Natural Resources Canada   Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA   COMMISSION GÉOLOGIQUE DU CANADA

DESCRIPTIVE NOTES

This map illustrates potential surface and subsurface granular aggregate occurrences in the Camsell Bend (NTS 95J) map sheet. Records have principally been derived from queries of a seismic shothole litholog geodatabase, assembled from a paper archive of > 80 000 records. Of the 4642 shothole records in the 95J map area, there are 151 surface and 141 subsurface potential granular aggregate occurrences (data from Aquitane, Chevron, Imperial Oil, Mobil Oil and Shell records). Secondary sources of granular aggregate records include gravel and sand deposits queried from a borehole geotechnical database (24 surface and 22 subsurface granular aggregate records; Smith et al., 2005) and 33 field observations of gravel deposits by D. Huntley (Geological Survey of Canada). The location of potential granular aggregate deposits are overlain on the drift isopach map of Smith et al. (2006). Deposit thickness is indicated by proportional symbols; only those deposits with an individual or combined thickness > 0.5 m are represented on this map. Where two or more potential granular aggregate deposits are separated by another stratigraphic unit(s), the thickness of the uppermost granular aggregate deposit is indicated. Sub-surface deposits are arbitrarily assessed as those situated > 0.5 m below the uppermost minerogenic deposit (i.e., excluding muskeg).

This Open File map provides a hard-copy version of the GIS-enabled potential granular aggregate occurrence maps currently being produced as part of a seismic shothole litholog geodatabase. Secondly, it provides a spatial sense of the extent and distribution of potential granular aggregate resources (at least those coincident with areas of past seismic and geotechnical exploration, and surficial geology ground truthing) in the 95J map area. Granular aggregate is critical to infrastructure development including roads, pipelines, petroleum well pads, and concrete production. Geographic concentrations of granular deposits, particularly those at depth, may also indicate the presence of potential aquifers. This map, and the accompanying GIS-enabled version and geodatabase, therefore provides an important source of data to industry and communities in support of efficient and responsible resource development.

SOURCES OF GRANULAR AGGREGATE

Granular aggregate is typically mined from glacial, modern, or paleo-river deposits. Environmental concerns and habitat degradation often prevent modern streambeds from being mined for gravel, however, terraces and abandoned braided channels can represent commercially viable granular aggregate sources. Identification of these types of landforms and deposits is usually found on surficial geology maps, such as is currently being prepared for the 95J map sheet (Huntley, pers. comm., 2006). Gravel deposits, particularly cemented gravels, and those found in the subsurface overlying bedrock, may be associated with paleo-river channels, remnants of which are postulated to cross parts of the 95J map area (Duk-Rodkin and Hughes, 1994; Smith et al., 2006).

Glacial deposits commonly used as sources of granular aggregate include eskers, kames, sub- and pro-glacial meltwater channels, fans, and raised deltas. Identification and delineation of such deposits is a key component of the surficial geology maps completed for much of the Mackenzie Corridor north of 64° (cf., Duk-Rodkin, 2005), and those currently being undertaken by Duk-Rodkin and Huntley (GSC-Calgary) at 1:100 000 and/or 1:250 000 scale for the remaining parts of the Corridor south of 64°. In remote areas, dense forest cover and extensive bog and fen deposits can mask many granular aggregate-associated landforms and deposits. Thus, stratigraphic records that provide an indication of earth material composition can be key to identifying potential granular aggregate deposits. This is particularly the case with subsurface deposits, which may otherwise have no surface expression (topographic, vegetative, or hydrological). Recent studies by the British Columbia Ministry of Energy, Mines and Petroleum Resources and Geological Survey of Canada in northeast British Columbia have demonstrated the utility of using seismic shothole lithologs for identifying granular aggregate resources in remote, forest and organic deposit-covered regions (Best et al., 2004; Levson et al., 2004). An initial report of gravel situated below 1-4 m of till in four consecutive shothole records, led to a series of backhoe test pits, and a regional airborne electromagnetic (EM) survey that identified two significant gravel deposits, one of which (Kotcho East, ~ 450 000 m^3), has since been mined out. The success of this investigation provided impetus to assembling the shothole litholog geodatabase discussed here.

DRILLERS' UNIT IDENTIFICATIONS

Whereas records from the borehole geotechnical database (Smith et al., 2005) and observational field data are considered accurate and reliable, interpretation of the granular aggregate records from the seismic shothole litholog geodatabase requires caution and an appreciation of their nature and accordant uncertainty. First, the shothole records were created during geophysical seismic exploration (largely in the 1960's and early 1970's) when holes were drilled to set charges. Drill operators would log the material they were drilling through at varying degrees of resolution. The drillers are not by practice trained geologists, thus their descriptions of units are often vague, or uncertain. What they did seem particularly adept at though, is noting significant changes between different stratigraphic materials (e.g., clay, rocks, sand [= till] and say shale [= bedrock]), as well as unusual occurrences such as massive ground ice, flowing holes (artesian aquifers) and gas. Differences in the types of information recorded are noted between drillers working on the same seismic operation, and between different operations.

Gravel is another sedimentological unit that was noted with particular fervor. In northeast British Columbia it was found that drillers singled out gravel because it was generally more difficult to drill through, and thus helped account for slower rates of progress (T. Ferbey, BCMEMPR, pers. comm., 2005). At the same time, test pitting in northeast British Columbia conducted as a follow-up of shothole gravel records, in some cases, indicated no such deposits existed – it is assumed then that phantom gravel became the excuse for slow progress. Regardless, the success of the British Columbia work proves that shothole records are an effective means of identifying potential granular aggregate deposits.

DEPTH ESTIMATES

A second consideration in assessing the shothole granular aggregate records is the accuracy and precision of reported depth measurements. Thickness and vertical depth of granular aggregate deposits are likely to be approximations at best. In some cases, they may be gross over-estimates; for example, where a log record reads 0-12 m gravel, it may actually mean that in the 12 m deep shothole, the bottom of the hole (i.e., where the charge was set), and some undetermined thickness above, was gravel. Sometimes this uncertainty can be assessed by comparing individual records with those around it (including the borehole geotechnical database (Smith et al., 2005)), to see if there's any reasonable lateral continuity. However, this example serves as further justification for treating the shothole records as "potential" occurrences and exploration targets that require further ground truthing before they can be integrated into resource assessments and development strategies.

SEDIMENTOLOGICAL CHARACTERIZATION

A third consideration has to do with what constitutes a suitable granular aggregate resource, and which records from the shothole geodatabase this might pertain to. Sand, gravel, and crushed rocks and bedrock are all different types of granular aggregate used by industry. The makeup and desired content of each varies with the intended application, but for the purposes here, the general road-building top-dress requirement of < 5% fines (silt and clay) content has been adopted. For the most part, the shothole records do not include detailed particle-size characteristics of deposits, although there is a companion sample database of ~ 7500 records (< 10% of the shothole records) that includes measurements of particle size, moisture content, lithological, and other information for selected stratigraphic units. As a rule, any layer description including clay and/or silt was deleted from the granular aggregate queries. Those records that were selected included individual citations or combinations of: gravel, rocks, boulders, and sand. Bedrock, particularly competent sandstone and limestone can be mined as potential aggregate, but are not included on this map, yet will be available to users as a GIS layer on the shothole geodatabase. In the case of the borehole geotechnical database (Smith et al., 2005), detailed sedimentological measurements were made and then applied under a United Soil Classification scheme. This makes it simple to query records of well and poorly-sorted gravel with < 5% fines (GW and GP, respectively) as well as sand deposits (SW and SP) indicated to contain significant gravel contents.

LOCATION UNCERTAINTIES

A final consideration to be taken into account involves the location of the shothole itself. The original paper archive of > 80 000 shothole records did not have geographic locations indicated on the card files, but instead was accompanied by 4x enlarged mylar copies of NTS 1:250 000 topographic maps with hand-drawn seismic lines and shothole numbers. It is uncertain whether these were simply copied from existing company maps illustrating seismic line locations and shothole numbers, or whether they were drawn onto the basemaps using actual surveyed latitude and longitude records (the latter is assumed). Regardless, questions of accuracy exist. For the geodatabase, geographic coordinates were determined by digitally overlaying the mylar maps onto NTS digital base maps and then correcting the seismic lines on the mylar maps to correspond with "cutlines" indicated on the digital bases (where obvious corresponding lines existed; intersections of two or more lines were used to anchor various shotpoints and accordant lines). Standard shothole spacing intervals (generally multiples of 110 feet, e.g., 330, 440, 1650) were also applied (where calculations of line length and number of shotholes from the mylar maps indicated them to be likely; anomalous shothole spacing does occur, and was preserved as represented on the mylar maps). Shothole locations were then digitized from the NTS basemap. This somewhat involved method suggests a moderate degree of geographic uncertainty. However, Chevron Canada has provided digital records of shothole locations for most of their existing paper archives, which indicate that digitized locations using the outlined methodology were generally within 20-250 m of the surveyed coordinates. In the geodatabase, Chevron records that have corrected shothole locations are identified by the inclusion of a LID_extension in the Unique Identifier (UID) code (e.g., 045-A4R58-77x-379 is read as Company code – LID_extension – Line_name – Shotpoint, whereas 045-000-77x-379 would indicate a shotpoint whose coordinates were interpolated from the maps). Users are thus cautioned about this uncertainty when using records dating prior to 1974 (when the original paper archive was assembled). Recent and archival contributions from industry post-dating 1974 (and corrected Chevron records) are based on surveyed coordinates and thus considered accurate.

INTERPRETATION

The granular aggregate records are presented overtop the drift isopach map of Smith et al. (2006). In some cases, there appears to be coincidences between concentrations of granular aggregate and what are variously interpreted to be buried valleys and glacio-depositional landforms. Elsewhere, deposits appear very much to be isolated features. Such spatial heterogeneity is typical of glacial environments where deposition often occurs in a staccatos manner, reflecting different phases of ice buildup and retreat, and the truncation of depositional units. Significance of any individual or cluster of granular aggregate deposits will be determined by potential users in consideration of several criteria, including: nature and size of the deposit, intended use of the granular aggregate resource, and proximity to a development site. Thus, while it seems obvious to focus on the larger clusters of points, and thickest deposits, individual users may find isolated granular aggregate sites suitable to meet their needs, or discover through further field investigations that deposits are more extensive then suggested. For illustrative purposes, several sites on the 95J map are briefly discussed.

Site A is small glaciofluvial outwash terrace with 4-18 m thick gravel deposits. Site B is a prominent ice-contact glaciolacustrine delta, through which the Mackenzie Highway has been cut. An abundance of sand and gravel is found here, ranging up 25 m thick. Site C appears to be an ice-contact glaciofluvial terrace of sand and gravel, up to 13 m thick. Airphotos indicate that this site is presently covered by organic deposits, with no obvious indication of granular aggregate deposits lying beneath. Similar deposits may exist in terraces elsewhere along the Willowlake River. Site D exhibits extensive surface (up to 25 m thick) and subsurface gravel deposits (1-10 m of gravel underlying 2-10 m of overburden). Airphotos reveal the area to be heavily drumlinized, while streams adjacent to the gravel deposits exhibit a fair degree of incision. This site is interpreted to be a glacial meltwater channel created either during the initial Late Wisconsinan advance of the Laurentide Ice Sheet across the region, or as a subglacial tunnel channel during full-glacial conditions. It is speculated that this deposit may extend discontinuously northwestward, trending towards the Willowlake River channel. It may also exist east and southeast of here along other paleodrainage channels, correlating with a number of potential subsurface granular aggregate deposits illustrated on the map. Site E is interpreted to correspond to small outwash/proglacial terraces, which exhibit between 1 and 6 metres of potential granular aggregate resource. Site F also occurs in a region of heavily drumlinized till. It is uncertain what the nature of the potential granular aggregate deposits are here, but may share a similar glacial-advance/subglacial origin as those at Site D. The potential granular aggregate deposits indicated at Site G could represent the largest single deposit in the 95J map sheet. This site exhibits up to 20 m of gravel and sand, deposited in what is interpreted to be an ice-contact glaciolacustrine delta extending across > 120 km^2.

REFERENCES

Best, M.E., Levson, V. and McConnell, D.,
2004: Sand and gravel mapping in northeast British Columbia using airborne electromagnetic surveying methods. In: Resource Development and Geoscience Branch, Summary of Activities 2004. 6 pp.

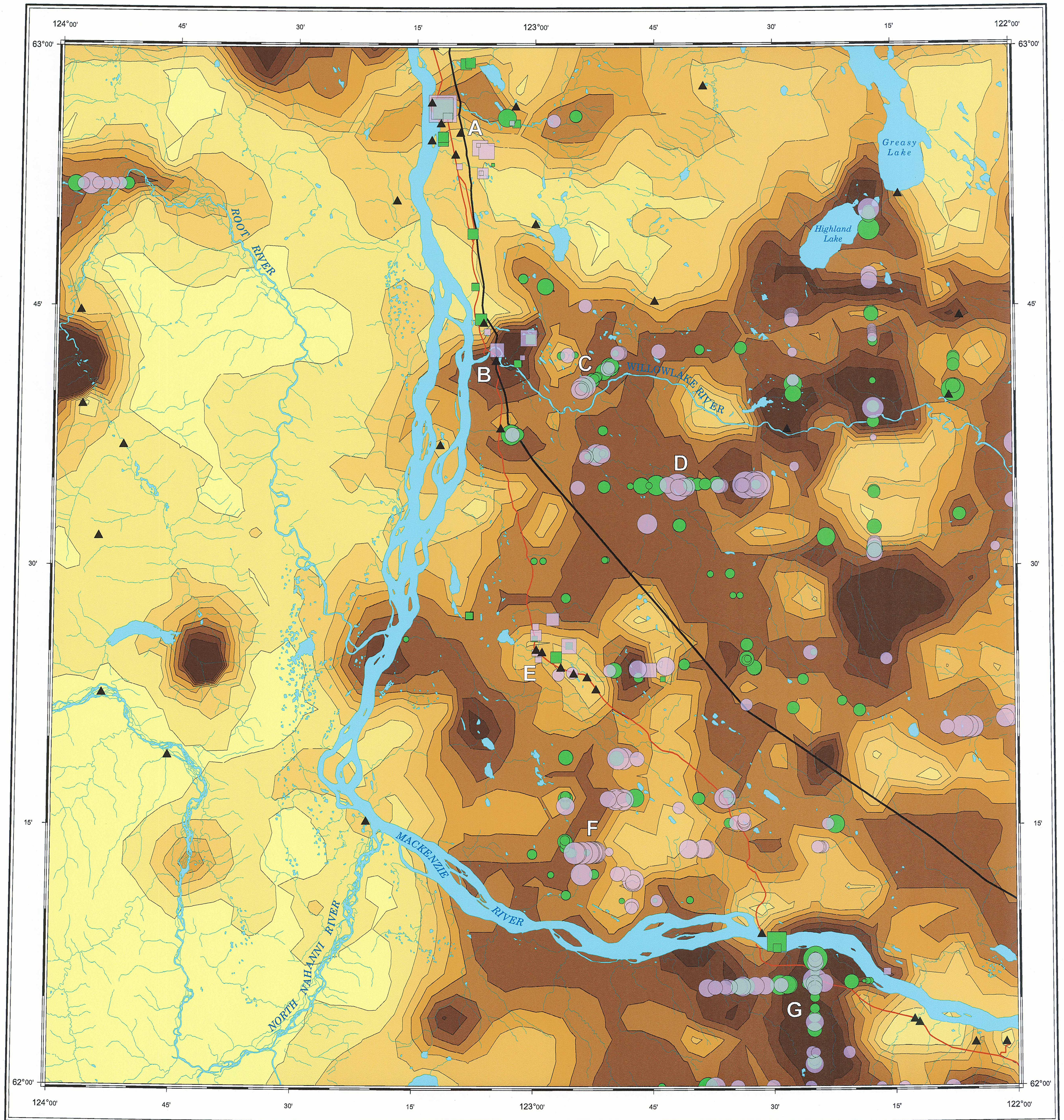
Duk-Rodkin, A.
2005: A GIS dataset of surficial geological features for the Fort Norman map area (96C), Northwest Territories; Geological Survey of Canada, Open File 4885, 1 CD

Duk-Rodkin, A. and Hughes, O.L.
1994: Tertiary-Quaternary drainage of the pre-glacial Mackenzie basin. Quaternary International, 22/23: 221-241.

Levson, V.M., Ferbey, T., Kerr, B., Johnsen, T., Bednarski, J., Smith, R., Blackwell, J. and Jonnes, S.
2004: Quaternary geology and aggregate mapping in northeast British Columbia: applications for oil and gas exploration and development. In: Resource Development and Geoscience Branch, Summary of Activities 2004. 12 pp.

Smith, I.R., Lesk-Winfield, K., Huntley, D.H., Sidwell, C.F., Liu, Y., and MacDonald, L.E.
2006: Drift isopach map, Camsell Bend, Northwest Territories, Canada; Geological Survey of Canada, Open File 5235, 1 map, scale 1:250 000.

Smith, S L., Burgess, M M., Chartrand, J. and Lawrence, D E.
2005: Digital borehole geotechnical database for the Mackenzie Valley/Delta region. Geological Survey of Canada, Open File 4924, 30 pages, 1 CD.



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LEGEND

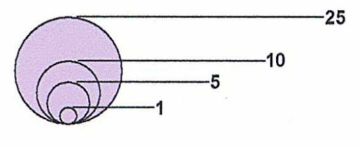
INTERPOLATED DRIFT THICKNESS (metres)

- ▨ 0 - 2
- ▨ 2 - 4
- ▨ 4 - 6
- ▨ 6 - 8
- ▨ 8 - 10
- ▨ 10 - 12
- ▨ 12 - 14
- ▨ 14 - 16
- ▨ > 16

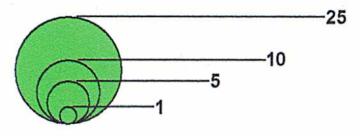
GRANULAR AGGREGATE OCURRENCES

SHOTHOLE DATABASE

SURFACE DEPOSIT THICKNESS (m)

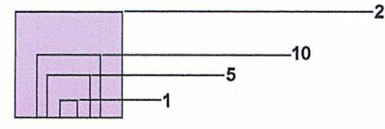


SUBSURFACE DEPOSIT THICKNESS (m)

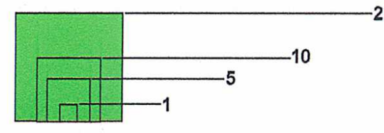


GEOTECHNICAL DATABASE

SURFACE DEPOSIT THICKNESS (m)



SUBSURFACE DEPOSIT THICKNESS (m)



MAP SYMBOLS

Gravel, field observation.. ▲

Road..

proposed Mackenzie Valley gas pipeline............

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Database compiled by: K. Lesk-Winfield, Y. Liu, S. Loster-Anderson, L.E. MacDonald, I.R. Smith

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This map was produced from processes that conform to the ESS Info Publishing Services Subdivision Quality Management System, registered to the ISO 9001: 2000 standard

Proposed Mackenzie Valley gas pipeline route provided by Imperial Oil Ltd., April 8, 2006

Digital base map from data compiled by Geomatics Canada, modified by the Geoscience Information Division

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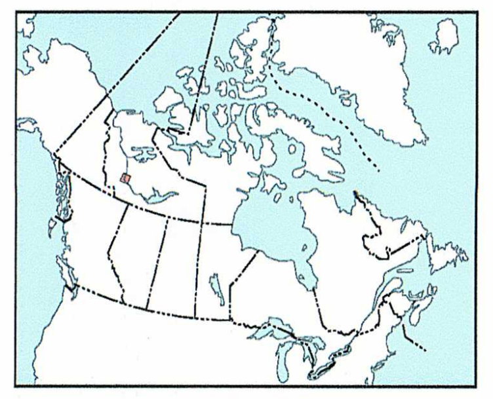
3303-33rd Street, N.W., Calgary, Alberta T2L 2A7



LOCATION MAP

OPEN FILE 5315

POTENTIAL GRANULAR AGGREGATE OCCURRENCES

CAMSELL BEND

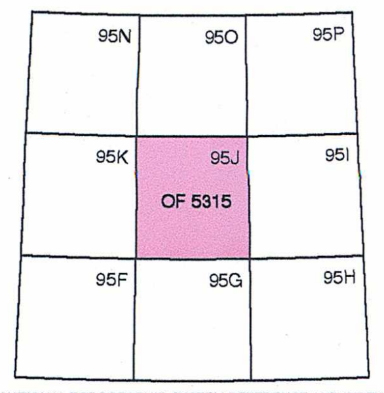
NORTHWEST TERRITORIES

Scale 1:250 000/Échelle 1/250 000

kilometres 5 0 5 10 15 20 kilomètres

Universal Transverse Mercator Projection
North American Datum 1983

Projection transvers universelle de Mercator
Système de référence géodésique nord-américain, 1983



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX
TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

OPEN FILE
DOSSIER PUBLIC
5315
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2006: Potential granular aggregate occurrences, Camsell Bend, Northwest Territories; Geological Survey of Canada, Open File 5315, scale 1:250 000.