



Associated
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Northern Airfield Infrastructure Design and Construction Considerations for Inuvik Airport

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September 26, 2023

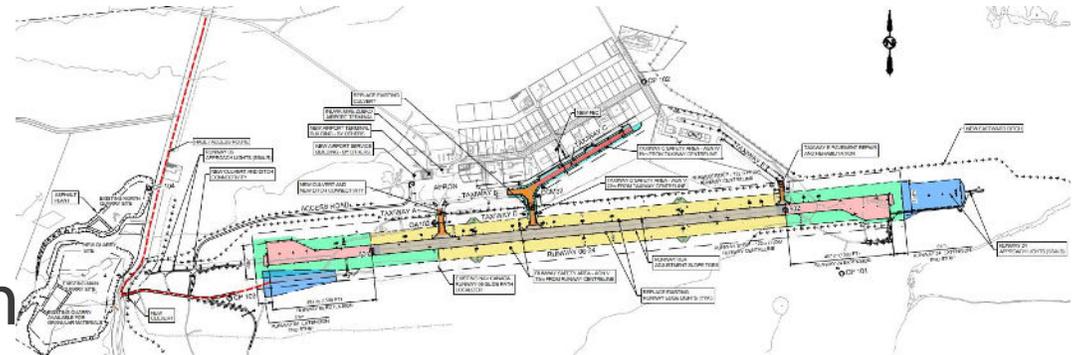
Overview

- Inuvik (Mike Zubko) Airport, NWT
- Background History
- Infrastructure Assessment
- Project Scope
- Multiple Accounts Evaluation
- Risk Assessment
- Construction
- Project Schedule/Plan of Construction



Inuvik (Mike Zubko) Airport

- Vital Transportation Link for Remote Northern Community
- GNWT Infrastructure Owned/Operated
- Latitude: 68d 18m 14s N
- Longitude: 133d 28m 59s W
- Single runway, 5 taxiways, 1 apron
 - 06-24 Primary: 6,001 ft/1,829 m
- Reference Code: AGN V, Precision
- Design Aircraft: Airbus A330-300



Background History

- Original Construction – 1956 to 1958 by Transport Canada, paved in 1969
- Objective to prevent or minimize thaw of underlying permafrost and ice rich frozen soil
- Non frost susceptible Embankment fill material from quarry west of airport
- Min 3.6 m depth embankment fill estimated to protect permafrost; reduced to 2.4 m

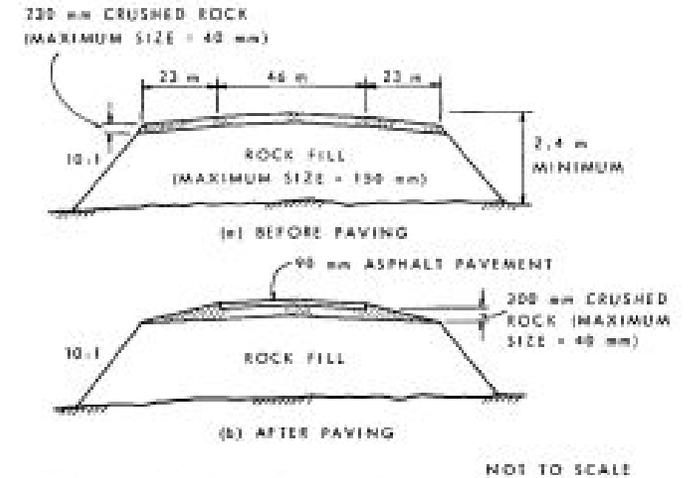


FIGURE 4. Typical sections, Inuvik runway.



Background History

- Inuvik Runway, NWT: remote, ice rich frozen ground; only routine maintenance required; successful 50+ year performance
- Aging Airfield Infrastructure with safety related deficiencies.
- Permafrost Degradation Increased Resulting in unacceptable bumps and settlement in Runway and Taxiway areas.
- Originally continuous permafrost zone, now discontinuous and sporadic due to thermal degradation.
- Multiple Runway and Taxiway Repairs completed in 1985 and 2003



Infrastructure Assessment

- Runway 06-24 and Taxiway Infrastructure:
 - Excessive Runway settlement – Sept 2013 @ 500 mm depth
 - Excessive Runway bumps and dips repairs in 2013, 2016, 2017
 - Surface ponding on Taxiway D
 - Discontinuous and sporadic permafrost due to thermal degradation
 - Airfield surface drainage deficiencies
 - Effects of climate change



Existing Condition Assessment – Runway



Existing Condition Assessment – Runway



Runway 06 Threshold



Runway 06-24 Sinkhole Repair Area

Existing Condition Assessment – Taxiway



Taxiway D Holdline



Taxiway D Centerline Bumps and Dips



Taxiway D Cracks

Existing Condition Assessment - Drainage

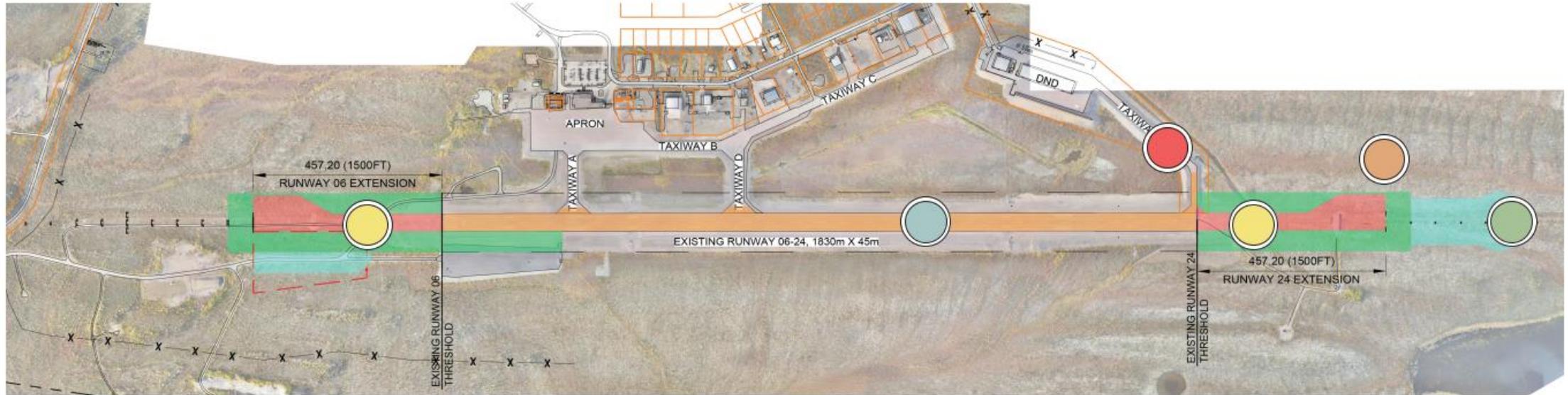


Standing Water in Infield Areas



Taxiway E ditch

Project Scope – Runway Extension



● Runway 06-24 Extension – 1,500' X 150' at each end

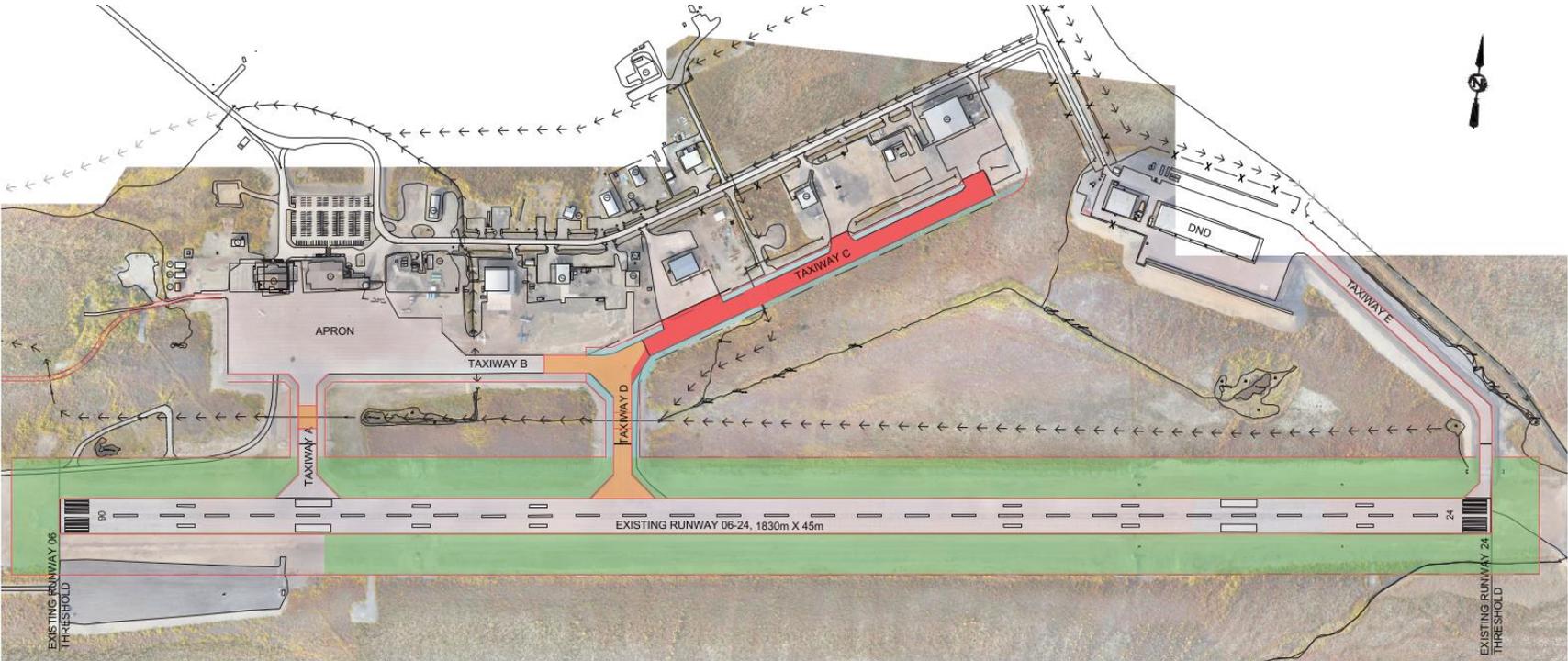
● New Airfield Lighting; Runway, Taxiways, Apron, Approach Lighting

● New Stormwater Infrastructure

● Relocated Navigational Aids

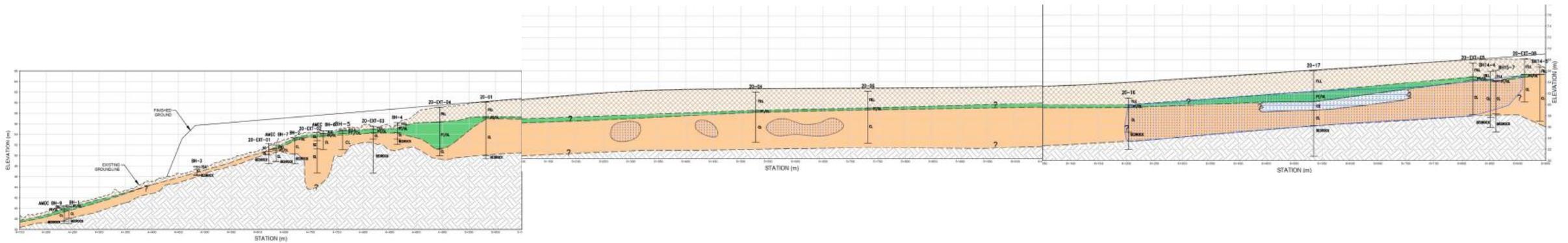
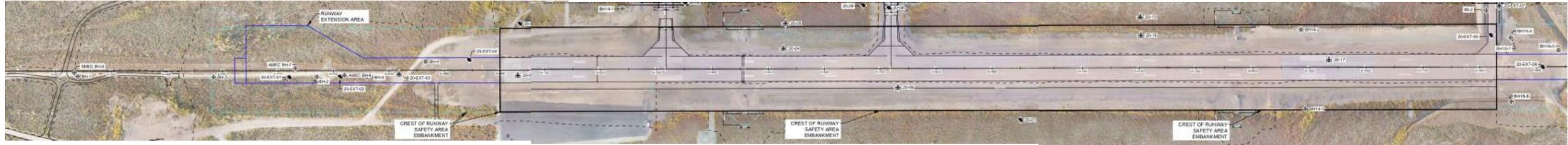
● Taxiway E Rehabilitation

Project Scope - Civil Infrastructure Improvements



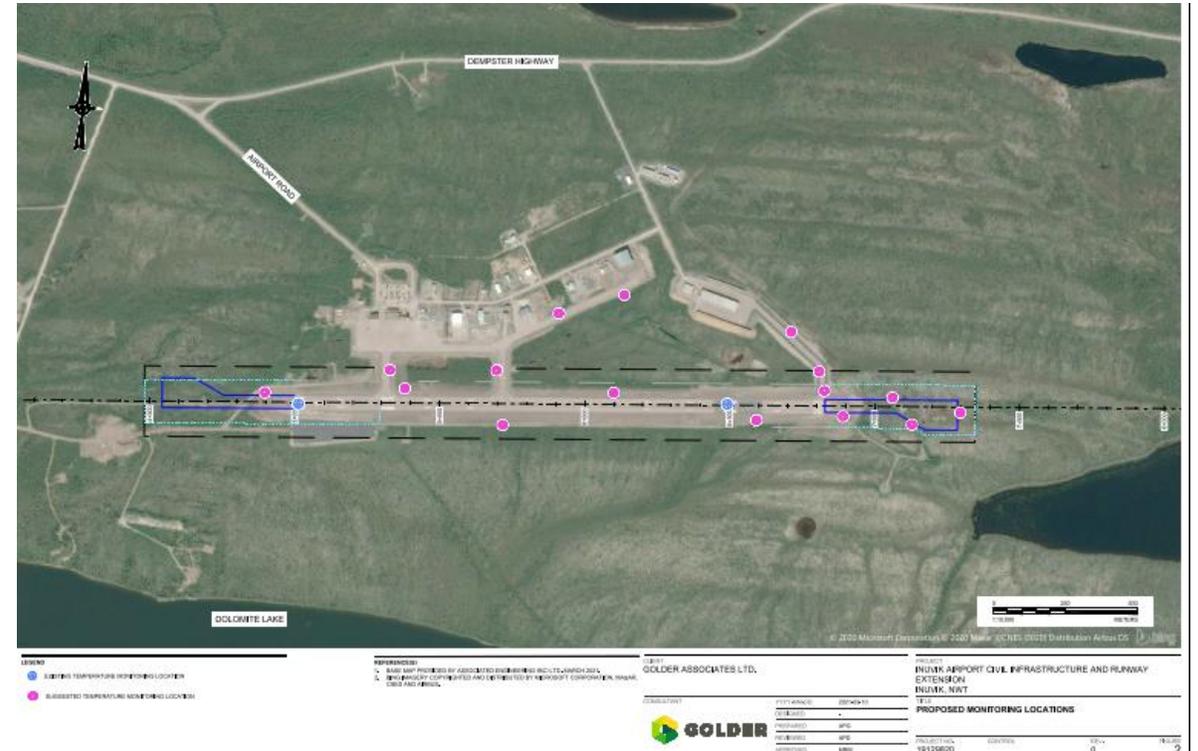
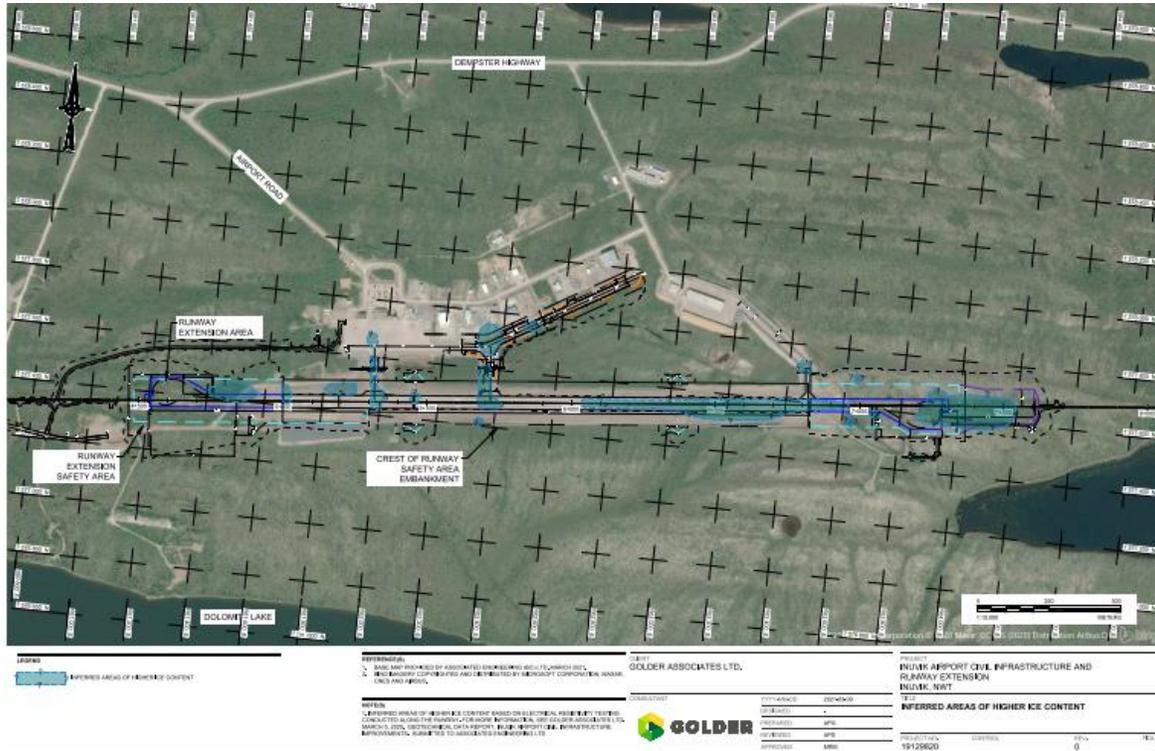
-  Taxiway C Widening and Relocation
-  Taxiway B and D Rehabilitation
-  Runway Safety Area Widening
-  Stormwater Improvements

Existing Condition – Runway Profile



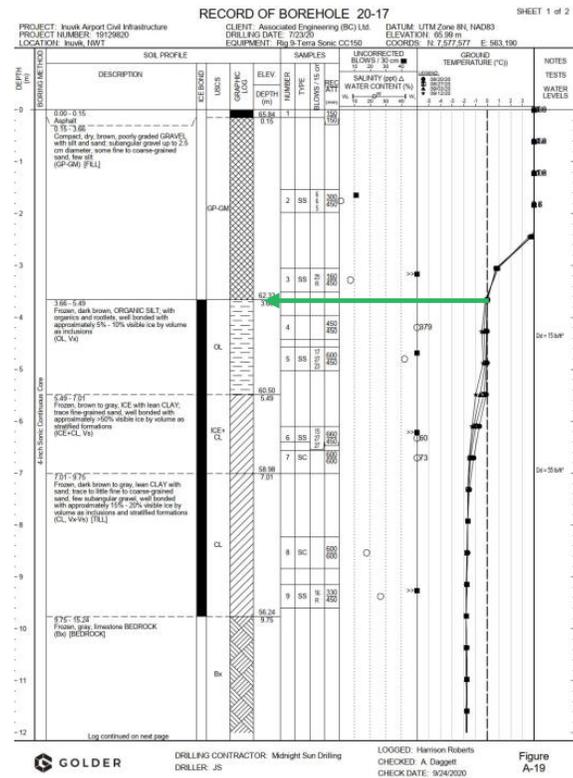
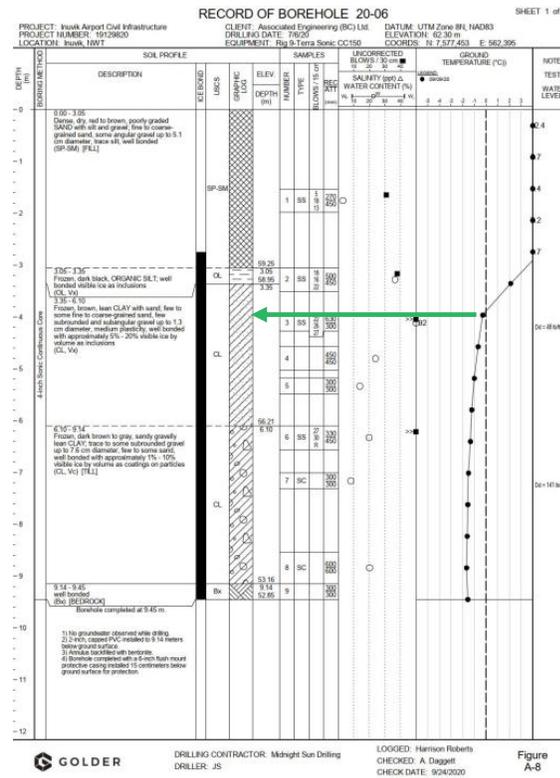
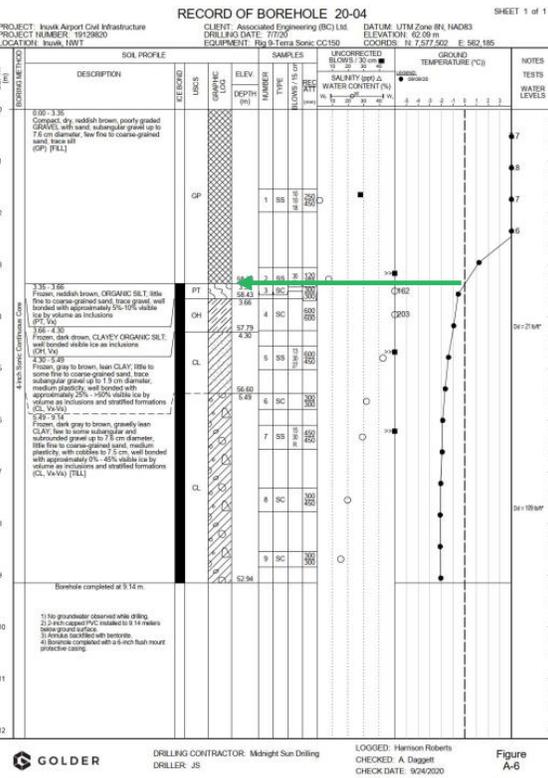
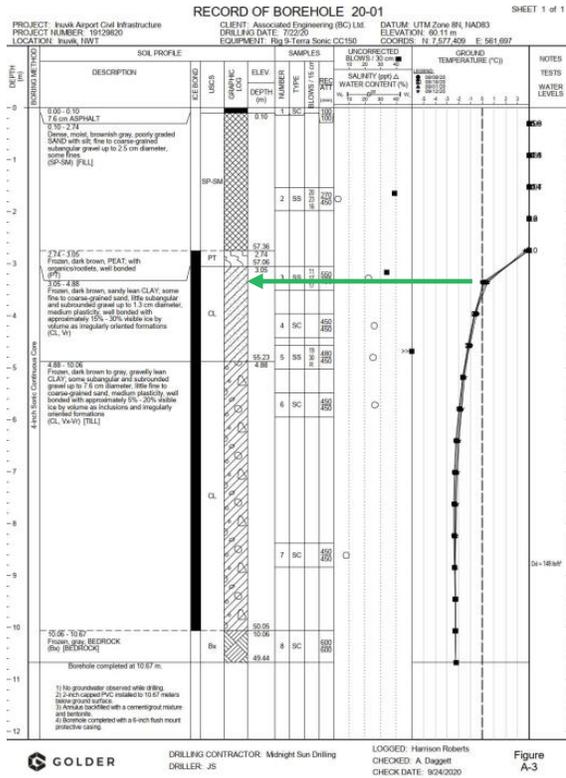
Runway Subsurface Conditions – Geophysical Survey Results

Existing Condition – Resistivity Testing



Inferred Areas of Higher Ice Content – Proposed Ground Temperature Monitoring Locations

Existing Condition – Runway Profile



Paved - Borehole Logs 20-01

RSA - Borehole Logs 20-04

RSA - Borehole Logs 20-06

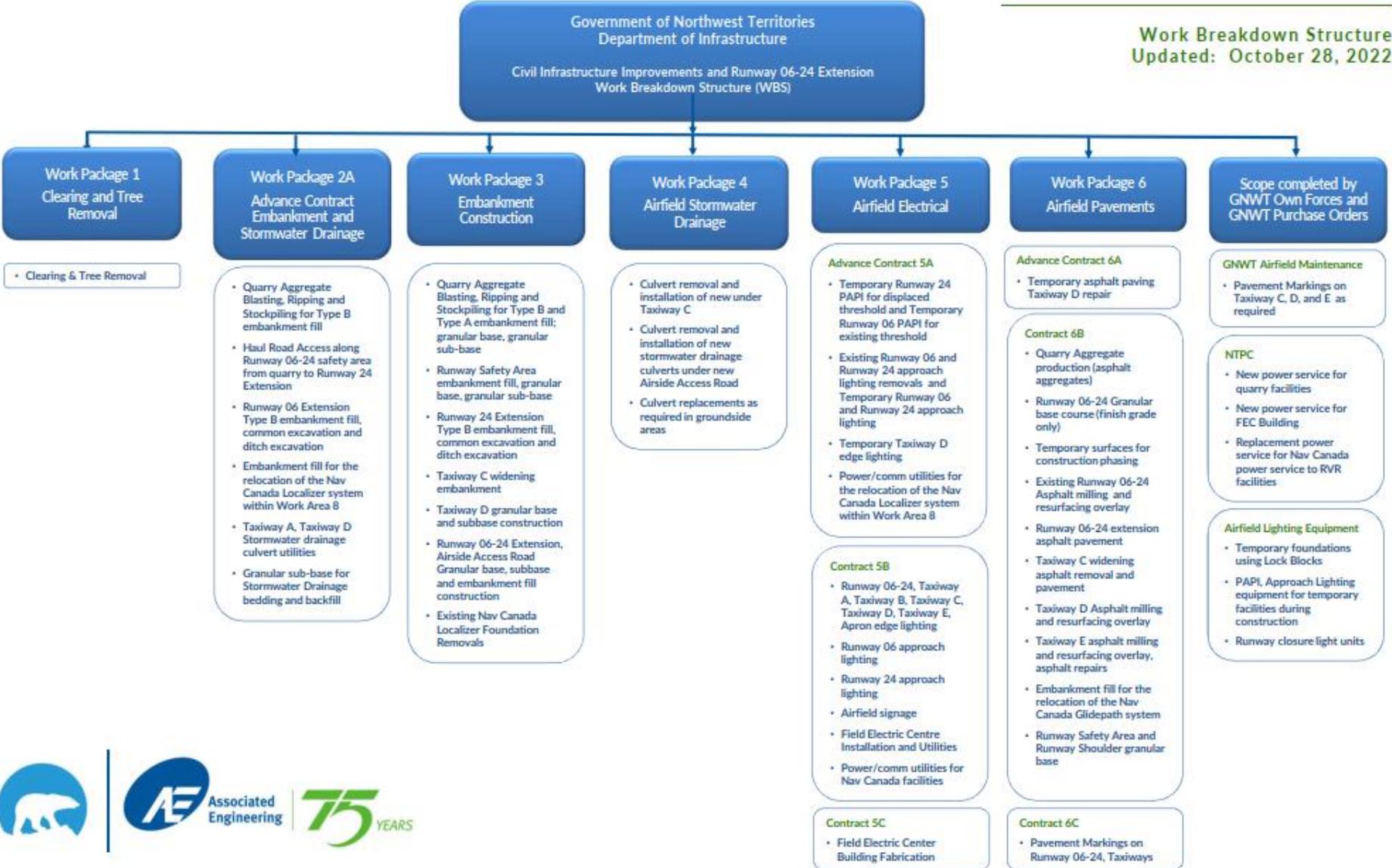
Paved - Borehole Logs 20-17

Runway Subsurface Conditions – 0C Ground Temperature close to Original Ground Elevation



Project Scope – Work Breakdown Structure

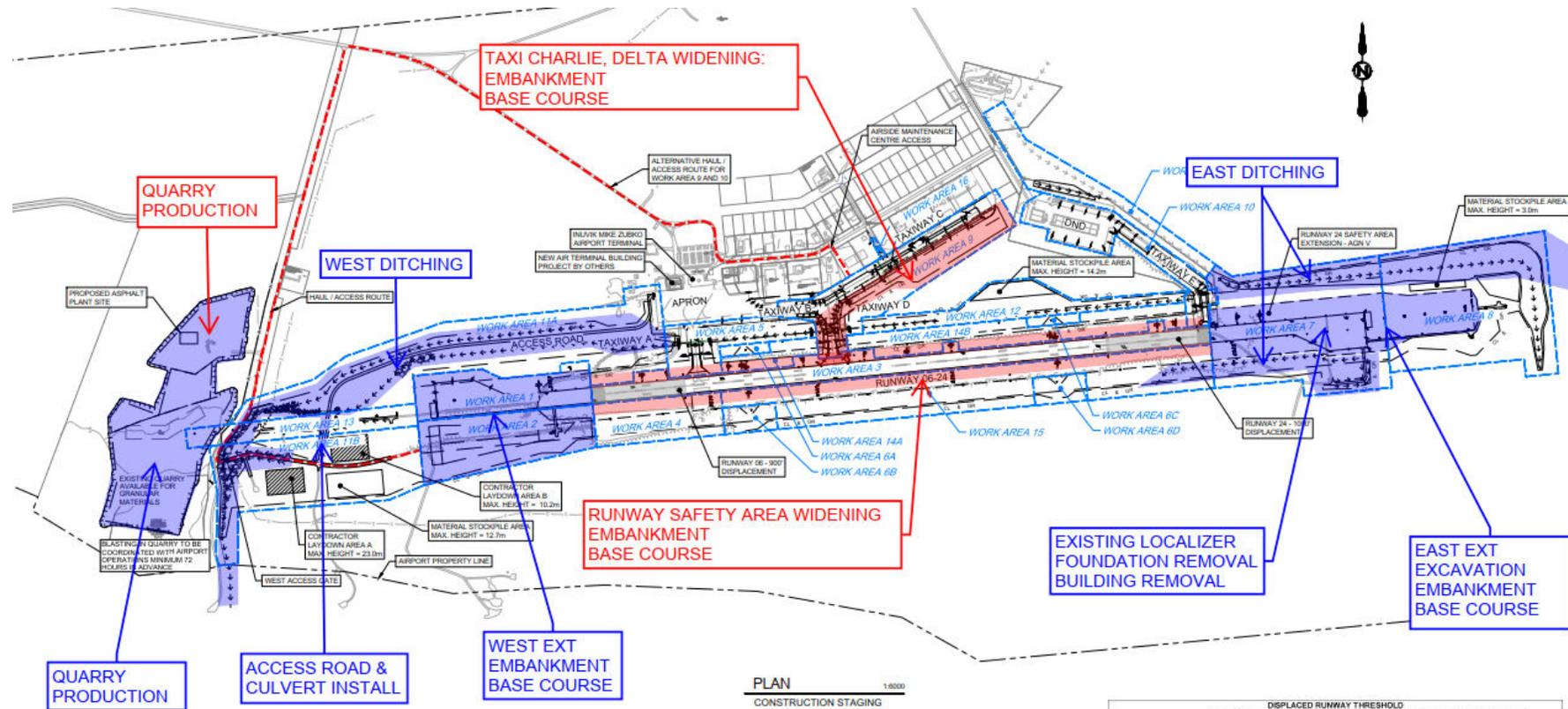
Work Breakdown Structure
Updated: October 28, 2022



Associated Engineering



Project Scope - Embankment Fill and Utilities

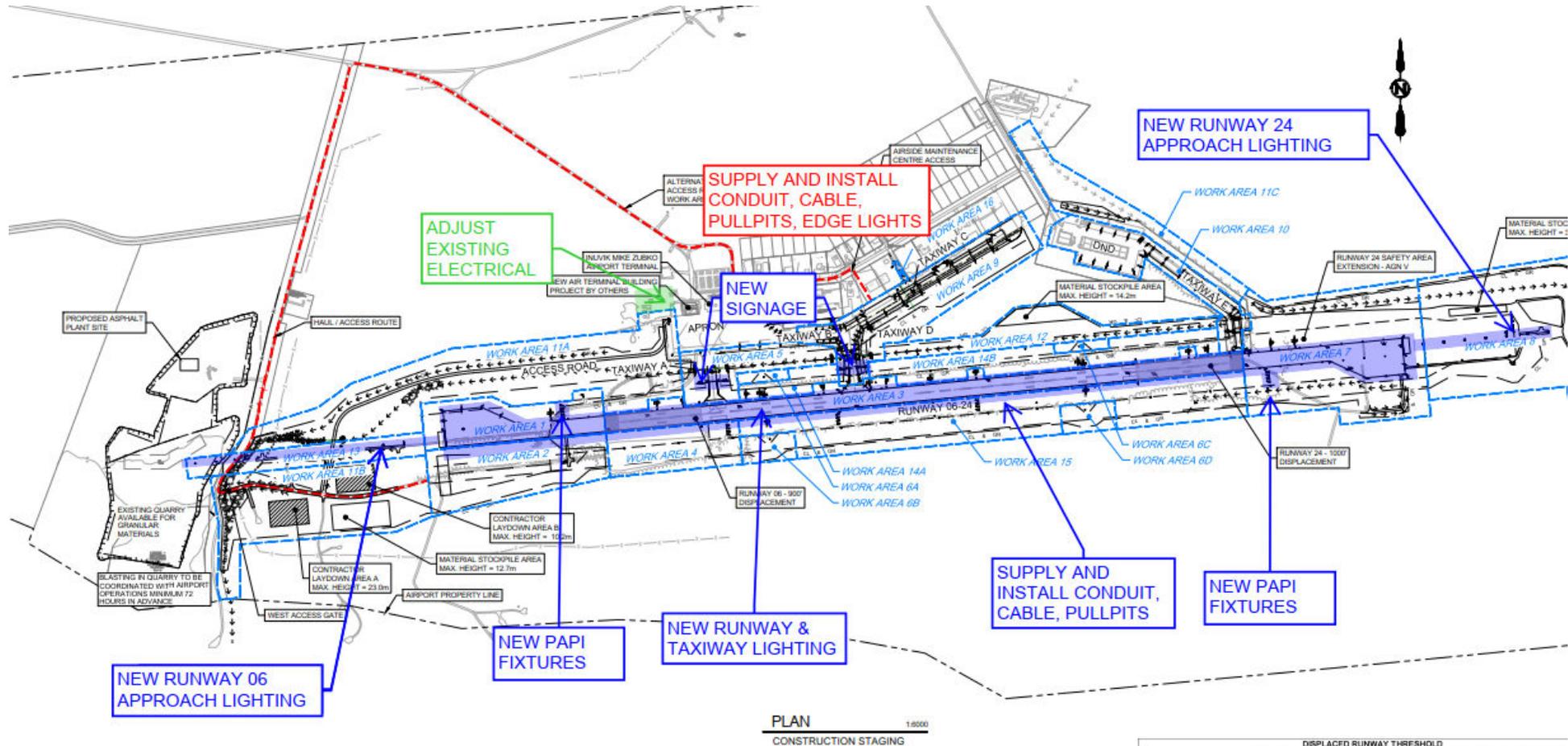


WORK PACKAGE 3&4

DISPLACED RUNWAY THRESHOLD	
SCHEDULE	INFRASTRUCTURE REQUIREMENTS
Runway 06 - 900' Displacement	Temporary PAPI Required
January 27, 2022 - September 8, 2022	Temporary Wingbar Lights Required
May 16, 2024 - July 11, 2024	Temporary Threshold Pavement Markings
June 12, 2025 - August 7, 2025	Temporary Displaced Threshold Centreline Markings
Runway 24 - 1,000' Displacement	Temporary Aiming Point Markings
December 29, 2022 - October 5, 2023	Temporary Runway End Lights
July 11, 2024 - September 5, 2024	Disconnect Existing Threshold Lights
August 7, 2025 - October 2, 2025	Disconnect Existing PAPI
	Disconnect Existing Approach Lights



Project Scope - Airfield Lighting and Electrical

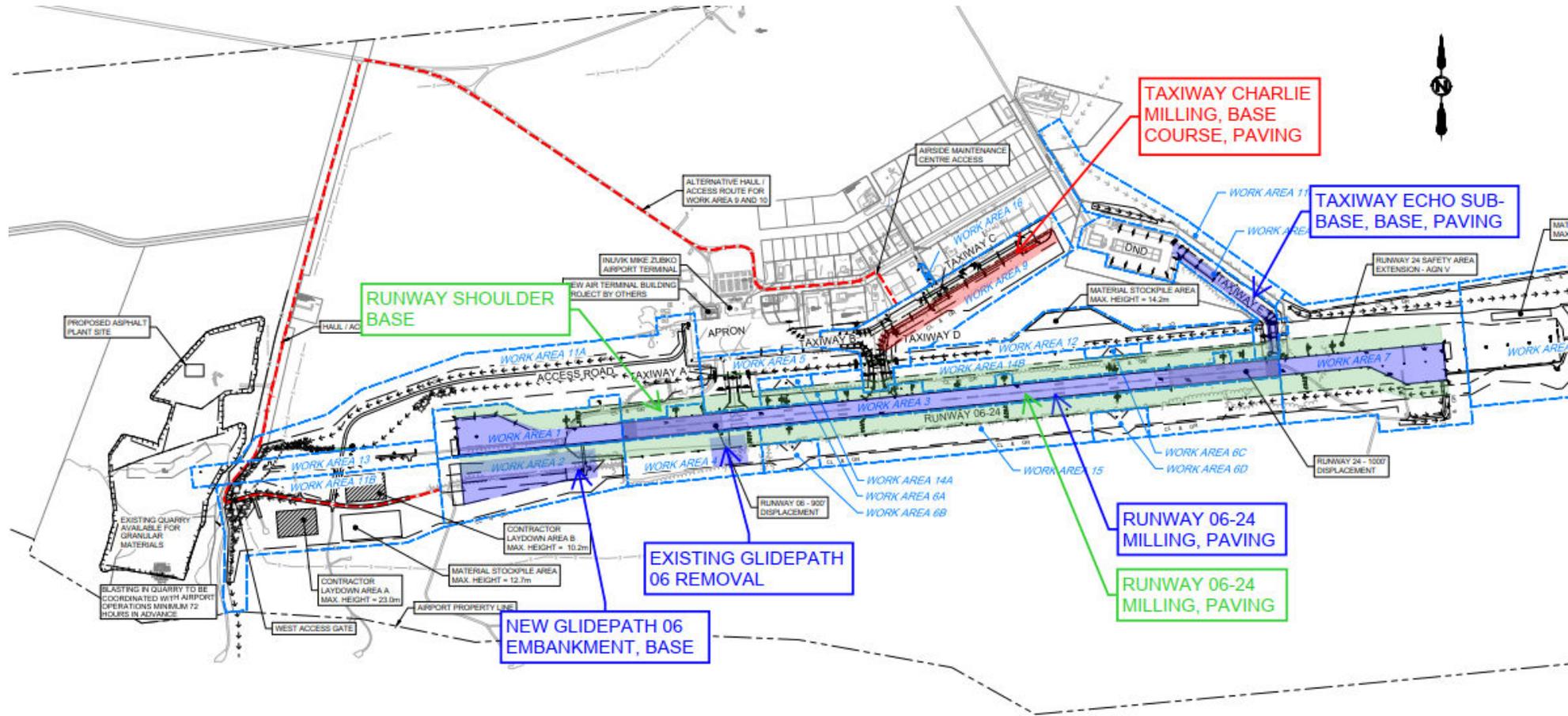


WORK PACKAGE 5B

SCHEDULE	DISPLACED RUNWAY THRESHOLD	INFRASTRUCTURE REQUIREMENT
Runway 06 - 900' Displacement		
January 27, 2022 - September 8, 2022		Temporary PAPI Required
May 16, 2024 - July 11, 2024		Temporary Wingbar Lights Required
June 12, 2025 - August 7, 2025		Temporary Threshold Pavement Markings
		Temporary Displaced Threshold Centreline Markings
Runway 24 - 1000' Displacement		
December 29, 2022 - October 5, 2023		Temporary Aiming Post Markings
July 11, 2024 - September 5, 2024		Temporary Runway End Lights
August 7, 2025 - October 2, 2025		Disconnect Existing Threshold Lights
		Disconnect Existing PAPI
		Disconnect Existing Approach Lights



Project Scope - Airfield Pavement



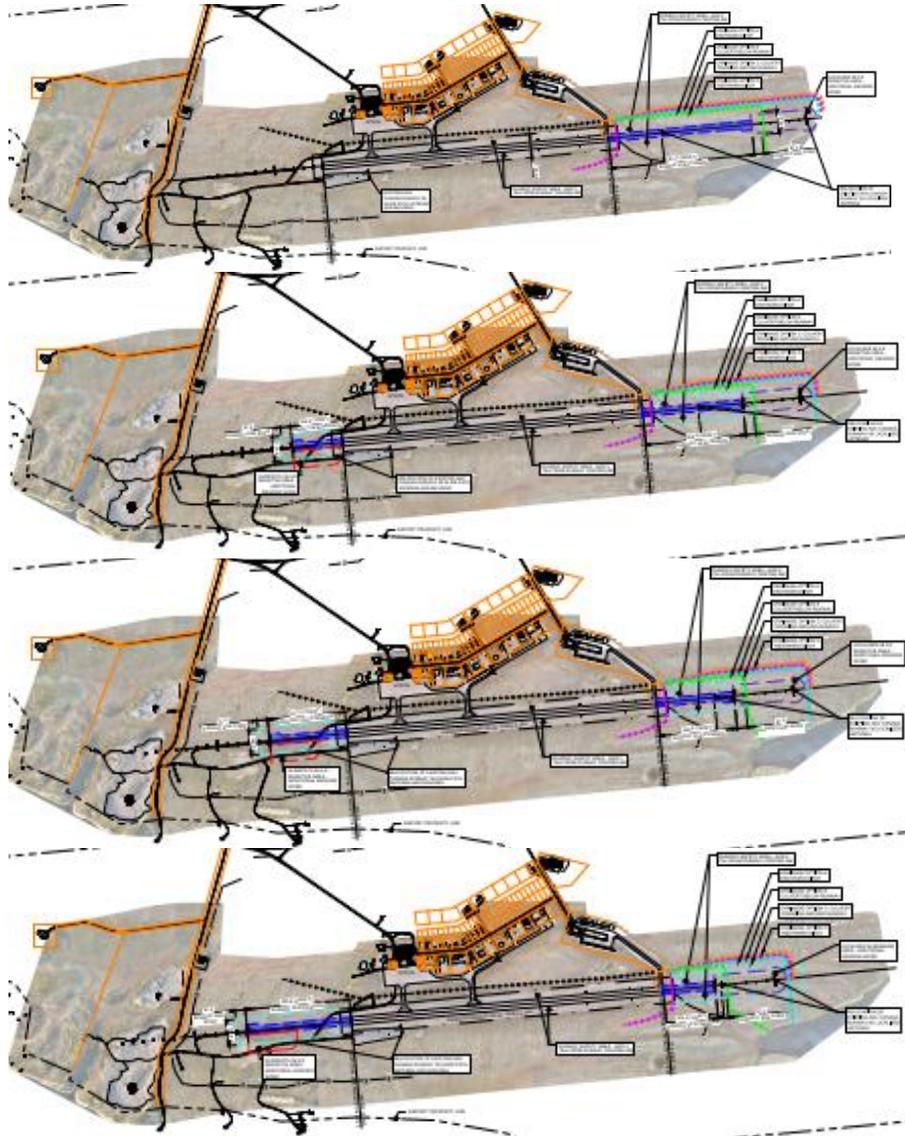
PLAN
1:6000
CONSTRUCTION STAGING

DISPLACED RUNWAY THRESHOLD	
SCHEDULE	INFRASTRUCTURE REC
Runway 06 - 900' Displacement	Temporary PAPI Required
January 27, 2022 - September 8, 2022	Temporary Wingbar Lights Require
May 16, 2024 - July 11, 2024	Temporary Threshold Pavement M
June 12, 2025 - August 7, 2025	Temporary Displaced Threshold C
Runway 24 - 1,000' Displacement	Temporary Aiming Point Markings
December 29, 2022 - October 3, 2023	Temporary Runway End Lights
July 11, 2024 - September 5, 2024	Disconnect Existing Threshold Ligh
August 7, 2025 - October 2, 2025	Disconnect Existing PAPI
	Disconnect Existing Approach Light

WORK PACKAGE 6B



Multiple Accounts Evaluation



3000 FT RUNWAY 06 24 EXTENSION OPTIONS	DRAINAGE OPTIONS	LENGTH (FT)	RUNWAY 06 EXTENSION (A)			LENGTH (FT)	RUNWAY 24 EXTENSION (B)			SUB-TOTAL DRAINAGE Cut(m ³)	TOTAL (A+B)		RANK/VARIANCE					
			CIVIL		DRAINAGE		CIVIL		DRAINAGE		Cut(m ³)	Fill(m ³)	Rank	Variance(m ³)	%	Rank	Variance(m ³)	%
			Cut(m ³)	Fill(m ³)	Cut(m ³)		Cut(m ³)	Fill(m ³)	Cut(m ³)									
Option 1	1A: Eastward Ditch	0	0	0	54,500	3000	41,500	574,000	582,350	636,850	678,350	574,000	16	532,250	342%	4	241,500	73%
	1B: Culvert under Rwy		54,500		50,100		104,600	146,100	574,000	1	0	-5%						
	1C: Culvert under Rwy End Strip		54,500		366,000		420,500	462,000	574,000	13	315,900	201%						
	1D: Westward Ditch*		121,100		35,100		156,200	197,700	574,000	5	51,600	29%						
Option 2	2A: Eastward Ditch	1000	17,000	90,000	54,500	2000	38,500	242,500	444,000	498,500	554,000	332,500	15	407,900	261%	1	0	0%
	2B: Culvert under Rwy		54,500		43,500		98,000	153,500	332,500	2	7,400	0%						
	2C: Culvert under Rwy End Strip		54,500		211,100		265,600	321,100	332,500	11	175,000	109%						
	2D: Westward Ditch*		121,100		28,500		149,600	205,100	332,500	6	59,000	697%						
Option 3	3A: Eastward Ditch	1500	17,000	259,000	54,500	1500	35,100	142,000	386,500	441,000	493,100	401,000	14	347,000	221%	2	68,500	21%
	3B: Culvert under Rwy		54,500		53,500		108,000	160,100	401,000	3	14,000	4%						
	3C: Culvert under Rwy End Strip		54,500		153,000		207,500	259,600	401,000	10	113,500	69%						
	3D: Westward Ditch*		121,100		38,500		159,600	211,700	401,000	7	65,600	38%						
Option 4	4A: Eastward Ditch	2000	17,000	432,500	54,500	1000	32,500	81,000	244,500	299,000	351,100	513,500	12	205,000	129%	3	181,000	54%
	4B: Culvert under Rwy		54,500		56,000		110,500	162,600	513,500	4	16,500	6%						
	4C: Culvert under Rwy End Strip		54,500		137,000		191,500	243,600	513,500	9	97,500	59%						
	4D: Westward Ditch*		121,100		41,000		162,100	214,200	513,500	8	68,100	40%						

Inuvik Airport Runway 06-24 Extension Options - Multiple Accounts Evaluation Summary

CATEGORY	Rank Weighting	Weighted Ranking															
		Runway Extension Option 1				Runway Extension Option 2				Runway Extension Option 3				Runway Extension Option 4			
		SW Opt. A	SW Opt. B	SW Opt. C	SW Opt. D	SW Opt. A	SW Opt. B	SW Opt. C	SW Opt. D	SW Opt. A	SW Opt. B	SW Opt. C	SW Opt. D	SW Opt. A	SW Opt. B	SW Opt. C	SW Opt. D
A - PROJECT & TECHNICAL																	
Part A - Project & Technical - Subtotal	1.00	7.1	7.8	6.7	7.7	6.9	7.6	6.9	7.4	7.4	7.9	7.3	7.8	6.9	7.0	6.7	7.0
Part A Account Weighting	3.00	21.3	23.3	20.1	23.0	20.7	22.8	20.7	22.2	22.1	23.6	21.9	23.3	20.7	20.9	20.0	20.9
Ranking		9	3	15	4	12	5	12	6	7	1	8	2	12	10	16	10
B - OPERATIONS																	
Part B - Operations - Subtotal	1.00	9.1	6.1	6.9	8.7	9.1	6.1	7.1	8.7	9.3	6.1	7.3	8.9	9.5	6.1	7.5	9.1
Part B Account Weighting	3.00	27.3	18.3	20.7	26.1	27.3	18.3	21.3	26.1	27.9	18.3	21.9	26.7	28.5	18.3	22.5	27.3
Ranking		3	13	12	7	3	13	11	7	2	13	10	6	1	13	9	3
C - EXTERNAL																	
Part C - External - Subtotal	1.00	10.0	8.2	9.0	10.0	8.0	6.2	7.0	8.0	7.8	6.0	6.8	7.8	7.6	5.8	5.8	7.6
Part C Account Weighting	1.00	10.0	8.2	9.0	10.0	8.0	6.2	7.0	8.0	7.8	6.0	6.8	7.8	7.6	5.8	5.8	7.6
Ranking		1	4	3	1	5	13	11	5	7	14	12	7	9	15	15	9
D - FINANCIAL																	
Part D - Financial - Subtotal	1.00	4.9	4.2	4.0	5.2	8.6	8.0	7.8	9.0	8.3	7.8	7.6	8.8	6.5	6.1	5.9	7.1
Part D Account Weighting	2.00	9.8	8.4	8.0	10.4	17.2	16.0	15.6	18.0	16.6	15.6	15.2	17.6	13.0	12.2	11.8	14.2
Ranking		14	15	16	13	3	5	7	1	4	6	8	2	10	11	12	9
E - ENVIRONMENTAL																	
Part E - Environmental - Subtotal	1.00	4.3	5.8	4.8	5.5	7.1	8.6	7.6	8.3	7.8	9.3	8.3	9.0	8.2	9.7	8.7	9.4
Part E Account Weighting	1.00	4.3	5.8	4.8	5.5	7.1	8.6	7.6	8.3	7.8	9.3	8.3	9.0	8.2	9.7	8.7	9.4
Ranking		16	13	15	14	12	6	11	7	10	3	7	4	9	1	5	2
MULTIPLE ACCOUNTS EVALUATION - TOTALS																	
Overall Ranking		10	15	16	7	4	12	11	2	3	9	8	1	6	14	13	5

Note: Colours indicate relative ranking of options within each category, Green - Highest Score, Red - Lowest Score



Risk Assessment and Evaluation



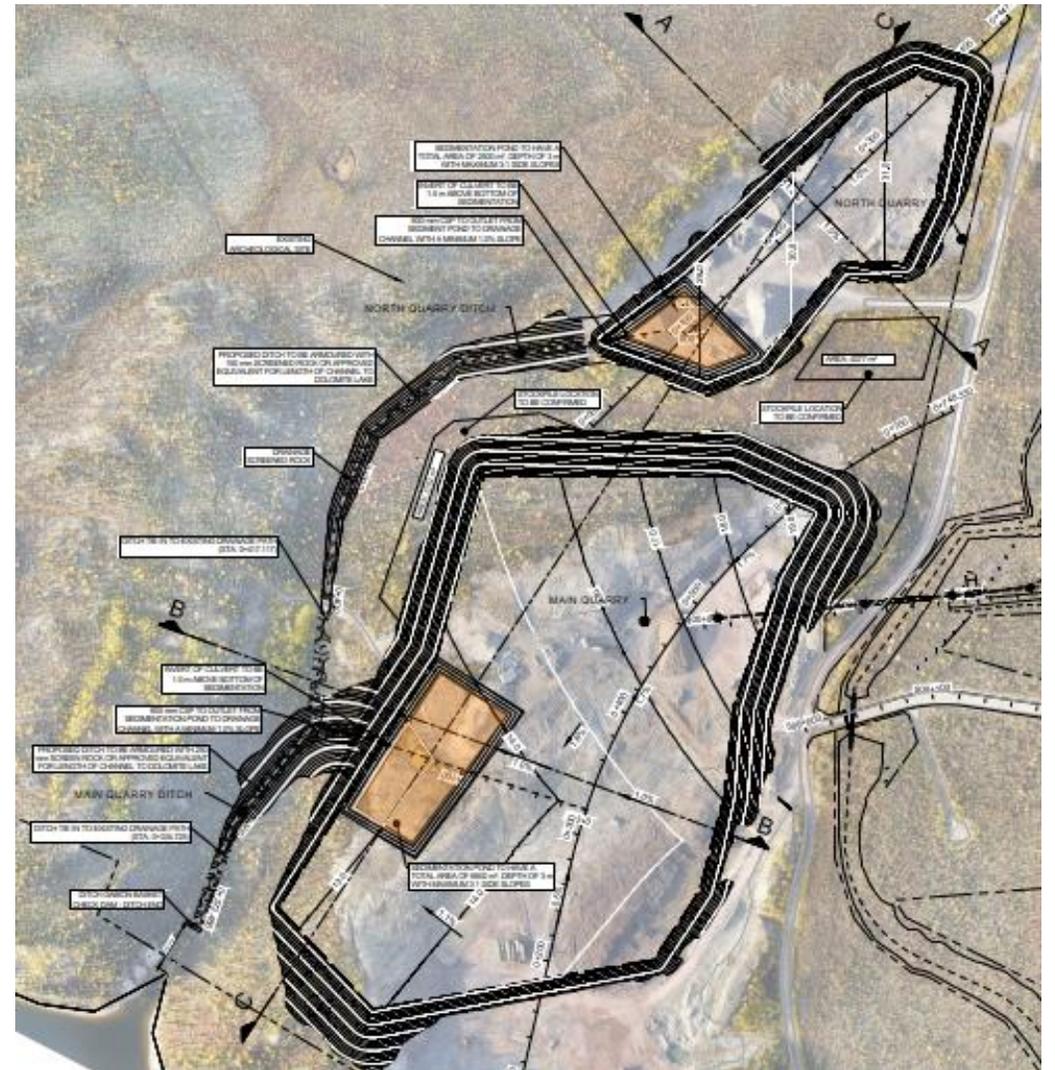
- Plan Project Activities
- Manage Schedule, Quality and Costs
- Identify Potential Conflicts
- Optimize Project Opportunities
- Establish Sound Practices and Communication Strategies

TECHNICAL	OPERATIONAL	EXTERNAL	ORGANIZATIONAL	COMMERCIAL
Scope	Safety	General Public	Resources	Contract Terms and Conditions
Requirements	Security	Airlines	Dependencies	Contractors
Design	Interface with Other Stakeholders and Projects	Regulator (TC)/ Air Traffic Services (Nav Canada)	Project Funding / Approval	Suppliers and Vendors
Quality	Site Conditions	DND		Procurement Process
Complexity		Weather		
Site Conditions		Environmental		
		Permits		
		Climate Change		

The Risk Register is a large spreadsheet with multiple columns. It includes a color-coded risk matrix at the top right, with colors ranging from red (high risk) to green (low risk). The register lists various risk items, their descriptions, and their associated risk levels. The columns include: Risk ID, Risk Description, Risk Category, Risk Level, Risk Owner, Risk Status, and Risk Mitigation/Response. The spreadsheet is organized into several sections, with the top section containing the most critical risks.

Airport Quarry

- Owned by GNWT
- Aggregates used for original Inuvik Airport construction
- Main Quarry:
 - Granular Base
 - Granular Subbase
 - Embankment Fill
 - Total approx 2.6 million tonnes
- North Quarry:
 - Asphalt Aggregates
 - Total approx 60,000 tonnes



Quarry Aggregates

- North Quarry (Dolomite, PN 108): Asphalt Aggregates
 - Coarse Aggregate, Fine Aggregate, no VMA Sand (offsite)
 - Specific Gravity: 2.844 Coarse, 2.802 Fine
 - Crushed Fragments: 100%
 - Absorption: between 0.14% and 0.86%
 - Micro-Deval: 8.8% coarse, 4.0% fine
 - L.A. Abrasion: 23.5%
 - Magnesium Sulphate Soundness: between 2.6% and 11.9%
- Asphalt Mix Design:
 - Asphalt cement PG 52-46
 - Fibre Reinforcement; Hydrated Lime anti-strip additive



Project Schedule

Work Package	2022	2023	2024	2025	2026	2027
WP1 <i>Clearing and Tree Removal</i>	Minor					
WP2A <i>Advance Works</i>	Major	Major				
WP3&4 <i>Embankment Construction & Airfield Drainage</i>		Major	Major	Minor		
WP5A <i>Advance Contract - Airfield Electrical</i>		Minor	Minor	Minor		
WP5B <i>Airfield Electrical</i>					Major	Major
WP5C <i>Field Electric Centre</i>				Major		
WP6A <i>Advance Contract – Airfield Pavements</i>		Minor				
WP6B <i>Airfield Pavements</i>				Minor	Major	Major

Minor = Minor works in that calendar year. Small number of activities on critical path.
 Major = Major works in that calendar year. High number of activities on critical path.



Project Schedule Constraints

- Ongoing Stakeholder Coordination discussions to review operational impacts during construction
- Planned construction schedule activities based on:
 - Nav Canada Localizer, Glidepath relocation to suit existing and new facilities and runway approach design
 - Runway 06 and Runway 24 Visual Aids during construction (temporary PAPI, approach lighting)
 - Displaced Runway 06 and Runway 24 thresholds
 - Revised Runway 06 and Runway 24 declared distances
 - Taxiway Closures

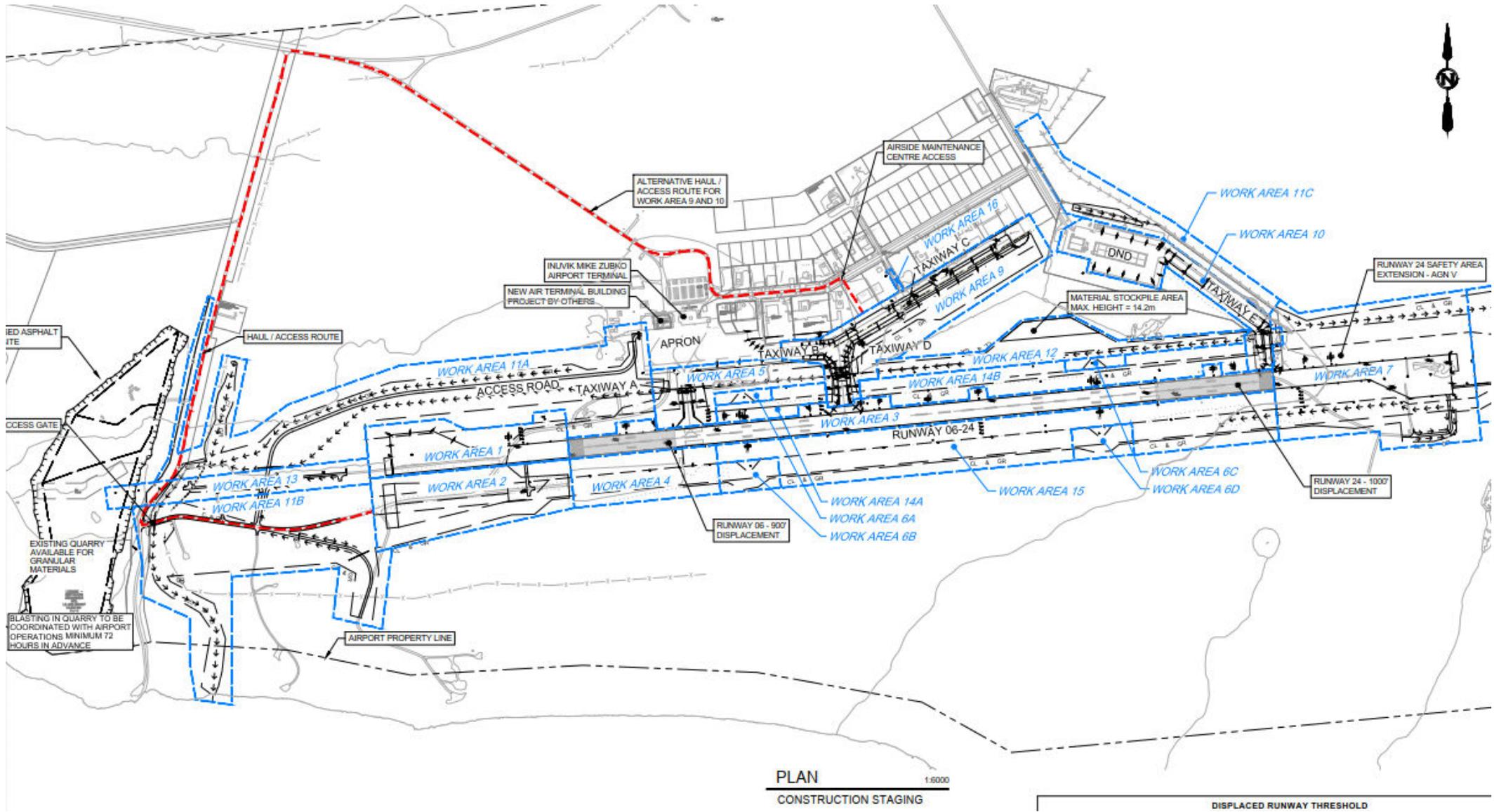


Plan of Construction

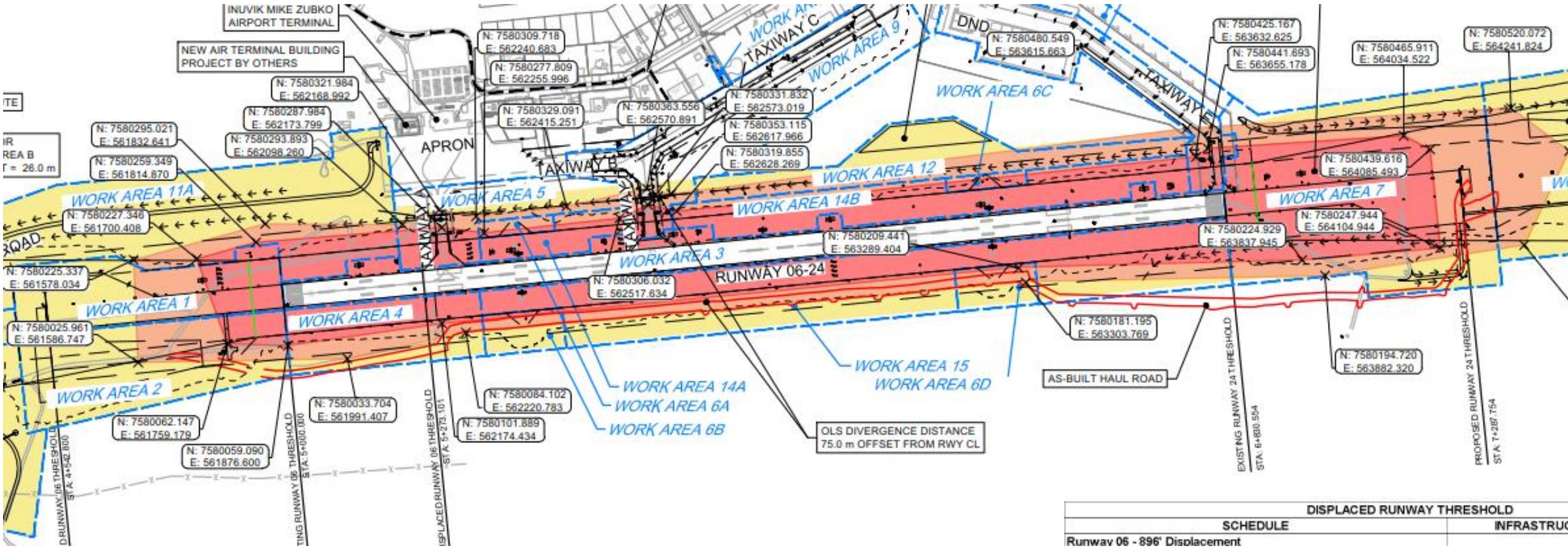
- Existing certification: TP 312 4th edition vs TP 312 5th edition
- Nav Canada approach design and publication schedule
- Non-instrument vs Non-precision runway category revisions to reduce size of protected areas
- Runway operational impact schedule: Multiple temporary runway threshold displacements, declared distances changes
- Multiyear Project: PCO issued and updated on annual basis
- Quarry Blasting requirements
- Emergency/DND aircraft operations with 30 min prior notice



Plan of Construction



Plan of Construction



Construction Activities – Summer 2023



Main Quarry



Main Quarry – Rock drill rig on east bluff



Existing original ground – tundra

Construction Activities – Summer 2023



Sub excavation –
Runway 24 aircraft turning pad area



Sub excavation disposal area –
south access road shoulder



Runway Safety Area -
north side of runway

Construction Activities – Summer 2023



Runway Safety Area -
north side of runway



New Runway 24 Localizer Antenna



Existing Runway Ditch – East End

Challenges, Results and Lessons Learned

- Top priority: Airfield surface and subsurface drainage
- Top priority: Protect permafrost
 - Protect tundra
 - Initial embankment lift during winter
 - Eliminate/minimize/reduce common excavation
- Trenchless pipe installation –
 - Winter installation schedule, expect variable permafrost
- Monitor ground temperatures, surface settlement





Questions?

Contact Dave Anderson, andersond@ae.ca