DESCRIPTION OF MAP UNITS
(See explanation for description of materials)

UNIT	DISTRIBUTION AND THICKNESS	TERRAIN AND NATURAL SLOPES	DRAINAGE AND PERMEABILITY	WORKABILITY AND COMPACTION	STABILITY	POSSIBLE USE	ORIGIN OF DEPOSIT
DUNE SAND	Three areas; 1) near NW corner of quadrangle, 2) in Secs. 3, 4, & 5, T. 163 N., R. 96 W., 3) 2½ mi. NW of Noonan. All areas in or on lee side of Pleistocene drainage courses and basins. Thickness: trace to at least 20 feet.	Uneven terrain characterized by low dunes, rounded mounds, small depressions, and blowouts. Natural slopes gentle to moderate.	Drainage good except where sand is closely underlain by impervious clayey till. Permeability high.	Easily worked with hand tools except below water table. Compaction fair.	Low strength when dry; very weak when saturated. Low angle slopes necessary in cuts. Poor foundation material. Frost heave is medium in undrained material.	Fair for sweetening concrete aggregate; silt content high. May be good pervious fill.	Wind-blown sand derived mostly from deposits in Pleistocene drainage courses and shallow basins. Prevailing winds from northwest.
SAND BAR	Four small deposits less than ½ mi. NW of Noonan, and four slightly larger about 3½ mi. NW of Noonan. All sand bars in Pleistocene drainage courses. Thickness: 5 ft. to at least 12 ft. Bar sand may extend below ground level of surrounding drainage courses.	Low mounds elongate in shape with flat to rolling surface and gently sloping sides.	Material loose and porous to slightly compacted. Permeability moderate to high. Drainage good. Water table near surface in most places.	Same as dune sand.	Same as dune sand.	Good for sweetening concrete aggregate. May be good pervious fill. (See analysis S-4 below.)	Channel bars formed in Pleistocene drainage courses.
DEPOSITS IN PLEISTOCENE DRAINAGE COURSES AND SHALLOW BASINS	Form network over ground moraine plain. Major course: 1) wide valley near N border of quadrangle, contains Long Creek, 2) narrow but deeply incised valley trends E and N from Sec. 14, T. 162 N., R. 97 W., trends across Highway 5 into Sec. 33, T. 163 N., R. 96 W. and northeasterly to Sec. 19, T. 163 N., R. 95 W., where it widens to an indefinitely defined basin, 3) valley trending NE through Sec. 4, T. 162 N., R. 95 W. Other courses tributary or secondary. Sediments in major courses at least 30 ft. deep in places. Sediments less than 6 ft. deep common in other courses. In places deposits present only in traces. Valleys widen to shallow basinlike areas in places.	Valleys characteristically elongate, flat-floored and sinuous, with gently sloping sides. Wide, shallow, basinlike areas generally very flat with inconspicuous and indefinite slopes. Valleys trending away from terminal moraine are V-shaped with moderate to steep slopes. Undrained depressions common. Intermittent streams meander over floors of major and some secondary courses.	Materials generally permeable but poorly drained because surrounding ground moraine is impervious; permeability low in clays. Undrained sloughs and marshy areas common; subject to flooding. Most courses have very gentle gradients down which surface runoff water moves slowly by seepage and discontinuous intermittent streams. Valleys trending from Max moraine have moderate to high gradients; water flows in these valleys only during the most prolonged rains. Long Creek is only well-developed drainage in the quadrangle.	Easily worked with hand tools above water table. Depth to water table 2 to 7 ft.; water table high in wide basinlike areas. Quicksand reported in shallow farm wells. Moisture control necessary for compaction of fine material.	Low to medium strength depending on material and ground water conditions. Surface material generally silty and clayey with low strength when wet. Low angle slopes necessary in cuts. Frost heave is moderate to high in silt.	Coarse materials used locally as road metal. Local concentrations of gravel used for concrete aggregate and road metal. (See analyses of samples S-1, S-7, S-9 below.) Shallow wells productive except in dry periods. Roads in channels subject to flooding and trafficability low after rains.	Deposits in valleys and shallow basins which were eroded by 1) meltwater from glacier or isolated ice blocks, 2) water from heavy snows and rains during and immediately after glacial period. Major valleys cut along ice margin during melting of glacier. Deposits derived from material carried in ice and from surrounding glacial deposits.
KAME	Scattered over small area in the east central part of quadrangle, near Noonan. Many kames surrounded by deposits, Pleistocene drainage courses and shallow basins. Elongate kames about 1 mi. E of Noonan and about 2 mi. NW of Noonan oriented roughly E-W. Thickness includes topographic height (5 to 50 ft.) and in most kames material extends to unknown depth below ground level of surrounding deposits.	Knobs, low mounds, and irregularly-shaped hills which generally have a definite topographic outline. Slopes very gentle to fairly steep. Large kames have gently undulatory surface.	Surface and subsurface drainage generally fair to excellent. Clay lenses locally make perched water tables. Sand and gravel highly permeable; silt less so. Water table may be encountered near level of surface of surrounding deposits.	Easily excavated with light machinery, but boulders may be large and abundant enough to require special handling. Gravel may be removed by dragline or power shovel. Special equipment necessary to compact silt or silty sand.	Low to high strength depending on material. Road cuts in kames generally stable at 1 on 1. Frost heave is absent in course material; slight to high in silt.	Source of sand and gravel for concrete aggregate, pervious fill, and highway material. Material for aggregate requires washing. Overburden can be removed by tractor. (See analyses of samples from kames below.)	Material washed from glacial ice and deposited in holes and cracks in glacier or in reentrants in margin of ice.
BOULDER KAME	Three small boulder kames in Secs. 2 & 3, T. 162 N., R. 96 W.; three larger in Secs. 11, 12, and 14, T. 162 N., R. 97 W. Maximum thickness of small deposits probably 10 ft. Maximum thickness of larger deposits probably 20 ft.	Deposits generally low mounds. Surface of smaller deposits smooth rounded with gentle slopes. Surface of larger deposits flat with moderate slopes at edges.	Drainage and permeability high.	Difficult working with hand tools because of abundant boulders as large as 4 ft. in diameter. Easily worked with light machinery except boulders may require special handling. Overburden thin in most places. Compaction fair to good.	Cuts stable with 1 on 1 slopes or steeper because of good drainage and high permeability.	Source of gravel for highway use, concrete aggregate, and pervious fill. Selected boulders may make good crushed rock or riprap.	Origin unknown, but may be similar to kames.
KAME TERRACE	In Secs. 12, 13, & 14, T. 162 N., R. 97 W., also in Secs. 2, 3, & 4, T. 162 N., R. 96 W. All deposits are along S edge of Pleistocene drainage courses. Thickness: trace to at least 18 ft.	Deposits have terrace form on valley sides of Pleistocene drainage courses. Slopes moderate.	Drainage and permeability high.	Same as boulder kame.	Same as boulder kame.	Same as boulder kame.	Similar to kames except material deposited between a valley wall and edge of an ice mass.
ESKER	Long narrow discontinuous ridge about 3 mi. NW of Noonan. Maximum thickness probably 30 ft.	Surface of ridge rolling and uneven along length. Slope of sides moderate to fairly steep.	Drainage and permeability mostly high except where till (pebbly clay) is present.	Same as kame except clay and silt not as abundant.	Same as kame.	Same as kame except overburden slight. (See analysis of sample S-2 below.)	Deposited by a glacial stream flowing in or at bottom of glacier.
GROUND MORAINE	Covers large areas in northern 2/3 of quadrangle. Underlies most of glacial deposits in area N of Max moraine. Thickness: maximum probably 100 ft. and generally less than 50 ft.; commonly trace to 20 ft.	Surface flat to gently rolling and contains numerous undrained depressions and kettles. Surface slopes gently away from Max moraine.	Surface drainage poor; marshy areas and undrained depressions common. Permeability and subsurface drainage low to negligible because of high clay content. Water movement largely by capillary action.	Hard, compact, tough; plastic when wet and breaks into blocky fragments when dry. Difficult digging with hand tools, but easily worked with power tools. Local "hardpan" or caliche zone from 6 in. to 3 ft. thick is near surface. Scattered large boulders may require special handling. Sheepsfoot and rubber-tired rollers make good compaction. Subject to wind erosion where not compacted and sod cover absent.	High stability in road cuts but may gully. When compacted properly, has high strength. Good foundation material; settling negligible. Tends to break into blocky masses when dry; plastic and sticky when wet. Frost heave is medium.	Good impervious fill if compacted. Unsurfaced roads; stable when dry, very low trafficability when wet. Subgrade: good if drainage controlled. Scattered boulders are possible source of riprap, pervious fill, and crushed rock.	Glacial debris deposited under the glacier and by settling from melting ice.
MAX MORAINE	Covers most of southern 1/3 of quadrangle. Thickness: generally less than 100 ft., but locally may be 150 ft. Differs from ground moraine in 1) rougher terraine, 2) abundant boulders, 3) origin (See origin of deposit.)	Terrain rough; abundant knobs, irregular ridges, kettles and other undrained depressions. Slopes steep to moderate.	Generally same as ground moraine except kettles and other undrained depressions are deeper. Minor surface drainage 1 to 2 mi. south of contact with ground moraine; all integrated drainage in northerly direction.	Same as ground moraine except boulders more abundant both on surface and buried in till.	Same as ground moraine.	Same as ground moraine except roads may require cut and fill because of rough terrain.	Probably similar to ground moraine.
FORT UNION FORMATION	Underlies surficial (glacial) deposits in entire quadrangle (See cross section below). Several exposures in meltwater channels near Noonan; also two along Highway 5 and one in west central part of Sec. 4, T. 162 N., R. 96 W. Thickness: probably more than 500 ft.	Slopes of natural exposures steep along valley sides of Pleistocene drainage courses. Two exposures along Highway 5 are manmade.	Drainage fair in silt and fine sandstone; clays impervious. Lignite beds and fine sandstone at depth are waterbearing.	Difficult excavation with hand tools but easily worked with power tools except for scattered large masses of hard limy siltstone. Where excavation intersects lignite, draining may be necessary. Moisture control necessary to compact clays and silty clays, but silts and clays compact fairly well with roller equipment.	Subject to landsliding in other areas; moisture control necessary for stabilization. Partially cemented silts weather easily due to leaching of lime cement. Frost heave is high in silts.	Lignite and sandy layers are sources of water. Sandy layers too fine and variable for most uses. Poor road metal because silts and clays unstable when wet. Subgrade poor because of probable frost heave.	Lake, slow stream, lagoon, and flood plain deposits. Sediments of some beds may be of wind blown origin.