Sensitivity: General

# Napier Road Footbridge Concept Options Report

Prepared for Taupo District Council
Prepared by Beca Limited

**13 November 2023**



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## Revision History

| Revision Nº | Prepared By | Description | Date |
|---|---|---|---|
| A | Denzel Belbin<br>Lance Knauf | For Client Review | 13/11/2023 |
| | | | |
| | | | |
| | | | |
| | | | |

## Document Acceptance

| Action | Name | Signed | Date |
|---|---|---|---|
| Prepared by | Lance Knauf |  | 13/11/2023 |
| Reviewed by | Ken Read |  | 13/11/2023 |
| Approved by | Andrew Ball |  | 13/11/2023 |
| on behalf of | Beca Limited | | |

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# Executive Summary

The Napier Road footbridge is located 3km southeast of the Taupo CBD, on the northern side of Napier Road near the crest of a 15m high slope. Since its construction in 2010, deformation and settlement of the footbridge has occurred a decision was made to close the footbridge in early 2023.

Taupo District Council have requested Beca Ltd (Beca) to assess the current condition of the footbridge and provide concept options to restore the footbridge.

Site observations identified a slip headscarp approximately 30m long, extending from the eastern end of the footbridge to 5m west of the footbridge.

The maximum amount of displacement is observed between 5m and 10m in from the eastern end. At this location the headscarp was observed between the footbridge and kerb. No deformation was observed in the western half of the footbridge where the headscarp was observed on the downslope side of the footbridge.

The 15m high heavily vegetated slopes below the footbridge were found to be steeper than suggested by the available LIDAR data. This discrepancy may be due to the dense vegetation. Beyond the slope crest, the upper 5m of the slope is approximately 60° to the horizontal, below which the gradient reduces to an estimated 30° which reduces further towards the base of the slope.

Site testing found that the foundation soils and slope below the footbridge comprises low strength sand fill to a depth of the order of 4m. The fill is estimated to be approximately 30m to 35m in length along the carriageway.

We consider that the footbridge deformation is most likely caused by failure of the low strength sand fill which is interpreted to have been pushed out over the edge of the natural gully slopes during initial road construction or widening the works that occurred between 1987 and 1990.

The rate of deformation has likely been accelerated by the placement of additional fill between 2008 and 2010 at the top of the slope and construction of the footbridge. Deformation (both horizontal and vertical) is expected to continue without mitigation. The absence of deformation or cracking within the road suggests, the low strength fill is likely restricted to the footpath and berm areas, however based on the preliminary geotechnical investigations undertaken the risk to the road is unknown.

Based on the above assessment the following concept options were considered:

- Option 1 – Underpinning the existing structure
- Option 2 – Footbridge ‘like for like’ replacement
- Option 3 – Footpath relocation
- Option 4 - Road and footpath realignment
- Option 5 – Arch bridge
- Option 6A – Low retaining wall
- Option 6B – High retaining wall

With consideration to construction access, protection of both the road and footpath networks and costs we recommend Options 2, 4 or 6A to be considered further. Further geotechnical investigation may be required to quantify the risk to the road depending on the option selected. Early involvement from a suitably skilled contractor will be beneficial during the concept option assessment.

# 1 Introduction

A footbridge on Napier Road, Taupo has been closed to pedestrians due to excessive deformation of the bridge.

Taupo District Council have requested Beca Ltd (Beca) to assess the current condition of the footbridge and provide concept options to restore the footbridge.

This assessment comprises a desktop study of publicly available information, and a site-specific ground investigation.

This report summarises the findings of the investigation and provides concept remedial options for the footbridge.

# 2 Site Description

The footbridge is located on the north side of Napier Road, in the Hilltop subdivision of Taupo, approximately 3km southeast of the Taupo CBD.

The footbridge runs along the crest of a 15m high slope which falls at angles of up to 60 degrees down to the stream at the base of the slope (See the Geotechnical Investigation Plan presented in Appendix A).

The footbridge lies within road reserve, while the slope and wetland at the base of the slope lies within the Dr Armstrong Reserve.

The footbridge is an approximately 24m long and 1.5m wide timber structure founded on timber piles. The timber piles are approximately 200mm in diameter, in 400mm diameter concrete line bores at approximately 2m spacing.

# 3 Background

In January 2023, Taupo District Council closed the footbridge due to concerns over the deformation and engaged Beca to undertake a preliminary assessment.

An inspection carried out by Beca on 1 Feb 2023 found horizontal displacement up to approximately 200mm and vertical displacements ranging between 200mm and 600mm across the length of the footbridge.

A ground investigation was recommended to understand the underlying soil conditions to aid selection of possible remediation works.

# 4 Desktop Study

## 4.1 Historical Photographs

### Aerial Images

The earliest available photograph in 1946 (Retrolens) shows the site prior to the development of Napier Road. The site is situated on the crest of a northwest to southeast orientated natural gully. The slopes appear to be well vegetated and have remained so until this day.

Construction of Napier Road occurred around 1963 comprising cut to fill earthworks.

Road widening works appear to have occurred between 1987 and 1990 to allow for an intersection with Kiddle Drive 50m east of the footbridge. These widening works may have involved fill being placed over the crest of the gully.

No further changes were noted to the layout since 1990.

**Street View and Inspection Photos**

Streetview imagery (roadrunner.argonautltd.co.nz) from 2008 prior to construction of the footbridge shows the crest of the slope to be located approximately 1.5m behind the kerb.

Following construction in 2010, deformation in the railings is shown in 2013.

Subsequent street view and structural inspection photos show a progressive increase in deformation through to 2023 when the bridge was closed.

No cracking or deformation is observed within the road.

### 4.2 Publicly Available Geological Information

The published geology (Townsend et al., 2008) indicates that the Taupo Pumice Formation underlies the site. This is described as primary, non-welded ignimbrite and reworked deposits from the 181 AD Taupo eruption; very low density pumice.

We reviewed the New Zealand Geotechnical Database and The Waikato Regional Council Groundwater map (waikatomaps.waikatoregion.govt.nz) however no relevant information was found.

### 4.3 Active Faults Database

The nearest mapped known active faults shown on the GNS Active Faults Database are the northeast to southwest striking Rotokawa Fault and Aratiatia Fault both located approximately 3km northeast of the site.

## 5 Ground Investigation

The ground investigation was performed on the 19th of September 2023 and consisted of:

- Observation of the headscarp, distribution of deformation, and inspection of exposed soils.
- Measurement of the upper slope angle and estimation of the slope profile down to the base of the gully.
- Observation of the lower slopes for groundwater seepage.
- Five hand auger boreholes progressed to refusal depths of between 1.2m and 5.0m. Refusal was caused by dry hole collapse and gravel intrusion from the loose sands and gravels collapsing into the auger hole.
- Dynamic Cone Penetration (DCP) tests were performed during progression of HA01 and HA02 however the equipment broke during testing. Following which strength was qualitatively assessed during drilling.

The location of the hand augers are shown on the Geotechnical Investigation Plan presented in Appendix A.

Hand Auger logs, including DCP test results and sample photos are presented in Appendix B.

## 6 Ground Model

### 6.1 Site Observations

The headscarp is approximately 30m long, extending 5m west of the footbridge.

The maximum amount of displacement is observed between 5m and 10m in from the eastern end as shown in Figure 1. At this location the headscarp was observed between the footbridge and kerb.



Figure 1: Eastern end of footbridge looking west showing maximum displacement.

Beneath the footbridge sand fill has been placed as shown in Figure 2 beyond the crest observed in 2008.

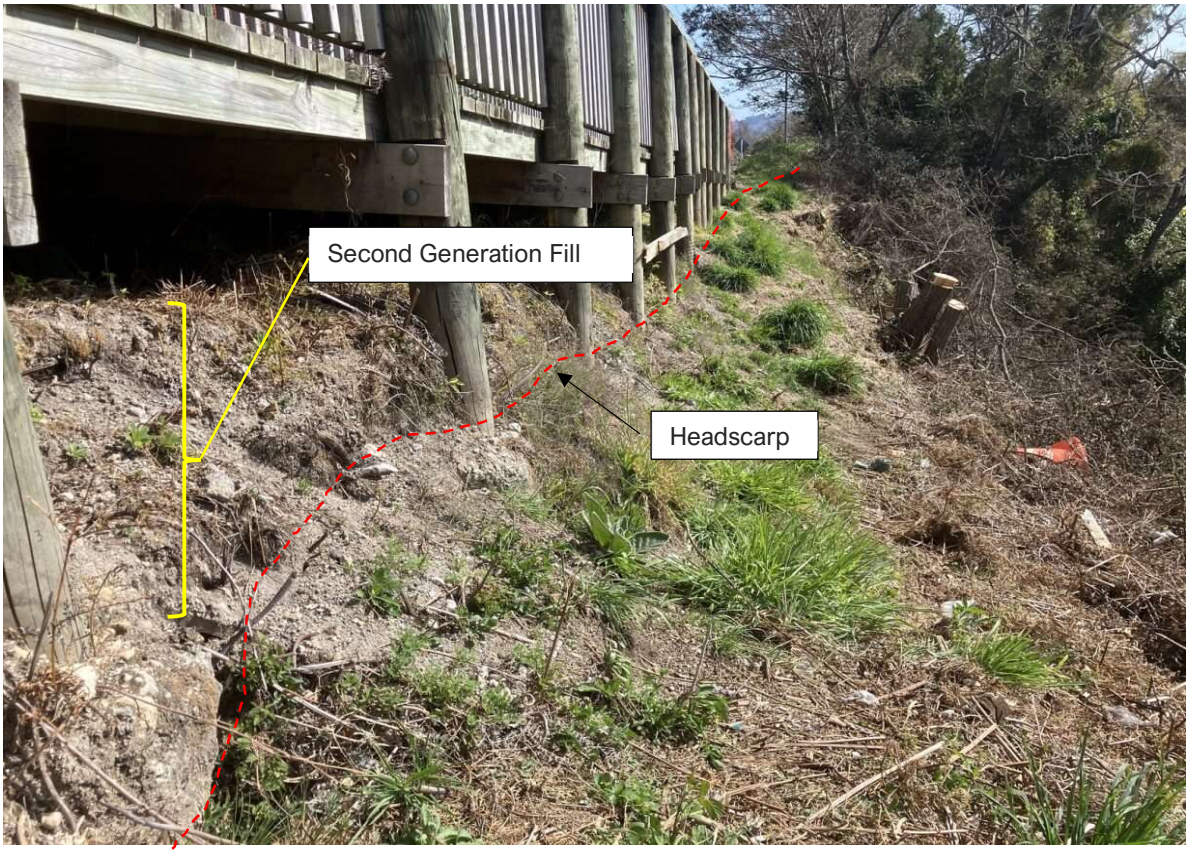



Figure 2: Western extent of footbridge showing underlying fill and headscarp.

No deformation was observed in the western half of the footbridge where the headscarp was observed on the downslope side of the footbridge piles and footpath as indicated on Figure 2.

No cracking or deformation was observed in the road or concrete kerbs. The extent of the headscarp is illustrated on the Geotechnical Investigation Plan provided in Appendix A.

### 6.2 Slope Profile

The slope profile was observed to be steeper than suggested by the LIDAR data. This discrepancy may be due to the dense vegetation.

Beyond the slope crest, the upper 5m of the slope is approximately 60° to the horizontal, below which the gradient reduces to an estimated 30° which reduces further towards the base of the slope. Despite the limited access to the lower slopes, the combination of measurements and estimates are expected to provide a more accurate representation of the ground profile.

The natural slopes observed east of the site were estimated at an overall angle of 60° to the horizontal.

### 6.3 Soil Profile

The soils encountered by the hand augers are summarised in the attached Geological Cross Section presented in Appendix C using the measured and estimated slope profile.

Very loose to loose gravelly sand, with varying organics, interpreted as fill was encountered at all locations to varying depths as detailed below.

Within HA01 the fill was underlain by medium dense to dense sands at a depth of 0.5m. These are inferred as natural soils of the Taupo Pumice Formation and extended beyond the refusal depth of 3.2m.

Collapsing soils within HA02 to HA05 made interpretation difficult. The presence of organics followed by a loss of recovery in both HA02 and HA05 at depths of 3.8m and 2.0m respectively marks the interpreted boundary between the sand fill and in-situ soils.

Sand fill was encountered to refusal depths of 1.6m and 4.0m within HA03 and HA04 respectively.

The results of the hand auger boreholes combined with the site observations suggest the fill extends from the eastern end of the footbridge to a point approximately 5m beyond the western end. The approximate extent of fill is illustrated in the Geotechnical Investigation Plan found in Appendix A.

### 6.4 Groundwater

Groundwater seepages were not observed on any part of the slopes, however the dense vegetation made visibility difficult.

High groundwater was noted across the base of the slope and in the wetland/gully floor at the base of the slope, attributed to the Waipahihi Stream. Based on this observation, the groundwater table is expected to be greater than 10m below the road level.

## 7 Assessed Failure Mechanism

The observed footbridge deformation is likely caused by a slope failure in the low strength sand fill on which it is founded.

Granular soils generally exhibit relatively shallow planar failure mechanisms sub-parallel to the slope face. The failure may progressively mobilise during periods of heavy or sustained rainfall.

The rate of deformation may have been accelerated by the placement of additional fill over the original embankment fill between 2008 and 2010 at the top of the slope, and construction of the footbridge.

# 8 Current Risk

Deformation of the footbridge (both horizontal and vertical) is expected to continue without mitigation.

The extent of the headscarp is likely associated with the extent of low strength fill. The absence of deformation and cracking within the road suggests the low strength fill is likely restricted to the verge area behind the kerb and below the footbridge.

Based on the findings of the preliminary geotechnical investigation undertaken there is an unknown risk to the road. Further investigation within the road would be required to confirm this risk.

# 9 Remedial Concept Options

After assessing the situation and determining the current risk the following remedial concept options have been considered:

- Option 1 – Underpinning the existing structure
- Option 2 – Footbridge ‘like for like’ replacement
- Option 3 – Footpath relocation
- Option 4 - Road and footpath realignment
- Option 5 – Arch bridge
- Option 6A – Low retaining wall
- Option 6B – High retaining wall

Concept sketches for each option are presented in Appendix D.

## 9.1 Option 1 – Underpinning the Existing Structure

This would involve installation of new deep piles along the full 24m footbridge length and connection of these to the existing timber structure.

It may be possible to optimise during detailed design such that the new piles are installed at a greater interval than the existing.

The low strength fill material is not expected to provide a suitable bearing stratum and it is recommended that new piles be embedded into the undisturbed natural soils below the fill.

As shown on the concept sketch provided in Appendix D these are anticipated to be a minimum depth of 4m to 6m below road level, however due to uncertainty in the ground model deeper piles may be required.

The piles would need to be suitably sized to resist horizontal forces applied by the ongoing deformation of the fill.

Driven piles are not considered appropriate due to the risk of vibration and energy from the driving process causing settlement and further deformation of the slope and footbridge.

Bored piles will need to be cased or formed by continuous flight auger methods to avoid collapse of the pile bore before casting concrete.

Installation of piles between the road kerb and footbridge carries a significant risk of service strike. Access to the downslope side of the footbridge is limited and therefore may present significant limitation to the feasibility of this option.

This option does not fully address the slope stability risk to the road.

## 9.2 Option 2 – Footbridge Replacement

This option involves demolition and removal of the existing structure to gain access for the plant and materials required to reconstruct the footbridge and install deeper piles as described above.

It may be possible to use steel beams rather than timber to either completely span the high-risk soils or reduce the number of supporting piles required through the loose sands.

Other considerations and risks are the same as mentioned above, however this option has the added benefit that the location of the footbridge could be shifted to avoid a power cable near the road kerb.

This option does not fully address the slope stability risk to the road.

## 9.3 Option 3 – Footpath Relocation

This option involves the relocation of the footpath to the southern side of Napier Road. This is expected to involve the construction of approximately 50m of new footpath and an appropriately designed 20m long pedestrian crossing to re-join the existing footpath beyond the fill extent.

Consideration should be given to the water main located on the southern side of the road.

The slope stability risk to the road is unchanged for this option.

## 9.4 Option 4 – Road and Footpath Realignment

This option involves an approximately 2.5m shift of the northern traffic lane to enable the realignment of the footpath behind the current slip scarp extent.

Road realignment and construction of a new kerb is expected over a length of approximately 80m and will require the removal of the existing concrete traffic island. Footpath realignment is expected to be approximately 35m in length.

This options will not remediate the slope instability which is expected to continue, however this option is expected to provide added resilience to the network at minimal cost.

## 9.5 Option 5 – Arch Bridge

This option involves the removal of the existing footbridge and placement with an arch bridge that spans the extent of low strength fill. This is expected to be of the order of 30m to 35m long. The economic constraints and perceived benefit of this footbridge suggest this option may not be feasible.

The slope stability risk to the road is unchanged for this option.

## 9.6 Option 6 – Retaining Wall

This option would remediate the slip by construction of an approximately 30m long retaining wall to support the existing low strength fill. Two options of wall locations are discussed below.

### 9.6.1 Option 6A – Low wall

To protect the road from ongoing slope instability the construction of a retaining wall along the northern kerbside may be considered. In this location, the depth of low strength fill is anticipated to be nominal such

that a design retained height of the order of 1m to 2m. Resulting pile lengths are of the order of 5m such that the wall could be constructed using timber poles.

This option may be considered in conjunction with Options 3, 4 or 5.

This option primarily protects the road from further slope instability. If used in combination with Option 3 or 4 a footpath can be constructed along a new alignment.

### 9.6.2 Option 6B – High wall

To stabilise the slope and allow the construction of a footpath in the existing footbridge location a retaining wall could be constructed on the downslope side of the existing footbridge. This stabilises the road while enabling fill to be placed at the crest of the slope such that the footpath can be constructed at grade without the need for a bridging structure.

In this location the depth of low strength fill is expected to be of the order of 3m. Retaining wall design would need to allow for forces applied by the low strength fill with addition of fill required to form the footpath. Combined with an allowance for future regression of the slopes below the wall design retaining heights of the order of 3 to 5m are anticipated resulting in pile lengths of the order of 8 to 10m. At this length steel H-piles or concrete reinforced piles are expected to be required with the potential need for ground anchors to provide additional support to the wall.

This option protects both the road and footpath on the existing alignment from ongoing slope instability

## 9.7 Concept Options Summary

The pros and cons associated with each of the above options are summarised below.

| Option | Relative Cost | Pros | Cons |
|---|---|---|---|
| Option 1 – Underpinning the existing structure | Medium | Reuse the existing structure. | Access during construction may deem it not feasible without removal of the footbridge.<br>No protection of the road.<br>Design and construction risk. |
| Option 2 – Footbridge replacement | Medium | Removal of structure creates easier access, likely reducing time for construction. | Costs of rebuilding the footbridge<br>No protection of the road.<br>Design and construction risk. |
| Option 3 – Footpath relocation | Very Low | Quick easy solution to the immediate problem. | Road remains at risk.<br>Pedestrians may not want to cross road twice and will walk along berm.<br>Increased safety hazard to pedestrians crossing the road twice and/or walking along the berm. |
| Option 4 – Road and footpath realignment | Low | Added resilience to road and footpath network at relatively low cost. | Change of existing road geometry.<br>Slope instability will continue – 'buying time'. |
| Option 5 – Arch Bridge | High | Reconstruction of a resilient footbridge. | High cost.<br>No protection of the road. |
| Option 6A – Low Wall | Medium | Primarily protects the road.<br>If used in combination with Option 3 or 4 can protect the | Construction within the northern traffic lane.<br>Relocation of power cable. |

| Option | Relative Cost | Pros | Cons |
|---|---|---|---|
| | | road and enable footpath construction at a reasonable cost. | |
| Option 6B – High Wall | High | Provided long term protection of footpath and road. | Design and construction risks.<br>High cost.<br>Protection or relocation of power cable during construction. |

# 10 Recommendation

Based on the above assessment we recommend Options 2, 4 or 6A should be considered further.

Options 2 and 6A require further investigation to progress design. That investigation is likely to comprise machine boreholes and cone penetration testing within the road and berm to confirm the extent of the low strength fill and to quantify risk to the road. Survey of the slope and road configuration would be required.

Option 4 could be adopted without further investigation, however that would require an acceptance of the unknown slope instability risk. To assess this risk a slightly reduced scope of investigation and survey compared to that above may be undertaken.

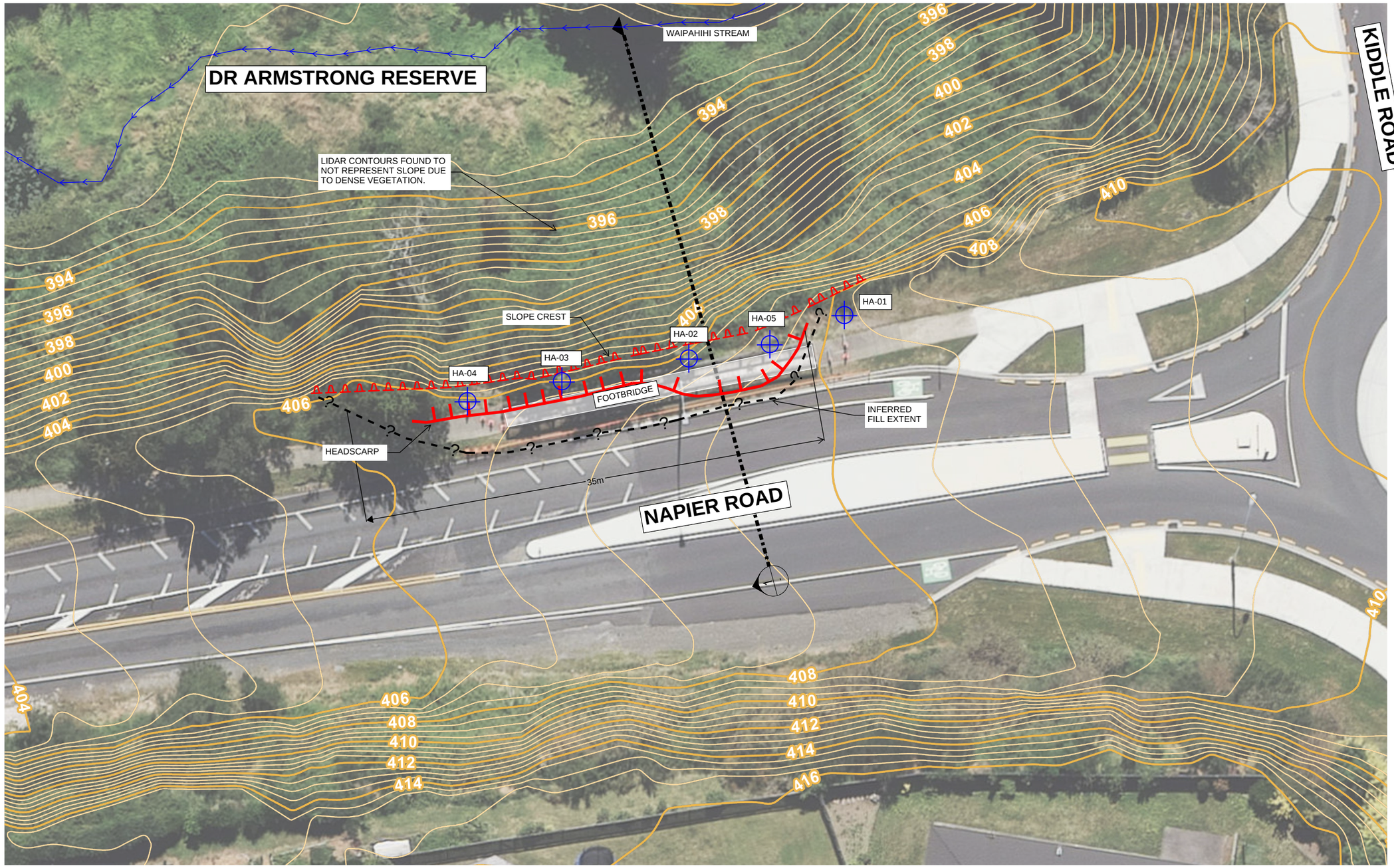
It is expected that early involvement from a suitably skilled contractor will be beneficial during the concept option assessment.

Following client review of this report we can discuss how to proceed with the project.

# A

## Appendix A – Geotechnical Investigation Plan

Drawing Plotted: 11:55 am




PDF ONLY
NO DWG FILE

| No. | Revision | By | Chk | Appd | Date |
|---|---|---|---|---|---|
| A | FOR CLIENT INFORMATION | DB | KR | AB | |

| | | | |
|---|---|---|---|
| Original Scale (A1) | 1:150 | Design | DB |
| Reduced Scale (A3) | 1:300 | Drawn | DB |
| | | Dsg Verifier | KR |
| | | Drg Check | KR |

Approved For Construction* Date

* Refer to Revision 1 for Original Signature

Client: CO-LAB BETTER TOGETHER; GREAT LAKE TAUPŌ Taupō District Council

Project: CO-LAB STRUCTURES ASSET MANAGEMENT SERVICES

Title: NAPIER ROAD RP 704 (DEBRETTS) FOOTBRIDGE GEOTECHNICAL INVESTIGATION PLAN

Discipline: GEOTECHNICAL

Drawing No.: 5642469-5105-GE-SK002

Rev.: A

Document No. CO:LAB HORIZONTAL A1 TDC.DWT

DO NOT SCALE FOR SET OUT DIMENSIONS

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# B

## Appendix B – Hand Auger Logs

# Geotechnical Log Key Sheet

## SOIL AND ROCK DESCRIPTIONS

Soil and Rock Descriptions are in general accordance with the NZ Geotechnical Society (NZGS), 2005.
Hand-held Vane Shear Strength measurements are in general accordance with the NZGS, 2001.

### METHODS

| | |
|---|---|
| BH | Machine Borehole |
| CPT | Cone Penetration Test |
| DCP | Dynamic Cone Penetration |
| HA | Hand Auger |
| SPT | Standard Penetration Test |
| IVAN | In-situ Vane Test |
| MA | Machine Auger |
| OB | Open Barrel |
| SNC | Sonic Core Drilling |
| TP | Test Pit/Trench |
| TT | Triple Tube |
| PT | Thin-walled Open Drive Tube |
| VE | Vacuum Excavation |
| W | Wash Boring |

### WEATHERING

| | |
|---|---|
| CW | Completely Weathered |
| HW | Highly Weathered |
| MW | Moderately Weathered |
| SW | Slightly Weathered |
| UW | Unweathered |

### SAMPLES

| | |
|---|---|
| B | Bulk Disturbed Sample |
| C | Core Sample |
| D | Small Disturbed Sample |
| U | Thin-wall Open Drive (Push) Tube Sample |

### WATER

Groundwater Level (GWL)

### IN-SITU TESTS

*Shear Vane*

| | |
|---|---|
| Su | In-situ peak undrained shear strength and remoulded undrained shear strength |
| UTP | Unable to Penetrate |
| CB | Pilcon-type vane tested in Core Barrel |
| DH | Pilcon-type vane tested in-situ (downhole) |
| GV | Geonor vane, tested in-situ |
| IcV | Icone vane, tested in-situ |

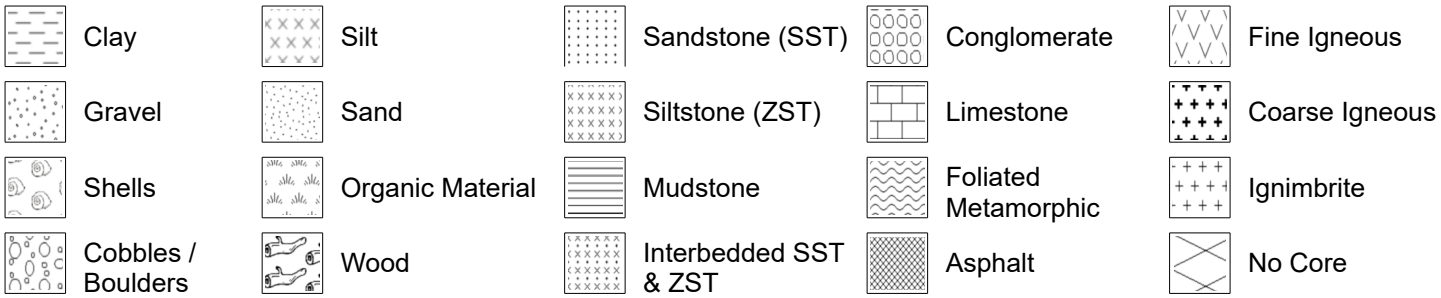
*Standard Penetration Test (SPT)*

| | |
|---|---|
| N | SPTn Sampler (Split-spoon) |
| Nc | SPTn Solid Cone |
| HB | SPT Hammer Bouncing |

### TERMINOLOGY

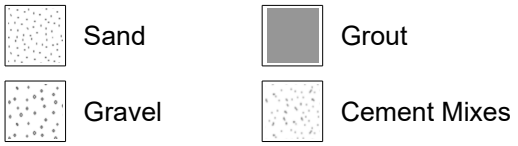
| | |
|---|---|
| RL | Relative Ground Level |
| RQD | Rock Quality Designation |

### GRAPHIC LOG (1 or a combination of the following)

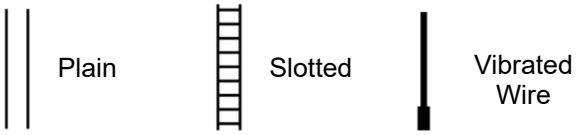



### MONITORING INSTALLATION

*Backfill Material*




*Standpipe*




### ORGANIC SOILS

*Von Post Degree of Humification*

| | |
|---|---|
| H1 | Completely unconverted and mud-free peat, when pressed gives clear water and plant structure is visible. |
| H2 | Partially unconverted and mud-free peat, when pressed gives almost clear water and plant structure is visible. |
| H3 | Very slightly decomposed or very slightly muddy peat, when pressed gives marked muddy water, no peat substance passes through the fingers and plant structure is less visible. |
| H4 | Slightly decomposed or slightly muddy peat, when pressed gives muddy water and plant structure is less visible. |
| H5 | Moderately decomposed or very muddy peat with growth structure evident but slightly obliterated. |
| H6 | Moderately decomposed or very muddy peat with indistinct growth structure. |
| H7 | Fairly well decomposed or very muddy peat but the growth structure can just be seen. |
| H8 | Well decomposed or very muddy peat with very indistinct growth structure. |
| H9 | Practically decomposed or mud-like peat in which almost no growth structure is evident. |
| H10 | Completely decomposed or mud peat where no growth structure can be seen, entire substance passes through the fingers when pressed. |

# Hand Auger Log

**Hand Auger ID:** HA-01

Sheet 1 of 1

| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project Number:** | 5642469 |
| **Site Location:** | Napier Road, Footbridge - Refer to Site Plan | **Client:** | Taupo District Council |
| **Location:** | 4m East of foot bridge | **Coordinate System:** | NZTM2000 |
| | | **Northing:** | 5711491.7 |
| | | **Easting:** | 1869217.0 |
| | | **Vertical Datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 408.00 |
| | | **Location Method:** | Map +/- 1m |

| Groundwater (m) | In Situ Tests: Su (kPa) | In Situ Tests: Scala blows/50mm | Samples | Depth (m) | RL (m) | Graphic Log | Soil/ Rock Description | Geological Unit |
|---|---|---|---|---|---|---|---|---|
| | | 1 1 2 2 3 4 3 4 4 3 2 3 3 4 3 5 4 5 5 4 5 3 4 4 5 4 4 4 3 4 3 3 2 2 2 2 4 5 3 5 4 4 3 4 5 6 5 | | 0.5 | 407.5 | | Loose, fine gravelly medium to coarse SAND, minor silt, trace organics; dark brown; moist. Gravel: sub-angular, SW, andesite. Organics: rootlets. | Fill |
| | | | | | | | Medium dense, fine to medium gravelly fine to coarse SAND, minor silt; greyish brown; moist. Gravel: sub-angular, MW, pumice. | |
| | | | | 1.0 | 407.0 | | Medium dense, fine to medium gravelly fine to coarse SAND; light grey; moist. Gravel: sub-rounded, MW, pumice. | Taupo Pumice Formation |
| | | | | 1.5 | 406.5 | | *0.70m: dense.* | |
| | | | | 2.0 | 406.0 | | Dense, fine to coarse SAND, some fine to medium gravel; brownish grey; moist. Gravel: sub-rounded, MW, pumice. | |
| | | | | 2.5 | 405.5 | | *2.00 - 2.20m: minor fine to medium gravel; light grey.* | |
| | | | | | | | *2.70m: minor fine to medium gravel.* | |
| | | | | 3.0 | 405.0 | | *3.00m: minor medium to coarse gravel.* | |
| | | | | | | | 3.20m - End of hand auger, hole collapsed to 3m. | |
| | | | | 3.5 | 404.5 | | | |
| | | | | 4.0 | 404.0 | | | |
| | | | | 4.5 | 403.5 | | | |

| | | | | |
|---|---|---|---|---|
| **Date Started:** | 19/09/2023 | **Vane ID:** | N/A | **Comments:** |
| **Logged By:** | DB | **Vane Width:** | N/A | Groundwater not encountered. |
| **Diameter:** | 50mm | **Vane Type:** | N/A | |

For Explanation of Symbols and Abbreviations See Key Sheet

# Photo Log

**Location ID:** HA-01



| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project number:** | 5642469 |
| **Site location:** | Napier Road, Footbridge - Refer to Site Plan | **Client Name:** | Taupo District Council |
| **Location:** | 4m East of foot bridge | **Coordinate system:** | NZTM2000 |
| | | **Northing:** | 5711491.7 |
| | | **Easting:** | 1869217.0 |
| | | **Vertical datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 408.00 |
| | | **Location method:** | Map +/- 1m |




Box 1 - 0.00mbgl to 3.20mbgl

# Hand Auger Log

**Hand Auger ID:** HA-02

Sheet 1 of 1

| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project Number:** | 5642469 |
| **Site Location:** | Napier Road, Footbridge - Refer to Site Plan | **Client:** | Taupo District Council |
| **Location:** | Area of maximum displacement | **Coordinate System:** | NZTM2000 |
| | | **Northing:** | 5711490.6 |
| | | **Easting:** | 1869209.3 |
| | | **Vertical Datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 406.00 |
| | | **Location Method:** | Map +/- 1m |

| Groundwater (m) | In Situ Tests: Su (kPa) | In Situ Tests: Scala blows/50mm | Samples | Depth (m) | RL (m) | Graphic Log | Soil/ Rock Description | Geological Unit |
|---|---|---|---|---|---|---|---|---|
| | | 0 0 0 0 0 0 0 0 2 4 3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 1 1 1 0 1 0 0 1 0 0 0 0 1 1 0 0 0 0 1 2 2 1 1 0 1 1 1 0 1 1 1 1 | | 0.5 | 405.5 | | Very loose, fine to medium gravelly fine to coarse SAND, minor organics, trace silt; dark grey, mottled brown and white; dry, well graded, non plastic. Sand: sub-angular to sub-rounded, pumice. Gravel: sub-angular to sub-rounded, slightly weathered, andesite. Organics: amorphous, trace roots. Organic odour. | Fill |
| | | | | | | | 0.7m to 0.9m: no recovery. | |
| | | | | 1.0 | 405.0 | | Very loose, fine to coarse SAND, some fine to medium gravel, minor silt; dark brownish grey; dry, well graded. Gravel: sub-angular to sub-rounded, unweathered, pumice. | |
| | | | | 1.5 | 404.5 | | *1.40 - 1.60m: fine to medium gravelly SAND; greyish brown, mottled white [CW pumice clast].* | |
| | | | | 2.0 | 404.0 | | Loose, fine to medium SAND; greyish brown; moist, poorly graded. Sand: sub-angular, pumice.<br>*2.00m: hole collapse to 1.2m.* | |
| | | | | 2.5 | 403.5 | | Very loose, fine to medium gravelly fine to coarse SAND, minor organics, trace silt; dark grey, mottled brown and white; dry, well graded, non plastic. Sand: sub-angular to sub-rounded, pumice. Gravel: sub-angular to sub-rounded, slightly weathered, andesite. Organics: amorphous, trace roots. Organic odour.<br>*2.60m: mottled orange and white.* | |
| | | | | 3.0 | 403.0 | | | |
| | | | | 3.5 | 402.5 | | 'Very loose', fine to medium gravelly fine to coarse SAND, minor organics; dark brownish grey, mottled white., moist, well graded. Gravel: sub-angular to sub-rounded, pumice. Organics: amorphous.<br>*3.60 - 3.80m: some organics; black. Organics: amorphous.* | |
| | | | | 4.0 | 402.0 | | 3.8m to 5.0m: no recovery. | Taupo Pumice Formation |
| | | | | 4.5 | 401.5 | | 5.00m - End of hand auger, hole collapsed to 4.7m and obstructed by gravel. | |

| | | | | |
|---|---|---|---|---|
| **Date Started:** | 19/09/2023 | **Vane ID:** | N/A | **Comments:** |
| **Logged By:** | LK | **Vane Width:** | N/A | Groundwater not encountered. |
| **Diameter:** | 50mm | **Vane Type:** | N/A | |

For Explanation of Symbols and Abbreviations See Key Sheet

# Photo Log

**Location ID:** HA-02



| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project number:** | 5642469 |
| **Site location:** | Napier Road, Footbridge - Refer to Site Plan | **Client Name:** | Taupo District Council |
| **Location:** | Area of maximum displacement | **Coordinate system:** | NZTM2000 |
| | | **Northing:** | 5711490.6 |
| | | **Easting:** | 1869209.3 |
| | | **Vertical datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 406.00 |
| | | **Location method:** | Map +/- 1m |




Box 1 - 0.00mbgl to 5.00mbgl

# Hand Auger Log

**Hand Auger ID:** HA-03

Sheet 1 of 1

| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project Number:** | 5642469 |
| **Site Location:** | Napier Road, Footbridge - Refer to Site Plan | **Client:** | Taupo District Council |
| **Location:** | 3m inside western end of footbridge. | **Coordinate System:** | NZTM2000 |
| | | **Northing:** | 5711489.1 |
| | | **Easting:** | 1869203.9 |
| | | **Vertical Datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 405.00 |
| | | **Location Method:** | Map +/- 1m |

| Groundwater (m) | In Situ Tests: Su (kPa) | In Situ Tests: Scala blows/50mm | Samples | Depth (m) | RL (m) | Graphic Log | Soil/ Rock Description | Geological Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | 0.0 | 405.0 | | 'Very loose', fine to coarse SAND, some fine to medium gravel; brownish grey; dry, well graded. Gravel: sub-angular to sub-rounded, pumice, andesite. | Fill |
| | | | | 0.5 | 404.5 | | 'Very loose', fine to medium gravelly fine to coarse SAND; light grey, mottled brown and white; dry, well graded, pumice. Gravel: sub-rounded, pumice. | |
| | | | | | | | 0.6m to 0.8m: no recovery. | |
| | | | | 1.0 | 404.0 | | 'Very loose', fine to coarse SAND, some fine to medium gravel; brownish grey; dry, well graded. Gravel: sub-angular to sub-rounded, pumice, andesite. | |
| | | | | | | | 1.2m to 1.6m: no recovery. | |
| | | | | 1.5 | 403.5 | | 1.60m - End of hand auger, refusal on gravel. | |
| | | | | 2.0 | 403.0 | | | |
| | | | | 2.5 | 402.5 | | | |
| | | | | 3.0 | 402.0 | | | |
| | | | | 3.5 | 401.5 | | | |
| | | | | 4.0 | 401.0 | | | |
| | | | | 4.5 | 400.5 | | | |

| | | | | |
|---|---|---|---|---|
| **Date Started:** | 19/09/2023 | **Vane ID:** | N/A | **Comments:** |
| **Logged By:** | LK | **Vane Width:** | N/A | Groundwater not encountered. |
| **Diameter:** | 50mm | **Vane Type:** | N/A | |

For Explanation of Symbols and Abbreviations See Key Sheet

# Photo Log

**Location ID:** HA-03



| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project number:** | 5642469 |
| **Site location:** | Napier Road, Footbridge - Refer to Site Plan | **Client Name:** | Taupo District Council |
| **Location:** | 3m inside western end of footbridge. | **Coordinate system:** | NZTM2000 |
| | | **Northing:** | 5711489.1 |
| | | **Easting:** | 1869203.9 |
| | | **Vertical datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 405.00 |
| | | **Location method:** | Map +/- 1m |




Box 1 - 0.00mbgl to 1.60mbgl

# Hand Auger Log

**Hand Auger ID:** HA-04

Sheet 1 of 1

| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project Number:** | 5642469 |
| **Site Location:** | Napier Road, Footbridge - Refer to Site Plan | **Client:** | Taupo District Council |
| **Location:** | 3m West of foot bridge | **Coordinate System:** | NZTM2000 |
| | | **Northing:** | 5711487.5 |
| | | **Easting:** | 1869198.2 |
| | | **Vertical Datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 406.00 |
| | | **Location Method:** | Map +/- 1m |

| Groundwater (m) | In Situ Tests: Su (kPa) | In Situ Tests: Scala blows/50mm | Samples | Depth (m) | RL (m) | Graphic Log | Soil/ Rock Description | Geological Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | 0.0 | 406.0 | | 'Medium dense', fine to coarse SAND, minor silt, trace organics; brown; moist, non plastic. | |
| | | | | 0.5 | 405.5 | | 'Very loose', fine to medium SAND, some fine to coarse gravel; greyish brown; moist. Gravel: sub-rounded, MW, pumice. | |
| | | | | | | | 0.6m to 0.8m: no recovery. | |
| | | | | | | | 'Very loose', fine to medium SAND, some fine to coarse gravel; greyish brown; moist. Gravel: sub-rounded, MW, pumice. | |
| | | | | 1.0 | 405.0 | | 1.0m to 1.2m: no recovery. | |
| | | | | | | | 'Very loose', silty fine to medium SAND; black; moist, non plastic. | |
| | | | | 1.5 | 404.5 | | 'Very loose', fine to coarse SAND, some fine to coarse gravel; dark brown; moist, non plastic. Gravel: sub-rounded, MW, pumice. *1.30 - 1.40m: trace silt.* | Fill |
| | | | | 2.0 | 404.0 | | 2.0m to 2.3m: no recovery. | |
| | | | | 2.5 | 403.5 | | 'Very loose', fine to coarse SAND, some fine to coarse gravel; dark brown; moist, non plastic. Gravel: sub-rounded, MW, pumice. | |
| | | | | 3.0 | 403.0 | | | |
| | | | | 3.5 | 402.5 | | *3.40m: mottled light grey.* | |
| | | | | | | | 3.8m to 4.0m: no recovery. | |
| | | | | 4.0 | 402.0 | | 4.00m - End of hand auger, hole collapsed to 3.6m and obstructed by gravel. | |
| | | | | 4.5 | 401.5 | | | |

| | | | | |
|---|---|---|---|---|
| **Date Started:** | 19/09/2023 | **Vane ID:** | N/A | **Comments:** |
| **Logged By:** | DB | **Vane Width:** | N/A | Groundwater not encountered. |
| **Diameter:** | 50mm | **Vane Type:** | N/A | |

For Explanation of Symbols and Abbreviations See Key Sheet

# Photo Log

**Location ID:** HA-04



| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project number:** | 5642469 |
| **Site location:** | Napier Road, Footbridge - Refer to Site Plan | **Client Name:** | Taupo District Council |
| **Location:** | 3m West of foot bridge | **Coordinate system:** | NZTM2000 |
| | | **Northing:** | 5711487.5 |
| | | **Easting:** | 1869198.2 |
| | | **Vertical datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 406.00 |
| | | **Location method:** | Map +/- 1m |




Box 1 - 0.00mbgl to 4.00mbgl

# Hand Auger Log

**Hand Auger ID:** HA-05

Sheet 1 of 1

| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project Number:** | 5642469 |
| **Site Location:** | Napier Road, Footbridge - Refer to Site Plan | **Client:** | Taupo District Council |
| **Location:** | 2m inside eastern end of footbridge. | **Coordinate System:** | NZTM2000 |
| | | **Northing:** | 5711491.4 |
| | | **Easting:** | 1869213.0 |
| | | **Vertical Datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 405.50 |
| | | **Location Method:** | Map +/- 1m |

| Groundwater (m) | In Situ Tests: Su (kPa) | In Situ Tests: Scala blows/50mm | Samples | Depth (m) | RL (m) | Graphic Log | Soil/ Rock Description | Geological Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | 0.5 | 405.0 | | 'Very loose', fine to coarse SAND, minor organics, minor fine to medium gravel; dark grey, dry, well graded. Sand: sub-angular, pumice. Organics: rootlets, amorphous. Gravel: sub-rounded, pumice. | Fill |
| | | | | 1.0 | 404.5 | | *0.60m: some fine to medium gravel, trace organics; greyish brown, mottled white.* | |
| | | | | 1.5 | 404.0 | | *1.20 - 1.40m: minor organics.* | |
| | | | | 2.0 | 403.5 | | *1.40 - 1.60m: light grey.* | |
| | | | | 2.5 | 403.0 | | 'Loose', fine to coarse SAND, minor fine to medium gravel; brown, mottled white; moist, well graded. Sand: sub-angular, pumice. Gravel, sub-rounded, pumice. 2.1m to 2.6m: no recovery. | Taupo Pumice Formation |
| | | | | 3.0 | 402.5 | | 2.60m - End of hand auger, hole collapsed to 2.2m and obstructed by gravel. | |
| | | | | 3.5 | 402.0 | | | |
| | | | | 4.0 | 401.5 | | | |
| | | | | 4.5 | 401.0 | | | |

| | | | | |
|---|---|---|---|---|
| **Date Started:** | 19/09/2023 | **Vane ID:** | N/A | **Comments:** |
| **Logged By:** | LK | **Vane Width:** | N/A | Groundwater not encountered. |
| **Diameter:** | 50mm | **Vane Type:** | N/A | |

For Explanation of Symbols and Abbreviations See Key Sheet

# Photo Log

**Location ID:** HA-05



| | | | |
|---|---|---|---|
| **Project:** | CoLab - Structures Asset Management | **Project number:** | 5642469 |
| **Site location:** | Napier Road, Footbridge - Refer to Site Plan | **Client Name:** | Taupo District Council |
| **Location:** | 2m inside eastern end of footbridge. | **Coordinate system:** | NZTM2000 |
| | | **Northing:** | 5711491.4 |
| | | **Easting:** | 1869213.0 |
| | | **Vertical datum:** | NZVD 2016 |
| | | **Ground level (mRL):** | 405.50 |
| | | **Location method:** | Map +/- 1m |

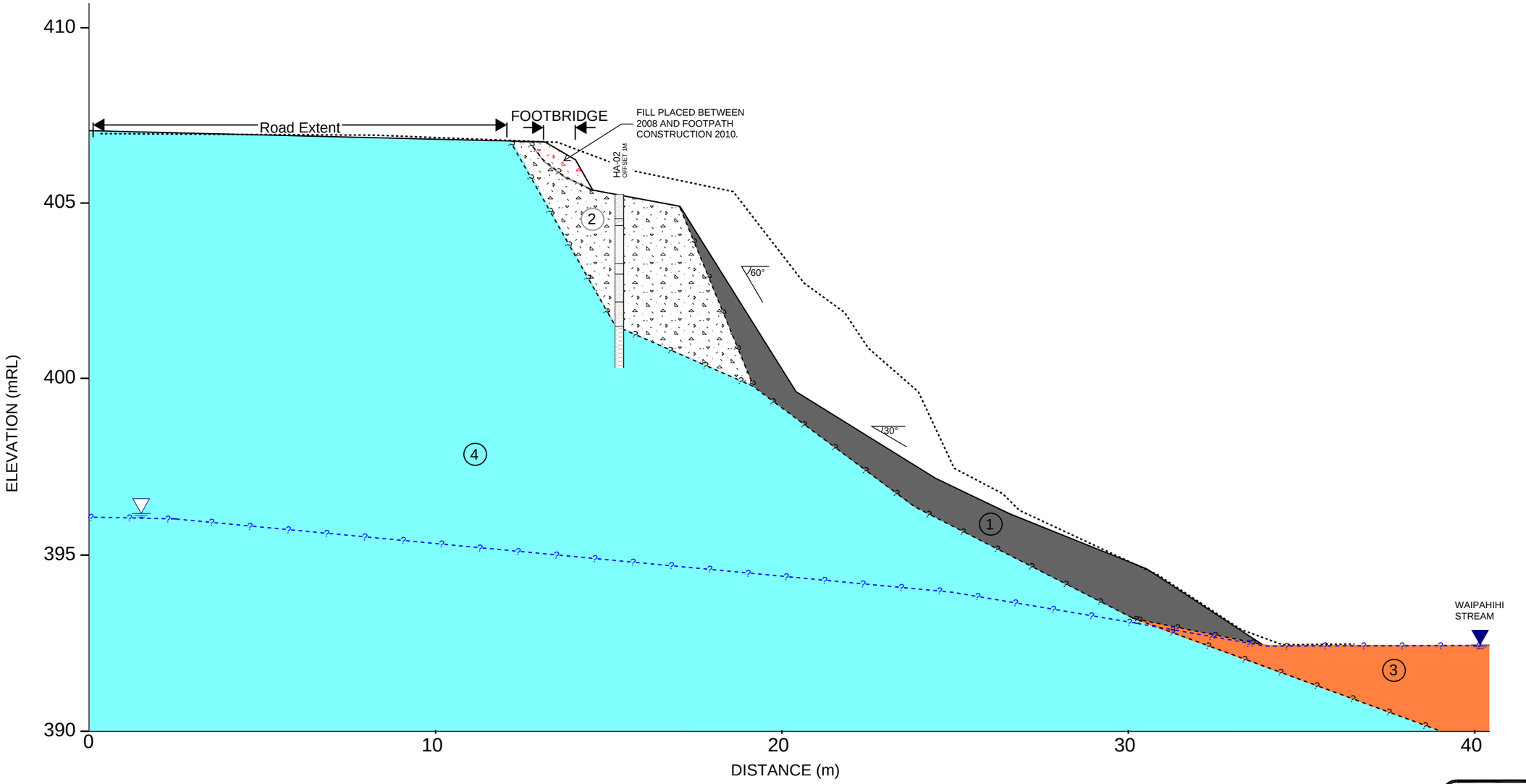


Box 1 - 0.00mbgl to 2.60mbgl

# C

## Appendix C – Geological Cross Section

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**PDF ONLY**
**NO DWG FILE**

1. Inferred COLLUVIUM
2. Very Loose gravelly SAND, minor organics [FILL]
3. Inferred RECENT ALLUVIUM
4. Medium Dense to Dense gravelly SAND [TAUPO PUMICE FORMATION]

## Legend

- Measured and estimated ground surface
- Interpreted geological boundary
- Measured/dipped groundwater
- Interpreted groundwater level
- Interpreted groundwater level
- Lidar surface

**Material Key**

GRAVEL · Gravelly SAND · SILT · Core Loss · Cobbly SILT · SAND · Medium grained IGNEOUS

H 1:125
0 1.875 3.75 5.625 7.5m
V 1:125
0 1.875 3.75 5.625 7.5m

BH01
OFFSET 2M
Baseline offset

LONGSECTION
Scale 1:125

Coord. System: NZTM2000 Height Datum: NZVD2016

| No. | Revision | By | Chk | Appd | Date |
|---|---|---|---|---|---|
| A | FOR CLIENT INFORMATION | DB | KR | AB | |

Original Scale (A1)
Reduced Scale (A3) 1:125

| | | | |
|---|---|---|---|
| Design | DB | | Approved For Construction* |
| Drawn | DB | | |
| Dsg Verifier | KR | | |
| Drg Check | KR | | Date |

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Client: CO-LAB BETTER TOGETHER · GREAT LAKE TAUPŌ Taupō District Council

Project: CO-LAB STRUCTURES ASSET MANAGEMENT SERVICES

Title: NAPIER ROAD RP 704 (DEBRETTS) FOOTBRIDGE GEOTECHNICAL INVESTIGATION PLAN

Discipline: GEOTECHNICAL

Drawing No.: 5642469-5105-GE-SK003

Rev.: A

Document No.: CO-LAB HORIZONTAL A1 TDC.DWT

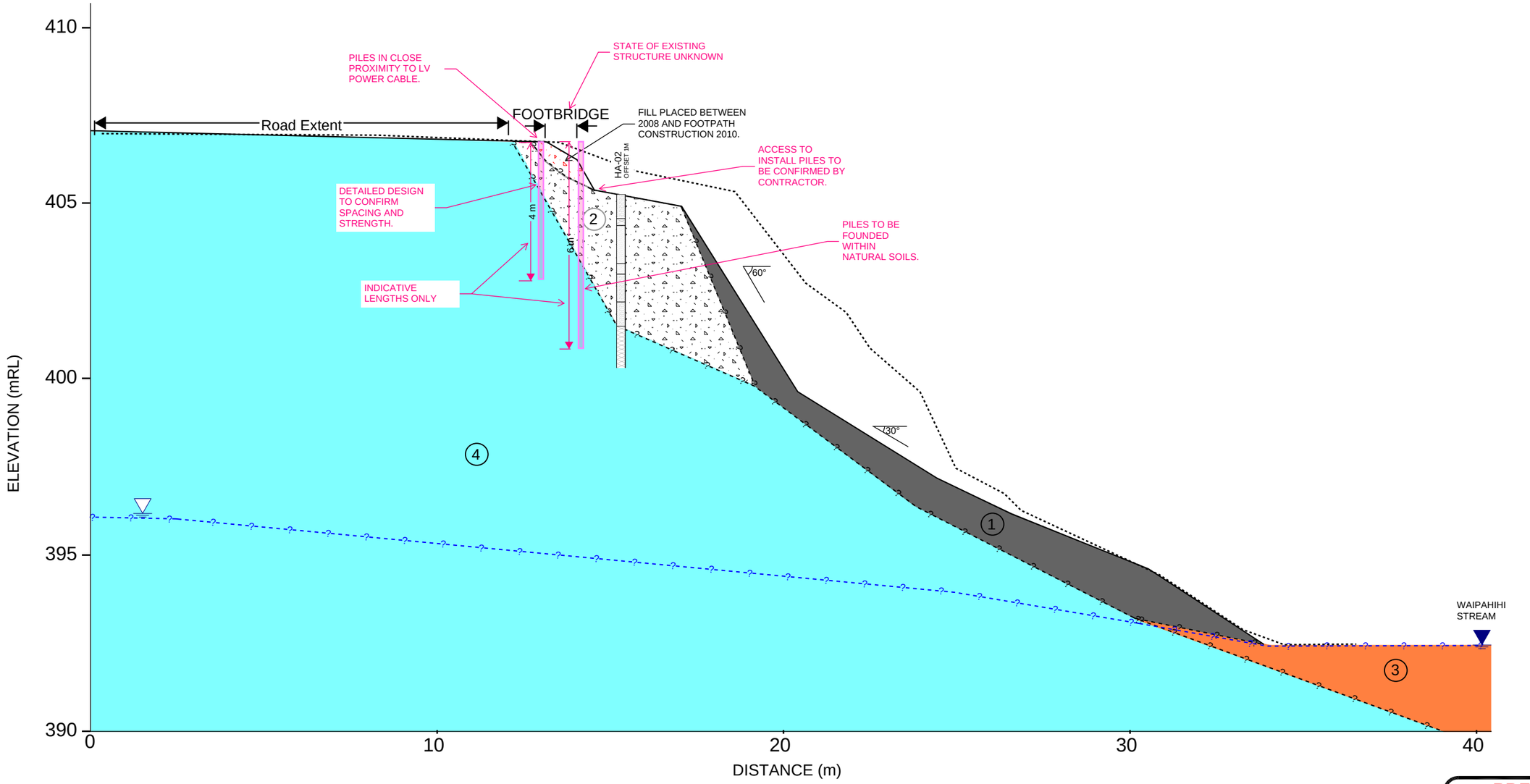
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# D

## Appendix D – Concept Sketches

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**PDF ONLY**
**NO DWG FILE**

1. 'INFERRED COLLUVIUM'
2. Very Loose gravelly SAND, minor organics [FILL]
3. INFERRED RECENT ALLUVIUM
4. Medium Dense to Dense gravelly SAND [TAUPO PUMICE FORMATION]

## Legend

- Measured and estimated ground surface
- Interpreted geological boundary
- Measured/dipped groundwater
- Interpreted groundwater level
- Interpreted groundwater level
- Lidar surface

**Material Key**

GRAVEL · Gravelly SAND · SILT · Core Loss · Cobbly SILT · SAND · Medium grained IGNEOUS

H 1:125
0 1.875 3.75 5.625 7.5m
V 1:125
0 1.875 3.75 5.625 7.5m

BH01 OFFSET 2M ← Baseline offset

LONGSECTION
Scale 1:125

Coord. System: NZTM2000 Height Datum: NZVD2016

| No. | Revision | By | Chk | Appd | Date |
|---|---|---|---|---|---|
| A | FOR CLIENT INFORMATION | DB | KR | AB | |

Original Scale (A1) · Reduced Scale (A3) 1:125

| | | | |
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| Design | DB | | Approved For Construction* |
| Drawn | DB | | |
| Dsg Verifier | KR | | |
| Drg Check | KR | | Date |

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Client: CO-LAB BETTER TOGETHER · GREAT LAKE TAUPŌ Taupō District Council

Project: CO-LAB STRUCTURES ASSET MANAGEMENT SERVICES

Title: NAPIER ROAD RP 704 (DEBRETTS) FOOTBRIDGE CONCEPT OPTIONS 1 & 2

Discipline: GEOTECHNICAL

Drawing No.: 5642469-5105-GE-SK004

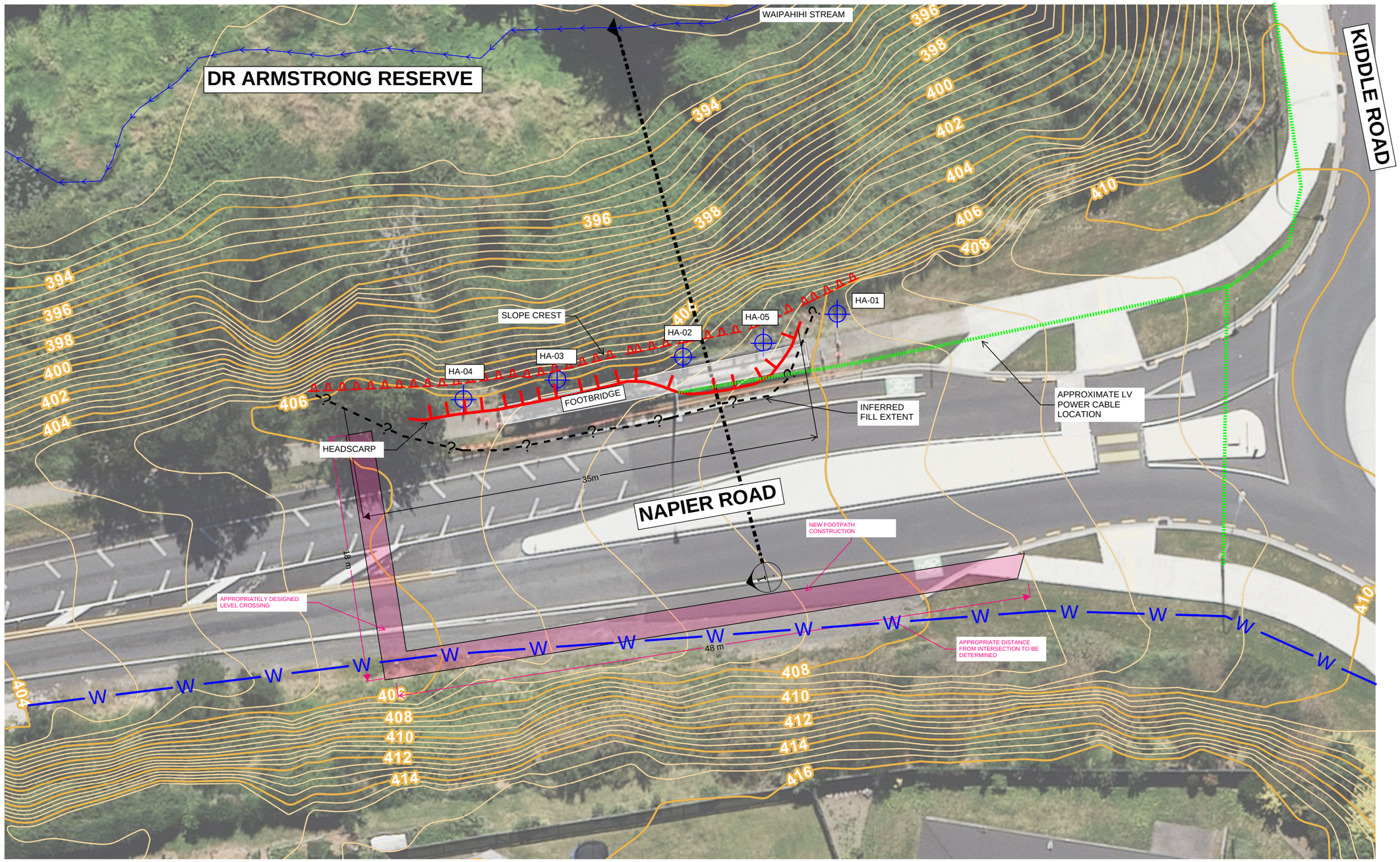
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|---|---|---|---|
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| Reduced Scale (A3) | 1:300 | Drawn | DB |
| | | Dsg Verifier | KR |
| | | Drg Check | KR |

Approved For Construction* Date

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Client: CO-LAB BETTER TOGETHER; GREAT LAKE TAUPŌ Taupō District Council

Project: CO-LAB STRUCTURES ASSET MANAGEMENT SERVICES

Title: NAPIER ROAD RP 704 (DEBRETTS) FOOTBRIDGE CONCEPT OPTION 3

Discipline: GEOTECHNICAL

Drawing No.: 5642469-5105-GE-SK005

Rev.: A

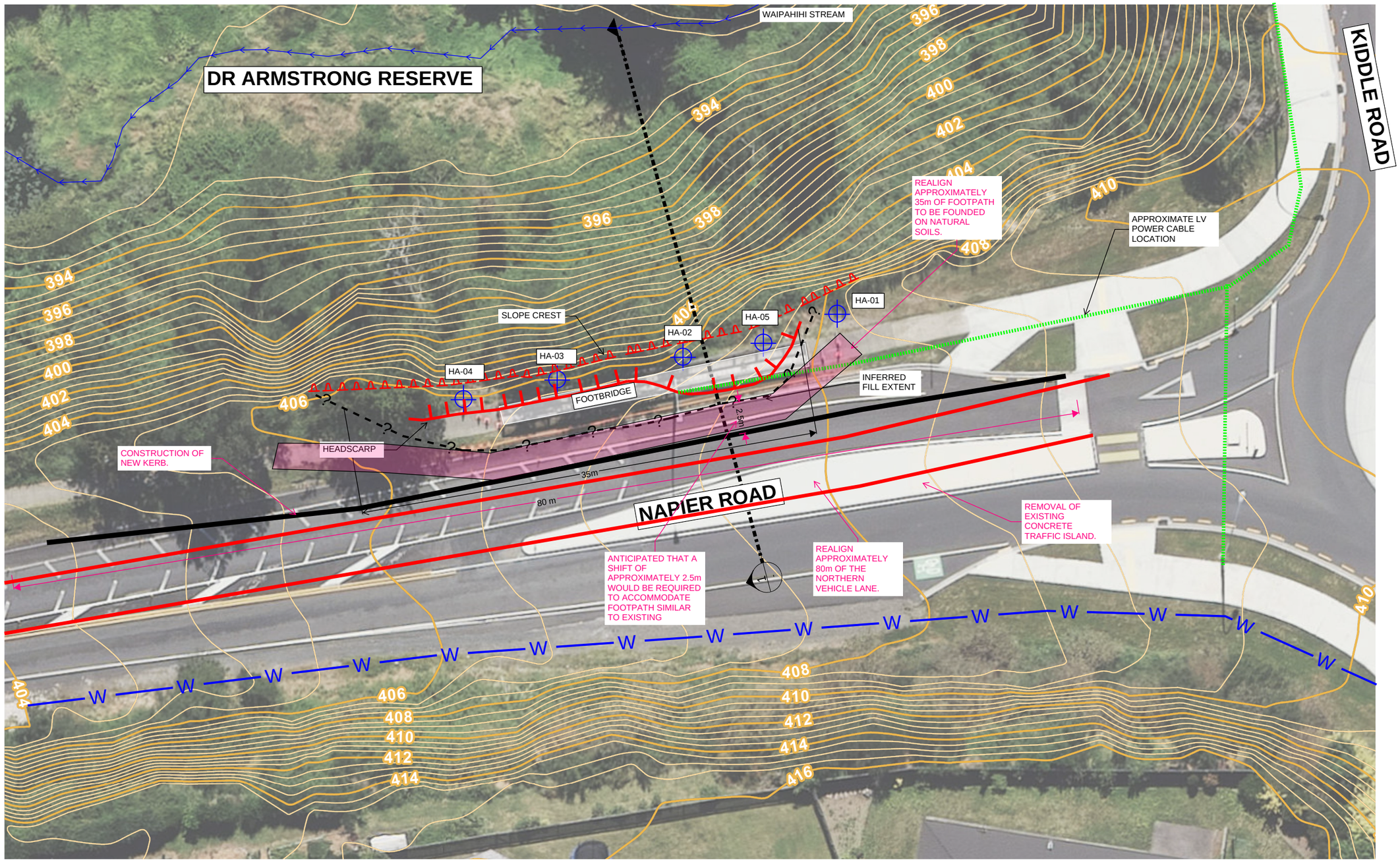
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|---|---|---|---|---|
| Original Scale (A1) | 1:150 | Design | DB | Approved For Construction* |
| Reduced Scale (A3) | 1:300 | Drawn | DB | |
| | | Dsg Verifier | KR | |
| | | Drg Check | KR | Date |

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Client: CO-LAB BETTER TOGETHER — GREAT LAKE TAUPŌ Taupō District Council

Project: CO-LAB STRUCTURES ASSET MANAGEMENT SERVICES

Title: NAPIER ROAD RP 704 (DEBRETTS) FOOTBRIDGE CONCEPT OPTION 4

Discipline: GEOTECHNICAL

Drawing No.: 5642469-5105-GE-SK006

Rev.: A

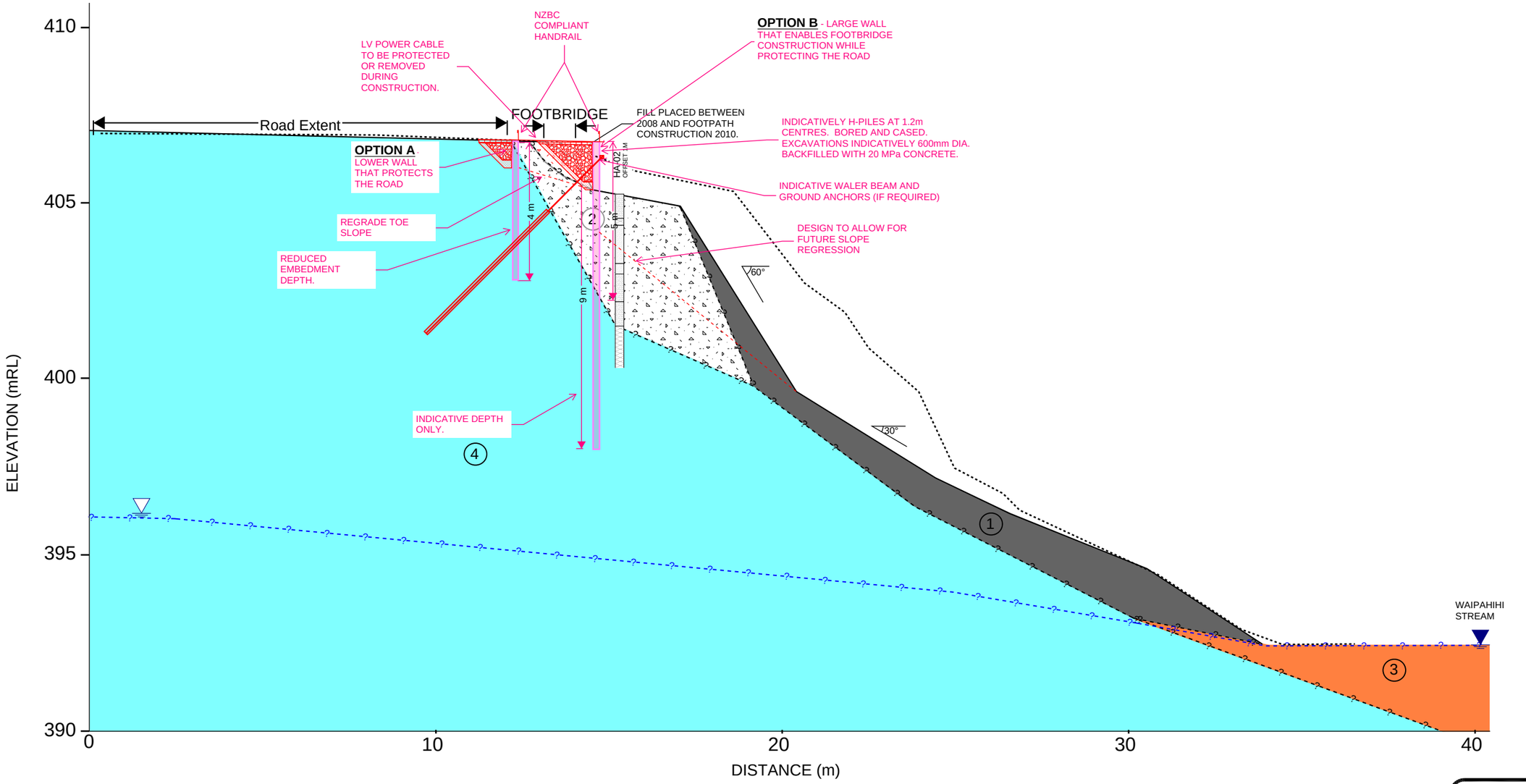
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**NO DWG FILE**

1. 'INFERRED COLLUVIUM'
2. Very Loose gravelly SAND, minor organics [FILL]
3. INFERRED RECENT ALLUVIUM
4. Medium Dense to Dense gravelly SAND [TAUPO PUMICE FORMATION]

## Legend

- Measured and estimated ground surface
- Interpreted geological boundary
- Measured/dipped groundwater
- Interpreted groundwater level
- Interpreted groundwater level
- Lidar surface

**Material Key**

GRAVEL, Gravelly SAND, SILT, Core Loss, Cobbly SILT, SAND, Medium grained IGNEOUS

H 1:125
0 1.875 3.75 5.625 7.5m
V 1:125
0 1.875 3.75 5.625 7.5m

Coord. System: NZTM2000 Height Datum: NZVD2016

BH01 OFFSET 2M ← Baseline offset

LONGSECTION
Scale 1:125

| No. | Revision | By | Chk | Appd | Date |
|---|---|---|---|---|---|
| A | FOR CLIENT INFORMATION | DB | KR | AB | |

Original Scale (A1)
Reduced Scale (A3) 1:125

| | | | |
|---|---|---|---|
| Design | LK | | Approved For Construction* |
| Drawn | LK | | |
| Dsg Verifier | KR | | |
| Drg Check | KR | | Date |

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Client: CO-LAB BETTER TOGETHER; GREAT LAKE TAUPŌ Taupō District Council

Project: CO-LAB STRUCTURES ASSET MANAGEMENT SERVICES

Title: NAPIER ROAD RP 704 (DEBRETTS) FOOTBRIDGE CONCEPT OPTIONS 6A & 6B

Discipline: GEOTECHNICAL

Drawing No.: 5642469-5105-GE-SK007

Rev.: A

Document No.: COLAB HORIZONTAL A1 TDC.DWT

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