HOW TO BE A GRAD

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redfox

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Contents

Purpose

An internal collection of knowledge for graduates and undergraduates to use. Some General engineering guidance, some engineering concepts, some software demos and some specific engineering design processes.

General Engineering Guidance

Refer Image Below.

Figure 1, Your Brain After Reading This Section

General Approach to Thinking

Tristan's words of somewhat wisdom

- Figure it out yourself
    - Learn to google
    - Use textbooks over uni notes or random sites.
    - If you actually have no idea, know when to ask a question then refer next dot point
- When you do ask questions
    - Ask the right questions
- Problem solving
    - Learn to Frame problems
    - Use "First Principles" (Basic Physics and maths) when you can

Developing spreadsheets

- Use the latest projects spreadsheet as a starting point
- Refer to excel section or if your lucky the design spreadsheets section.

Excel

Learn to Excel it good.

Also enable developer to access the developer ribbon in excel for macros and other useful stuff. Google it.

General Notes

- Square brackets in formulas are optional for the formula

Shortcuts

- Show Equations: Ctrl+ `
- Lock value ($): F4
- Enter Cell: F2

Look ups

VLOOKUP

VLOOKUPs are good for searching for a value in one column based on the value in another column in the same row.

Title 1	Return 2
A	1
B	2
C	3
D	4

Lookup	Result
A	1

Result
=VLOOKUP(F16,Table1[#All],2,FALSE)

HLOOKUP

HLOOKUPs are like VLOOKUPs but horizontal

Date	Time	Item 1	Item 2
15/07/2025	10	Alex	20
16/07/2025	11	Tristan	30

		Column
Hlookup	Item 1	Alex

```
=HLOOKUP(H31,B29:E31,2,FALSE)
```

Index match

Vlookup for nerds. Can search for greater, less or equal to while vlookup can only do exact or approximate which requires sorted data. Vlookup also needs the lookup column to the left of the return column

Match

Returns row number based on lookup

Title 1	Return 2
A	1
B	2
C	3
D	4

Lookup	A		
Match		1	returns row number

Lookup	A	
Match	=MATCH(G35,Table13[Title 1],0)	returns row number

Index

Searches for specified row and column in an array. Below it is searching for row 2 In the column return 2

Title 1	Return 2
A	1
B	2
C	3
D	4

Index	2

Index	=INDEX(Table13[Return 2],2)

Index Match

This combines index and match to provide a similar result to VLOOKUP but a bet more specific

		Lookup	A
Title 1	Return 2		
A	1		
B	2		
C	3	Combo	1
D	4		

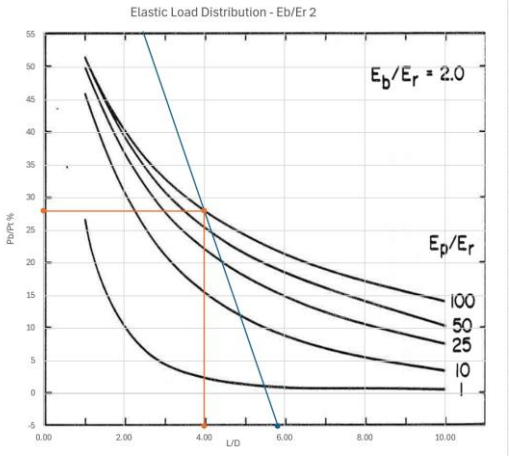
Combo	=INDEX(Table13[Return 2],MATCH(G35,

By finding the relevant row (row 2) containing the lookup (A) using match within an Index search which looks for the value in that row (1) it can return the right answer (1).

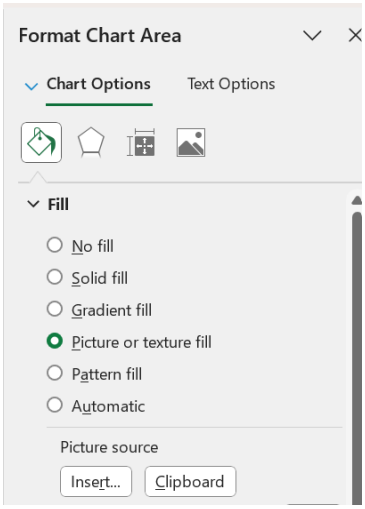
Graphs

Putting Pictures as backgrounds in graphs to overlay data

Useful for overlaying data on a graph such as below



Right click your graph, format chart area, under chart options and fill



Adjust picture and graph so that the graphs are both to the same scale.

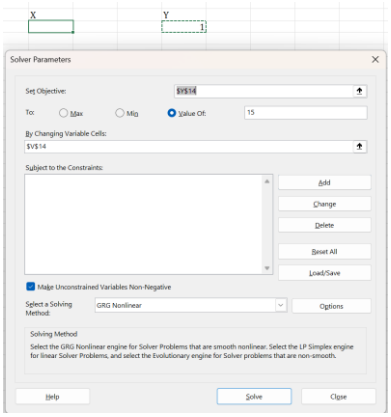
Trendlines and other basic math

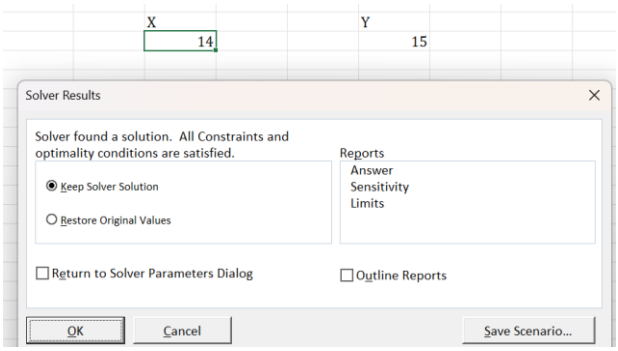
Graphing straight lines or points

Graphing multiple series in the same column

Solver

Can be used to optimise a cell (X) so that another cell that uses that cell (Y, which = X+1) to return a desired value (Y=15)





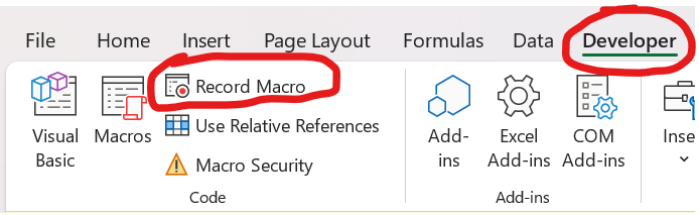
Macros

Macros Use VBA, google it.

Try to think about what you want to do before you start. Using AI can help with macros but if you don't understand what its doing there's no point. So when you start do it yourself or just with the normal internet

Getting Started by Using Record Macro

Click Record, do thing you want to do Stop record.



The easiest version of this is a basic copy paste macro.

Go to the developer ribbon and macros, find your macros then improve it from there.

Add A button

Insert a shape, right click assign a macro, select your new macro

VBA Skillz

Fill out with different snippets of code

Geotechnical Engineering Concepts

Consolidation Settlement

Primary Consolidation

Reduction in volume as water is expelled from voids in soil as a result of the pressure applies.

Secondary Consolidation

Secondary Consolidation occurs after primary consolidation when the excess hydrostatic pressure formed by the applied pressure is dissipated. This consolidation occurs over a much longer time period.

Pile Basics

Shaft Friction Resistance and End Bearing

Piles use a combination of skin friction (Qs) and end bearing (Qb) to support applied axial loads.

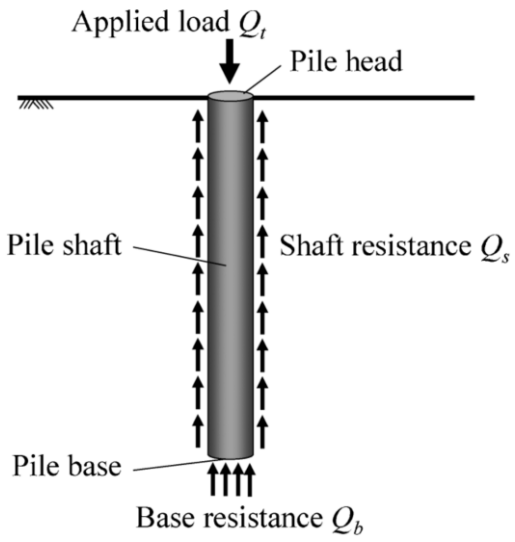


Figure 2, Basic Pile Axial Forces

Explain

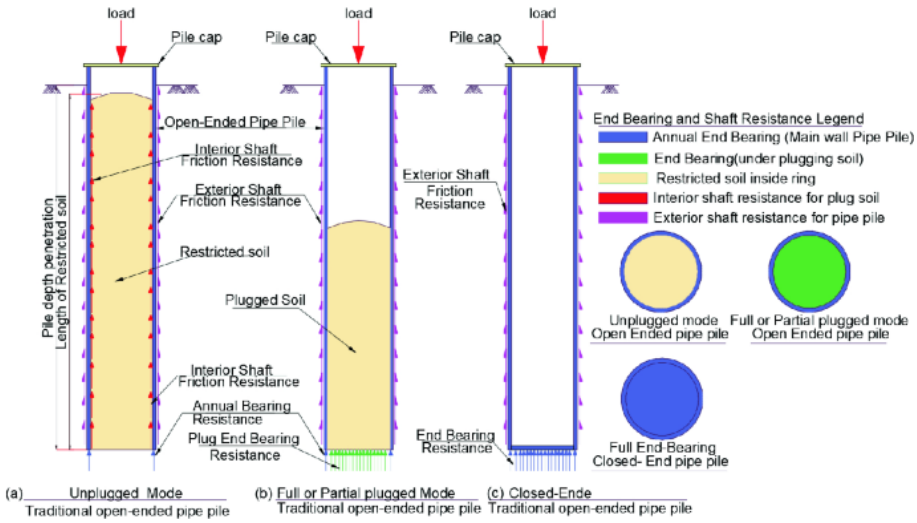


Figure 3, Diagram of Unplugged, Plugged and Closed End Piles

Rock Sockets

Pile socketed into rock.

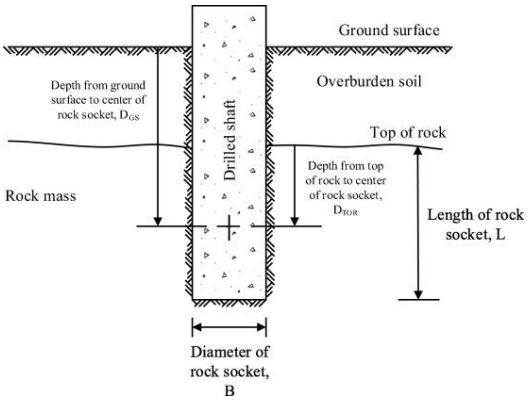
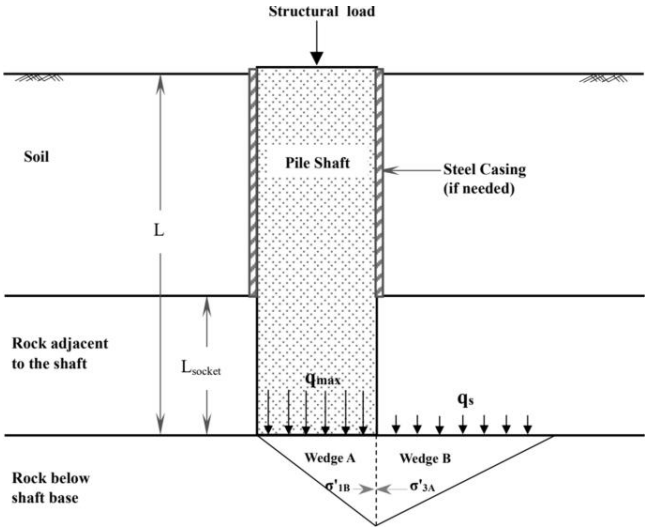


Figure 4, General Rock Socket Diagram

Pile Liners

If there is a liner (can be used with augured piles) for the purpose of design there will be no skin friction as there is the pile, the liner then the soil so any so any skin friction can be ignored.



Further explained in axial design spreadsheet section

Textbooks (Where to find design stuff out)

Textbooks are preferred over university notes. Start a bedtime reading folder with all your textbooks and other technical documents so that you can use them. Collect as many as you can and remember your favourites and other peoples favourites.

Figure 5, Collect Textbooks

Below are some relevant Textbooks and documents and what they have.

Textbook	Useful Stuff inside
Geotechnical	
Burt Look Handbook of geotechnical investigation	For general guidance of geotechnical parameters for materials (Hand wavey) and other things related to geo site investigations
Craig's Soil Mechanics (Karen's Favourite)	Soil mechanics, settlement
Pells	Rock Socket
Civil	
Austroads	Almost Everything Roads or it'll tell you where to find it
Structural	

John Fennec

John Fennec is the desktop sitting in one of the small office rooms. RFA stores lots of software and licenses on it. The desktop is remotely connected into using a file as show below:

Several people (particularly in the geo team use it). If you log in and someone else is on the remote desktop it will kick them out. If your connection to the remote desktop drops out randomly someone else may have connected in, kicking you out. Find out who it is and discuss priorities etc.

When the computer is turned off and the shortcut breaks

Ask for a remote desktop file, ask for the password (if its not on the computer desk on a post it note). May need to setup VPN

Authentication for anything logged in as JF

Lucas has the authenticator for John Fennec so ask him to authenticate and send him the 2 numbers.

When the computer is turned off and the shortcut breaks

1. Go to JF physical computer
2. Command prompt: ipconfig
3. Grab IPV4 address
4. Go to your computer
5. Right click shortcut, edit
6. Change computer: Ip address to new IPV4 from JF

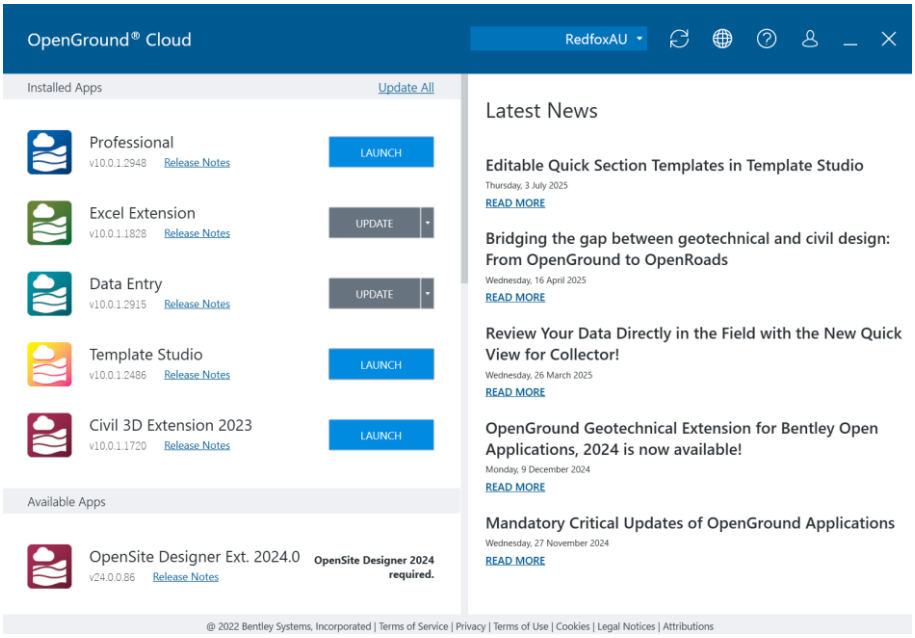
Open Ground

Getting started

Accessing open ground will require access to the John Fennec computer.

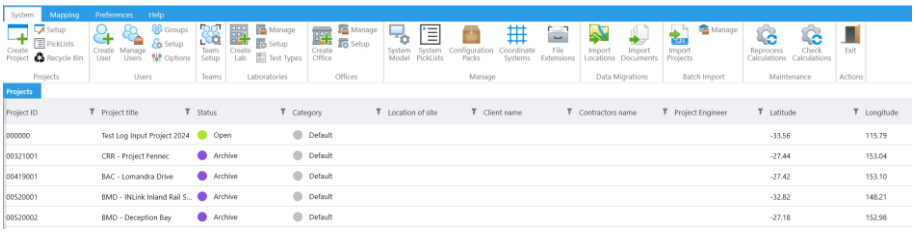
Open Ground and Template studio are opened through the Open Ground Cloud Launcher

Click launch on Professional to open Open Ground. If it needs an update just update it then launch. The same applies to Template Studio.



Opening or Creating a Project

To create a new project, in the systems tab click create project. Most of the time however you will just click an existing project down below.



Setting Up a Project

Guide required

Data Input & Changes

Data is mainly inputted through the spreadsheet for efficiency. The purpose of this process is to digitise the logs done onsite, not to create data for input. Most of the data should be on the original log completed by the site logger.

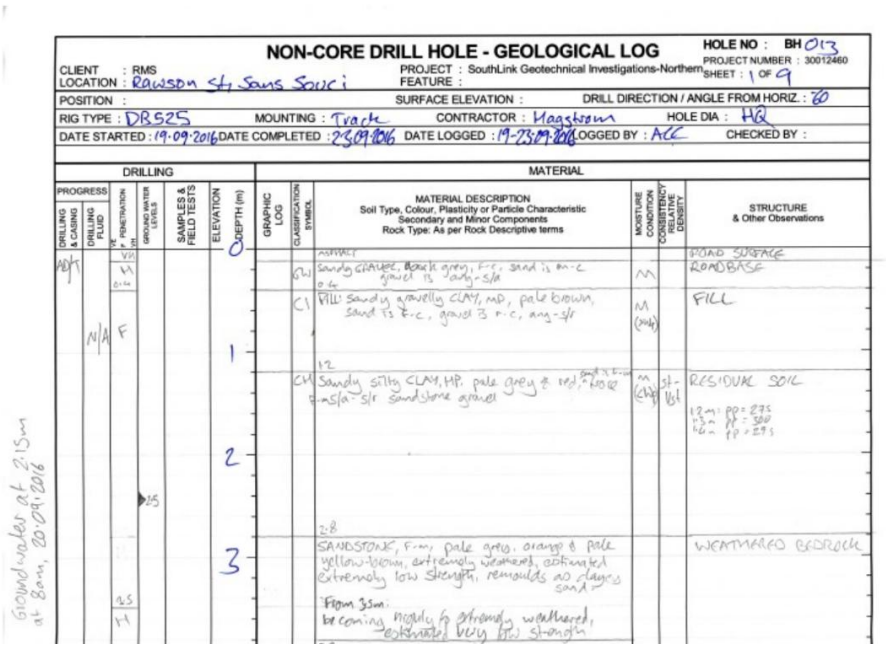
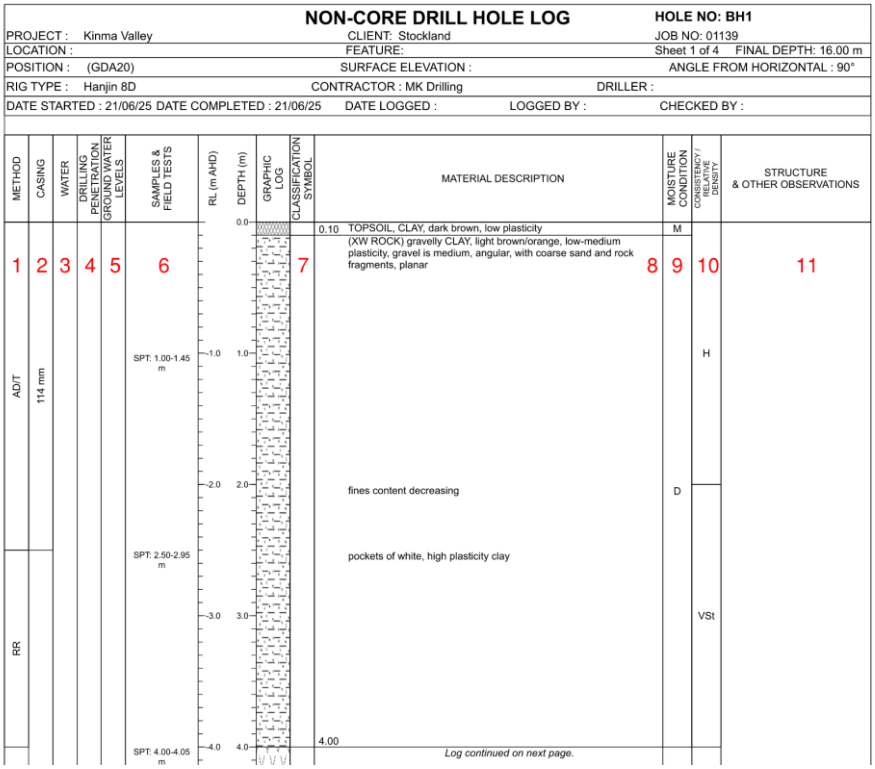


Figure 6, Example site log to be digitised

An example Open Ground digitised log for the soil section of a borehole can be seen below. The sections are called up in a red markup for reference later in the guide.



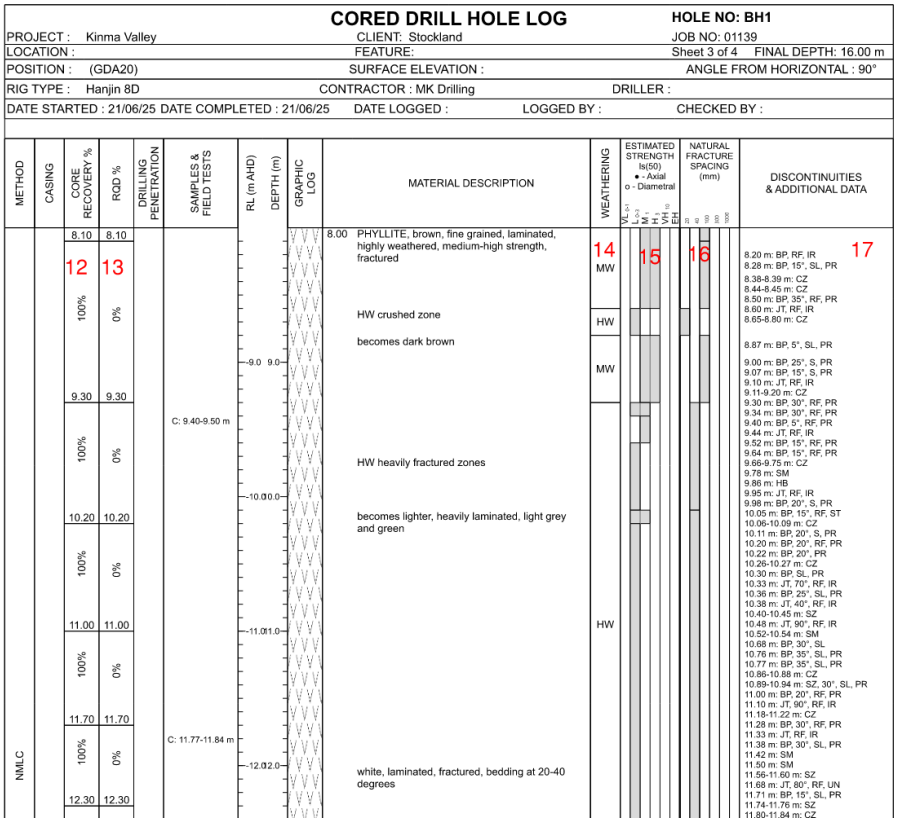
NON-CORE DRILL HOLE LOG — **HOLE NO: BH1**

PROJECT : Kinma Valley	CLIENT: Stockland	JOB NO: 01139	
LOCATION :	FEATURE:	Sheet 1 of 4	FINAL DEPTH: 16.00 m
POSITION : (GDA20)	SURFACE ELEVATION :	ANGLE FROM HORIZONTAL : 90°	
RIG TYPE : Hanjin 8D	CONTRACTOR : MK Drilling	DRILLER :	
DATE STARTED : 21/06/25	DATE COMPLETED : 21/06/25	DATE LOGGED :	LOGGED BY : CHECKED BY :

METHOD	CASING	WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & OTHER OBSERVATIONS
1	2	3	4	5	6				7		8	9	10	11
AD/T	114 mm				SPT: 1.00-1.45 m	-1.0	1.0			0.10 TOPSOIL, CLAY, dark brown, low plasticity (XW ROCK) gravelly CLAY, light brown/orange, low-medium plasticity, gravel is medium, angular, with coarse sand and rock fragments, planar	M	H	
						-2.0	2.0			fines content decreasing	D		
RR					SPT: 2.50-2.95 m	-3.0	3.0			pockets of white, high plasticity clay		VSt	
					SPT: 4.00-4.05 m	-4.0	4.0			4.00 *Log continued on next page.*			

Figure 7, Soil Section of Borehole Log

An example Open Ground digitised log for the rock section of a borehole can be seen below. The sections are called up in a red markup for reference later in the guide.



CORED DRILL HOLE LOG — HOLE NO: BH1

PROJECT : Kinma Valley | CLIENT: Stockland | JOB NO: 01139
LOCATION : | FEATURE: | Sheet 3 of 4 FINAL DEPTH: 16.00 m
POSITION : (GDA20) | SURFACE ELEVATION : | ANGLE FROM HORIZONTAL : 90°
RIG TYPE : Hanjin 8D | CONTRACTOR : MK Drilling | DRILLER :
DATE STARTED : 21/06/25 DATE COMPLETED : 21/06/25 | DATE LOGGED : | LOGGED BY : | CHECKED BY :

METHOD	CASING	CORE RECOVERY %	RQD %	DRILLING PENETRATION	SAMPLES & FIELD TESTS	RL (m AHD) / DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	WEATHERING	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral	NATURAL FRACTURE SPACING (mm)	DISCONTINUITIES & ADDITIONAL DATA
NMLC		8.10 12 100% 9.30 9.30 100% 10.20 10.20 100% 11.00 11.00 100% 11.70 11.70 100% 12.30	8.10 13 0% 9.30 9.30 0% 10.20 10.20 0% 11.00 11.00 0% 11.70 11.70 0% 12.30		C: 9.40-9.50 m C: 11.77-11.84 m	9.0 9.0 10.0 10.0 11.0 11.0 12.0 12.0		8.00 PHYLLITE, brown, fine grained, laminated, highly weathered, medium-high strength, fractured HW crushed zone becomes dark brown HW heavily fractured zones becomes lighter, heavily laminated, light grey and green white, laminated, fractured, bedding at 20-40 degrees	14 MW HW MW HW	15	16	17 8.20 m: BP, RF, IR 8.28 m: BP, 15°, SL, PR 8.38-8.39 m: CZ 8.44-8.45 m: CZ 8.50 m: BP, 35°, RF, PR 8.60 m: JT, RF, IR 8.65-8.80 m: CZ 8.87 m: BP, 5°, SL, PR 9.00 m: BP, 25°, S, PR 9.07 m: BP, 15°, S, PR 9.10 m: JT, RF, IR 9.11-9.20 m: CZ 9.30 m: BP, 30°, RF, PR 9.34 m: BP, 30°, RF, PR 9.40 m: BP, 5°, RF, PR 9.44 m: JT, RF, IR 9.52 m: BP, 15°, RF, PR 9.64 m: BP, 15°, RF, PR 9.66-9.75 m: CZ 9.78 m: SM 9.86 m: HB 9.95 m: JT, RF, IR 9.98 m: BP, 20°, S, PR 10.05 m: BP, 15°, RF, ST 10.06-10.09 m: CZ 10.11 m: BP, 20°, S, PR 10.20 m: BP, 20°, RF, PR 10.22 m: BP, 20°, PR 10.26-10.27 m: CZ 10.30 m: BP, SL, PR 10.33 m: JT, 70°, RF, IR 10.36 m: BP, 25°, SL, PR 10.38 m: JT, 40°, RF, IR 10.40-10.45 m: SZ 10.48 m: JT, 90°, RF, IR 10.52-10.54 m: SM 10.68 m: BP, 30°, SL 10.76 m: BP, 35°, SL, PR 10.77 m: BP, 35°, SL, PR 10.86-10.88 m: CZ 10.89-10.94 m: SZ, 30°, SL, PR 11.00 m: BP, 20°, RF, PR 11.10 m: JT, 90°, RF, IR 11.18-11.22 m: CZ 11.28 m: BP, 30°, RF, PR 11.33 m: JT, RF, IR 11.38 m: BP, 30°, SL, PR 11.42 m: SM 11.50 m: SM 11.56-11.60 m: SZ 11.68 m: JT, 80°, RF, UN 11.71 m: BP, 15°, SL, PR 11.74-11.76 m: SZ 11.80-11.84 m: CZ

Figure 8, Rock Section of Borehole Log

Need to add test pit log

Commented [AL1]: Add example test pit log

Add/Edit Data (for small data changes)

To add/edit data click the add/edit data button and edit the relevant cells or add new cells

Data Input Spreadsheet

File Setup

This spreadsheet is used for soil and rock boreholes as well as test pits. As long as you clear all data, fill out this page and hide unnecessary sheets it should work. The spreadsheet does not determine which template/style of log is used, it is used to ease the importing of ground data into OpenGround. Some data types will be shared between types of investigations such as soil descriptions being required in soil boreholes as well as test pits.

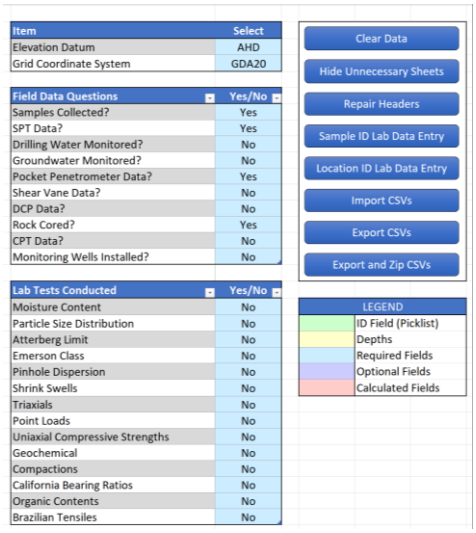


Figure 9, File setup page

Item & Field Data Questions:

Fill out according to project and field data information. This area will determine what sheets will be used once it is filled out and the hide unnecessary sheets button is pressed.

Lab Tests Conducted:

Most of the time filled out in Open Ground if there aren't that many tests. Put as no if not doing in the spreadsheet.

Buttons:

Clear data: at the start of the project

Hide Unnecessary Sheets: once the Field Data Questions and Lab Test Results filled in.

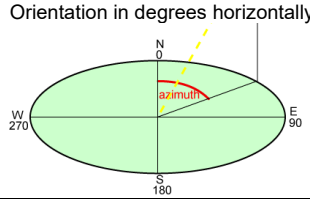
Export CSVs: Once spreadsheet complete to prepare for import into Open ground. Once Exported Zip all spreadsheets (excluding the data entry one).

Location

This section is vital and defines the different investigation locations. Without setup this nothing works or makes sense.

Column Name	Description of Input
Location ID	Name of investigation e.g. BH1
Location Type	Type of investigation
Depth (m)	Length of BH
Easting	Check coordinates grid
Northing	
Ground Level	Top of BH in RL (should be provided by surveyor, in survey)
National Grid Referencing System	Auto filled
National Datum Referencing System	Auto filled
Date Start	Start of investigation
Date End	End of investigation
Purpose / Location	
Logged By	Logger
Checked by	Reviewer
Contractor	Drilling contractor
Termination	Reason for stopping e.g. target depth (target depth reached) or refusal (material too hard)
Core hole break	Depth of transition from soil to rock in depth not RL. Where the soil log changes to rock core log

Incl-orient

Column Name	Description of Input
Location ID	Should be a drop down from this point onwards from defined list in locations page
Depth Top (m)	Autofilled
Depth Base (m)	Depth to base of BH
Orientation (deg)	Orientation in degrees horizontally. If a straight up and down borehole its 0 
Inclination (deg)	Inclination in degrees from vertical of borehole 

Method + Plant

The different methods of investigation for different depths. e.g. for 1 borehole auguring down 2m into soil followed by 3m of wash boring followed by NMLC rock coring. This section is called up as number 1 in the marked up log.

Column Name	Description of Input
Depth Top (m)	Autofilled based on ground level or previous bottom depth within the same BH
Depth Base (m)	Depth to the bottom of where the method stopped
Type	Method of investigation e.g wash boring within BH
Plant	Machine that conducted the investigation
Contractor	Autofilled
Pit Length (m)	Relevant to test pitting
Pit Width (m)	Relevant to test pitting

Casing

Casing is a pipe that is used to prevent the collapse of the borehole. The depth of the casing depends on a number of factors including if the walls of the hole are collapsing in. The casing depth and type should be recorded on site. This section is called up as number 2 in the marked up log.

Figure 10, PVC pipe used for casing (can be other materials)

Column Name	Description of Input
Depth Base (m)	Depth to the bottom of the casing
Casing Type	Type of casing that should be recorded on site.
Casing Diameter (mm)	Once the casing type is filled the diameter should be autofilled

Penetration

Column Name	Description of Input
Depth Base (m)	Depth to base of material with specific resistance
Resistance	Resistance of the material as per log information e.g easy or hard

Samples

This section is called up as number 6 in the marked up log.

Column Name	Description of Input
Sample ID	Autofilled sample ID based on the other columnes
Depth Top (m)	Depth top to bottom where sample/test collected
Depth Base (m)	
Sample Type	Type of sample/test conducted e.g SPT or
Supress Sample on Log	Put yes

SPTs

Standard Penetration Testing (refer your uni notes).

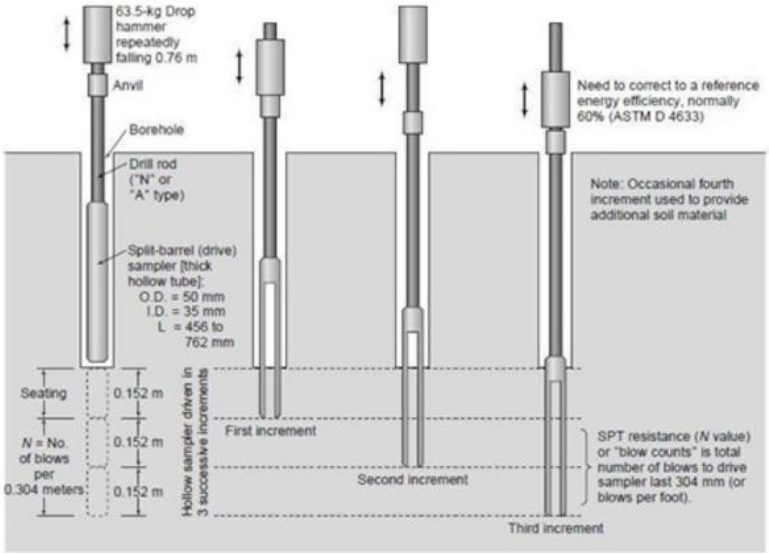


Figure 11, SPT Test Diagram Example (do not use)

Column Name	Description of Input
Test Type	Split spoon (S) or Cone (C)
Depth Top (m)	Top of test
Depth Base (m)	Bottom of test
Blows Seating 150mm	First 150mm blows are seating blows
Blows Main 150mm	Blows for following 150mm of run
Blows Main 150mm	Blows for following 150mm of run
Penetration Seating (mm)	Penetration for seating blows (calculated)
Penetration Main (mm)	Penetration for main blows (calculated)
Penetration Main (mm)	Penetration for main blows (calculated)
Rod Weight Penetration (mm)	Optional

Hammer Weight Penetration (mm)	Optional
Hammer Bouncing	If hammer bounce occurred put yes

Strata

Material description for log This section is called up as number 8 in the marked up log.

Column Name	Description of Input
Depth Base (m)	Depth of material with geological
Legend Code	Pattern for each material (Auto filled by soil type)
Soil Type	Soil type (Should be in log)
Non Component Description	Component description adhering to style and order outlined in AS1726 (Order, Capitalisation and wording all matter) e.g. silty CLAY, medium plasticity, red mottled brown, trace gravel, medium, angular, moist, stiff.
Boundary	Ignore
Origin	Origin of material e.g Alluvium or bedrock.
Origin Log	Autofilled
Geology Unit	Ignore

Stratum Details

Little comments in material description that identify small changes or features that don't deserve an entire new strata row being created. E.g increase in gravel content or weathering

Column Name	Description of Input
Depth Top (m)	Depth of the comment
Depth Base (m)	Can be ignored
Description	Description/Comment

Moisture

Moisture condition in section. This section is called up as number 9 in the marked up log.

Column Name	Description of Input
Depth Top (m)	Top of area with moisture condition
Depth Base (m)	Bottom of area with moisture condition
Min Moisture	Minimum moisture in section
Conjunction	Either – (e.g Dry to Moist) or / (In between dry & moist)
Max Moisture	Maximum moisture
Boundary	Ignore

Consistency

Consistency or density of the material. Dependant on site observations and which type of material it is e.g grave, sand, silt or clay. This section is called up as number 10 in the marked up log.

Column Name	Description of Input
Depth Top (m)	Depth to top of Soil with specific consistency (Calculated)
Depth Base (m)	Depth to bottom of Soil with specific consistency
Min Consistency	Minimum consistency of the section e.g soft for a clay
Conjunction	Either – (e.g soft to firm) or / (In between soft & firm)
Max Consistency	Maximum consistency of the section e.g firm for a clay
Boundary	Ignore

Additional Obs

Any additional observations in the material that don't require a callout elsewhere e.g. a brick being in the top layer of material. This section is called up as number 11 in the marked up log.

Column Name	Description of Input
Depth Top (m)	Depth of observation
Description	Observation to appear on log

Hand Penetrometer

Results of hand penetrometer testing.

Column Name	Description of Input
Depth (m)	Depth of hand penetrometer testing
Qualifier	Use "="
Result (kPa)	Result of hand penetrometer testing

Weathering

Weathering condition of rock. This section is called up as number 14 in the marked up log.

Column Name	Description of Input
Depth Top (m)	Depth to top of material with weathering conditions
Depth Base (m)	Depth to bottom of material with weathering condition
Min	Minimum weathering condition of material e.g XW for extremely weathered rock
Max	Maximum weathering condition of material e.g HW for highly weathered rock

Strength

Rock Strength. This section is called up as number 15 in the marked up log.

Column Name	Description of Input
Depth Top (m)	Depth to top of rock with strength
Depth Base (m)	Depth to bottom of rock with strength
Lower Strength	Lower bound of strength (if only 1 reading fill this one in and leave upper strength empty
Upper Strength	Upper bound of strength

RQD

Total core recovery and rock quality designation This section is called up as number 12 and 13 in the marked up log.

Column Name	Description of Input
Depth Top (m)	Depth to top of section with that RQD and TCR
Depth Base (m)	Depth to bottom of section with that RQD and TCR
TCR (%)	% of total core recovery = 100% - % of core loss
RQD (%)	Rock quality designation = ((sum of length of rock core pieces>100mm) / (Run Length)) * 100%

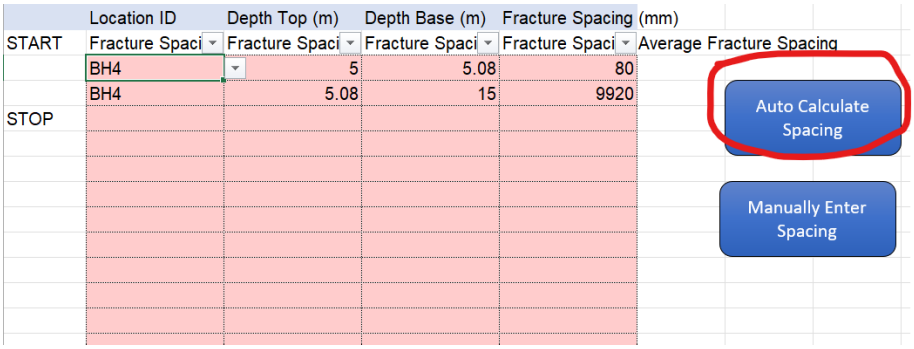
Defect Desc

Defect location and description such as cracks or clay vanes etc. This section is called up as number 17 in the marked up log.

Column Name	Description of Input
Depth Top (m)	Depth to defect
Depth Base (m)	If defect not in range leave empty
Defect Type	Type of Defect
Dip (deg)	Angle of Defect
Planarity	Planarity of defect
Roughness	Description of roughness of defect
Coating	Coating in defect
Primary Aperture	Ignore
Primary Composition	Ignore
Secondary Aperture	Ignore
Secondary Composition	Ignore
Sign	Ignore
Aperture Width	Ignore
Defect description	Ignore
Remarks	Ignore
General description (Displays Vertically)	Optional

Defect Spacing

If the defect description page is filled out the “Auto Calculate Spacing” Button can be used to fill out the defect spacing. This is the preferred method. This section is called up as number 16 in the marked up log.



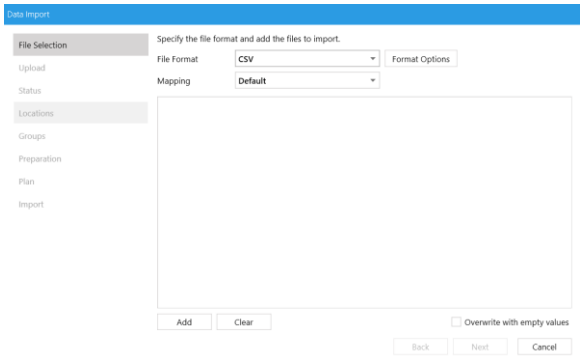
The defect spacing can also be manually entered using the Manually Enter Spacing Button and the relevant columns

Data import into Open Ground

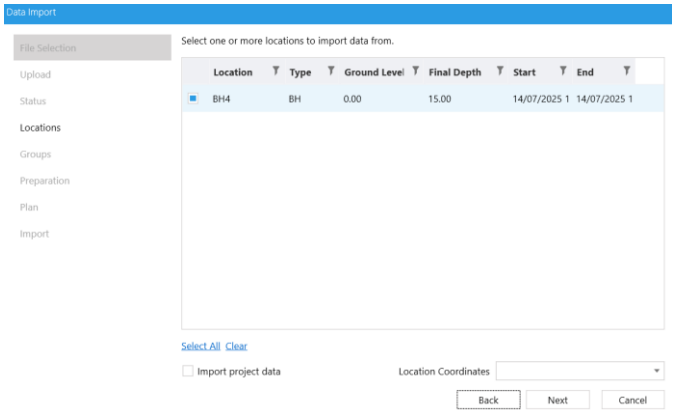
Import Process

Once the spreadsheet is filled out export the data using the export CSVs button on the file setup page. Zip up all the exported CSVs (make sure not to select the import spreadsheet) and they are ready for import.

Log into Open Ground and open the project. Go to the data ribbon and import data button.



Ensure to select which locations and groups to import (should be all of them most of the time)



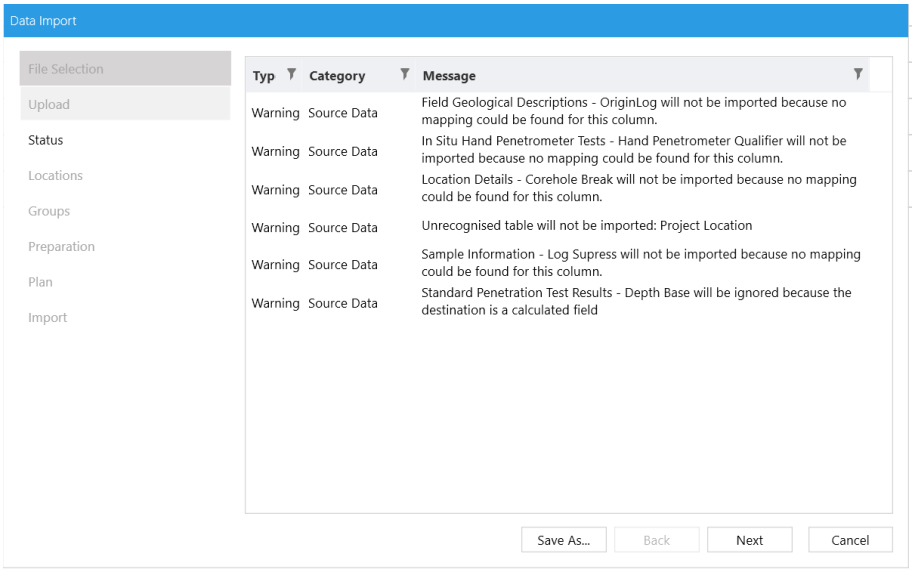
Look at the additions, updates, unaffected columns and check what is happening. This is a good way to tell if something has gone wrong. Are you adding one borehole.

The following are the changes which will be applied.

Table	Additions	Updates	Unaffected	Files
Location Details (LocationDetails)	0	1	12	0
Casing Diameter by Depth (Casing)	0	1	2	0

Errors to look out for

Ignore these errors. If more than these show up then there may be issues with the headings. Run the fix headings button on the input spreadsheet and re attempt. If that doesn't work investigate mismatched headings in the repair headings macro, save and run repair headings.



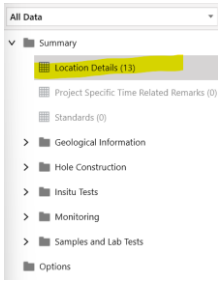
If there are 2 of the same data type at the same point it can cause issues. If its not a typo open the CSV and manually adjust by like 1mm.

If all else fails unzip and import what CSVs you can that work then manually reimport. Data not imported will have to be imported manually using the Add/Edit data section.

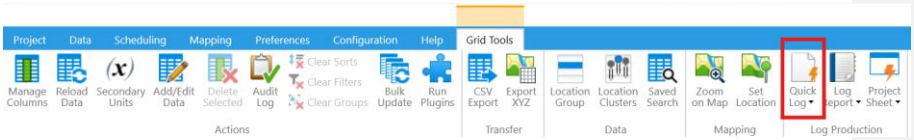
Data Output

Quick Logs

1. Open location details in the side ribbon and click the Borehole or Test pit you want to plot.

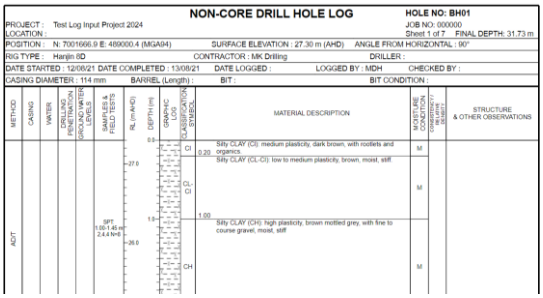


2. Go to the Grid tools ribbon and click quick log.



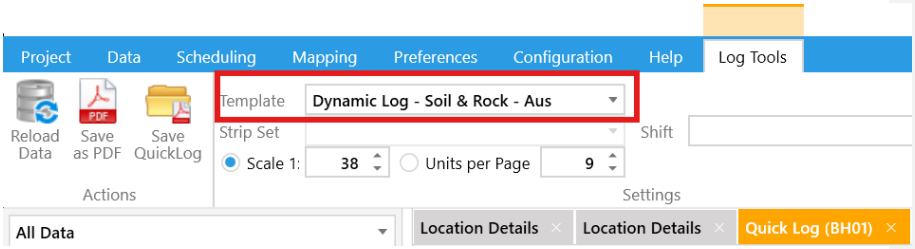
3. A log should open like below

!RFA!mu6033



4. Select the relevant template you want to use for the log. There are a number of different templates, some project specific, some general.
   The main ones used are
   - Dynamic Log – Soil & Rock – AUS
   - Test pit log template?

Commented [AL2]: What are our standard Templates
- Test pit
- Quick section
-



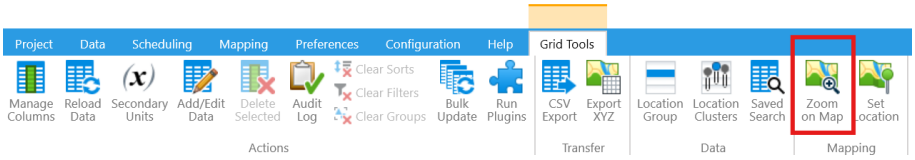
If you want to change the log you will have to use template studio.

The dynamic logs allow for both soil logs and rock logs to be combined in the same log separated out.

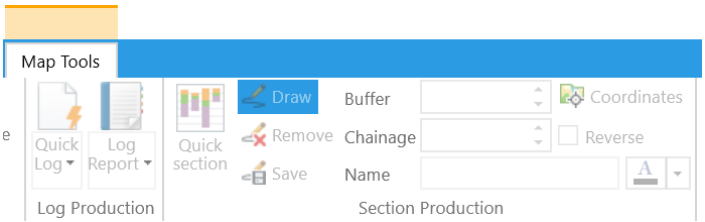
Quick Sections

The quick sections have scaling issues. **For better logs use the Civil3D segment of this guide.**

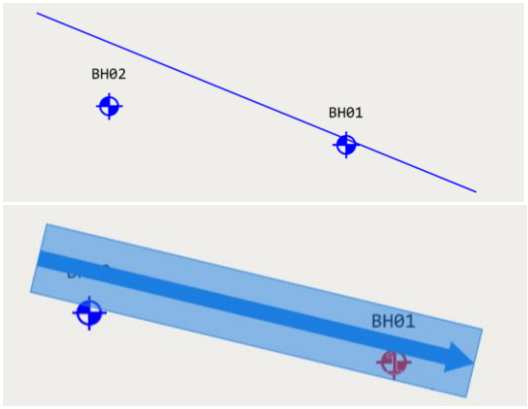
1. Go to the grid tools ribbon and click zoom on map



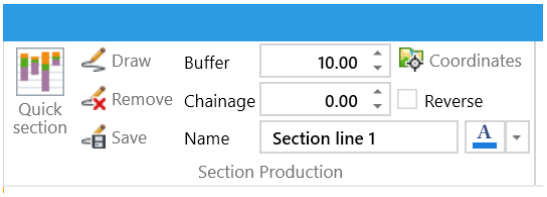
2. Zoom into your data and Click draw



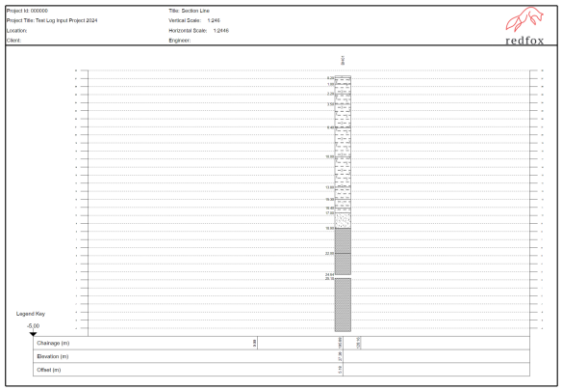
3. Click the start of your section line then double click the end



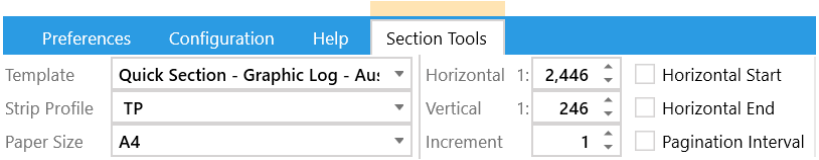
4. In the top bar you can adjust your buffer which specifies how far offset the section line data points will be picked up



5. Click Quick section and your section should pop up



6. Adjust your scale and select your template (Changing parts of a template requires template studio)

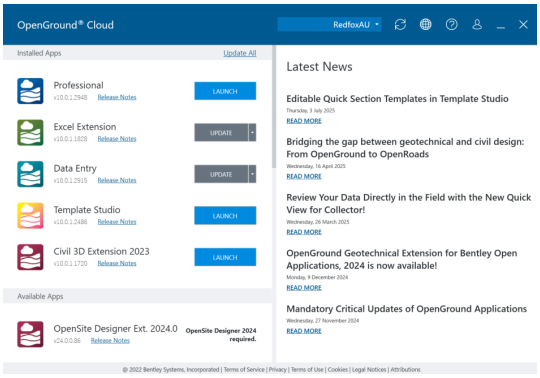


Template Studio for Output Presentation

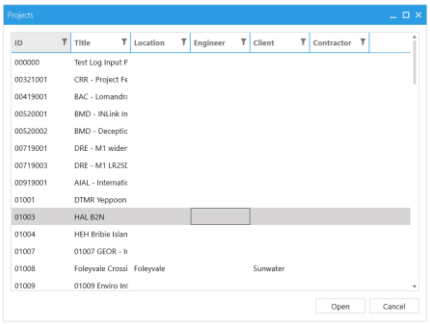
Getting Started

Template studio is where you adjust your templates. It's a tricky software with not many guides. A lot of figuring out stuff by messing around.

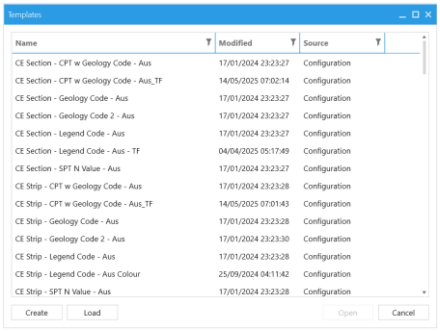
Opening Template studio is done through the cloud launcher like Open Ground



Next a Projects pop up will appear, open the project you are working on or the test log input project.



Open the template you would like to edit or create a new log. At the start of the template name it will tell you the type of template and what level it is at e.g dynamic log or strip.



General Breakdown of an Open Ground log

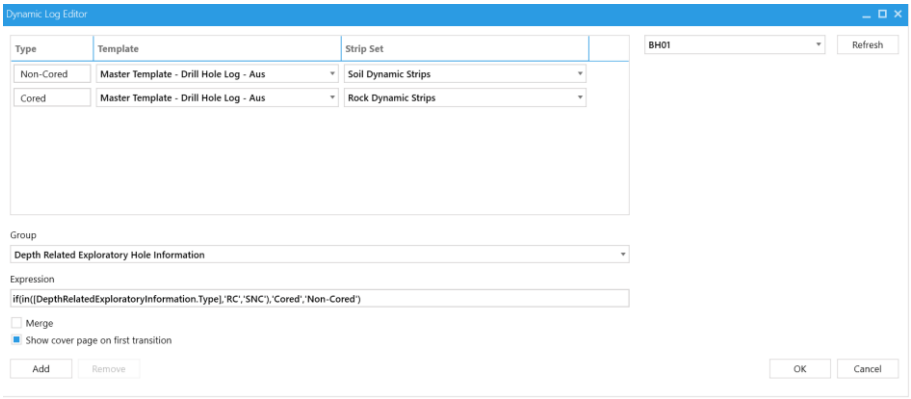
Open Ground logs work in a series of relationships where one type contains one or more types which can contain other types etc.

Type	Description
Dynamic Log	Contains multiple logs
Log	Contains your header, footer and strip sets
Strip Set	Contains your strips
Strip	Contains your columns
Column	Contains your headers/Data
Header/Data	Headers are the header of each column in the log

There are templates for the dynamic log to the strip. Different parts of the overall log are adjusted at different levels. This means that you must select the right level template to edit. E.g to decide which strips go into the strip set you must edit the strip set template but to edit the actual data going into the strip you must edit the strip template.

Dynamic Log

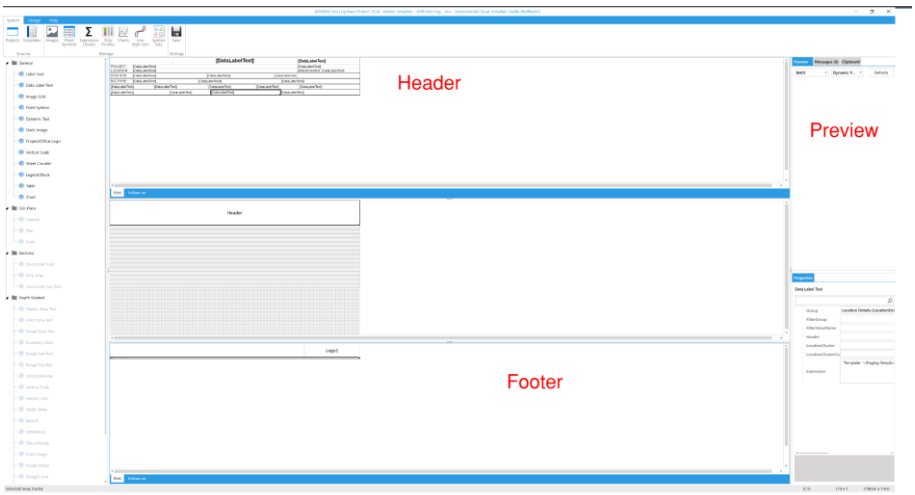
This is the top of the chain. A dynamic log allows you to change type of log within one log depending on something like swapping from a soil log to a rock log once rock coring starts in a borehole.



This is a dynamic log template menu. The main section shows the different logs that are being added to this dynamic log (Non Cored for soil and cored for rock). The expression below is an if statement that uses data stored Open Ground (input in our input spreadsheet) to determine when to change log type.

Log

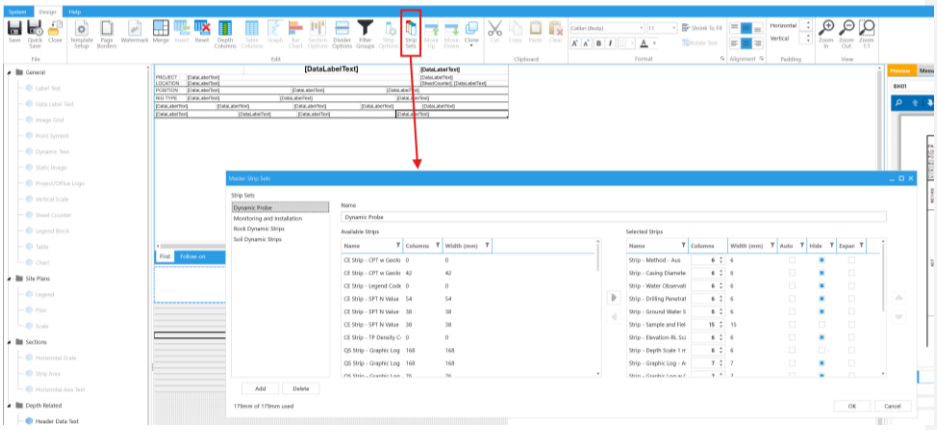
This is what you think of when you think of your logs. Logs determine the header, footer and which strip set is used. Master Template, Drill hole log is what is used below.



The important parts of this page are the header and footer where you can click the different cells and set what is contained within the header and footer. As well as the preview bar which allows you to set which test location and strip set to test then when you click refresh a preview will be here.

Strip Set

The strip sets for a log can also be accessed through the log template by navigating to the design ribbon and clicking the strip sets button. This menu allows you to click a strip set and decide which strips from the available strips section (templates) can be added to the selected strips (the strip templates in the strip set)

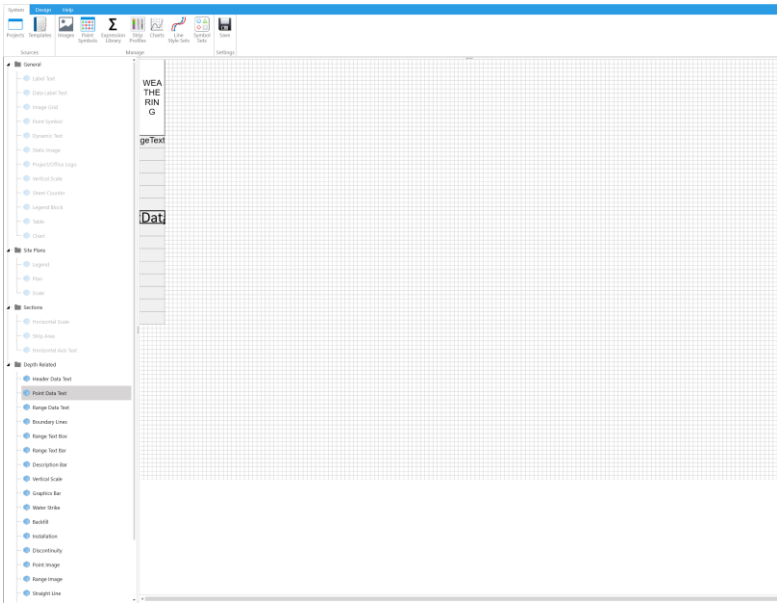


The width and other parameters can be defined here too.

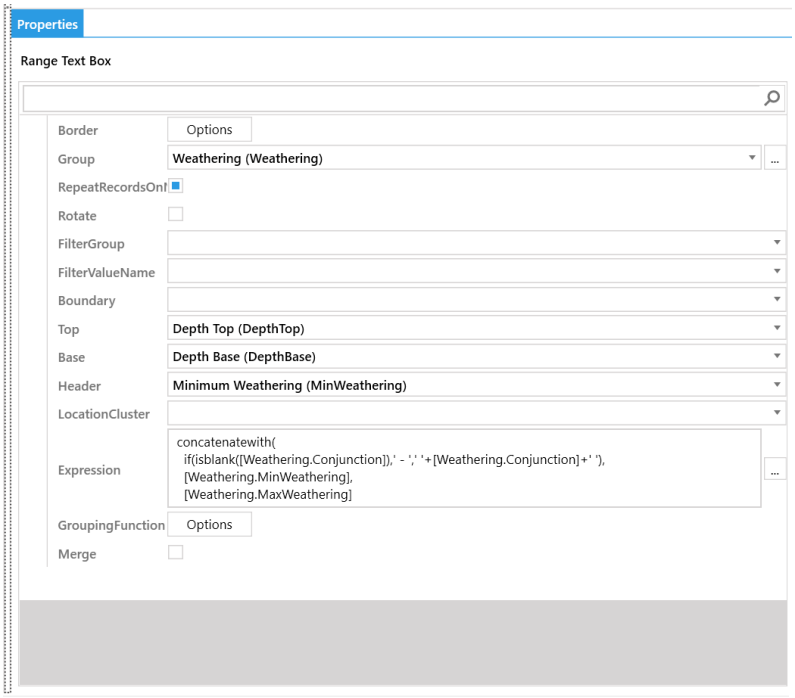
Strips, Columns, Headers

By selecting a strip template you can set what will appear in each strip. The header is what will appear above the strip in the log. The cells below In the same column determine what data will be displayed under the header. There can be multiple columns within one strip displaying different data.

Add data to a strip by clicking a cell (more of a data slot as the order doesn't mean it will be under the other one as the properties govern its position) and double clicking a type of data from the pane on the left.



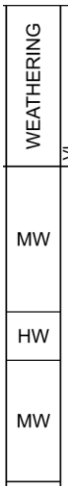
To edit what data will appear from that cell, click the cell and the properties pane will appear in the bottom right. The properties pane is where all of the real work is done. For this case we will use the weathering strip, range text box.



The group input tells us where the data will be pulled from the inputs (in this case weathering).

The Top and base field uses the depth top and depth base inputs in this case. So that the top and bottom of the section of rock with that weathering condition can be displayed.

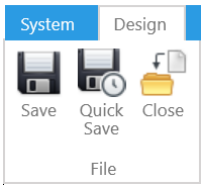
The header is what text will appear, in this case the minimum weathering condition input such as XW or MW.



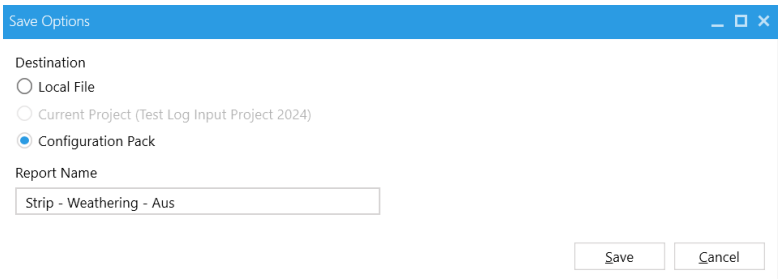
The expression field is an override that allows you to code different things that may not be possible using the main fields in the properties pane.

Saving your Templates

When saving, don't quick save. Go to design and save.

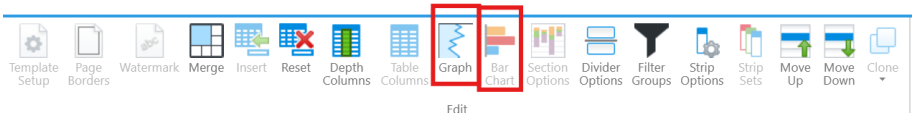


There are 3 options for saving, don't use local, if the changes are project specific just save it to the current project option, if the changes are for all projects and you are sure its right save to the config pack option as this will change it for all projects.

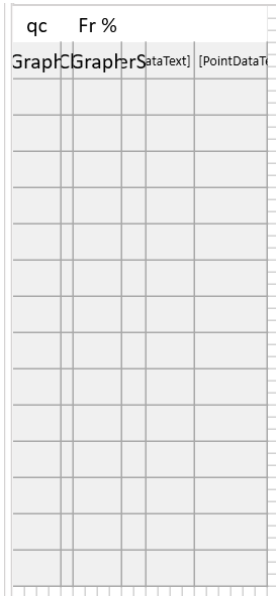


Section Templates

Editing the Section templates is done through CE strip templates.



The graph or bar chart buttons up the top will be accessible when clicking on a cell with one in it. They can be customised in the following menu. In the example below a bar chart is used to display different soil and rock layers in a section while a graph is used to input the Qc and friction ratio recorded along the borehole.



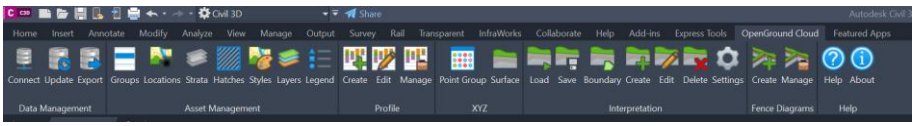
Civil 3D

Civil 3D can be used to make better section outputs compared to the quick sections directly out of Open Ground. They allow for more control and customisation of your log

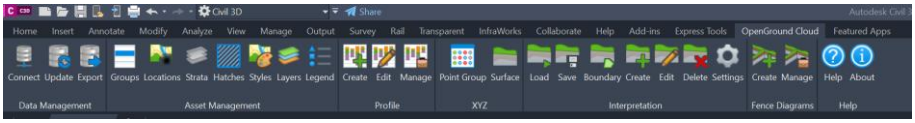
Linking your Project

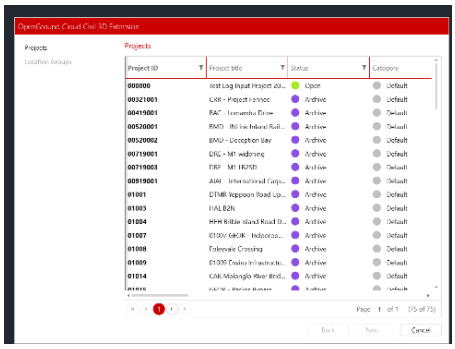
MAKE SURE YOU GET AN AEC LICENSE FOR AUTODESK

This is the Open Ground integration tab. It should open when you open Civil 3D. All Open Ground work is done through here



1. Connect to the appropriate project using the connect button (far left)
2. Using the Asset management tab click locations and select project - follow through wizard

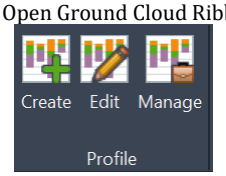




3. This should load in your chosen locations in real space (double middle click to recenter)

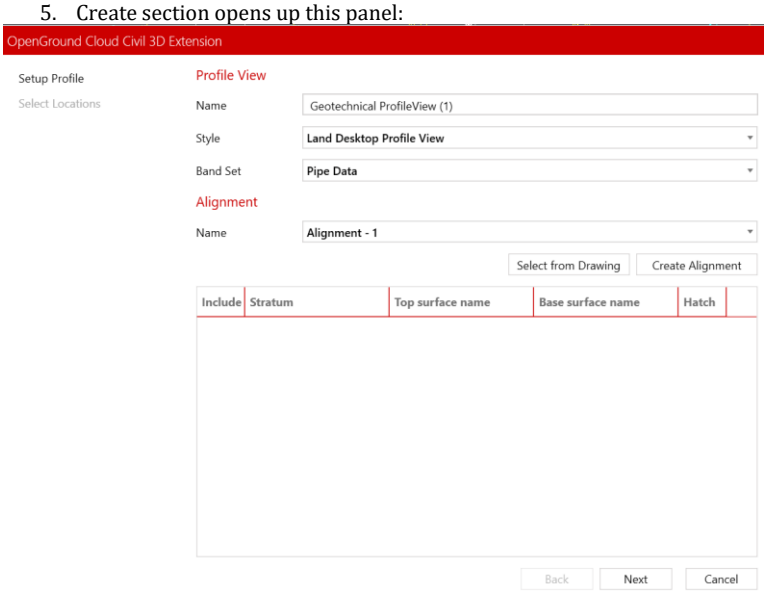
Cutting Sections in Open Ground

4. Navigate to profile panel under Open Ground Cloud Ribbon:

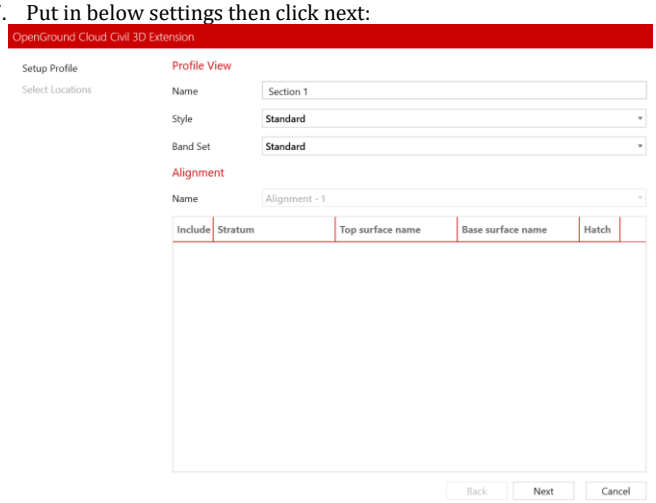


Profiles can be created or edited using these tools

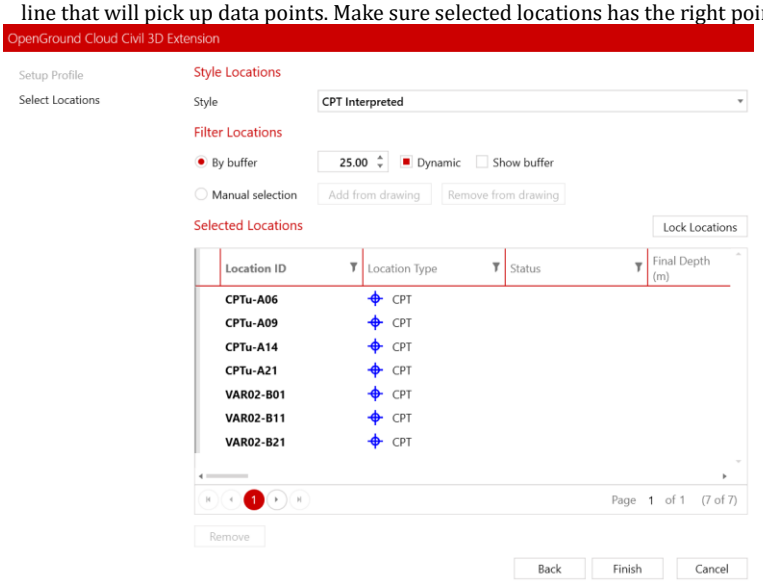
5. Create section opens up this panel:



6. Click create alignment and draw section through points.
7. Put in below settings then click next:



8. Put in below settings and adjust other parameters. Buffer is the offset from the section line that will pick up data points. Make sure selected locations has the right points.



9. Select where to put the new section (repeat steps 4-9 for each section)

Customising Civil3D sections

Need a AEC license to write guide

Commented [AL3]: Customising Civil 3D section of guide missing as we need an AEC license to write the guide. Notes in notebook

Exporting Civil 3d sections

10. File -> Export as DXF. If any issues with export save a copy of the Civil3d file and explode everything then re-export as DXF

Design Spreadsheets

ASAOKA Settlement Calculation Spreadsheet

ASAOKA Concept

Method of predicting end of primary settlement and the coefficient of consolidation (Cv) using the historical settlement data.

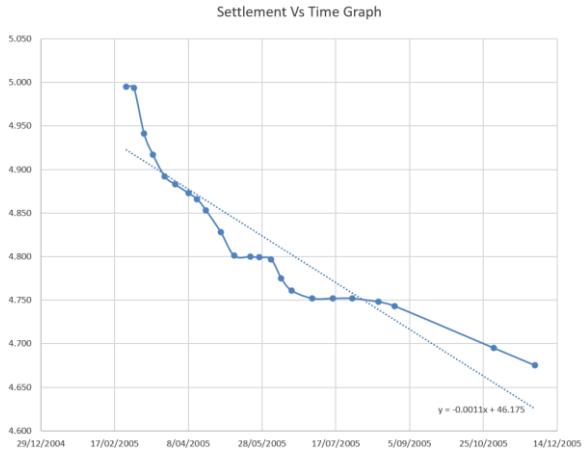


Figure 12, Settlement Vs Time Graph

On a graph of the settlement (S) on the y axis as well as the settlement -1 (S-1) on the x-axis. Graphing the historical data as well as a line with a gradient of x and an intercept of 0. Then find the intercept of the 2 lines using a line of best fit from the settlement data to find the predicted settlement at the point.

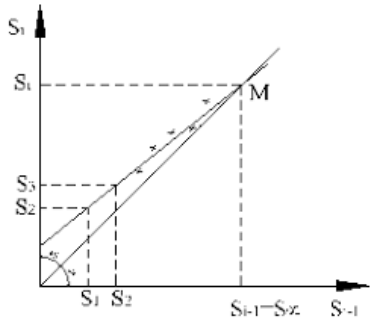


Figure 13, ASAOKA Method Graph

ASAOKA Process Breakdown

Raw/Processed Data

This method relies on 1 surcharging point so ensure the data inputted is not too strange big jumps in settlement etc.

SETTLEMENT POINT NO.	1.000
19/01/2005	
1/02/2005	
3/02/2005	
5/02/2005	
7/02/2005	
11/02/2005	
14/02/2005	
16/02/2005	
18/02/2005	
21/02/2005	
25/02/2005	4.995
2/03/2005	4.994
9/03/2005	4.941
15/03/2005	4.917
23/03/2005	4.892
30/03/2005	4.883
8/04/2005	4.873
14/04/2005	4.866
20/04/2005	4.853
30/04/2005	4.828
9/05/2005	4.801
20/05/2005	4.8
26/05/2005	4.799
3/06/2005	4.797
10/06/2005	4.775
17/06/2005	4.761
1/07/2005	4.752
15/07/2005	4.752
28/07/2005	4.752
15/08/2005	4.748
26/08/2005	4.743
1/11/2005	4.695
29/11/2005	4.675
18/07/2006	

Getting Settlement Per Day

The ASAOKA Method relies on settlement data being consistent times apart so in the spreadsheet the rate per day is calculated and then that is what is used for the S & S-1 graph. This part of the spreadsheet calculates the settlement per day using the inconsistently timed data collections to get a consistent time.

date	settle			
25/02/2005	4.995	0.001	5	0.0002
2/03/2005	4.994	0.053	7	0.007571429
9/03/2005	4.941	0.024	6	0.004
15/03/2005	4.917	0.025	8	0.003125
23/03/2005	4.892	0.009	7	0.001285714
30/03/2005	4.883	0.010	9	0.001111111
8/04/2005	4.873	0.007	6	0.001166667
14/04/2005	4.866	0.013	6	0.002166667
20/04/2005	4.853	0.025	10	0.0025
30/04/2005	4.828	0.027	9	0.003
9/05/2005	4.801	0.001	11	9.09091E-05
20/05/2005	4.8	0.001	6	0.000166667
26/05/2005	4.799	0.002	8	0.00025
3/06/2005	4.797	0.022	7	0.003142857
10/06/2005	4.775	0.014	7	0.002
17/06/2005	4.761	0.009	14	0.000642857
1/07/2005	4.752	0.000	14	0
15/07/2005	4.752	0.000	13	0
28/07/2005	4.752	0.004	18	0.000222222
15/08/2005	4.748	0.005	11	0.000454545
26/08/2005	4.743	0.048	67	0.000716418
1/11/2005	4.695	0.020	28	0.000714286
29/11/2005	4.675			

Massaged Settlement for use in S Vs S-1 Graph

For this method to work the data needs to be in consistent time intervals. This section of the spreadsheet uses the daily settlement calculation and creates an S reading for each day.

SUM =IFERROR(VLOOKUP(A6,$E$3:$I$32,5)+B5,NA())

	A	B	C	D	E	F	G	H	I
1									
2		si			date	settle			
3	25/02/2005	0.0002			**25/02/2005**	4.995	0.001	5	0.0002
4	26/02/2005	0.0004			**2/03/2005**	4.994	0.053	7	0.007571429
5	27/02/2005	0.0006			**9/03/2005**	4.941	0.024	6	0.004
6	28/02/2005	B5,NA())			**15/03/2005**	4.917	0.025	8	0.003125
7	1/03/2005	0.001			**23/03/2005**	4.892	0.009	7	0.001285714
8	2/03/2005	0.008571			**30/03/2005**	4.883	0.010	9	0.001111111
9	3/03/2005	0.016143			**8/04/2005**	4.873	0.007	6	0.001166667

Graphing

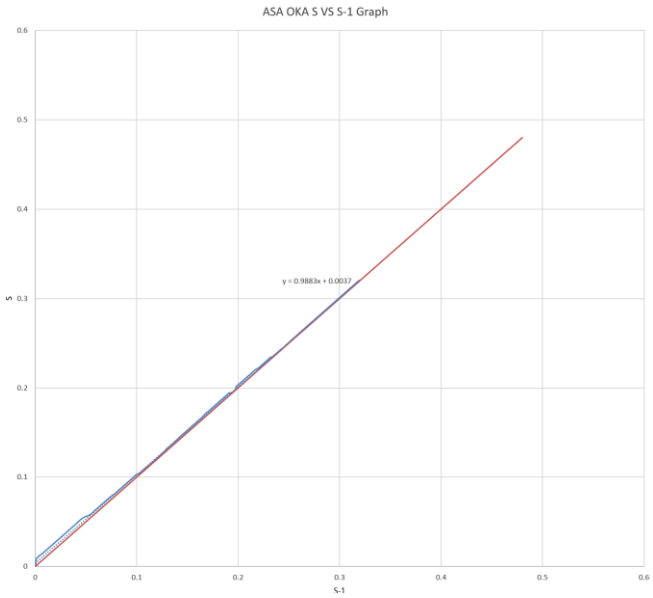


Figure 14, ASAOKA Method Graph from RFA Spreadsheet

The S & S-1 graph is created by graphing the same data in a series function but stepping the second series (S-1) 1 row (date) down to create S-1 as seen below.

```
=SERIES(,'Point 1'!$B$3:$B$790,'Point 1'!$B$4:$B$791,1)
```

Figure 15, Graphing Function for S & S-1

Getting Settlement and Cv

Settlement is the intersection of the 2 lines calculated in this section.

The current settlement is calculated by getting the max reading – the min reading to get the settlement.

The Forecast is calculated using the y=ax+c from the S vs S-1 trendline to calculate the intercept with the 1:1 line,

Duration	277		
	Verification		
	0.3200	If Red, check equation line is correctly inpu	
	Settlement		
Current	0.3200	m	101.27%
Forecast	0.316001	m	
a	*x*	+	*b*
0.98830855	*x*	+	0.003695

The CV is calculated in this cell

cv	21.31124	m2/yr

This cell useds a version of the following formula from "The Asaoka method revisited" paper which contains the methodology.

Substitute for C and solve for c_v :

$$c_v = \frac{-4H^2}{\pi^2} \cdot \frac{\ln \beta}{\Delta t}$$

Raise with Karen why there is not Delta T in the formula

cv	=365*(-((4*H50^2)/(PI()^2))*LN(G47))	m2/yr

Axial Pile Design Spreadsheet

The general purpose of this spreadsheet is to design a pile for axial loading. The spreadsheet mainly works for rock socket piles but other piles can be designed in this spreadsheet with some adjustment and consideration. This spreadsheet does a number of checks that can fail but are required to be conducted as a part of the TMR requirements.

Phi G

Geotechnical reduction factor from AS2159. Go down and fill out all input cells to find the relevant geotechnical strength reduction factor that is used later in the spreadsheet.

AS2159:2009 Piling Design and Installation
Section 4.3 Calculation of Geotechnical Strength Reduction Factor (f_g)

	Input Cells, Yes = Y, or number input
	Final Result, f_g
	Intermediate Calculated Values
	Information Cells

Conditional formatting is used in this spreadsheet

$$\phi_g = \phi_{gb} + (\phi_{tf} - \phi_{gb})K \geq \phi_{gb}$$

where

ϕ_{gb} = basic geotechnical strength reduction factor as given in Clause 4.3.2
ϕ_f = intrinsic test factor
= 0.9, for static load testing (see Section 8)
= 0.75, for rapid load testing (see Section 8)
= 0.8, for dynamic load testing of preformed piles (see Section 8)
= 0.75, for dynamic load testing of other than preformed piles (see Section 8)
= 0.85, for bi-directional load testing (see Section 8)
= ϕ_{gb}, for no testing
K = testing benefit factor
= $1.33p/(p + 3.3) \leq 1$, for static or rapid load testing
= $1.13p/(p + 3.3) \leq 1$, for dynamic load testing
p = percentage of the total piles that are tested and meet the specified acceptance criteria

f_{tf}

Test Type	Value	Select (Y)
Static Load	0.9	○
Rapid Load	0.75	○
Dynamic Load of Preformed	0.8	○
Dynamic Load of non-Preformed	0.75	○
Bi-directional Load Testing	0.85	○
No Testing*		◉
Satifsfactory correlation between static and dynamic tests, increased f_{tf} by:	0.05	☐ Y
Intrinsic test factor, f_{tf}		0.00

* value calculated below

K

Percentage of Piles Tested and Meet the Specified Acceptance Criteria	0
Test benefit factor, K	N/A

f_{gb}

Basic Geotechnical Strength Reduction Factor, f_{gb} (Calculated Below)	0.52

f_g

Geotechnical Strength Reduction Factor, f_g = $f_{gb} + (f_{tf} - f_{gb})K \geq f_{gb}$	**0.52**

Section 4.3.2 Calculation of Geotechnical Strength Reduction Factor (f_{gb})
Table 4.3.2(A)

Determine the individual risk rating for each Risk Factor (IRR_i). Values range from 1 to 5.

Risk Factor	Weighting factor, w_i	Typical description of risk circumstance for individual risk rating. See Table 4.3.2 (B)			Chosen IRR_i	$w_i IRR_i$
		1 (Very low risk)	3 (Moderate risk)	5 (Very high risk)		
Site						
Geological complexity of site	2	Horizontal strata, well-defined soil and rock characteristics	Some variability over site, but without abrupt changes in stratigraphy	Highly variable profile or presence of karstic features or steeply dipping rock levels or faults present on site, or combinations of these	2	4
Extent of ground investigation	2	Extensive drilling investigation covering whole site to an adequate depth	Some boreholes extending at least 5 pile diameters below the base of the proposed pile foundation level	Very limited investigation with few shallow boreholes. Very limited	4	8
Amount and quality of geotechnical data	2	Detailed information on strength compressibility of the main strata	CPT probes over full depth of proposed piles or boreholes confirming rock as proposed founding level for piles	Limited amount of simple in situ testing (e.g., SPT) or index tests only	3	6

Socket area description

If the pile is bored and rock socketed with a liner there will be no skin friction for the section of pile with liner on the pile, so the only materials required to be inputted is the rock section as well as any section of the pile in soil without a liner

Geotechnical Reduction Factor ϕ_r	
Geotechnical Reduction Factor ϕ_s	0.52

Socket Design

Unit	q_u (MPa)	q_{bu} (MPa)	q_{bult} (MPa)	τ_{ult} (kPa)	E_{rm} (MPa)
Class-V	1.4	1	3.5	150	100
Class-IV	3.5	1.75	5.5	400	300
Class-III	7	3.5	8	600	550

Socket Stratigraphy

Unit	Top RL (m AHD)	Bottom RL (m AHD)
Class-V	-8.7	-12.1
Class-III	-12.1	-30.0

Pile inputs

Most of these parameters should be provided by structures, including the SLS Axial load, the ULS Axial load, the Ep (pile modulus) and possibly the pile diameter.

The pile self-weight should also be considered in the ULS axial load so the spreadsheet considers it

Inputs		
Parameter	**Value**	**Unit**
Pile Diameter	1.2	m
SLS Axial	5611	kN
ULS Axial	10000	kN
Perimeter	3.8	m
Base Area	1.1	m^2
E_p (Pile Modulus -	32800	MPa
Est Pile Length	24.1	m
Pile Self Weight	681	kN

Pells Elastic Method

Pells Theory:

The

Determine Rock Socket length - Elastic method (Pells 1978)

P_t 10000 kN

Unit	Socket Length in Material (m)	Skin Friction (kN)	Modulus (MPa)
Class-V	3.40	1923	100
Class-III	3.57	8077	550
Total	7.0	10000	
Average τ (kN/m)		1429	

	Unit	E_b (MPa)	E_r (MPa)
Founding in	Class-III	550	331

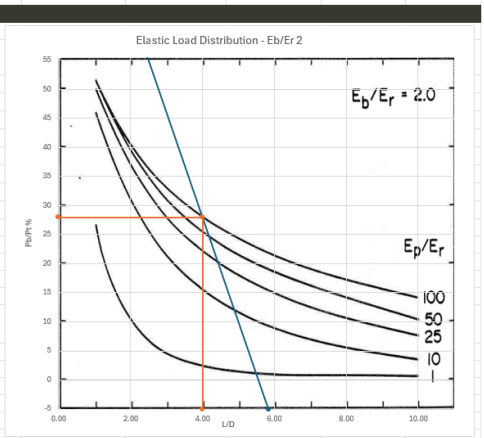
L_{max} (m)	7.0		
L_{max}/D	5.8		
E_b/E_r	1.7	*Use Design Chart:*	*Elastic Chart 2*
E_p/E_r	99		
Design L/D (Refer Figure)	4.0	*Input from E_p/E_r Design Line*	*Check against orange line*
Design L	4.8		*Pb/Pt = 0.28*

τ Average Adjustment

Pile Length Reduction (m)	2.2
Reduced by τ_{ave} (kN)	3143
Actual Reduction (kN)	4976
Eqv. Reduced Length [1] (m)	1.3
Design L/D	4.8
Design L (m)	5.7

Design Socket

Unit	Socket Length in Material (m)	Skin Friction (kN)	Modulus (MPa)
Class-V	3.40	1923	100
Class-III	2.30	5202	550
	5.70		



Equivalent Reduction [1]

Unit	Socket Length in Material (m)	Skin Friction (kN)	Modulus (MPa)
Class-V	3.40	1923	100
Class-III	1.37	3101	550
Total	4.8	5024	550
Average τ (kN)		1053	

Design Pile Capacity

Founding In	Class-III	*Check this makes sense*
$Q_{b,ult}$	9048	kN
$Q_{s,ult}$	7125	kN
ϕ_g	0.52	
R_{ug}	8410	kN

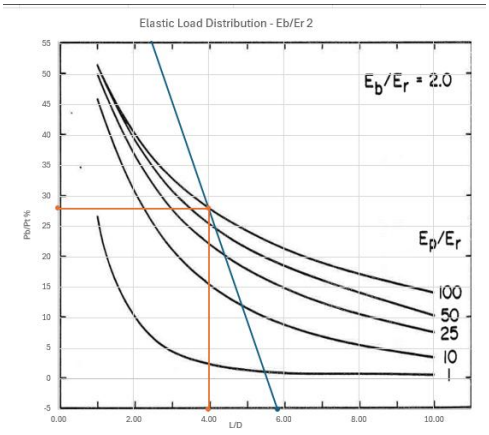
R*>S*	Insufficient
Utilisation	119%

Pells Process

1. Look at the Eb/Er value in blue, use this to find the relevant graph. In the top right of the elastic load distribution graphs it will have an Eb/Er, match this to the blue cell one (rounding up). If the relevant graph is not in there (move the graph in excel and see if its underneath) you may have to look around for it and do it manually or re setup the graphing.

	Unit	E_b (MPa)	E_r (MPa)
Founding in	Class-III	550	331
L_{max} (m)	7.0		
L_{max}/D	5.8		
E_b/E_r	1.7	*Use Design Chart:*	*Elastic Chart 2*
E_p/E_r	99		
Design L/D (Refer Figure)	4.0	*Input from E_p/E_r Design Line*	*Check against orange line*
Design L	4.8		*Pb/Pt = 0.28*
τ Average Adjustment			
Pile Length Reduction (m)	2.2		
Reduced by τ_{ave} (kN)	3143		
Actual Reduction (kN)	4976		
Eqv. Reduced Length (m)	1.3		
Design L/D	4.8		
Design L (m)	5.7		

2. Look at the blue Ep/Er, that decides which line you should line you should be trying to line up with.
3. Adjust the Design L/D (Input orange) so that the orange dot touches the relevant Ep/Er line.



4. For the Pells process if the result is insufficient that is ok.

Design Pile Capacity		
Founding In	Class-III	*Check this makes sense*
$Q_{b,ult}$	9048	kN
$Q_{s,ult}$	7125	kN
ϕ_g	0.52	
R_{ug}	8410	kN
R*>S*	Insufficient	
Utilisation	119%	

Settlement and Row and Armitage

Settlement and Row and Armitage Theory

Theory

Predicted Settlement at Top of rock Socket

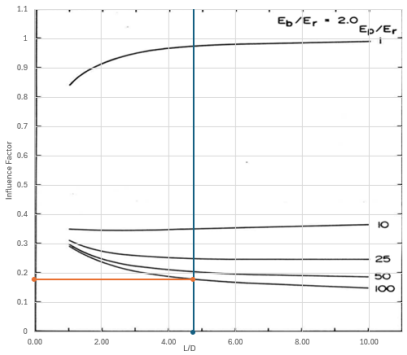
SLS Axial	5611	kN		
Modulus Reduction Factor	0.5			
Factored Mean Modulus	141		*Read off Figure 9*	*Check Against Design line Ec/Er = 99*
Influence Factor	0.18			
Settlement	**6.0**	mm		

It is recommended that modulus reduction factor should be applied for calculations relating to long term serviceability. Suggested values are:

(a) Mean in situ deformation properties assessed from pressuremeter testing or other large scale in situ measurements $\phi_m = 0.75$

(b) Mean in situ deformation properties assessed by correlation with rock mechanics indices such as RQD or RMR $\phi_m = 0.5$

Figure 9: Elastic Settlement Influence Factors



Serviceability Checks

$P_{b.SLS} < Q_{be}$	Pass
Differential Settlement <10mm	Pass

Check that under serviceability the socket base load is less than the limit of linear elastic behaviour.

Determine Rock Socket length - (Rowe And Armitage)

Inputs

$P_{t\,ULS}$	10000	kN
$P_{t\,SLS}$	5611	kN
$P_{b\,elastic}$	3958	kN
$P_{b\,elastic}/P_{t\,ULS}$	0.40	
Eb/Er	1.7	
Ep/Er	99	
Calculated L/D	3.36	
L	4.0	m

Design Socket Outputs

Unit	Socket Length in Material (m)	Shaft Resistance (kN)	Modulus (MPa)
Class-V	3.4	1923	100
Class-III	0.6	1420	550

Settlement Check

SLS Axial	5611	kN	
Factor	0.5		
Factored Mean Modulus	85.1		Inputs
Refer Rowe and Armitage Charts - Figure	A17		*Pb/Pt =0.4*
Influence Factor	0.23		*L/D =3.36*
Settlement	**12.6**	mm	
Settlement <10mm	Fail		

Capacity Outputs

Founding In	Class-III		*Check this makes sense*
Qb,ult	9048	kN	
Qs,ult	3343	kN	
Φg	0.52		
R_{ug}	**6443.0**	kN	
R*>S*	Insufficient		
Utilisation	155%		

Settlement and Row and Armitage Process

For the settlement and Row and Armitage Process at this stage, Failing and Insufficient results are ok.

1. Find the relevant Elastic Settlement graph using the Eb/Er
2. Use the Ep/Er value to decide which line is relevant
3. Adjust the influence factor to line up with the Ep/Er line

Predicted Settlement at Top of rock Socket

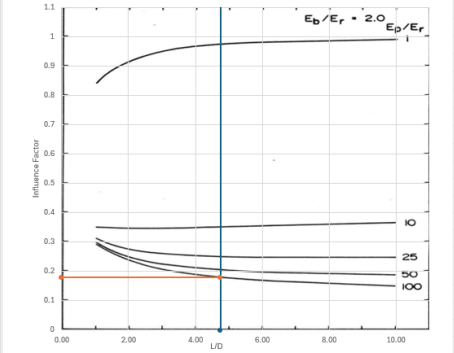
SLS Axial	5611	kN		
Modulus Reduction Factor	0.5		Read off Figure 9	Check Against Design line
Factored Mean Modulus	141			Ec/Er = 99
Influence Factor	0.18			
Settlement	6.0	mm		

It is recommended that modulus reduction factor should be applied for calculations relating to long term serviceability. Suggested values are:

(a) Mean in situ deformation properties assessed from pressuremeter testing or other large scale in situ measurements ϕ_m = 0.75

(b) Mean in situ deformation properties assessed by correlation with rock mechanics indices such as RQD or RMR ϕ_m = 0.5

Figure 9: Elastic Settlement Influence Factors



Serviceability Checks

$P_{b\ SLS} \leq Q_{bu}$	Pass	Check that under serviceability the socket base load is less than the limit of linear elastic behaviour.
Differential Settlement <10mm	Pass	

4. See which Rowe and Armitage chart is relevant, should be In red (A_).

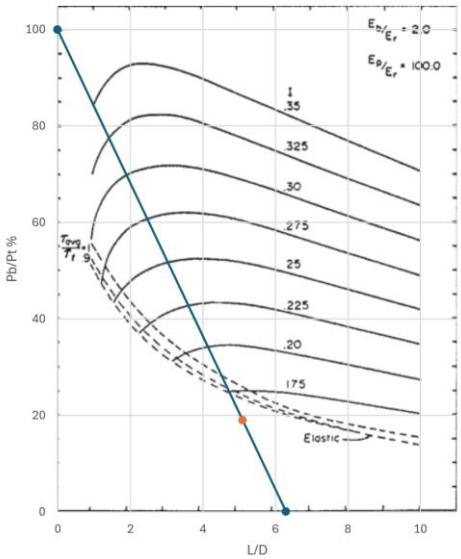
Settlement Check			Capacity Outputs		
SLS Axial	5611	kN	Founding In	Class-III	Check this makes sense
Factor	0.5		Qb,ult	9048	kN
Factored Mean Modulus	85.1	Inputs	Qs,ult	3343	kN
Refer Rowe and Armitage Charts - Figure	A17	Pb/Pt =0.4	Φg	0.52	
Influence Factor	0.23	L/D =3.36	R_{ug}	6443.0	kN
Settlement	12.6	mm			
			R*>S*	Insufficient	
Settlement <10mm	Fail		Utilisation	155%	

5. Got to the Rowe Charts sheet and put in the relevant Lmax/D (x, x-int orange input cell) and the relevant Pb/Pt. These values are auto calculated and next to the influence factor and relevant chart cells.

Lmax/D	x-int	y-int
x	6.3	0
y	0	100
Optional Nominate marker		
Will draw along line if one left blank/0		
Pb/Pt		19.00
or		S

6. Look at the relevant graph and find read the influence factor off the graph (most of the time the orange dot on the blue line will be in between the influence factor lines so you just have to read them off).

Figure A17



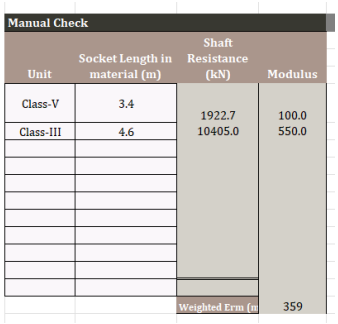
7. At this stage these checks can still fail

Manual Check of Capacity and Resistance: IMPORTANT

Manual Check Theory & Process

This is the section that actually matters.

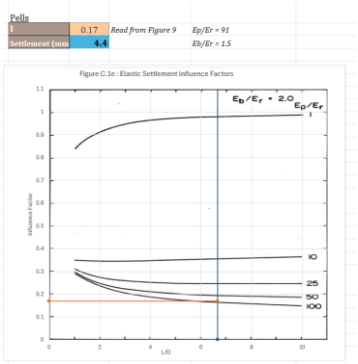
1. Ignore the calculation sheet (its background calcs)
2. Under the manual check heading adjust the lengths of your socket in each material so that it passes the R*>ΦS* (utilisation should be around 85-90%). Use some common sense when adjusting the lengths In each material, e.g. if the socket is 3.4m embedded in class V rock with the next part of the embedment in class III rock, you cant increase the embedment in the class V, only the class III.



Manual Check

Unit	Socket Length in material (m)	Shaft Resistance (kN)	Modulus
Class-V	3.4	1922.7	100.0
Class-III	4.6	10405.0	550.0
		Weighted Erm (m	359

3. Go and repeat the Pells influence factor check adjusting the influence factor process on this page.

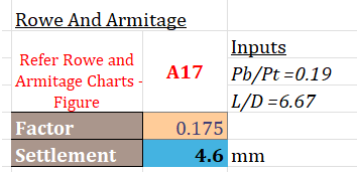


Pells

I	0.17	*Read from Figure 9*	*Ep/Er = 91*
Settlement (mm	4.4		*Eb/Er = 1.5*

Figure C.1e : Elastic Settlement Influence Factors

4. Go and repeat the Rowe and Armitage check on this page, using the relevant graph and values mentioned in this page



Rowe And Armitage

Refer Rowe and Armitage Charts - Figure	A17	Inputs *Pb/Pt =0.19* *L/D =6.67*
Factor	0.175	
Settlement	**4.6**	mm

5. At this stage all of the checks must pass (this is your actual design)

Capacity check

Founding In	Class-III	*Check this makes sense*
Eb/Er	1.5	
Ec/Er	91	
Qb,ult	9048	kN
Qs,ult	12328	kN
Φg	0.52	
R_{ug}	**11115.2**	kN
ϕS*	**10000.0**	kN
R*>ϕS*	**Pass**	
Utilisation	90%	

Serviceability check

Serviceability Verification	
SLS Load<Q_{be}	**Pass**
Settlement <10mm	**Pass**

Settlement < 10mm

Settlement <10mm	**Pass**

Conclusion

- Use Engineering Judgement
- Think don’t just follow a process