Memorandum

To	The Expert Panel	From	Shaun Grieve
Copy		Document Code	10722-PTA-2BO-GO-MEM-0006
Date	24 August 2026	Pages (including this page)	6
Subject	**Summary of Geological and Geotechnical Assessments Relevant to the Expert Panel Information Request**		

1 Introduction

I am a Chartered Professional Engineer (CPEng) and Technical Principal Geotechnical with WSP New Zealand. I have led all geotechnical aspects of this project, including investigation scoping, planning and review, assessment of ground conditions, geomorphology and landslide hazards, and identification of geotechnical risks and opportunities. I have extensive experience in Northland ground conditions, including Northland Allochthon and Waipapa Terrane materials.

Relevant experience includes leading the geotechnical work for the Brynderwyn Hills Recovery and Resilience Programme, including investigation, landslide mapping, slope stability assessment and development of resilience improvement works on State Highway 1. I also led the client-side geotechnical advisory services supporting procurement and development of the Northland Corridor Ara Tūhono Warkworth to Te Hana programme. More broadly, I have provided technical leadership and review for major transport infrastructure projects involving slope stability, earthworks, material reuse, settlement and liquefaction assessments, and geotechnical inputs to design, consenting and designation processes.

2 Purpose and Context

This memorandum has been prepared in response to the Expert Panel's request for additional geotechnical information relating to the Brynderwyn Hills Section of the Alternative to the Brynderwyn Hills project (the Project) (RFI#2). This memorandum provides a summary of geological and geotechnical findings relevant to the specific matters raised by the Panel, being:

- Geomorphological assessment and landslide mapping;
- Basis of the indicative design geotechnical geometries;
- Potential geotechnical effects beyond the designation boundary; and
- Preliminary liquefaction assessment of the northern lowland area near Waipū.

The Project has been supported by an extensive programme of geological and geotechnical investigations, assessments and design development undertaken over multiple phases of project development. This work has informed route selection, environmental assessment, designation development and preparation of the Project indicative design. While there are challenging the Project area includes complex geological and geotechnical conditions, in my opinion, these conditions are sufficiently understood for the current phase and can be managed through detailed design and construction phase, through compliance with standard engineering and design requirements and relevant codes and as regulated under the Building Act 2004 where relevant.

Memorandum

This memorandum provides a targeted summary of findings relevant to the matters raised by the Panel. The broader programme of geological and geotechnical investigations, assessments and design development undertaken for the Project is substantially more extensive than presented herein and has informed route development, designation establishment, environmental assessment and preparation of the Project indicative design.

This memorandum is not intended to be a Geotechnical Interpretive Report or to reproduce the full extent of geological and geotechnical investigations, assessments and design development completed for the Project. It provides targeted technical information relevant to the matters raised by the Panel, drawing on the broader geotechnical work completed to date.

3 Geological and Geotechnical Assessments Completed

The Project has been supported by a substantial geological and geotechnical investigation and assessment programme undertaken over multiple stages of project development. I have led the scoping and management of the various phases of investigations and assessment completed to date.

The programme has included:

- Borehole investigations;
- Cone Penetration Testing (CPT);
- Test pit investigations;
- Groundwater monitoring;
- Geological mapping and modelling;
- Engineering geological unit development;
- Geomorphological assessments;
- Terrain instability assessments;
- Historical aerial photograph interpretation;
- Landslide mapping;

These investigations and assessments have been used to develop an understanding of geological and geotechnical conditions along the corridor, identify constraints and opportunities, support route selection, inform designation development and develop the Project indicative design for the current consenting and designation phase.

The geological and geotechnical programme has also informed earthworks development, constructability assessments, material characterisation and spoil management planning.

In my professional opinion, the investigations and assessments completed to date are thorough and adequate to support the Project indicative design.

4 Geomorphological Assessment and Landslide Mapping

A comprehensive geomorphological assessment has been undertaken across the Project corridor. The assessment incorporated LiDAR interpretation, terrain mapping, geological mapping, historical aerial photograph review, landslide identification and field verification.

The assessment identified areas of historical and active slope instability, including landslides, slumps, earthflows and hummocky terrain associated with Northland Allochthon materials. These findings formed a key input into route selection, alignment refinement and designation development.

Areas of elevated landslide susceptibility were identified and considered throughout project development, with avoidance and minimisation adopted where practicable.

A geomorphological and landslide map accompanies this memorandum and summarises the findings of the broader terrain instability assessments completed for the Project (refer **Attachment A:** Ground Investigation, Geomorphology and Geotech Features dated 26 March 2026).

NZTA design requirements and relevant design codes outlined below require the Project, including the indicative alignment or any amended design, to avoid inducing slope instability or ground displacements that could cause structural damage or reduce the serviceability of structures or ground surfaces on neighbouring properties. These requirements can be addressed through detailed design and construction measures, which may include designed batter slopes, erosion protection, drainage measures, ground improvement or other stabilisation measures where required.

5 Design Framework and Development Approach

The Project is currently at the consent and designation phase of development. As is typical for projects of this scale, an indicative design has been developed to demonstrate the feasibility of the corridor, identify key project requirements, establish an appropriate designation footprint and inform environmental assessments.

The indicative design has been developed using the geological, geomorphological and geotechnical information available at the time of design and incorporates the findings of ground investigations, engineering geological assessments and terrain instability assessments completed across the corridor.

The purpose of the indicative design is not to establish final construction solutions. Rather, it provides confidence that the proposed corridor can be accommodated within the designation footprint and that geological and geotechnical risks can be appropriately managed through future project phases.

Detailed design will be undertaken during subsequent project phases and will be supported by additional investigations, analyses and design development where required.

Geotechnical design will be completed in accordance with applicable NZTA requirements, the NZTA Bridge Manual where relevant, project-specific design criteria and recognised engineering standards. These standards and requirements include:

- NZTA Bridge Manual (SP/M/022), 3rd edition, Amendment 4, 2022.
- NZS 1170.0:2002 – Structural Design Actions, Part 0: General Principles.
- NZS 1170.5:2004 – Structural Design Actions, Part 5: Earthquake Actions – New Zealand.

- AS 2159:2009 – Piling: Design and Installation.
- NZ Building Code Verification Method B1/VM4.
- MBIE and NZGS Earthquake Geotechnical Engineering Practice Modules.
- NZTA F/1 Specification for Earthworks Construction.
- Transfund Research Report 239 – Guidelines for Design and Construction of Geosynthetic Reinforced Soil Structures in New Zealand.
- NZTA Research Report 553 – The Development of Design Guidance for Bridges in New Zealand for Liquefaction and Lateral Spreading Effects.

More geotechnical investigations are being undertaken as the design process progresses. Future design development will also be subject to NZTA's normal technical review, verification and assurance processes. This may include, where required:

- Detailed slope stability assessment;
- Earthworks design;
- Ground improvement design;
- Retaining structure design;
- Bridge foundation design;
- Settlement assessment;
- Liquefaction assessment; and
- Development of construction methodologies and mitigation measures.

Accordingly, the indicative design should be considered a demonstration of geotechnical feasibility rather than a final design solution. Any final design will be required to comply with the design criteria and engineering standards, and will be subject to compliance with the Building Act 2004 if relevant.

6 Basis of Indicative Design Geometries

The geotechnical sketches and typical sections included within the indicative design drawings represent indicative design solutions developed using geological, geomorphological and geotechnical information available at the time of consent design.

The indicative design cut and fill geometries were developed using engineering geological interpretation and geotechnical assessment that in my opinion are appropriate for the current stage of design. This process included consideration of likely material behaviour, groundwater conditions, slope performance, constructability and the need for future design refinement.

The proposed cut and fill geometries were developed having regard to:

- Geological conditions;
- Engineering geological units;
- Ground investigation findings;

- Terrain and geomorphological assessments;
- Groundwater conditions;
- Anticipated material behaviour; and
- Previous experience within comparable Northland geological environments.

7 Earthworks Design and Material Reuse Considerations

Earthworks development has been a key consideration throughout the Project, given the scale of proposed cuts and fills and the variability of geological materials along the corridor. The geological and geotechnical assessments completed to date have informed the indicative earthworks design, material characterisation, anticipated material reuse opportunities, spoil management planning and constructability considerations.

A key design driver has been understanding the likely behaviour and suitability of materials generated from cut areas, including the extent to which materials may be reused within engineered fills, embankments, landscape areas or other project earthworks. This assessment has considered mapped geological units, ground investigation findings, groundwater conditions, anticipated excavation characteristics and experience with comparable Northland materials.

The indicative design has therefore been developed with consideration of both geotechnical performance and practical earthworks delivery. As noted, the design and location of spoil sites contained in the application are indicative only. Further refinement of material classification, reuse opportunities, spoil placement requirements and construction methodology will be undertaken during subsequent design phases, supported by additional testing and contractor input where required.

8 Potential Effects Beyond the Designation Boundary

Potential geotechnical effects associated with major cuts, fills and spoil placement areas have been considered throughout corridor development, route refinement and designation establishment.

Geotechnical considerations have been integrated into both route selection and designation development. The designation footprint has generally been developed to accommodate proposed earthworks, anticipated mitigation measures, construction activities and future design refinement.

The Project includes earthworks within both Waipapa Terrane and Northland Allochthon geological environments. These geological conditions have been considered throughout development of the indicative design and designation footprint.

Based on investigations and assessments completed to date, no geotechnical constraints have been identified that indicate stabilisation measures extending beyond the proposed designation boundary would be required for the indicative alignment and indicative spoil placement areas. This work includes consideration of the indicative alignment cuts and fills and potential spoil placement areas identified at this stage of project development.

Consistent with normal infrastructure delivery practice, detailed design undertaken during subsequent project phases will further refine slope geometries, earthworks treatments, construction methodologies, spoil placement and mitigation requirements in accordance with applicable NZTA requirements and

recognised engineering standards. As noted, the final design of the Project will be required to comply with applicable NZTA requirements, the NZTA Bridge Manual where relevant, project-specific design criteria and recognised engineering standards and will be subject to the Building Act 2004 where relevant. I am confident that any potential effects both within and beyond the Designation Boundary will be appropriately managed through these established processes.

9 Preliminary Liquefaction Assessment

The northern lowland area near Waipū comprises alluvial and floodplain deposits of varying thickness and composition. Ground investigations undertaken within this area include boreholes and Cone Penetration Testing to characterise subsurface conditions.

Investigations completed to date indicate that potentially liquefiable materials may be present within portions of the alluvial sequence and that liquefaction susceptibility varies spatially along the corridor. These conditions have been recognised during project development and considered as part of the indicative design process.

Liquefaction is a geotechnical risk within the existing environment regardless of the Project in susceptible locations noted above. In terms of effects to the Project, established engineering approaches are available to assess and manage liquefaction-related risks where required during subsequent design phases. Based on investigations and assessments completed to date, I consider liquefaction-related risks to the Project are manageable through normal detailed design processes and compliance with recognised engineering standards and the requirements of the Building Act 2004 where relevant

10 Conclusions

The Project has been supported by an extensive programme of geological and geotechnical investigation and assessment. This work has informed route selection, designation development, environmental assessment and preparation of the Project indicative design.

In my opinion, the work completed demonstrates that:

- Geological and geotechnical conditions are sufficiently understood for the current phase of the Project;
- Geomorphological and landslide assessments have been completed;
- Geotechnical risks have been identified and assessed;
- The corridor is geotechnically feasible; and
- Geotechnical risks to and from the Project within and beyond the Designation Boundary can be appropriately managed through subsequent detailed design and construction phases.

In my opinion, the geological and geotechnical investigations and assessments completed for the Project provide an adequate basis to support the proposed designation. Detailed design will be undertaken during subsequent project phases in accordance with applicable NZTA requirements, the NZTA Bridge Manual where relevant, project-specific design criteria, recognised engineering standards, NZTA's normal technical assurance processes and compliance with the requirements of the Building Act 2004 where relevant.

Attachment A: Ground Investigation, Geomorphology and Geotech Features dated 26 March 2026

GROUND INVESTIGATIONS

- BOREHOLE PLANNED
- CONE PENETRATION TEST PLANNED
- TEST PIT PLANNED
- BOREHOLE COMPLETED
- CONE PENETRATION TEST COMPLETED
- TEST PIT COMPLETED
- BOREHOLE CANCELLED
- TEST PIT CANCELLED
- HISTORICAL BOREHOLE COMPLETED
- HISTORICAL CONE PENETRATION TEST COMPLETED

CONFIDENCE LEVELS

SLOPE INSTABILITY FEATURES HAVE BEEN MAPPED WITH LOW; MODERATE OR HIGH CONFIDENCE LEVELS DEPENDING ON THE CLARITY AND NUMBER OF OVERLAPPING DATASETS FOR THAT PARTICULAR FEATURE (I.E., FIELD MAPPING, AERIAL IMAGES, LIDAR, BOREHOLE INFORMATION).

SLUMP

A SLUMP IS THE NAME GIVEN TO A SLIDE WHEN THE UNDERLYING FAILURE SURFACE IS CURVED RATHER THAN PLANAR. THE MOTION OF A SLUMP IS ROTATIONAL, SO THAT PORTIONS OF THE SLIDE DROP AND RISE WITH RESPECT TO THE ADJACENT STABLE SLOPES (JACKSON, 2013). IN THIS STUDY, SLUMPS ARE MAPPED AS COMPARATIVELY SMALL-SCALED AND ISOLATED FEATURES OFTEN ASSOCIATED WITH SLOPE OVER-STEEPENING CAUSED BY RIVER INCISION.

- HIGH
- LOW
- MODERATE

LANDSLIDES

THE DISPLACEMENT OF A RIGID OR SEMI-RIGID MASS OF SOIL OR ROCK SO THAT IT DESCENDS ALONG A DISTINCT UNDERLYING FAILURE SURFACE UNDER THE INFLUENCE OF GRAVITY (JACKSON, 2013).

- HIGH
- LOW
- MODERATE

DEBRIS FLOW

DEBRIS FLOW IS AN EXTREMELY RAPID, FLOW-LIKE MASS MOVEMENT, TRAVELING IN A STEEP, ESTABLISHED CHANNEL AND INVOLVING A SATURATED, UNSORTED MIXTURE OF GRANULAR SOILS, ORGANICS, AND OTHER DEBRIS (HUNGR ET AL., 2001).

- HIGH
- LOW
- MODERATE

NATURAL SLOPE INSTABILITY

IN THIS STUDY THE TERM NATURAL SLOPE INSTABILITY HAS BEEN USED PREDOMINANTLY WITHIN THE NORTHLAND ALLOCHTHON TERRANE TO HIGHLIGHT POTENTIAL AREAS OF SLOW AND CONTINUOUS LAND MOVEMENT OFTEN OCCURRING OVER SHALLOW SLOPE ANGLES. VISUAL CHARACTERISTICS CAN INCLUDE HUMMOCKY GROUND AND DISTORTED CONTOUR LINES WITH NO CLEAR SCARPS, HEAD-SCARPS OR EVACUATION AREAS.

SCARP	STEEP SURFACE ON DISPLACED MATERIAL OF LANDSLIDE PRODUCED BY DIFFERENTIAL MOVEMENTS WITHIN DISPLACED MATERIAL (CRUDEN & VARNES, 1996).
HEADSCARP	AREA AT THE UPPER EDGE OF A LANDSLIDE, MARKING THE DETACHMENT POINT OF EVACUATED MATERIAL.
RIDGES	LONG, NARROW, ELEVATED LANDFORM, STRUCTURAL FEATURE, OR A COMBINATION OF BOTH SEPARATED FROM THE SURROUNDING TERRAIN BY STEEP SIDES.
GULLY EROSION	ACTIVE PROCESS FORMING A GULLY; A SMALL HOLLOW OR CHANNEL INCISED INTO SEDIMENTS OR UNCONSOLIDATED ROCK BY RUNNING WATER (IAG, 2014).
BREAK IN SLOPE - CONCAVE	A ZONE WHERE THE TOPOGRAPHIC SLOPE ABRUPTLY CHANGES (WILSON, 1968). CURVING INWARDS.
BREAK IN SLOPE - CONVEX	A ZONE WHERE THE TOPOGRAPHIC SLOPE ABRUPTLY CHANGES (WILSON, 1968). CURVING OUTWARDS.
RIVER TERRACE	A VALLEY-CONTAINED SURFACE THAT TYPICALLY CONSISTS OF A LONG, NARROW AND GENTLY INCLINED LANDFORM BOUNDED ALONG THE LOWER EDGE BY A STEEPER DESCENDING SLOPE OR TREAD, AND ALONG THE HIGHER EDGE BY A STEEPER ASCENDING SLOPE (IAG, 2014)
SPRING	A CONCENTRATED DISCHARGE OF GROUNDWATER THAT EMERGES ON THE GROUND AS A STREAM OF WATER THAT FLOWS FREELY (TODD, K, 1980). IN THIS STUDY THE TERM SPRING HAS BEEN USED WHERE THERE IS AN APPARENT POINT SOURCE WITH ASSOCIATED EROSIONAL FEATURES.
DRAINAGE	IN THIS STUDY DRAINAGE REFERS TO A NATURAL WATER COURSE OR DRAINAGE PATH. DRAINAGE NETWORKS HAVE BEEN AUTO-GENERATED BASED ON DIGITAL ELEVATION MODEL (DEM) TOPOGRAPHY WITH MANUAL ADJUSTMENT WHERE REQUIRED.
SEEPAGE	THE FLOW OF GROUNDWATER TO THE SURFACE (RS WESTERHOFF ET AL., 2019). IN THIS STUDY THE TERM SEEPAGE HAS BEEN USED WHERE THERE'S NO APPARENT POINT SOURCE OR ASSOCIATED EROSIONAL FEATURES
SWAMP	AN AREA OF LOW-LYING GROUND WHERE WATER COLLECTS, DOMINATED BY HYDROPHILIC PLANTS
STANDING WATER - INTERMITTENT	SURFACE WATER APPEARING AND DISAPPEARING SEASONALLY.
STANDING WATER - PERENNIAL	SURFACE WATER PRESENT AT ALL SEASONS OF THE YEAR.
CUT FILL PLATFORM CONCAVE	INNER EDGE OF A LEVEL EARTH-WORKED SURFACE. CURVING INWARDS.
CUT FILL PLATFORM CONVEX	OUTER EDGE OF A LEVEL EARTH-WORKED SURFACE. CURVING OUTWARDS.

QUARRY

EXCAVATION IN WHICH ROCK OR OTHER MATERIALS HAVE BEEN EXTRACTED

- RIVER GRAVEL
- LIMESTONE
- GREYWACKE
- OTHER

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REVIEWED	CHRISTINE PARKES	26/03/2026
VERIFIED	AARON GEORGE	26/03/2026
APPROVED	MICHAEL HORNE	26/03/2026

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TITLE: **GROUND INVESTIGATION, GEOMORPHOLOGY AND GEOTECH FEATURES COVER PAGE**

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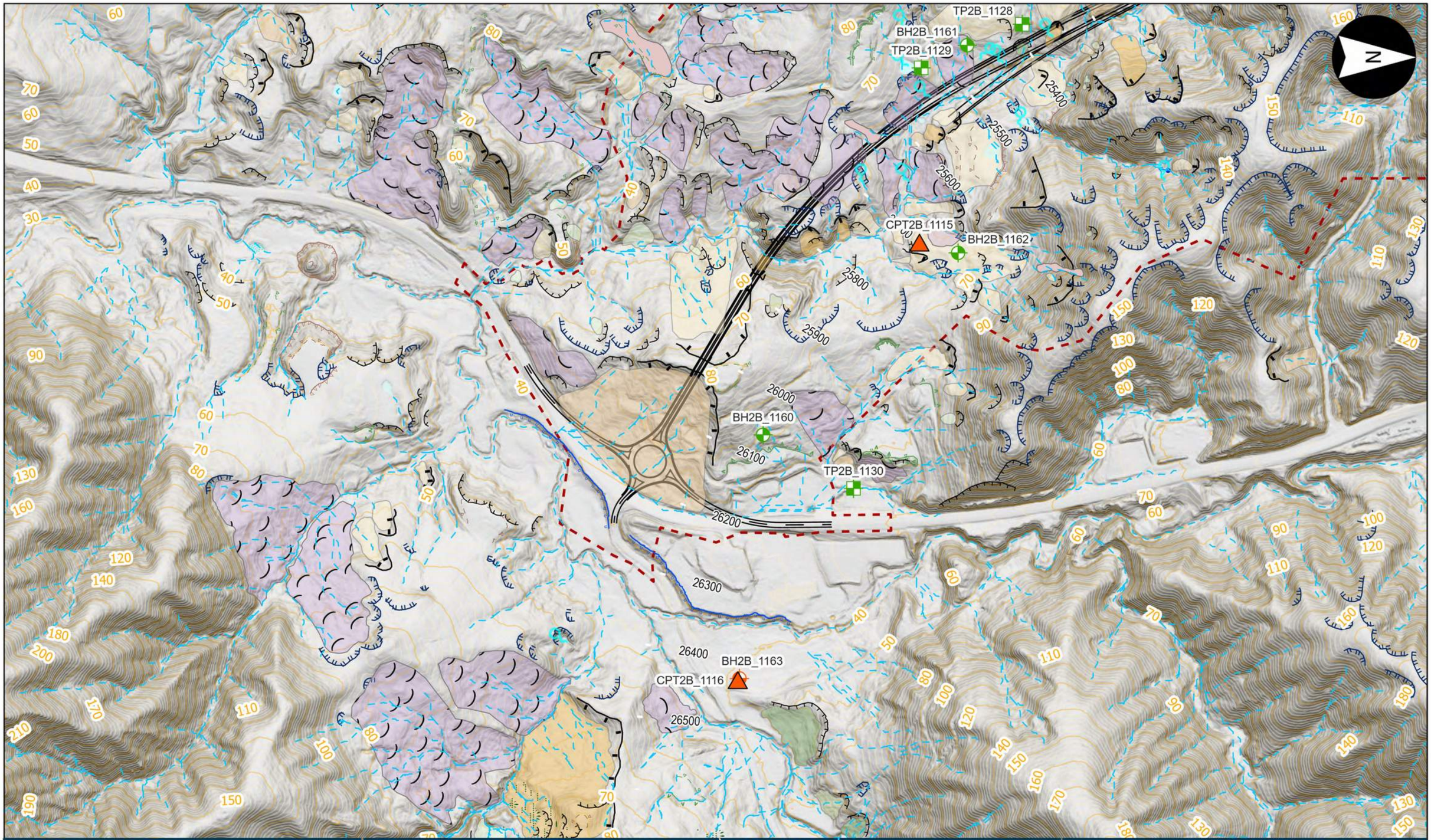

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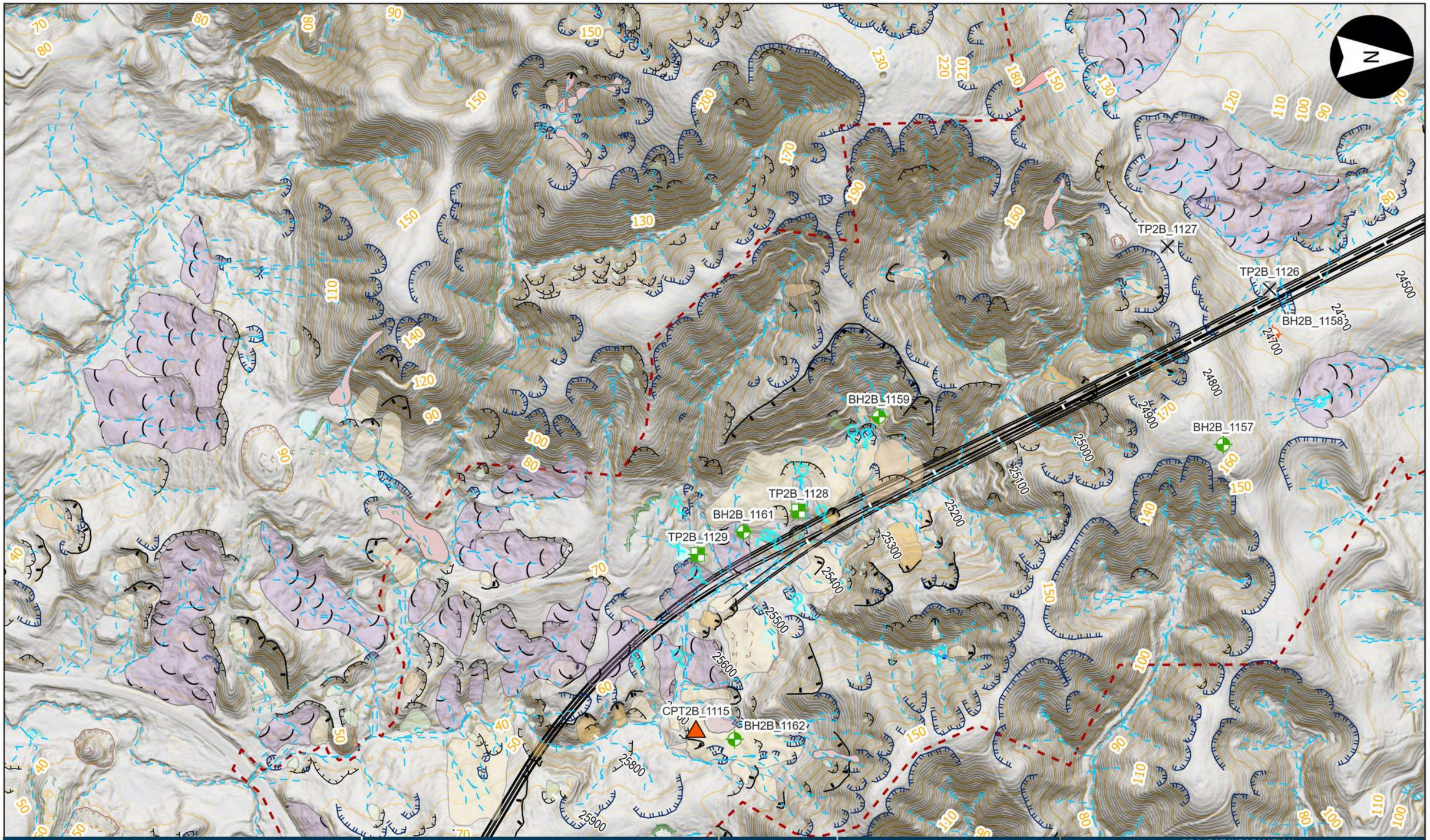

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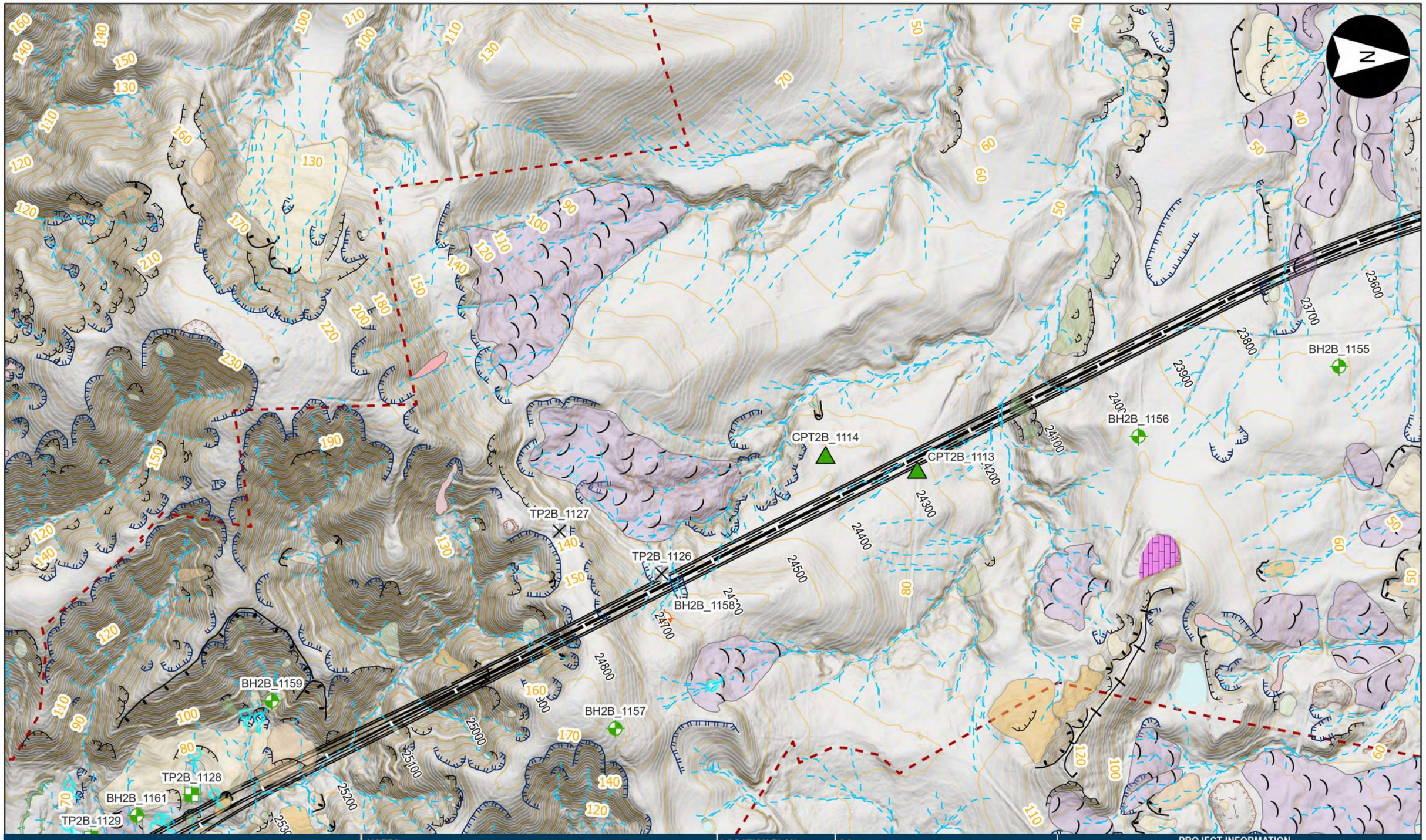

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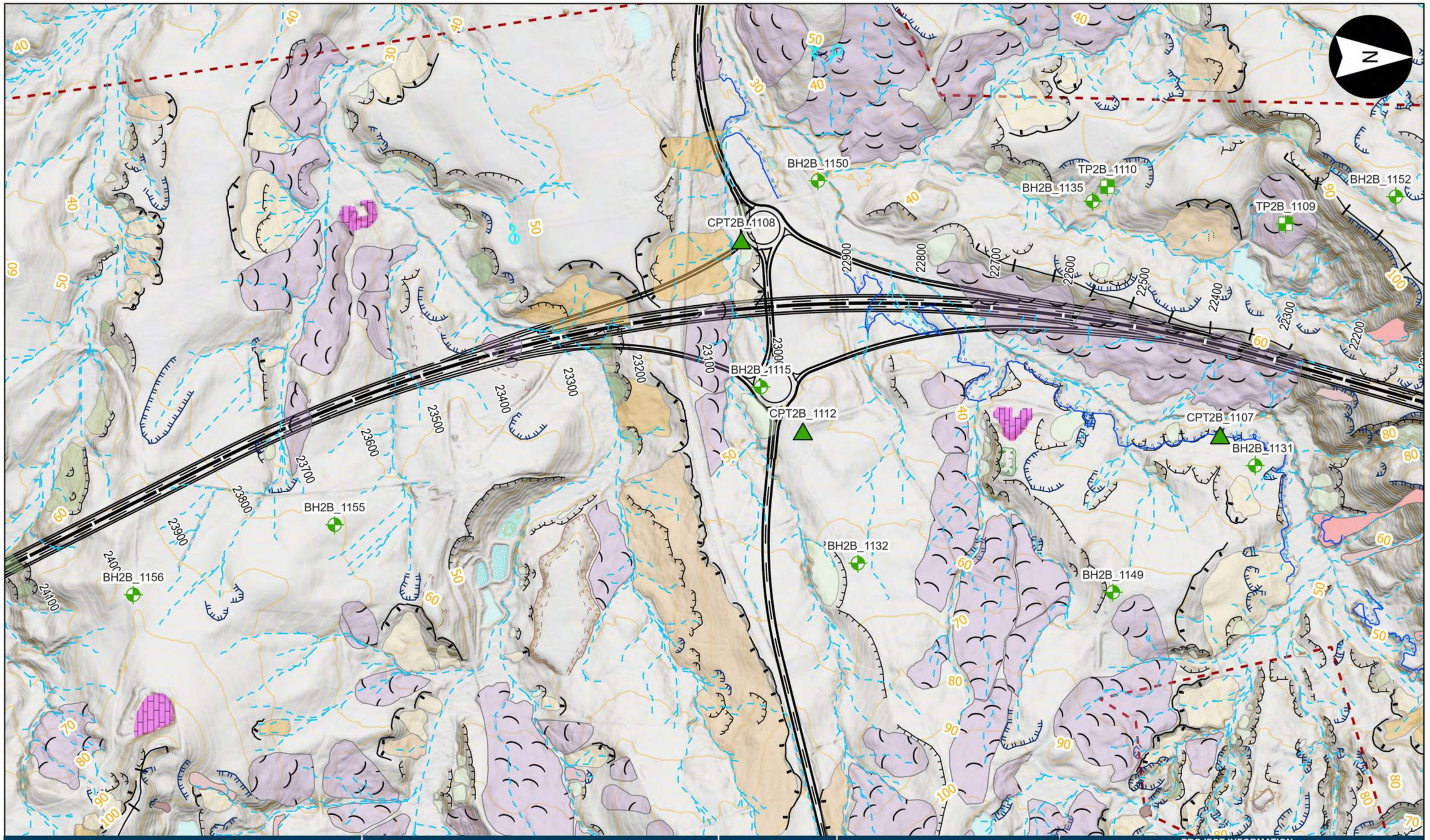

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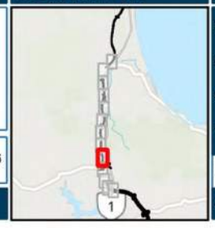

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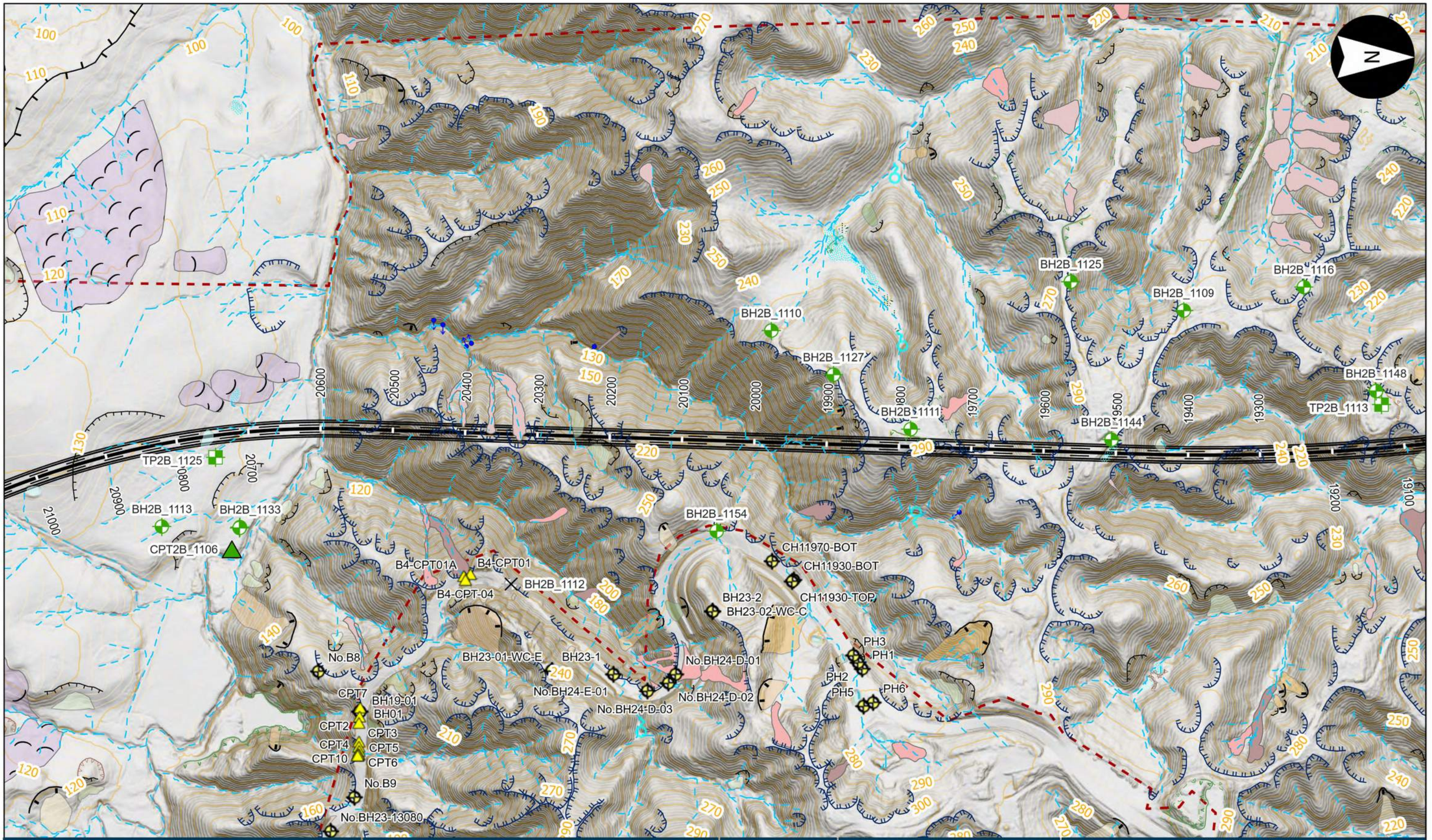

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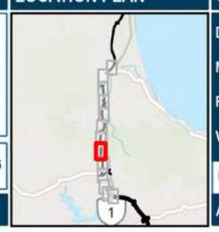

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APPROVED	MICHAEL HORNE	26/03/2026

PROJECT INFORMATION

TITLE: **GROUND INVESTIGATION, GEOMORPHOLOGY AND GEOTECH FEATURES**

SECTION: **BRYNDERWYN HILLS SECTION**

DOC CODE:10722-PTA-2B0-GL-SKC-0207 SHEET 7 OF 13 B

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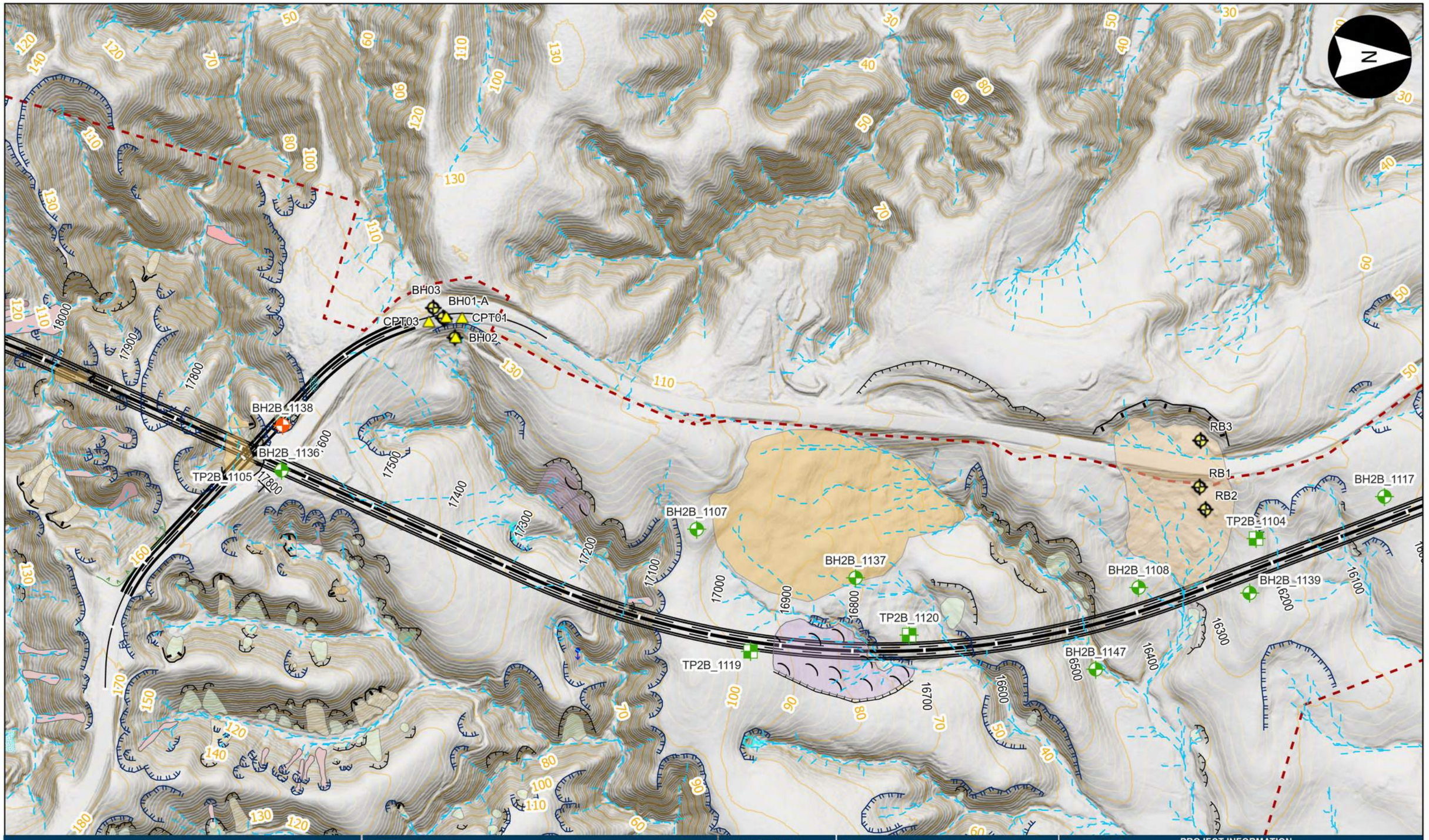

NZ TRANSPORT AGENCY WAKA KOTAHI | Northland Corridor | Roads of National Significance

A3 Scale: 1:5,000 | COORDINATE SYSTEM: NZGD 2000 New Zealand Transverse Mercator

NOTES

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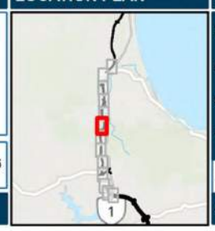
REV	REVISION DETAILS	DATE
B	FOR INFORMATION	26/03/2026

LOCATION PLAN



QA

DRAWN	HARMOND SANTOS	26/03/2026
MAPPED	BEX HAWKSWORTH	26/03/2026
REVIEWED	CHRISTINE PARKES	26/03/2026
VERIFIED	AARON GEORGE	26/03/2026
MICHAEL HORNE		26/03/2026

APPROVED DATE

PROJECT INFORMATION

TITLE: **GROUND INVESTIGATION, GEOMORPHOLOGY AND GEOTECH FEATURES**

SECTION: **BRYNDERWYN HILLS SECTION**

DOC CODE:10722-PTA-2B0-GL-SKC-0208 SHEET 8 OF 13 B

DOCUMENT CODE REV

NZ TRANSPORT AGENCY WAKA KOTAHI | Northland Corridor | Roads of National Significance

A3 Scale: 1:5,000 | COORDINATE SYSTEM: NZGD 2000 New Zealand Transverse Mercator

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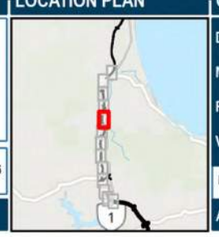
REV	REVISION DETAILS	DATE
B	FOR INFORMATION	26/03/2026

LOCATION PLAN



QA

DRAWN	HARMOND SANTOS	26/03/2026
MAPPED	BEX HAWKSWORTH	26/03/2026
REVIEWED	CHRISTINE PARKES	26/03/2026
VERIFIED	AARON GEORGE	26/03/2026
MICHAEL HORNE		26/03/2026

APPROVED DATE

PROJECT INFORMATION

TITLE: **GROUND INVESTIGATION, GEOMORPHOLOGY AND GEOTECH FEATURES**

SECTION: **BRYNDERWYN HILLS SECTION**

DOC CODE:10722-PTA-2B0-GL-SKC-0209 SHEET 9 OF 13 B

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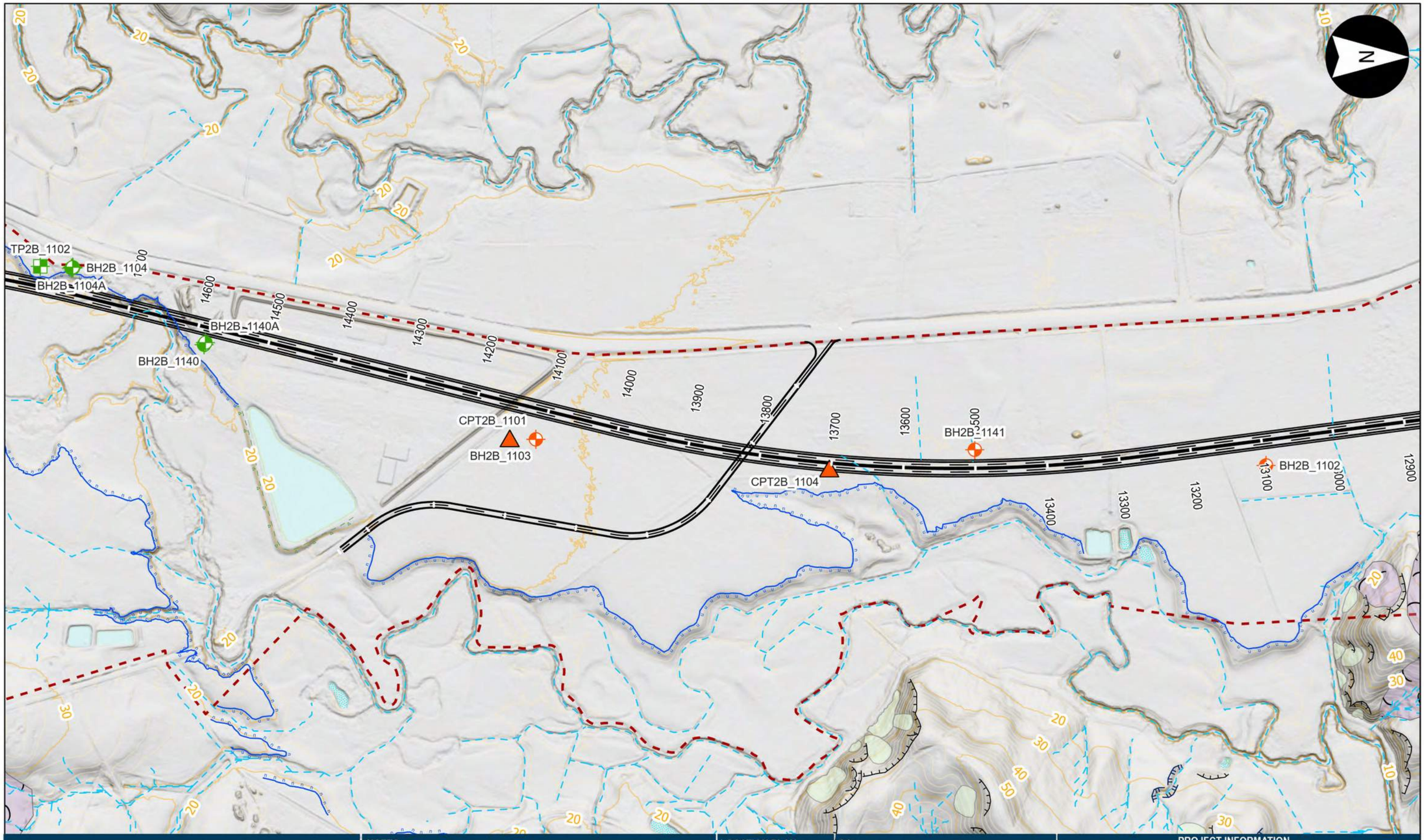

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REV	REVISION DETAILS	DATE
B	FOR INFORMATION	26/03/2026

LOCATION PLAN

QA

DRAWN	HARMOND SANTOS	26/03/2026
MAPPED	BEX HAWKSWORTH	26/03/2026
REVIEWED	CHRISTINE PARKES	26/03/2026
VERIFIED	AARON GEORGE	26/03/2026
MICHAEL HORNE		26/03/2026

APPROVED DATE

PROJECT INFORMATION

TITLE: **GROUND INVESTIGATION, GEOMORPHOLOGY AND GEOTECH FEATURES**

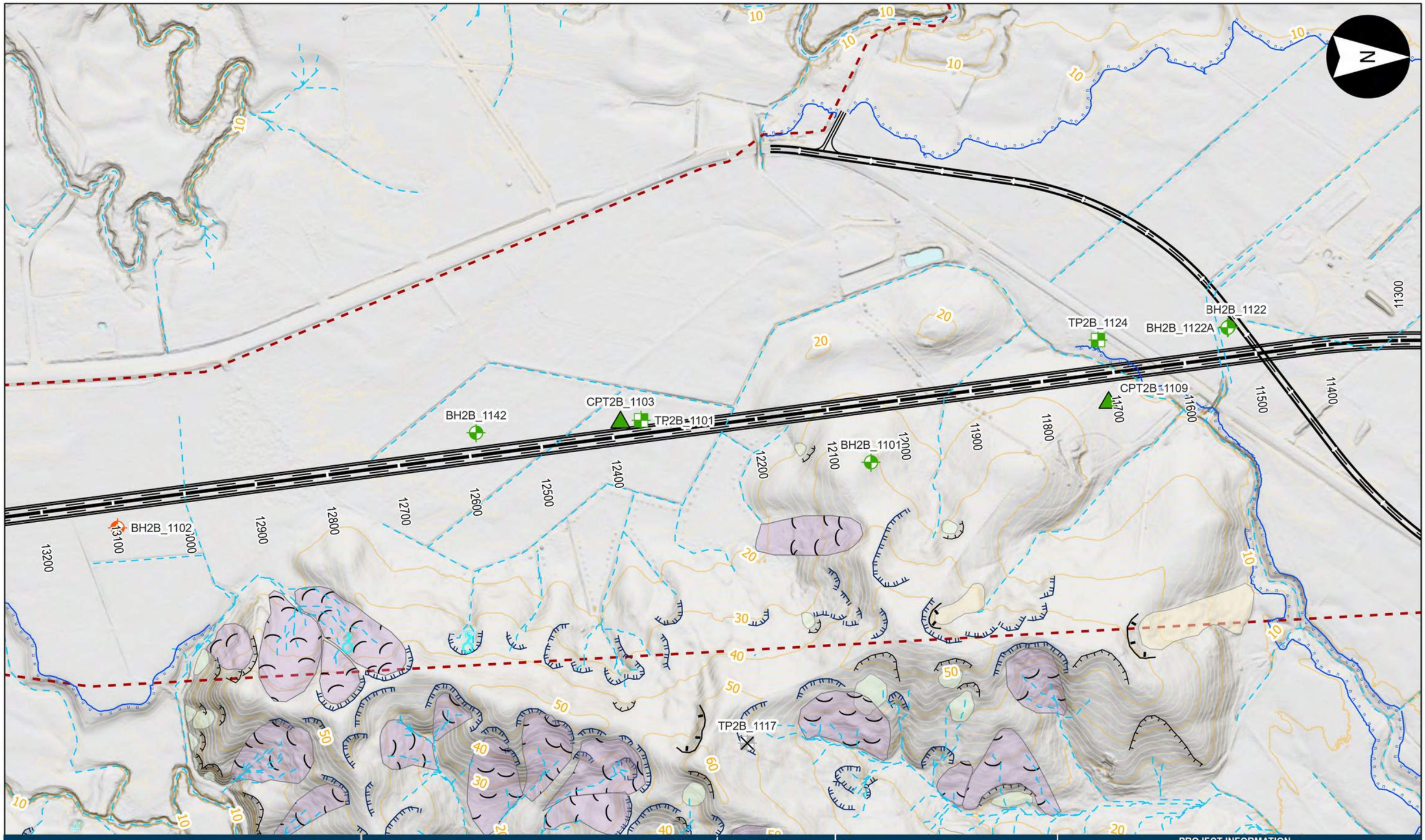
SECTION: **BRYNDERWYN HILLS SECTION**

DOC CODE:10722-PTA-2B0-GL-SKC-0210 SHEET 10 OF 13 B

DOCUMENT CODE REV

NZ TRANSPORT AGENCY WAKA KOTAHI | Northland Corridor | Roads of National Significance

A3 Scale: 1:5,000 | COORDINATE SYSTEM: NZGD 2000 New Zealand Transverse Mercator



NZ TRANSPORT AGENCY WAKA KOTAHI | Northland Corridor | Roads of National Significance

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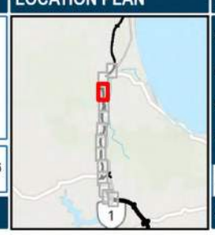
REV	REVISION DETAILS	DATE
B	FOR INFORMATION	26/03/2026

LOCATION PLAN



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DRAWN	HARMOND SANTOS	26/03/2026
MAPPED	BEX HAWKSWORTH	26/03/2026
REVIEWED	CHRISTINE PARKES	26/03/2026
VERIFIED	AARON GEORGE	26/03/2026
MICHAEL HORNE		26/03/2026

APPROVED DATE

PROJECT INFORMATION

TITLE: **GROUND INVESTIGATION, GEOMORPHOLOGY AND GEOTECH FEATURES**

SECTION: **BRYNDERWYN HILLS SECTION**

DOC CODE:10722-PTA-2B0-GL-SKC-0211 SHEET 11 OF 13 B

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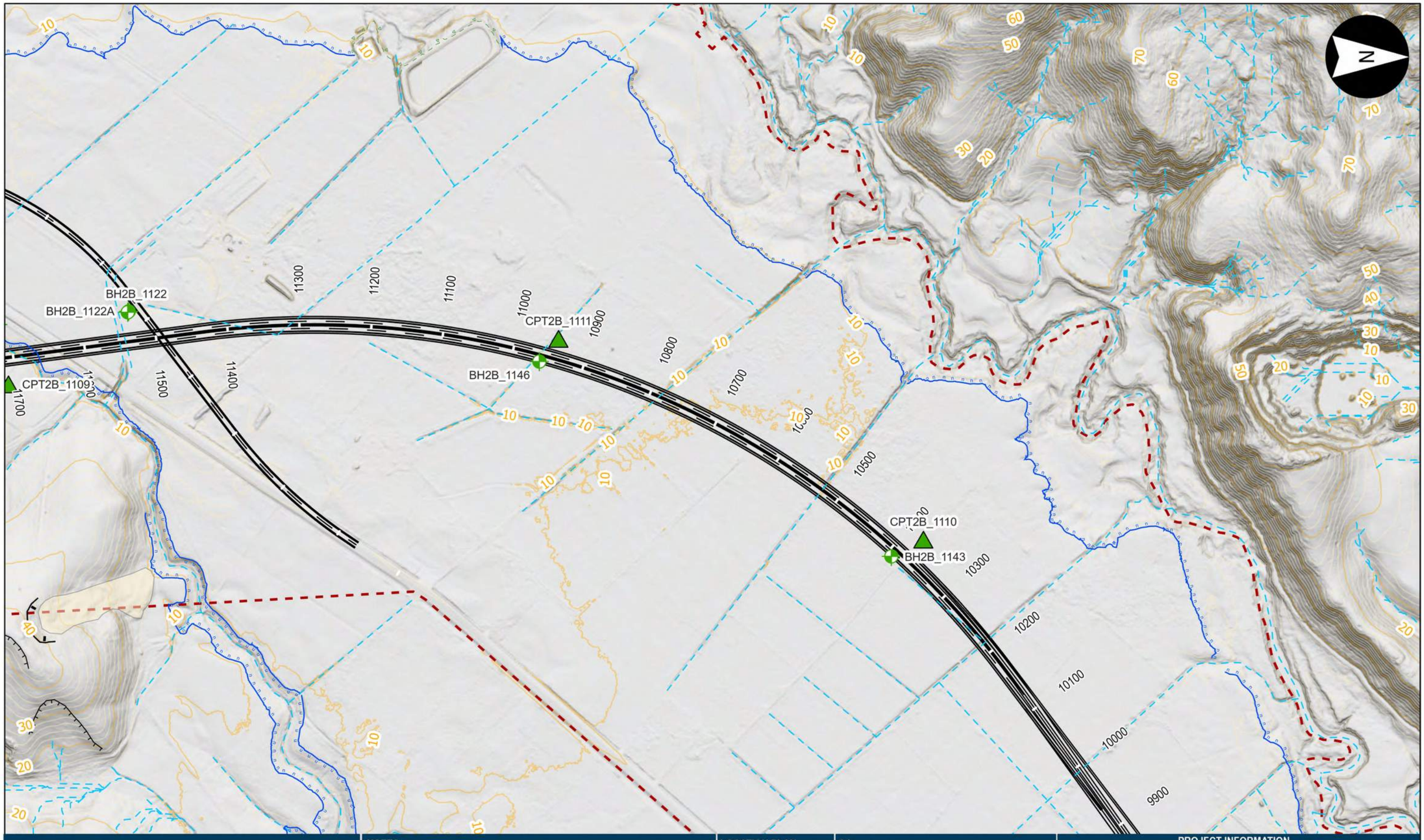

NZ TRANSPORT AGENCY WAKA KOTAHI

Northland Corridor | Roads of National Significance

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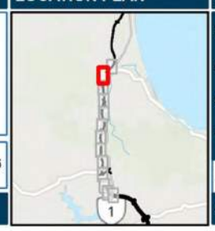
REV	REVISION DETAILS	DATE
B	FOR INFORMATION	26/03/2026

LOCATION PLAN



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DRAWN	HARMOND SANTOS	26/03/2026
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MICHAEL HORNE		26/03/2026

APPROVED DATE

PROJECT INFORMATION

TITLE: GROUND INVESTIGATION, GEOMORPHOLOGY AND GEOTECH FEATURES

SECTION: BRYNDERWYN HILLS SECTION

DOC CODE:10722-PTA-2B0-GL-SKC-0212 SHEET 12 OF 13 B

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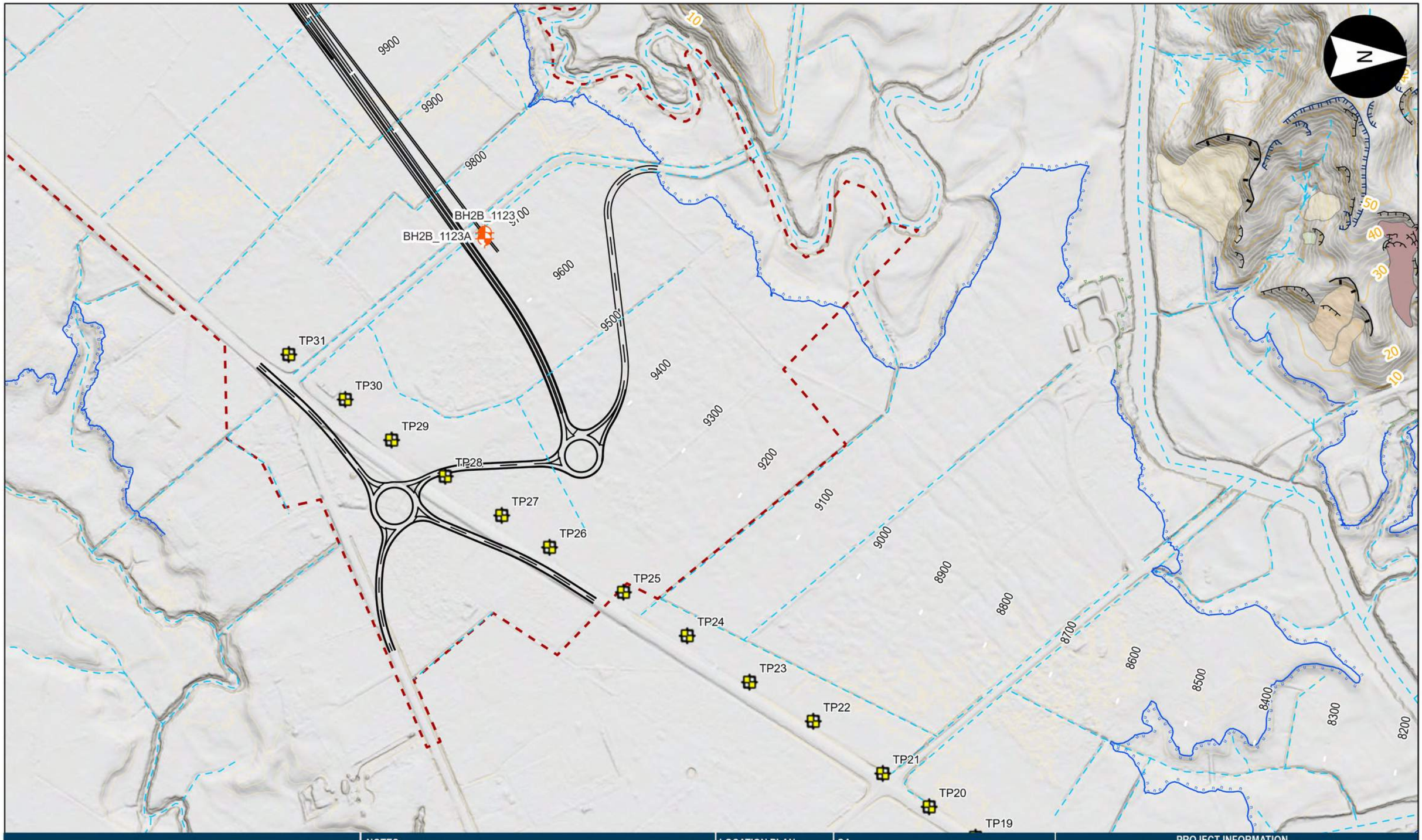

NZ TRANSPORT AGENCY WAKA KOTAHI

Northland Corridor | Roads of National Significance

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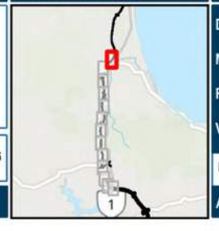

QA

DRAWN	HARMOND SANTOS	26/03/2026
MAPPED	BEX HAWKSWORTH	26/03/2026
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DOC CODE:10722-PTA-2B0-GL-SKC-0213 SHEET 13 OF 13 B

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