dependent on moisture contents. Should generally be placed as soon as possible after excavation and subject to minimum construction traffic when wet.	Important to determine in situ variability in lithology and properties, including depth and nature of the weathered zone. In situ loading tests advisable to assess bearing strength at selected sites. Assessment of shrink-swell potential and sulphate/sulphide contents highly advisable.
Very Stiff Fine Soil/Very Weak Mudstone	Very stiff CLAY to very weak MUDSTONE. Weathers to fissured soft to stiff clay. Generally very low to low permeability; flow dominantly through discontinuities, most notably in the fissured top few metres. Includes very weak SILTSTONE and calcareous types. Considered to be overconsolidated.	Generally good foundation conditions, dependant on shear strength, consolidation characteristics and the depth and nature of weathered zone. Settlement rates usually slow with moderate total settlements in unweathered deposits. In open excavations, foundation levels in moisture susceptible mudstones may need protection to prevent rapid softening. In some strata potentially high sulphate/sulphide contents and/or shrink-swell movements need to be accounted for in foundation design.	Hard digging. Excavations often stable in short to medium term but where fissured or prone to rapid softening may be unstable and require immediate support. May heave on the removal of overburden, particularly in wet conditions.	May be suitable as selected cohesive fill or as general cohesive fill depending on plasticity, moisture content and sulphate/sulphide content where buried concrete and steel are likely to be used. Compaction properties highly dependent on moisture contents. Should generally be placed as soon as possible after excavation and subject to minimum construction traffic when wet.	Important to determine in situ variability in lithology and properties, including depth and nature of the weathered zone. In situ loading tests advisable to assess bearing strength at selected sites. Assessment of shrink-swell potential and sulphate/sulphide contents highly advisable.
Mudstone	Very weak to medium strong usually fissured MUDSTONE. Weathers to a firm to stiff silty clay generally within 2-6 m of ground surface; highly weathered mudstone clasts in a silt/clay matrix may occur to depths of 10-15 m. Generally low permeability, higher permeability in fissured near-surface material; flow dominantly through discontinuities. Includes SILTSTONE and calcareous types.	Generally good foundation conditions, depending on nature and thickness of the weathered zone. In open excavations, foundation levels in moisture susceptible mudstones need protection to prevent rapid deterioration. In some strata potentially high sulphate/sulphide contents and/or shrink-swell movements need to be accounted for in foundation design.	Weathered mudstones may be excavatable by hard digging but ripping may be required at depth or for major excavations. Base of excavations may heave on the removal of overburden in wet conditions. Excavated slopes in fresh or slightly weathered material are often stable in short to medium term; weathered and/or fissured mudstones may require immediate support.	Suitable as general granular fill and certain types of selected granular fill if placed under controlled compaction conditions. Should generally be subject to minimum construction traffic when wet. Where present, pyrite-rich material may oxidise and produce acidic, sulphate-rich conditions, which should be accounted for where buried concrete and steel are used.	Important to determine in situ variability in lithology and properties, including depth and nature of the weathered zone. In situ loading tests advisable to assess bearing strength at selected sites. Assessment of shrink-swell potential and sulphate/sulphide contents highly advisable.
Sandstone	Very weak to medium strong medium to widely jointed thinly to thickly bedded fine to coarse-grained SANDSTONE; may contain beds of mudstone and siltstone. Weathers to loose sand or clayey sand. Highly weathered rock may be present to depths in excess of 10 m, e.g. in the vicinity of faults. Medium to very high permeability; flow is through matrix and discontinuities. Includes calcareous types.	Usually good foundation conditions with very low and rapid settlement of weathered material. Bed thickness and depth of weathered zone important in foundation design. Frost-susceptibility of near-surface silty and fine sandy lithologies should be considered in design of shallow foundations.	Highly weathered rock is usually excavatable by hard digging with excavations requiring immediate support. In fresher material ripping or occasionally blasting may be required depending on joint/ bedding spacing and orientation; excavated side slopes generally stable in short to medium term.	May be suitable as selected granular fill if care is taken in selection and abstraction and strength permits. Weaker sandstone may easily break down to granular soil that is usually suitable as general granular fill if of suitable grading.	Important to determine intact rock strength, spacing and nature of discontinuities (including water flows), and nature/depth of weathered zone materials.
Strong Sandstone	Medium strong to extremely strong medium to widely jointed thinly to thickly bedded fine to coarse-grained SANDSTONE; may contain slate or mudstone and siltstone beds. Weathers to a loose to very dense sand, gravel or silty/clayey sand. Low to high permeability; flow is through matrix and discontinuities. Includes GREYWACKES.	Usually very good foundation conditions, depending on nature and thickness of the weathered zone.	Highly weathered rock may be excavatable by hard digging. In fresher material ripping or blasting is required depending on joint/bedding spacing and orientation. Where fresh to slightly weathered excavated slopes may maintain long-term stability.	Suitable as selected granular fill if care is taken in selection and abstraction.	Important to determine intact rock strength, spacing, orientation and nature of discontinuities (including water flows) and nature/depth of weathered zone materials.
Conglomerate/ Breccia	Very weak to very strong coarse-grained CONGLOMERATE or BRECCIA, comprising rounded or angular clasts of gravel-size or larger in a finer indurated or cemented matrix. May weather to silty, sandy gravels, cobbles or boulders depending on inherent clast size. Permeabilities are variable but may be low to very high; flow through matrix and discontinuities.	Usually good foundation conditions. Bed thickness and depth and nature of the of the weathered zone need to be accounted for in foundation design.	Depending on matrix strength and degree of weathering rock may be excavatable by hard digging with excavations requiring immediate support, or in stronger and/or fresher material require ripping or blasting.	May be suitable as selected granular fill if care taken to separate matrix and if clast size and composition are suitable; otherwise suitable as general granular fill.	Important to determine intact rock strength, spacing, orientation and nature of discontinuities (including water flows), and nature/depth of weathered zone materials.
Oolitic Limestone	Very weak to strong thickly to thinly bedded shelly fine to medium-grained OOLITIC LIMESTONE; may contain sandstone or very stiff clay/very weak mudstone beds. Weathers to gravelly, calcareous sand. Low to very high permeability; flow mainly through discontinuities but also through matrix.	Usually good foundation conditions. However, bed thickness, variable rockhead levels and possible dissolution cavities may need to be accounted for in foundation design.	Weathered material may be excavatable by hard digging or ripping. In fresher material blasting may be required for massive beds depending on interbeds of clay and mudstone and spacing of discontinuities. Excavations usually stable in medium to long term.	Suitable as selected granular fill if care is taken in selection and abstraction. Weaker material may only be suitable as general granular fill.	Important to determine nature and extent of karstic ground conditions (dissolution features, cavities and uneven rockhead). Geophysical methods may be advisable to identify karstic features at depth.
Limestone	Very weak to strong closely to widely jointed thinly to very thickly bedded fine-grained crystalline LIMESTONE. Topmost 0.5-1.5 m often weathered to calcareous silty clay with gravel. Zones of highly weathered rock may extend to depths in excess of 10 m below ground surface; may have variable rockhead levels and contain dissolution cavities. Generally moderate to very high permeability; flow is through discontinuities and matrix. Includes DOLOMITIC LIMESTONE and DOLOSTONE, sometimes with dolomitic mudstone.	Usually good foundation conditions. However, variable rockhead levels and dissolution cavities may give rise to reduced bearing capacities and excessive differential settlements. Use of shallow foundations may be precluded except for light structures unless ground remediation measures are undertaken. Soakaways near structures generally not advisable.	Ripping or blasting usually required depending on joint/bedding spacing and orientation. Clay infills in dissolution features may give rise to stability problems during excavation and dissolution cavities may affect the excavation profile.	Suitable as selected granular fill. Weaker material may only be suitable as general granular fill.	Important to determine nature and extent of karstic ground conditions (dissolution features, cavities and uneven rockhead). Geophysical methods may be advisable to identify karstic features at depth.
Strong Limestone	Strong to extremely strong closely to widely jointed thinly to very thickly bedded fine-grained crystalline LIMESTONE; may contain a little chert at some levels. Weathers to calcareous gravel; may have variable rockhead levels and contain dissolution cavities such as sink holes and caves. Generally very high permeability; flow is through discontinuities.	Usually good foundation conditions. However, variable rockhead levels and dissolution cavities may give rise to reduced bearing capacities and excessive differential settlements. Use of shallow foundations may be precluded except for light structures unless ground remediation measures are undertaken. Soakaways near structures generally not advisable.	Ripping may be possible in highly weathered zones but blasting is usually required for excavation. Presence of infilled or open dissolution cavities may affect the excavation profile and stability.	Suitable as selected granular fill if care taken in selection and abstraction.	Important to determine nature and extent of karstic ground conditions (dissolution features, cavities and uneven rockhead). Geophysical methods may be advisable to identify karstic features at depth.
Chalk	Very weak to medium strong porous white and greyish white fine-grained CHALK and CHALKY LIMESTONE. Nodular seams or tabular beds of flint are frequently present in the upper units and thin calcareous clay/mudstone (marl) beds, sometimes sheared, are present at some horizons. Generally very close to medium spaced discontinuities near-surface; widely to extremely widely spaced at depth. Weathers to calcareous silt with flint gravel and cobbles. Dissolution hollows and pipes, often infilled, frequently occur beneath a thin superficial cover. Very high to medium permeability; flow is through matrix and discontinuities.	Potentially good foundation conditions but largely dependent on the nature and thickness of the weathered zone and presence of marl bands and beds of flint nodules. Possible presence of dissolution cavities and variable rockhead levels may need to be accounted for in foundation design. Soakaways near structures generally not advisable.	Usually excavatable by hard digging or rippable but blasting may be required at depth or for major excavations. Clay infills in dissolution features may give rise to stability problems and dissolution cavities may alter excavation profile.	Strong chalk may be suitable as selected granular fill. Weaker chalk may be suitable as general chalk fill. Chalk can quickly degrade by weathering or inappropriate construction methods to a wet cohesive soil. Often difficult to handle in earthworks, chalk quality should be assessed before selection of plant and methods of excavation, haulage and compaction.	Important to determine in situ variations in lithology (including presence of marl layers and flint beds), spacing and orientation of discontinuities, and depth and nature of the weathered zone. Important to locate open/infilled dissolution fissures, pipes and sinkholes. Geophysical methods may be applicable. In situ loading tests may be advisable to assess bearing strength at selected sites.
Strong Chalk	Weak to strong porous white and greyish white fine-grained CHALK and CHALKY LIMESTONE. Nodular seams or tabular beds of flint are frequently present in the upper units, and thin calcareous clay/mudstone (marl) beds, sometimes sheared, are present at some horizons. Generally very close to medium spaced discontinuities near-surface; widely to extremely widely spaced at depth. Weathers to calcareous silt with flint gravel and cobbles. Dissolution hollows and pipes, often infilled, frequently occur beneath a thin superficial cover. Very high to medium permeability; flow is through matrix and discontinuities.	Potentially good foundation conditions but largely dependent on the nature and thickness of the weathered zone and presence of marl bands and beds of flint nodules. Possible presence of dissolution cavities and variable rockhead levels may need to be accounted for in foundation design. Soakaways near structures generally not advisable.	Generally requires ripping and in some places blasting, although upper weathered material may be excavated by hard digging. Clay infills in dissolution features may give rise to stability problems and dissolution cavities may alter excavation profile.	Strong chalk may be suitable as selected granular fill. Weaker chalk may be suitable as general chalk fill. Chalk can quickly degrade by weathering or inappropriate construction methods to a wet cohesive soil. Often difficult to handle in earthworks, chalk quality should be assessed before selection of plant and methods of excavation, haulage and compaction.	Important to determine in situ variations in lithology (including presence of marl layers and flint beds), spacing and orientation of discontinuities, and depth and nature of the weathered zone. Important to locate open/infilled dissolution fissures, pipes and sinkholes. Geophysical methods may be applicable. In situ loading tests may be advisable to assess bearing strength at selected sites.
Slate	Strong to very strong thinly to very thickly bedded medium to widely jointed foliated fine-grained SLATE with well-marked fissility along foliations (cleavage planes). Weathers to clayey gravel. Low to very low permeability; flow is through discontinuities.	Generally good foundation conditions, depending on depth and nature of the weathered zone.	Weathered material may be excavatable by hard digging or ripping; fresh rock generally requires blasting.	Suitable as general granular fill if tabular nature of excavated material can be dealt with satisfactorily.	Important to determine spacing, orientation and nature of discontinuities including cleavage planes, and depth and properties of weathered zone materials.
Schist	Very weak to strong generally widely jointed foliated, often with pronounced mineral layering, medium to coarse-grained SCHIST. Usually shows marked strength anisotropy, stronger normal to foliation. Weathers to gravelly sand or sandy clay. Medium to very low permeability; flow is through discontinuities. Includes PHYLLITES.	Generally good foundation conditions, but dependent on inherent variability of the schist rock and depth and nature of the weathered zone.	Ripping or blasting required depending on strength along foliations and spacing and orientation of discontinuities.	Variable strengths and durability affect use as engineered fill, but generally suitable as general granular fill if care taken in selection and abstraction.	Important to determine spacing, orientation and nature of discontinuities including foliations, and depth and properties of weathered zone materials.
Granofels	Strong to extremely strong medium to widely jointed non-foliated fine to coarse-grained GRANOFELS. Weathers to a sandy gravel or gravelly sand. Medium to very low permeability; flow is through discontinuities. Includes QUARTZITE, GRANULITE, HORNFELS and AMPHIBOLITE.	Potentially good foundation conditions, but may be dependent on degree of metamorphism and variability of interbedded metamorphic lithologies and associated weathering profiles.	Highly weathered zones may be excavatable by hard digging or ripping but blasting usually required for fresher material.	Suitable as selected granular fill if care taken in selection and abstraction.	Important to determine spacing, orientation and nature of discontinuities, and depth and properties of weathered zone materials.
Gneiss	Very strong to extremely strong widely jointed banded and foliated medium to coarse-grained GNEISS. Weathers to sandy gravel or cobbles. Low to very low permeability; flow is through discontinuities.	Usually very good foundation conditions.	Highly weathered zones may be excavatable by hard digging or ripping but blasting usually required for fresher material.	Suitable as selected granular fill if care taken in selection and abstraction.	Important to determine spacing, orientation and nature of discontinuities, and depth and properties of weathered zone materials.
Marble	Medium strong to very strong jointed thickly to thinly bedded fine to coarse-grained MARBLE. Weathers to gravel. Medium to very low permeability; flow is through discontinuities. Includes all metamorphosed rocks containing more than 50% vol. of carbonate minerals.	Generally good foundation conditions. However, possible presence of dissolution cavities and variable rockhead levels may need to be accounted for in foundation design.	Ripping may be possible in highly weathered zones but blasting usually required for excavation. Presence of infilled or open dissolution cavities may affect the excavation profile and stability.	Suitable as selected granular fill if care taken in selection and abstraction.	Important to determine nature and extent of karstic ground conditions (dissolution features, cavities and uneven rockhead). Geophysical methods may be advisable to identify karstic features at depth.
Mylonite	Medium strong to very strong foliated fine-grained MYLONITE. Weathers to gravelly sand or gravelly sandy clay. Medium to very low permeability; flow is through discontinuities. Formed by ductile deformation associated with major fault, thrust and shear zones.	Generally good foundation conditions but may be dependent on orientation and strength along foliations and on depth and nature of the weathered zone.	Highly weathered zones may be excavatable by hard digging or ripping but blasting usually required for fresher material.	Suitable as selected granular fill if care taken in selection and abstraction.	Important to determine variations in lithology (including depth and nature of weathered zone) and the presence of shear planes and/or shear zones.
Basaltic-rock	Very strong medium, irregular or columnar, jointed generally dark-coloured fine-grained BASALTIC-ROCK. May weather to gravel and/or gravelly clay beyond the limit of Anglian glaciation in southwest England. In Northern Ireland, may be locally altered to very weak clay-rich rock. Medium to very low permeability; flow is through discontinuities. Includes ANDESITIC-ROCK, PHONOLITIC-ROCK and other fine-grained mafic and ultra-mafic igneous rocks. Often associated with interbedded tuffs.	Usually very good foundation conditions when fresh or slightly weathered. However, highly weathered and altered rock (and possible presence of palaeosols) may need to be accounted for in foundation design.	Highly weathered zones may be excavatable by hard digging or ripping in some areas but blasting usually required for fresher material, depending spacing and orientation of discontinuities.	Suitable as selected granular fill if care taken in selection and abstraction. Some basalts may exfoliate to a slight extent after long periods of weathering.	Important to determine spacing, orientation and nature of discontinuities and depth and properties of weathered/altered zone materials, including the possible presence of tuff layers and palaeosols.
Rhyolitic-rock	Very strong closely to moderately jointed, generally light-coloured fine-grained RHYOLITIC-ROCK and interbedded PYROCLASTIC-ROCK AND TEPHRA. Weathers to gravel or gravelly clay. Medium to very low permeability; flow is through discontinuities. Includes DACITIC-ROCK and other fine-grained felsic rocks.	Usually good foundation conditions depending on depth and nature of the weathered zone.	Highly weathered zones may be excavatable by hard digging or ripping in some areas but blasting usually required for fresher material, depending spacing and orientation of discontinuities.	Fresh rock suitable as selected granular fill.	Important to determine spacing, orientation and nature of discontinuities and depth and properties of weathered zone materials.
Gabbroic-rock	Strong to extremely strong moderately jointed generally dark-coloured medium to coarse-grained GABBROIC-ROCK. Generally weathers to clayey gravelly sand or sandy gravel. Medium to very low permeability; flow is through discontinuities. Includes DIORITIC-ROCK and other medium to coarse grained mafic and ultramafic igneous rocks.	Usually very good foundation conditions.	Highly weathered zones may be excavatable by hard digging or ripping in some areas but blasting usually required for fresher material.	Fresh rock suitable as selected granular fill.	Important to determine spacing, orientation and nature of discontinuities and depth and properties of weathered zone materials.
Granitic-rock	Medium strong to very strong moderately jointed generally light-coloured medium to coarse-grained GRANITIC-ROCK. Joints subvertical and parallel to surface (sheet joints), which reduce in frequency with depth. Generally weathers to sandy gravel or gravelly sand but in southwest England, granite may contain highly altered zones of kaolinite clay (e.g. 'China Clay') sometimes to depths in excess of 100 m. Medium to very low permeability; flow is through discontinuities. Includes SYENITIC-ROCK and other medium to coarse grained felsic igneous rocks.	Usually very good foundation conditions when fresh or slightly weathered. However, in some areas, most notably in the southwest of England, weathered zones of significant thickness containing large core stones in a finer sandy clay matrix may give rise to irregular engineering rockhead levels and variable foundation conditions.	Highly weathered and altered rock may be excavatable by hard digging with excavations requiring immediate support. Ripping or blasting will be required in fresher rock depending on spacing and orientation of joint sets.	Fresh rock suitable as selected granular fill.	Important to determine depth and nature of the weathered/altered zone and spacing and orientation of discontinuities.

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The 1:1 000 000 Series, Engineering Geological Maps of the United Kingdom

In 1996–7, the BGS collaborated with Professor Bill Dearman to develop a small-scale engineering geological map of the UK. The initial interpretation was completed but the map was never published. In late 2008 the original interpretation was revived and applied to a new digital version of the 1:625 000 scale geological map. Two engineering geological maps have been produced, for bedrock and for superficial deposits. Sadly, Professor Dearman died in early 2009 before the maps were completed; they are dedicated to him in celebration of his achievements.

The engineering geology maps are based on the 5th edition of the BGS 1:625,000 scale bedrock geology map and the recently compiled (2010) line-work for a new superficial geology map of the UK. The maps are attributed with 'engineering geological units' (in place of the lithostratigraphical units shown on the original geological maps), each of which may comprise one or more separate 'engineering geological lithologies'. For the bedrock map a system of stripes has been used as a means of displaying the relative proportions of engineering geological lithologies present within each map unit. For example, the Cretaceous Hastings Beds, which consist of interbedded sands and clays is classified as 'fine soil' and 'coarse soil' in the proportion 1:1, represented on the map as alternating, coloured stripes of equal width; the separate colours representing each engineering geological lithology.

The faces of the maps also include a number of very small scale inset maps, text boxes and schematic diagrams. These cover topics such as landslides, shrink/swell clays, seismicity, mining, potential sulphate hazard etc. The purpose of these is to illustrate aspects of the engineering geology that have a significant impact upon land-use and development but could not be incorporated into the main map. In many instances the inset information relates to both superficial and bedrock deposits although it may only be displayed on one of the maps. It should be noted that the information and topics included are not exhaustive and that there are many other aspects of engineering geology that could not be included due to space constraints.

In addition to the two map sheets an extended engineering geological key has also been produced. It includes a description of each engineering geological lithology and information on engineering geological considerations, including suitability for foundations, excavatability, use of material as engineered fill, and appropriate site investigation approaches. The classes shown in the key are based on those used on engineering geological maps produced for BGS applied geological mapping projects to provide information to civil engineers and planners for various areas of the UK.

The maps and the extended key are intended to be used mainly by geoscience, civil engineering and environmental science undergraduate and postgraduate students to aid understanding of the importance of geology to development and regeneration. The maps may also be useful to those engineering and environmental geologists and geotechnical engineers in the early stages of their careers that may not be familiar with the geology of the whole of the UK. They are not intended to be used for site-specific investigation. For further information regarding engineering geological hazards, GeoSure products and other BGS datasets visit the BGS website http://www.bgs.ac.uk/ or contact BGS Enquiries enquiries@bgs.ac.uk.

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NATURAL ENVIRONMENT RESEARCH COUNCIL

1:1 000 000 SERIES
EXTENDED KEY FOR THE ENGINEERING GEOLOGY MAPS OF THE UNITED KINGDOM

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