GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES

TERRAIN CLASSIFICATION AND SENSTITIVITY SERIES
LEGEND

To accompany map sheets NTS 95N (Dahadinni River), NTS 95O (Wrigley), NTS 95K (Root River), NTS 95J (Camsell Bend), NTS 95I (Bulmer Lake), NTS 95G (Sibbeston Lake), NTS 95H (Fort Simpson), NTS 95B (Fort Liard), NTS 95A (Trout Lake), NTS 85E (Mills Lake), and NTS 85D (Kakisa River).

Map Unit	Name	General Description	Local Description	Permafrost, Ground Ice Conditions	Drainage (thaw season)	Hazards	Sources of Construction Material
I	ORGANIC TERRAIN (including muskeg)	Peat, fen; peat-fen complex; commonly occurring as a cover on Units II, IX and X; flat to moderately sloping.	Fenland: Moderately decomposed fen, peat 6-10 ft. ir thickness derived from sedge, tamarack, and mosses. Surface flat to gently sloping in places with reticulate network of low (<3 ft.) ridges (patterned fen). Peatland: Moderately decomposed forest and/or un-decomposed sphagnum peat, 3-30 ft. thick. Flat to gently sloping areas with occasiona mounds (3-20 ft.): numerous steep-sided depressions and trenches, exposed peat scarps.	Commonly unfrozen to depths of 10 ft. Ground surface is frozen to depths of 1-3 ft. Segregated ice in peat (60-80%), and in mineral soil belc Peat in wet depressions commonly thawed to at least 3 ft.	No organized drainage; water at surface throughout summer months. Higher surfaces of peat platforms dry. Depressions interconnected by seepage channels.	Wet sites: material compressible and of low strength. Alternations of permanently frozen peat mounds (some actively degrading) and water bodies and thawed depressions present serious problems in construction of roads, pipelines etc; material highly compressible when thawed.	Unsuitable
II	SILT-CLAY PLAINS (marine and lake deposits)	Clay and silt, commonly surfaced by sand or silty sand, with discontinuous organic cover (see Unit I). Principally forming plains bordering rivers and coastal areas. Highly unstable in eroded slopes.	Silt and fine sand 3-150 ft. thick. Terrain is flat to gently sloping with low hummocks (up to 15 ft. high), slopes t 20° in some places.	In the flat areas 10-50% segregated ice occurring as thin (<1") seams parallel with bedding segregated ice in a reticulate network up to 60% by volume and thick tabular bodies in Zones 2 and 6S. In northern part of Zone 6S ice occurs as reticulate networks and tabular bodies (up to 3m thick); in southern part of Zone 6S no ice recorded except below areas of unit I.	Deranged. Surface seepage through organic filled depressions and down-slope seepage in shallow sub-parallel runs.	Failure common along scarps; generally unsuitable for location of structures because of poor bearing capacity and drainage characteristics.	No sources of coarse granular material; most of the unit is a poor[2] source of fill but local coarse sands are suitable for fill.
III	THERMOKARST[2] LAKE BEDS	Clay, silt, peat, and local sand on low, flat areas formerly occupied by tundra ponds. These materials generally less than 10 feet thick over till or sand. Pingos generally confined to this unit.	Not Present				
IV	BEACHES (marine and lake)	Gravel and/or sand ridges or flat areas along present or former shorelines.	Low beach ridges (2-5 ft. high) with slopes to 6°. Mainly gravel with minor sand and some silt. Beach ridges form parallel to sub-parallel belts, although in places beach material without distinct ridges forms belts up to 4± miles wide.	None observed	Ground surface commonly dry; drainage mainly subsurface.	Minor gullying on hillsides and sloping areas.	Good construction sites and aggregate source where material is coarse; beaches at 800 to 900 ft. elevations offer the best potential.
V	RIVER DEPOSITS-FINE	Silt and silty sand in river channels, floodplains, low terraces adjoining rivers and alluvial fans; includes organic silt, peat and minor gravel.	Silt and fine sand 5-100 ft. thick forming floodplains and low bordering terraces, commonly with meander scars; in places with numerous channels. The unit is flat; (overall relief ranges from 3-15 ft. except for channel margins). Peat cover is negligible on the active floodplains, but is up to 15 ft. thick in the abandoned channels and terraces. Includes modern floodplain of the Mackenzie River, and terraces within the "inner valley" of the Mackenzie River.	Frozen groundwater in sand and silt of low terraces in Zone 2. Observed not observed. Permafrost and segregated ice also present in areas where bog is greater than 5 ft. thick	Many areas wet, lakes and marshy areas common. Surface drainage with no integrated drainage system (in meander scar areas, impeded by meander scroll ridges.)	Ground ice slumping and gullying on margins of lakes and channels, under-cutting and bank collapse along channels during high water; flooding during breakup and summer storms; channel shifts.	Gravel deposits rare and small; generally poor[2] source of borrow material.
VI	RIVER DEPOSITS COARSE	Gravel and sand in river channels, floodplains, low terraces adjoining rivers, and alluvial fans. Includes some silt, peat and organic silt.	Floodplains and terraces consisting of sand and gravel 10-75 ft. in thickness, commonly with a veneer of silt 1-6 ft. thick. Topography is level to gently sloping (0-3°) with local relief to 15 ft. due to the presence of former channels, bars, steep scarps etc. (slopes to 35°). Alluvial fans and fan aprons consist of silt, sand and gravel to thickness of 150 ft. and form slopes of 1-12° with relief to 150 ft. (from head to toe). Peat cover is largely restricted to former river channels, and ranges in thickness from 5-10 ft. Includes modern floodplain of the Mackenzie River and terraces within the "inner valley" of the Mackenzie River.	None observed	Surfaces of coarser-grained materials are dry; ponds and swamps in former river channels. In alluvial fans one or more shifting streams usually present; downslope seepage in poorly defined runs. In areas of rock fans ephemeral streams and surface wash-subsurface percolation.	Minor slumping on margins of lakes and channels in areas with a veneer of silt; under-cutting and bank collapse along channels during high water; flooding during breakup and summer storms; channel shifts.	Includes much gravel and mixed gravel and sand; the unit contains much sandy material suitable for fill. Exploitation of sites adjoining rivers may lead to accelerated erosion or channel shifts.
VII	GRAVEL-SAND HILLS RIDGES, AND TERRACES	Gravel, generally till, sand and some silt. Includes eskers, and other glacio-fluvial deposits, river terraces, sand dunes, and a few small moraines consisting of deformed gravelly-sandy strata.	Plain and Terrace areas: Sand and gravel 5-100 ft. thick, locally with veneer of silt or sand; forms flat to gently sloping benches interrupted by shallow channels and low scarps (relief to 30 ft.) Hummocky and Ridged Areas: Gravel and sand 5-90 ft. in thickness. Terrain chacterized by hummocks (up to 30 ft. in height), and long sinuous eskers (up to 90 ft. in height) often b..ached by streams. Dune Areas: Fine to medium sand up to 60 ft. thick. Occurring as dune ridges, some parallel to subparallel in formation, others irregulary shaped dunes with no apparent pattern.	Frozen groundwater in gravel, sand, and silt in Zone 2. Not observed elsewhere. Where overlying bog is 5 ft. thick permafrost may be present below. No segregated ice in well-drained sites, although segregated ice may be present in association with silt layers beneath depressions in Zones 2,3, and 6N. None observed. Probably absent.	Ground surface relatively dry, except on large flat areas and in channel traces; drainage mainly subsurface.	Some gullying on hillsides and sloping banks, principally where material is fine sand or silt; blowing sand, and blowouts in dune areas (especially where vegetation mat is removed.)	Major source of gravel and mixed gravel and sand; generally suitable as borrow material. Good construction sites and sources of aggregate. Good source of sand; generally suitable as borrow material.
VIII	SILT-CLAY HILLS AND RIDGES	Mainly silt and clay with minor sand and gravel in moraines, strata tilted and folded.	Not Present				
IX	TILL PLAINS	Till, occurring as ground moraine with low rolling relief or parallel drumlin ridges. Large areas are clayey to silty till as a thin veneer on shale; locally forms a thin veneer on other kinds of bedrock. Includes undifferentiated areas of Unit I.	Silty to clayey till plains, generally 0-20 ft. thick (locally to 150 ft.), underlain by bedrock[4]. Contains small drumlin fields, crevasse fillings and ridge moraine, composed of mainly silty to clayey till; locally gravelly. Overall, unit IX forms a sloping-rolling plain, generally bedrock controlled with slopes to 3°; individual parallel to subparallel, straight to sinuous ridges (relief to 15 ft) provide slopes to 30° in places. Local relief (due to stream incision) up to 60 ft. Discontinuous peat cover up to 15 ft. in depressions, and as irregular patches on hills.	Within the plain area locally 5-40% segregated ice as thin (<1") horizontal layers or as a reticulate network in Zones 2,3, and 6N. Segregated ice may be present in some drumlins in Zones 2,3, and 6N, although none observed; intervening depressions in some zones likely contain segregated ice. Presence of ground ice controlled by exposure, elevation, drainage, and/or organic cover. No ice observed in crevasse fillings, and/or ridge moraine. Ice content highly variable depending on topographic position: crests of prominent ridges and hummocks well-drained and ice free to depths of 5-15 ft.	Ground surface commonly wet-water in depressions - no organized drainage with down-slope seepage in sub-parallel runs. Crests of drumlins and ridges relatively dry, with a well-integrated drainage system developed between the drumlins.	Moderate susceptibility to gullying. Ground ice slumps and superficial mudflows on slopes, and large flow slides in clay-rich till. Drumlinoid features display a minor susceptibility to gullying, creep , and channelling.	Gravel deposits rare and small; usefulness of the silty till[3] material as fill is limited by its ice content. Where bedrock is close to the surface, it is a source of borrow material. Gravelly and sandy till in drumlins may provide minor source of borrow material. Crests of prominent ridges offer restricted but good construction sites.
X	HUMMOCKY TILL	Clayey to gravelly-sandy till, local gravel, forming rolling to hilly moraine composed of individual and coalescent hummocks. Local contrasts in material and ground ice between well drained hills and poorly drained depressions. Includes small undifferentiated areas of Unit I.	Mainly gravelly till with thickness ranging from 3-90 ft. Topography variates from a subdued rolling moraine (with slopes from 5-30°) to hummocky moraine composed of individual to coalescent hummocks with slopes to 20°	Lower slopes and depressions commonly 5-40% segregated ice as thin (<1") horizontal layers, or in a reticulate network in Zones 2,3, and 6N. Presence of ground ice controlled by exposure, elevation, drainage and/or organic cover.	Surfaces of ridges and hummocks is dry, poorly drained depressions in places containing bogs or ponds. Water moves downslope, and follows poorly defined drainage connecting depressions.	Minor susceptibility to gullying.	Hummocks and ridges provioe major sources of gravel and mixed gravel and sand; usefulness of the silty till[3] material as fill is limited by its ice content. The silty[3] till is suitable borrow material where ice content is low.
XI	UPLAND AND PIEDMONT COMPLEX	Areas of moderate to low slope, in part hilly, surfaced by till, dis-integrated bedrock, and local clay, silt, sand, or gravel. Unconsolidated deposits generally form a thin veneer over rock but in places they are thick.	Not Present				
XII	MOUNTAINOUS AND ROCK AREAS	Rocky outcrop or rock thinly covered by rubble. Moderate to steep slopes.	Bare rock with discontinuous shallow patches of rubble and bedrock colluvium with clayey, silty, sandy matrix and/or reworked till on crests and on steep slopes; variable thicknesses of bedrock rubble and colluvium and/or reworked till at base of slopes. Topography ranges from low hills with rounded summits and gentle slopes to mountains up to 5000 ft. high with sharp ridge crests and steep slopes.	Ice content low to nil in rubble, scree and other overburden of fine grained colluvium may contain ice in northern areas or at higher elevations.	Downslope drainage, wet ground on local flat areas.	Rockfalls, slides, and active creep, on steep slopes, gullying of soft materials. Mud-flows and flash floods in steep gullies. Areas of shale are highly unstable and are subject to mass wasting; detachment slides, rotational slumping commonly occur when organic cover and/or vegetation are removed or altered.	Rubble and in place rock from limestone, dolomite, and harder sandstone units can serve as sources of coarse granular material. Less resistant sandstone and shale are also a possible source of borrow material, however, the latter is unstable and subject to mass wasting.
XIII	ERODED AND/OR ERODING RIVER BANKS, COASTAL CLIFFS AND VALLEY WALLS - UNCONSOLIDATED MATERIALS	Various unconsolidated materials on moderate to steep slopes; generally with surface veneer of slope debris; includes unstable areas.	Same as general description. Surface colluvial debris up to 15 ft. thick. Material on upper part of slope is same as adjacent map unit; different materials commonly occur lower on the slope; locally bedrock rubble forms the base of the slope (see Unit XIIIR). Slopes generally less than 150 ft. high.	Silty, clayey colluvium contain disseminated ice crystals to seams 3 ft thick in Zones 2 and 6N.	Surface of sandy and gravelly materials is generally dry; other materials commonly wet with local running water and active gullying.	Active stream erosion; major ground ice s..mping and gullying. Large detachment slides in areas of unit II bordering the Mackenzie River.	Varied material; see description pertaining to adjoining unit.
XIIIR	ERODED AND/OR ERODING RIVER BANKS, COASTAL CLIFFS[5] AND VALLEY WALLS-BEDROCK	Bedrock outcrops or bed-rock partly covered by rock detritus or unconsolidated materials; slopes commonly steep; includes unstable areas.	Steep slopes and rock faces consisting of shale, sandstone, or limestonm, some partly covered by debris. Strata are flat-lying or inclined at a low angle. Unconsolidated material on upper part of slope same as adjacent map unit. Includes debris avalanches which commonly occur as thin narrow tongues; earth and mudflows as bulbous masses, and slump deposits as blocks.	Fine grained material may contain segregated ice in Zones 2,3, 6S, and northern part of 6S, presence controlled by exposure, elevation, drainage, and/or organic cover.	Locally water runs down rock faces; gullying.	Shale bedrock commonly fails as debris avalanches in mountainous regions; rockfalls, and superficial debris flows on steep eroded slopes; local susceptibility to extensive gullying and slumping in areas of soft shale, or where substantial thickness, of overburden covers rock. Flooding in valley bottoms.	Rubble and in-place rock from limestone, dolomite and harder sandstone units can serve as sources of coarse granular material. Less resistant sandstone and shale is a source of low ice borrow material.

[1] Segregated Ice: Ice as distinct lenses, layers, veins, and masses in soils, commonly, but not always, oriented normal to direction of heat loss.

[2] Thermokarst: Heat from water in thaw pits, sinks and ponds results in melting of ground ice in areas of saturated peat and underlying mineral soils. The thaw basins may enlarge to the point of coalescing. They are usually steep-sided and flat-bottomed and are best developed in peat-covered, stratified, waterlaid silt and fine sand.

[3] Clay, silt, and fine sand are commonly poor borrow materials under permafrost conditions because of their instability under the high moisture conditions that result from thawing of contained ground ice. Some improvement in properties for use as fill could be achieved by artificial drying.

[4] See bedrock map insert and legend on individual map sheets.

[5] Excess Ice: Ice in excess of the quantity that would be retained as water in the soil voids upon thawing.

[6] Little data available.

TERRAIN SENSITIVITY AND PERFORMANCE RATING TABLE

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ZONE			2			3			4			5			6N			6S (NORTH)			6S (SOUTH)			FLOODING HAZARD
MAP UNIT	Slopes <3°	Slopes >3°	PERMAFROST TERRAIN			NON PERMAFROST TERRAIN Material performance	PERMAFROST TERRAIN			NON PERMAFROST TERRAIN Material performance	PERMAFROST TERRAIN			NON PERMAFROST TERRAIN Material performance	PERMAFROST TERRAIN			NON PERMAFROST TERRAIN Material performance	PERMAFROST TERRAIN			NON PERMAFROST TERRAIN Material performance	PERMAFROST TERRAIN			NON PERMAFROST TERRAIN Material performance	
			0	D	P		0	D	P		0	D	P		0	D	P		0	D	P		0	D	P		
I	X		a	3	3	3	a	3	3	3	a	3	3	3	a	3	3	3	a	3	3	3	a	3	3	3	N
II	X		a	3	3	3	←				NOT PRESENT			→	e			3	a	3	3	3-2	a	2	3	3-2	N
		X	a	3	3	3									e			3	a	3	3	3-2	a	3	3	3-2		
III	NOT PRESENT		←																							→		
IV	X	X	←								NOT PRESENT															1	N	
V	X		a	3	3	2-3	a	3	3	2-3	d	2	3	2-3	d	2	3	2-3	a	3	3	2-3	a	2	3	2-3	c	1	3	2-3	3-2
		X	a	3	3	2-3	a	3	3	2-3	b,d	2-3	3	2-3	b,d	2-3	3	2-3	a	3	3	2-3	a	3	3	2-3	c	2	3	2-3	
VI	X		a	2	1	1	e			1	e			1	e			1	e			1	e			1				1	3-2
		X	a	3	2	1	e			1	e			1	e			1	e			1	e			1				1	
VII	X		e			1	e			1	e			1	e			1	e			1				1	N			1	N
		X	a	2	1-2	1	e			1-2	e			1-2	e			1-2	e			1-2				1-2				1-2	
VIII	NOT PRESENT																														
IX	X		a	3	2-3	2	b	2	2-3	2	b	2	2-3	2	b	2	2-3	2	a	3	2-3	2	c	1-2	2	2				2	N
		X	a	3	2-3	2	b	2-3	2-3	2	b	2-3	2-3	2	b	2-3	2-3	2	a	3	2-3	2	c	1-2	2	2				2	
X	X		a	3	2-3	2	b	2	2-3	2	b	2	2-3	2	b	2	2-3	2	a	3	2-3	2	c	1	2	2				2	N
		X	a	3	2-3	2	b	2-3	2-3	2	b	2-3	2-3	2	b	2-3	2-3	2	a	3	2-3	2	c	1-2	2	2				2	
XI	NOT PRESENT																														
XII	X	X	e			1-2	e			1-2	NOT PRESENT			→	e			1-2	←							NOT PRESENT					N
XIII		X	d	3	3	2-3	d	3	3	2-3	e			1-3	e			1-3				1-3				1-3				1-3	3-2 (valley bottoms)
XIIIR		X	d	2-3	1-2*	1-2*	d	2-3	1-2	1-2	e			1-2*	e			1-2*	d	2-3	1-2	1-2*				1-2*				1-2*	3-2 (valley bottoms)

* Performance rating 3 applies for areas of shales in all climatic zones.

KEY TO PERFORMANCE RATING TABLE - EXPLANATORY NOTES

Sensitivity - Performance Scale

Rating Number	General	Degradation (D)	Performance (P)	Flooding Hazard
1	good sites	low frequency, and/or low intensity	least troublesome materials	----------
2	fair sites	moderate frequency and intensity	moderately troublesome materials	flooding under extreme conditions
3	poor sites	high frequency and/or high intensity	highly troublesome materials	flooding a common occurrence
N	not applicable or not represented			no flood hazard

Permafrost Occurrence: (O)

a extensive permafrost; abundant ground ice

b localized permafrost, moderate content of ground ice chiefly on north facing or shaded areas, higher elevations poorly drained areas, or areas with thick organic cover.

c minor permafrost with moderate to low ground ice, chiefly in areas of organic cover.

d permafrost and ground ice in fine-grained materials.

e ground ice not seen but permafrost conditions (<32°F) may occur.

Degradation of Permafrost Areas (D)

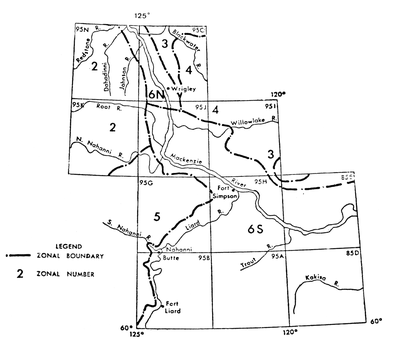
Rating applies to thermokarst subsidence on flat or gently sloping sites and to gullying or slope failures on sloping sites resulting from man-induced disturbance of frozen ground such as stripping of the surface down to mineral soil, long term ponding of water on surface, or re-routing of flowing water for substantial periods. Degradation of somewhat lesser intensity and/or frequency results from compaction or mechanical disturbance of the surface vegetation mat or peat. Earthflows may develop in sloping sites following fire on units rated as 2 or 3.

Performance of Newly Thawed Material (P)

The rating is for performance of thawed materials under worst conditions (i.e. immediately after melting of constituent ice) when subjected to load in place, when used as fill, or when exposed on a cut slope. Rating also applies to "normal" active layer materials under the same conditions.

Performance of normal unfrozen material

The rating is for performance of materials under typical field moisture conditions when subjected to load in place, when used as fill, or when exposed on a cut slope.



Climatically Significant Zones (after Tarnocai, 1973)

TERRAIN CLASSIFICATION AND SENSITIVITY SERIES
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GEOLOGICAL SURVEY
OTTAWA

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