Design Considerations for Remote Gravel Runways


Presentation to SWIFT Conference 2022 – Montreal, Thursday September 15, 2022

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Agenda

- Typical Airports with Gravel Runways and User Requirements
- Canadian Standards and Applicable TC Advisory Circulars
- Investigations and Surveys
- Typical Design Aircraft, Geometrics and Runway Design
- General Pavement Design Principles (Structural and Frost Protection)
- Airfield Lighting, AWOS and Communications (Building?)
- Deicing and Fueling Issues
- Gravel Operations and Maintenance
- Future Operational Requirements and Runway Paving Issues

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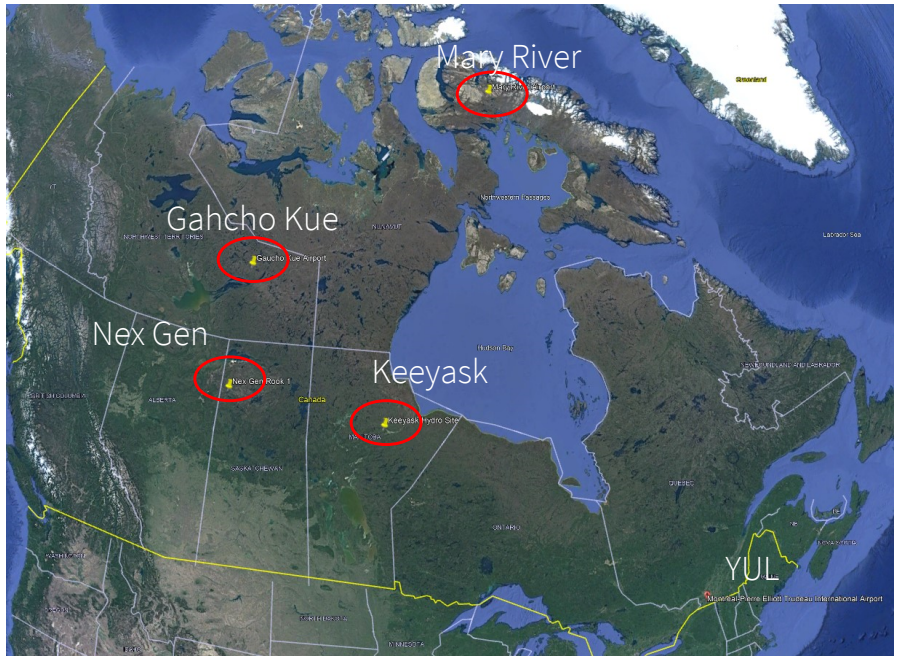
Typical Airport Projects with Gravel Runway and User Requirements (Hatch Projects)



- Mary River Airport, Nunavut, Baffin Island, 1000km northwest of Iqaluit, Iron Ore (65 % pure), B737-200, 1600m runway, staff rotation, equipment supply, emergency evac, 24/7, GNSS approaches.
- Gahcho Kue Airport, NWT, 280 km NE of Yellowknife, Diamond Mine, B737-200, Bae-146, Dash-7, 1619m runway, staff rotation, 24/7, GNSS approaches
- NexGen Rook 1, Northern Saskatchewan, Uranium Mine, 990m (2023) runway to expand to 1600m (2024), Twin Otter to ATR-42/Q-400, staff rotation, 24/7, possible paving
- Keeyask Hydro Electric Station, northern Manitoba, emergency landing strip (on access road option and in gravel pit), daytime VFR only

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Canadian Airport Standards for Gravel Airstrips (Practical Considerations) - 1

- Registered or Certified Aerodrome
  - Registered only (unless there will be scheduled passenger operations – not encountered by Hatch)
- TP312 5th ed.
  - Compliance not required for registered aerodromes but in practice get as close as possible to ensure safest possible operations. OLS is key and can cut down on graded strip where gravel scarce/costly.
- Daytime vs 24/7
  - Remote airstrips in northern Canada where daylight hours are short and medical evacuations are unpredictable really require a lighted runway (also leads to GPS procedures on a non-instrument runway)

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Canadian Airport Standards for Gravel Runways (Practical Considerations) - 2

- Applicable TC Advisory Circulars
  - AC 300-004 Unpaved Runway Surfaces☆
  - AC 301-002 Aerodrome Registration (CARs Part 301- Aerodromes)
  - AC 302-011 Airport Pavement Bearing Strength
  - AC 302-016 Airport Pavement Management System
  - AC 301-001 Procedures to follow in order to support Instrument Approach Procedures (IAP) at a non-certified aerodrome
  - AC 300-021 Thin Bituminous Surface Runways (new)

  All above available at Transport Canada online as downloadable PDFs

  Advisory Circulars (canada.ca)

☆For pavement design can use FAA AC 150/5320-6G (2021) with undefined layers for gravel surfacing or still can use PWC ASG-19 although last update was in 1993.

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Geotechnical Investigations and Topographic Surveys

- Topographic Investigations and/or LIDAR surveys for basic design. Try to get as much info on potential approach and take-off surfaces
- Geotechnical investigation depends on information available from non-airport development for facilities which require the airstrip in the first place (mine, hydro site etc.)
- For standalone airport geotechnical investigation use FAA AC 150/5320-6G Airport Pavement Design and Evaluation (2021) or old AK-68-90-100 TP 1449 Geotechnical Investigations (1979)

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Typical Design Aircraft and Aerodrome Geometry

- Typically, now using a 40-50 pax aircraft (e.g., Q400 and ATR-42/72) for gravel operations with Twin Otter for initial ops and shorter runways
- Jet operations on gravel typically restricted to B737-100/200 types with gravel kits which will ultimately disappear (Nolinor has largest fleet or B737-200C types w/gravel kits e.g., regular operations into Mary River, NU)
- Usually design for 1500-1600m runway (depending on terrain elevation) and Aircraft Group Number (AGN) IIIA/B which would cover the B737 types.

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General Gravel Pavement Design Principles

- Typically use the gravel runway surfacing specified in AC 300-004 for the top 150 mm of runway surface so you have a surface that will not lose fines and can be regraded (but it must be checked for CBR strength as per TC Advisory Circular)
- Total pavement thickness (without the gravel surfacing) based on design aircraft and spring reduced subgrade strength (CBR or “S”) – typically use ASG-19 and flexible pavement design tables. Sometimes only use granular base course if subbase not available or if two types of material not practical. (FAA design manual not very helpful on gravel pavement design because of mandatory layers in FAARFIELD so you have to know how to use it.)
- Frost protection biggest issue and protection of active layer in permafrost. Careful analysis required of frost penetration if site not free-draining. Since big expense, partial frost protection and more regrading is a more cost-effective solution for initial operations with no paved surface.

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Example Mary River Airport, NU : Pavement Design Issues

- Original runway (prior to 2005) constructed with native materials (glaciofluvial sands). Soft spots removed – no as-built records.
- Thermal analysis shows that at least 2000mm aggregate thickness required for full frost protection on existing runway but only 650mm aggregate required for aircraft structural loading for CBR 10.
- Construction during summer traps heat in the granular structure which increases thaw depth by about 300mm in the subsequent year. No increase if constructed in winter.
- Gravel runway crossfall 2.5% but only 1.5% on paved runway.

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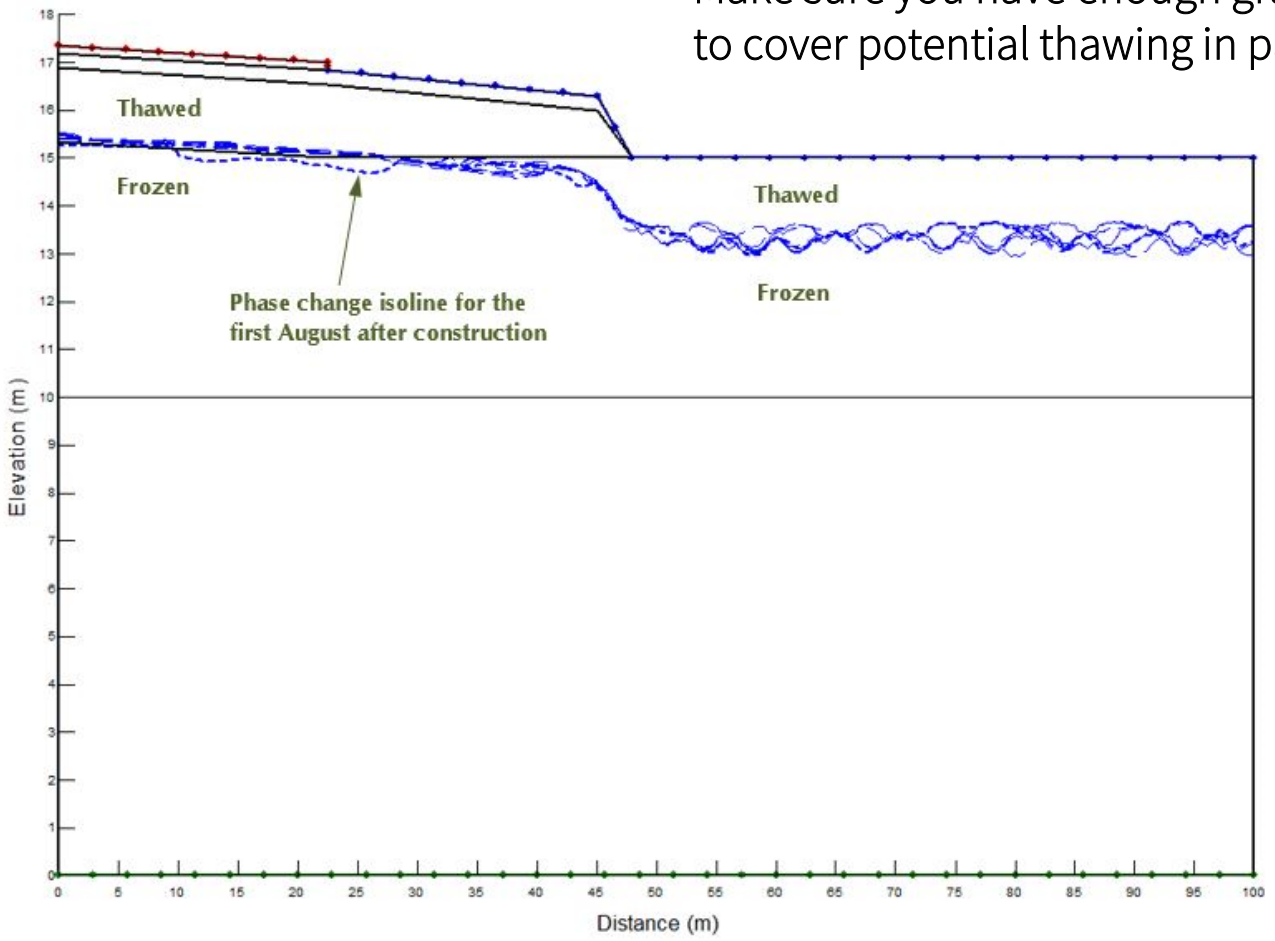
Example: Mary River Airport, NU - Thermal August Isoline Thawing/Frozen

Make sure you have enough graded area width to cover potential thawing in pavement surface.



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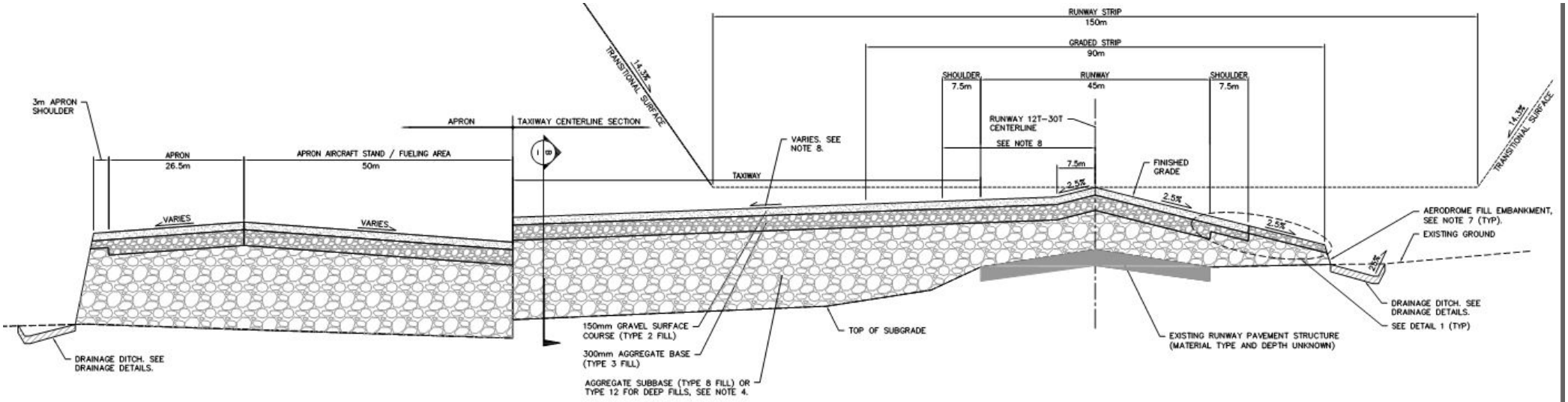
Example: Mary River Airport, NU - Runway, Taxiway and Apron Pavement Section



SECTION A RUNWAY/TAXIWAY/APRON TYPICAL SECTION

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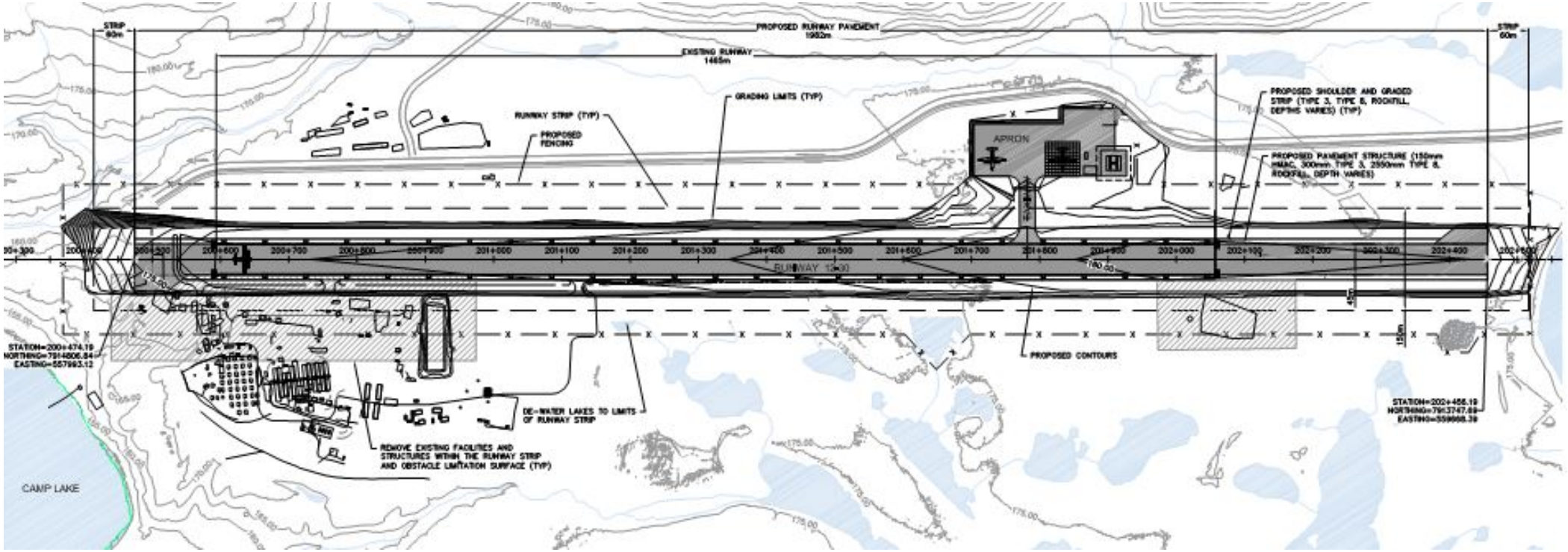
Mary River Airport, NU - Runway, Taxiway and Apron Geometry



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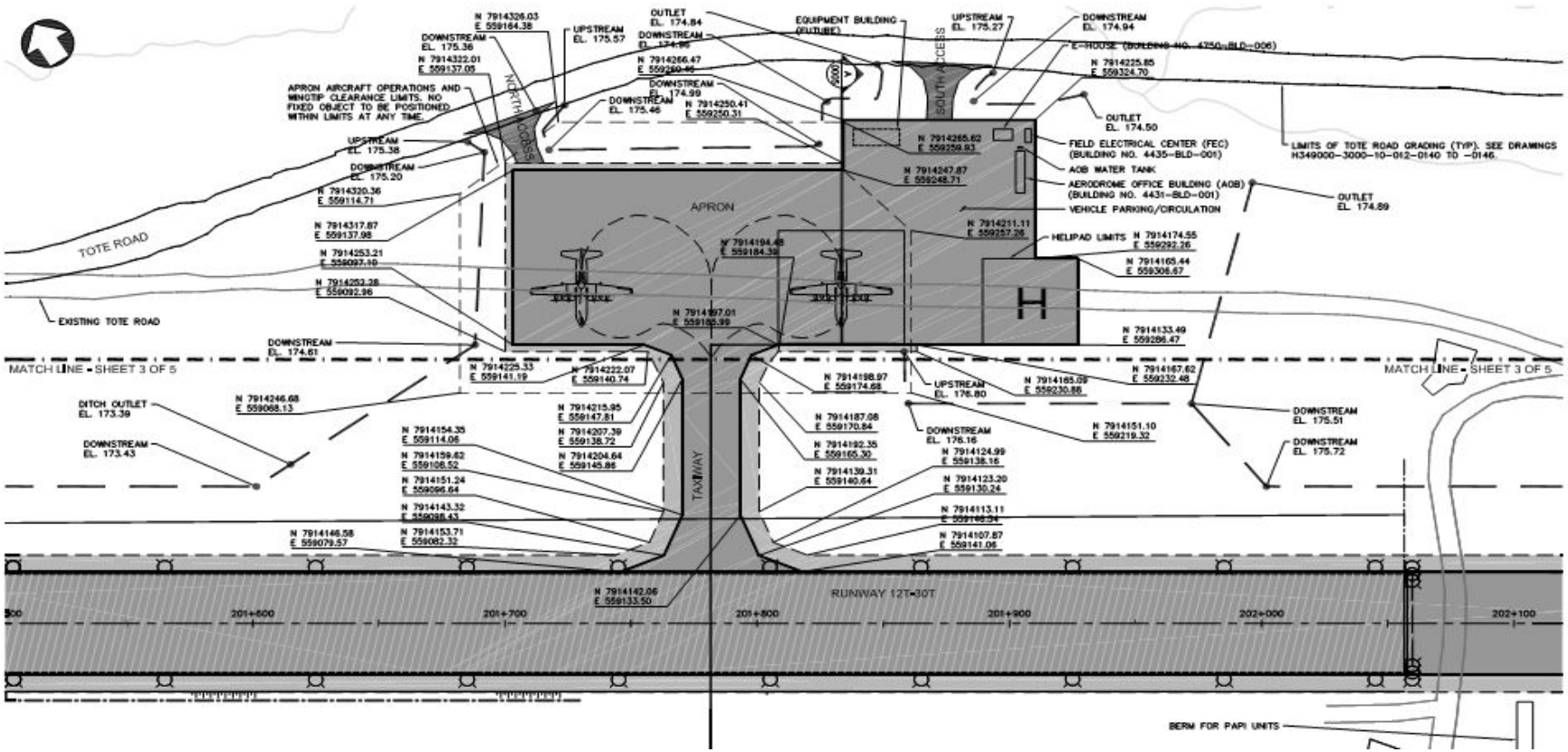
Example: Mary River Airport, NU - Apron Layout



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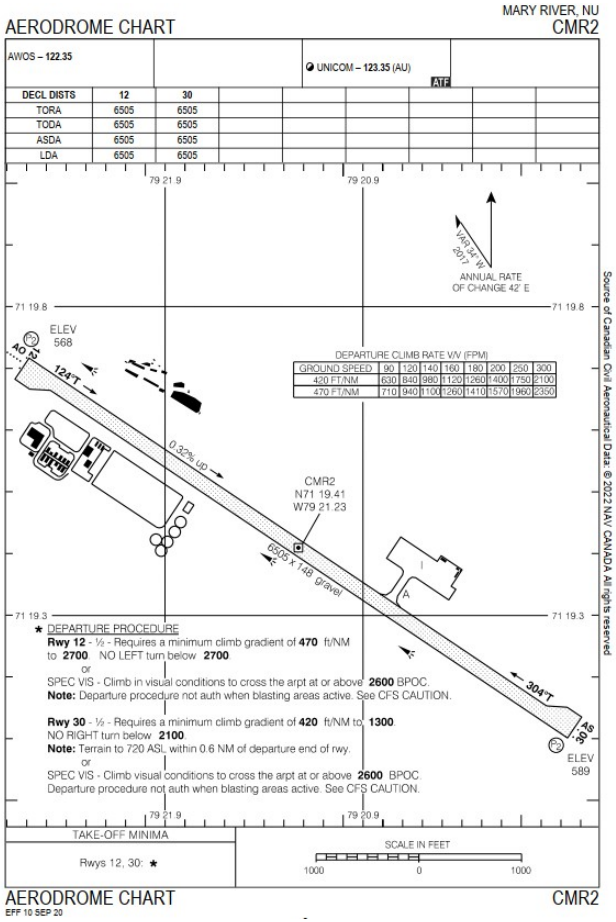
Mary River Airport NU - Completed 2014



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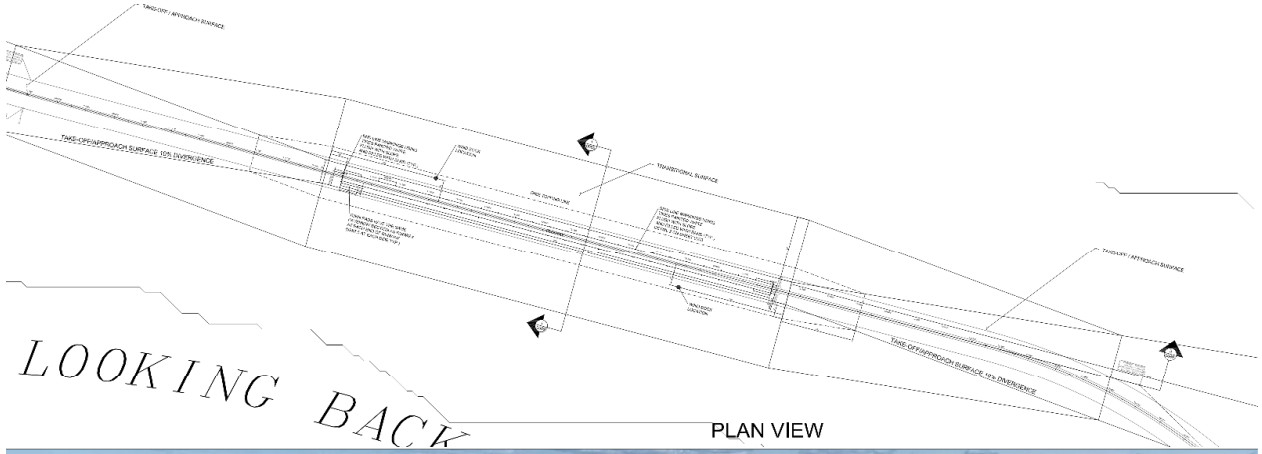
Road/Runway Emergency Airport



Keeyask Hydroelectric Site for Manitoba Hydro

Road is the Runway – emergency use but meets TP 312 OLS criteria with power lines moved to meet transitional surface

SOP for road/runway operations

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Airfield Lighting and Weather Services

- Remote gravel strips at high latitudes (no sunlight), 24/7 medical evacuation and limited winter/poor weather visibility need airfield lighting
- Most Configurations Include:
  - Lighted windsocks
  - MI runway edge and threshold lights
  - APAPI
  - ODALS and/or RTIL
  - Basic AWOS
  - ARCAL for pilot light control
  - Obstruction Lights on major adjacent structures

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Airfield Lighting Typical Fixture Applications on Gravel Runways

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Approach Procedures on Gravel Runways

- Transport Canada AC 301-001 itemize procedures to follow in order to support Instrument Approach Procedures (IAP) at a non-certified aerodrome

- Items to Consider:
  - Need Airfield Lighting Package
  - Non-Certified but comply with TP 312 OLS and other standards to make it safe
  - Allow a lengthy period for design, application (could be 1-3 years) , approvals and flight checking
  - Do you really need it – yes, if you are on a semi-scheduled staffing rotation, flying B737s or similar types into site and need better accessibility in all weather.

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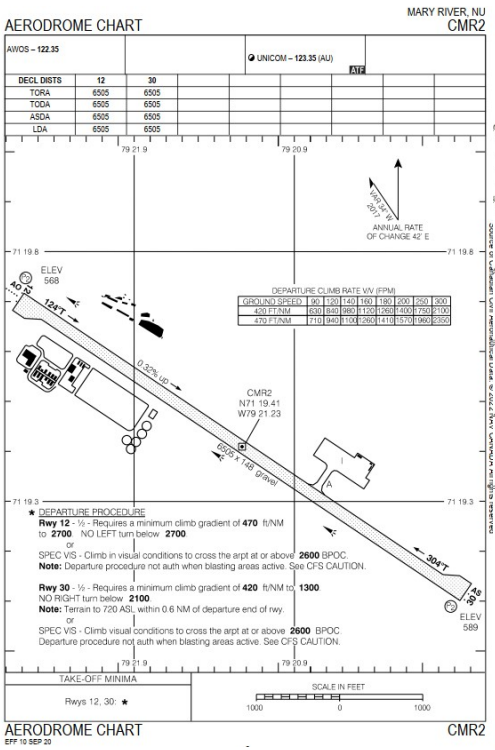
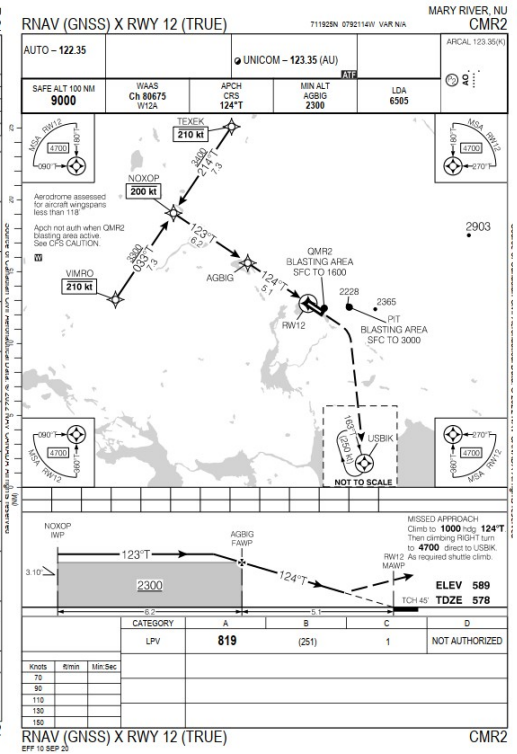
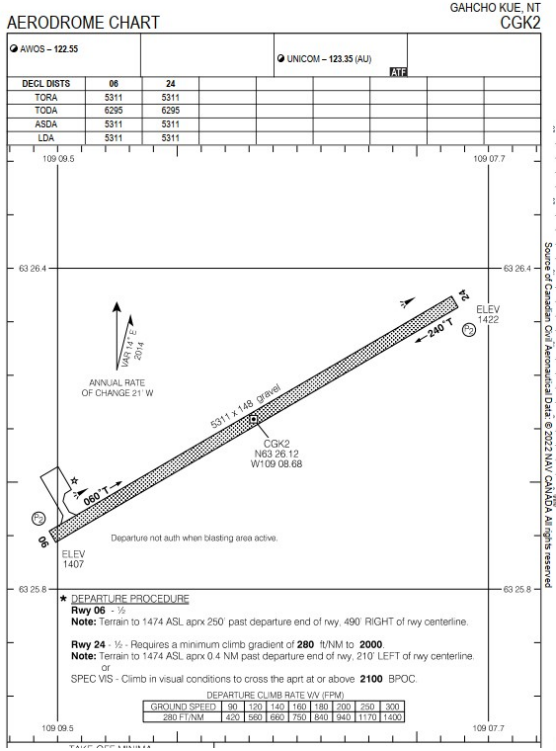
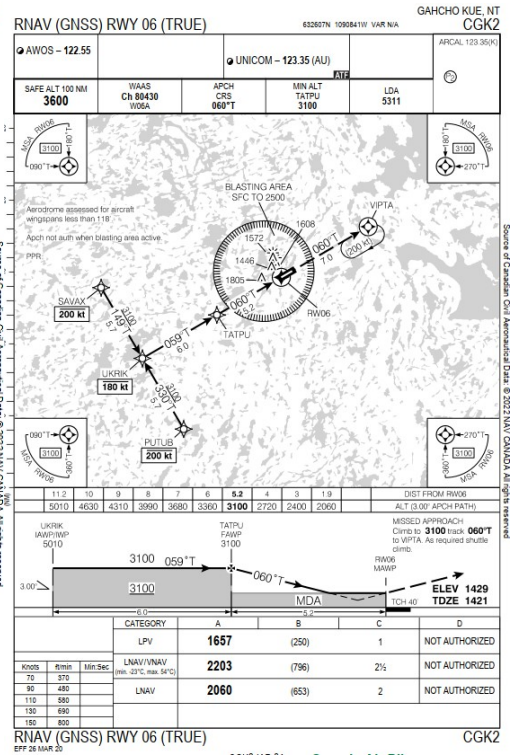
Example: Gravel Sites with Instrument Procedures









Mary River Aerodrome, NU

Gahcho Kue Aerodrome, NT

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Deicing and Fueling Issues

- Typical design methodology for deicing runoff and potential fuel spills is to install geomembrane below the gravel surface and to drain it to a lined detention pond with enough storage for winter operations.
- Fuel storage on site; is it really needed? Jet A-1, Avgas. Decision by your service provider. Can you get deliveries at your remote site?

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Gravel Operations and Surface Maintenance

- AC 300-004 Unpaved Runway Surfaces
  - Need stockpile of gravel surface dressing
  - Grader and rollers
  - Surface treatment to retain fines
- AC 302-011 Airport Pavement Bearing Strength
  - Surface CBR testing
- AC 302-016 Airport Pavement Management System
  - Keep surveys up to date to monitor loss of surface and frost heave and settlement

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Future Operations and Paving Requirements

- Long term retirement of B737-200 w/gravel kits is inevitable – was considered in original studies of many Hatch projects.
- Future Critical Aircraft –later B737 types and paved runway?
- Need to update payload studies on newer B737 types to replace 200 series and on the runway length requirements for the B767.

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Paved Runway Design Issues: Additional Investigations

1. Mix Design, Plant and Material Investigations
2. Validate runway is “stable” for paving and freeze-thaw conditions (as-builts on initial construction and monitoring of settlement)
3. Validate aircraft performance for runway length (extension?) and critical aircraft (B737 types and B767?)

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Asphalt Mix Design, Plant and Material Investigations

- Need Polymer Modified asphalt cement (e.g., PG 58-46PM for Mary River, NU). Issues on transportation of asphalt cement (integrity of mixed polymers) and/or possibly make PMA on site due to duration of sealift and 2-year logistics plan.
- Very short construction season and one-year for sealift of plant and paving equipment. Consideration of full time infrared joint heating.
- Need to prove that local aggregates meet PMA HMAC requirements for airport mix designs, stripping, PSV, TSR, stabilities etc.

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Construction Phasing: Gravel to Paved Runway

- Need to increase gravel pavement thickness to provide long term permafrost protection and stable paved surface – staging to carry out during active runway/night/extended weekends.
- All gravel materials for asphalt paving and upgrade of aggregate pavement structure need to be stockpiled in advance (short season) – need collaboration with selected contractor on overall plan.
- Possible to do paving of full runway width to a primed gravel surface (using special prime) with longitudinal transition slopes not exceeding 1%. Consideration of new TC AC 300-021 Thin Bituminous Surface Runways.

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Mary River Operations with B737-200C Gravel Kit

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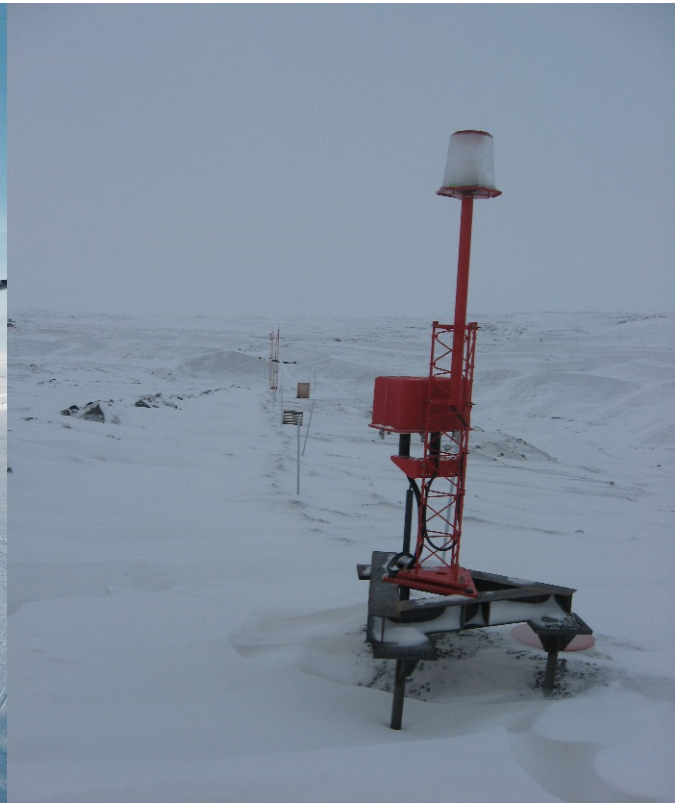
Runway Winter OPS and ODALS Runway 12



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