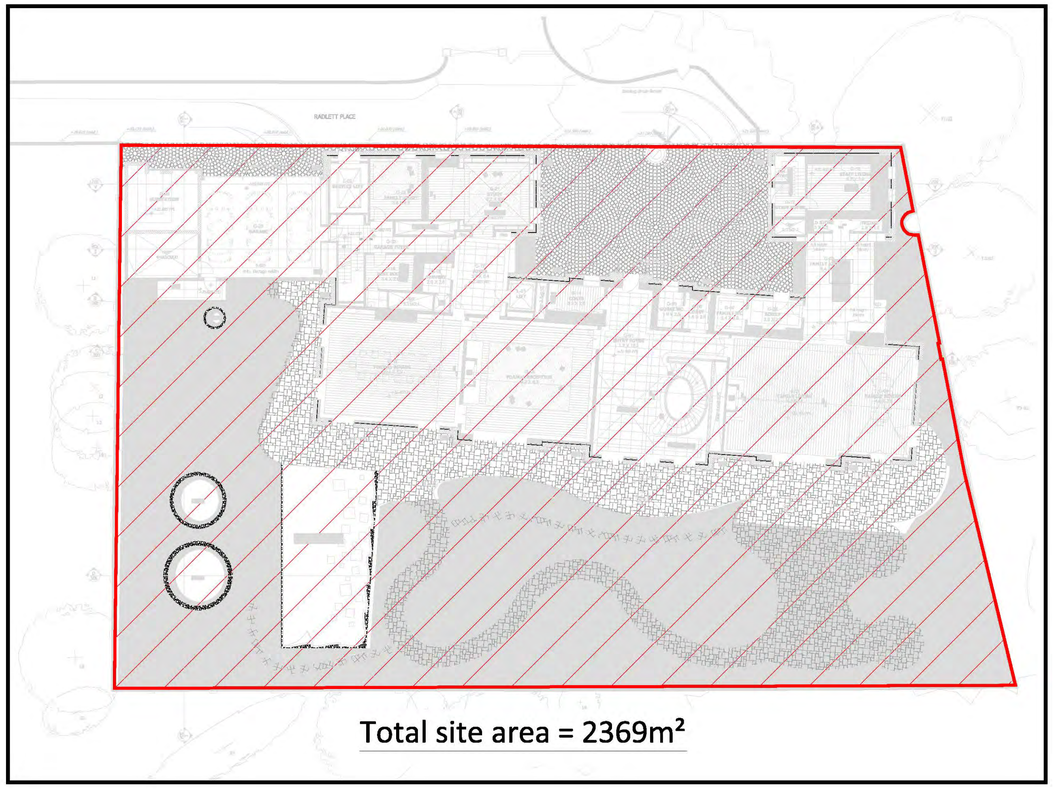
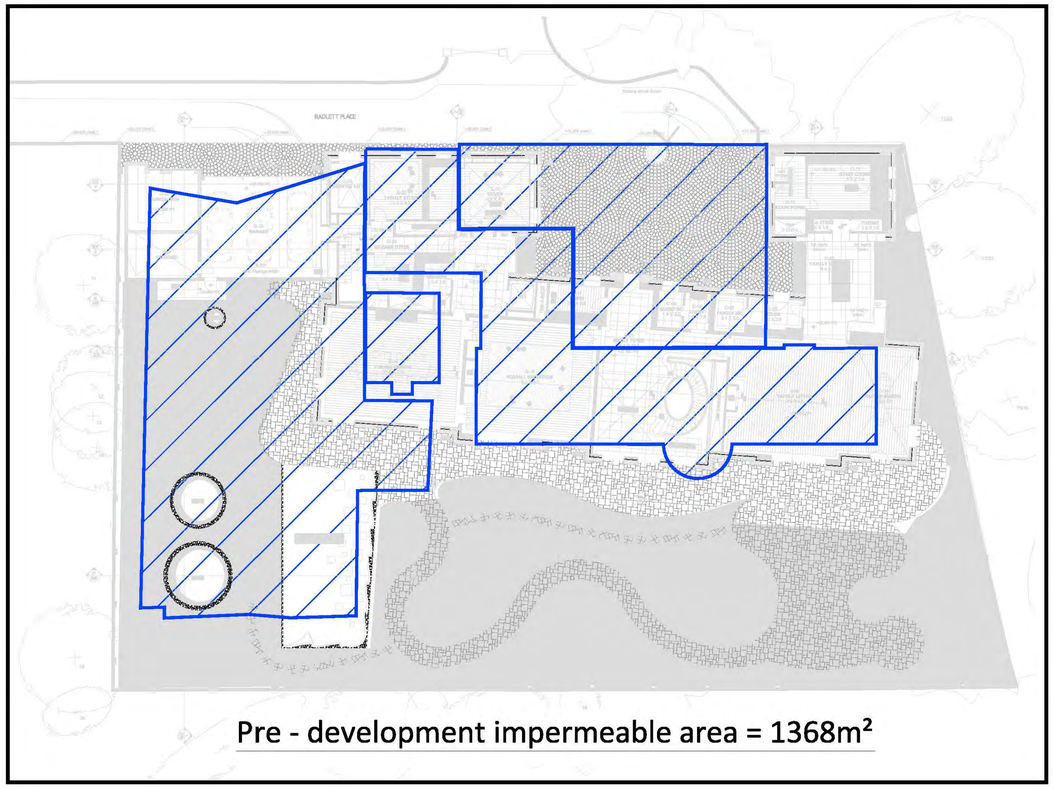
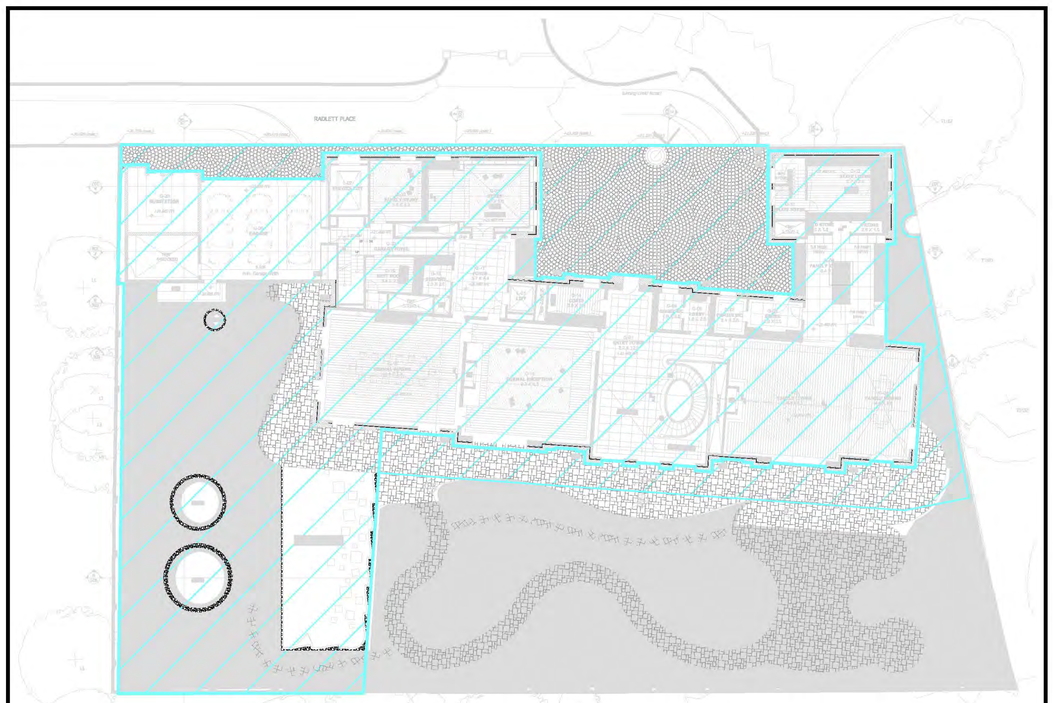
APPENDIX C – CHANGE OF USE: LAND PERMEABILITY PLAN



Total site area = 2369m²



Pre - development impermeable area = 1368m²



Post - development impermeable area = 1697m²

Post - development green roof area = 542m²

minimum depth of sub-strate = 150mm

Rev	Date	Description	Drn	App
--	--.--.--	-----	--	--

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Project: 1 Radlett Place

Drawing Title: Land Permeability Plan

Drawing Status: For Information

Drawn by	Checked by	Sheet size	Scale
JD	RN	A3	NTS

Drawing Number: J1219-Sk-024

Revision: -

APPENDIX D – SURFACE WATER RUNOFF CALCULATIONS

J1219

Category 4: Surface Water Runoff

Sur 1 Summary Template – November 2010 Version

Introduction

This template can be used to demonstrate compliance with the criteria specified in Sur 1 in the Code for Sustainable Homes (for the November 2010 version). The form can be used by the Code Assessor to aid in assessing the Sur 1 issue and can be provided as supporting evidence **in addition** to the items listed in the schedule of evidence for Sur 1. Completing this template is optional.

National policy documents have been used to set the standards for the mandatory element of Sur 1. PPS25 Development and Flood Risk (ODPM, 2006) and the SuDS manual are two of the key documents used. Further reading is listed in the References section of the Technical Guide.

Instructions

Where submitting this template as supporting evidence for a Code assessment please ensure that the **assessor completes the contact details (page 2)** and the **appropriately qualified professional completes the rest of the template**, ensuring that it is signed and dated. If the form is incomplete and / or unsigned it will not be accepted as evidence supporting a Code assessment.

The Technical Guide states the calculation methodologies to be used to demonstrate compliance with some aspects of the criteria, for example the greenfield runoff rates. Although flexibility in choice of methodology is available for some of the criteria, best practice methodologies should always be used. If required, information regarding applicable calculation methodologies can be found in the SUDS Manual (CIRIA, 2007). Reputable software, such as Microdrainage, can be used for calculation purposes.

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The below sections to be completed by the Assessor	
Contact Details	
Consultant/engineer details	
Company Name	
Company Address	
Contact Name	
Contact Telephone Number	
Developer/client details	
Company Name	
Company Address	
Contact Name	
Contact Telephone Number	
Development details	
Development Name	
Development Address	
BRE Reference Number	
Client Reference Number (if applicable)	
Number of dwellings on the site:	

THE CODE FOR SUSTAINABLE HOMES
CERTIFICATION MARK

All of the following sections of the template to be completed by the Engineer / Consultant		
MANDATORY REQUIREMENTS		
Appropriately Qualified Professional		
1. ☑	I can confirm that I am an appropriately qualified professional in line with the Code definition.[1]	
Assessment Information		
2.	For sites containing a mixture of non-Code and Code assessed dwellings there are several assessment options for Sur 1. The first would be to assess the whole site (including the non-Code dwellings) under the Code criteria. The second would be to demonstrate with several separate reports that each group of Code dwellings (and the associated sub catchments serving those dwellings) on the site have met the criteria individually. Please tick one of the following boxes;	
☐	A. The site contains a mixture of Code and non-Code dwellings and the whole site has been assessed under the Sur 1 criteria including any associated sub catchments serving these dwellings.	
	OR	
☐	B. The site contains a mixture of Code and non-Code dwellings and there is more than one assessed area for Sur 1 within the site boundary. Please write the number of assessed areas within the site in the space provided below (you will need to complete this template for each assessed area)[2]. **Number of assessed areas:**	
	OR	
☑	C. The site only contains Code assessed dwellings and the associated sub catchment serving those dwellings.	
Site Information		
3.	A. Please provide the site area[3](delete units of measurement as applicable)	2369 m^2
	B. Please provide the impermeable area of the site pre-development (delete units of measurement as applicable)	1368 m^2

[1] Refer to the technical guide for details on the definition of an appropriately qualified professional.
[2] It would aid the QA process to provide a site plan highlighting each assessment area and highlighting which area is being assessed in this report.
[3] The site area will include all areas within the boundaries of the site, including both permeable and impermeable areas. If box 2B has been ticked, the 'site area' will be only that for which this template demonstrates compliance.

	C. Please provide the impermeable area of the site post development (delete units of measurement as applicable)	1697 m^2 [redacted]

Special Cases[4]

4.	Please tick the relevant box below to identify where a special case applies for the site:
☐	A. The impermeable area has decreased as a result of the development, and the mandatory element of this issue has been met by default.
☐	B. A minimum flow rate or maximum storage requirement has been set by the sewerage undertaker (or other statutory body).
☐	C. Planning approval has been granted for the detailed drainage strategy prior to the Code requirement being set for the development.
☐	D. The assessed dwelling is directly connected to existing infra-structure which pre-dates the Code requirement.

5.	Tick one or both of the following to confirm if some or all of the highways will be omitted from the impermeable areas in the calculations for one of the following reasons[5]:
☐	A. The highways are being adopted
☑	B. The Code dwellings are being built beside existing highways.

SECTION 1: Peak Rate of Runoff

6.	A. Pre-development peak rate of runoff for the **1 year return period event** [6]	28.3	l/s
	B. Post-development peak rate of runoff for the **1 year return period event** [6] (this figure must be less than or equal to A, except where the 5l/s rule has been used)	5.0	l/s
	C. Pre-development peak rate of runoff for the **100 year return period event** [6]	85.5	l/s

[4] Refer to the Technical Guide for details on the supporting evidence required to demonstrate compliance with these special cases. This evidence must be provided to demonstrate how the special case is being met.

[5] Refer to the technical guide for details on when an adoptable road can be omitted from the assessment.

[6] Peak rate of runoff calculations should be carried out for the range of storm durations up to and including the 6 hour storm. The peak rate of runoff for the storm event will then be the 'worst case' runoff rate for the range of storm durations. The climate change allowance should be added only to the post development calculations.

	D. Post-development peak rate of runoff for the **100 year return period event** [6] (this figure must be less than or equal to C, except where the 5l/s rule has been used)	5.0 l/s
7. ☑	Please tick this box to confirm that the 5l/s rule has been applied where the peak rates of runoff have increased post development, but are still equal to or less than 5l/s.	
8.	If, post-development, it was necessary to reduce the peak rate of runoff to meet the Code criteria, please provide a brief explanation below describing how the peak rate was reduced. For example, 'soakaways reduce the peak rate of runoff to pre-development levels'.[7]	
	Green roof infiltration to reduce volume run-off + Attenuation to reduce peak rate of run-off N/A ☐	
9. ☑	Please tick this box to confirm that the post development peak rate of runoff calculations include an allowance for climate change in accordance with current best practice (PPS25, 2006).	
10.	Please tick one of the following boxes as applicable to this site:	
☑	A. This is a greenfield site and is less than 50 ha therefore runoff rate calculations have been carried out in accordance with the IH Report 124 'Flood estimation for small catchments' (Marshall and Bayliss, 1994). The pro rata method on the size of catchment detailed in table 4.2 of the SuDS manual has been used.	
☐	B. This is a greenfield site of 50 to 200 ha therefore runoff rate calculations have been carried out in accordance with the IH Report 124 'Flood estimation for small catchments' (Marshall and Bayliss, 1994).	
☐	C. This is a greenfield site of more than 200 ha (or where there is a preference to do so and the catchment is considered suitable for its application) therefore runoff rate calculations have been carried out in accordance with the 'Flood estimation handbook' (Centre for Ecology and Hydrology, 1999).	

[7] Note that detailed documentary evidence (as per the schedule of evidence table in the Technical guide) is required to demonstrate how the peak rate of runoff has been reduced.

☐	D. This is a greenfield site of more than 200ha where the Flood Estimation handbook is considered inappropriate for the development therefore the IH Report 124 has been used.
☐	E. This is a brownfield site and runoff rates have been calculated in accordance with current best practice simulation modelling.
☑	F. This is a Brownfield site where the pre development surface water drainage system is not known therefore the runoff rates have been calculated using the Greenfield run-off model ticked above (please tick the relevant methodology), but using soil type 5.

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SECTION 2: Volume of Runoff

Section 2A

11. ☑	Please tick this box to confirm that the following post development volume of runoff calculations include an allowance for climate change in accordance with current best practice (PPS25, 2006).
☑	Please tick this box to confirm that the following volume of runoff calculations are for the 100 year event of 6 hour duration.

12.	A. Pre-development volume of runoff	69.9 m^3
	B. Volume of runoff caused by the new development **prior to mitigation**	106.3 m^3
	C. **Additional** predicted volume of rainwater caused by the new development prior to mitigation (= 12B – 12A)	36.4 m^3
	D. If the answer to 12C is greater than zero, please provide a brief explanation below describing how you have reduced the additional volume discharged from the developed site, for example, 'soakaways will infiltrate all of the additional volume':	
	Green roof infiltration systems will reduce the additional volume N/A ☑ (criterion 2A cannot be satisfied, see section 13)	
	Please provide the additional volume of runoff discharged from the site when all (if any) mitigation measures described in 12D are in place.	10.5 m^3

13.	A. Where there is an increase in the volume of runoff as a result of the development and criteria 2A cannot be satisfied via infiltration or other SuDS techniques (as listed below), please provide an explanation below (evidence to support the reasoning should be provided in the hydrological report):
	Soakaways: Ground strata impermeable **Porous/Pervious paving:** Ground strata impermeable

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	Rainwater re-use harvesting: Used for irrigation but unsuitable for additional storage (not accounted for in design). **Green Roof:** Unable to provide additional areas of green roof. Maximum area already taken **Other surface infiltration techniques:** Ground strata unsuitable N/A ☐ (all additional volumes of run-off have been dealt with)

Section 2B		
14.	Where it has not been possible to reduce all of the additional volume by infiltration or other SuDS techniques, the volume of runoff should be discharged in accordance with one of the following rates of runoff, whichever is the higher. Please tick one of the boxes below to confirm the level of flow control that has been achieved:	
☐	A. The peak discharge rate has been reduced to pre development 1 year peak flow rate	
	Please state the pre development 1-year peak flow rate	l/s
	OR	
☐	B. The peak discharge rate has been reduced to the site's estimated mean annual flood flow rate (Qbar).	
	Please state Qbar:	l/s
	OR	
☐	C. The peak discharge rate has been reduced to 2l/s/ha.	
	Please state the peak discharge rate at 2l/s/ha:	l/s
	OR	
☑	D. The limiting discharge rate requires a flow rate of less than 5l/s at a discharge point, therefore a flow rate of up to 5l/s has been used.	

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SECTION 3: Designing for Local Drainage System failure	
15. ☑	Tick here to confirm that the consequences of system failure caused by extreme rainfall, lack of maintenance, blockage or other causes, have been considered and evaluated fully and there will be no increased risk to dwellings either on or off site.[8]

AWARDING OF CREDITS: WATER QUALITY CRITERIA[9]	
16. ☐	A. Tick here to confirm that there will be no discharge from the developed site for rainfall depths up to 5 mm. Please provide a brief explanation below describing how the runoff from rainfall depths up to 5 mm will be prevented from leaving the site:
☑	B. Tick here to confirm that the runoff from all hard surfaces shall receive an appropriate level of treatment in accordance with the SuDS Manual to minimise the risk of pollution to the receiving watercourse. Please provide a brief explanation below describing how the hard surfaces will receive an appropriate level of treatment:
	Run-off from hard surfaces is passed through attenuation tanks (ie detention).

[8] Refer to the technical guide for details on the evidence that would be required to demonstrate that this has been considered fully.
[9] Note that where the mandatory element has been met by special cases 3. C and 3.D, no credits can be achieved.

Signature	
The following declaration should be signed by the appropriately qualified professional responsible for ensuring that the development meets the Sur 1 mandatory criteria and the necessary criteria to allow the awarding of credits, where applicable.	
I confirm that the information provided in this document is truthful and accurate at the time of completion.	
Name of Appropriately Qualified Professional:	A. YATES
Signature of Appropriately Qualified Professional:	A. Yates.
Date:	28/9/12

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Project	RADLETT PLACE		
Part of structure	DRAINAGE CALCS		
Date	9/12	Job number	J1219
Engineer	Checked by	Checked date	Sheet number
AM			1

Calculate pre development run off rates

Site impermeable area pre development = 1368 m²

Site location = 527212 N, 183774 E

Using Modified Rational Method

$Q_p = 2.78 C i A$

where

$C = C_v C_r$

i = rainfall intensity (mm/hr)

A = catchment area (ha)

Q_p = peak discharge (l/s)

$C_v = 0.9$ where A = impervious area only

$C_r = 1.30$

take t_e = 5 min

for site

M5-60 = 21 mm

r = 0.45

for 1 year return period

M5-60 = 21 mm

Z1 = 0.40 (Fig 6.3b Wallingford Procedure)

M5-5 = 0.40 × 21 = 8.4 mm

for M1, Z2 = 0.617

∴ M1-5 = 8.4 × 0.617 = 5.18 mm

$i = \frac{M1-D}{D} = \frac{5.18}{5/60}$ = 62.6 mm/hr.

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Project			
Part of structure			
Date		Job number	
Engineer	Checked by	Checked date	Sheet number 2

for 100 year return period

$M5\text{-}5 = 8.4$ mm.

for M100, $Z2 = 1.872$

$M100\text{-}5 = 8.4 \times 1.872 = 15.72$ mm

$i = \frac{15.72}{5 \div 60} = 188.6$ mm/hr.

Calculate Q_p

1 year $Q_p = 2.78 \times 0.9 \times 1.30 \times 62.6 \times \frac{1368}{10000}$

$= 27.85$ L/s

100 yr $Q_p = 2.78 \times 0.9 \times 1.3 \times 188.6 \times \frac{1368}{10000}$

$= 83.92$ L/s

Calculate greenfield run-off rates for permeable areas

⇒ use Ioh Report 124

$QBAR_{rural} = 0.00108 AREA^{0.89} . SAAR^{1.17} . SOIL^{2.17}$

$AREA = 50$ ha $= 0.50$ km²

$SAAR = 640$ mm

$SOIL = 0.50$ (Brownfield site = soil type 5)

$QBAR_{rural} = 0.00108 (0.5)^{0.89} \times 640^{1.17} \times 0.5^{2.17}$

$= 0.249$ m³/s

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Project			
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Date		Job number	
Engineer	Checked by	Checked date	Sheet number 3

Site permeable area = 2369 − 1368

= 1001 m^2

Modify $QBAR_{rural}$ for area.

$$QBAR_{rural} = \frac{1001}{500\,000} \times 0.249$$

$= 4.98 \times 10^{-4}$ m^3/s

= 0.498 l/s

Modify for various return periods as FSSR 14 regional growth curves.

Region = 6

Return period	Growth factor	Greenfield run off rate
1 year	0.85	0.42 l/s
QBar	1.00	0.50 l/s
30 year	2.24	1.12 l/s
100 year	3.19	1.59 l/s

Combined pre-development run-off rates.

1 year = 27.85 + 0.42 = 28.27 l/s

100 year = 83.92 + 1.59 = 85.51 l/s

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Project			
Part of structure			
Date		Job number	
Engineer	Checked by	Checked date	Sheet number 4

Calculate post development run off rates.

Site impermeable area post development = 1697 m^2

Rainfall rates as previously calculated . . .

1 year $Q_p = 2.78 \times 0.9 \times 1.30 \times 62.6 \times \frac{1697}{10000}$

$= 34.55$ l/s

100 year $Q_p = 2.78 \times 0.9 \times 1.30 \times 188.6 \times \frac{1697}{10000}$

$= 104.10$ l/s

Greenfield run-off rates.

Post development permeable area = 2369 - 1697

= 672 m^2

$\therefore QBAR_{rural} = \frac{672}{500000} \times 0.249$

$= 3.35 \times 10^{-4}$ m^3/s

$= 0.335$ l/s

1 year QBAR = 0.85 × 0.335 = 0.28 l/s

100 year QBAR = 3.19 × 0.335 = 1.07 l/s

Combined run-off rates.

1 year 34.55 + 0.28 = 34.83 l/s

100 year 104.10 + 1.07 = 105.17 l/s.

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Project			
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Date		job number	
Engineer	Checked by	Checked date	Sheet number 5

Allowance for climate change

⇒ building design life = 50 years, ie. to 2065

⇒ ∴ + 20% for climate change.

Post development run off rates.

1 year	34.83	× 1.2	=	41.80 l/s
100 year	105.17	× 1.2	=	126.20 l/s.

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Project			
Part of structure			
Date		Job number	
Engineer	Checked by	Checked date	Sheet number 6

Volume run-off calculations

from Wallingford Procedure.

$$PR = 0.829\,PIMP + 25.0\,SOIL + 0.078\,UCWI - 20.7$$

where

PIMP = % of area with impermeable surfacing

SOIL = 0.45 (Soil Type 4)

UCWI = 65 (for SAAR = 640mm, Fig 9.7)

Pre development

Drained area = 1368 m^2

Undrained area = 1001 m^2

$$\therefore PIMP = \frac{1368}{1368+1001} = 0.577 = 57.7\,\%$$

$$\therefore PR = 0.829(57.7) + 25.0(0.45) + 0.078(65) - 20.7$$

$$= 43.5\,\%$$

Use 100 year return period 6 hour storm

M5-60 = 21 mm.

r = 0.45

for D = 360 min, Z1 = 1.70

$\therefore$ M5-360 = 1.70 x 21 = 35.7 mm

for M100, Z2 = 1.92

$\therefore$ M100-360 = 1.92 x 35.7 = 67.8 mm.

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Project			
Part of structure			
Date		job number	
Engineer	Checked by	Checked date	Sheet number 7

Pre development run-off

$= \frac{67.8}{1000} \times (1368 + 1001) \times 0.435 = 69.9\ m^3$

Post development

Drained area = 1697 m^2

Undrained area = 672 m^2

PIMP $= \frac{1697}{2369} = 0.716 = 71.6\ \%$

$PR = 0.829(71.6) + 25.0(0.45) + 0.078(67) - 20.7$

$= 55.1\ \%$

rainfall rate as above = 67.8 mm

+ 20% for climate change

M100 -360 + CC $= 67.8 \times 1.2 = 81.4$ mm.

Post development run-off

$= \frac{81.4}{1000} \times (1697 + 672) \times 0.551 = 106.3\ m^3$

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Project			
Part of structure			
Date		Job number	
Engineer	Checked by	Checked date	Sheet number 8

Code for Sustainable Homes – Sur 1

2A. Volume Run-Off

Post development run-off volume is greater than pre development run-off.

1. Soakaways. Soakaway tests were not successful & had extremely low infiltration rates & ∴ not practicable to use soakaways. Refer to site investigation report. London Clay strata beneath site.

2. Green roofs. A portion of the impermeable areas are covered with green roofs. These areas act as an infiltration form of source control (ref. CIRIA C644).

Area of green roofs = 542 m²

Depth of substrate = minimum 150 mm.

∴ Run-off rate reduction = 70% (C644 Table 10.1)

∴ Site impermeable area = 1697 − 0.7(542)

= 1318 m²

Undrained area = 672 + 0.7(542)

= 1051 m²

$PIMP = \frac{1318}{2369} = 0.556 = 55.6\%$

$PR = 0.829(55.6) + 25.0(0.45) + 0.078(65) - 20.7$

$= 41.7\%$

∴ $Volume = \frac{81.4}{1000} \times 2369 \times 0.417 = 80.4\ m^3$

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Project			
Part of structure			
Date		Job number	
Engineer	Checked by	Checked date	Sheet number 9

Post development run-off still greater than pre

∴ provide attenuation

Determine limiting discharge rate

a) 1 year pre development peak flow rate ⇒ varies with storm duration

b) Q_{bar} = 0.50 l/s

c) 2 l/s/ha = $2 \times \frac{2369}{10000}$ = 0.47 l/s

d) 5.0 l/s to reduce risk of blockage.

Limiting discharge = max {a, b, c, d}

Calculate 1 year pre development peak flow rates

Storm duration D	Z1	M5-D mm	Z2	M1-D mm
5	0.39	8.19	0.61	5.00
10	0.54	11.34	0.61	6.92
15	0.65	13.65	0.62	8.46
30	0.82	17.22	0.63	10.85
60	1.00	21.00	0.64	13.44
120	1.19	24.99	0.66	16.49
240	1.38	28.98	0.67	19.42
360	1.51	31.71	0.68	21.56
600	1.68	35.28	0.69	24.34
1440	2.03	42.63	0.71	30.27

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Project			
Part of structure			
Date		Job number	
Engineer	Checked by	Checked date	Sheet number 10

Pre development drained area = 1368 m²

Storm duration D	M1-D mm	i mm/hr	Q_p l/s
5	5.00	60.0	26.70
10	6.92	41.5	18.47
15	8.46	33.8	15.04
30	10.85	21.7	9.66
60	13.44	13.4	5.96
120	16.49	8.2	3.65
240	19.42	4.9	2.18
360	21.56	3.6	1.60
600	24.34	2.4	1.07
1440	30.27	1.3	0.58

∴ Limiting discharge = 5.0 l/s

Calculate storage for 100 year return period + 20% CC

Storm duration D	Z1	M5-D mm	Z2	M100-D mm
5	0.39	8.19	1.87	15.32
10	0.54	11.34	1.93	21.89
15	0.65	13.65	1.97	26.89
30	0.82	17.22	2.01	34.61
60	1.00	21.00	2.03	42.63
120	1.19	24.99	2.01	50.23
240	1.38	28.98	1.98	57.38
360	1.51	31.71	1.96	62.15
600	1.68	35.28	1.93	68.09
1440	2.03	42.63	1.87	79.72

Drained impermeable area = 1318 m²

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Project			
Part of structure			
Date		Job number	
Engineer	Checked by	Checked date	Sheet number 11

Storm duration D	M100-D mm	M100-D +CC	i mm/hr	Q_p l/s
5	15.32	18.38	220.6	94.6
10	21.89	26.27	157.6	67.6
15	26.89	32.27	129.1	55.3
30	34.61	41.53	83.1	35.6
60	42.63	51.16	51.2	21.9
120	50.23	60.28	30.1	12.9
240	57.38	68.86	17.2	7.4
360	62.15	74.58	12.4	5.3
600	68.09	81.71	8.2	3.5
1440	79.72	95.70	4.0	1.7

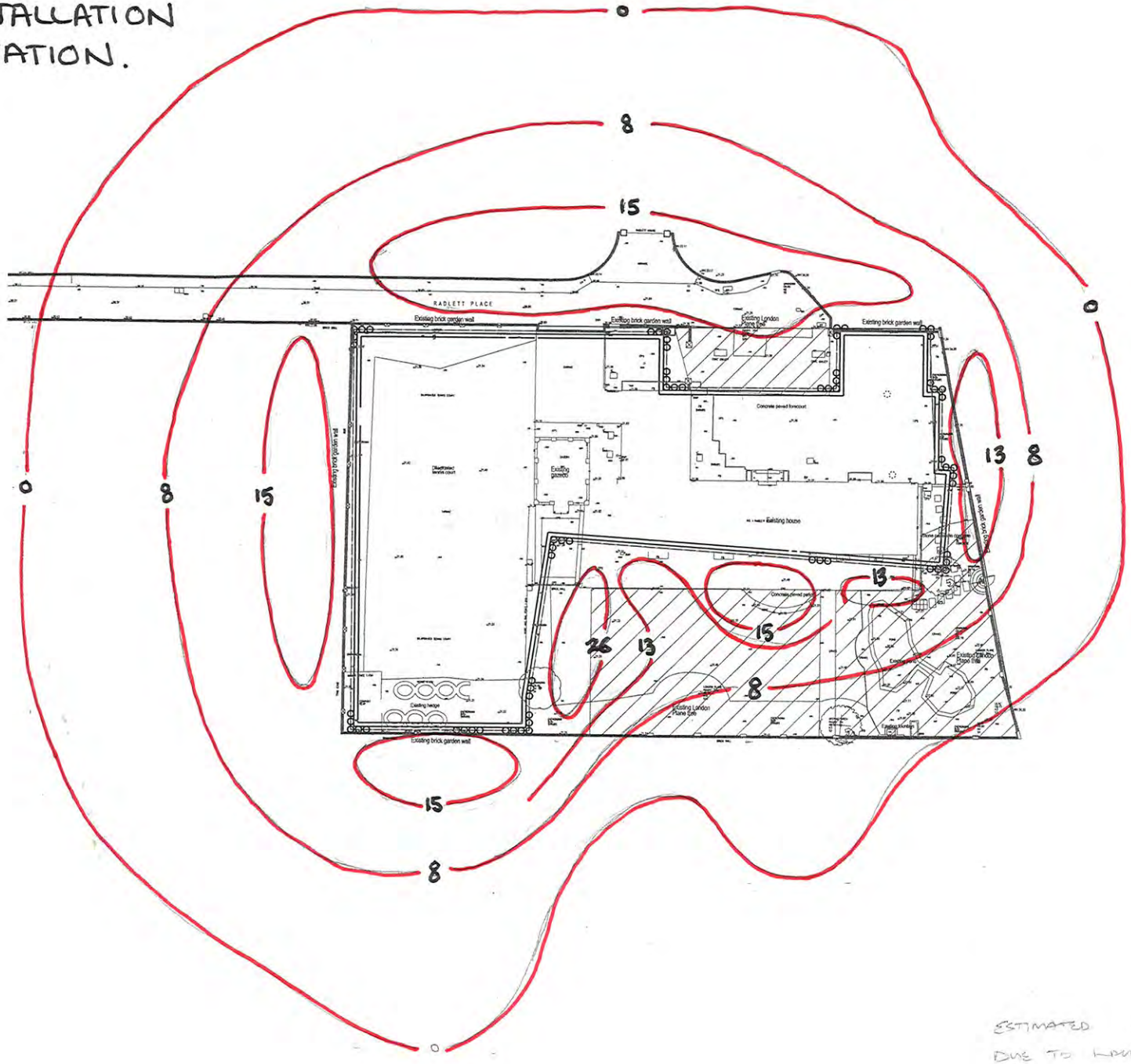
Outflow limited 5 l/s.

Storm duration D	Storage flow l/s	Storage required m^3
5	89.6	26.9
10	62.6	37.6
15	50.3	45.3
30	30.6	55.1
60	16.9	60.8
120	7.9	56.9
240	2.4	34.6
360	0.3	6.5
600	-	-
1440	-	-

⇒ provide min 61 m^3 of storage.

APPENDIX E – ESTIMATED GROUND SETTLEMENT

ESTIMATED GROUND SETTLEMENT PROFILE DUE TO INSTALLATION AND EXCAVATION.



ESTIMATED GROUND SETTLEMENT PROFILE DUE TO HDD INSTALLATION AND EXCAVATION (mm)

1:400 @ A3

RN 18/04/12

APPENDIX F – RETAINING WALL ANALYSIS

Webb Yates Engineers

23-24 Smithfield Street
London EC1A 9LF
Tel: 020 7489 0900
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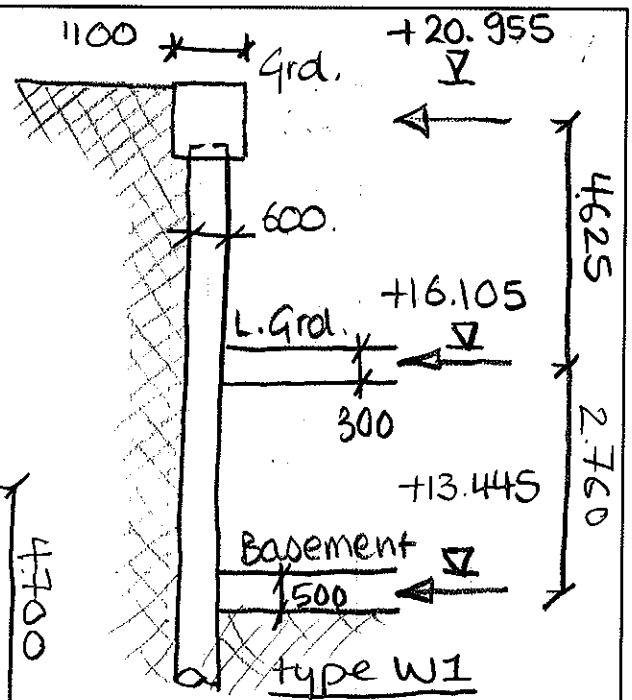
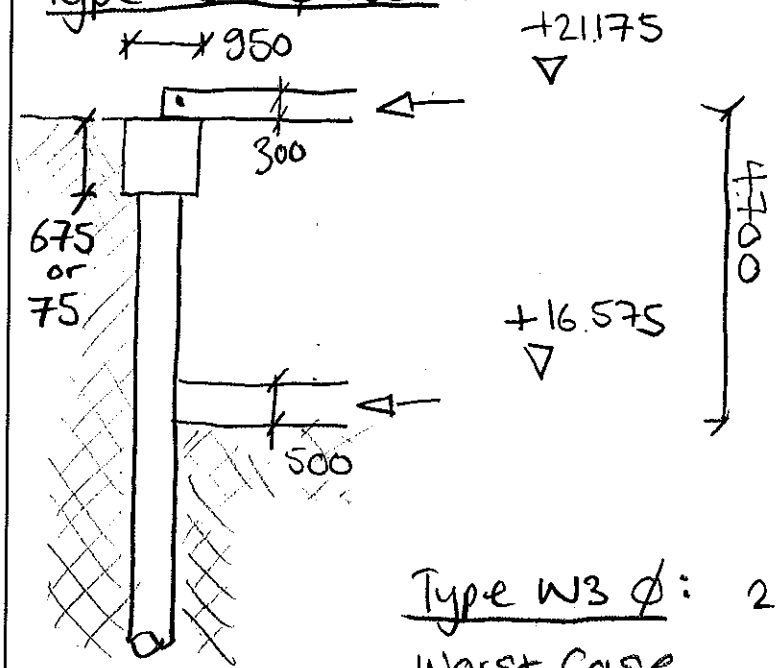
Project: Radlett Place.	Job No.: J1219
	Sheet No.:
Part of structure: Retaining wall Conditions.	Eng: E.L
	Date: 09/08/12

type W1: ϕ600mm :→

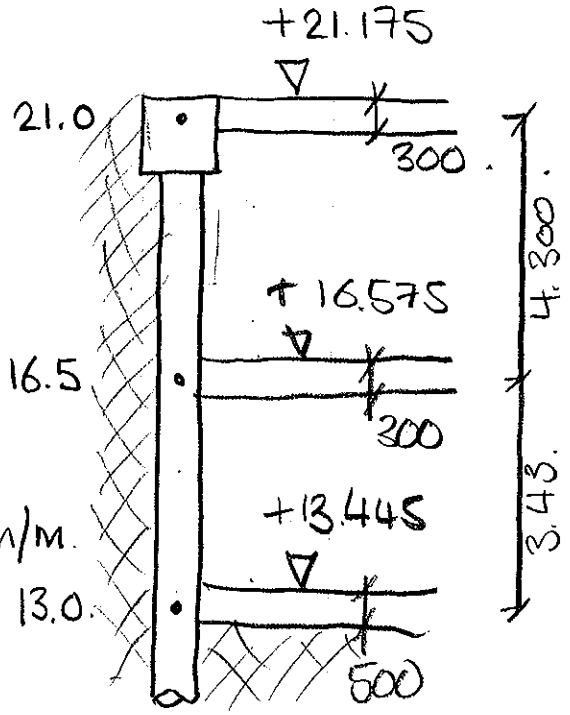


type W2: ϕ450 :↓



Type W3 ϕ:

Worst Case.
ϕ450mm.

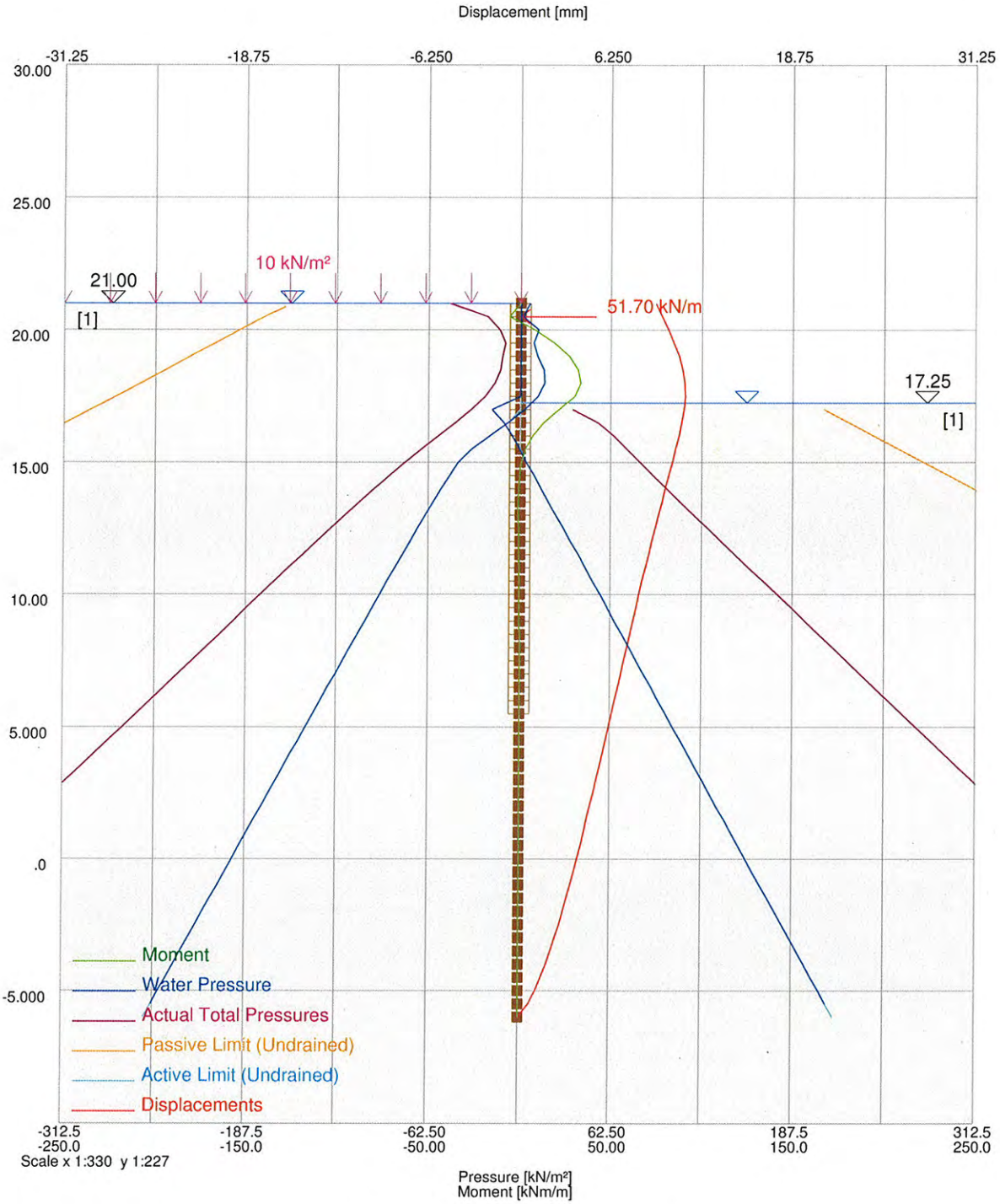


Deflection limit = 20mm.

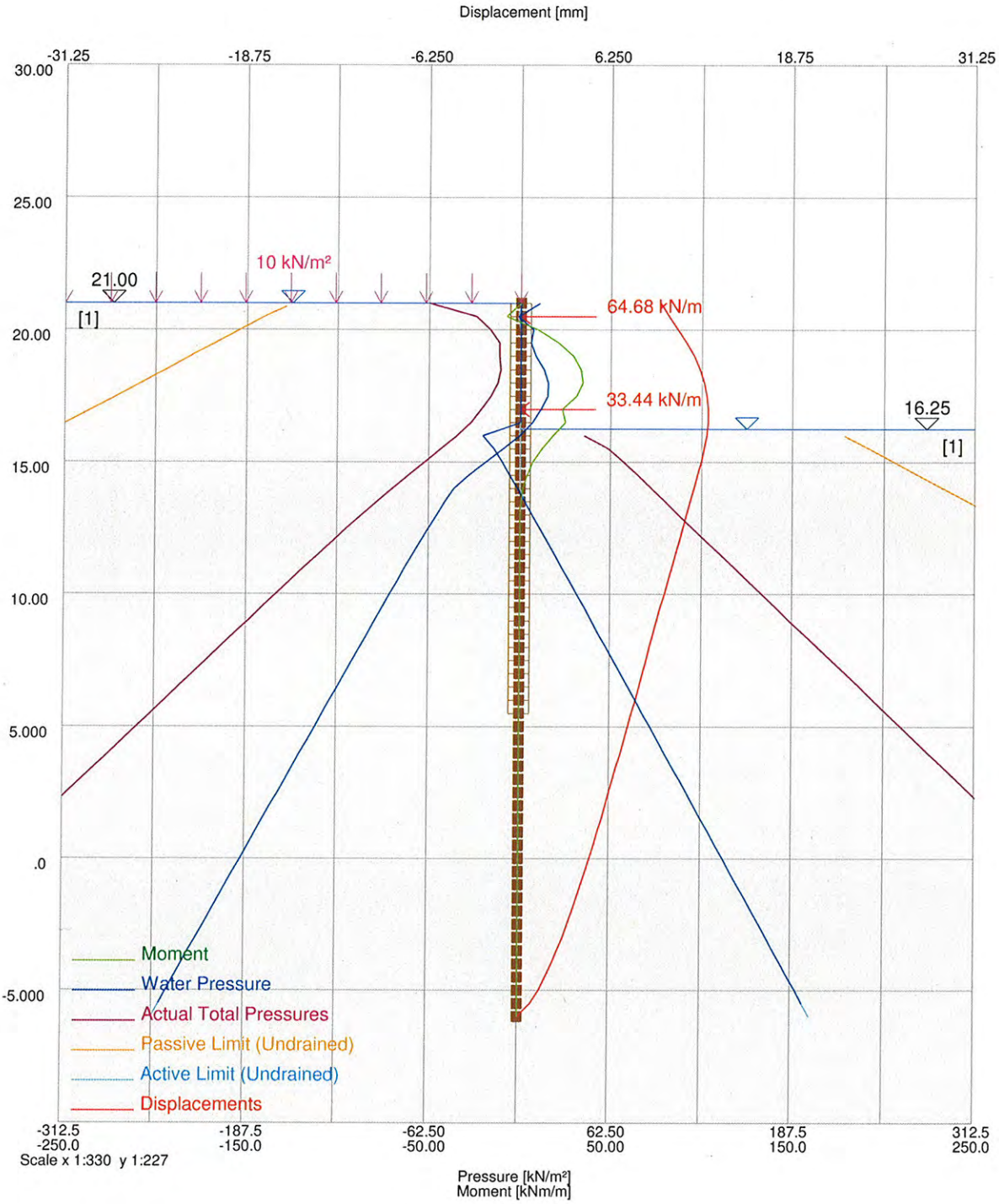
Surcharge = 10 kPa.

Strut Stiffness = 990E6 kN/m/m.

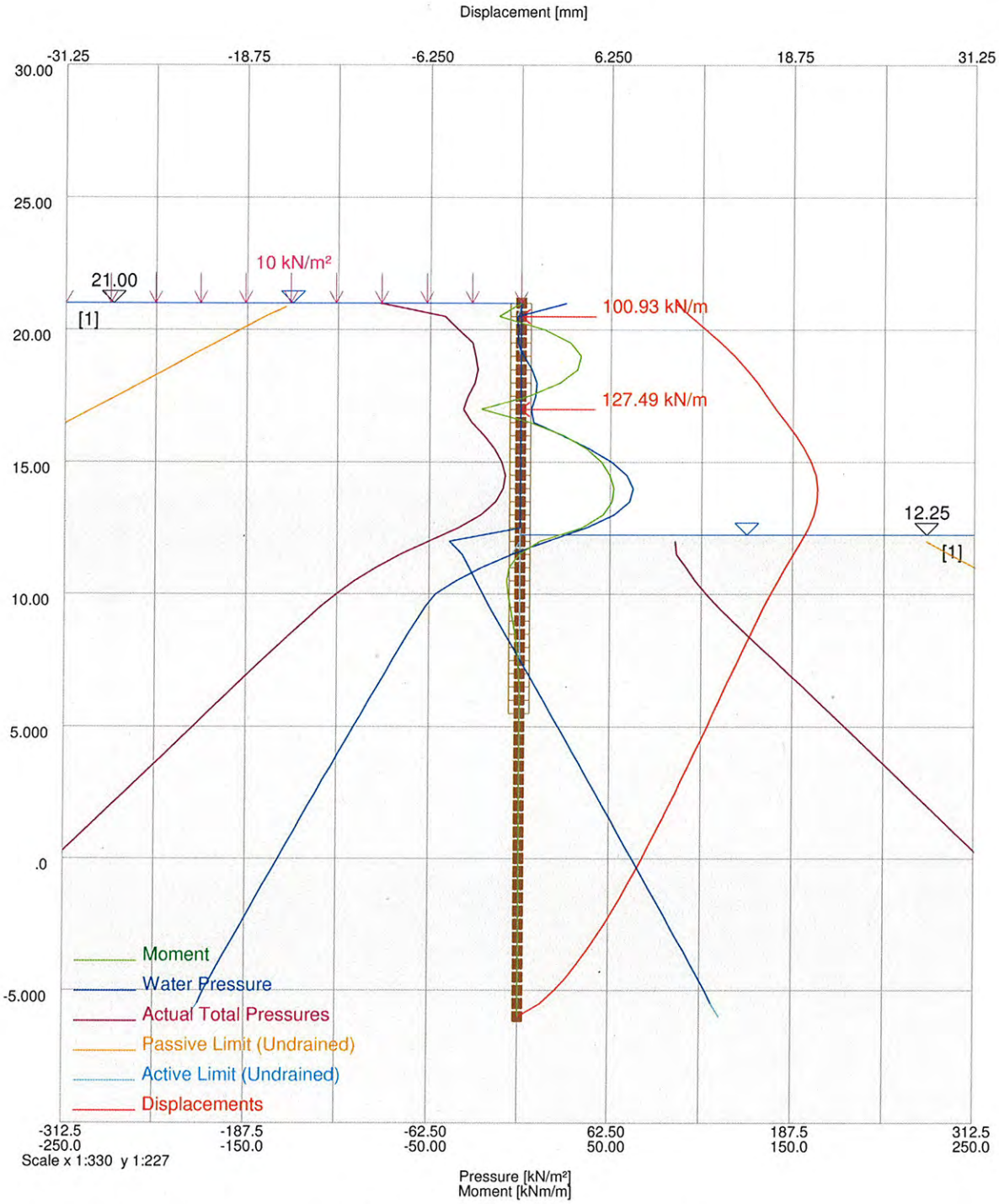
EI = W1
W2
W3 = 71732. kNm²/m.



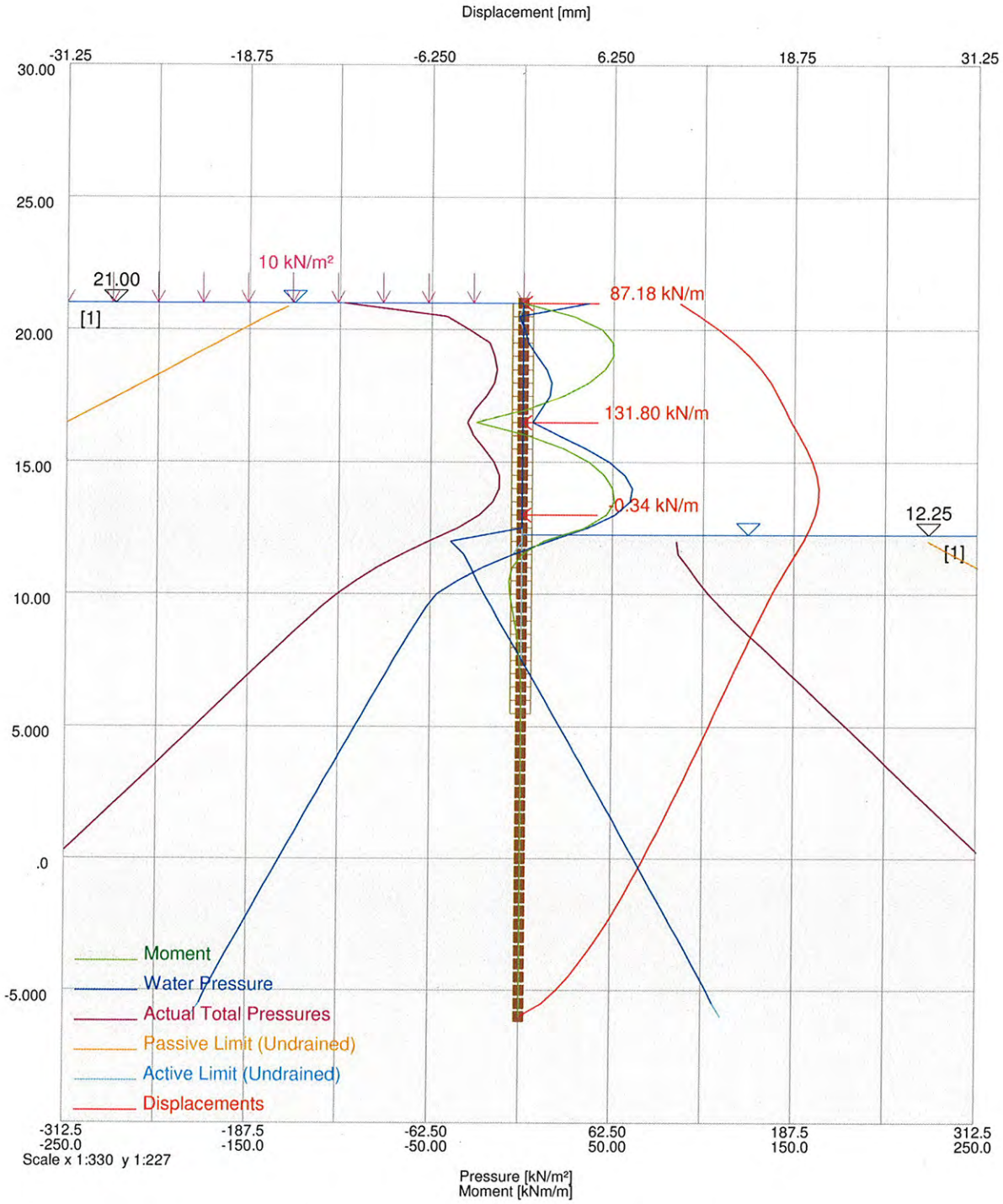
STAGE 4 : Excavate to -5 and dewater



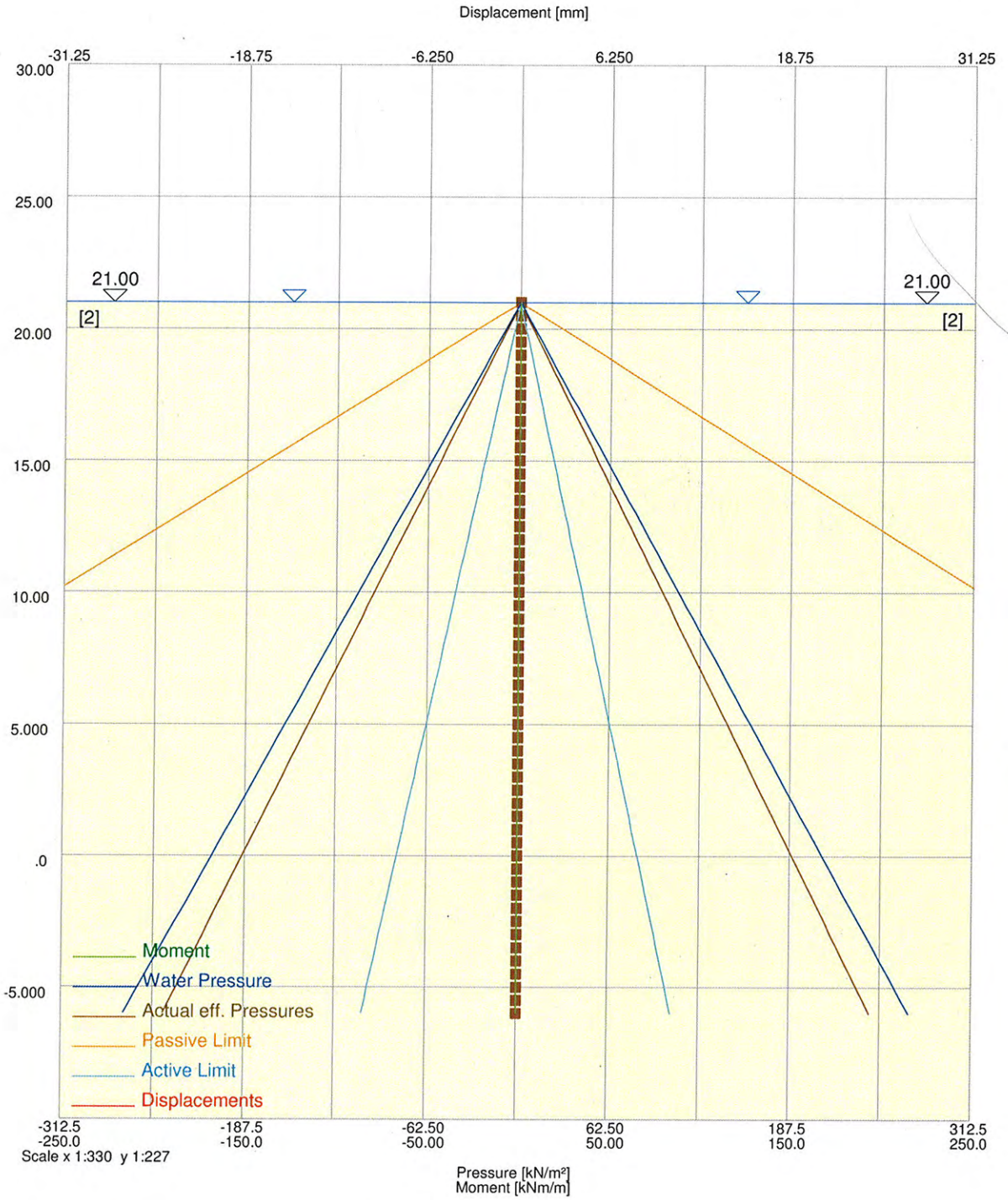
STAGE 5 : Install prop at -4



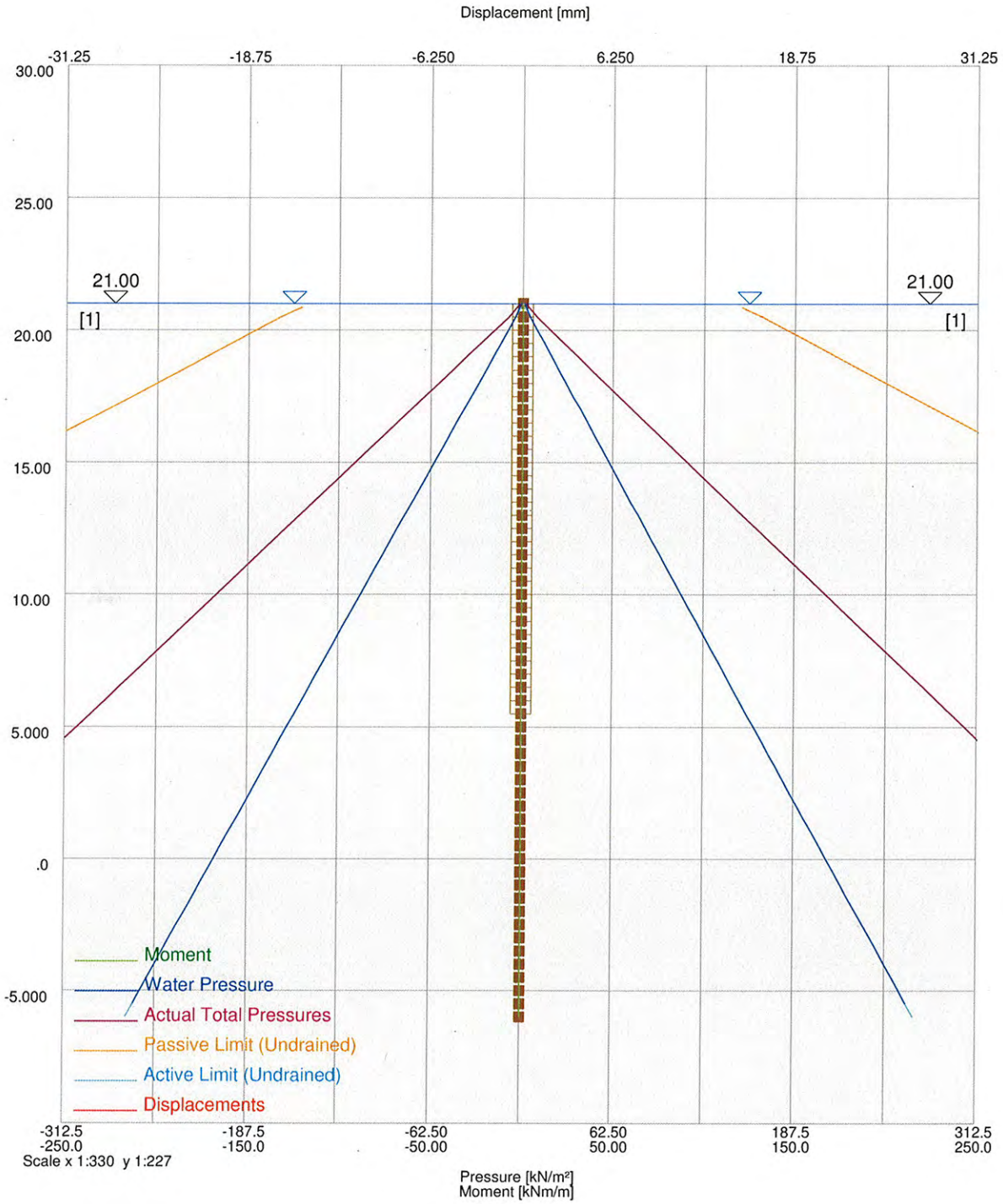
STAGE 6 : Excavate to -8.5 and dewater



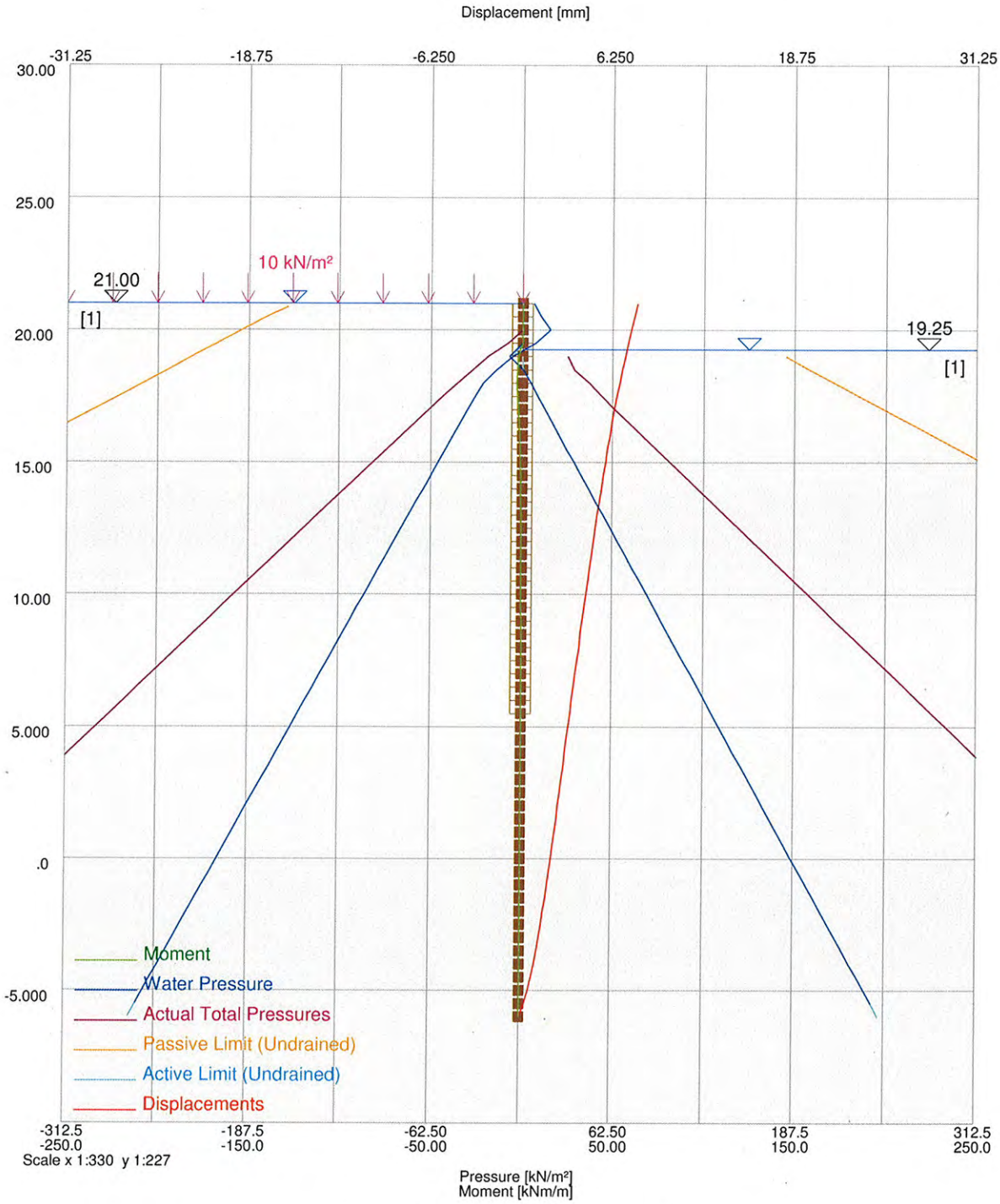
STAGE 7 : Install Base and GF slab, remove mid height prop



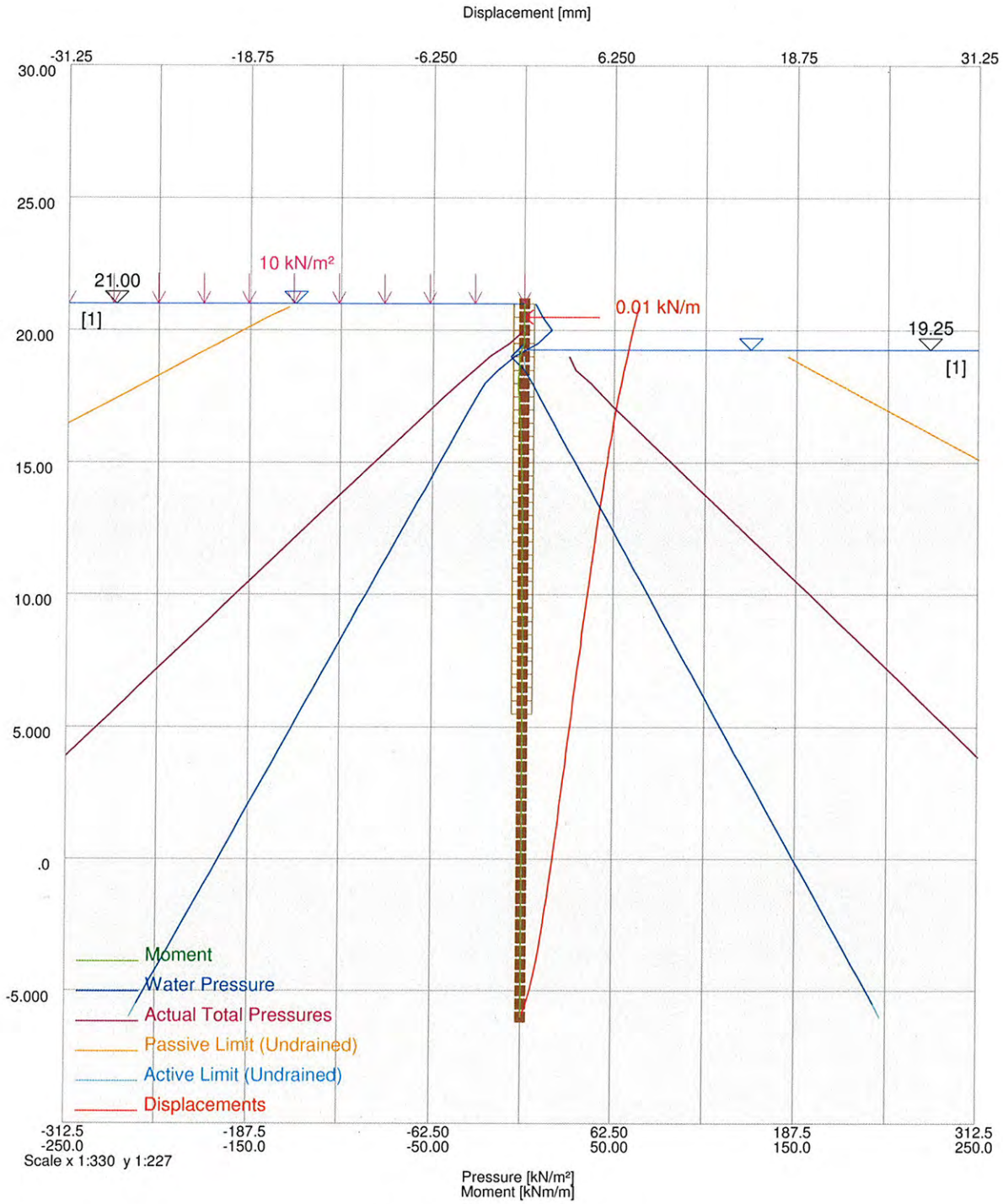
STAGE 0 : Initial condition



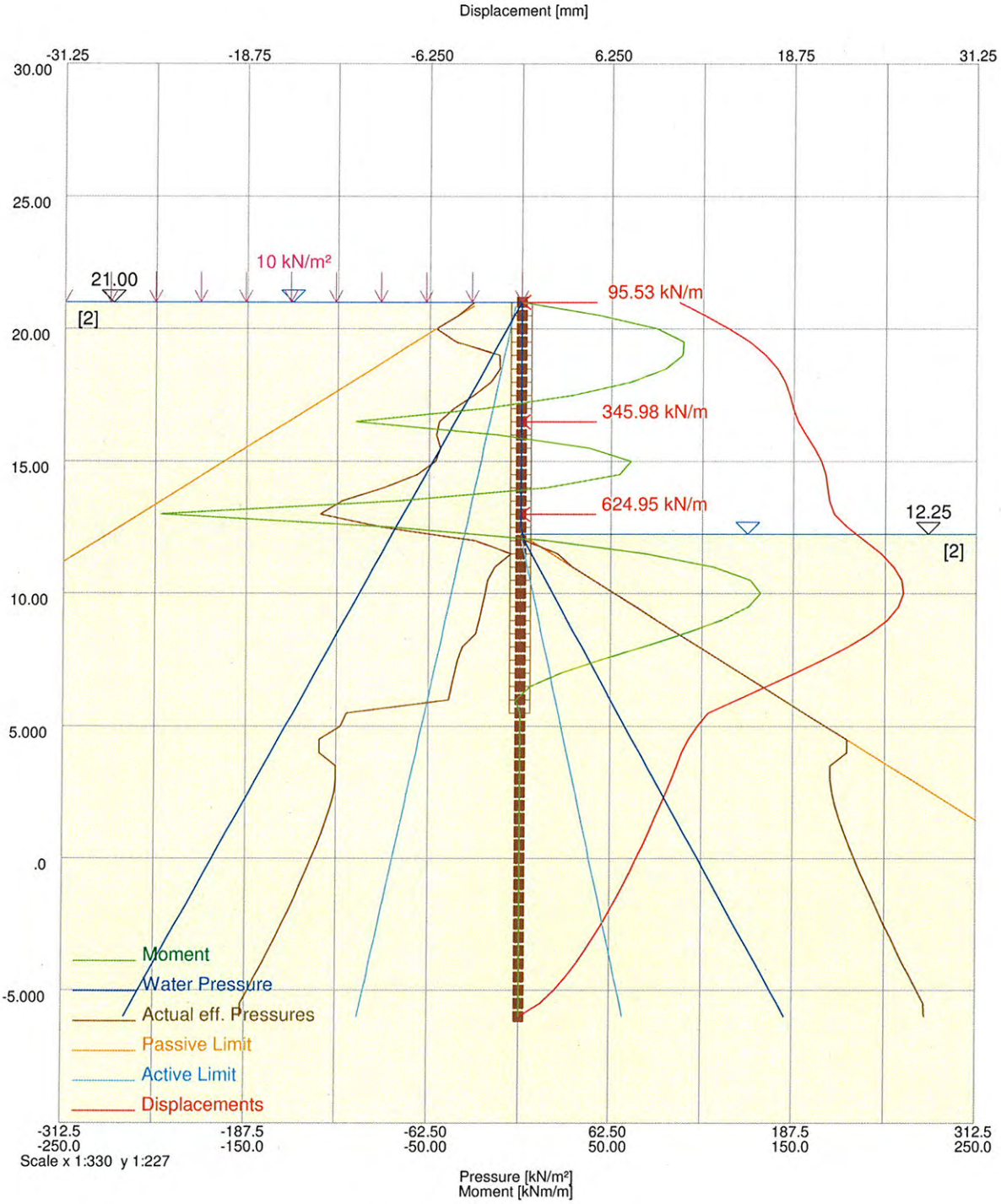
STAGE 1 : Insert Wall



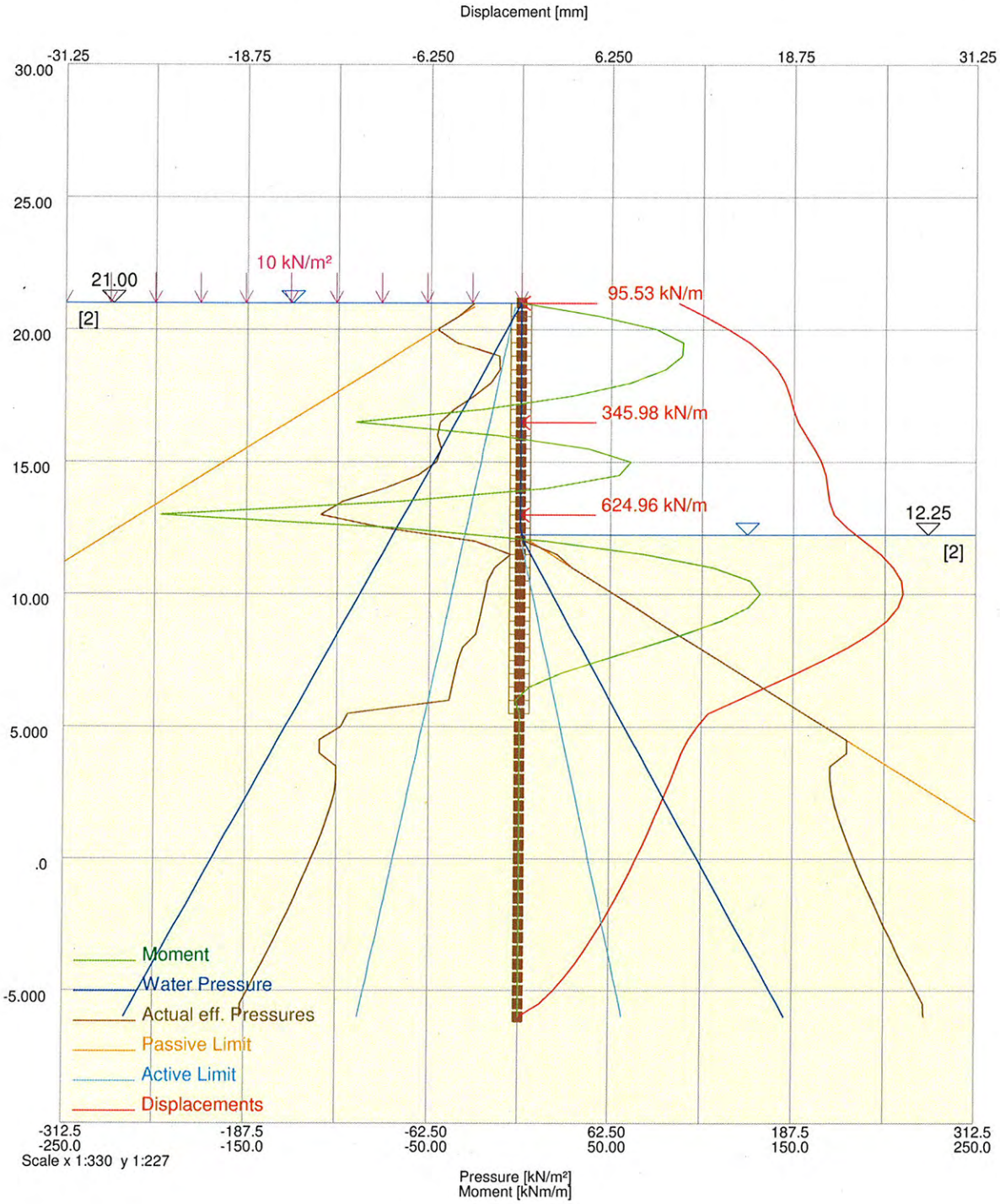
STAGE 2 : Add surcharge excavate to -2m and dewater



STAGE 3 : Install prop to head of wall



STAGE 8 : Undrained to Drained (LT)



STAGE 9 : Wall relaxation