



Design and Construction of Water Retention Dikes on Discontinuous Permafrost

Geographical location

Kelsey, Kettle and Long Spruce Generating Stations on the Nelson River, near Gillam, northern Manitoba.

When it began or was completed

Kelsey Generating Station was completed in 1961; Kettle and Long Spruce Generating Stations were completed in the 1970s.

Why a Canadian geotechnical achievement?

Impoundment for these sites required construction of several kilometres of containment dikes on discontinuous permafrost. Novel designs included: for dikes <30 m height, the permafrost affected soils were completely removed from the foundation to reduce the risk of long-term settlements; for dikes <10 m height, complete removal of permafrost was not cost effective. It was anticipated that long-term differential settlements up to 2 m would need to be accommodated as the frozen foundation soils thawed.

The dikes were designed with a medium grained clean sand core and a downstream filter to accommodate differential movements. Sands drains were used to promote drainage. Regular monitoring and maintenance managed risks of overtopping. Since construction, the dikes have performed as intended. Settlement monitoring (marker pins on the crest, settlement plates, and piezometers) indicate that settlements are largely complete. Settlement magnitudes have generally been within design tolerances.

The original design was by HG Acres and Company in consultation with Manitoba Hydro and the National Research Council. Permafrost conditions were mapped and documented in detail during construction, and long term monitoring has been carried out over the past 50-60 years. This represents a unique data set to help quantify the magnitudes and risks associated with construction over discontinuous permafrost.

The dikes are owned by Manitoba Hydro.

Submitted by

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Key References

Johnston, GH. 1969. **Dykes on Permafrost, Kelsey Generating Station, Manitoba.** Canadian Geotechnical Journal, Vol 6, pp 139-157.

MacPherson, JG, Watson, GH and Koropatnick, A. 1970. **Dikes on Permafrost Foundations in Northern Manitoba.** Canadian Geotechnical Journal, Vol 7, pp 356-364.

Brown, WG and Johnston, GH. 1970. **Dikes on permafrost: Predicting Thaw and Settlement.** Canadian Geotechnical Journal, Vol 7, pp 365-371.

Photographs



Aerial view of the Long Spruce Generating Station; dikes constructed on discontinuous permafrost extend to the upper left. Photo by Manitoba Hydro.



Example of differential settlement along a section of dike prior to rehabilitation.