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Daylight & Sunlight Assessments of a Proposed Residential Development at Main Street, Rathcoole, Co. Dublin.

Applicant: Lorat Trading Ltd.

Date: 14th December 2021

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MSc Environmental Design of Buildings

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1: Introduction

The proposed development consists of 23 no. residential units in Main Street Rathcoole. The development includes the demolition of outbuildings associated with Muldowney's Public House; the renovation of three existing cottages, into 2 No. units; the construction of 6 No. units in Block A and 15 No. units in Block B and all associated site and enabling works as described in the statutory notices.. Blocks A & B are three storeys.

1.1 Executive Summary

The report assesses the impact of the proposed development for Daylight and Sunlight on the neighbouring buildings and the quality of daylight and sunlight to within the proposed development. This analysis is carried out based on the drawings of Downey Planning & Architecture.

The results find that any impact on the adjacent residential structures would be minimal and imperceivable. There would be a good quality of daylight in the apartments analysed and the amenity areas would have sufficient sunlight. The proposed development meets the recommendations of the BRE guidelines.

2: Methodology

2.1 Notes on the use of BS 8206-2 2008 and BRE guidance document (2011) Site layout planning for daylight and sunlight.

This Daylight and Sunlight Assessment demonstrates compliance with the BRE guide 'Site Layout Planning for Daylight and Sunlight' (2nd edition) and BS 8206-2: 2008 – 'Lighting for Buildings – Part 2: Code of Practice for Daylighting'. This in accordance with the most relevant S.28 Ministerial Guidelines including Section 6.6 of the Sustainable Urban Housing Design Standards for New Apartments 2020, and Section 3.2 of the Urban Development and Building Heights Guidelines for Planning Authorities (2018).

We are aware of a new European standard, BS EN 17037:2018, however this is not currently enforced until such time as confirmed by a government circular, or as an update to the Development Plan or the relevant S. 28 Ministerial Guidelines.'

Sustainable Urban Housing: Design Standards for New Apartments, Guidelines for Planning Authorities (2020) directs planning authorities to have regard to quantitative performance approaches to daylight provision outlined in guides like the BRE guide 'Site Layout Planning for Daylight and Sunlight' (2nd edition) or British Standard BS 8206-2: 2008 – 'Lighting for Buildings – Part 2: Code of Practice for Daylighting'. The standards for daylight and sunlight access in buildings (and the methodologies for assessment of same) suggested in both of these documents have been referenced in this Sunlight and Daylight Access Analysis.

Neither the British Standard nor the BRE Guide set out rigid standards or limits. The BRE Guide is preceded by the following very clear warning as to how the design advice contained therein should be used:

"The advice given here is not mandatory and the guide should not be seen as an instrument of planning policy; its aims is to help rather than constrain the designer. Although it gives numerical guidelines, these should be interpreted flexibly since natural lighting is only one of many factors in site layout design."

That the recommendations of the BRE Guide are not suitable for rigid application to all developments in all contexts is of particular importance in the context of national and local policies for the consolidation and densification of urban areas.

2.2 Daylight to the existing dwellings

A proposed development could potentially have a negative effect on the level of daylight that a neighbouring property receives, if the obstructing building is large in relation to their distance from the existing dwelling. To ensure a neighbouring property is not adversely affected, the Vertical Sky Component (also referred to as VSC) is calculated and assessed. VSC can be defined as the amount of skylight that falls on a vertical wall or window. The site is analysed in plan, section and building use. Windows and amenity area are selected to test for impact from the proposed development.

BRE guidelines recommend that: *"Loss of light to existing windows need not be assessed if the distance of each part of the new development from the existing window is three or more times its height above the centre of the existing window."*
The diffuse light of the existing building may be adversely affected if part of a new building measured in a vertical section perpendicular to the main window wall of an existing building, from the centre of the lowest window, subtends an angle of more than 25° to the horizontal. If a window falls within a 45° angle both in plan and elevation with a new development in place then the window may be affected and should be assessed.

For loss of daylight and sunlight to existing buildings BRE guidance document (2011) "Site layout planning for daylight and sunlight" is used and BS8206 Part 2:2008 Lighting for Buildings, Code of Practice for Daylighting.

For loss of light the report recommends calculation of the Vertical Sky Component. This is the ratio of direct sky illuminance falling on the outside window, to the simultaneous horizontal illuminance under an unobstructed sky. The standard CIE Overcast Sky is used and the ratio is usually expressed as a percentage. The maximum value is just under 40% for a completely unobstructed vertical wall. The Vertical Sky Component on a window is a good measure of the amount of daylight entering it.

The BRE guidelines recommend one of two criteria is met when assessing for the Vertical Sky Component:
a) Where the Vertical Sky Component at the centre of the existing window exceeds 27% with the new development in place then enough sky light should still be reached by the existing window.

b) Where the Vertical Sky Component with the new development in place is both less than 27% and less than 0.8 times its former value, then the area lit by the window is likely to appear more gloomy, and electric light will be needed more of the time.

The BRE Guidelines state that if the VSC is:

- At least 27%, then conventional window design will usually give reasonable results;
- Between 15% and 27%, then special measures (larger windows, changes to room layout) are usually needed to provide adequate daylight;
- Between 5% and 15%, then it is very difficult to prove adequate daylight unless very large windows are used;
- Less than 5%, then it is often impossible to achieve reasonable daylight, even if the whole window wall is glazed

This report assesses the percentage of direct sky illuminance that falls on the centre point of neighbouring windows that could be affected by the proposed development.

2.3 Sunlight

The BRE guidelines recommend assessing the loss of sunlight to the main living rooms and conservatories if they have a window wall facing within 90° of due south. Kitchens and bedrooms are less important but care should be taken not to block too much sun. If the proposed development is fully north then sunlight need not be assessed.

The Annual Probable Sunlight Hours (APSH) is used to assess the quantity of sunlight for a given location. This is the total amount sunshine for a given location on an unobstructed horizontal surface taking cloud cover into account. Statistical data from the Irish Meteorological Service is used to assess the APSH and the Probable Sunlight Hours for winter. Table 1 shows the average sunlight hours for each month and the maximum possible without any cloud cover. This gives the factor of possible sunlight hours for each month.

Met Eireann Sunlight Hours Data Set 1981-2010													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Sunlight Hours/ Day	1.54	2.45	3:36	5.32	6.44	6:40	5.17	5.13	4.16	3.17	2.10	1.44	
Average Sunlight Hours/ Month	58.54	77:00	111.36	166.00	208.44	200.00	163.47	161.43	128.00	101.47	65:00	53:44	1496.25
Total Available Sunlight Hours	252	265	358	412	488	485	496	451	375	320	250	248	4383
Probable Sunlight Hours Ratio	23.37%	29.06%	31.17%	40.29%	42.77%	41.24%	33.02%	35.86%	34.13%	31.81%	26.00%	21.67%	34.14%

Table 1: Average monthly sunlight hours recorded at Dublin Airport - Data set 1981-2010

The BRE guidelines recommend that the centre of a window or 1.6m above ground for a door be assessed and receive at least 25% of the APSH and at least 5% during the period of 21st September to 21st March. If the available APSH is less than this then it should not be reduced below 0.8 times its former value or noticeable loss of sunlight may occur.

2.4 Sunlight to gardens and open spaces

For calculations of sunlight analysis it is general practice to use March 21 and the recommendations of the BRE guidance document (2011) "Site layout planning for daylight and sunlight". P.J Littlefair, in relation to Gardens and open spaces section 3.3.17 state:

"It is recommended that for it to appear adequately sunlit throughout the year, at least half of a garden or amenity area should receive at least two hours of sunlight on 21 March. If as a result of new development an existing garden or amenity area does not meet the above, and the area which can receive two hours of sun on 21 March is less than 0.8 times its former value, then the loss of sunlight is likely to be noticeable. If a detailed calculation cannot be carried out, it is recommended that the centre of the area should receive at least two hours of sunlight on 21 March."

2.5 Calculations of Trees & Hedges

Trees are not usually included in the assessments of impact, unless specified otherwise. In relation to the effects of trees and hedges the BRE guidelines states,

> *"It is generally more difficult to calculate the effects of trees on daylight because of their irregular shape and because some light will generally penetrate through the crown. Where the effects of a new building on existing buildings nearby is being analysed, it is usual to ignore the effects of existing trees. This is because daylight is at its scarcest and most valuable in winter when most trees will not be in leaf."*

2.6 Daylight in the proposed development.

The rooms are assessed for Average Daylight Factor (ADF). Table 2 contains the Input values for material used in the assessment model for the Average Daylight Factor.

Surface Reflectance			
Element	Reflectance	Transmissivity	Material Description
Internal walls	84%	0%	White Painted Walls
Internal ceiling	88%	0%	White Painted Ceiling
Floor	52%	0%	Light wood Flooring
External walls - proposed development	58.3%	0%	Light yellow Brick
External walls - outside site	20%	0%	CIBSE
External ground	20%	0%	CIBSE
Glass	20.1	68.8	Double glazed clear glass

Table 2: Surface reflectance parameters for ADF calculation

Additional assessment model input parameters:
Sensor Grid spacing 0.6m,
Sensor grid inset 0.35m,
Minimum inset 0.3m,
Work plane offset 0.85.

2.7 Environmental impact assessment

The BRE guidelines sets out criteria for classification for assessment of impact where a new development affects a number of existing buildings or open spaces. The guide does not give a specific range or percentages but sets out parameters set out below.

> *"Where the loss of skylight or sunlight fully meets the guidelines in this book. the impact is assessed as negligible or minor adverse. Where the loss of light is well within the guidelines, or only a small number of windows or limited area of open space lose light (within the guidelines), a classification of negligible impact is more appropriate. Where the loss of light is only just within the guidelines, and a larger number of windows or open space area are affected, a minor adverse impact would be more appropriate, especially if there is a particularly strong requirement for daylight and sunlight in the affected building or open space.*
>
> *Where the loss of skylight or sunlight does not meet the guidelines in this book, the impact is assessed as minor, moderate or major adverse. Factors tending towards a minor adverse impact include:*
> - *only a small number of windows or limited area of open space are affected*
> - *the loss of light is only marginally outside the guidelines*
> - *an affected room has other sources of skylight or sunlight*
> - *the affected building or open space only has a low level requirement for skylight or sunlight*
> - *there are particular reasons why an alternative, less stringent, guideline should be applied.*
>
> *Factors tending towards a major adverse impact include:*
> - *a large number of windows or large area of open space are affected*
> - *the loss of light is substantially outside the guidelines*
> - *all the windows in a particular property are affected*
> - *the affected indoor or outdoor spaces have a particularly strong requirement for skylight or sunlight, eg a living room in a dwelling or a children's playground.*
>
> *Beneficial impacts occur when there is a significant increase in the amount of skylight and sunlight reaching an existing building where it is required, or in the amount of sunlight reaching an open space.*
>
> *Beneficial impacts should be worked out using the same principles as adverse impacts. Thus a tiny increase in light would be classified as a negligible impact, not a minor beneficial impact."*

A flexible approach should be taken when assessing the impact with daylight and sunlight being one of many factors that influence the environment when planning a new development.

2.8 EN17037:2018

EN 17037 is a unified daylighting standard published by the European Committee for Standardization (CEN) in 2018 (CEN 17037:2018). It is applicable across all countries within the EU including Ireland. The assessment is carried out in addition to the assessment of the Average Daylight Factor as specified in the BRE guidelines and BS8206 Part 2:2008 Lighting for Buildings, Code of Practice for Daylighting.

The compliance calculation is based on an annual, climate-based simulation of interior illuminance distributions. For each hour of the year. the percentage of the floor area achieving minimum and target illuminance thresholds is measured on a room-by-room basis. To meet the standard, a room must achieve both of the following criteria:

Target Illuminance: 300 lux over 50% of floor area for at least 50% of daylight hours.

Minimum Illuminance: 100 lux over 95% of floor area for at least 50% of daylight hours.

Daylight hours are defined as the 4380 hours with the most diffuse horizontal illuminance in the weather file. In addition to this baseline (Minimum) requirement, rooms can achieve Medium and High levels of compliance by meeting higher illuminance thresholds, as outlined in the table below:

Minimum Illuminance			**Target Illuminance**		
High	500 lux	95%	High	750 lux	50%
Medium	300 lux	95%	Medium	500l ux	50%
Minimum	100 lux	95%	Minimum	300 lux	50%

Table 3: EN 17037:2018 Compliance threshold levels.

3: Daylight to adjacent buildings.

3.1 Site & Project description

This proposed development is on Main Street Rathcoole, it encompasses a commercial premises, 'Muldowney's' and three existing cottages. The cottages are to be renovated as part of this application, into 2 No. dwelling units. The public house is to be retained with some outbuildings to be demolished. To the East of the public house is a single storey house, No.116 Main Street. To the West is the Church of the Holy Family and beyond that a single storey dwelling 'St. Judes'. The land to the North has recently had a grant of permission under Reg. Ref. SD21A/0231 for a 3 storey Primary School.

Figure 1: Aerial view of site.

3.2 Preliminary assessment of adjoining dwellings

The BRE guideline recommends that loss of light to existing windows need not be assessed if the distance of each part of the new development from the existing window is three or more times its height above the centre of the existing window. The zone of influence 3 times the height of the proposal is plotted in Figure 2 in yellow. The location of a window wall in the properties adjacent to the proposed development are indicated in blue.

The document also states that if part of a new building measured in a vertical section perpendicular to the main window wall of an existing building, from the centre of the lowest window, subtends an angle of more than 25° to the horizontal, then the diffuse light of the existing building may be adversely affected. If a window falls within a 45° angle both in plan and elevation with a new development in place then the window may be affected and should be assessed.

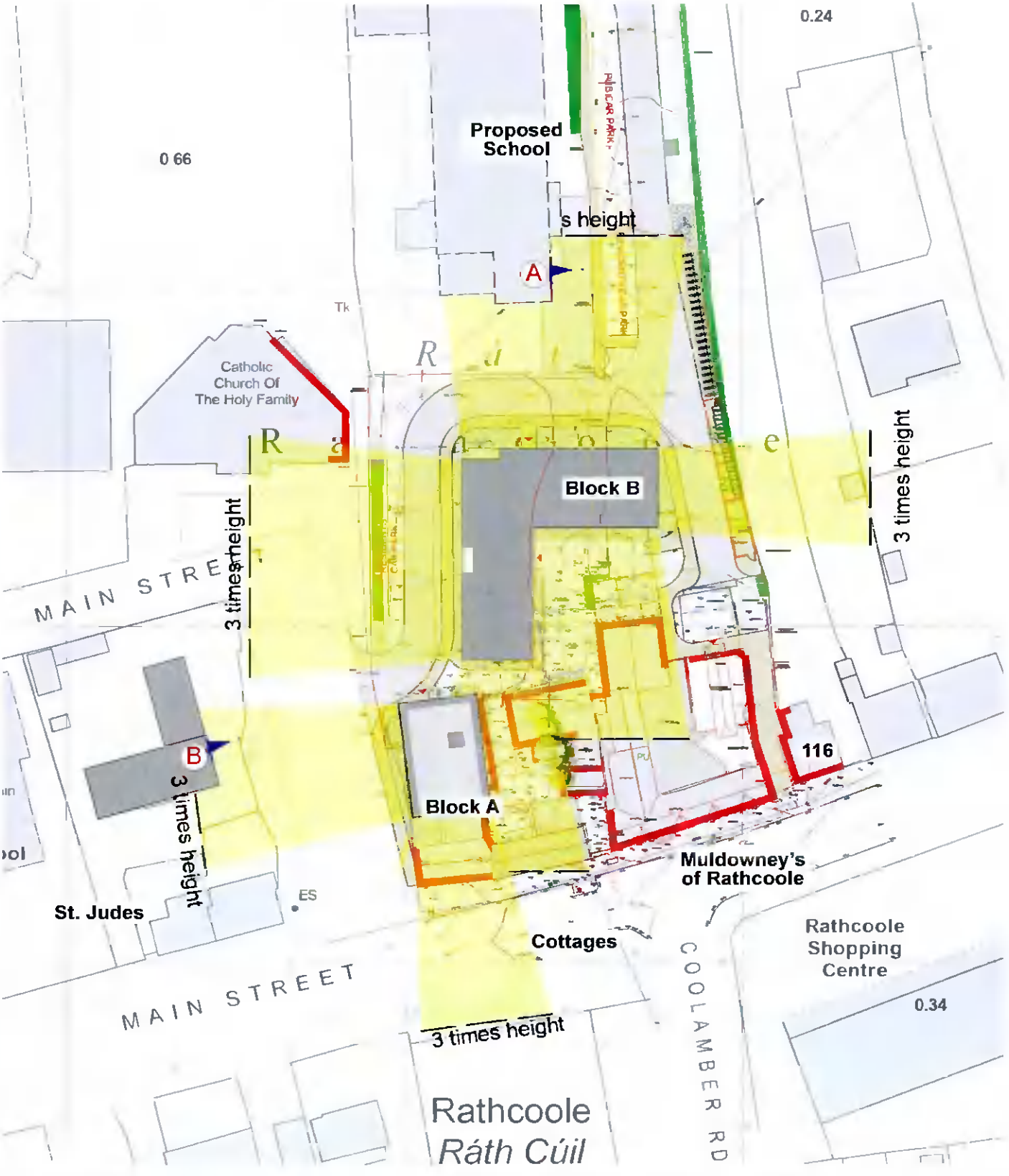
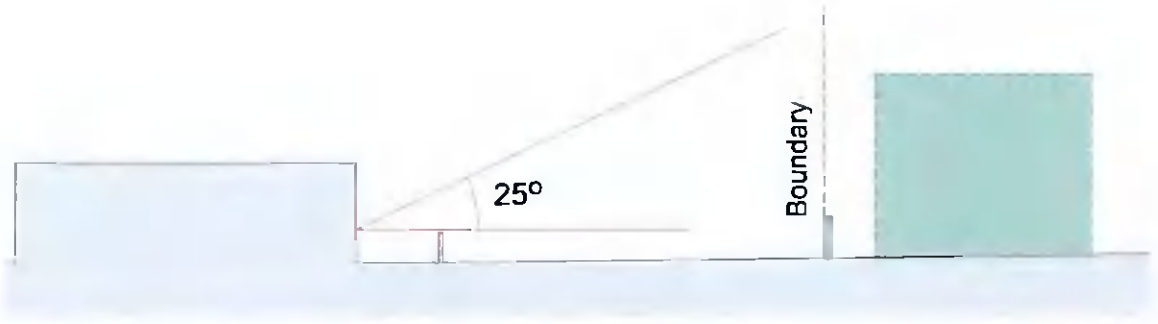


Figure 2: Site plan, an initial assessment for effect on daylight to adjacent properties.



Location B: Section taken perpendicular to window wall

Figure 3: Section through the window wall of the adjacent residential property, St. Judes.

The house to the East, No.116 Main Street is outside the zone of influence and will not have a noticeable reduction in available daylight.

Location A: The permitted school building lies within the Zone of Influence. There are no windows in the proposed school that face the proposed development and there will be no reduction in potential daylight or sunlight to the future development.

Location B; The Zone of Influence 3 times the height of the proposed development extends to the side elevation of St. Judes. A Section Plane through the window is plotted in Figure 3. The 25° line does not subtend the proposed development, indicating any reduction in available daylight is negligible and no further assessment required.

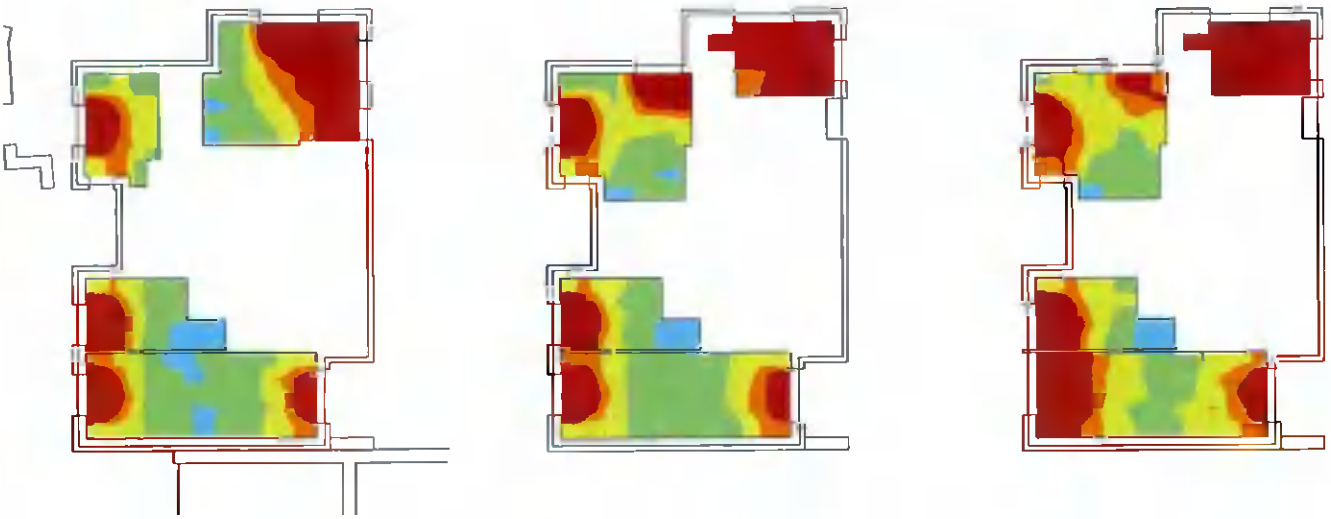
3.3 Conclusion

Any reduction to the daylight in neighbouring dwellings would be imperceptible and any impact will be negligible. The proposed development meets the recommendations of the BRE Guidelines and BS8206 Part 2:2008 Lighting for Buildings Code of Practice for Daylighting.

4: Daylight to Proposed Development.

The BRE guidelines recommend that the Average Daylight Factor (ADF) be assessed in habitable rooms of new developments. BS 8206-2 gives minimum values of ADF of 2% for kitchens and living rooms which include a kitchen, 1.5% for living rooms and 1% for bedrooms. An average daylight factor of 5% is a well 'daylit' space. Where there are two room uses within a space then the higher ADF value should be used. The assessment plane covers 100% of living space being considered.

The factors that affect ADF are room depth, aspect, window size relative to floor area and closeness to an adjacent obstruction. All habitable rooms throughout the development were assessed. The associated false colour plans representing the analysis of ADF are shown in Figures 4 -6. The room numbering follows the architectural drawings.



Ground Floor **First Floor** **Second Floor**

Figure 4: Block A False Colour Plans of all floors indicating habitable rooms assessed for ADF. Scale is 0-5%.

Average Daylight Factor - Block A						
Space ID	Description	Area m2	Sensor Count	ADF	Minimum Recommended ADF	Meets Criteria
U01.1	LKD	29.6	75	2.88%	2%	Y
U01.2	Bed	12.8	33	3.67%	1%	Y
U02.1	LKD	27.1	72	4.35%	2%	Y
U02.2	Bed	11.3	29	3.89%	1%	Y
U03.1	LKD	29.6	75	3.14%	2%	Y
U03.2	Bed	12.8	33	3.77%	1%	Y
U04.1	LKD	23.1	54	3.67%	2%	Y
U04.2	Bed	11.5	30	6.91%	1%	Y
U05.1	LKD	29.6	75	4.03%	2%	Y
U05.2	Bed	12.8	33	4.30%	1%	Y
U06.1	LKD	23.1	54	3.49%	2%	Y
U06.2	Bed	11.5	30	8.23%	1%	Y

Table 4: Block A - Average Daylight Factor of all habitable rooms.

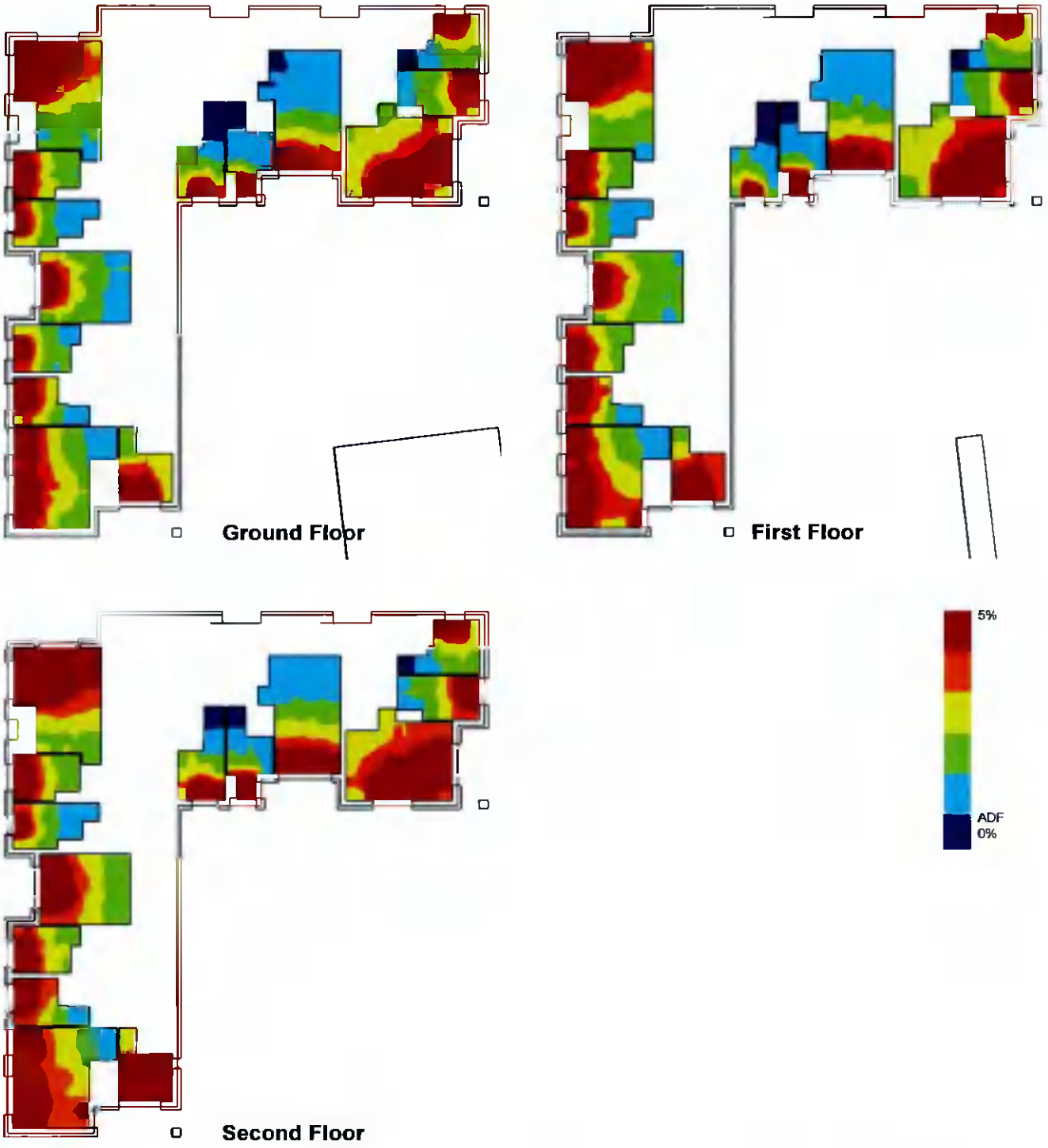
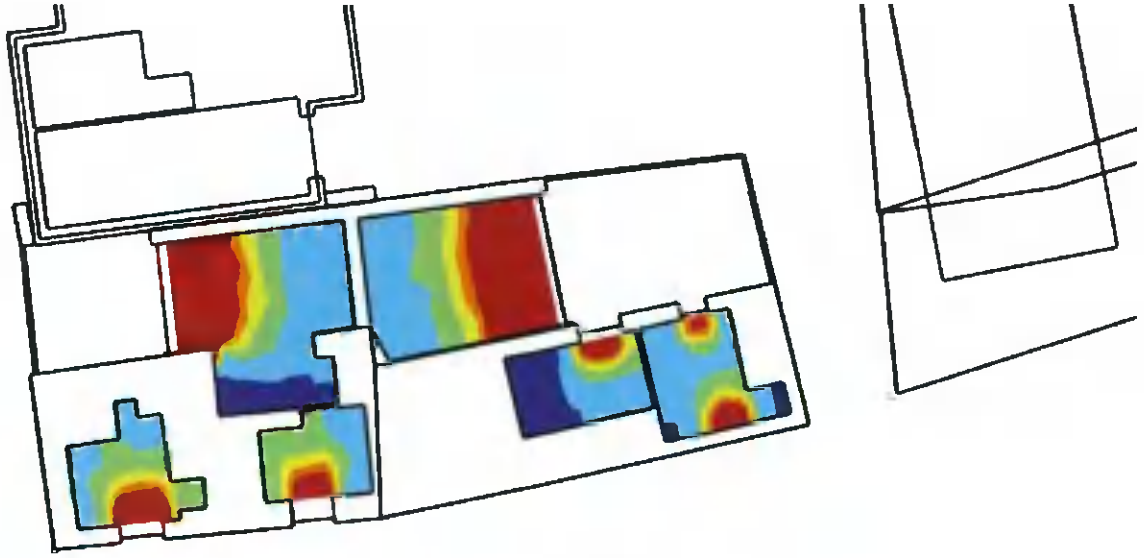


Figure 5: Block B False Colour Plans of all floors indicating habitable rooms assessed for ADF. Scale is 0-5%.

Average Daylight Factor - Block B						
Space ID	Description	Area m2	Sensor Count	ADF	Minimum Recommended ADF	Meets Criteria
U07.1	LKD	30.8	79	3.95%	2%	Y
U07.2	Bed	10.8	23	4.05%	1%	Y
U07.3	Bed	9.9	25	4.43%	1%	Y
U08.1	LKD	23.0	63	2.63%	2%	Y
U08.2	Bed	10.4	31	3.08%	1%	Y
U09.1	LKD	30.3	85	4.68%	2%	Y
U09.2	Bed	10.3	32	4.01%	1%	Y
U09.3	Bed	11.8	30	2.85%	1%	Y
U10.1	LKD	29.9	76	2.17%	2%	Y
U10.2	Bed	10.2	24	2.38%	1%	Y
U10.3	Bed	11 8	30	2.48%	1%	Y
U11.1	LKD	30.0	69	4.62%	2%	Y
U11.2	Bed	12.1	29	3.56%	1%	Y
U11.3	Bed	11.5	25	3.04%	1%	Y
U12.1	LKD	30.8	79	4.10%	2%	Y
U12.2	Bed	10.8	23	4.72%	1%	Y
U12.3	Bed	9.9	25	4.63%	1%	Y
U13.1	LKD	23.0	63	2.73%	2%	Y
U13.2	Bed	10.4	31	4.20%	1%	Y
U14.1	LKD	30.3	85	4.91%	2%	Y
U14.2	Bed	10.3	32	4.17%	1%	Y
U14.3	Bed	11.8	30	2.87%	1%	Y
U15.1	LKD	29.9	76	2.49%	2%	Y
U15.2	Bed	10.2	24	2.89%	1%	Y
U15.3	Bed	11.8	30	1.95%	1%	Y
U16.1	LKD	30.0	69	4.89%	2%	Y
U16.2	Bed	12.1	29	3.62%	1%	Y
U16.3	Bed	11.5	25	3.20%	1%	Y
U17.1	LKD	30.8	79	4.58%	2%	Y
U17.2	Bed	10.8	23	6.09%	1%	Y
U17.3	Bed	9.9	25	4.71%	1%	Y
U18.1	LKD	23.0	63	4.09%	2%	Y
U18.2	Bed	10.4	31	4.32%	1%	Y
U19.1	LKD	30.3	85	6 07%	2%	Y
U19.2	Bed	10.3	32	4.19%	1%	Y
U19.3	Bed	11.8	30	2 90%	1%	Y
U20.1	LKD	29.9	76	2.71%	2%	Y
U20.2	Bed	10.2	24	3.21%	1%	Y
U20.3	Bed	11 8	30	3.16%	1%	Y
U21.1	LKD	30.0	69	5.06%	2%	Y
U21.2	Bed	12.1	29	3.66%	1%	Y
U21.3	Bed	11.5	25	3.16%	1%	Y

Table 5: Block B - Average Daylight Factor of all habitable rooms.



Ground Floor

Figure 6: Block C False Colour Plans of all floors indicating habitable rooms assessed for ADF. Scale is 0-5%.

Average Daylight Factor - Block C						
Space ID	Description	Area m2	Sensor Count	ADF	Minimum Recommended ADF	Meets Criteria
C01.1	LKD	31.5	80	3.68%	2%	Y
C01 2	Bed	10.0	27	2.43%	1%	Y
C01.3	Bed	12.2	26	2.84%	1%	Y
C02.1	LKD	28.8	69	4.74%	2%	Y
C02.2	Bed	12.4	40	1.48%	1%	Y
C02.3	Bed	13.6	32	1.98%	1%	Y

Table 6: Block C - Average Daylight Factor of all habitable rooms.

Within the development the design was optimised for good quality daylight. Priority for light is given to living spaces over bedrooms and where possible they are dual aspect. The use of large windows also enhances available daylight and light penetration to the depths of the rooms.

The target ADF value of 2% is selected for all the main living rooms because they contain a kitchen. The BRE guidelines and BS 8602:2 recommend that the higher ADF value should be used were there are multiple uses in a room.

4.2 Conclusion

All the rooms assessed exceed the minimum recommendations for the Average Daylight Factor and will be well daylit. The proposed development meets the recommendations of the BRE Guidelines and BS8206 Part 2:2008 Lighting for Buildings, Code of Practice for Daylighting.

4.3 Assessment for Daylight Provision EN17037:2018

The rooms were assessed for daylight provision in accordance with the criteria set out in EN17037:2018. A summary of the results are displayed in Table 7

Fraction of rooms at each compliance level (area-weighted)				
	Fail	Minimum	Medium	High
Target Illuminance	1.16%	20.25%	37.54%	41.05%
Minimum Illuminance	1.16%	23.56%	37.54%	41.05%

Table 7: Summary of room compliance with EN 17037:2018

4.4 Conclusion

99% of the rooms meet the Target and Minimum illuminance levels. There is one room that does not meet the minimum value. This is a bedroom in the existing cottage with an existing window opening. All the remaining rooms exceed the Minimum and Target levels

5: Sunlight to gardens and open spaces

The BRE document indicates that for an amenity area to have good quality sunlight throughout the year, 50% should receive in excess of 2 hours sunlight on the 21st March. It also states that front gardens need not be assessed for sunlight.

5.1 Sunlight to Amenity within the Proposed Development

A large central area of public amenity space has been designed into this scheme. There are also two private amenity spaces connected to the cottage. A plan with generated analysis from a calculation of Sun on the Ground is shown in Figure 7 and results in Table 6 below.

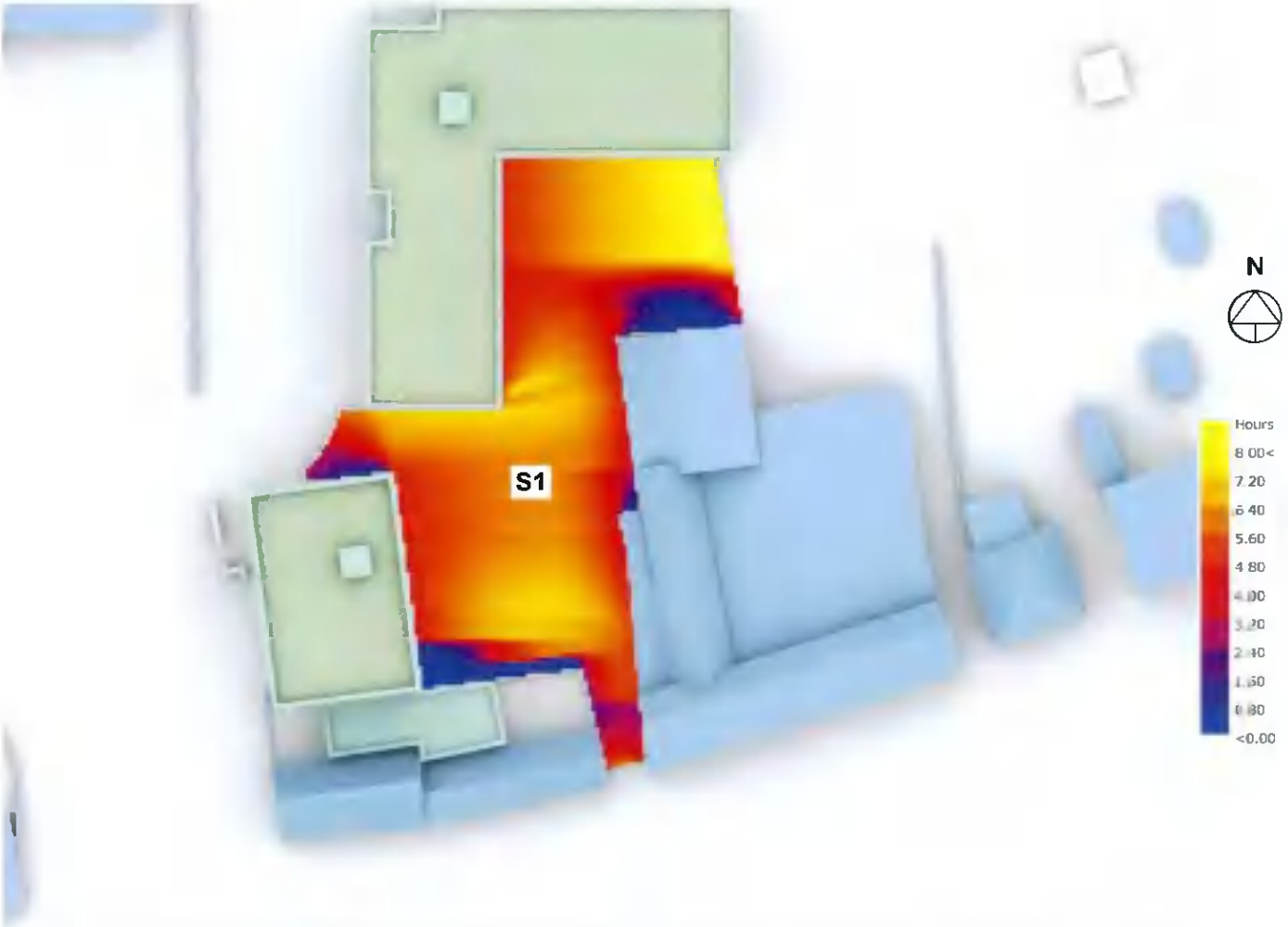


Figure 7: Radiation map of amenity areas, showing available sunlight on 21st March. The scale represents the percentage of daylight received from 0 - 8 hrs.

Sunlight on the Ground - Proposed Development			
Location ID	Location	Proposed % Area receiving 2 hours sunlight on 21st March	Meets Criteria
S1	Communal Open Space	94.3	Yes

Table 8: Calculation of Sun on the Ground to public amenity spaces within the development

5.2 Conclusion

The communal amenity is well orientated for access to sunlight. It exceeds the BRE criteria that in excess of 2 hours sunlight over 50% of the area on the 21st March. The proposed development meets and exceeds the criteria set out in the BRE guidelines for gardens and open spaces.

6: Shadow Diagrams

6.1 BRE Guidance on Shadow Studies

Shadow diagrams are a visual aid to understand where possible shading may occur. The BRE guidelines recommends using the March Equinox due the equal length of the day and night time. It states:

"If a space is used all year round, the equinox (21 March) is the best date for which to prepare shadow plots as it gives an average level of shadowing. Lengths of shadows at the autumn equinox (21 September) will be the same as those for 21 March, so a separate set of plots for September is not required."

June 21st and December 21st are provided below for information but it should be noted that the summer solstice is the best case scenario with shadows at their shortest. In Winter even low buildings will cast long shadows and it is common for large areas of the ground to be in shadow throughout the day especially in a built up area and sun barely rises above an altitude of 10° during the course of the day. The guidelines recommends that Sunlight at an altitude of 10° or less does not count. Below are the times for the Equinox and Solstice that the sun is above 10° altitude rounded to the nearest half hour.

Equinox: between 8:30 and 17:30
Summer Solstice: Between 6:30 and 20:00
Winter Solstice: Between 10:30 and 14:00

Section 6.2 shows the proposed shadow diagrams for the Equinox on the 21st March at 2 hourly intervals during the day between 09:00 and 17:00.
Section 6.3 shows the proposed shadow diagrams for the Summer Solstice on the 21st June at 2 hourly intervals during the day between 10:00 and 18:00.
Section 6.4 shows the proposed shadow diagrams for the Equinox on the 21st September at 2 hourly intervals during the day between 09:00 and 17:00.
Section 6.5 shows the proposed shadow diagrams for the Winter Solstice on the 21st December at 2 hourly intervals during the day between 10:00 and 16:00.

The shadows cast on the September equinox are the same as the March Equinox. They are included here with the Daylight Saving Time (DST) applied, as with the Summer Solstice diagrams. Much of the site is a greenfield, where there is no shadows cast from any structures on the site at present.

The use of shadow diagrams as an assessment method should be taken over the course of the day and not a specific time due to the transient nature of the sun and the shade caused by obstructions.

In relation to the effects of trees and hedges the BRE guidelines states,

> *"It is generally more difficult to calculate the effects of trees on daylight because of their irregular shape and because some light will generally penetrate through the crown. Where the effects of a new building on existing buildings nearby is being analysed, it is usual to ignore the effects of existing trees. This is because daylight is at its scarcest and most valuable in winter when most trees will not be in leaf."*

The trees were not included because they are mostly deciduous and guidelines recommends only including trees where there are dense bands of evergreen trees.

6.2 Shadow Casting diagrams March Equinox

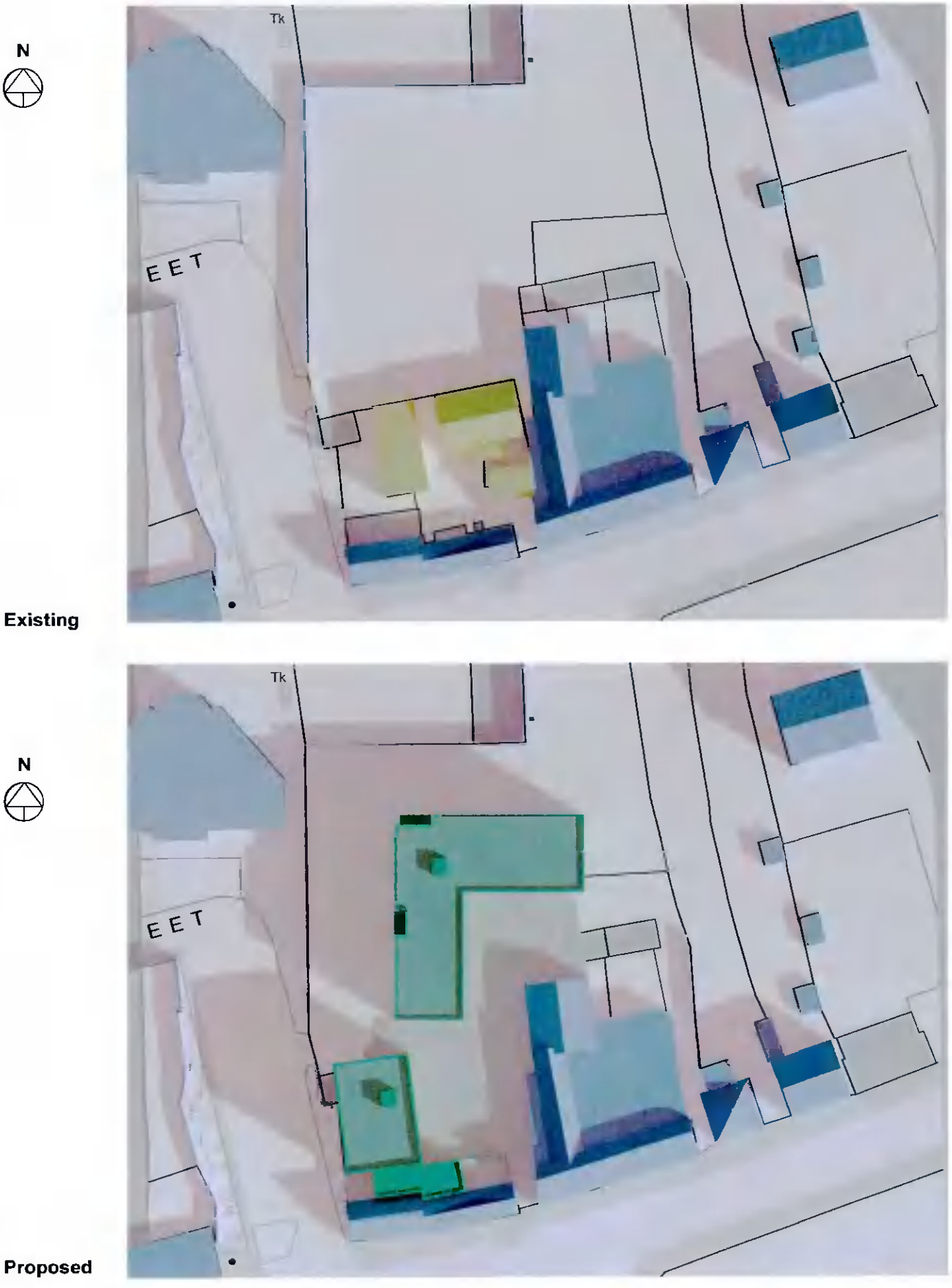
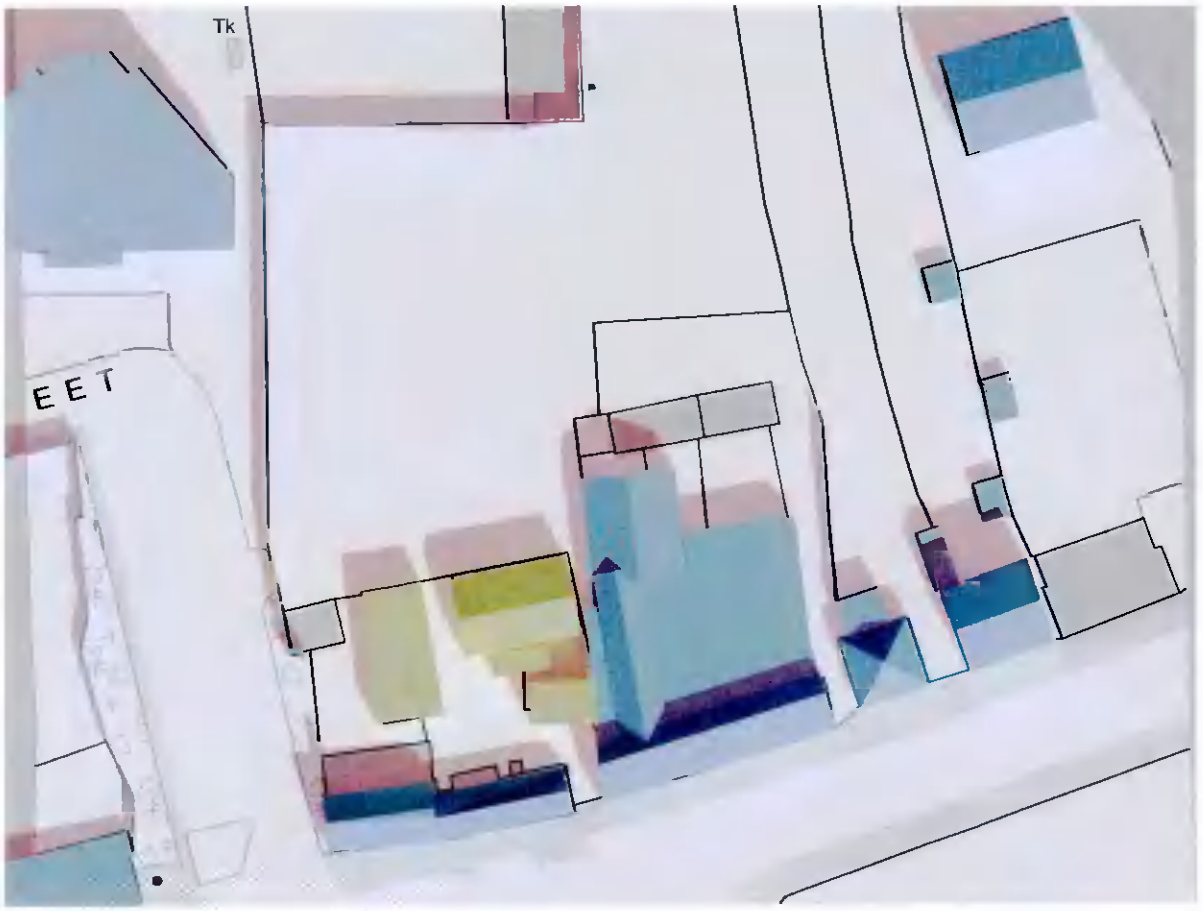


Figure 8: Shadow diagrams 21 March 09:00 GMT

N

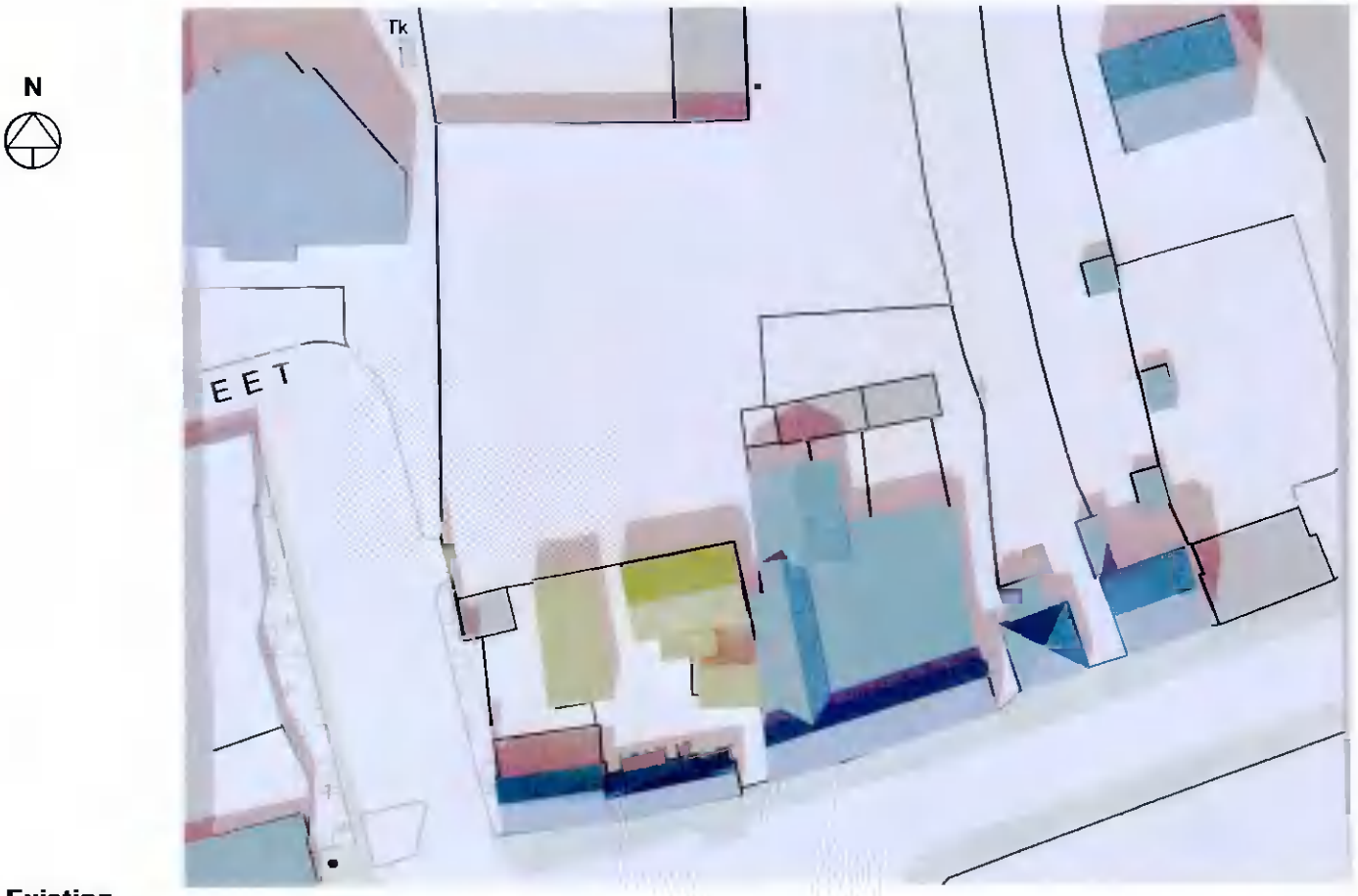


Existing

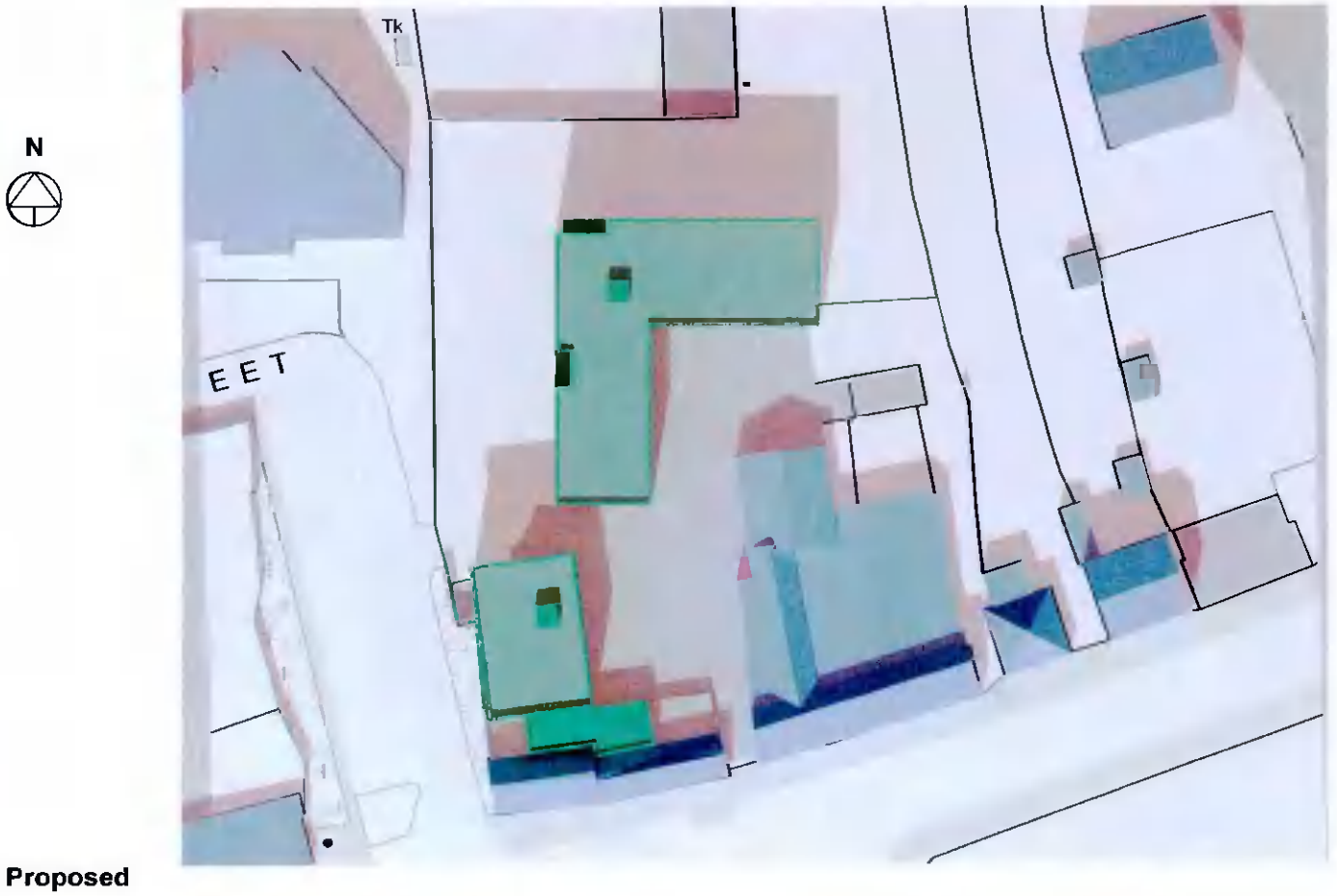
N

Proposed

Figure 9: Shadow diagrams 21 March 11:00 GMT



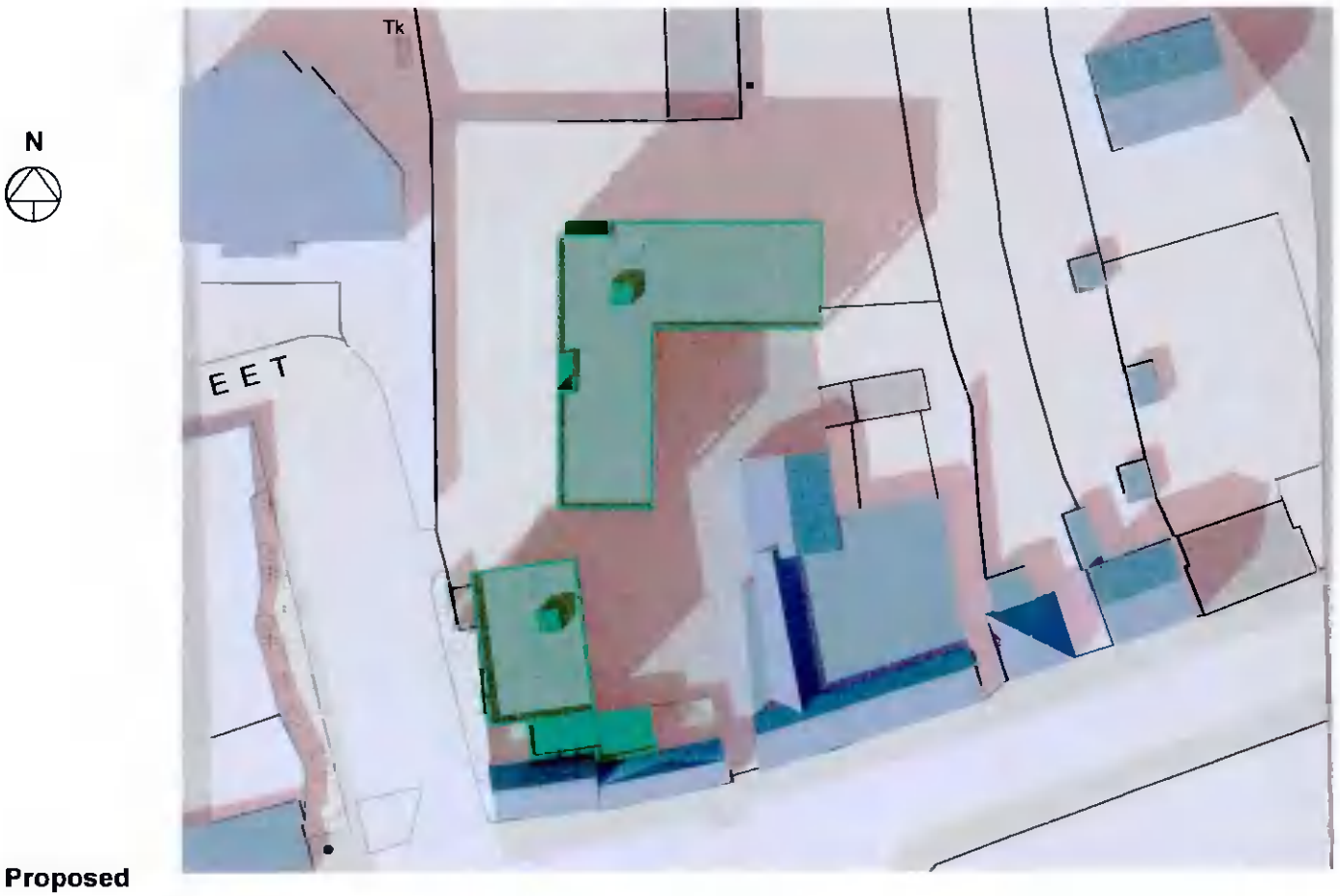
Existing



Proposed

Figure 10: Shadow diagrams 21 March 13:00 GMT

Existing



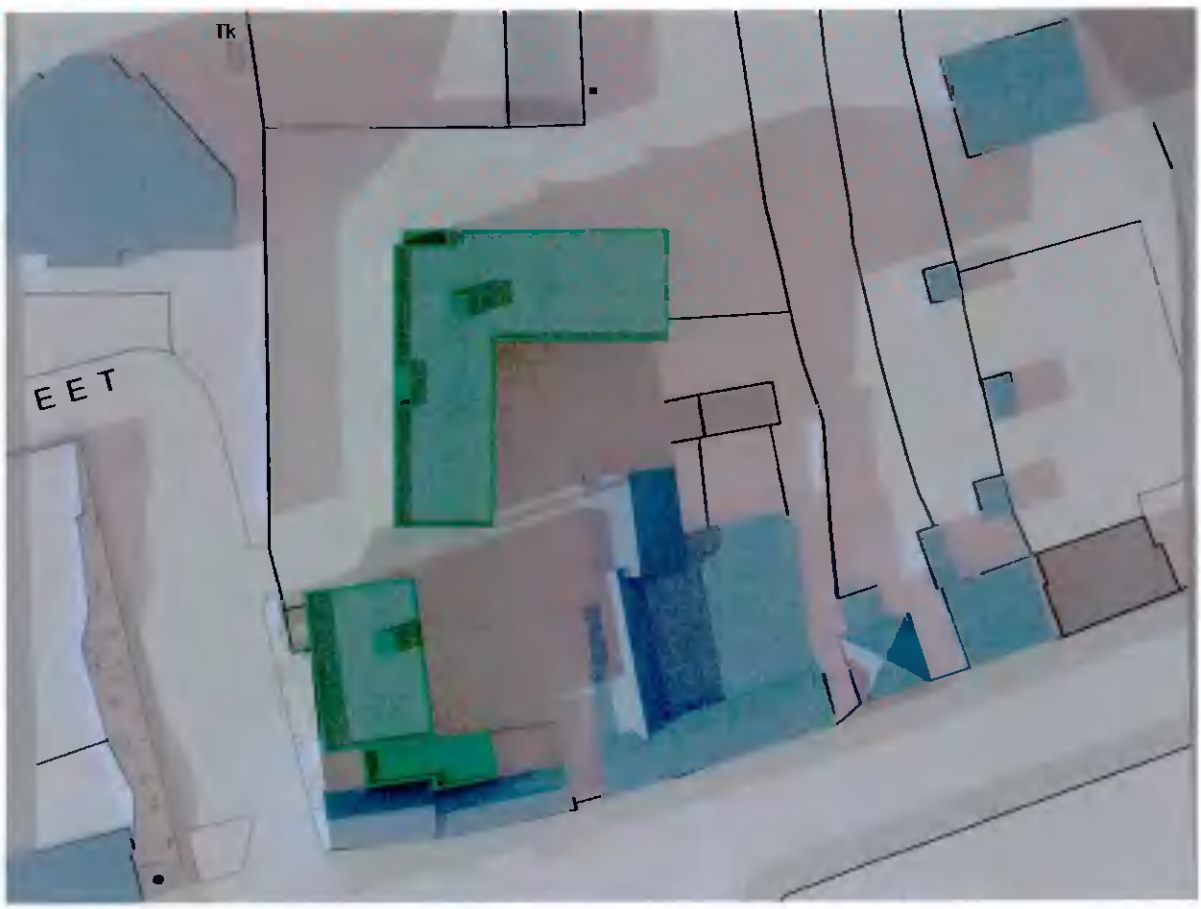
Proposed

Figure 11: Shadow diagrams 21 March 15:00 GMT

N

Existing

N

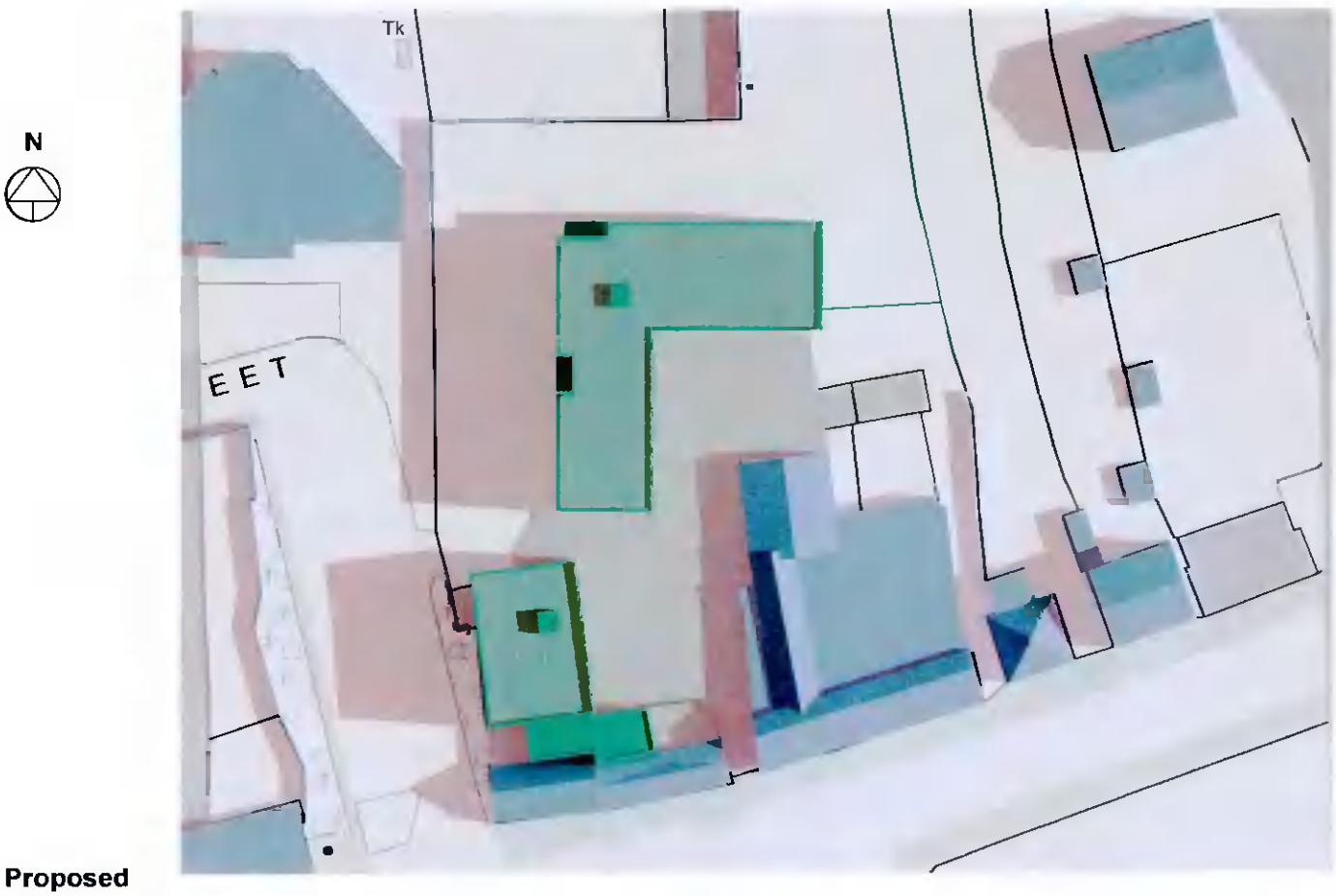


Proposed

Figure 12: Shadow diagrams 21 March 17:00 GMT

6.3 Shadow Casting diagrams June Solstice

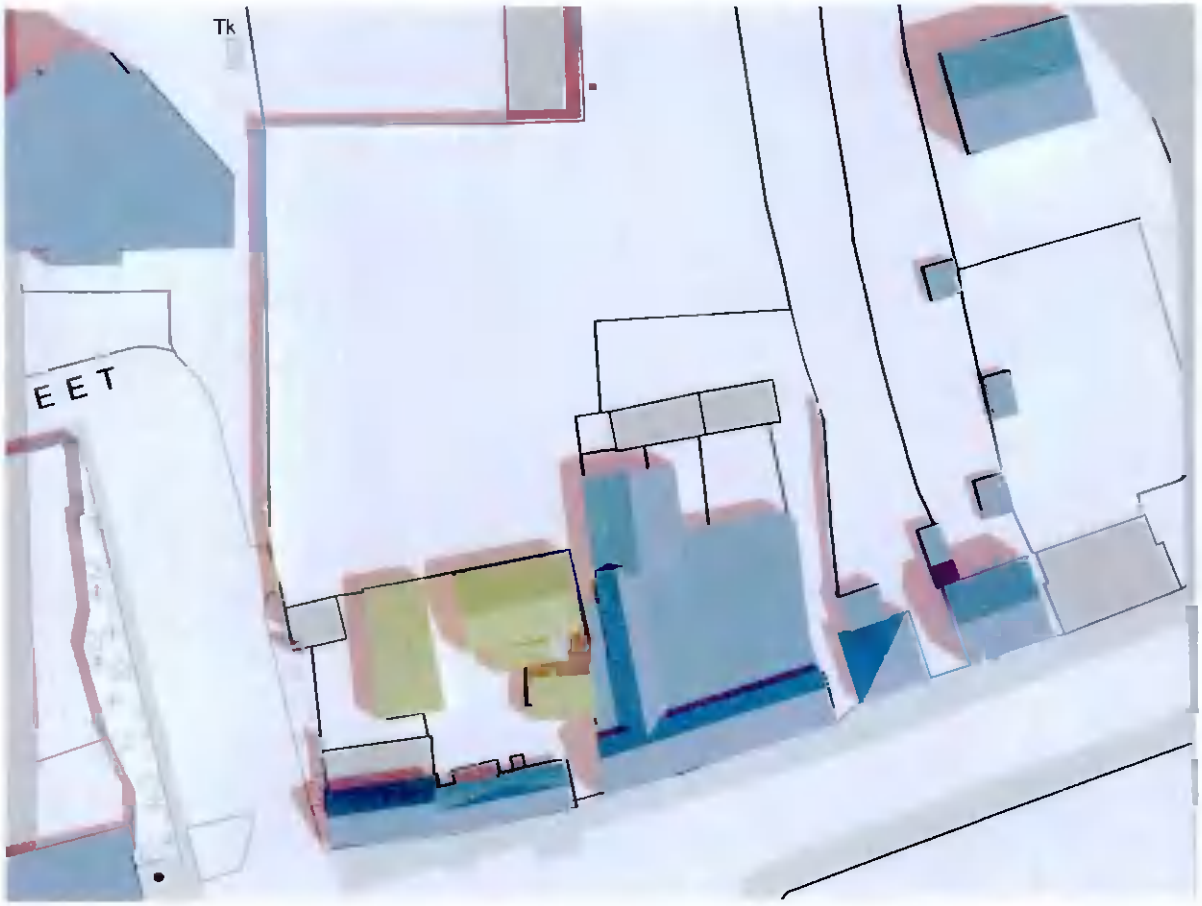
Existing



Proposed

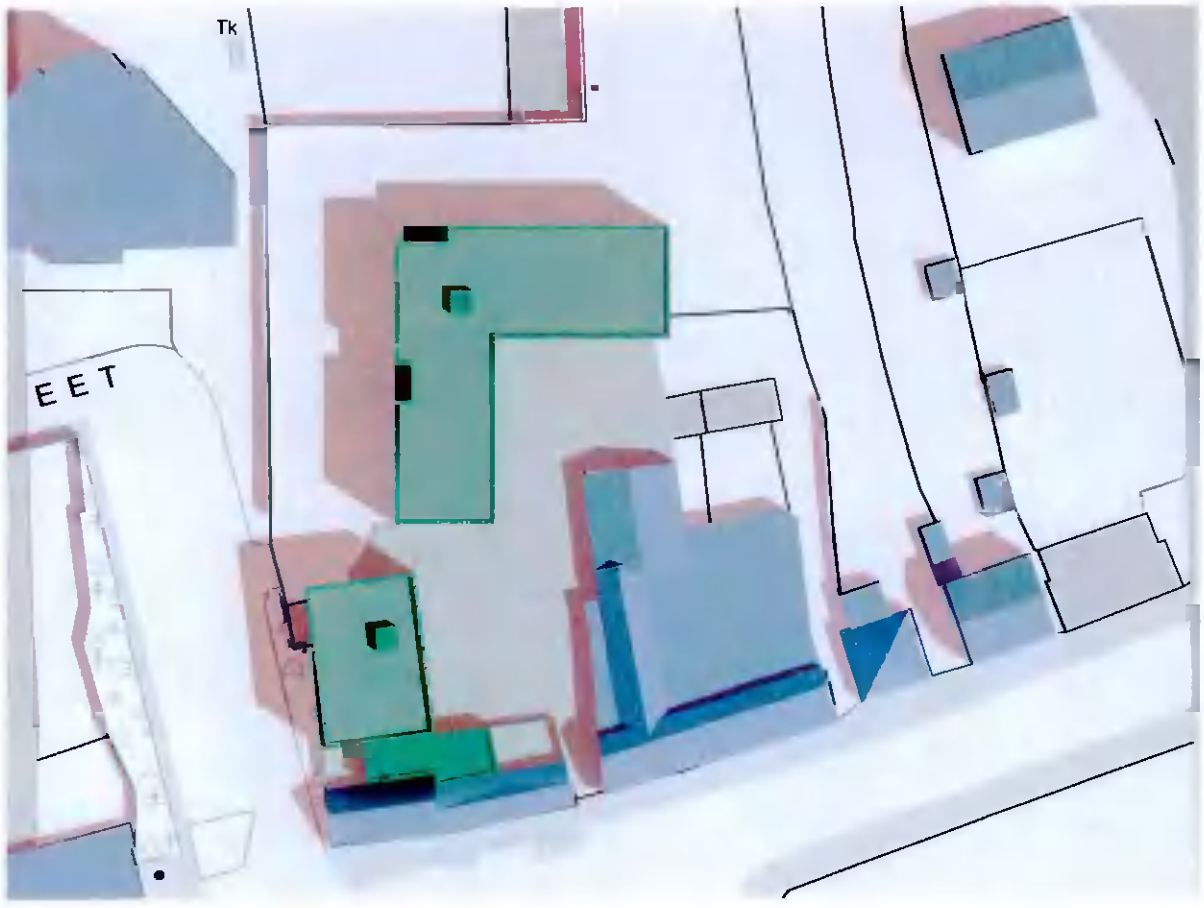
Figure 13: Shadow diagrams 21 June 09:00 GMT+1 (DST)

N



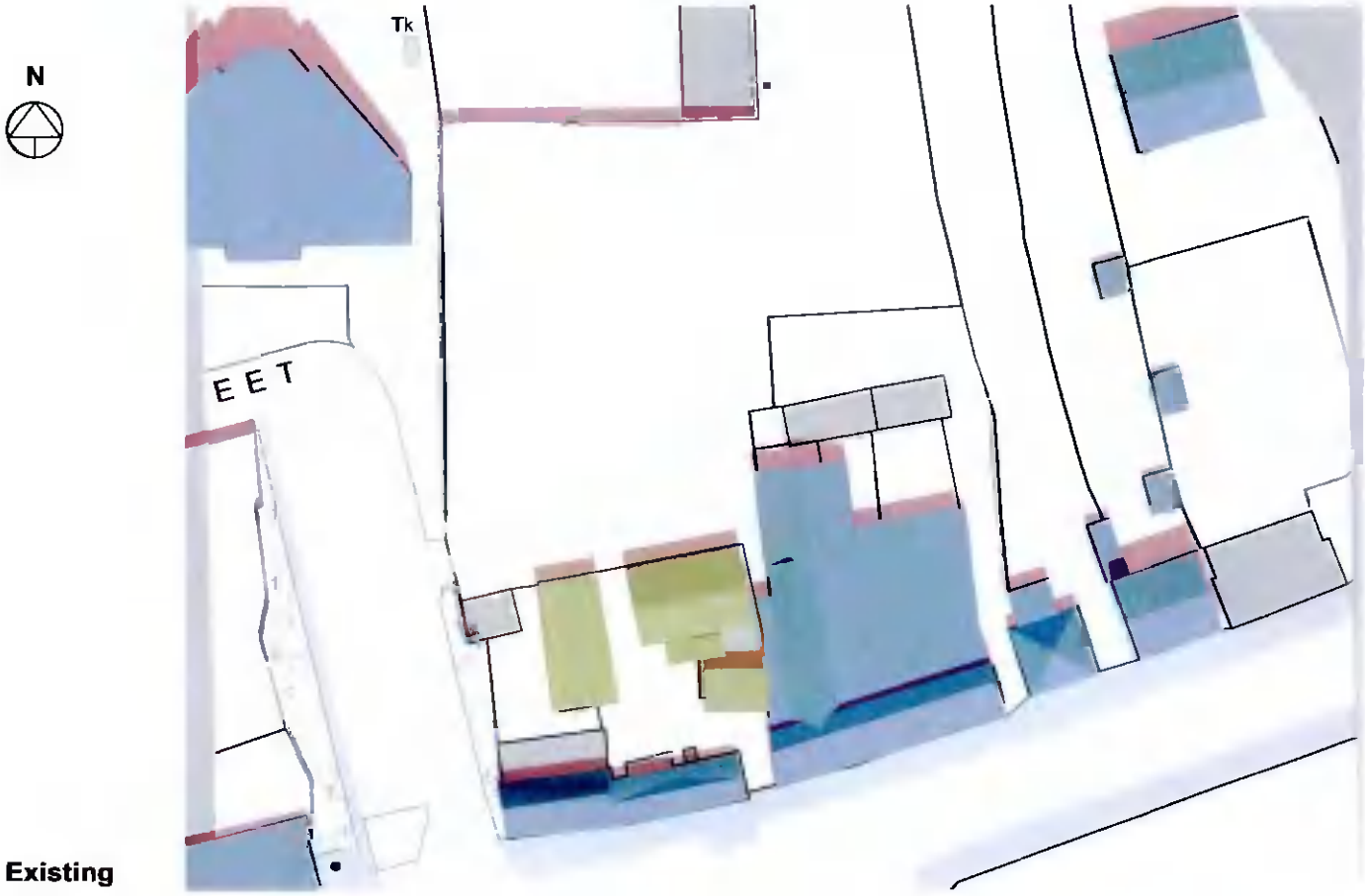
Existing

N



Proposed

Figure 14: Shadow diagrams 21 June 11:00 GMT+1 (DST)



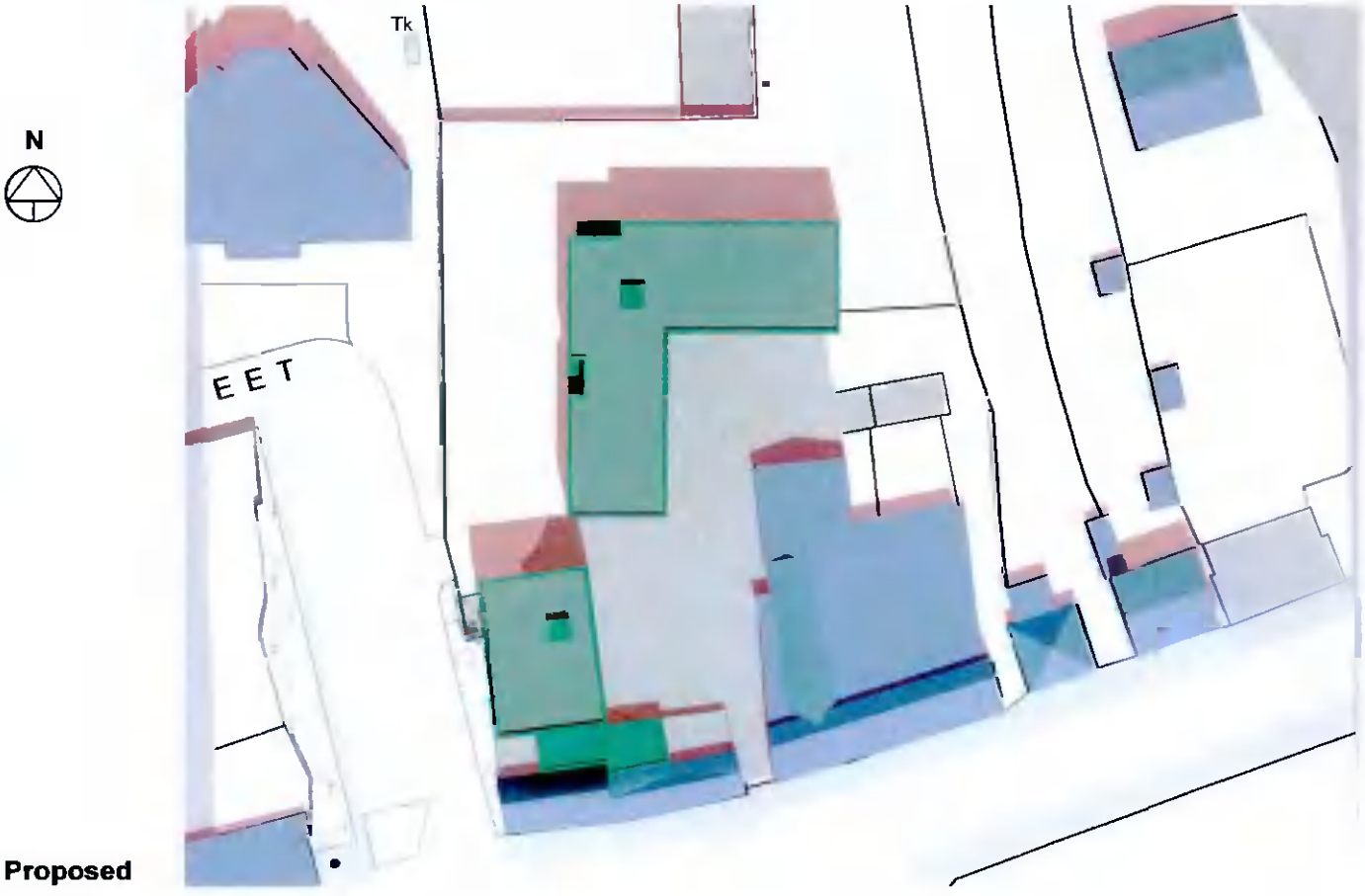
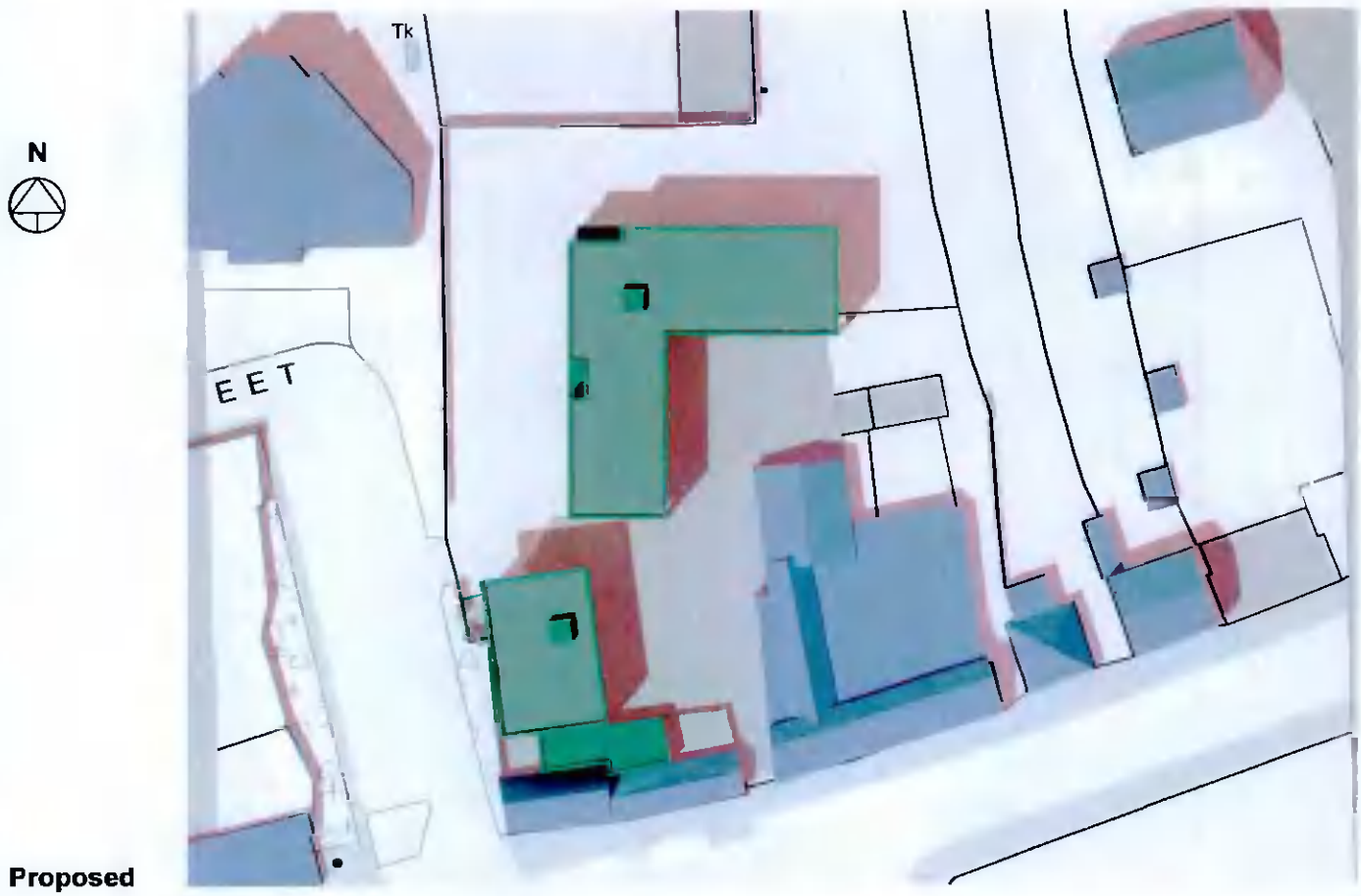


Figure 15: Shadow diagrams 21 June 13:00 GMT+1 (DST)

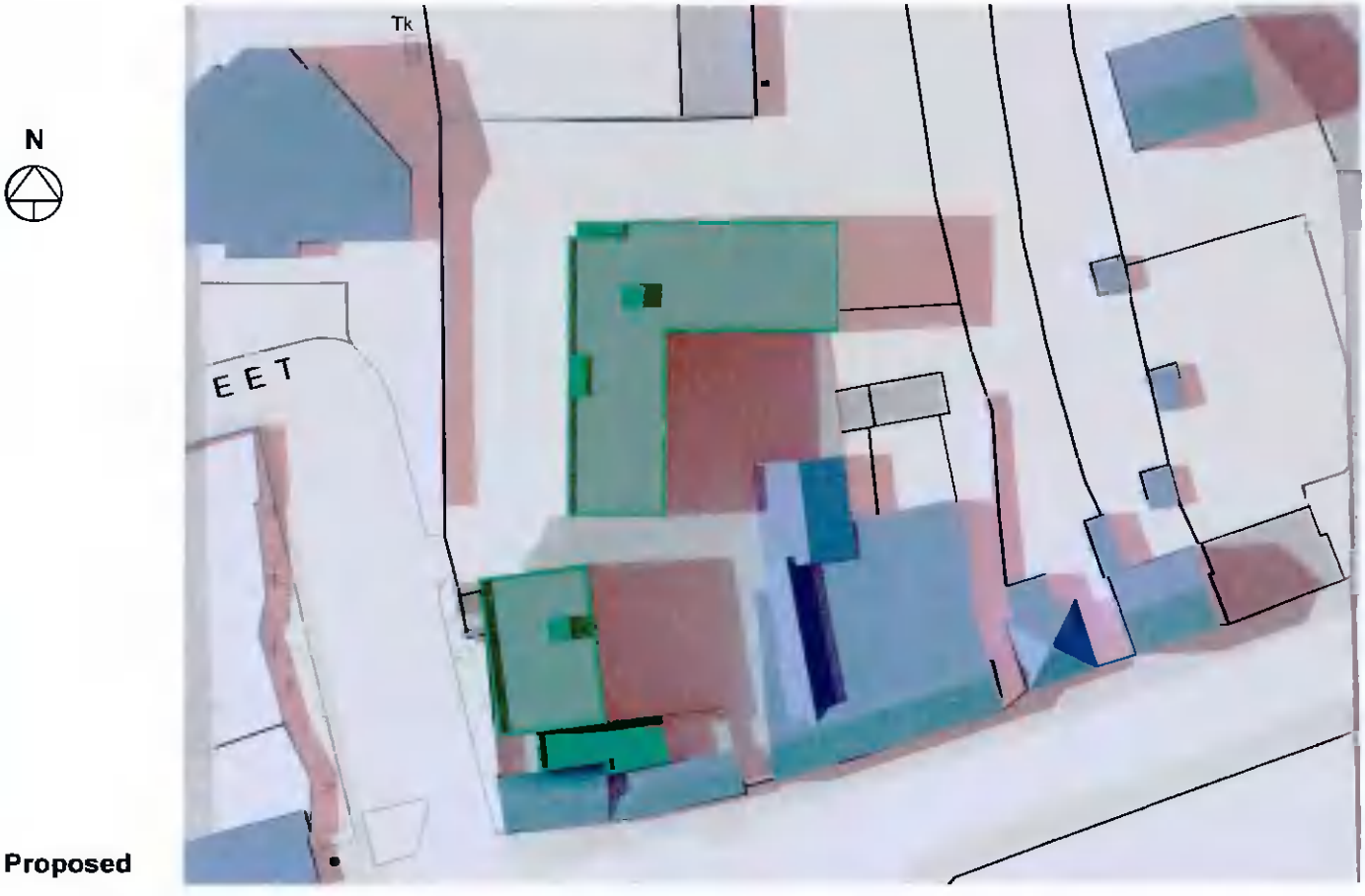
Existing



Proposed

Figure 16: Shadow diagrams 21 June 16:00 GMT +1 (DST)

Existing



Proposed

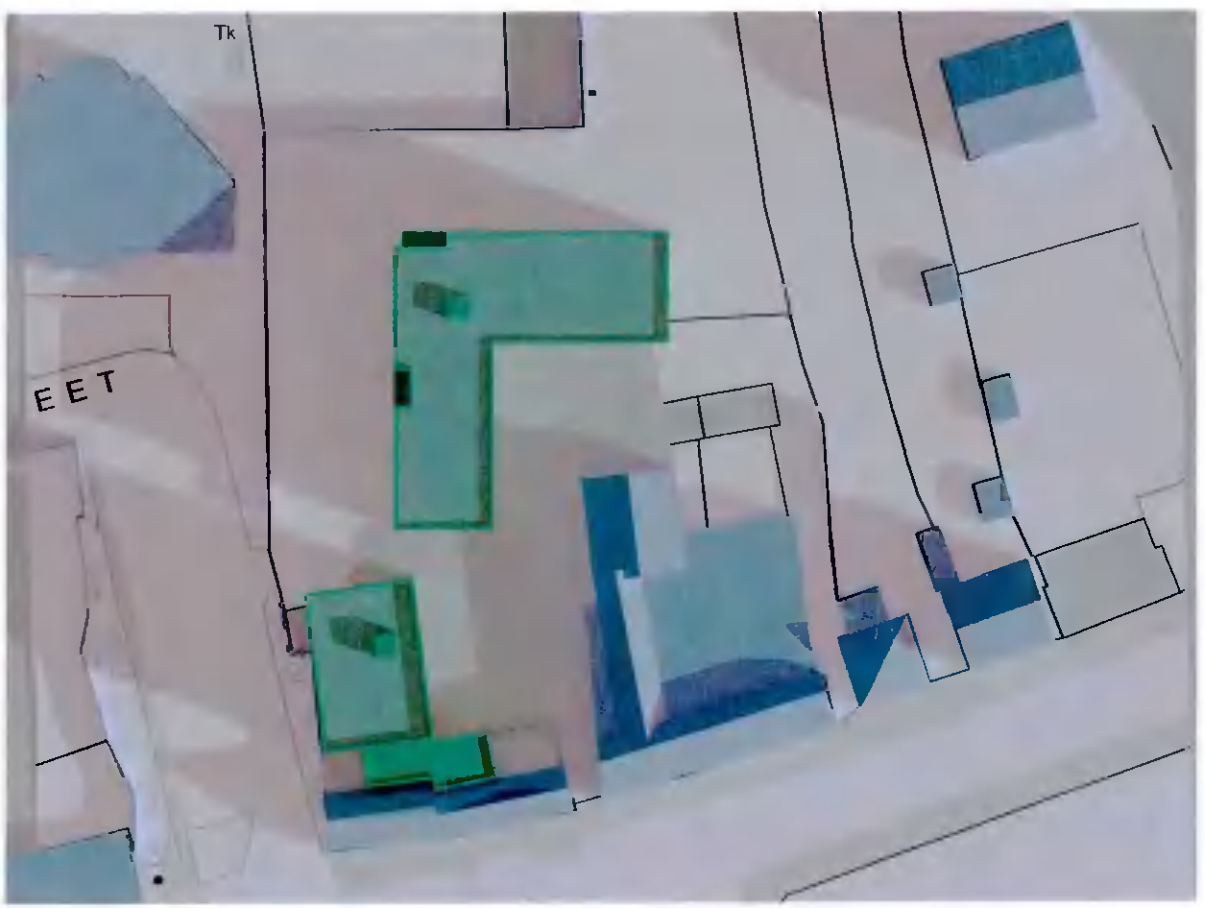
Figure 17: Shadow diagrams 21 June 18:00 GMT+1 (DST)

6.4 Shadow Casting diagrams September Equinox

N

Existing

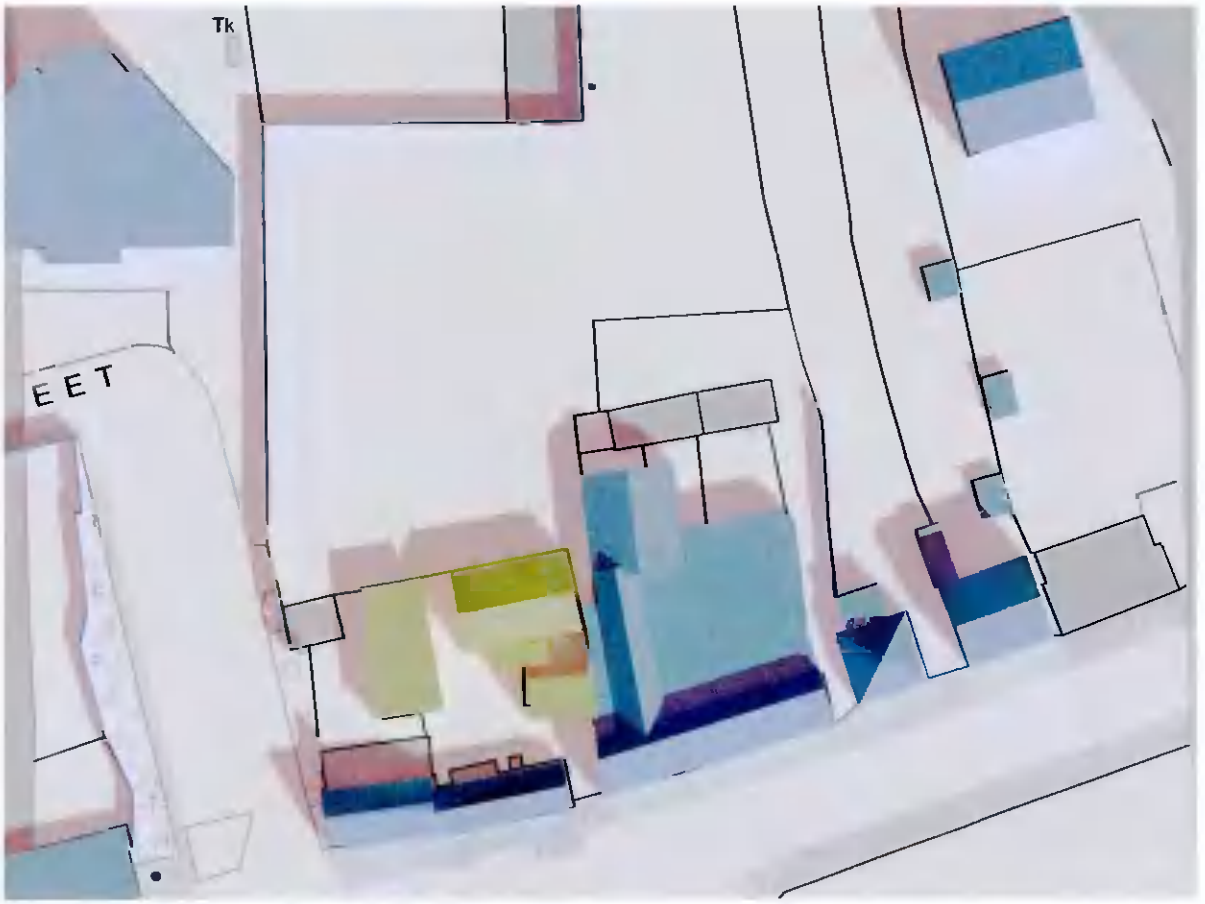
N



Proposed

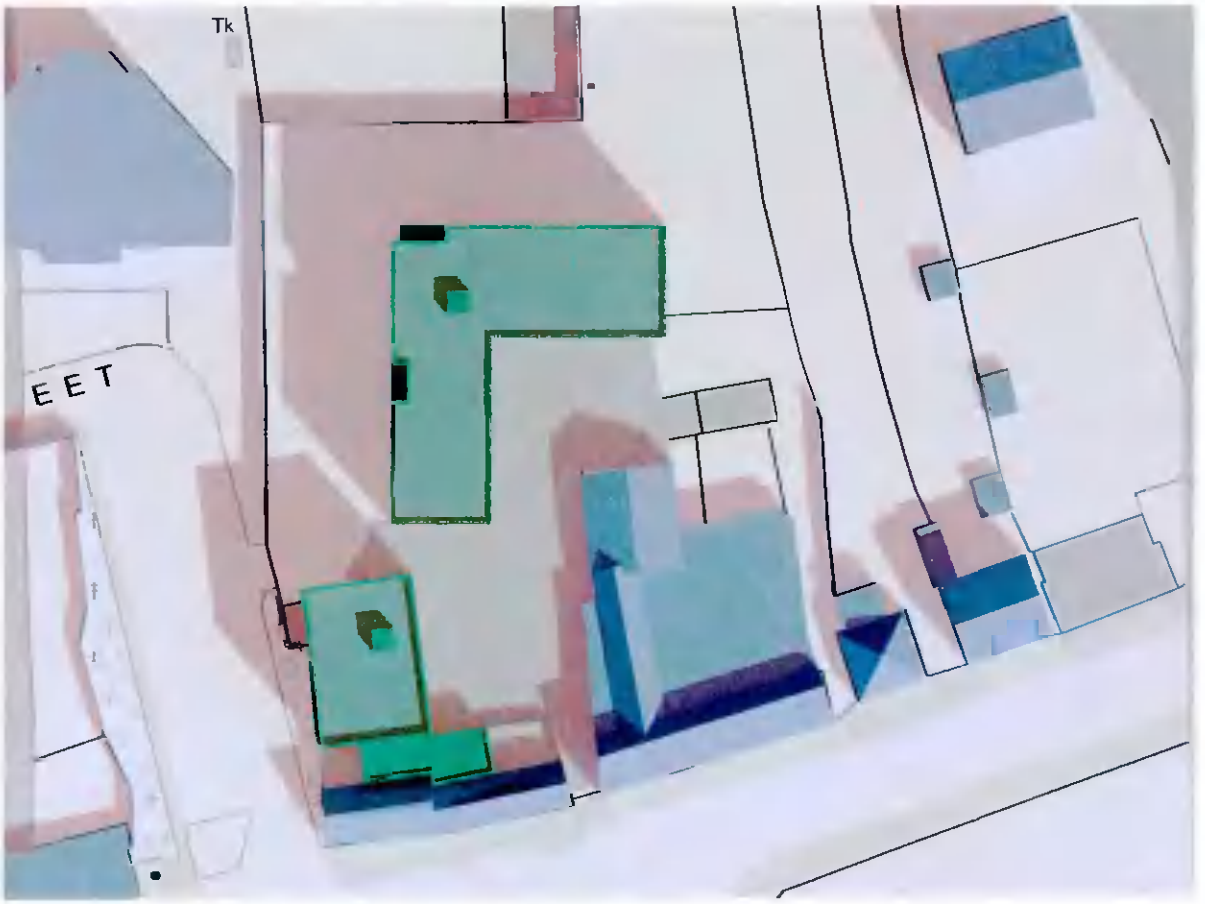
Figure 18: Shadow diagrams 21 September 09:00 GMT +1 (DST)

N



Existing

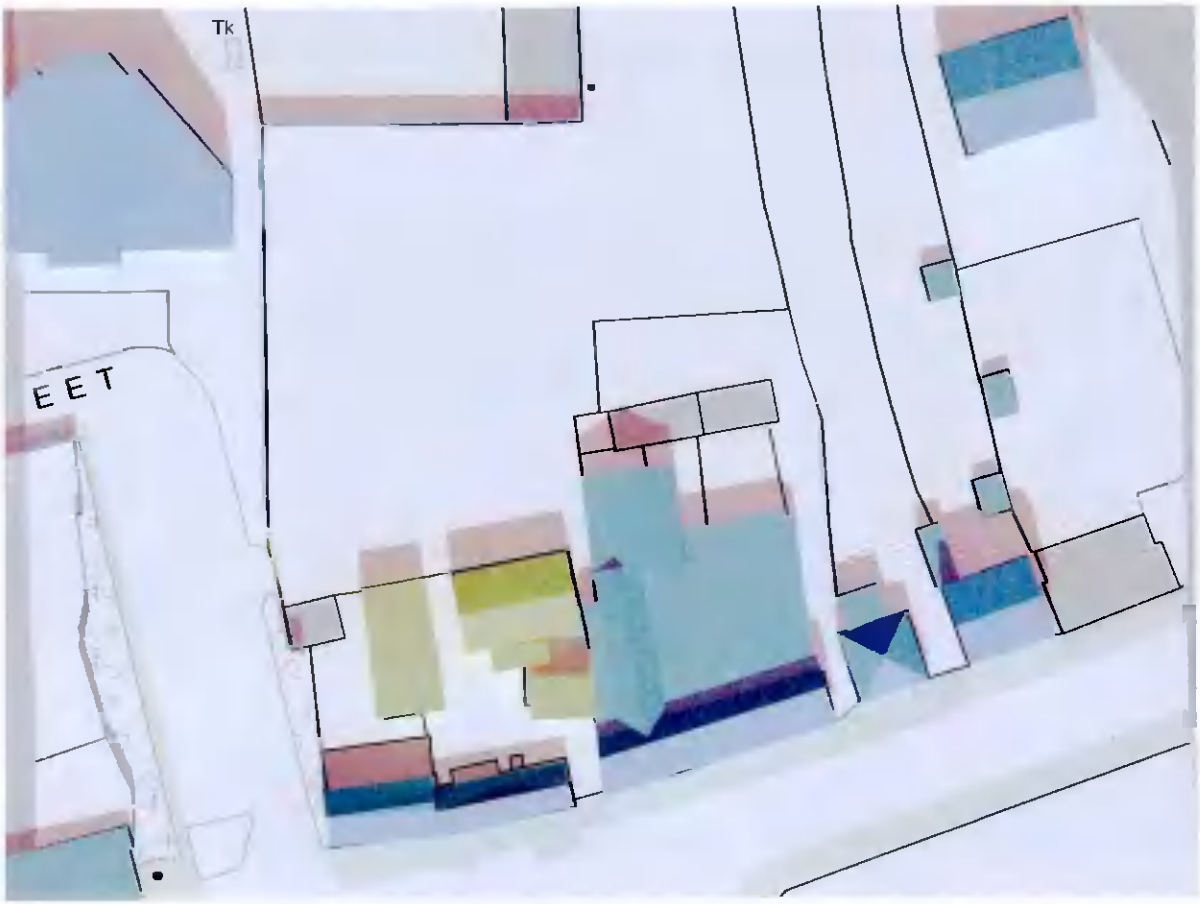
N



Proposed

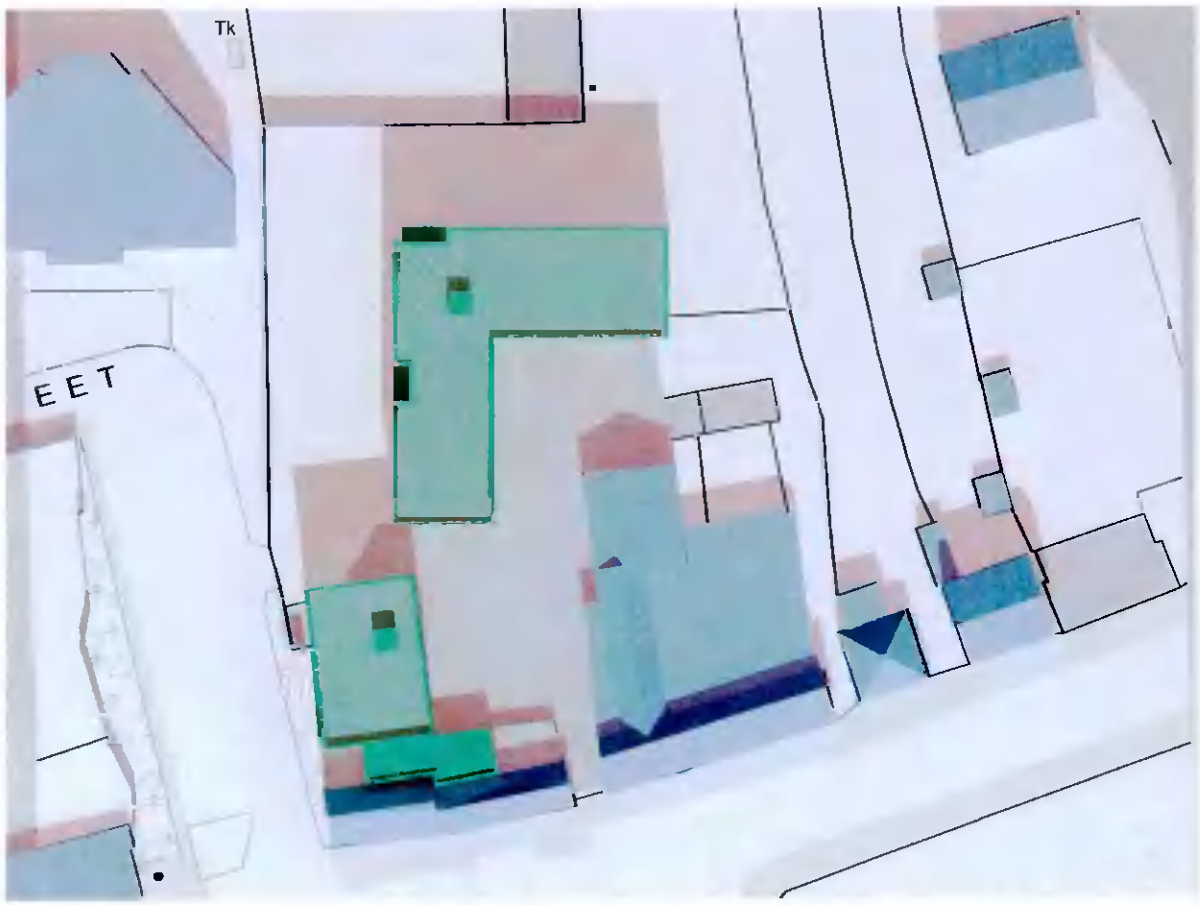
Figure 19: Shadow diagrams 21 September 11:00 GMT +1 (DST)

N



Existing

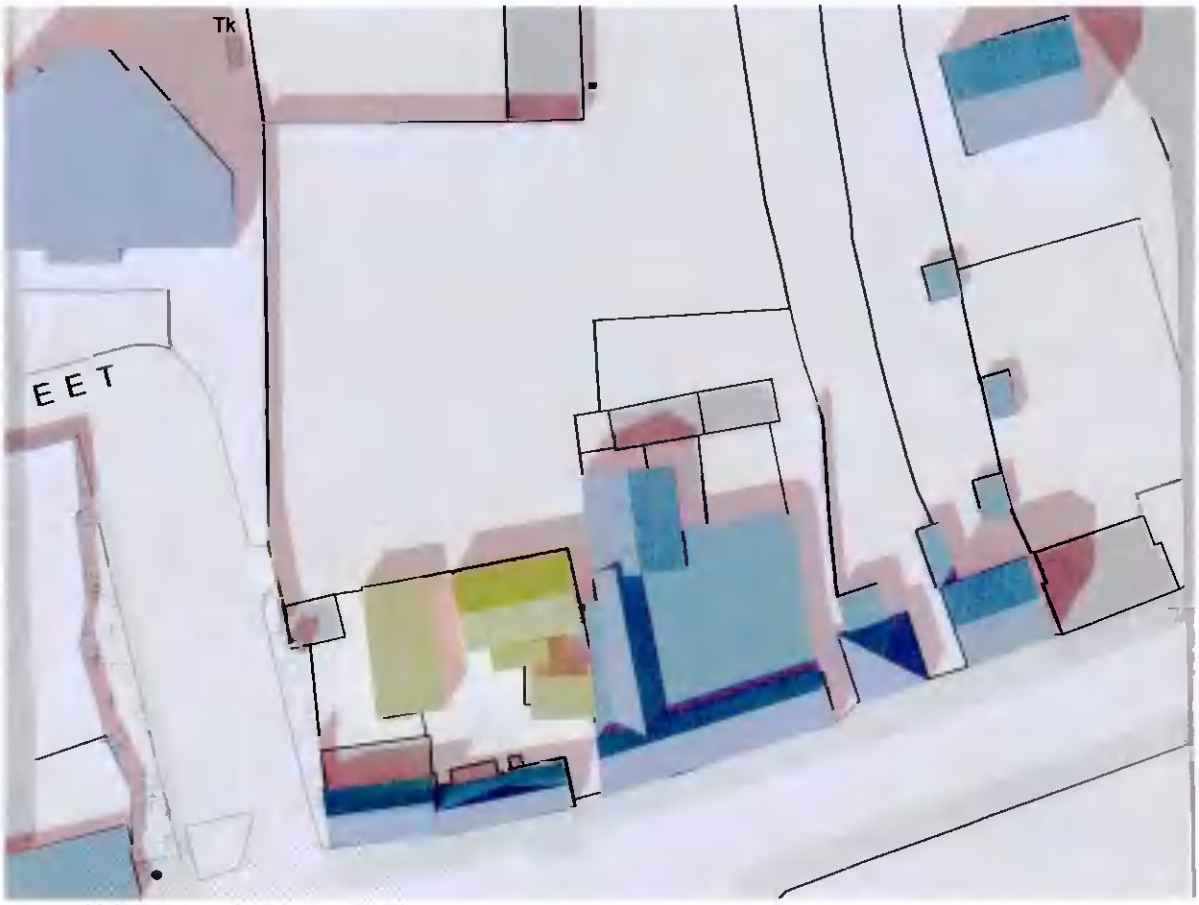
N



Proposed

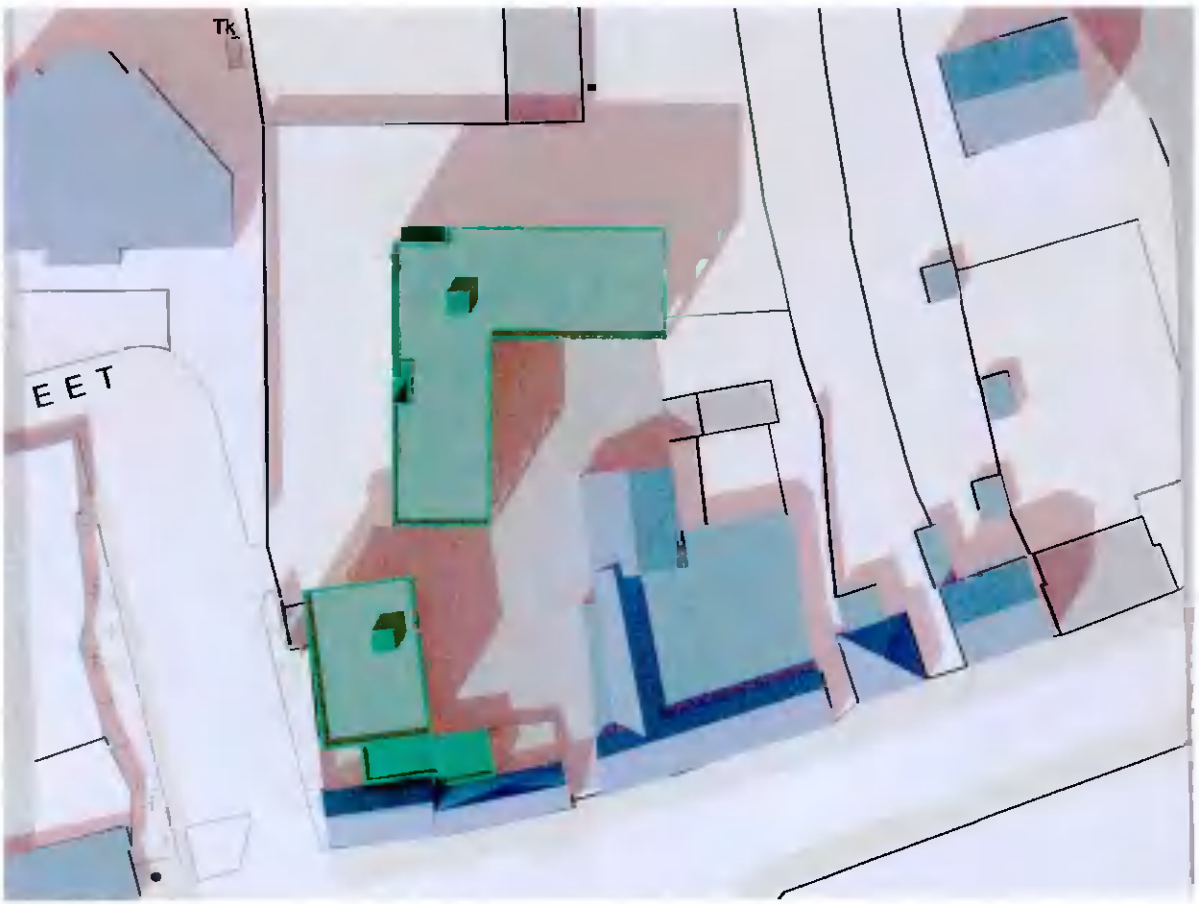
Figure 20: Shadow diagrams 21 September 13:00 GMT +1 (DST)

N



Existing

N



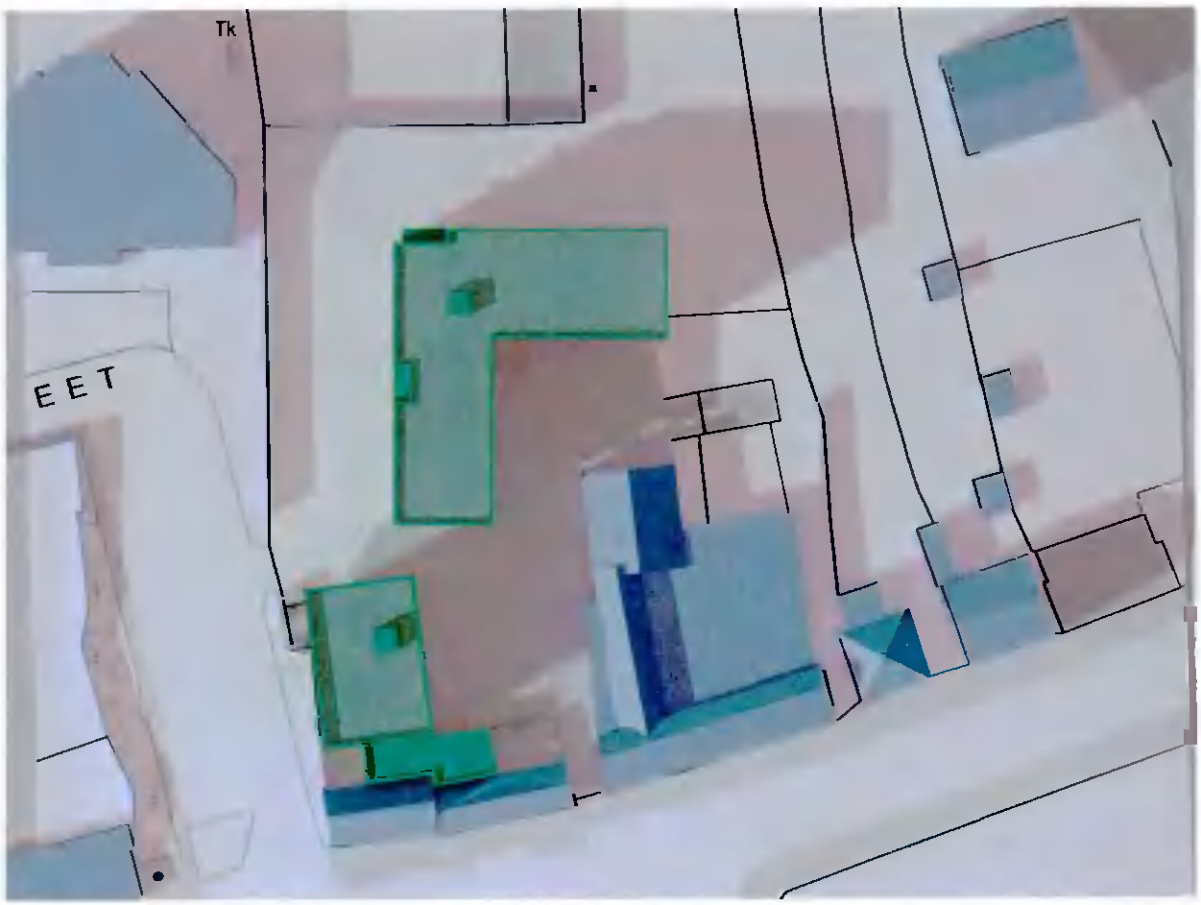
Proposed

Figure 21: Shadow diagrams 21 September 15:00 GMT +1 (DST)

N

Existing

N

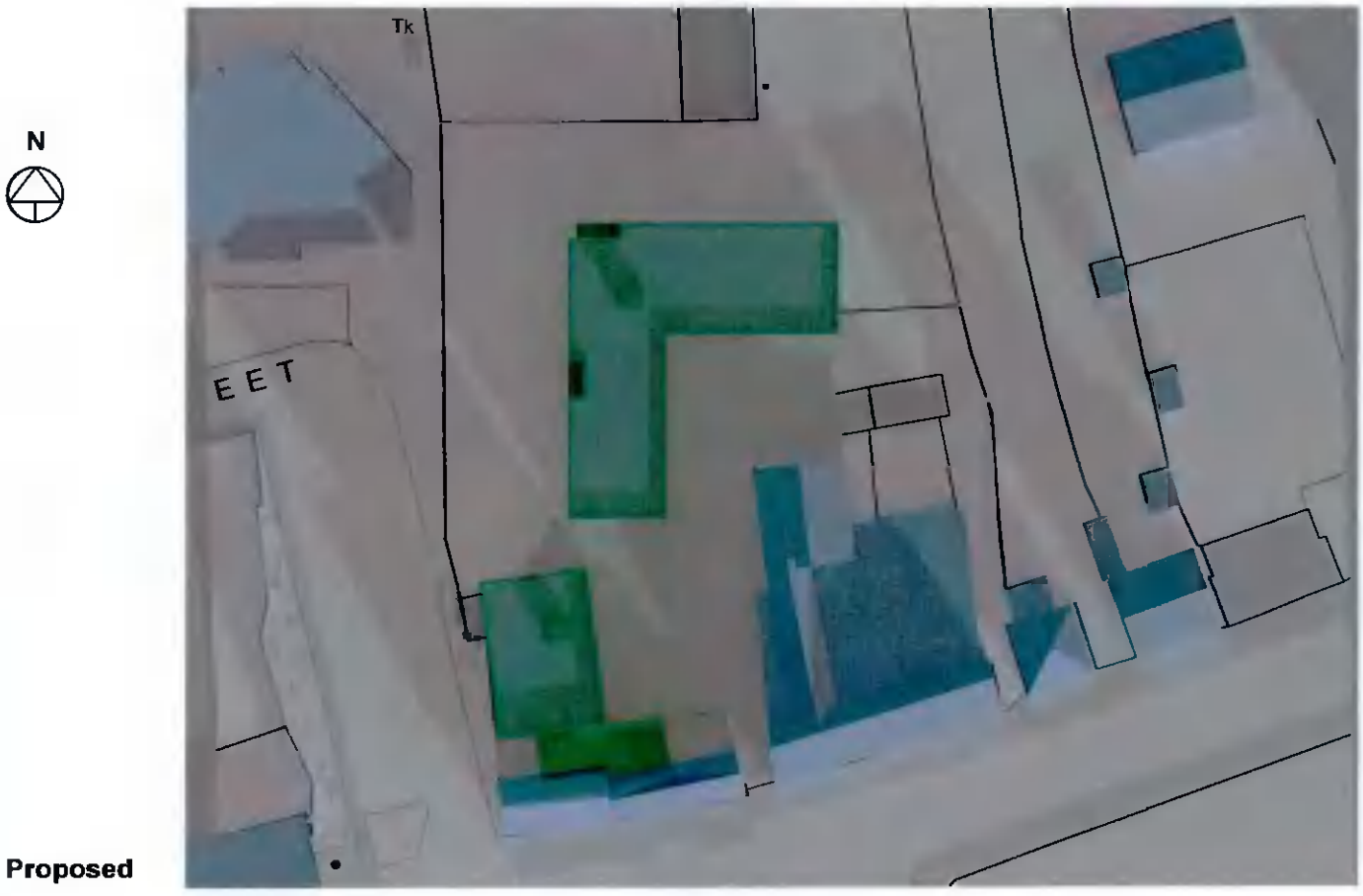


Proposed

Figure 22: Shadow diagrams 21 September 17:00 GMT +1 (DST)

6.5 Shadow Casting diagrams December Solstice

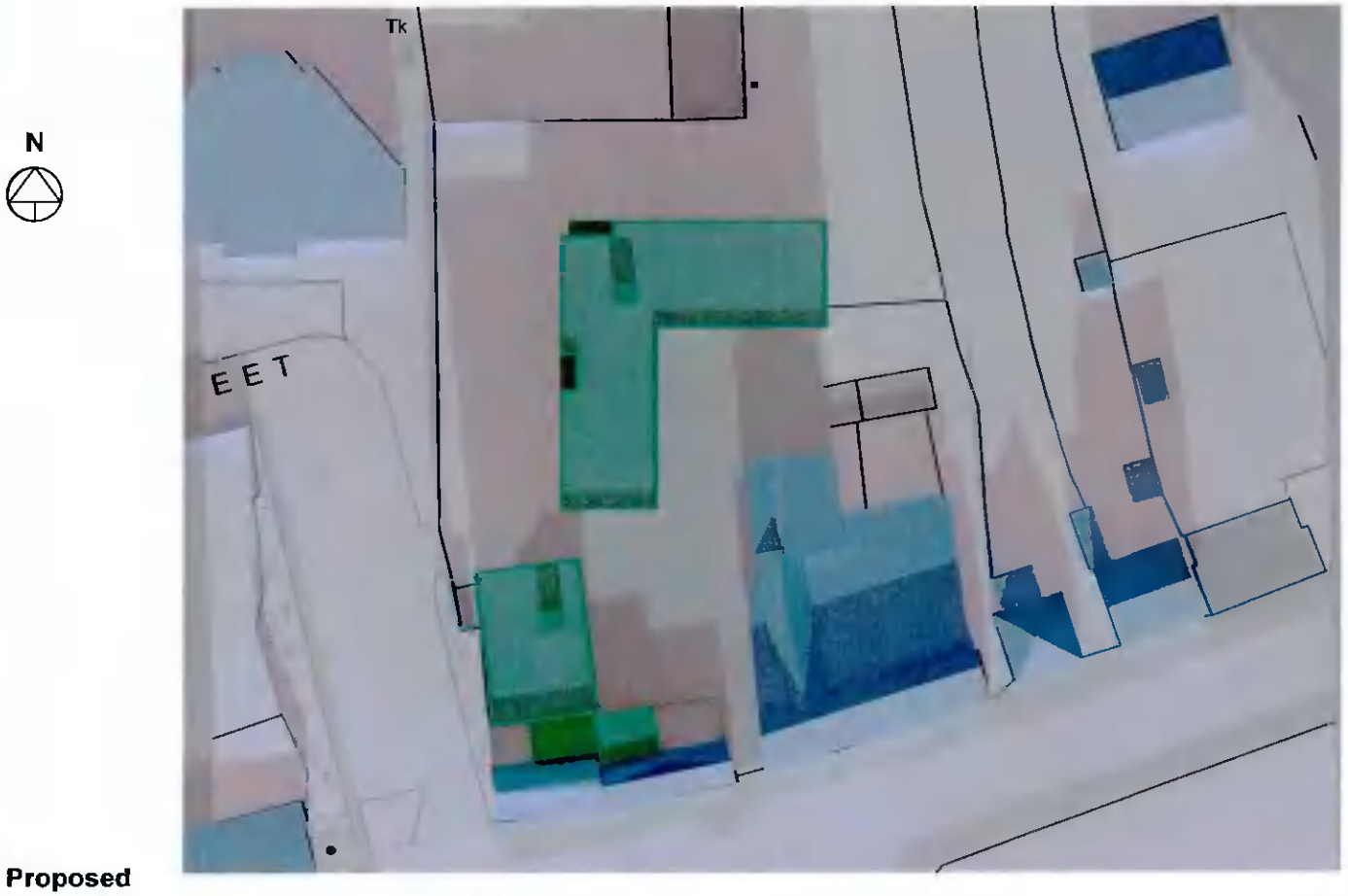
Existing



Proposed

Figure 23: Shadow diagrams 21 December 10:00 GMT

Existing



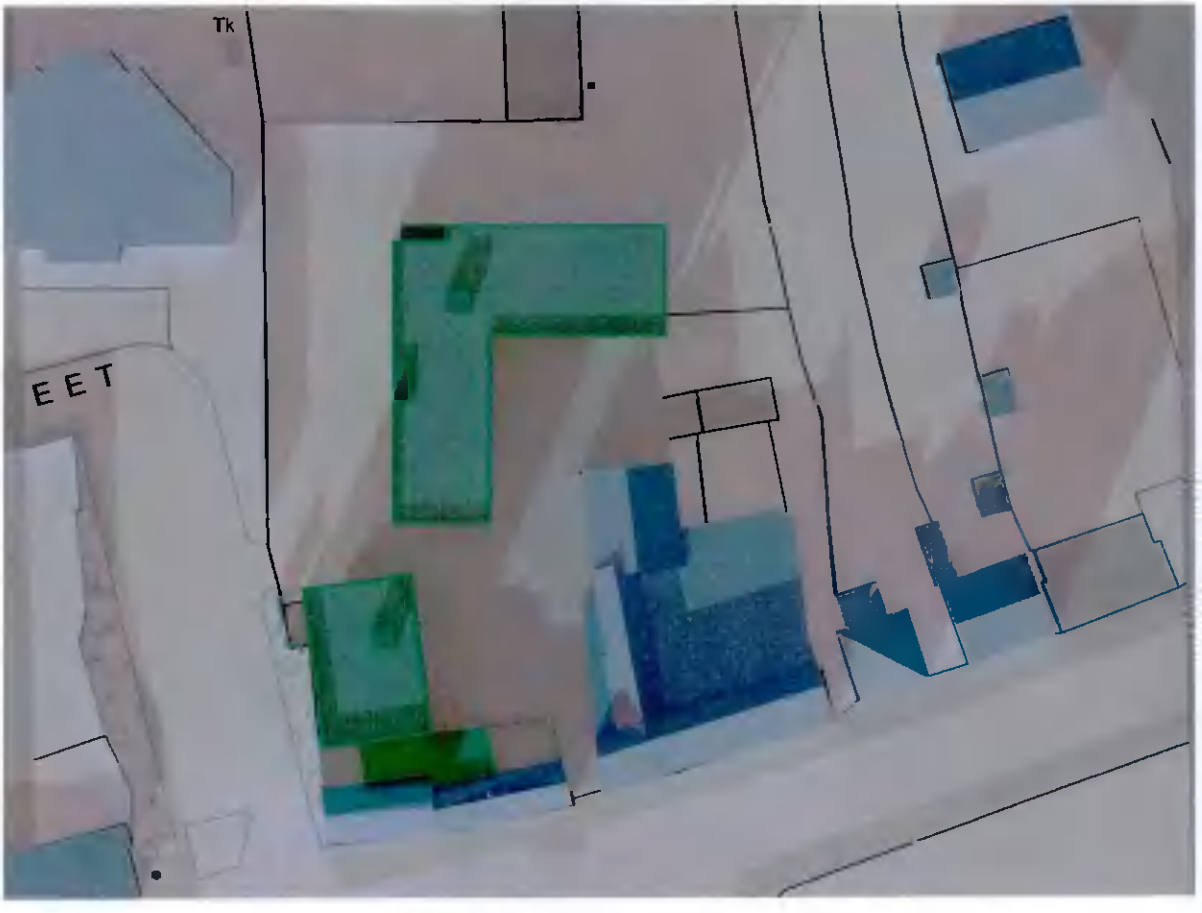
Proposed

Figure 24: Shadow diagrams 21 December 12:00 GMT

N

Existing

N



Proposed

Figure 25: Shadow diagrams 21 December 14:00 GMT

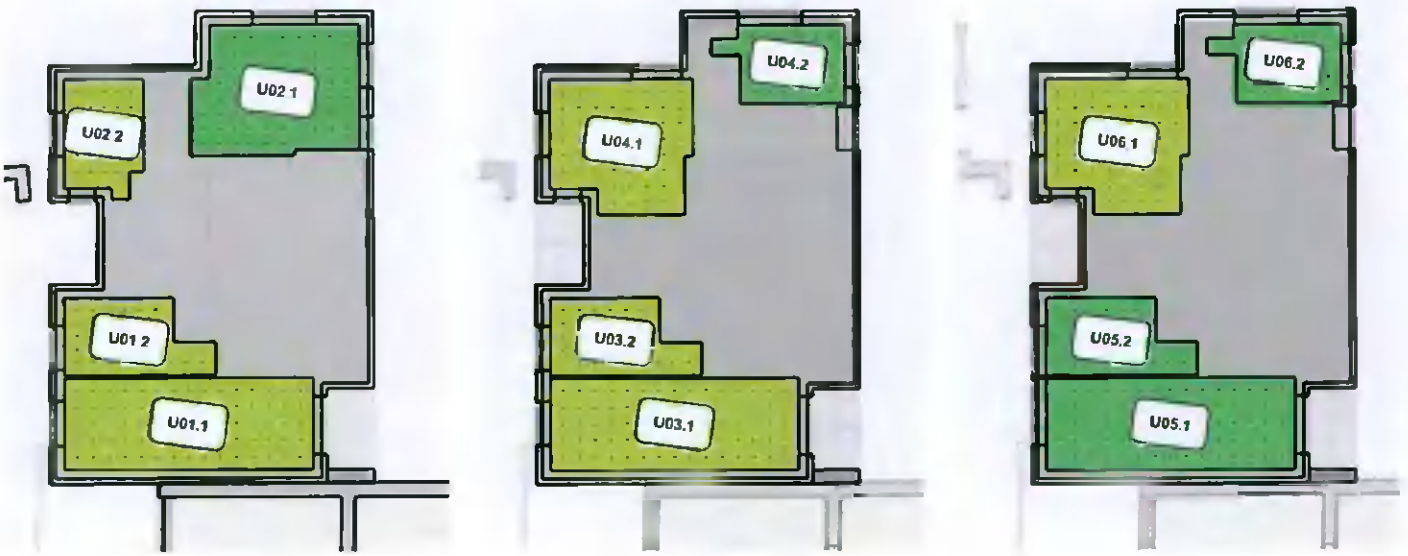
Appendix A

EN17037:2018 Daylight Provision Room Compliance

Space ID	Description	Area [m^2]	Sensor Count	Target Compliance	300lux_50	500lux_50	750lux_50	Minimum Compliance	100lux_95	300lux_95	500lux_95
C01.1	LKD	31.53	80	Minimum	59.57%	40.62%	22.33%	Minimum	59.47%	19.25%	5.50%
C01.2	Bed	10.02	27	Medium	68.36%	54.91%	43.65%	Medium	80.68%	54.70%	40.94%
C01.3	Bed	12.19	26	Medium	70.94%	58.04%	46.94%	Medium	81.39%	56.74%	40.87%
C02.1	LKD	28.78	69	Minimum	64.29%	48.45%	31.14%	Minimum	71.39%	34.04%	6.30%
C02.2	Bed	12.45	40	Fail	27.85%	2.03%	0.00%	Fail	28.42%	0.00%	0.00%
C02.3	Bed	13.58	32	Minimum	57.74%	41.67%	21.23%	Minimum	72.90%	38.88%	9.16%
U01.1	LKD	29.58	75	Medium	70.59%	55.41%	39.43%	Medium	82.28%	58.06%	39.43%
U01.2	Bed	12.84	33	Medium	74.59%	60.57%	46.32%	Minimum	78.54%	47.10%	22.31%
U02.1	LKD	27.10	72	High	78.22%	65.89%	53.08%	Medium	82.28%	58.33%	38.72%
U02.2	Bed	11.34	29	Medium	75.66%	63.04%	48.26%	High	86.14%	67.83%	51.14%
U03.1	LKD	29.58	75	Medium	73.52%	60.46%	46.42%	Medium	84.45%	64.63%	47.79%
U03.2	Bed	12.84	33	Medium	73.11%	58.56%	44.09%	Medium	80.89%	54.89%	30.73%
U04.1	LKD	23.11	54	Medium	74.63%	60.66%	46.03%	Medium	83.88%	60.21%	39.09%
U04.2	Bed	11.48	30	High	85.02%	78.26%	69.43%	High	90.71%	80.39%	71.12%
U05.1	LKD	29.58	75	High	77.69%	66.12%	54.41%	High	86.67%	71.10%	56.35%
U05.2	Bed	12.84	33	High	76.53%	63.97%	51.10%	Medium	80.82%	55.16%	34.59%
U06.1	LKD	23.11	54	Medium	75.71%	62.58%	48.97%	Medium	83.93%	61.14%	42.76%
U06.2	Bed	11.48	30	High	86.71%	81.35%	74.98%	High	92.12%	82.81%	75.41%
U07.1	LKD	30.78	79	Medium	75.53%	61.44%	45.05%	Medium	80.21%	50.73%	26.69%
U07.2	Bed	10.84	23	High	78.65%	68.74%	58.06%	High	85.71%	69.00%	54.59%
U07.3	Bed	9.92	25	High	78.63%	66.78%	51.64%	Medium	81.99%	55.82%	32.72%
U08.1	LKD	23.03	63	Minimum	66.87%	48.77%	30.23%	Medium	81.85%	55.46%	32.31%
U08.2	Bed	10.37	31	Medium	68.36%	50.30%	32.83%	Medium	81.87%	54.73%	30.80%
U09.1	LKD	30.33	85	High	78.49%	66.74%	53.15%	Medium	81.83%	56.05%	30.39%
U09.2	Bed	10.32	32	High	77.85%	65.66%	50.64%	Medium	84.66%	63.24%	41.99%
U09.3	Bed	11.77	30	Minimum	66.92%	48.33%	29.25%	Minimum	73.70%	33.06%	11.26%
U10.1	LKD	29.87	76	Minimum	60.94%	44.11%	33.17%	Minimum	73.17%	39.95%	21.62%
U10.2	Bed	10.24	24	Minimum	55.37%	38.01%	26.74%	Minimum	60.64%	20.05%	6.14%
U10.3	Bed	11.82	30	Medium	69.36%	53.72%	39.86%	Minimum	58.86%	18.88%	6.16%
U11.1	LKD	30.04	69	High	79.77%	70.66%	60.55%	High	86.94%	73.15%	59.50%
U11.2	Bed	12.13	29	Medium	70.50%	54.25%	36.21%	Medium	82.21%	55.07%	32.05%
U11.3	Bed	11.51	25	Minimum	65.50%	44.54%	12.72%	Minimum	67.76%	10.55%	0.00%
U12.1	LKD	30.78	79	High	78.84%	68.17%	56.67%	Medium	80.84%	56.28%	32.60%
U12.2	Bed	10.84	23	High	81.69%	73.90%	63.93%	High	86.71%	72.05%	59.79%
U12.3	Bed	9.92	25	High	78.54%	67.21%	53.20%	Medium	82.49%	58.15%	35.62%
U13.1	LKD	23.03	63	Medium	69.27%	52.65%	34.47%	Medium	82.81%	59.22%	37.26%
U13.2	Bed	10.37	31	Medium	76.90%	63.72%	49.41%	Medium	85.50%	65.96%	47.72%
U14.1	LKD	30.33	85	High	79.25%	68.42%	55.11%	Medium	84.47%	61.19%	41.48%
U14.2	Bed	10.32	32	High	77.74%	65.37%	51.42%	Medium	85.68%	65.89%	47.63%
U14.3	Bed	11.77	30	Minimum	66.53%	48.65%	30.00%	Minimum	76.80%	40.89%	15.59%
U15.1	LKD	29.87	76	Medium	66.58%	51.71%	40.11%	Medium	78.29%	50.53%	33.58%
U15.2	Bed	10.24	24	Minimum	59.27%	44.36%	31.67%	Minimum	70.87%	36.83%	20.07%
U15.3	Bed	11.82	30	Minimum	56.90%	40.80%	28.88%	Minimum	52.10%	10.48%	2.24%
U16.1	LKD	30.04	69	High	81.14%	73.17%	63.49%	High	86.69%	72.05%	58.93%
U16.2	Bed	12.13	29	Medium	71.67%	56.78%	40.84%	Medium	82.31%	56.69%	34.52%
U16.3	Bed	11.51	25	Minimum	64.77%	44.25%	14.61%	Minimum	71.16%	17.63%	0.00%
U17.1	LKD	30.78	79	High	80.43%	70.98%	60.66%	Medium	82.95%	61.74%	43.24%

EN17037:2018 Daylight Provision Room Compliance											
Space ID	Description	Area [m^2]	Sensor Count	Target Compliance	300lux_50	500lux_50	750lux_50	Minimum Compliance	100lux_95	300lux_95	500lux_95
U17.2	Bed	10.84	23	High	85.05%	79.50%	72.97%	High	88.17%	77.10%	66.12%
U17.3	Bed	9.92	25	High	78.86%	67.63%	55.30%	Medium	82.31%	58.24%	36.96%
U18.1	LKD	23.03	63	Medium	74.63%	60.64%	45.21%	Medium	85.87%	65.84%	47.35%
U18.2	Bed	10.37	31	Medium	75.96%	62.95%	48.74%	Medium	85.66%	66.30%	48.84%
U19.1	LKD	30.33	85	High	81.71%	73.24%	61.10%	Medium	86.12%	65.89%	46.78%
U19.2	Bed	10.32	32	High	78.24%	66.48%	52.99%	Medium	84.75%	64.25%	45.37%
U19.3	Bed	11.77	30	Medium	69.68%	53.74%	35.84%	Minimum	76.90%	43.26%	15.84%
U20.1	LKD	29.87	76	Medium	70.50%	57.40%	43.81%	Medium	79.93%	53.52%	36.67%
U20.2	Bed	10.24	24	Medium	64.77%	51.00%	38.22%	Minimum	73.84%	42.31%	25.23%
U20.3	Bed	11.82	30	High	75.41%	62.79%	50.14%	Minimum	70.43%	36.96%	18.61%
U21.1	LKD	30.04	69	High	81.90%	74.68%	65.05%	High	88.08%	76.60%	64.38%
U21.2	Bed	12.13	29	Medium	74.18%	60.14%	45.18%	Medium	81.64%	55.18%	32.40%
U21.3	Bed	11.51	25	Minimum	66.51%	47.10%	21.42%	Minimum	65.23%	7.10%	0.00%

Table 9: EN17037:2018 Daylight Provision individual room compliance values.



Ground Floor **First Floor** **Second Floor**

Figure 26: Block A False Colour Plans of all floors indicating habitable rooms assessed for daylight provision under EN17037:2018.

Ground Floor

First Floor

Second Floor

Figure 27: Block B False Colour Plans of all floors indicating habitable rooms assessed for daylight provision under EN17037:2018.

Ground Floor

Figure 28: Block C False Colour Plans of all floors indicating habitable rooms assessed for daylight provision under EN17037:2018.