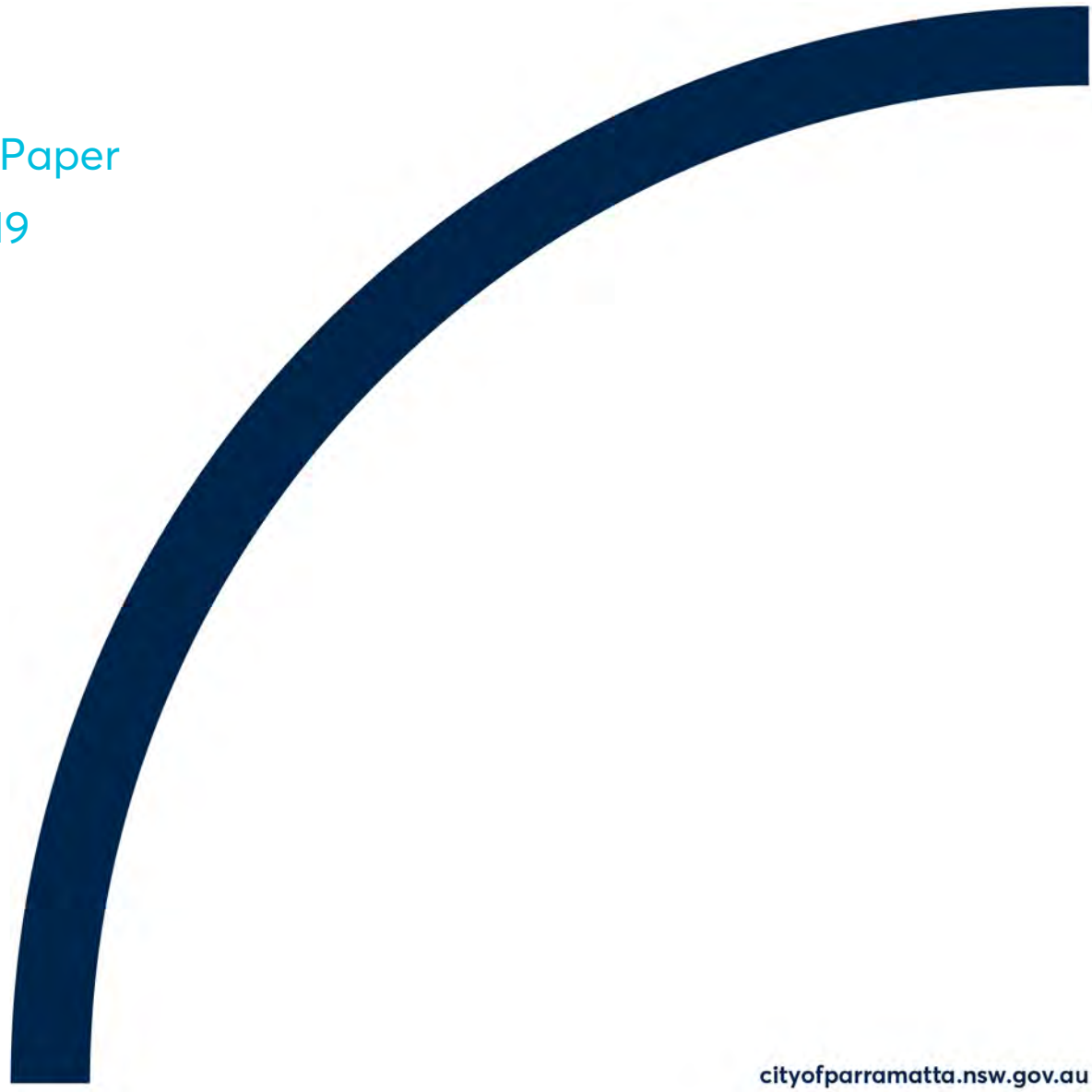
CITY OF PARRAMATTA

Overshadowing in the Parramatta CBD

Technical Paper

6 June 2019



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1. Executive Summary

The Parramatta CBD is anticipated to experience significant growth as part of the review into planning controls within the CBD. Controls within the Draft CBD Planning Proposal – endorsed in April 2016 – has the potential to deliver nearly 50,000 additional jobs and about 20,000 additional dwellings.

The Gateway Determination issued by the Department of Planning and Environment in December 2018 included a series of conditions that required additional work to be undertaken prior to publicly exhibiting the Draft Planning Proposal. Four of these conditions relate to assessing the potential impacts of overshadowing from proposed controls and the protection of sunlight access to key public areas within and around the CBD. In summary, the conditions require:

- an analysis of the potential overshadowing of Experiment Farm which may result from the planning controls (refer to Section 4 of this paper);
- an analysis to inform a sun access protection surface (sun access plane) for the protected area of Parramatta Square between 12-noon and 2:00pm, including consideration of the times of year the proposed controls would apply (refer to Section 5 of this paper);
- an assessment of the cumulative overshadowing from the southern areas of the CBD across nominated Heritage Conservation Areas (HCAs) – namely, Harris Park West, Experiment Farm, Tottenham Road, and South Parramatta (refer to Section 6 of this paper); and
- a comparison of the overshadowing from both the existing and the proposed controls on public open spaces surrounding the CBD (refer to Section 7 of this paper).

Figure 1 - Parramatta CBD viewed from Experiment Farm Reserve. 11 Hassall Street, Parramatta, is the tall apartment tower in the middle of the photo

This technical paper sets out the terms of the conditions issued by the Department; the method used to undertake the analysis and the findings of the technical analysis to address the conditions.

2. The Conditions

The Gateway Determination issued on 13 December 2018 by the Department of Planning and Environment sets out four conditions pertaining to analysing potential overshadowing under the CBD Planning Proposal. These are:

- Condition 1(j)(ii) — *Provide further assessment of the overshadowing impact of the proposed controls on public open spaces surrounding the CBD compared to the existing controls;*
- Condition 1(j)(iii) — *Incorporate an assessment of the potential overshadowing impacts on Experiment Farm that may result from the proposed planning controls (outside the proposed sun access plane of 10am–2pm);*
- Condition 1(j)(iv) — *Provide further analysis to inform a sun access plane for the protected area of Parramatta Square between 12pm and 2pm, including the times of the year that the proposed controls would apply;* and
- Condition 1(k)(ii) — *Carry out an urban design study of the southern interface areas to ensure that excessive cumulative shadow impacts are not created across the northern sections of adjoining heritage conservation areas (HCAs), including the Harris Park [West] HCA, the Experiment Farm HCA, the Tottenham Street HCA and the South Parramatta HCA. These areas should receive a minimum of two hours' direct sunlight between 9am and 3pm at midwinter (21 June). If required, heights and FSRs are to be adjusted accordingly.*

Each of these conditions have been analysed using Council's Geographic Information System (GIS) application. Several assumptions have been applied for the purpose of this analysis and these are discussed in Section 3 of this Paper.

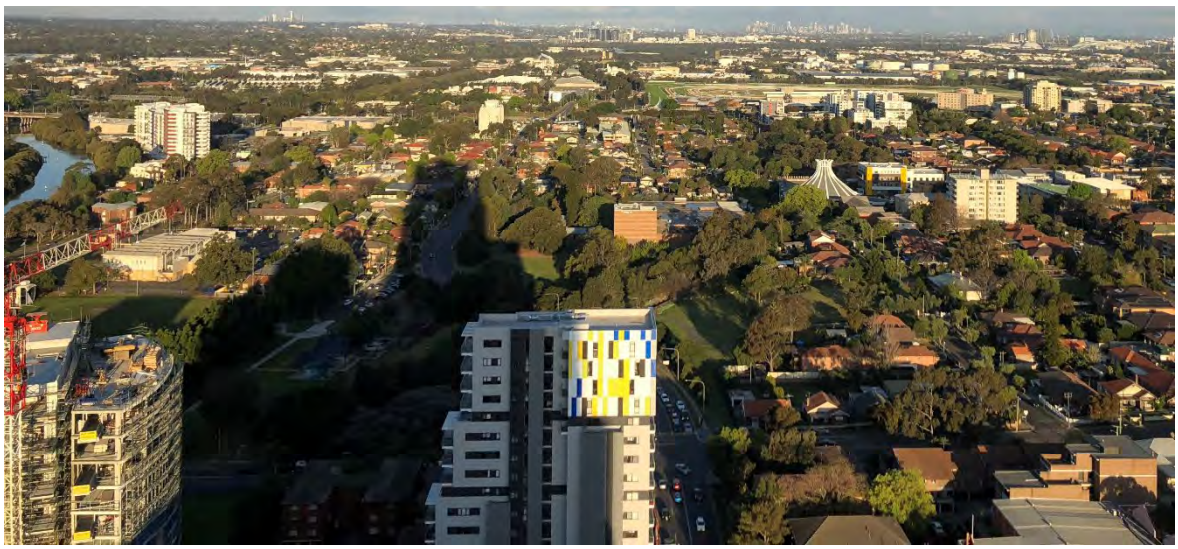


Figure 2 - Overshadowing cast by existing development in the Parramatta CBD. Photo taken from Level 33 at 11 Hassall Street, Parramatta, on 8 October 2018 at 6:15pm (UTC+11).

3. The Assumptions and Setting up the Model

To reliably identify and assess the impacts of potential overshadowing, the GIS model needs to apply some basic assumptions. These are set out and discussed below.

3.1. Establishing and Representing the terrain

Developing and applying a Digital Elevation Model (DEM) to represent approximately the ground level (existing) across the CBD is necessary, as the Parramatta CBD is not flat. Ground level (existing) ranges from about 4m at the Parramatta River to about 40m along the Great Western Highway ridgeline. This DEM represents the terrain, upon which the 3D models and extruded representations of the planning controls will be placed when they are measured from ground level (existing). It is also used to inform the ground level from which the Sun Access Protection surfaces will be generated.

The DEM for the purposes of this analysis adopts a horizontal resolution of 5m × 5m — each "pixel" of the grid is 25sqm in area. Vertical resolution is 1mm. This means that the ground representation is precise enough for modelling at a block or precinct scale. Figure 3 shows the DEM output for the southern half of the Parramatta CBD with a map scale of 1:8,000 @ A4. Figure 4 shows a magnified DEM output at the Church Street railway bridge with a map scale of 1:1,000 @ A4. In Figure 4, the individual "pixels" for each 5m × 5m grid can be clearly seen.

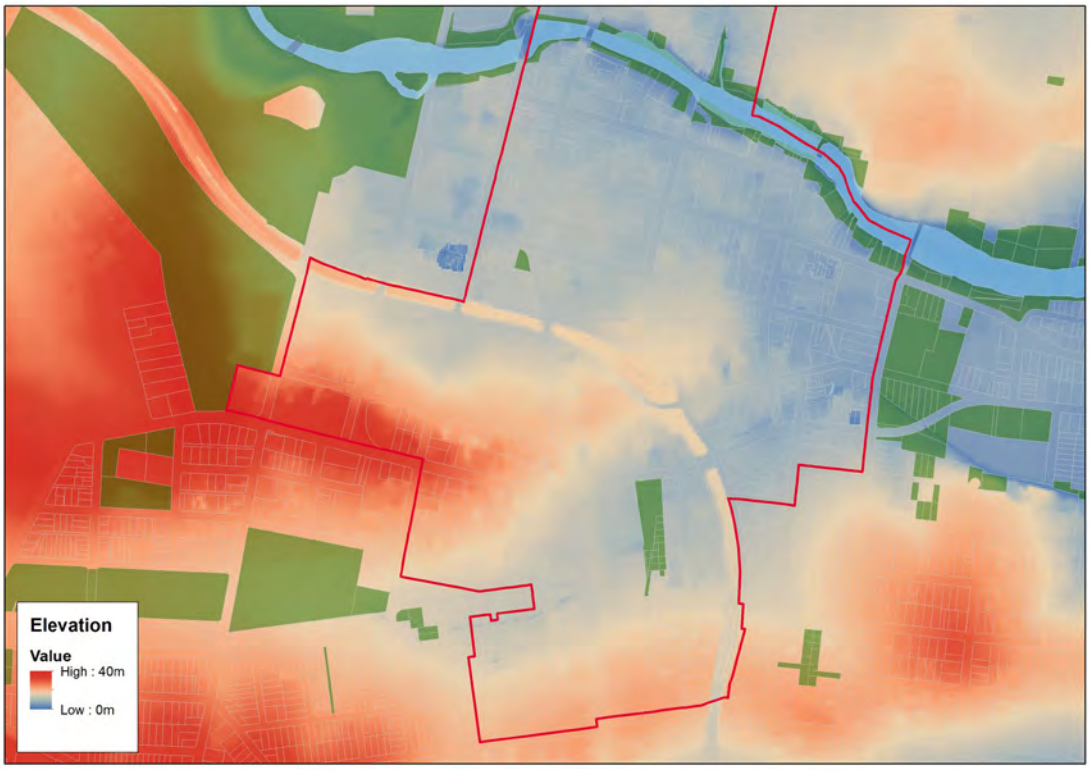


Figure 3 - Digital Elevation Model. Map Scale 1:8,000 @ A4 (scaled to 50% in this document)

Figure 4 - Digital Elevation Model at the Church Street railway overbridge abutment. Note the clear definition of individual 5×5m "pixels" . Map Scale 1:1,000 @ A4 (scaled to 50% in this document)

Note: Ground level (existing) has the same meaning as set out in Parramatta Local Environmental Plan 2011 – and means "the existing level of a site at any point".

3.2. Applying maximum heights to planning controls

Height of Buildings controls for the Parramatta CBD Planning Proposal, and the current Parramatta LEP 2011, are measured in one of two ways:

- The height is measured vertically from ground level (existing) — i.e. the terrain — and will shift vertically in absolute terms because of changes to the terrain; or
- The height is measured vertically from sea level (0m AHD), and does not respond to changes in the terrain. Heights in this case are expressed as Reduced Levels (RLs). RLs are an absolute value, irrespective of the terrain (see Box 1).

Box 1: Expressing and measuring heights as Reduced Levels (RLs)

A Reduced Level (RL) height is always measured from 0m AHD (sea level) for the purposes of expressing the value in planning instruments. Consequently, it will have different measurements from ground level (existing) depending on where the measurement is taken in the CBD. At Parramatta Square, the equivalent height to a 243m (RL) measurement may be 232m above ground (existing) as the terrain at Parramatta Square is about 11m (RL). On the Great Western Highway ridgeline, the equivalent height may be between 200m and 210m above ground level (existing) as the terrain along the ridge is between 30 and 40m (RL).

Land that is proposed to have an Incentive Height of Buildings control applied is measured from ground level (existing). This includes land along Auto Alley; Church Street between Macquarie Street and the Parramatta River; land surrounding significant heritage items such as St Johns Church and cemetery; or land on the edge of the Parramatta CBD within or near heritage conservation areas (HCAs), such as Parramatta North HCA, Sorrell Street HCA, Harris Park West HCA and Experiment Farm HCA.

The CBD Planning Proposal has sizeable areas where an Incentive Height of Buildings control is not applied. Draft provisions prepared for the Planning Proposal refers to airspace operations within Parramatta Local Environmental Plan 2011 where a development cannot intrude into prescribed airspace without the requisite approvals under the *Airports Act 1996* of the Commonwealth. Presently the airspace operations control applies only to nominated sites; but it is to be expanded to apply to the entire Parramatta CBD under the CBD Planning Proposal. This provision effectively caps heights to levels set out in the Radar Terrain Clearance Chart (RTCC) for Sydney Airport – declared 20 March 2015; or the Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) for Sydney Airport or Bankstown Airport, whichever is lower. Under these declared airspaces, any permanent or temporary structures (including cranes) must not penetrate the prescribed surfaces.

Additionally, Condition 1(j)(i) of the Gateway Determination requires Council to liaise with the Civil Aviation Safety Authority (CASA) and the federal Department of Infrastructure, Regional Development and Cities to either determine the maximum mapped height of building that can be applied in the Parramatta CBD or provide further justification for the removal of height controls on unconstrained land.

Consequently, for the purposes of modelling overshadowing under the proposed controls for the Parramatta CBD Planning Proposal, limits on building heights have been applied to land where no maximum Incentive Height of Buildings control is mapped. An explanation of the various heights and the rationale behind their application is set out in Table 1.

To model the impacts of overshadowing to meet the conditions of the Gateway Determination, heights of buildings are applied using these assumptions across all sites within the CBD. Figure 5 illustrates the current Height of Buildings control within Parramatta LEP 2011. Figure 6 illustrates the proposed Incentive Height of Buildings control for the Parramatta CBD Planning Proposal. These controls are used to test the comparison of overshadowing impacts for Conditions 1(j)(ii) and 1(k)(ii).

Maximum Height	Conditions	Remarks
243m (RL)	Applied to land proposed to have an Incentive Floor Space Ratio of 10:1 and is located to the north of the Great Western Highway / Parkes Street, Parramatta.	Measured from sea level (0m AHD) and applies irrespective of the level of the terrain. Based on the Radar Terrain Clearance Chart (RTCC) prescribed airspace for Sydney Airport – declared 20 March 2015.
213m (RL)	Applied to land proposed to have an Incentive Floor Space Ratio of 10:1 and is located to the south of the Great Western Highway / Parkes Street, Parramatta.	Measured from sea level (0m AHD) and applies irrespective of the level of the terrain. Based on the Radar Terrain Clearance Chart (RTCC) prescribed airspace for Sydney Airport – declared 20 March 2015.
92m	Applied to land proposed to have an Incentive Floor Space Ratio of 6:1	Measured from ground level (existing) and follows changes in the terrain. Based on internal urban design advice pertaining to a building height achievable for the density. This height includes the 15% Design Excellence bonus currently adopted. It does not include the 5% bonus for High Performing Buildings (HPB) as the modelling had commenced before this incentive was adopted. However, the variation for the additional 5% equates to about 4m in building height and would not have a material impact on the overshadowing results.

Table 1 - Explanation of height controls applied to land without an Incentive Height of Buildings control

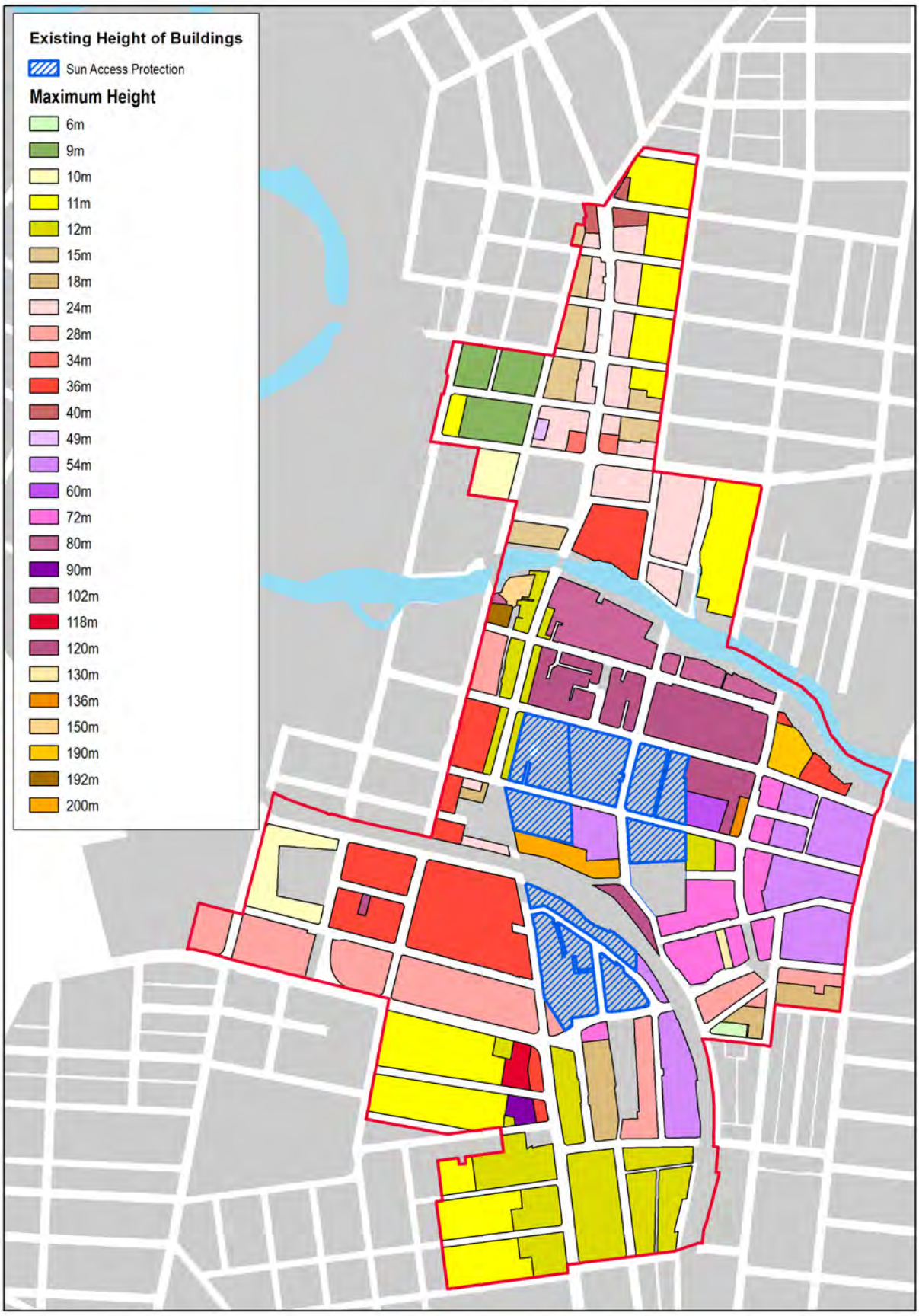


Figure 5 - Existing Height of Buildings control in Parramatta LEP 2011

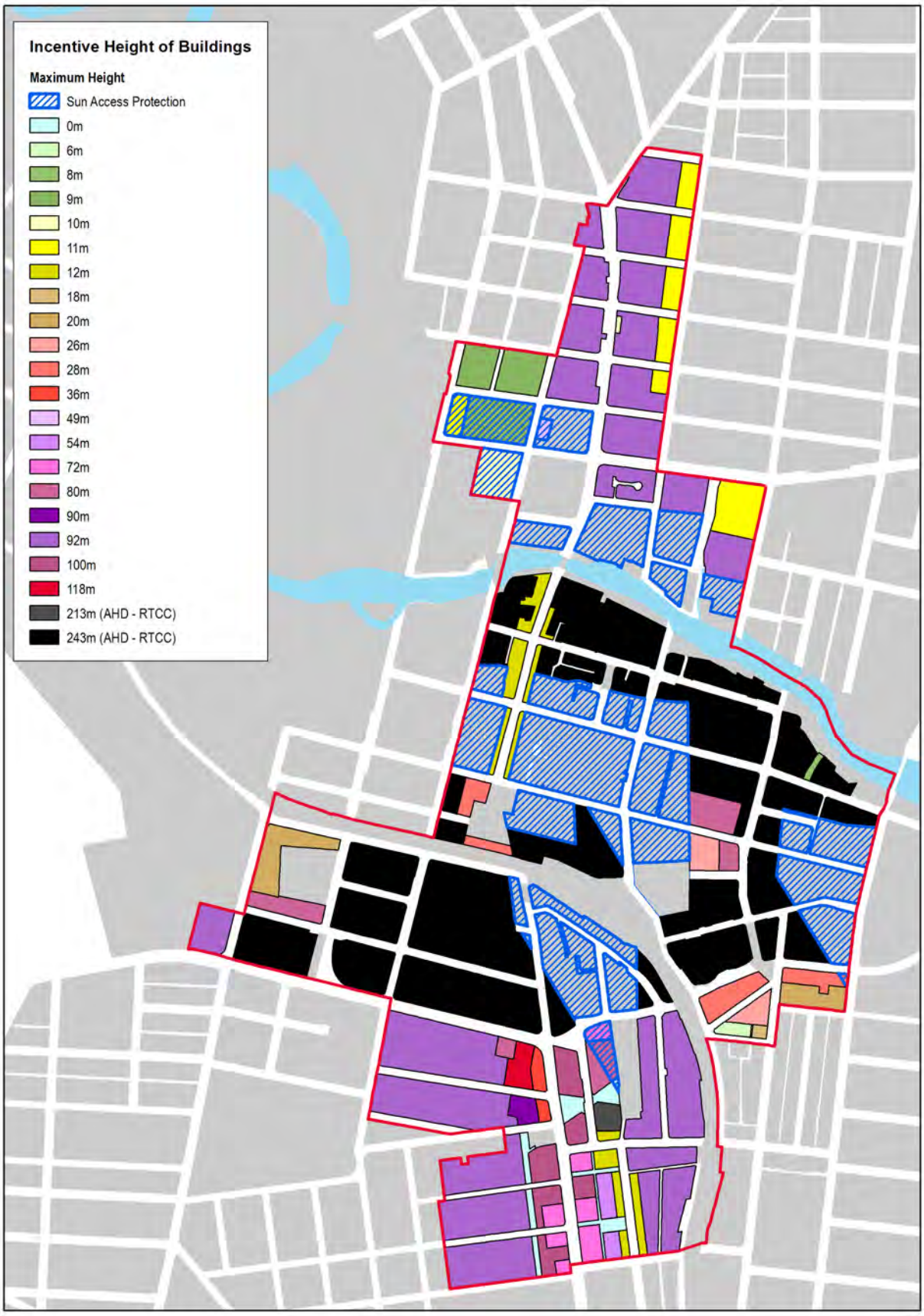


Figure 6 - Proposed Incentive Height of Buildings control under the Parramatta CBD Planning Proposal

3.3. Modelling planning controls

Current and proposed planning controls are extruded as three-dimensional polygons across the full extent of the planning control. This ensures that the coverage of any shadow extent potentially created as the result of an existing or proposed planning control will be modelled in full. It also ensures that Council is complying with the terms of the Gateway conditions, which explicitly refers to assessing the impacts of height controls for overshadowing. Extruding planning controls for the purposes of this modelling also assumes that a future building may be located anywhere within the extent of the planning control. Detailed considerations such as individual building design, articulation and architectural form as well as separation between buildings will likely modify the extent of any overshadowing.

Figure 7 shows the extruded form of the proposed Incentive Height of Buildings controls under the Parramatta CBD Planning Proposal. Height controls have been applied to land which, presently, does not have a maximum Incentive Height of Buildings control for the purposes of enabling overshadowing modelling to occur. These assumptions are discussed in Section 3.2.

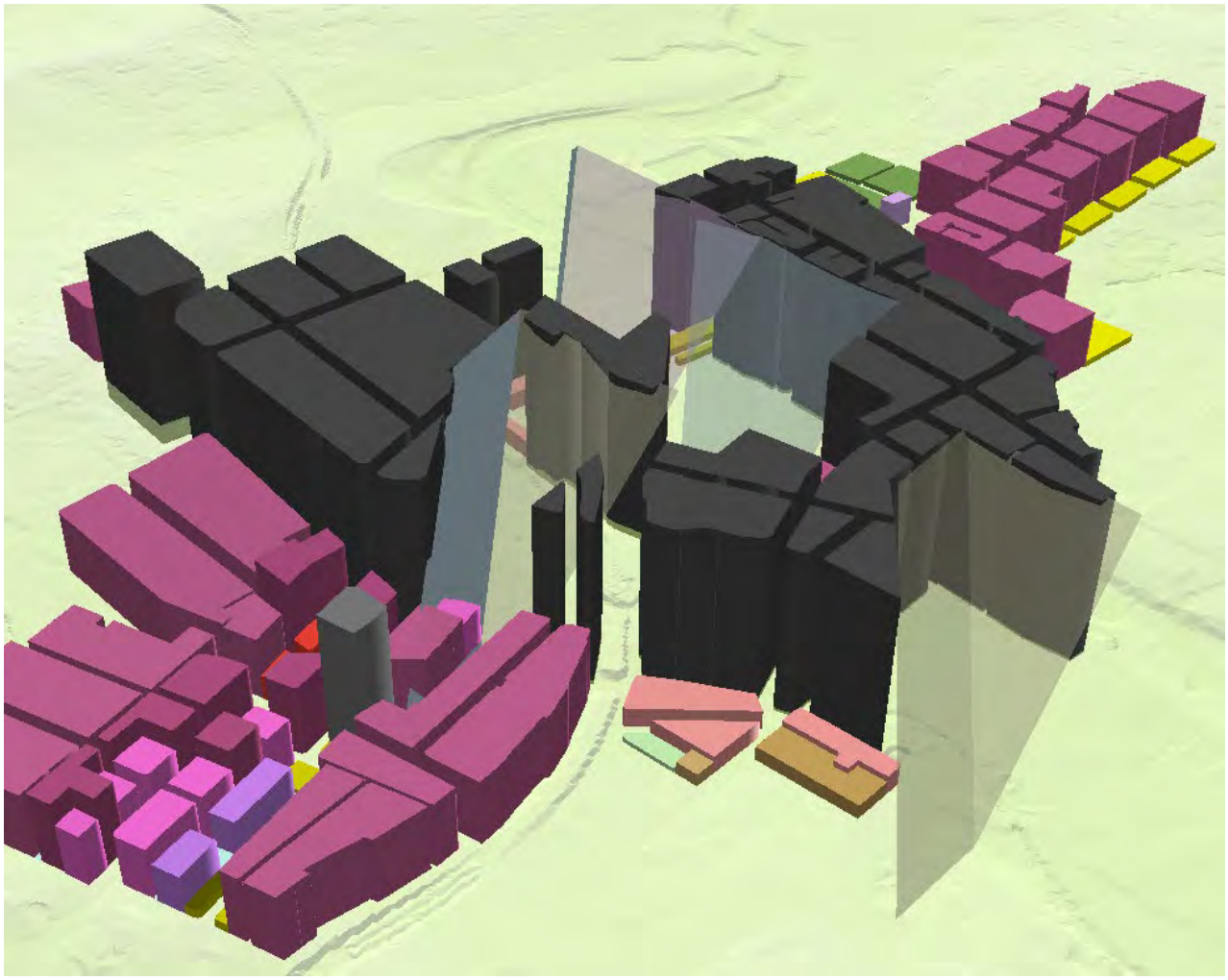


Figure 7 - Extruded representation of the Incentive Height of Buildings Control as 3D polygons. Grey and block polygons are measured as an RL from 0m AHD; other polygons measured from the terrain. Sun Access Protection surfaces included for illustration only.

3.4. Applying the period of the year and time of the day

The modelling adopts dates for the purposes of determining overshadowing throughout the year as set out in Table 2.

Period	Date
Mid-summer	21 December
Autumn equinox	21 March
Nominated date to avoid daylight saving in Autumn*	14 April
Mid-winter	21 June
Nominated date to avoid daylight saving in Spring*	31 August
Spring equinox	23 September

* Nominated dates are consistent with those used by the City of Sydney for the No Additional Overshadowing control, as per Clause 6.19 of *Sydney Local Environmental Plan 2012*.

Table 2 - Selected dates for overshadowing modelling

While most analysis would be applied on 21 June (mid-winter), the assessment needed for Parramatta Square under condition 1(j)(iv) requests analysis using dates outside just mid-winter – for example, autumn to spring equinox; or nominated dates consistent with the City of Sydney's No Additional Overshadowing control; or year-round.

The period of the day being assessed in the modelling also varies depending on the objective to be addressed in the Gateway Determination condition. These are set out in Table 3 and adopt 30-minute intervals across the nominated times. A reference to "UTC" means a reference to Co-ordinated Universal Time and is a time standard adopted globally. NSW Standard Time and NSW Summer Time are time zones under the *Standard Time Act 1987* where NSW Standard Time is 10 hours ahead of Co-ordinated Universal Time (i.e. UTC+10) and NSW Summer Time is one hour ahead of NSW Standard Time (i.e. UTC+11).

Assessment	Time period
Impacts on public open space areas surrounding the CBD (condition 1(j)(ii))	9am to 3pm
Impacts on Experiment Farm and curtilage (condition 1(j)(iii)	10am to 4.30pm (near sunset)
Impacts on Parramatta Square protected area (condition 1(j)(iv))	12-noon to 2pm*
Impacts on nominated heritage conservation areas surrounding the CBD (condition 1(k)(ii))	9am to 3pm
* Depending on the extent of the year being assessed, this period will cover both NSW Standard Time (UTC+10) or NSW Summer Time (UTC+11).	

Table 3 - Selected times of the day for overshadowing modelling

3.5. Constructing the shadows

Constructing the shadows uses the Sun Shadow Volume geoprocessing tool within Council's GIS applications (ArcMap and ArcScene). This geoprocessing tool calculates the extent of any shadows using the angle of inclination to the sun (the altitude) and the direction or bearing to the sun (the azimuth) for the selected times of the day and days of the year.

The length of the shadow depends on the time of day and the day of the year. In simple terms, the higher the sun is in the sky, the shorter the shadow cast by an object will be. Figure 8 compares two times of the same day – 9am and 12-noon – and how the shadow is theoretically constructed. Figure 9 compares the same time of day – 12-noon – on different days of the year (i.e. mid-summer versus mid-winter).

Figure 10 illustrates how the angle of inclination to the sun changes between 9am and 3pm on key dates of the year – mid-summer, mid-winter, and the autumn and spring equinoxes. This figure shows that the angle to the sun is highest between 12-noon and 1pm. The figure also shows that the highest angle of the sun on mid-winter (21 June) is *lower* than at any time between 9am and 3pm on the spring equinox (23 September) or mid-summer (21 December). For this reason, mid-winter is usually adopted to test the greatest extent of overshadowing from development as the shadows will be the longest.

Figure 11, Figure 12 and Figure 13 illustrate examples of the Sun Shadow Volume output for the Incentive Height of Buildings controls under the Parramatta CBD Planning Proposal at 9am, 12-noon and 3pm respectively on 21 June 2018.

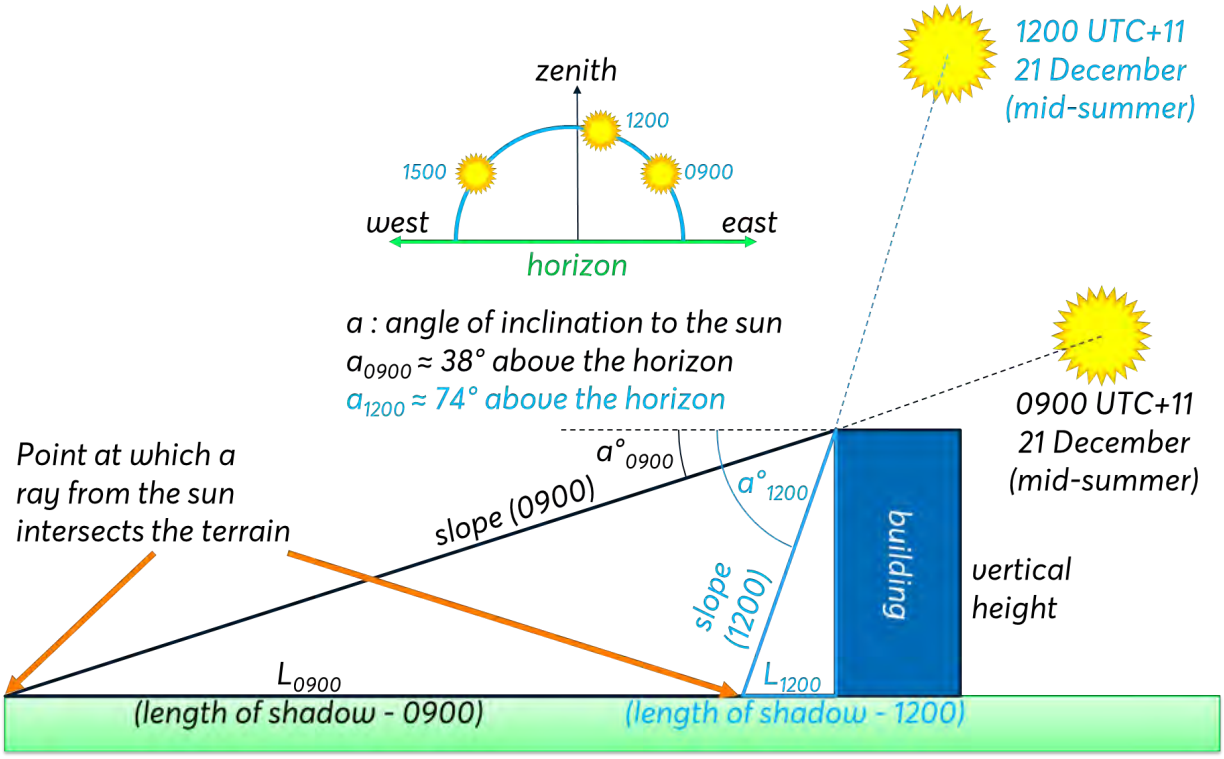


Figure 8 - Sun shadow comparison between 9am and 12-noon on 21 December (mid-summer)

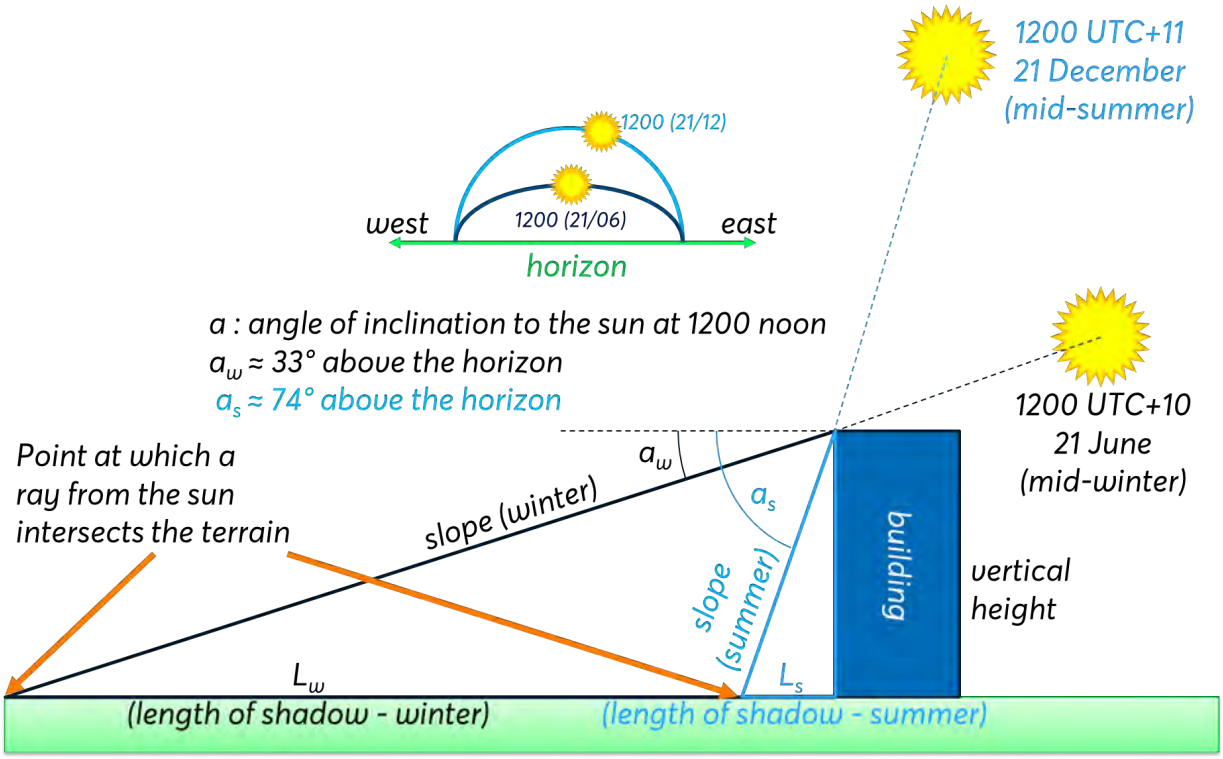


Figure 9 - Sun shadow comparison at 12-noon on 21 December (mid-summer) and 21 June (mid-winter)

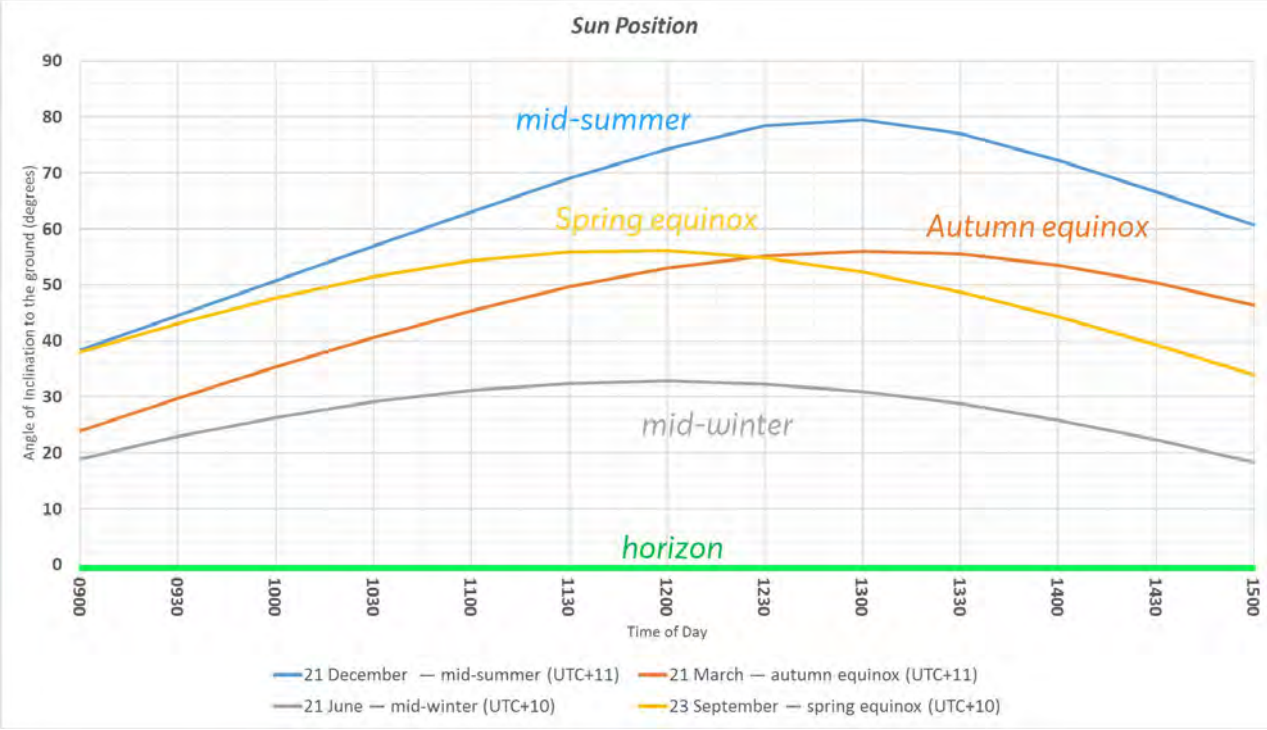


Figure 10 - Sun's angle of inclination to the ground between 9am and 3pm

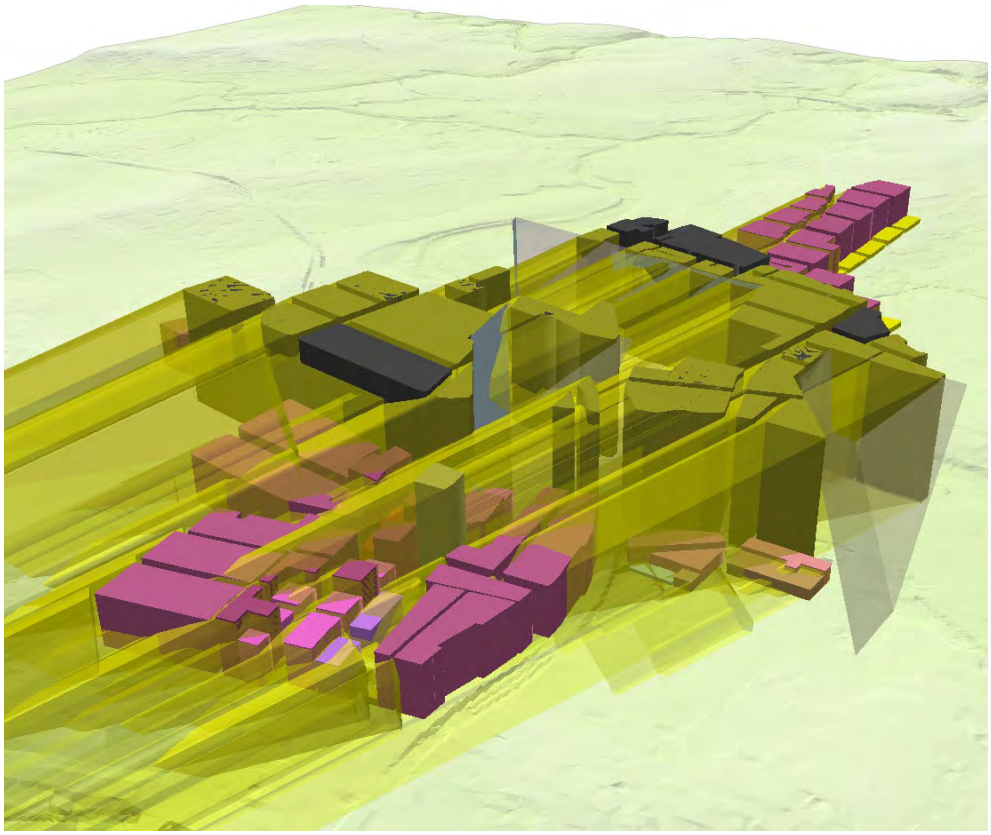


Figure 11 - Sun Shadow Volume output at 9am on 21 June

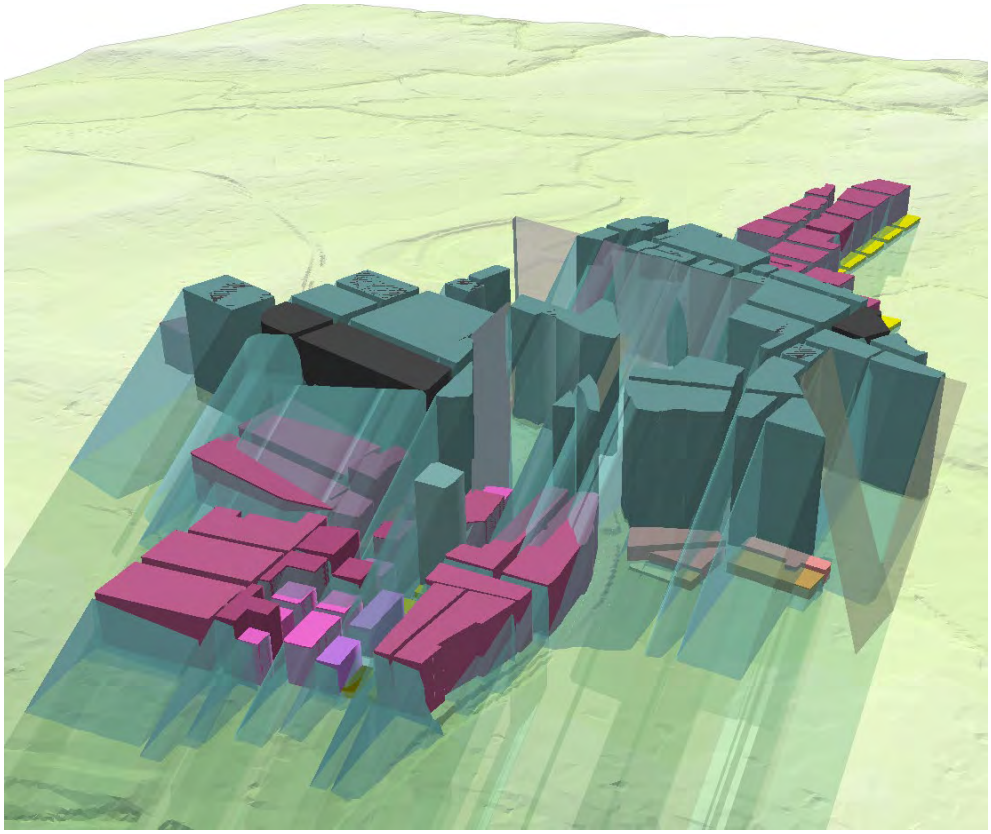


Figure 12 - Sun Shadow Volume output at 12-noon on 21 June

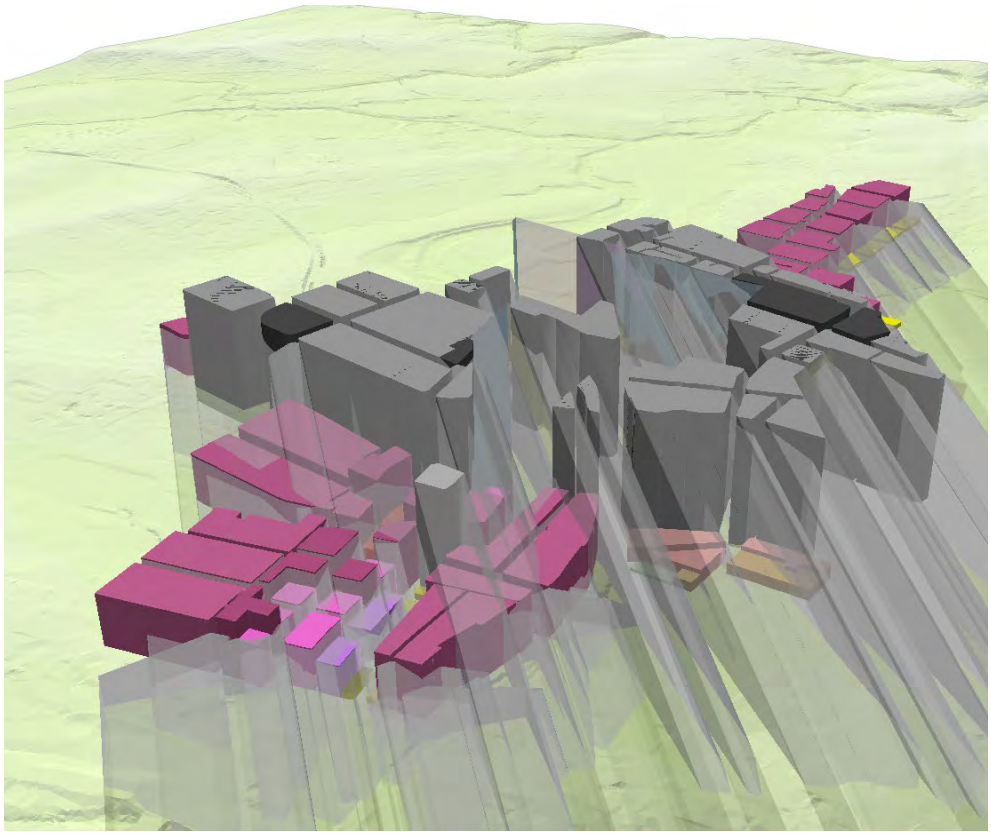


Figure 13 - Sun Shadow Volume output at 3pm on 21 June

4. Assessing Overshadowing of Experiment Farm

4.1. Introduction

This section of the Technical Paper sets out the findings of analysis on the options of overshadowing of Experiment Farm cottage and its immediate curtilage. This assessment is undertaken to address Condition 1(j)(iii) - *Incorporate an assessment of the potential overshadowing impacts on Experiment Farm that may result from the proposed planning controls (outside the proposed sun access plane of 10am–2pm)* – of the Gateway Determination.

Hector Abrahams Architects, when undertaking a heritage study of interface areas to the Parramatta CBD and surrounding conservation areas or significant items, identified a Protected Area for Experiment Farm and its curtilage and recommended that the "*Building and garden of Experiment Farm Cottage should have no additional overshadowing as a result of Parramatta CBD development. This applies throughout the day and is not limited by any time restrictions*" (Section 4.2.12, page 49). Council's response to this recommendation, which was adopted on 10 July 2017, supported this recommendation in part by amending the Draft CBD Planning Proposal to protect solar access to Experiment Farm between 10am and 2pm mid-winter. Council's response to the recommendation noted that protecting solar access beyond 2pm late into the afternoon would have significant adverse impacts on building height, and any consequent development yield, in the Parramatta CBD. This would be due to the significant elongation of any Sun Access Protection surface from Experiment Farm resulting from the low angle of inclination to the sun, particularly after 4pm.

4.2. Analysis Method

The method to assess options to address the Gateway Determination condition involves constructing a series of three-dimensional planes starting from ground level (existing) on the northern, eastern and western edges of the Protected Area to the maximum height within the CBD of 243m (RL). The topography for the Experiment Farm cottage slopes generally downward from the south-east to the north-west. Consequently, multiple height values — ranging between 8.6m (RL) and 18.8m (RL) — were applied at various vertices and corners of the property to ensure an accurate representation of the height of ground level (existing) across the site. Figure 14 shows the coordinates and elevation used for the control points to construct the Sun Access Protection planes and surface for Experiment Farm to take account of the changes in topography.

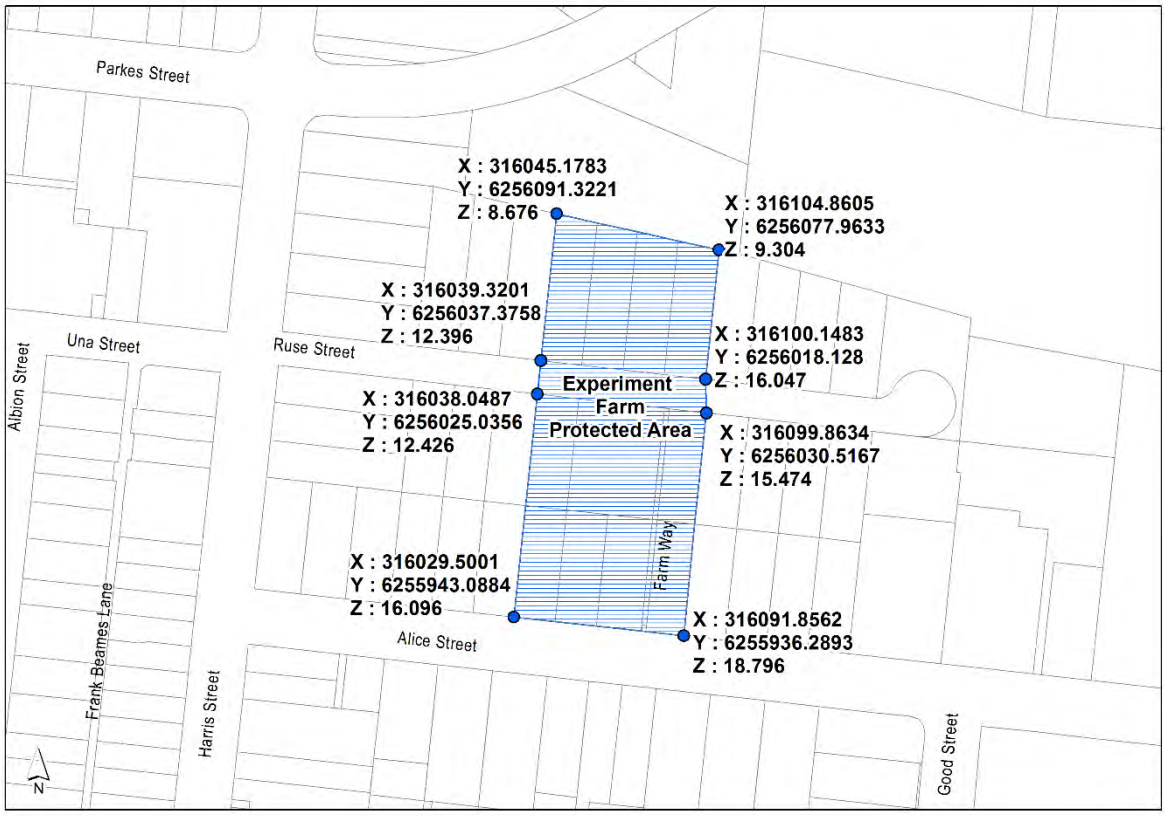


Figure 14 - Control points and X/Y/Z coordinates to determine sun access protection planes and surface for Experiment Farm. X/Y coordinates use Map Grid of Australia (MGA) 1994 Zone 56 projection. Z coordinates use the Australian Height Datum (AHD) and are measured in m(RL).

Details to determine the bearing (azimuth) and the angle of inclination (altitude) to the sun at nominated dates and times were obtained from the Sun and Moon Azimuth and Elevation on-line calculator provided by Geoscience Australia (source: *http://www.ga.gov.au/geodesy/astro/smpos.jsp*). Latitude and longitude coordinates for Parramatta were obtained using this on-line calculator and references the National Gazetter of Australia — and were set at latitude 33° 48′ S and longitude 151° 0′ E.

The vertical height to be determined from each control point is the difference between 243m (RL) and the Z-value representing ground level (existing), which is also expressed as an RL. For example, the vertical height calculated for the north-western control point (X: 316,045.1783; Y: 6,256,091.3221; Z: 8.676) is 234.324m (i.e. 243m – 8.676m).

Figure 15 shows the planes constructed for 30-minute intervals between 10am and 4:30pm on 21 June 2018. Times of the day before 10am were not modelled as these are not impacted by development in Parramatta CBD. Planes for 5pm were also not modelled as sunset on 21 June occurs at around 4:55pm, based on Geoscience Australia's on-line calculator for sunrise and sunset times (source: *http://www.ga.gov.au/geodesy/astro/sunrise.jsp*), and the sun would be below the horizon at 5pm.

The outer extremities of the planes are then joined together to form a surface that covers the nominated period for protection. Figure 16 and Figure 17 shows two Sun Access Protection Surfaces created using the planes from Figure 15 after connecting the outer extremities of these planes together. This technique is known as creating a "convex hull". In the example for Figure 16, the extent of coverage is between 10am and 2pm, consistent with Council's currently adopted position. In the example for Figure 17, the extent of coverage is modelled to provide sunlight access protection to the Experiment Farm Protected Area between 10am and 4:30pm on 21 June – effectively "all-day" protection.

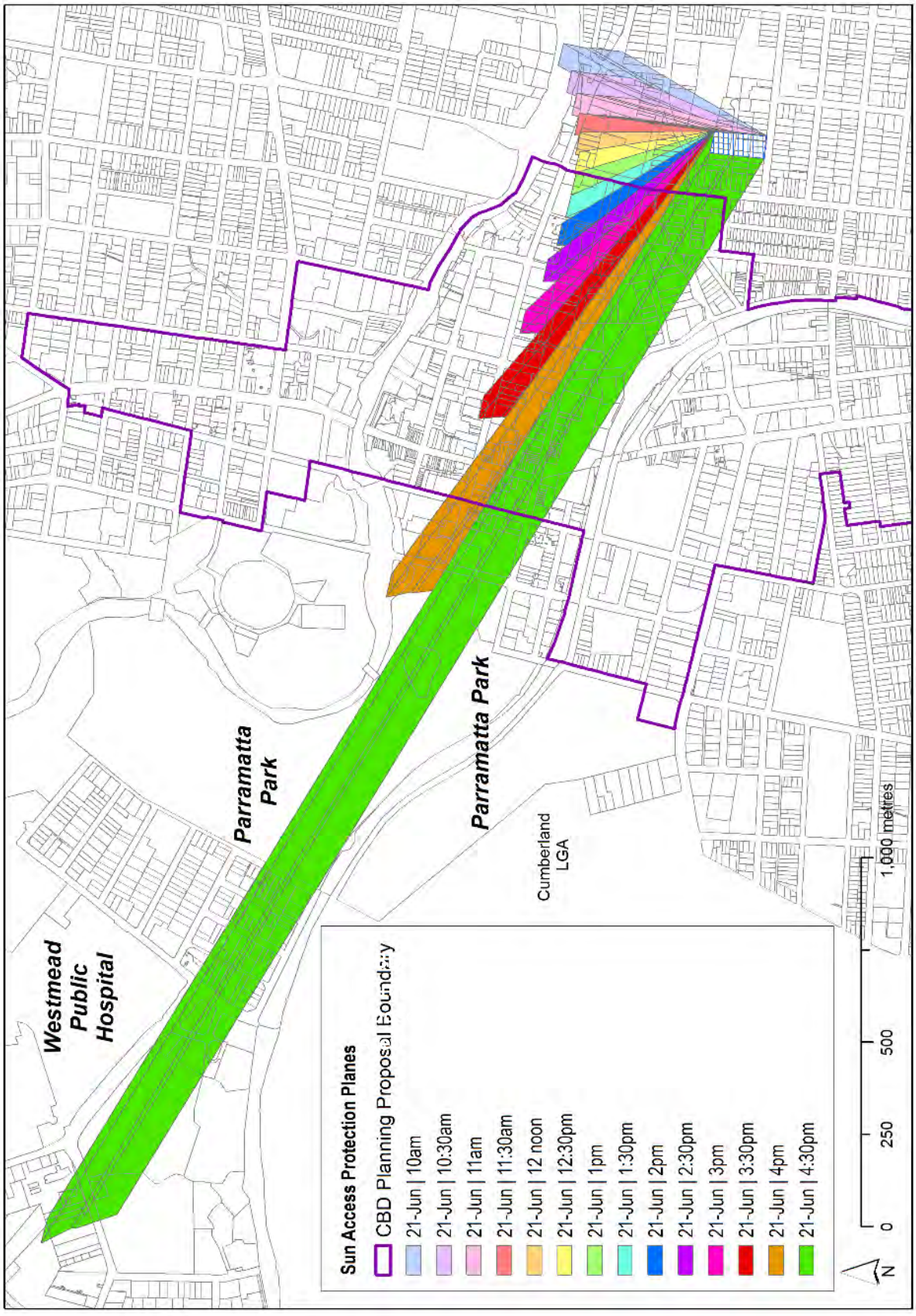


Figure 15 - Sun Access Protection Planes in Plan View for the Experiment Farm Protected Area on 21 June between 10am and 4:30pm. All times are UTC+10

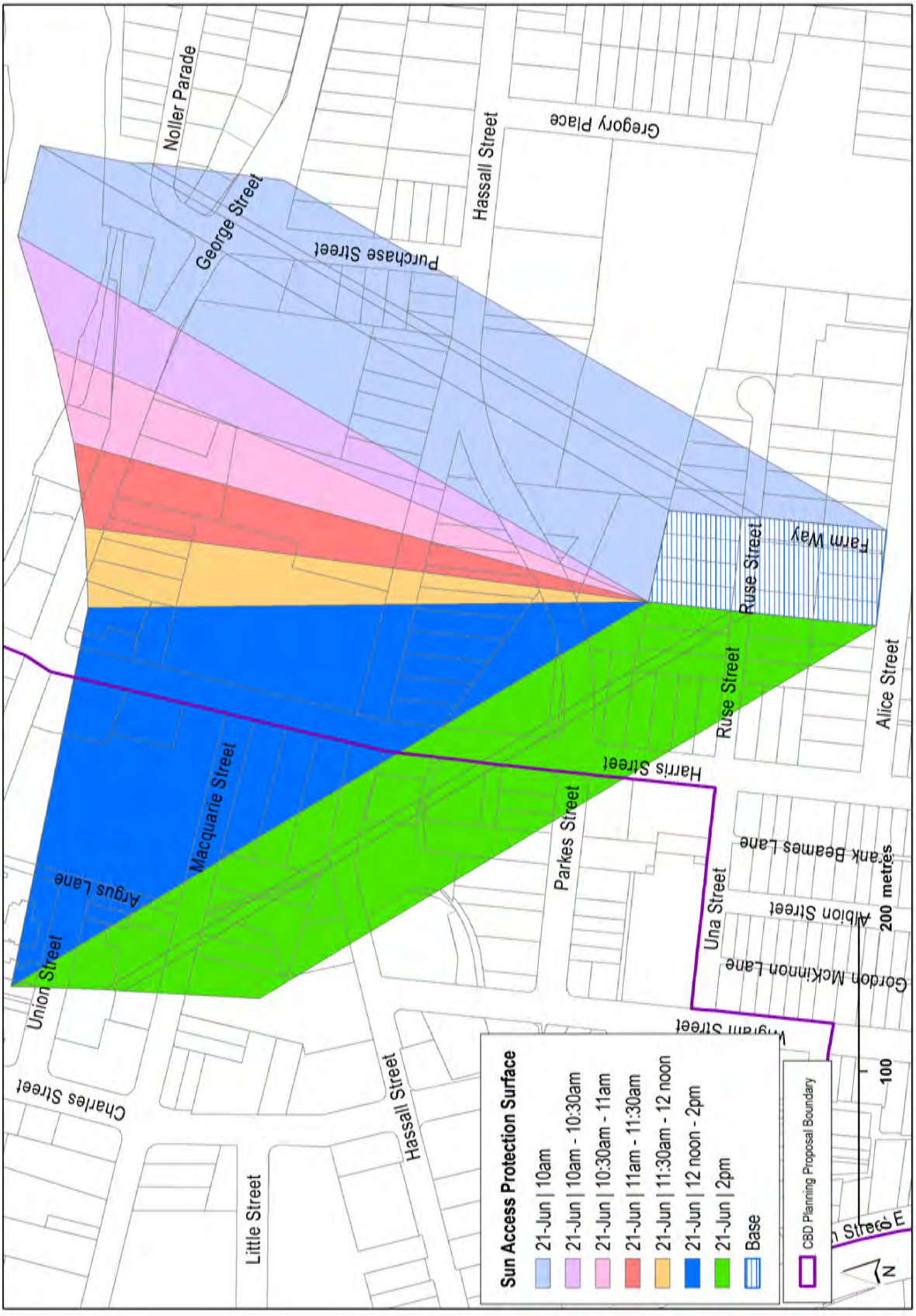


Figure 16 - Sun Access Protection Surface in Plan View for the Experiment Farm Protected Area on 21 June between 10am and 2pm. All times are UTC+10

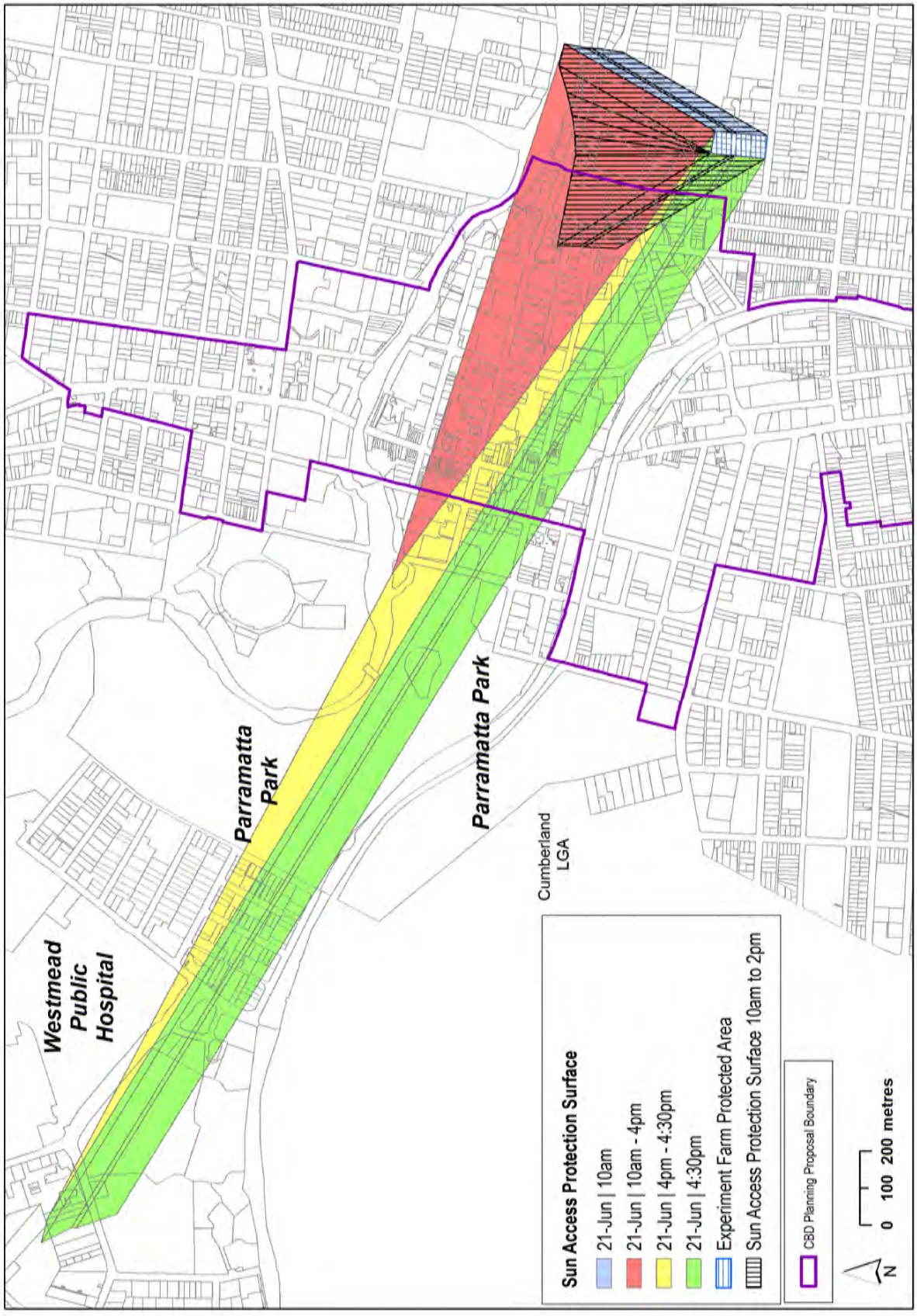


Figure 17 - Sun Access Protection Surface in Plan View for the Experiment Farm Protected Area on 21 June between 10am and 4:30pm compared with surface for 10am and 2pm (black hatched). All times are UTC+10

Figure 18 - Sun Access Protection Surface for Experiment Farm with elevation values

4.3. Impact Analysis of the Extended Protection Period beyond 10am to 2pm.

The impact of an "all-day" Sun Access Protection surface from Experiment Farm on the Parramatta CBD is significant. An area across the entire CBD between the railway line to the south and Phillip Street to the north will be captured by this proposed surface. The angle of inclination to the sun in the late afternoon ranges between 18.2° at 3pm to 3.9° above an ideal horizon at 4:30pm. The length of the western-most surface, as measured on the ground, ranges between 3.3km and 3.6km – putting the top edge of the surface at 243m (RL) near Westmead Private Hospital. A 4pm edge extends across the entire CBD to end at Parramatta Park (about 1.4km to 1.5km from Experiment Farm).

Scenario 21 June (mid-winter)	Parcels impacted	Comparison to base case
10am to 2pm – base case	36	
10am to 3pm	77	+41 parcels
10am to 4pm	213	+177 parcels
10am to 4:30pm	241	+205 parcels

Table 4 - Land parcels potentially impacted by Experiment Farm Sun Access Protection surfaces

It is worth noting that existing development already penetrates this surface with multiple buildings on the eastern side of the CBD casting a shadow over Experiment Farm in the late afternoon. Sites include the Sydney Water Headquarters in Smith Street, NSW Police Headquarters in Charles Street, 11 Hassall Street, 14 Hassall Street, 13-15 Hassall Street, and 24 Parkes Street. Development that is under construction near completion that will penetrate the late afternoon parts of the surface includes 4 Parramatta Square and 113-117A Wigram Street. Consequently, any perceived benefit of an "all-day" Sun Access Protection surface to Experiment Farm will already be compromised by existing development.

4.4. Implications of applying the Surface beyond 2pm on 21 June.

The implications of applying a Sun Access Protection surface beyond 2pm on 21 June are significant to future development within the Parramatta CBD due to:

- The number of additional land parcels impacted by an extended protection surface, particularly late in the afternoon;
- The limited height of buildings possible under the 4:30pm surface – which will range from 10-20m (RL) on the eastern side of the CBD to a maximum of 80-90m (RL) on the western side of the CBD near Marsden Street. This limitation of height controls will have major impacts on potential commercial and residential yield within the CBD.
- The benefit of an extended surface into the late afternoon will already be compromised by existing development – including development currently under construction or constructed within the last 10 years that is unlikely to be renewed in the foreseeable future.

4.5. Conclusions and Recommendation

There are two avenues for considering the protection of sunlight access to the Experiment Farm cottage and immediate curtilage identified by Hector Abrahams Architects from the analysis conducted:

- Maintain the currently adopted position to protect sunlight access for the period 10am to 2pm on 21 June (mid-winter). This will meet at a minimum the condition of the Gateway Determination. In terms of land coverage and protection, this option has the greatest initial benefit as no Sun Access Protection surface currently applies to Experiment Farm. The Draft CBD Planning Proposal was

amended following the resolution by the Administrator on 10 July 2017 to include a Sun Access Protection surface to Experiment Farm applying between 10am and 2pm on 21 June. Extending the protection before 10am have no impact on development within the CBD itself due to any additional surface facing the east, and therefore is of little benefit. Extending the protection beyond 2pm has major impacts on existing and potential development, particularly in the eastern parts of the CBD where height controls would need to be significantly reduced to fit under the limitations of the surface.

- Extend coverage of the Sun Access Protection surface to apply beyond 2pm on 21 June to 4:30pm. This extension effectively provides "all-day" protection to Experiment Farm from development in the CBD. However, it will significantly impact on the capability of the CBD to deliver opportunities for jobs and achieve the direction of Sydney's "Central City" due to height constraints imposed by the surface in the late afternoon. Accordingly, this option is not supported.

It is recommended that the currently adopted position of protecting sunlight access to Experiment Farm between 10am and 2pm on 21 June (mid-winter) is maintained for the purposes of addressing Condition 1(j)(iii) of the Gateway Determination.

Extension of the surface to 4:30pm on 21 June to meet the recommended "all-day" condition from Hector Abrahams Architects is not supported because such a surface would overly restrict building heights within a substantial corridor of the CBD and would already be penetrated by existing development.

5. Assessing Overshadowing of Parramatta Square

5.1. Introduction

This section of the Technical Paper sets out the findings of analysis on the options of overshadowing for the Parramatta Square Protected Area. This assessment is undertaken to address Condition 1(j)(iv) - *Provide further analysis to inform a sun access plane for the protected area of Parramatta Square between 12pm and 2pm, including the times of the year that the proposed controls would apply* – of the Gateway Determination.

Parramatta Local Environmental Plan 2011 defines the Parramatta Square No Additional Overshadowing area (the Protected Area) on the Sun Access Protection Map (Figure 19). The purpose of the Protected Area is to ensure sunlight access to the major civic open space and public plaza component of Parramatta Square, a significant office urban renewal precinct within Parramatta CBD, during lunchtime periods where the plaza will provide outdoor eating opportunities for thousands of workers within the Parramatta Square precinct. The Protected Area applies to approximately 50 per cent of the entire civic open space and public plaza area.

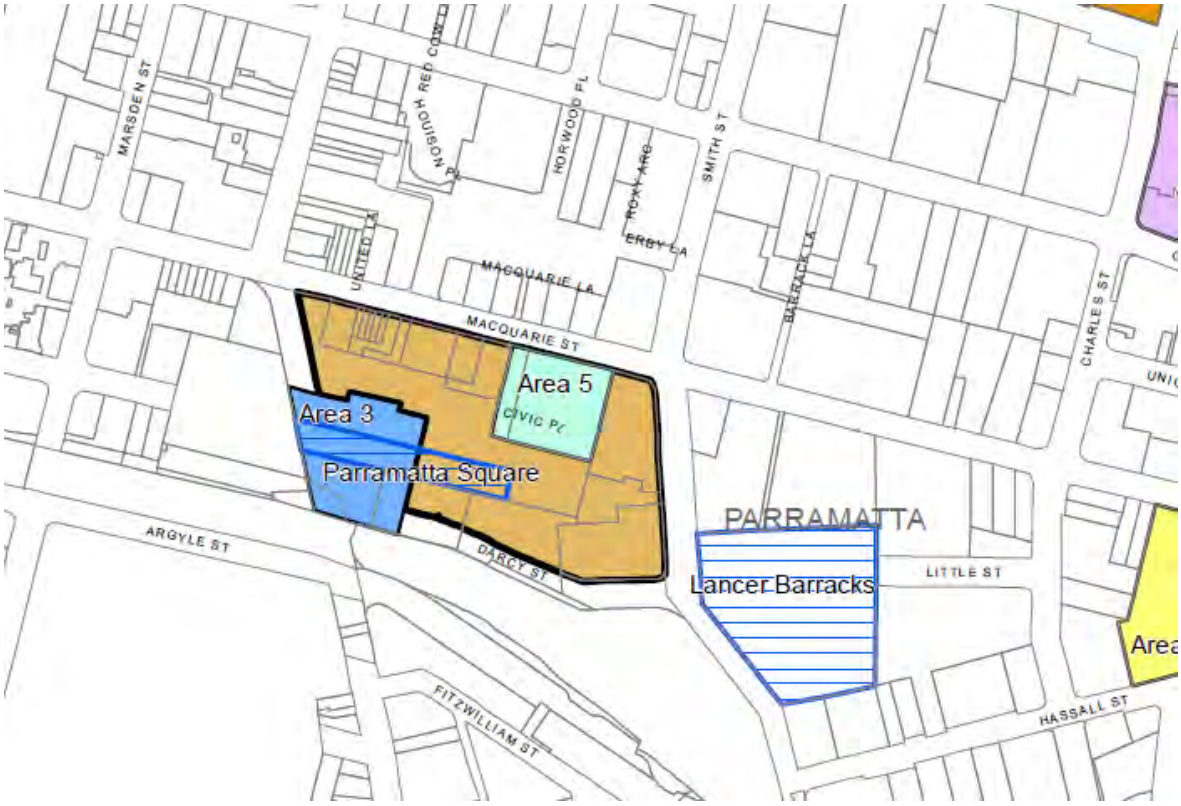


Figure 19 - Parramatta Square Protected Area (No Additional Overshadowing) – Extract from the Sun Access Protection Map of Parramatta Local Environmental Plan 2011. The Protected Area is shown in blue hatching.

5.2. Analysis Method

The method to assess options to address the Gateway Determination condition involves constructing a series of three-dimensional planes starting from ground level (existing) — 11m (RL) — on the northern, eastern and western edges of the Protected Area to the maximum height within the CBD of 243m (RL). Determining the bearing (azimuth) and the angle of inclination to the sun at nominated dates and times were obtained from the Sun and Moon Azimuth and Elevation on-line calculator provided by Geoscience Australia (source: *http://www.ga.gov.au/geodesy/astro/smpos.jsp*). Latitude and longitude coordinates for Parramatta were obtained using this on-line calculator and references the National Gazetter of Australia — and were set at latitude 33° 48′ S and longitude 151° 0′ E.

Figure 20 shows the planes constructed for 30-minute intervals between 12-noon and 2pm on the nominated dates. In the circumstances unique to Parramatta Square, an additional date and time – 21 May at 2pm – was included for assessment due to the Protected Area's east-west orientation. When assessing overshadowing for Parramatta Square outside the period of 12-noon to 2pm on 21 June (mid-winter), 2pm on 21 May (coloured golden orange on Figure 20, below) was identified as an outlier between 21 June (coloured brown) and the nominated dates of 31 August (coloured peppermint green) and 23 September (coloured blood orange). Consequently, 2pm on 21 May was included as an additional date and time for the purposes of developing Sun Access Protection Plane and Surfaces for Parramatta Square for periods outside of 21 June (mid-winter).

The outer extremities of the planes are then joined together to form a surface that covers the nominated period for protection. Figure 21 shows the Sun Access Protection Surface created using the planes from Figure 20 after connecting the outer extremities of these planes together. This technique is known as creating a "convex hull". In the example for Figure 21, the extent of coverage is modelled to provide year-round sunlight access protection to the Parramatta Square Protected Area.

Figure 20 - Sun Access Protection Planes for Parramatta Square in plan view

Figure 21 - Sun Access Protection Surface for Parramatta Square showing year-round protection in plan view

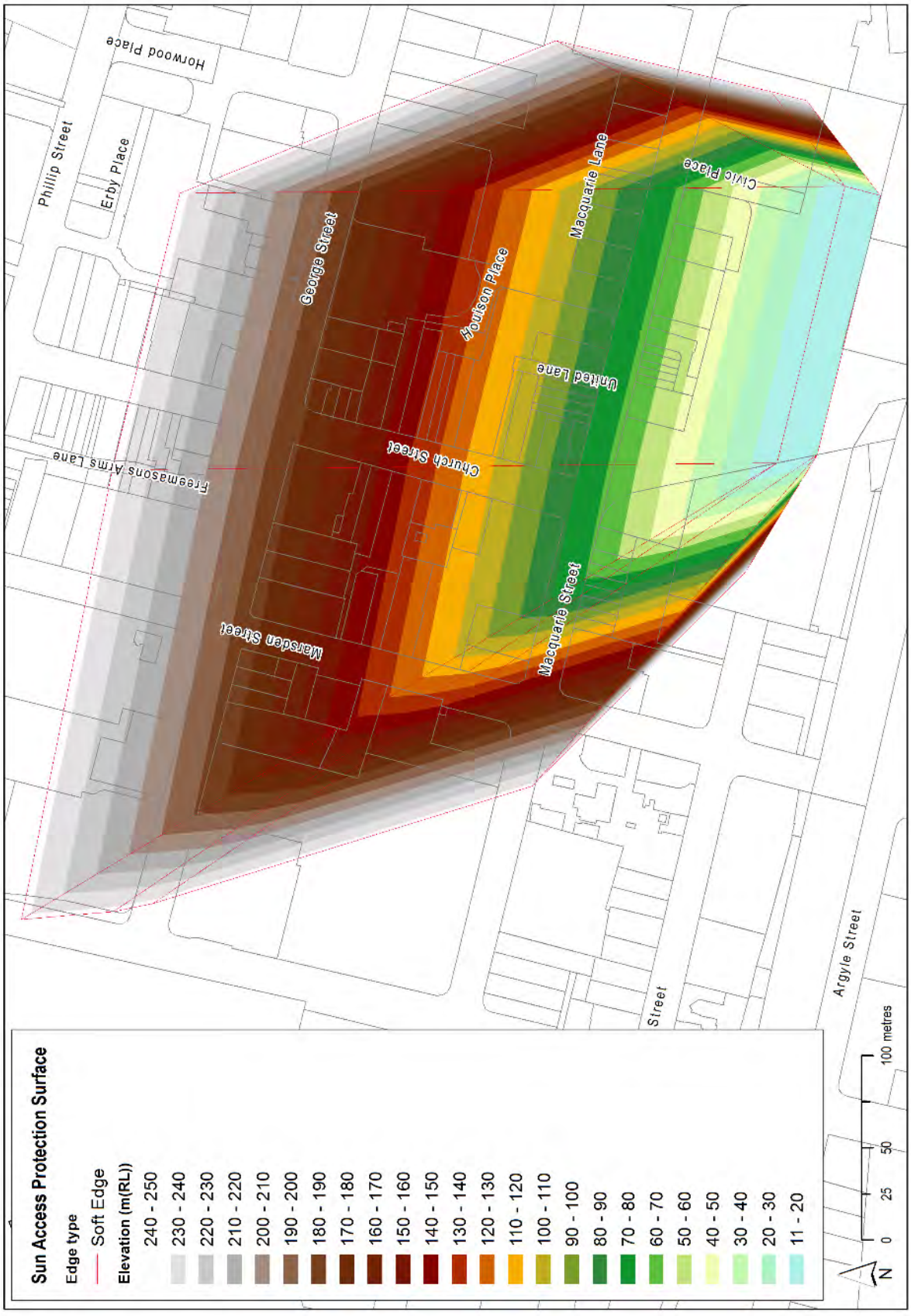


Figure 22 - Sun Access Protection Surface for Parramatta Square with elevation values

It is to be noted that Sun Access Protection surface will not affect development subject to existing planning controls west of Marsden Street, as (a) these controls will not be changed under the Parramatta CBD Planning Proposal; and (b) the existing controls are lower than the elevation of the Sun Access Protection surface. The lowest elevation of the surface on land west of Marsden Street is between 120m and 130m (RL) – or about 110m to 120m above ground (existing) – as shown in Figure 22. Current planning controls applying to land west of Marsden Street that would be subject to the Sun Access Protection surface have a maximum building height of 54m.

5.3. Impact Analysis of the Surface options.

Four scenarios to evaluate the impacts by the proposed protection surface from Parramatta Square are identified. The base hours to require sunlight access to the Protected Area have been kept at 12-noon to 2pm; and the assessment considers impacts for various periods of the year. The following periods have been identified for assessment:

- 12-noon to 2pm on 21 June (mid-winter) only (see Figure 23);
- 12-noon to 2pm for the period 14 April to 31 August (see Figure 24);
- 12-noon to 2pm for the period 21 March (autumn equinox) to 23 September (spring equinox) (see Figure 25); and
- 12-noon to 2pm for the period 21 December to 21 December (year-round) (see Figure 26).

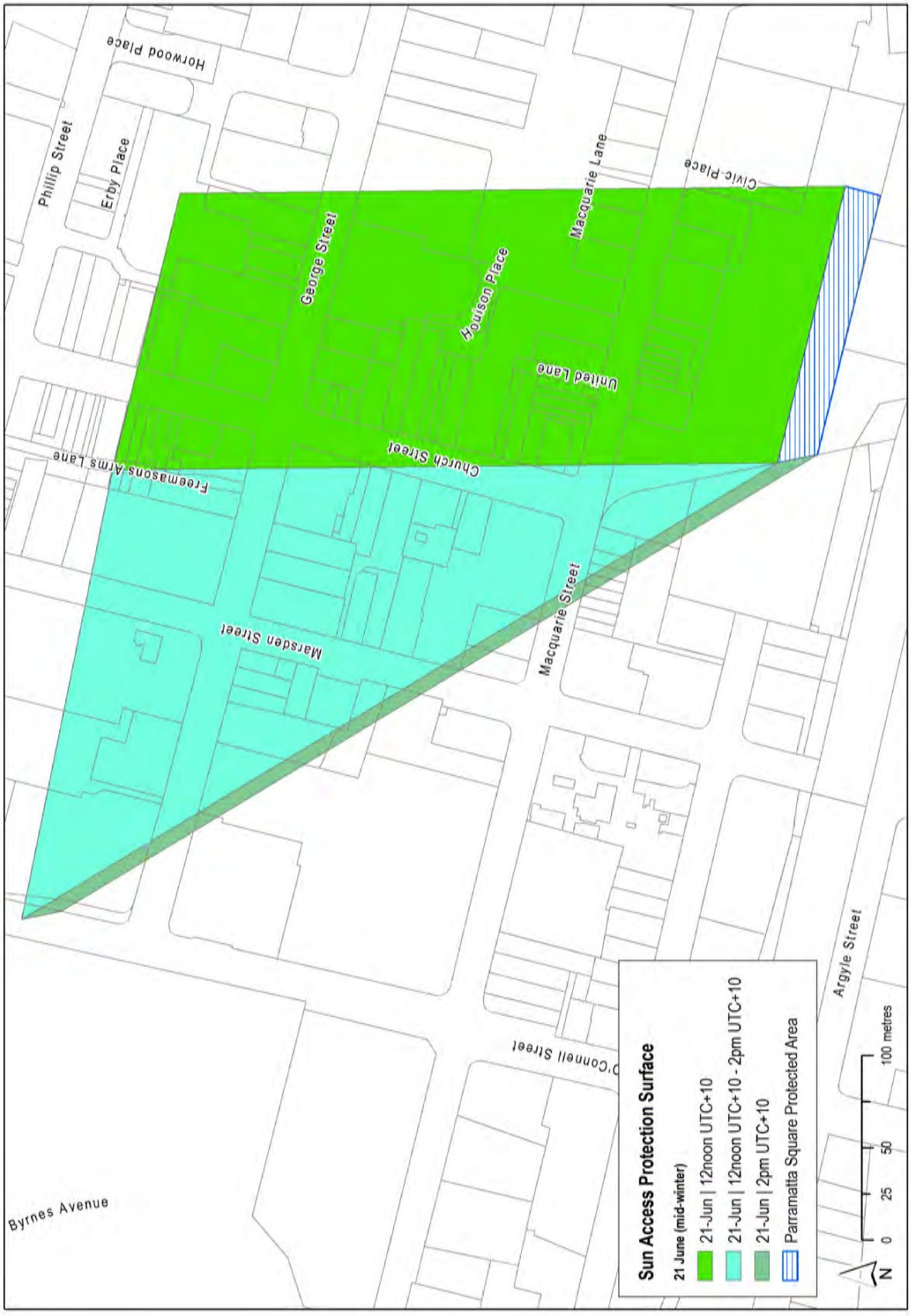


Figure 23 - Sun Access Protection Surface – 12-noon to 2pm on 21 June 2018 - Mid-winter protection

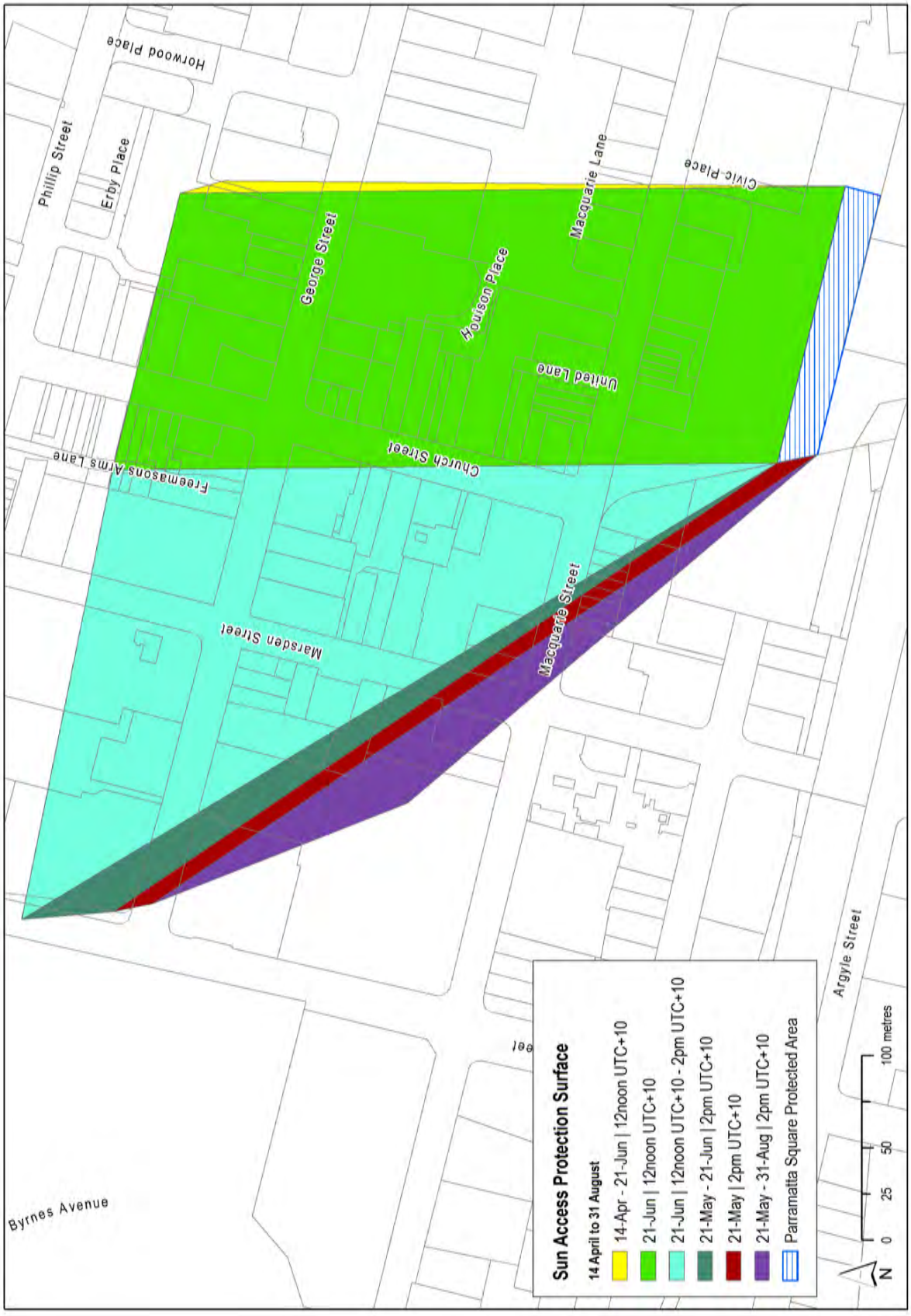


Figure 24 - Sun Access Protection Surface – 12-noon to 2pm for the period 14 April to 31 August

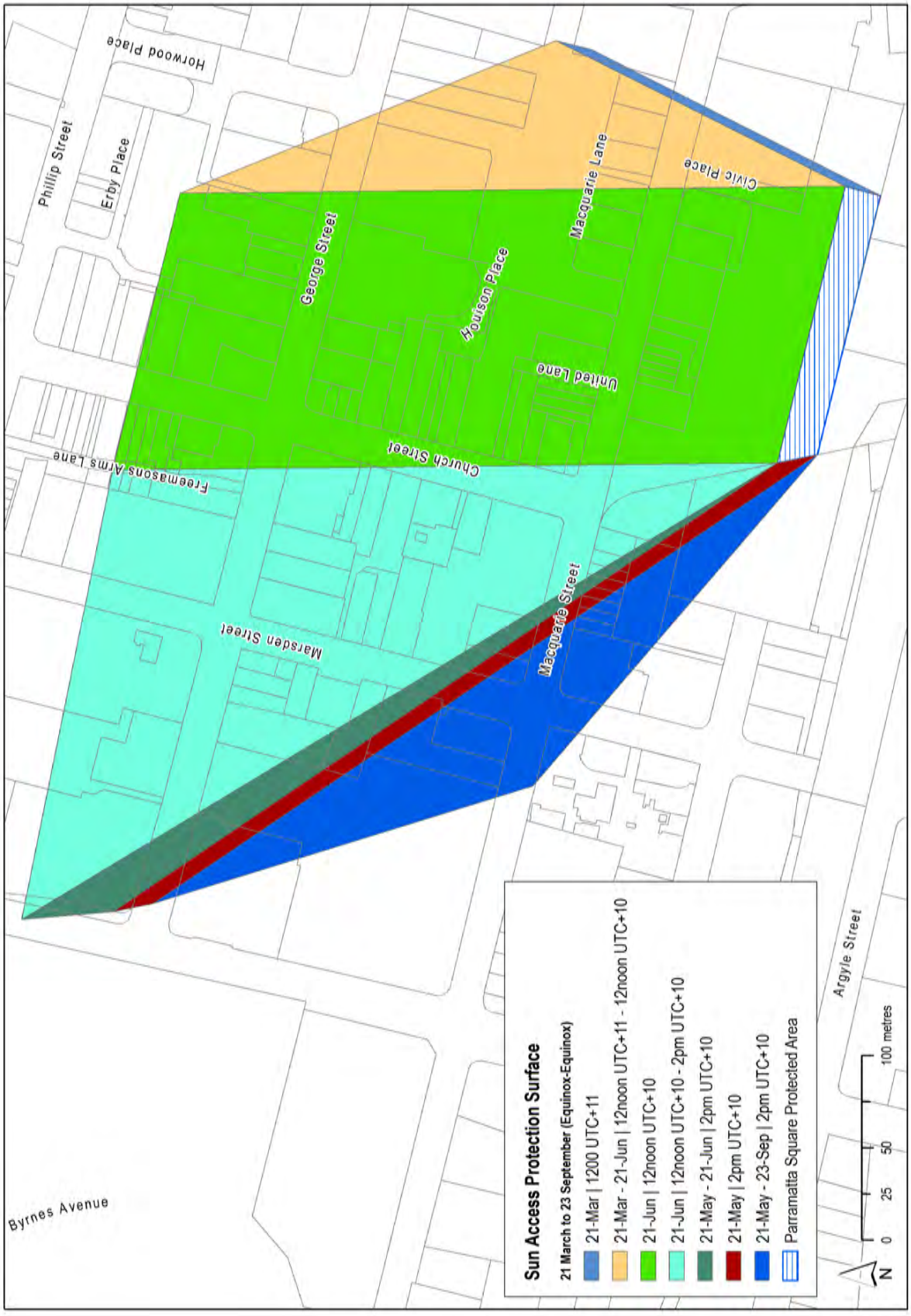


Figure 25 - Sun Access Protection Surface – 12-noon to 2pm for the period Autumn Equinox to Spring Equinox

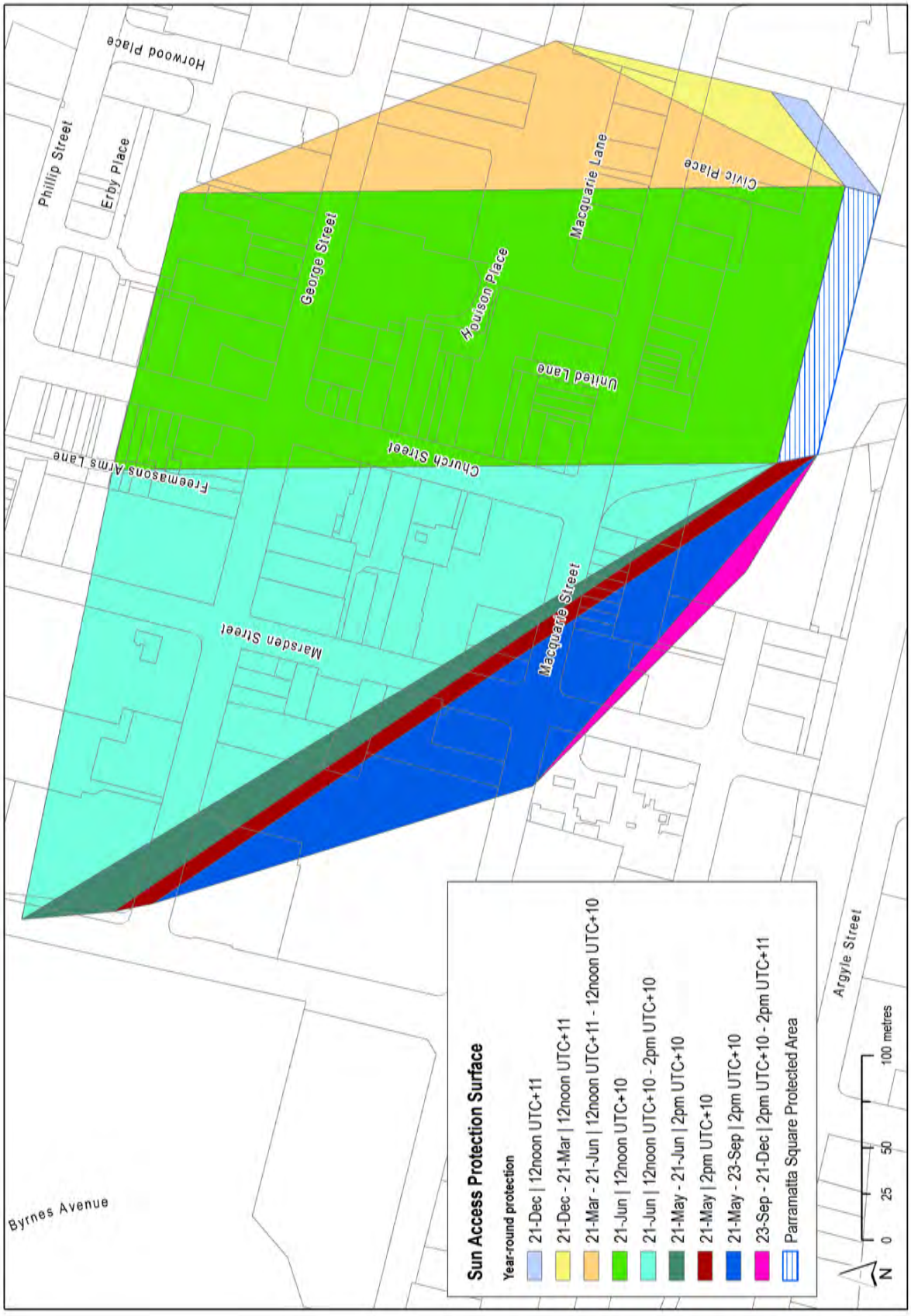


Figure 26 - Sun Access Protection Surface – 12-noon to 2pm for Year-round protection

Between 107 and 121 land parcels are wholly or partly impacted by the four options, above, for Sun Access Protection surfaces for Parramatta Square. These are set out in Table 5 and shown in Figure 27. The same number of land parcels are impacted for the equinox-to-equinox or the year-round scenarios; and the proportion of the land subject to the additional coverage between the equinox and mid-summer is slightly greater.

Scenario 12-noon to 2pm	Parcels impacted	Comparison to base case
21 June (mid-winter) – base case	107	
14 April to 31 August (nominated dates)	112	+5 parcels
21 March to 23 September (equinox to equinox) **21 December to 21 December (year-round)**	121	+14 parcels

Table 5 - Land parcels potentially impacted by Parramatta Square Sun Access Protection surface

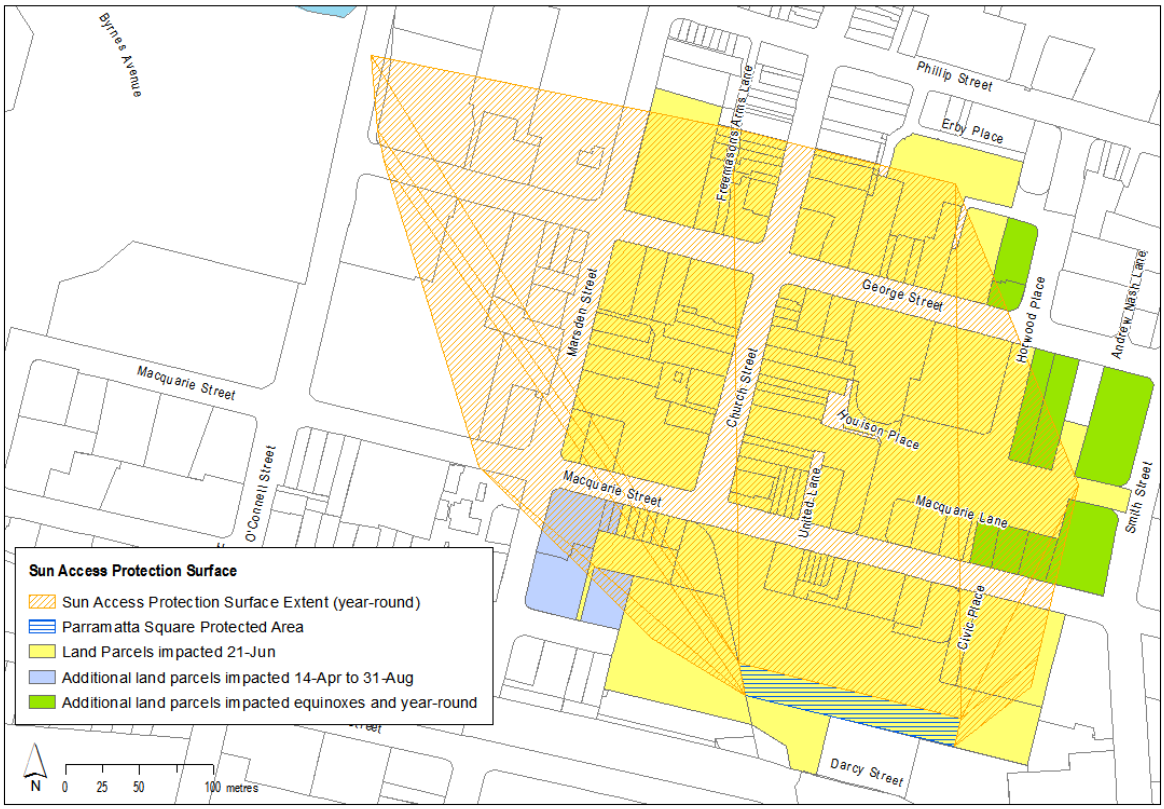


Figure 27 - Land parcels potentially impacted by scenarios for Parramatta Square Sun Access Protection surface

5.4. Implications of the Surface and relationship with the Lancer Barracks Surface

The additional land parcels affected beyond the base case of 21 June are minimal. This is mainly due to the Parramatta Square surface partly overlapping with the Sun Access Protection Surface from Lancer Barracks for the eastern portion. The overlapping extent between the two surfaces is shown on Figure 28 where the black-hatched area is the Sun Access Protection Surface for Lancer Barracks on 21 June between 12-noon and 2pm and the orange-hatched area is the Sun Access Protection Surface for Parramatta Square for year-round protection between 12-noon and 2pm.

In the area where the two surfaces overlap, the heights allowable to protect overshadowing of Lancer Barracks are lower than the corresponding heights allowable to Parramatta Square. This is due to the overlapping part of the surface from Lancer Barracks being applied at 2pm, compared to 12-noon for Parramatta Square.

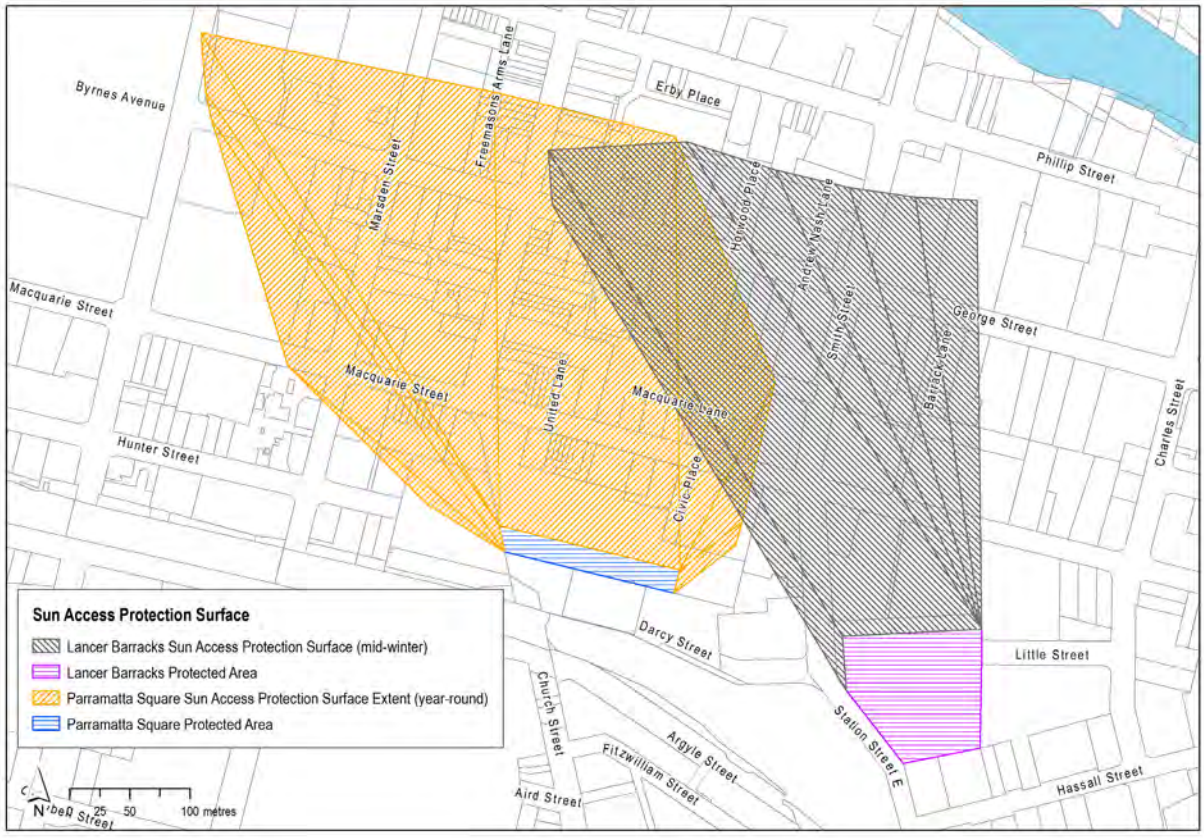


Figure 28 - Overlapping Sun Access Protection Surfaces for Parramatta Square and Lancer Barracks

Consequently, those parcels coloured green on Figure 27 will already have their maximum height limited to an existing Sun Access Protection surface from Lancer Barracks, which is currently modelled for 12-noon to 2pm on 21 June. In that situation, the green coloured parcels are more adversely impacted in terms of height from the Lancer Barracks surface compared to Parramatta Square, as the slope of the east-facing surface for the period from 21 December (mid-summer) extending to 21 June is initially steeper than that for Lancer Barracks.

Where the two surfaces overlap on 21 June – Parramatta Square at 12-noon and Lancer Barracks at 2pm – the heights allowable on the Parramatta Square surface are slightly lower than those for Lancer Barracks, as shown in Figure 29. Normally it is expected that a 2pm surface should be lower than a 12-noon surface. In this case, however, the lower base height of the Parramatta Square surface at 11m (RL) compared to the base height of Lancer Barracks at 13-16m (RL) combined with the more northerly location of the Parramatta Square protected area results in the Parramatta Square surface being lower on 21 June.

For other periods of the year, the angle of the Parramatta Square surface extends above the Lancer Barracks surface, and the impact of the existing Lancer Barracks surface is more limiting on building heights. The implications of this is only those six parcels coloured blue on Figure 27 will be newly impacted by the introduction of any Sun Access Protection surface to Parramatta Square, and only should Council consider extending the coverage of the surface beyond 21 June.

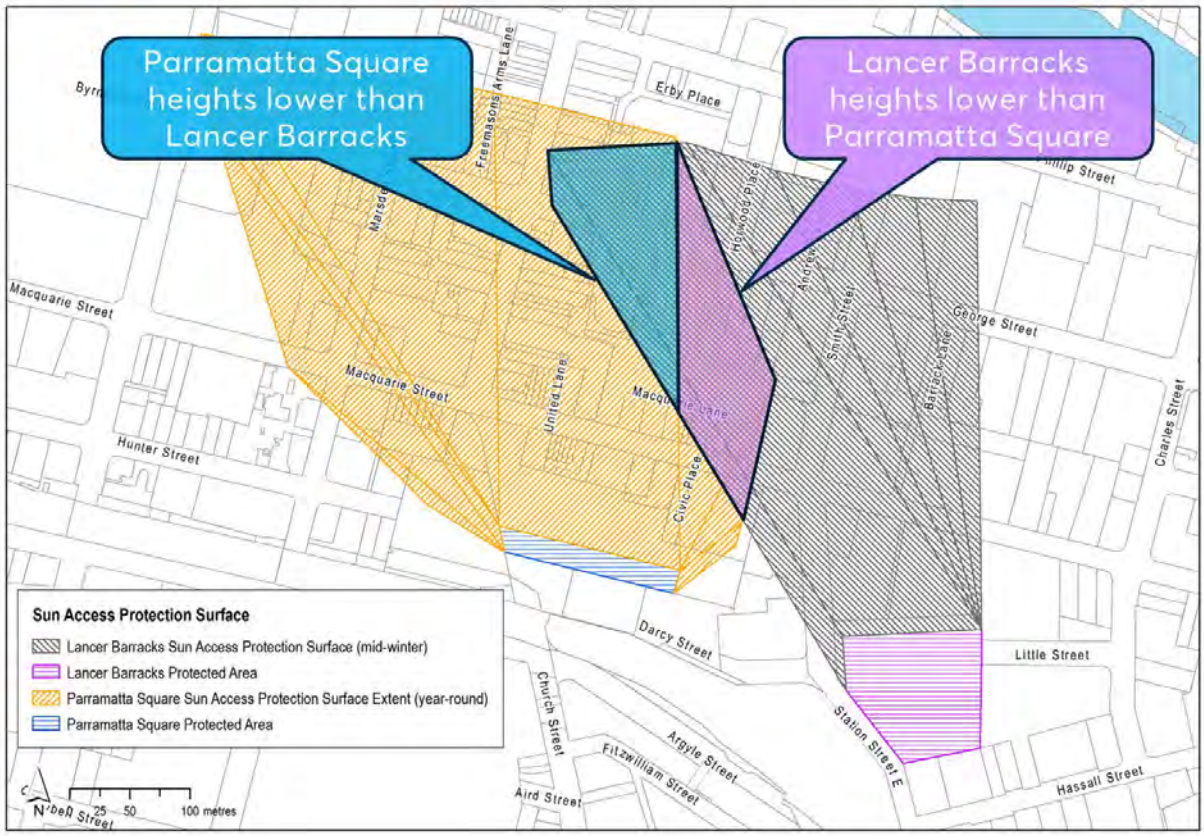


Figure 29 - Interaction between the Sun Access Protection surfaces of Parramatta Square and Lancer Barracks

5.5. Conclusions and Recommendation

There are three avenues for ensuring sunlight access to Parramatta Square from the analysis conducted:

- Maintain the currently adopted position to protect sunlight access for the period 12-noon to 2pm on 21 June (mid-winter). This will be meet at a minimum the condition of the Gateway Determination. In terms of land coverage and protection, this option has the greatest initial benefit. Extending the protection to periods beyond mid-winter will augment the benefit with minor impacts on additional land parcels.
- Extend coverage of the Sun Access Protection surface to apply to the period between 14 April and 31 August. This option will apply to six additional land parcels on the western side of the surface.
- Extend coverage of the Sun Access Protection surface to apply to either the period covered by the autumn to spring equinoxes (i.e. 21 March to 23 September) or year-round. The number of land parcels affected by both these periods are the same, but the proportion of the land parcels on the extremities would have more land subject to the surface. Land parcels on the eastern side of the Parramatta Square surface beyond the 12-noon on 21 June portion of the surface will be more adversely affected by the existing Lancer Barracks surface than Parramatta Square.

It is recommended that the currently adopted position of protecting sunlight access to Parramatta Square between 12-noon and 2pm on 21 June (mid-winter) is maintained for the purposes of addressing Condition 1(j)(iv) of the Gateway Determination. This option derives the greatest benefit to amenity within the Parramatta Square protected area for mid-winter, with additional periods of the year deriving incremental improvements for other periods of the year when parts of the Parramatta Square protected area may have shadows cast by buildings. Building heights to the east of the Parramatta Square protected area are already limited in height due to the Sun Access Protection Surface for Lancer Barracks.

6. Assessing Cumulative Overshadowing of Heritage Conservation Areas

6.1. Introduction

This section of the Technical Paper sets out the findings of analysis on the cumulative overshadowing of four nominated Heritage Conservation Areas situated to the south of the Parramatta CBD. This assessment is undertaken to address condition 1(k)(ii) - *Carry out an urban design study of the southern interface areas to ensure that excessive cumulative shadow impacts are not created across the northern sections of adjoining heritage conservation area (HCA), including the Harris Park [West] HCA, the Experiment Farm HCA, the Tottenham Street HCA and the South Parramatta HCA. These areas should receive a minimum of two hours' direct sunlight between 9am and 3pm at midwinter (21 June). If required, heights and FSRs are to be adjusted accordingly* – of the Gateway Determination.

Pursuant to feedback from a previous Councillor workshop, testing was also undertaken on the North Parramatta and Sorrell Street HCAs.

6.2. Analysis Method

Analysis for this task applies the Sun Shadow Volume geoprocessing tool to the extruded forms of current and proposed height controls, as set out in Sections 3.3 and 0 of this Technical Paper. Testing of overshadowing is undertaken between 9am and 3pm on 21 June (mid-winter) at 30-minute intervals. A comparison view between the shadows cast by the existing controls and the proposed CBD controls across this period is shown at Appendix 1 – Overshadowing of Heritage Conservation Areas.

6.3. Impact assessment of overshadowing on the Heritage Conservation Areas

The first pass of analysis indicates significant increases in overshadowing across the four southern HCAs; and minor increases in overshadowing across the two northern HCAs when comparing the overshadowing from current height controls in Parramatta LEP 2011 with those currently proposed in the CBD Planning Proposal, as set out in Table 6 and Table 7. In these tables, the average percentage is more representative of the impact *per se* as it shows the results of overshadowing over the entire six-hour period tested. The minimum and maximum values are useful as references to the upper and lower bounds of the overshadowing at any one nominated period across the day.

The second phase of analysis assessed impacts at a land parcel level to determine whether a land parcel could meet the minimum two-hour threshold of sunlight access between 9am and 3pm on 21 June as set out in the Gateway condition. This more detailed second phase of testing only needed to be undertaken on the southern HCAs due to higher incentive height of building controls located in the CBD core and southern parts of the CBD. Land parcels in the North Parramatta and Sorrell Street HCAs could meet the minimum two-hour threshold for sunlight access between 9am and 3pm on 21 June due to the generally lower incentive height of building controls north of the river combined with their location at the northern fringes of the CBD planning proposal area, which were not as impacted by shadows being cast.

Heritage Conservation Area	Minimum % of overshadowing	Maximum % of overshadowing	Average % of overshadowing
South Parramatta	0.0%	1.76%	0.23%
Tottenham Street	0.0%	10.98%	2.32%
Harris Park West	13.17%	45.76%	18.30%
Experiment Farm	0.0%	5.84%	0.99%
North Parramatta	19.96%	29.23%	21.78%
Sorrell Street	22.52%	44.57%	31.85%

Table 6 - Minimum, Maximum and Average proportion of overshadowing to the Heritage Conservation Areas under current controls

Heritage Conservation Area	Minimum % of overshadowing	Maximum % of overshadowing	Average % of overshadowing
South Parramatta	1.32%	77.43%	17.96%
Tottenham Street	4.32%	100.00%	56.74%
Harris Park West	21.69%	91.50%	63.09%
Experiment Farm	0.00%	90.16%	17.07%
North Parramatta	20.48%	59.19%	27.77%
Sorrell Street	29.85%	70.70%	43.47%

Table 7 - Minimum, Maximum and Average proportion of overshadowing to the Heritage Conservation Areas under CBD Planning Proposal controls

Results for the parcel-based analysis of overshadowing to the southern HCAs to test indicates a significant increase in the number of parcels that cannot achieve two hours of sunlight access between 9am and 3pm on 21 June under the CBD Planning Proposal controls as currently endorsed. Land parcels within the Harris Park West and Tottenham Street conservation areas are particularly impacted due to the significant change in height controls between the current Height of Buildings within Parramatta LEP 2011 and the Incentive Height of Buildings of the CBD Planning Proposal. The results of the overshadowing assessment at a parcel level are set out in Table 8 and Table 9 and illustrated in Figure 30. Those parcels that are overshadowed or not overshadowed across the six-hour period of 21 June are illustrated in Appendix 2 – Parcel-based Assessment of Overshadowing of Heritage Conservation Areas.

Heritage Conservation Area	Number of Parcels	Parcels with less than 2 hours sunlight access		Parcels with 2 hours or more of sunlight access	
South Parramatta	166	0	(0%)	166	(100%)
Tottenham Street	14	2	(14.3%)	12	(85.7%)
Harris Park West	184	24	(13%)	160	(87%)
Experiment Farm	121	0	(0%)	121	(100%)
Total across all HCAs	485	26	(5.4%)	459	(94.6%)

Table 8 - Comparison of land parcels achieving two hours or more of sunlight access between 9am and 3pm on 21 June under current Height of Buildings controls within Parramatta Local Environmental Plan 2011

Heritage Conservation Area	Number of Parcels	Parcels with less than 2 hours sunlight access		Parcels with 2 hours or more of sunlight access	
South Parramatta	166	16	(9.6%)	150	(90.4%)
Tottenham Street	14	9	(64.3%)	5	(35.7%)
Harris Park West	184	110	(59.8%)	74	(40.2%)
Experiment Farm	121	0	(0%)	121	(100%)
Total across all HCAs	485	135	(27.8%)	350	(72.2%)

Table 9 - Comparison of land parcels achieving two hours or more of sunlight access between 9am and 3pm on 21 June under proposed Incentive Height of Buildings controls within the CBD Planning Proposal

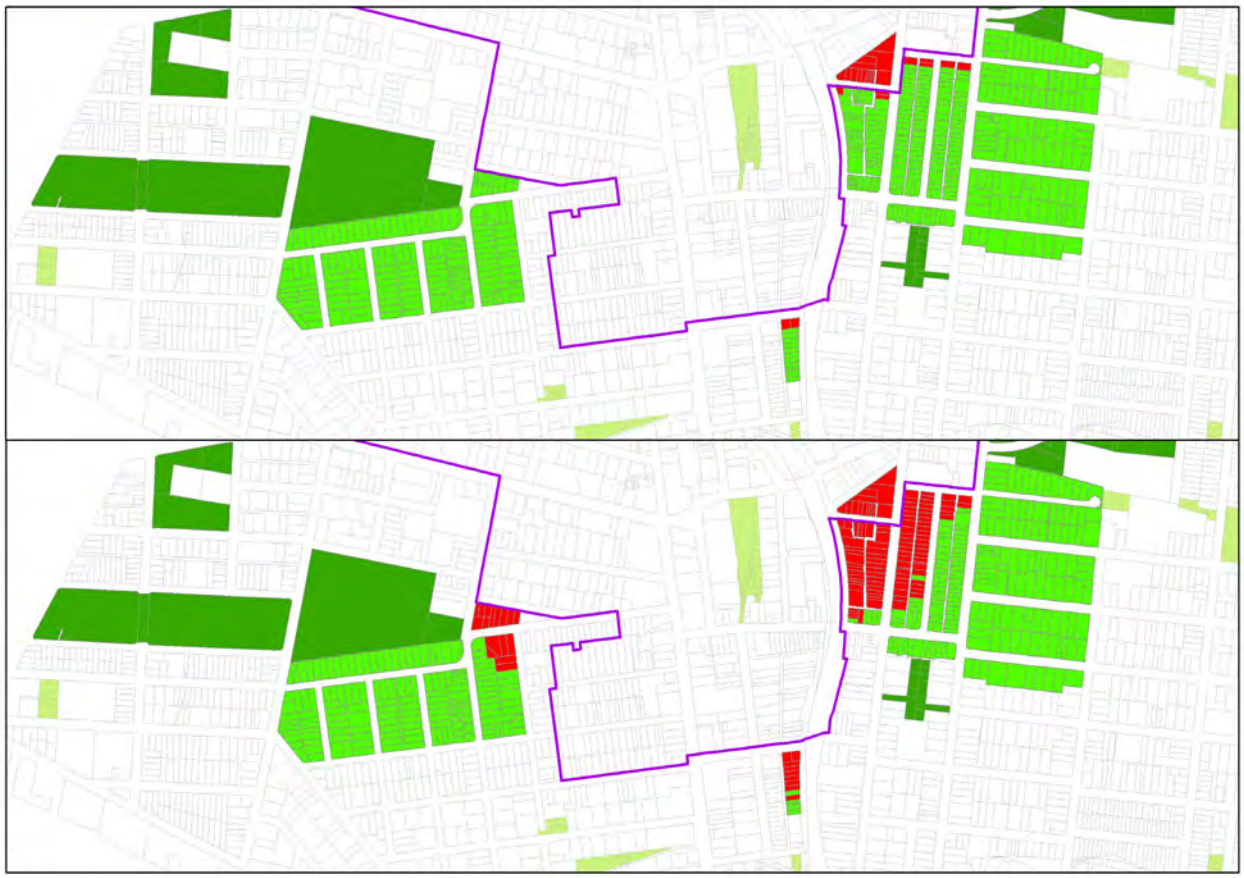


Figure 30 – Comparison of land parcels within the southern Heritage Conservation areas receiving 2 hours or more of sunlight (coloured light green) or not receiving 2 hours of sunlight (coloured red) between the current height controls under Parramatta Local Environmental Plan 2011 (top) and the proposed Incentive Height of Buildings controls for the CBD Planning Proposal (bottom)

Impacts on parcels within the South Parramatta HCA are primarily due to the potential overshadowing cast by the 243m (RL) Incentive Height of Buildings control on parcels along the Great Western Highway ridgeline. To a lesser extent, properties to the north-east with a 92m Incentive Height of Buildings control have an impact between 9am and 11am. Parcels which do not achieve two hours of sunlight access are in the north-eastern section of the HCA on Lansdowne and Lennox Streets.

Impacts on parcels within the Tottenham Street HCA are primarily due to the potential overshadowing cast by the 92m Incentive Height of Buildings control on parcels immediately to the north of the HCA. These controls start impacting the HCA from 10am; wholly cover the HCA between 11:30am and 2pm; before leaving late in the afternoon and being substituted by overshadowing from Incentive Height of Buildings controls along Church Street between 2pm and 3pm.

Impacts on parcels within the Harris Park West HCA are attributable to proposed 243m (RL) Incentive Height of Buildings controls located to the north-east and north-west of the HCA – within the blocks bounded by Harris Street, Hassall Street, Station Street East and Parkes Street. These controls start impacting the western edge in the morning before substantially covering the HCA from 10am right through to 3pm. Some 243m (RL) Incentive Height of Buildings controls from around Valentine Street impact the western edge of the HCA from 2pm to 3pm.

Impacts on parcels within the Experiment Farm HCA are mainly attributable to the same Incentive Height of Buildings controls impacting the Harris Park West HCA. The impacts from these controls starts around 12:30pm and continues through the afternoon. This HCA is not impacted by overshadowing in the morning.

6.4. Managing the Impacts of overshadowing on the Heritage Conservation Areas

The Gateway Determination condition also requires that if parcels within the HCAs cannot achieve the requisite two hours of sunlight access between 9am and 3pm on 21 June, consideration should be given to adjusting height controls and corresponding FSR controls to enable two hours of sunlight access to parcels within the HCAs.

To undertake this assessment, any blocks that had Incentive Height of Buildings controls which resulted in overshadowing of parcels within an HCA were identified and were subject to further testing to ascertain what reductions would be necessary to completely remove overshadowing from the HCAs. This assessment was undertaken on 28 blocks and the extent of any changes required to the Incentive Height of Buildings control are shown on Figure 31.

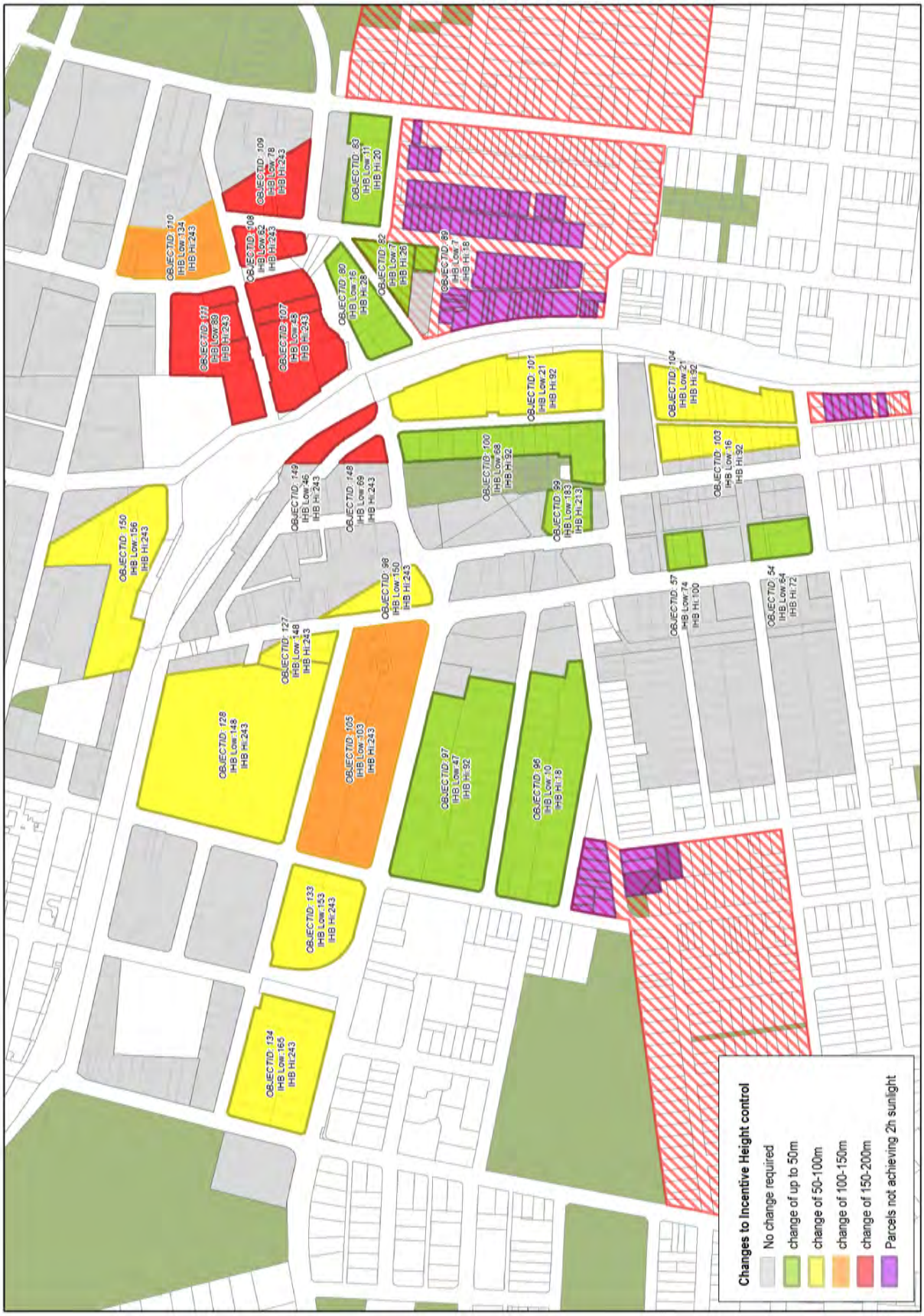


Figure 31 - Blocks identified for review and the extent of changes to the Incentive Height of Buildings control to completely remove overshadowing from HCAs

These 28 blocks were then further interrogated based on three principles to identify those where changes to the Incentive Height of Buildings control could be reasonably accommodated. These principles were:

- To minimise the overall loss of development yield. Revised heights must not be lower than current height controls; and
- To consider the existing development and the likelihood of future change within the block; and
- To consider where a change may result in multiple benefits – i.e. a reduction in height may benefit both land within the HCA and open space areas surrounding the CBD (as per the separate Gateway Determination condition and discussed in Section 7 of this paper).

When considering these three principles, 11 blocks were specifically found to be suitable for modifications to the Incentive Height of Buildings control. It should be noted that corresponding changes to the Incentive Floor Space Ratio control will also be undertaken to ensure both controls are consistent. The 11 blocks identified for change are shown in Figure 32.

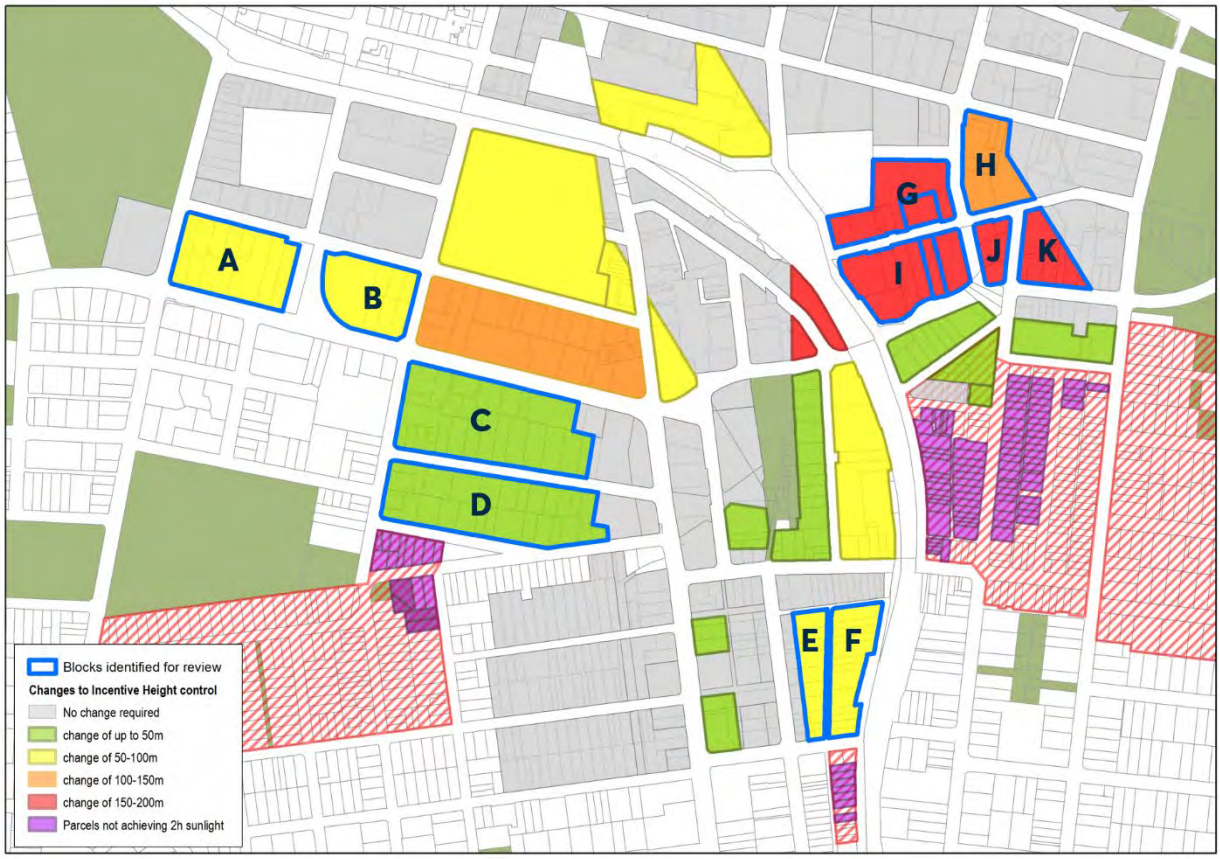


Figure 32 - Blocks identified for specific alteration to the Incentive Height of Buildings control.

An assessment of the characteristics and the recommended changes for each block is set out in Appendix 3 – Block Assessments. The summary of the recommended changes is set out in Table 10.

Block	LEP 2011 Current Height control	CBD Planning Proposal Incentive HOB control	Revised CBD Planning Proposal Incentive HOB control
Blocks A-B	28m	243m (RL) (NHC)	100m
Blocks C-D	Block C — 11m Block D — Pt 11m, Pt 12m	Block C — 92m (NHC) Block D — Pt 20m, Pt 26m, Pt 92m (NHC)	Block C — 49m Block D — Pt 11m, Pt 12m
Blocks E-F	12m	Block E — Pt 12m, Pt 92m (NHC) Block F — 92m (NHC)	Block E — Pt 12m, Pt 54m Block F — 20m
Blocks G-K	Block G — 72m Block H — Pt 72m, Pt 91.3m Block I — Pt 72m, Pt 130m Block J — 72m Block K —54m	243m (RL) (NHC)	Block G — Pt 90m, Pt 192m Block H — 167m Block I — Pt 72m, Pt 130m Block J — 80m Block K — 130m
(NHC) – No Height Control. Refer to Section 3.2 for the discussion on how heights are applied to areas with no incentive height of buildings control.			

Table 10 - Summary of current Height of Buildings, Incentive Height of Buildings controls and proposed revisions to the Incentive Height of Buildings control

A summary of the benefits of the changes in terms of reducing overshadowing on heritage conservation areas and, consequentially, open space areas outside the CBD are set out in Table 11.

Block	Summary of benefits arising from the changes
Blocks A-B	• Overshadowing significantly reduced to South Parramatta HCA • Overshadowing removed from Jones Park and Ollie Webb Reserve
Blocks C-D	• Overshadowing significantly reduced to South Parramatta HCA • Morning overshadowing removed from Jones Park and Ollie Webb Reserve
Blocks E-F	• Overshadowing significantly reduced to Tottenham Street HCA, particularly in the middle of the day.
Blocks G-K	• Overshadowing significantly reduced to Harris Park West HCA and Experiment Farm HCA

Table 11 - Summary of the benefits from revisions to the Incentive Height of Buildings controls

The proposed changes to these blocks significantly reduce the average overshadowing across the six-hour period between 9am and 3pm on 21 June. While the changes do not entirely remove the overshadowing back to levels under the current LEP controls, significant improvements to amenity within the HCAs will be possible with the proposed changes. The number of land parcels that would not receive two hours of sunlight between 9am and 3pm increased from 26 under current controls to 135 under the CBD Planning Proposal controls. The revisions to the Incentive Height of Buildings control reduces that back to 53 parcels, mainly in the Harris Park West HCA. A comparison between the

number of parcels achieving two hours of sunlight access between 9am and 3pm on 21 June under the Incentive Height of Buildings control and the proposed revisions to controls are set out in Table 12 and Table 13 and illustrated on Figure 33. Detailed maps showing the comparison between the Incentive Height of Buildings control and the revisions to the Incentive Height of Buildings control is set out in Appendix 4 – Parcel-based Assessment of Overshadowing of Heritage Conservation Areas with revised Incentive Height of Buildings controls.

Heritage Conservation Area	Number of Parcels	Parcels with less than 2 hours sunlight access		Parcels with 2 hours or more of sunlight access	
South Parramatta	166	16	(9.6%)	150	(90.4%)
Tottenham Street	14	9	(64.3%)	5	(35.7%)
Harris Park West	184	110	(59.8%)	74	(40.2%)
Experiment Farm	121	0	(0%)	121	(100%)
Total across all HCAs	485	135	(27.8%)	350	(72.2%)

Table 12 - Comparison of land parcels achieving two hours or more of sunlight access between 9am and 3pm on 21 June under proposed Incentive Height of Buildings controls within the CBD Planning Proposal

Heritage Conservation Area	Number of Parcels	Parcels with less than 2 hours sunlight access		Parcels with 2 hours or more of sunlight access	
South Parramatta	166	4	(2.4%)	162	(97.6%)
Tottenham Street	14	2	(14.3%)	12	(85.7%)
Harris Park West	184	47	(25.5%)	137	(74.5%)
Experiment Farm	121	0	(0%)	121	(100%)
Total across all HCAs	485	53	(10.9%)	432	(89.1%)

Table 13 - Comparison of land parcels achieving two hours or more of sunlight access between 9am and 3pm on 21 June under revisions to the Incentive Height of Buildings controls within the CBD Planning Proposal

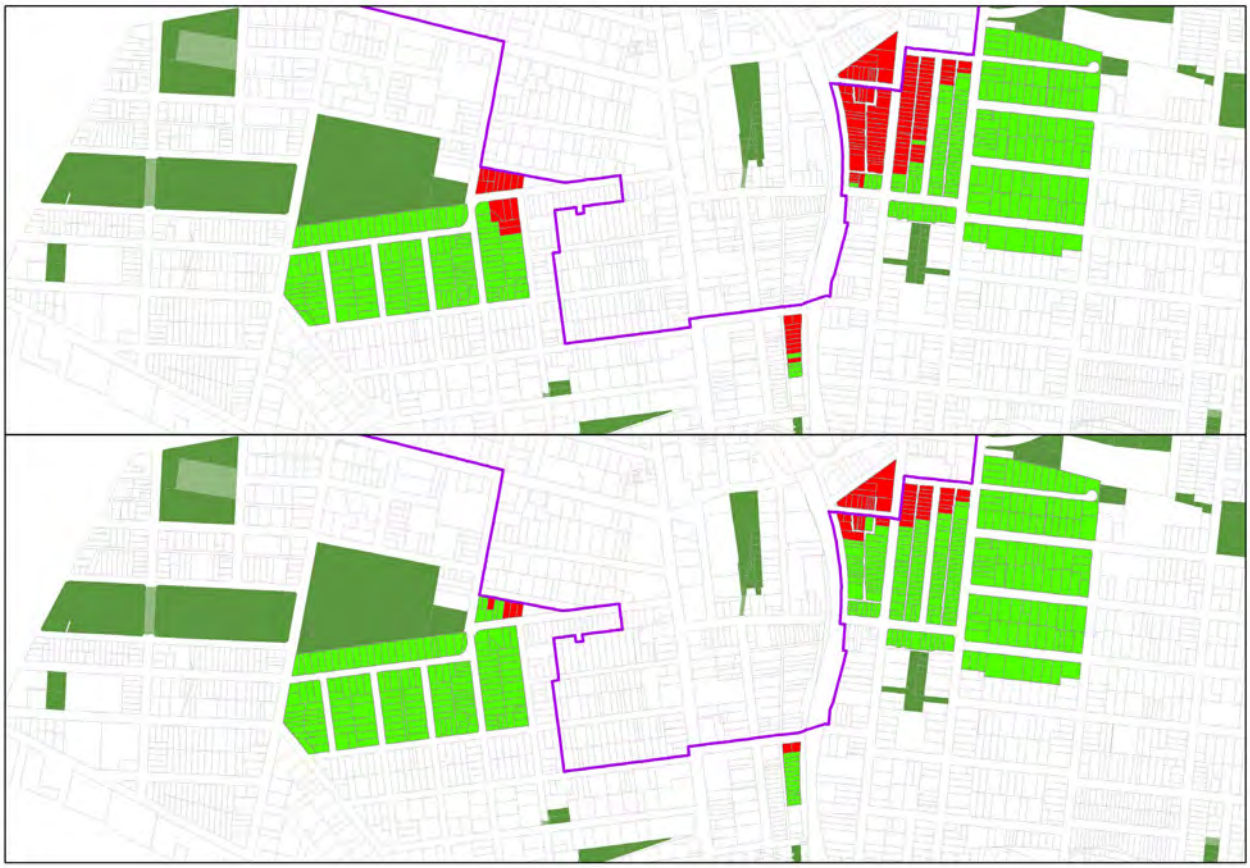


Figure 33 - Comparison of land parcels within the southern Heritage Conservation areas receiving 2 hours or more of sunlight (coloured light green) or not receiving 2 hours of sunlight (coloured red) between the proposed Incentive Height of Buildings controls under the CBD Planning Proposal (top) and proposed revisions to the Incentive Height of Buildings control to address the Gateway condition (bottom)

6.5. Conclusions and Recommendation

The findings of the analysis for this condition identified significant adverse impacts to surrounding land parcels within the four heritage conservation areas to the south of the CBD resulting from overshadowing from the Incentive Height of Buildings controls within the CBD Planning Proposal. The proposed revisions to the 11 blocks identified in Section 6.4 of this paper would reduce the extent of the adverse impacts from overshadowing on the surrounding areas. The changes will also still enable degrees of uplift for future development where it could be realistically accommodated.

It is recommended that the changes set out in this section of the technical paper are considered for adoption to amend the Incentive Height of Buildings controls within the CBD Planning Proposal. Consequential changes to Incentive Floor Space Ratio controls to align those controls with the amended Incentive Height of Buildings controls will be necessary. Principles that will inform the determination of any revised Incentive Floor Space Ratio control includes:

- Where a revised Incentive Height of Buildings control is consistent with an equivalent Incentive Height of Buildings control elsewhere in the CBD Planning Proposal, the corresponding Incentive Floor Space Ratio control would be applied; or
- Where a revised Incentive Height of Buildings control is consistent with an equivalent Height of Buildings control under the current Parramatta LEP 2011, the corresponding Floor Space Ratio control would be applied; or
- In any other circumstances, undertaking urban design analysis to determine an Incentive Floor Space Ratio control that will be consistent with the revised Incentive Height of Buildings control.

7. Assessing Cumulative Overshadowing of Open Space Areas outside the Parramatta CBD

7.1. Introduction

This section of the Technical Paper sets out the findings of testing for overshadowing from existing and proposed planning controls on open space areas surrounding the Parramatta CBD. This assessment is undertaken to address condition 1(j)(ii) — *Provide further assessment of the overshadowing impact of the proposed controls on public open spaces surrounding the CBD compared to the existing controls* — of the Gateway Determination.

Providing quality open space has an important role in urban development and the amenity of the urban environment. With the significant growth that could be accommodated under the Parramatta CBD Planning Proposal, there is a need to ensure that adverse impacts on open space areas that are reasonably accessible from the Parramatta CBD – such as overshadowing – can be avoided or minimised as far as practicable.

Opportunities to increase the physical supply of open space within or around the Parramatta CBD are very limited – and potentially very costly to acquire if land is already used for residential or commercial development. Combined with high density residential development in and around the CBD, the existing open space areas have an additional role as *de facto* back yards where residents without private open space in their apartments can use the space for passive recreational activities. Limited opportunities for some dedication or provision of land for open space may be negotiated with individual developers, however the quantities of these spaces would be small and functionally limited to passive open space. Opportunities for larger areas of open space capable of providing additional sportsfields or larger organised play areas would be extremely difficult to realise. Consequently, the *existing* open space areas need to be protected as far as practicable to ensure their continued efficient use for an increasing residential and workforce population. This includes ensuring sunlight access to the grassed surfaces and playing fields as pressures for organised sport opportunities grow through greater involvement by more people. Conversion of turfed surface to synthetic playing fields should only be considered as a last resort due to significant installation and maintenance costs. In any event, conversions can be difficult in parts of Parramatta due to Aboriginal and colonial archaeology that may be below the surface and impact some open space areas such as Robin Thomas Reserve.

Public open spaces surrounding the Parramatta CBD range in size and function from small neighbourhood parks with limited amenities (e.g. Rosella Park or Noller Park) to large sportsfields (e.g. Robin Thomas Reserve or Ollie Webb Reserve) which host organised sport and local sporting competitions. Other notable open space areas serve a curtilage function to significant heritage items (e.g. Hambledon Cottage Reserve or Experiment Farm Reserve). Parramatta Park, to the west of the CBD, has a regional/metropolitan function and has multiple items of local, state, and world-heritage significance. Part of Parramatta Park has been identified for the potential location of the new Parramatta aquatic centre, which is anticipated to include both indoor and outdoor aquatic facilities.

7.2. Identifying the Open Space Areas

Ten (10) open space areas were identified for testing the impacts of overshadowing from the current and proposed planning controls. These open space areas are generally located to the south-east and south-west of the CBD. These open space areas were selected based on potential impacts of overshadowing from particularly tall height of buildings controls in the CBD core where heights of up to 243m (RL) are proposed. Areas north of the Parramatta River generally have a maximum height of 92m with edges of the CBD interfacing the surrounding residential areas having lower heights with no impacts on open space areas surrounding the CBD anticipated due to the lower heights and orientation of the parks mainly to the north and east of the CBD. Accordingly, the open space areas identified for testing are set out in Table 14 and shown in Figure 34.

Criteria from the Greater Sydney Commission's audit into open space areas and consultation with Council's Recreation and Open Space teams have established some functional criteria for each open space area. Descriptions of the criteria are as follows:

- Active Open Space – is land set aside for the primary purpose of formal outdoor sports for the community. Active open space supports team sports, training and competition; and typically features sports facilities such as playing fields, change rooms, grandstands and car parks.
- Passive Open Space – is land set aside for parks, gardens, linear corridors, conservation bushland and nature reserves. These areas are made available for passive recreation, play and unstructured physical activities.
- Water Play Facilities – offers water-based activities during the warmer months of the year (e.g. between September and May). Water parks can be located within active or passive open spaces.
- Regional Level – is open space of city-wide or metropolitan significance.
- District Level – is open space of significance to multiple neighbourhoods that may extend beyond the LGA boundary.
- Local Level – is open space significant to single neighbourhoods; and are located within or near residential areas.

7.3. Analysis Method

Analysis for this task applies the Sun Shadow Volume geoprocessing tool to the extruded forms of current and proposed height controls, as set out in Sections 3.3 and 0 of this Technical Paper. Testing of overshadowing is undertaken between 9am and 3pm on 21 June (mid-winter) at 30-minute intervals. A comparison view between the shadows cast by the existing controls and the proposed CBD controls across this period is shown at Appendix 5 – Overshadowing of Public Open Space areas.

Park	Open Space Category						
	Active Uses			Passive Uses			
	Regional	District	Local	Regional	District	Local	Water Play
Noller Park						✓	
Ollie Webb Reserve		✓			✓		
Parramatta Park				✓			✓
Mays Hill Reserve						✓	
Jones Park		✓				✓	
Robin Thomas Reserve		✓			✓		
James Ruse Reserve					✓		✓
Experiment Farm Reserve						✓	
Hambledon Cottage Reserve						✓	
Rosella Park, Harris Park						✓	

Table 14 - Open Space areas selected for testing

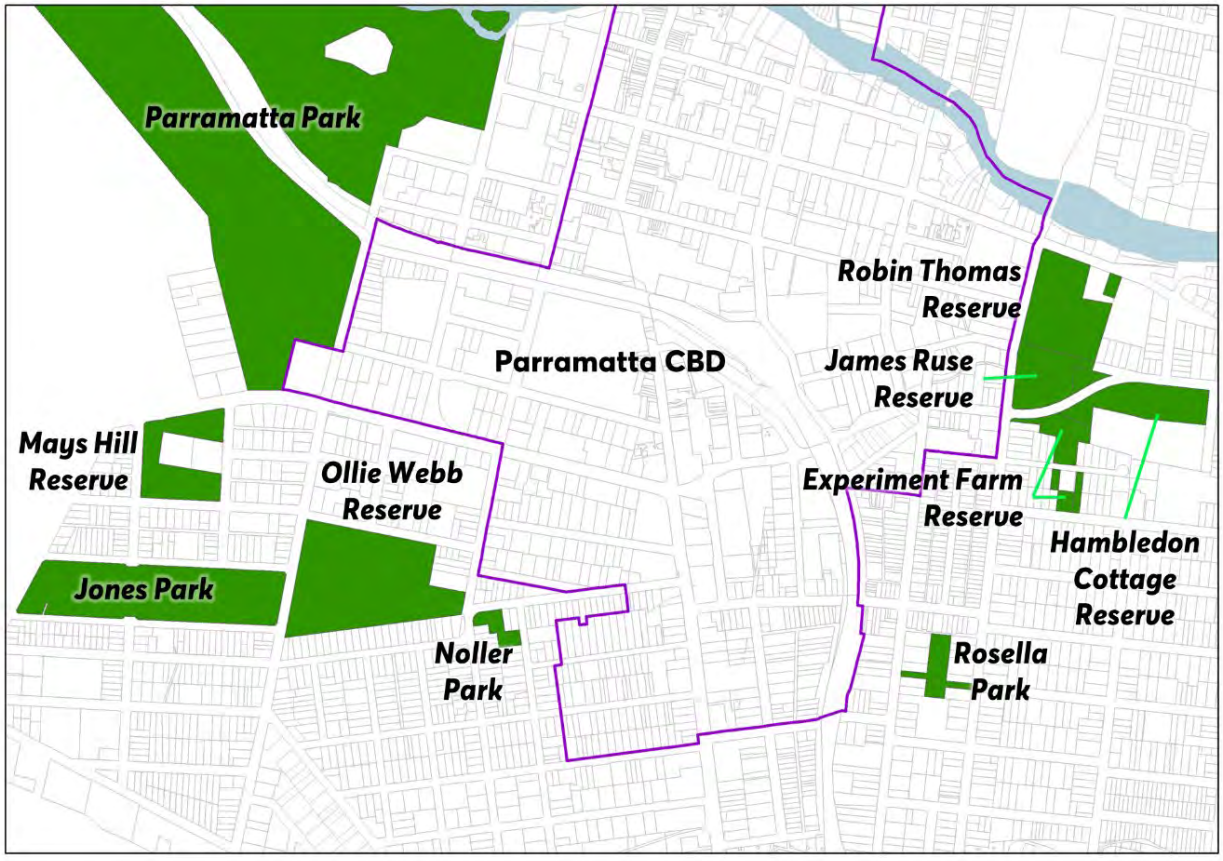


Figure 34 - Open Space Areas selected for testing

7.4. Impact assessment of overshadowing on open space areas

Initial impact assessment of overshadowing applied a threshold for the provision of public open space from the City of Sydney in the absence of any criteria specified in the Gateway Determination. Using the test from *Sydney Development Control Plan 2012* (Clause 3.1.4), a threshold requiring a minimum of 50% of a park's area is to receive four hours or more of sunlight between 9am and 3pm on 21 June.

Using this criteria, all ten parks achieved the minimum threshold of four hours of sunlight between 9am and 3pm on 21 June under current controls; while seven of the ten achieved the threshold under the endorsed CBD Planning Proposal controls. Noller Park achieved about 2 hours of sunlight between 1pm and 3pm (a reduction of 67% from the current controls); James Ruse Reserve received about 3 hours of sunlight between 9am and 12-noon (a reduction of 33% from the current controls); and Ollie Webb Reserve received about 3.5 hours of sunlight between 11:30am and 3:00pm (a reduction of nearly 50% from current controls).

A summary of the hours of sunlight received by the various parks; and the minimum, maximum and average proportion of overshadowing between 9am and 3pm is set out in Table 15 and Table 16, below.

Internal consultation with Council's Open Space and Recreation teams recommended different degrees of protection for open spaces based on their use and functions. For open spaces that are primarily passive use the four-hour standard from the City of Sydney's Development Control Plan is a reasonable threshold. For open spaces that have sportsfields and are in regular use for organised and competition sports, the amount of sunlight access should be maximised as far as practicable. This will enable the grass and turf surfaces to recover and regenerate from use. With increasing pressure on the sportsfields to accommodate more competition events from a growing population and interest in sports such as soccer, the capability of sportfields that cannot recover and regenerate because of insufficient sunlight caused by overshadowing from surrounding development will reduce the availability of those sportsfields; and will require competition events to be relocated elsewhere.

Park	Hours of sunlight received	Minimum % of overshadowing	Maximum % of overshadowing	Average % of overshadowing
Noller Park	6	0.0%	6.2%	0.5%
Ollie Webb Reserve	6	0.0%	0.0%	0.0%
Parramatta Park	6	0.0%	0.3%	0.0%
Mays Hill Reserve	6	0.0%	0.0%	0.0%
Jones Park	6	0.0%	0.0%	0.0%
Robin Thomas Reserve	5	0.0%	88.1%	18.5%
James Ruse Reserve	4.5	0.0%	91.6%	21.8%
Experiment Farm Reserve	6	0.0%	24.4%	3.0%
Hambledon Cottage Reserve	6	0.0%	18.0%	1.8%
Rosella Park, Harris Park	6	0.0%	0.0%	0.0%

Table 15 - Hours of sunlight received; Minimum, Maximum and Average proportion of overshadowing of open space under current height controls. Green boxes indicate 50% of the open space area receiving at least 4 hours of sunlight between 9am and 3pm.

Park	Hours of sunlight received	Minimum % of overshadowing	Maximum % of overshadowing	Average % of overshadowing
Noller Park	2	0.0%	100.0%	61.0%
Ollie Webb Reserve	3.5	0.0%	100.0%	42.5%
Parramatta Park	6	0.0%	0.5%	0.1%
Mays Hill Reserve	6	0.0%	23.1%	1.9%
Jones Park	5.5	0.0%	58.3%	8.7%
Robin Thomas Reserve	4.5	0.0%	95.2%	25.8%
James Ruse Reserve	3	0.0%	100.0%	47.2%
Experiment Farm Reserve	5	0.0%	100.0%	28.4%
Hambledon Cottage Reserve	5	0.0%	97.1%	19.0%
Rosella Park, Harris Park	6	0.0%	33.0%	4.6%

Table 16 - Hours of sunlight received; Minimum, Maximum and Average proportion of overshadowing of open space under CBD Planning Proposal incentive height controls. Green boxes indicate 50% of each public open space area receiving at least 4 hours of sunlight between 9am and 3pm. Red boxes indicate 50% of each public open space area receiving less than 4 hours of sunlight.

7.5. Managing the Impacts of overshadowing on the Open Spaces

The Gateway Determination condition does not explicitly require amendments to be made to planning controls, unlike the condition pertaining to the impacts on heritage conservation areas. Several improvements to sunlight access to open spaces also resulted from the changes made to address overshadowing on heritage conservation areas (refer to Section 6 of this paper).

Two further blocks were identified for potential changes to the Incentive Height of Buildings controls. Both these blocks have site-specific planning proposals that either have been recently gazetted or are currently being assessed. These blocks are bounded by:

(a) Macquarie Street, George Street, Harris Street and Argus Lane (the Cumberland Media and Albion Hotel block); and

(b) Charles Street, George Street and the Parramatta River.

As both these blocks have or have had site-specific planning proposals running independently of the CBD Planning Proposal, the CBD Planning Proposal can be reasonably amended to be consistent with these separate proposals particularly if:

(a) the planning proposal is well-progressed (as in the case of 142 Macquarie Street); or

(b) the planning proposal is consistent with the controls sought by the site-specific planning proposal (as in the case of 135 George Street/118 Harris Street); or

(c) the planning proposal has been recently gazetted (as in the case of 180 George Street and 184-188 George Street);

provided the results of testing indicate that the potential impacts of overshadowing could be reduced compared to impacts from the CBD Planning Proposal controls as endorsed on April 2016.

On those grounds, modifications to the Incentive Height of Buildings control were made to these blocks to reflect the heights sought by the site-specific planning proposals and a further iteration of shadow modelling was undertaken to ascertain any improvements. The results are set out in Table 17. Significant improvements are made to Noller Park and Ollie Webb Reserve where sunlight access is increased by 1.5 hours. Some other parks had modest improvements of 30 minutes, namely Jones Park, James Ruse Reserve and Hambledon Cottage Reserve. Remaining parks had no changes between the CBD planning proposal controls and the identified revisions to the Incentive Height of Buildings control.

Park	Hours of sunlight received	Minimum % of overshadowing	Maximum % of overshadowing	Average % of overshadowing
Noller Park	3.5	0.0%	100.0%	39.2%
Ollie Webb Reserve	5	0.0%	97.5%	18.2%
Parramatta Park	6	0.0%	0.5%	0.1%
Mays Hill Reserve	6	0.0%	23.1%	1.9%
Jones Park	6	0.0%	18.0%	1.4%
Robin Thomas Reserve	4.5	0.0%	95.2%	25.8%
James Ruse Reserve	3.5	0.0%	100.0%	39.1%
Experiment Farm Reserve	5	0.0%	100.0%	19.6%
Hambledon Cottage Reserve	5.5	0.0%	85.0%	12.2%
Rosella Park, Harris Park	6	0.0%	33.0%	4.6%

Table 17 - Hours of sunlight received; Minimum, Maximum and Average proportion of overshadowing of open space under revisions to the CBD Planning Proposal incentive height controls. Green boxes indicate 50% of each public open space area receiving at least 4 hours of sunlight between 9am and 3pm. Red boxes indicate 50% of each public open space area receiving less than 4 hours of sunlight.

7.6. Conclusions and Recommendation

The findings of the analysis for this condition identified significant adverse impacts to surrounding open space areas to the south of the CBD resulting from overshadowing from the Incentive Height of Buildings controls within the CBD Planning Proposal. The proposed revisions to the blocks identified in Section 6.4 and the two additional blocks identified in Section 7.5 of this paper would reduce the extent of the adverse impacts from overshadowing on the open spaces. The changes will also still enable degrees of uplift for future development where it could be realistically accommodated, or match outcomes already sought by site-specific planning proposals that are running or have run separate to the CBD Planning Proposal.

It is recommended that the following treatments are adopted for managing overshadowing to open space areas:

Park	Recommended Treatment
Passive Use Parks Noller Park Hambledon Cottage Reserve Experiment Farm Reserve Rosella Park Mays Hill Reserve	Minimum 4 hours sunlight access to 50% of the park's area between 9am and 3pm on 21 June on all parks, except: Noller Park – when considering its use as a small neighbourhood park adjoining a stormwater channel, 3.5 hours is acceptable.
Active Use Parks Ollie Webb Reserve Jones Park	Amend maximum heights within the CBD Planning Proposal consistent with the results of analysis undertaken for the Heritage Conservation Areas.
Active Use Parks Robin Thomas Reserve **Passive Use Parks** James Ruse Reserve	Amend maximum heights within the CBD Planning Proposal consistent with the site-specific planning proposals in the following blocks: (a) Macquarie Street, George Street, Harris Street and Argus Lane (the Cumberland Media and Albion Hotel block); and (b) Charles Street, George Street and the Parramatta River (180 George Street and 184-188 George Street site-specific planning proposals).
Parramatta Park	Minimum 4 hours sunlight access between 9am and 3pm on 21 June

Table 18 - Recommended treatments to manage overshadowing on public open space areas surrounding the Parramatta CBD

Appendix 1 – Overshadowing of Heritage Conservation Areas

This Appendix contains the comparative shadow analysis for the Heritage Conservation Areas for the six heritage conservation areas to the south and north of the Parramatta CBD. This analysis models the overshadowing for the current Height of Buildings controls (light grey) against the proposed Incentive Height of Buildings controls (dark grey) at 30-minute intervals between 9am and 3pm on 21 June.

In Figure 35 to Figure 47, the southern Heritage Conservation Areas are shown in red hatching and are in order from left to right: South Parramatta Conservation Area, Tottenham Street Conservation Area, Harris Park West Conservation Area and Experiment Farm Conservation Area.

In Figure 48 to Figure 60, the northern Heritage Conservation Areas are in order from left to right: North Parramatta Conservation Area and Sorrell Street Conservation Area, which were tested in accordance with feedback from a previous Councillor Workshop.

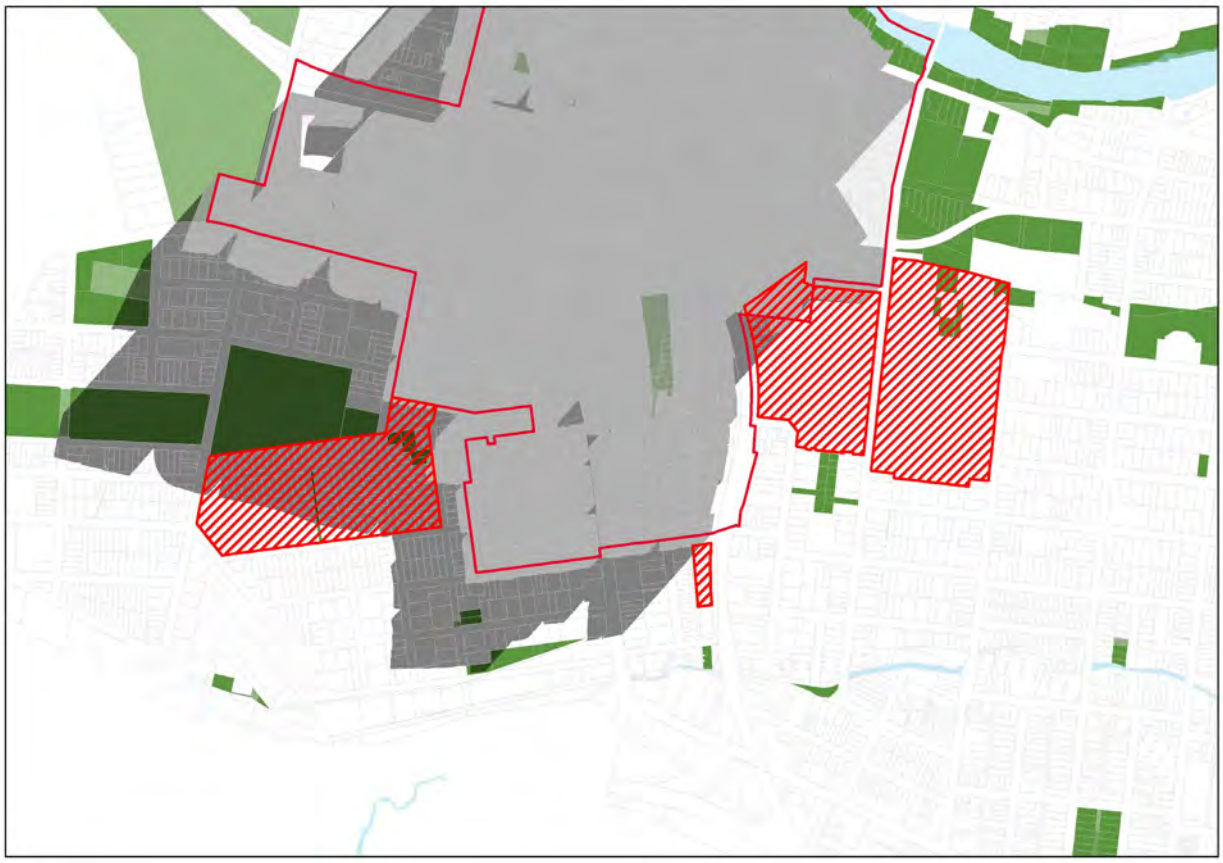


Figure 35 - Current and Proposed Controls overshadowing - 21 June - 9am

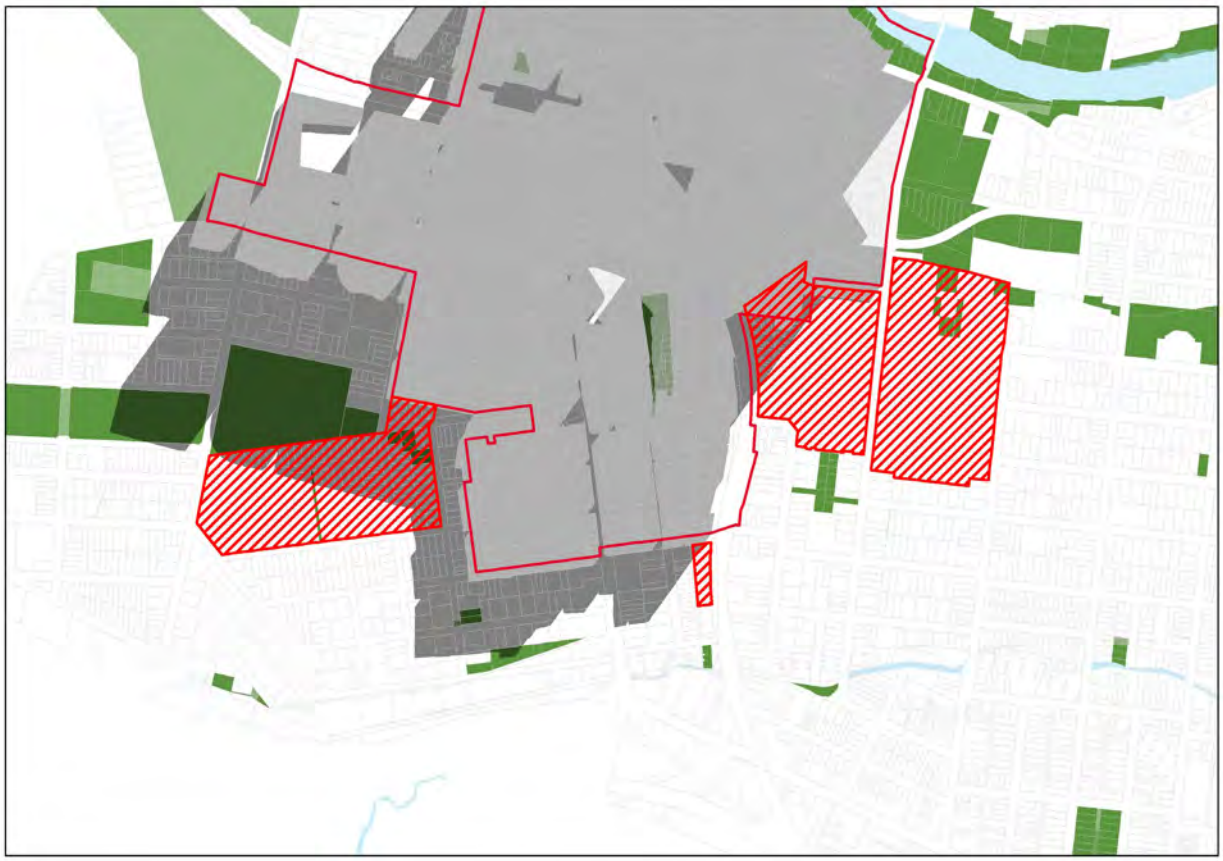


Figure 36 - Current and Proposed Controls overshadowing - 21 June - 9:30am

Figure 37 - Current and Proposed Controls overshadowing - 21 June - 10am

Figure 38 - Current and Proposed Controls overshadowing - 21 June - 10:30am

Figure 39 - Current and Proposed Controls overshadowing - 21 June - 11am

Figure 40 - Current and Proposed Controls overshadowing - 21 June - 11:30am

Figure 41 - Current and Proposed Controls overshadowing - 21 June - 12-noon

Figure 42 - Current and Proposed Controls overshadowing - 21 June - 12:30pm

Figure 43 - Current and Proposed Controls overshadowing - 21 June - 1pm

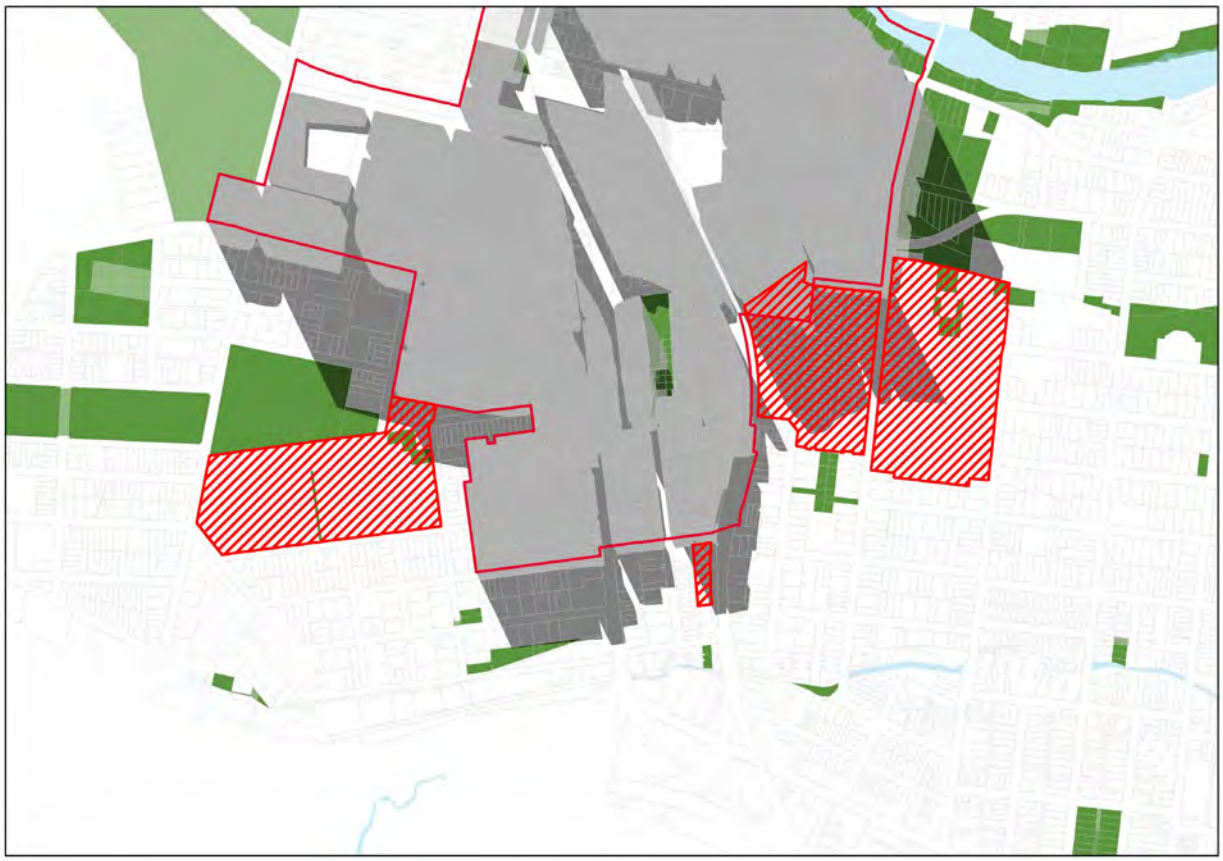


Figure 44 - Current and Proposed Controls overshadowing - 21 June - 1:30pm

Figure 45 - Current and Proposed Controls overshadowing - 21 June - 2pm

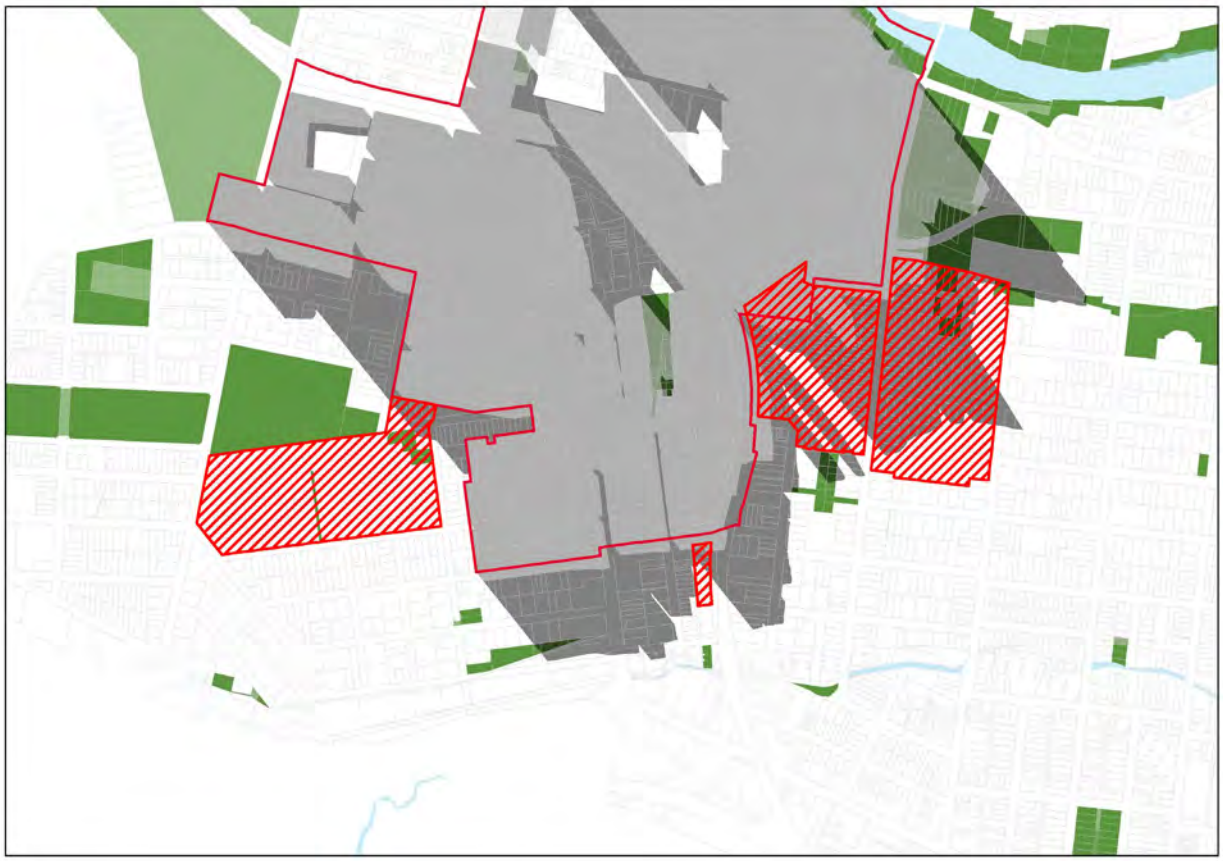


Figure 46 - Current and Proposed Controls overshadowing - 21 June - 2:30pm

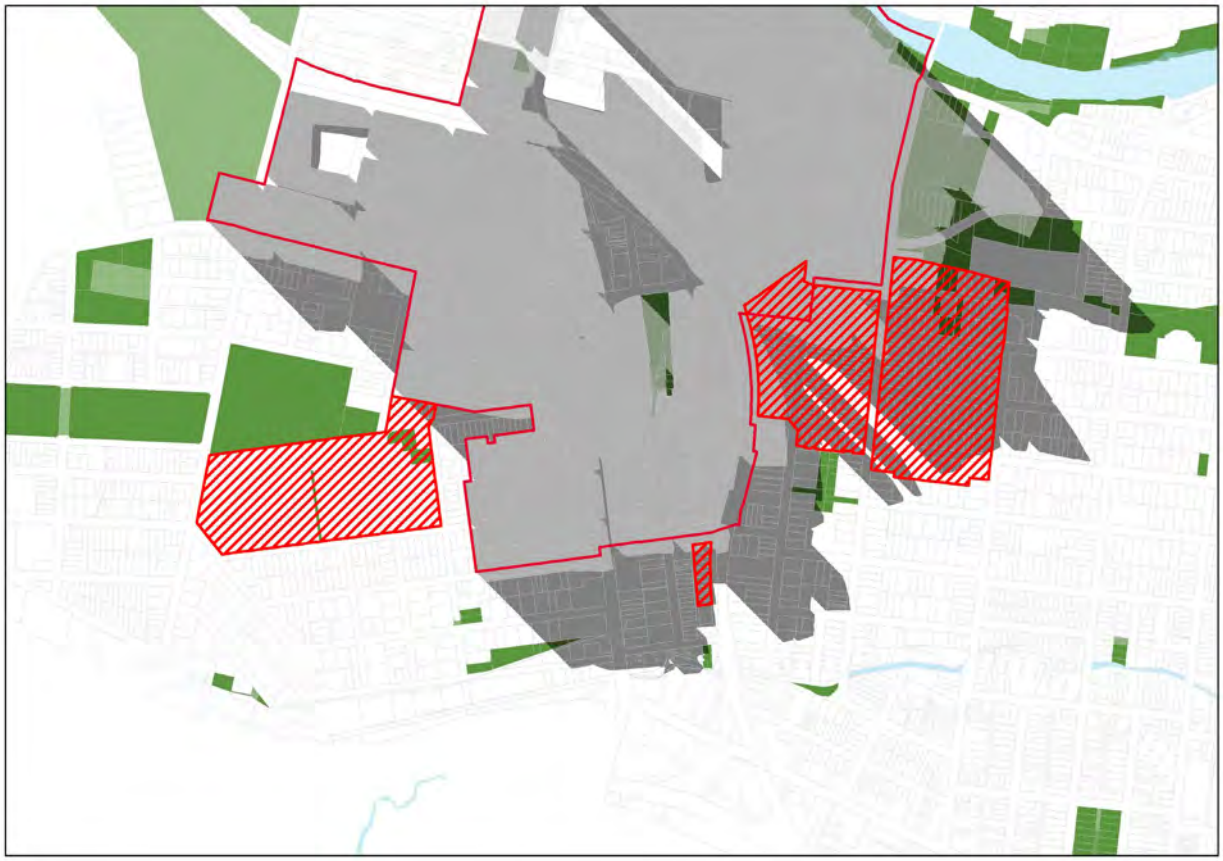


Figure 47 - Current and Proposed Controls overshadowing - 21 June - 3pm

Figure 48 - Current and Proposed Controls overshadowing - 21 June - 9am

Figure 49 - Current and Proposed Controls overshadowing - 21 June - 9am

Figure 50 - Current and Proposed Controls overshadowing - 21 June - 10am

Figure 51 - Current and Proposed Controls overshadowing - 21 June - 10:30am

Figure 52 - Current and Proposed Controls overshadowing - 21 June - 11am

Figure 53 - Current and Proposed Controls overshadowing - 21 June - 11:30am

Figure 54 - Current and Proposed Controls overshadowing - 21 June - 12-noon

Figure 55 - Current and Proposed Controls overshadowing - 21 June - 12:30pm

Figure 56 - Current and Proposed Controls overshadowing - 21 June - 1pm

Figure 57 - Current and Proposed Controls overshadowing - 21 June - 1:30pm

Figure 58 - Current and Proposed Controls overshadowing - 21 June - 2pm

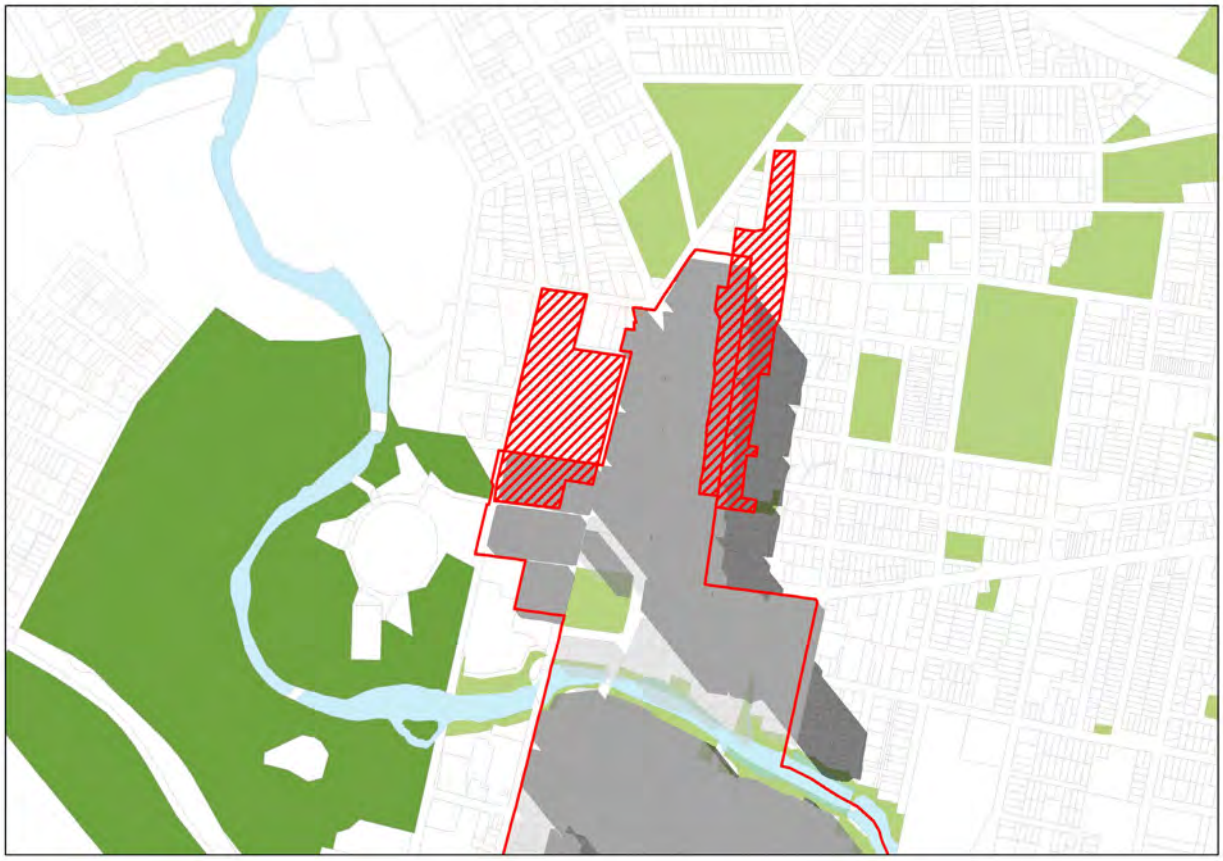


Figure 59 - Current and Proposed Controls overshadowing - 21 June - 2:30pm

Figure 60 - Current and Proposed Controls overshadowing - 21 June - 3pm

Appendix 2 – Parcel-based Assessment of Overshadowing of Heritage Conservation Areas

This Appendix contains the comparative shadow analysis for the Heritage Conservation Areas for the four heritage conservation areas to the south of the Parramatta CBD. This analysis models the overshadowing for the current Height of Buildings controls (top row) against the proposed Incentive Height of Buildings controls (bottom row) at 30-minute intervals between 9am and 3pm on 21 June.

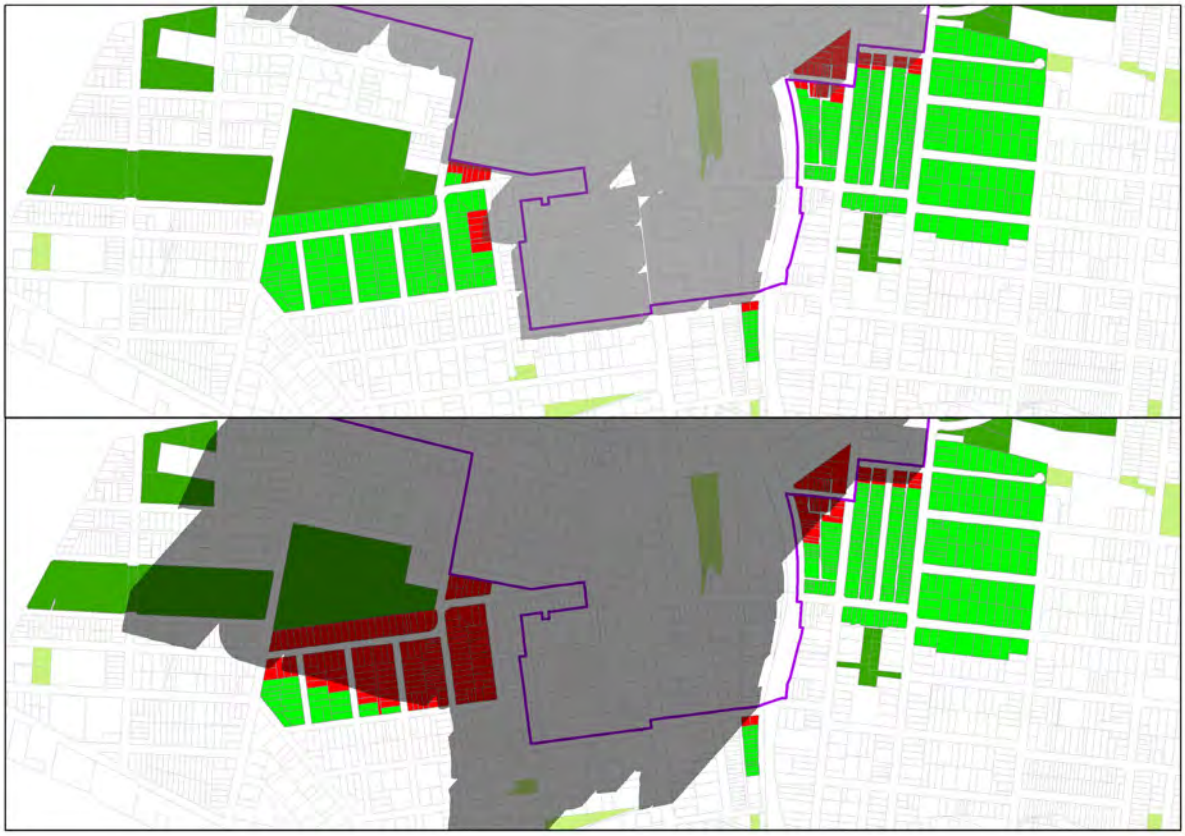


Figure 61 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 9am

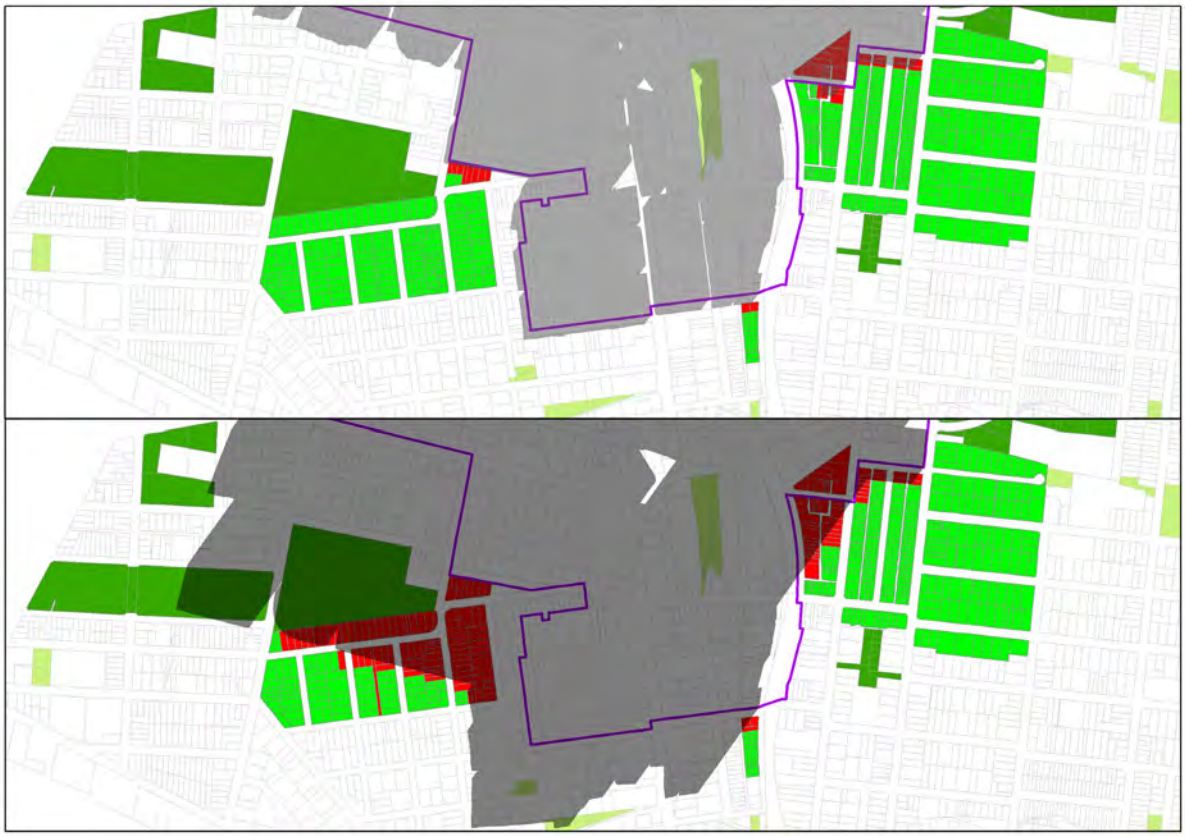


Figure 62 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June – 9:30am

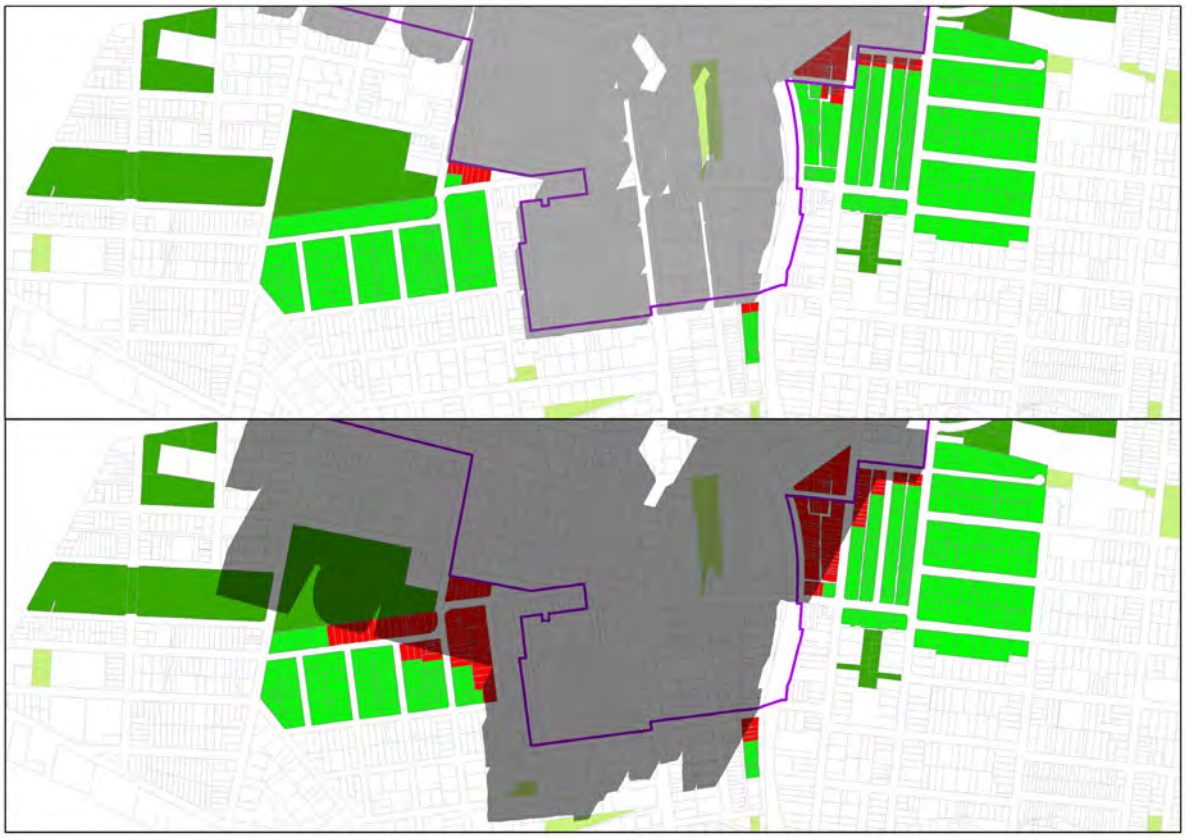


Figure 63 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 10am

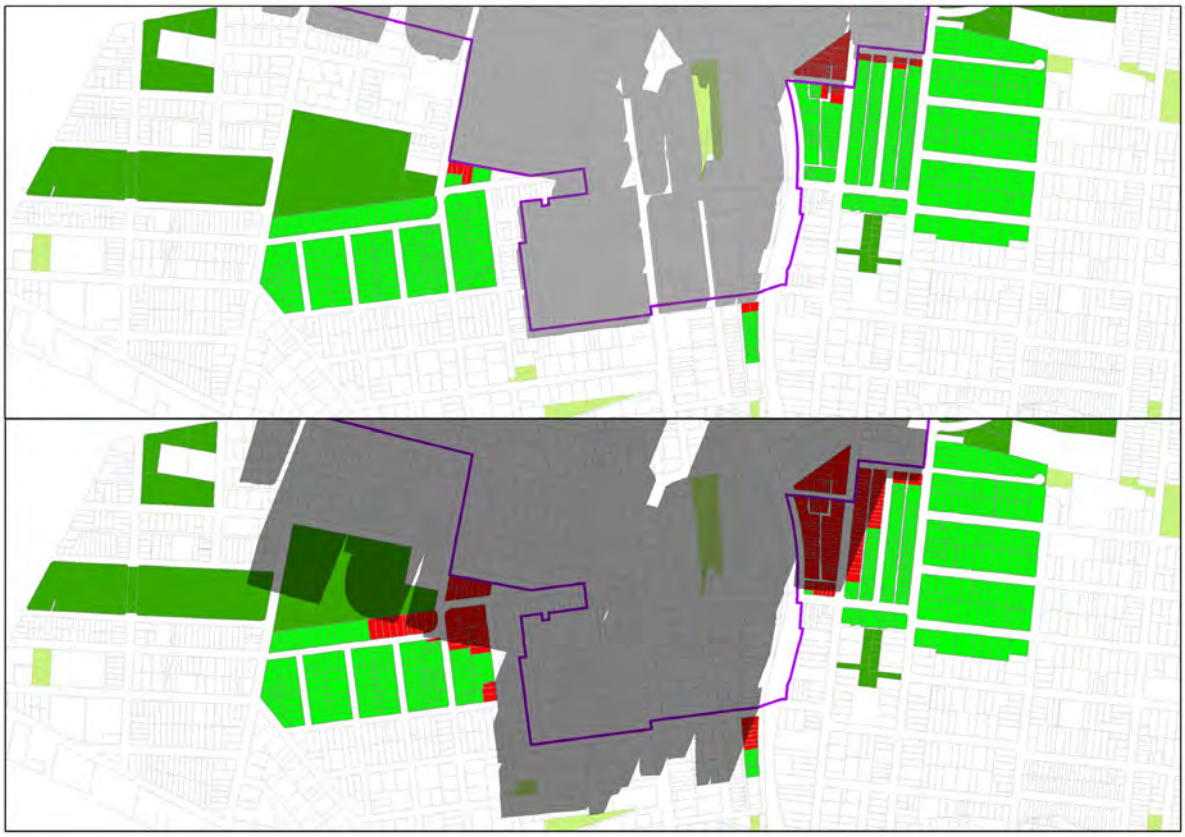


Figure 64 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 10:30am

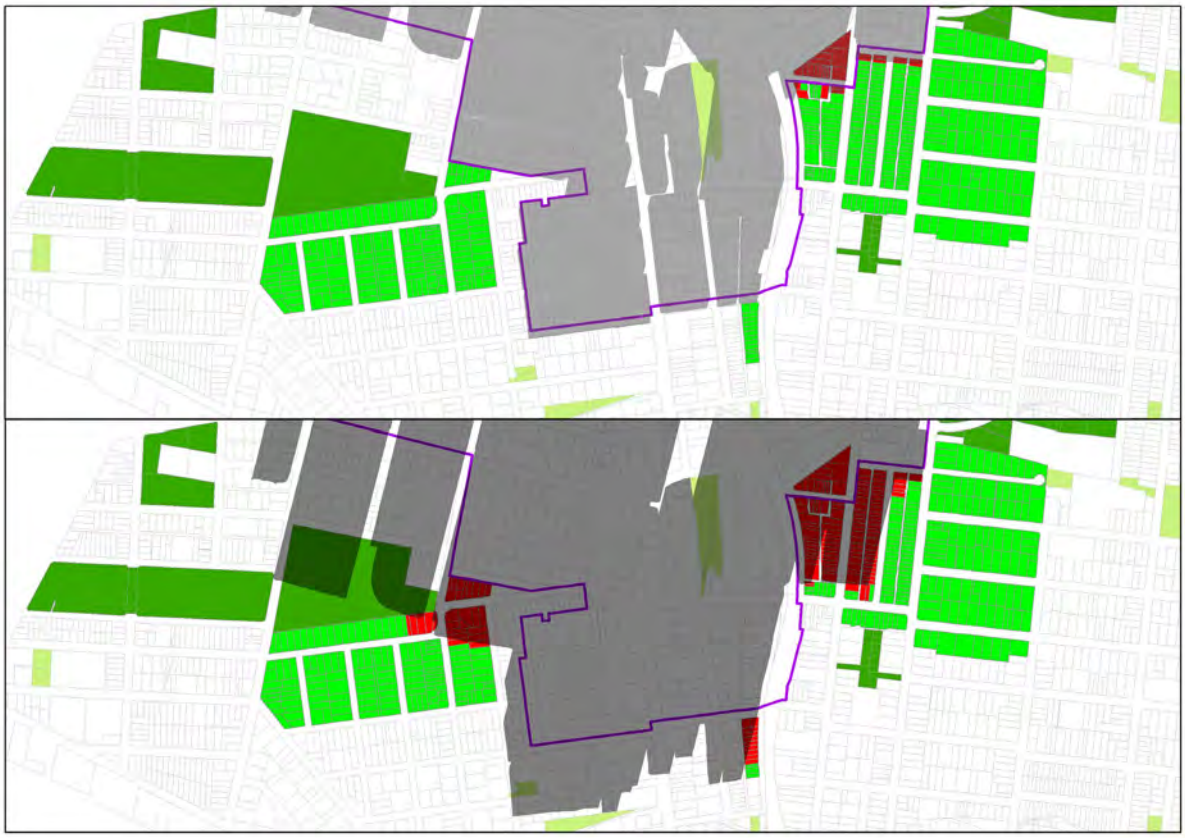


Figure 65 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 11am

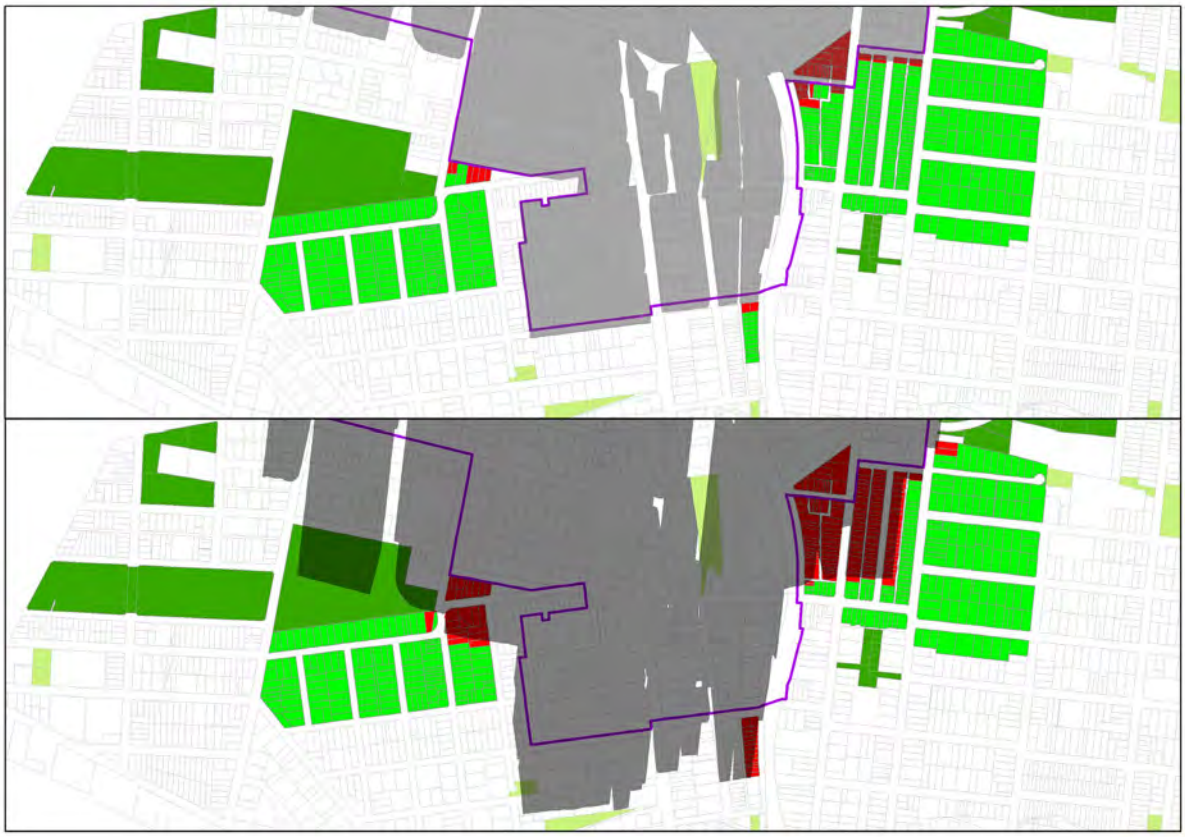


Figure 66 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 11:30am

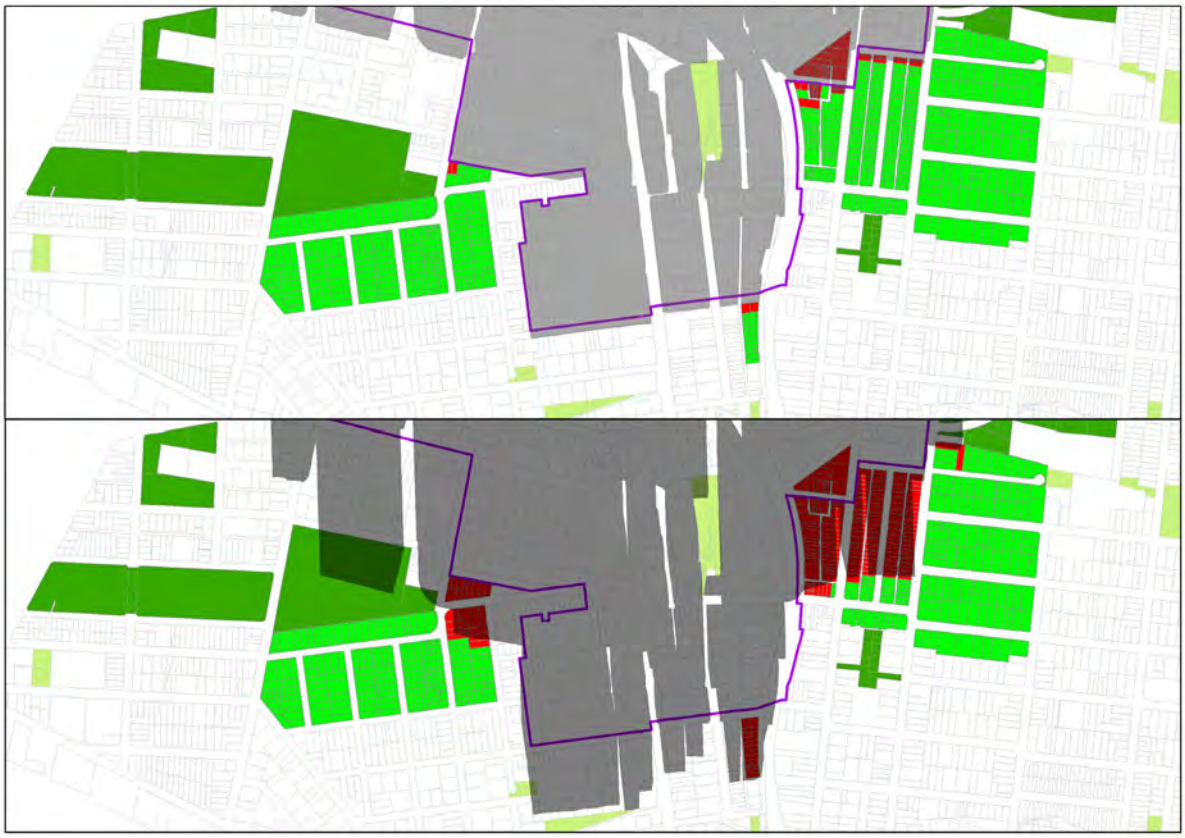


Figure 67 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 12-noon

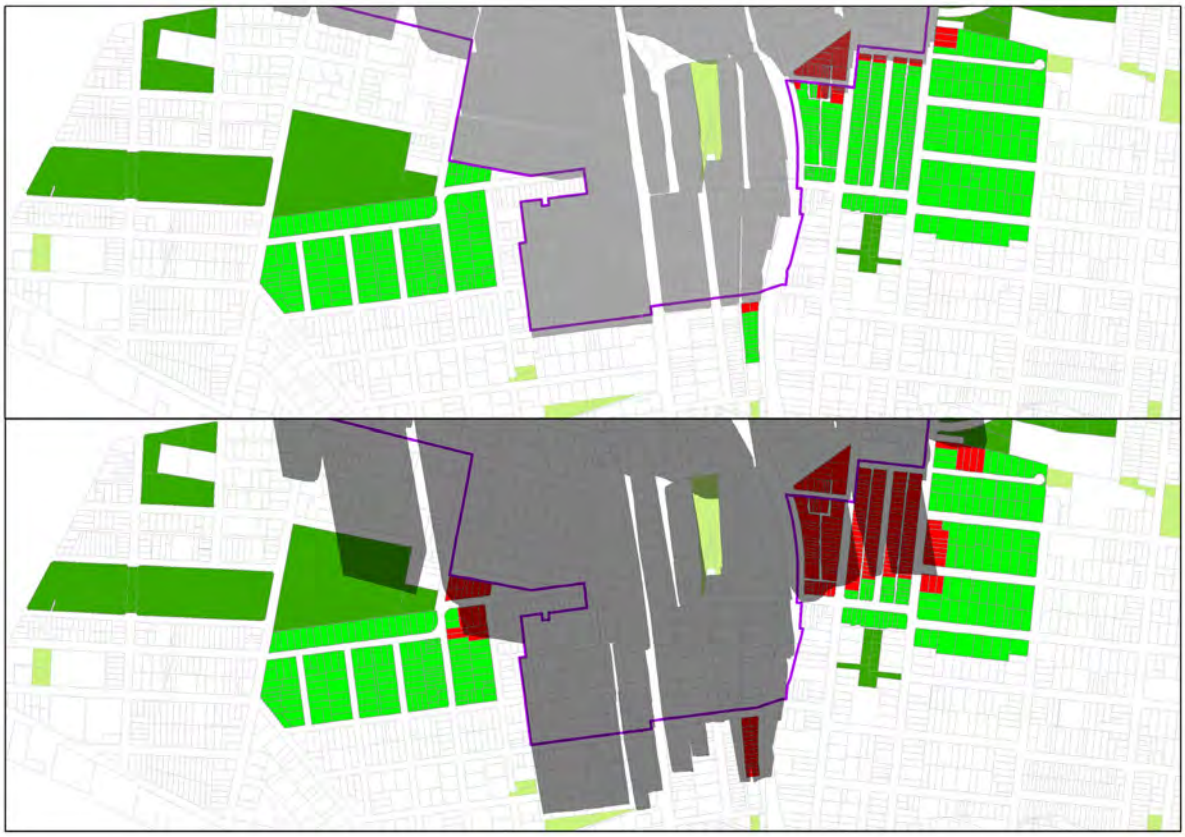


Figure 68 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 12:30pm

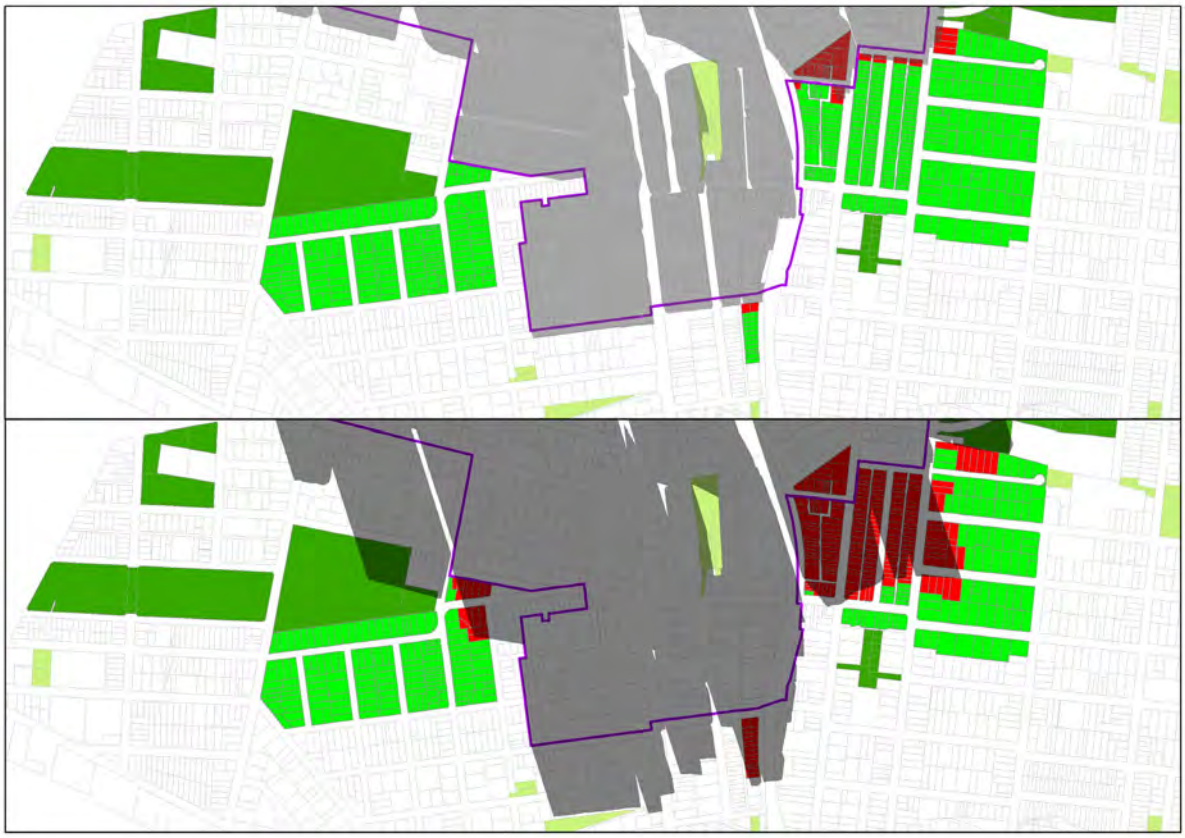


Figure 69 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 1pm

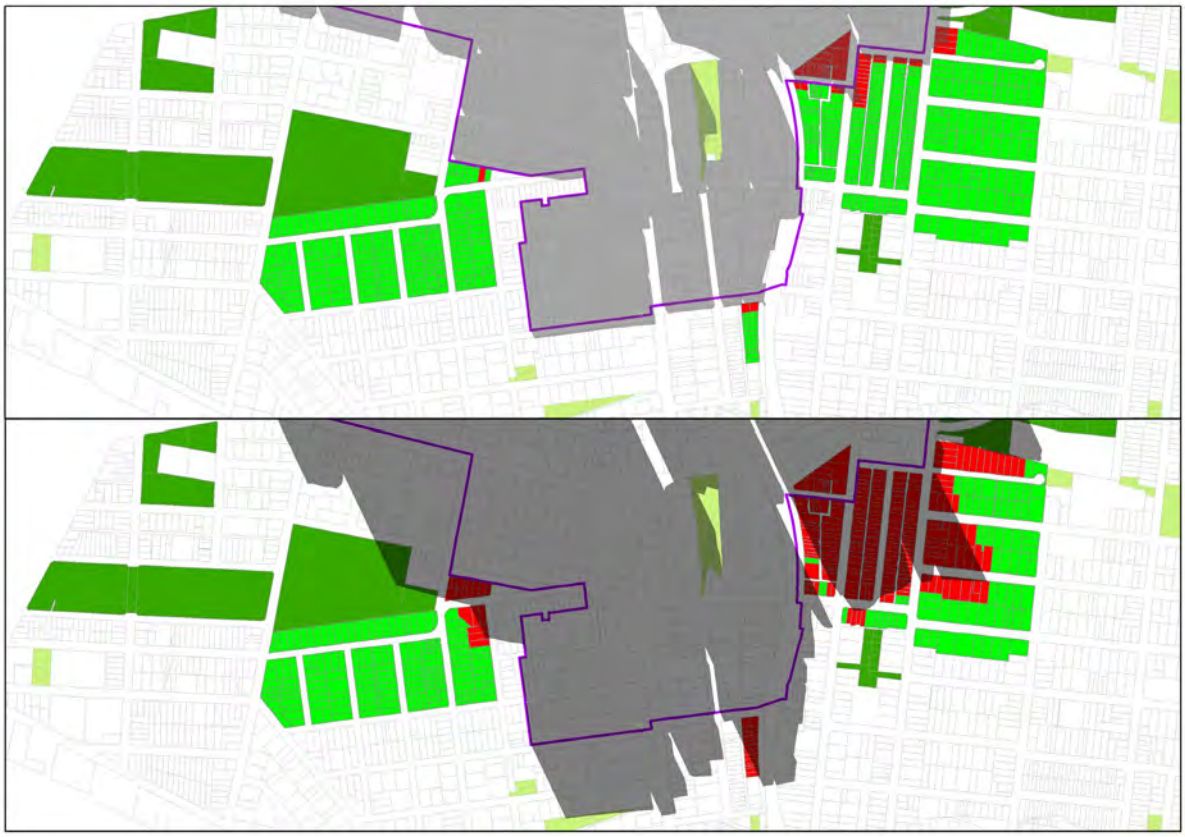


Figure 70 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 1:30pm

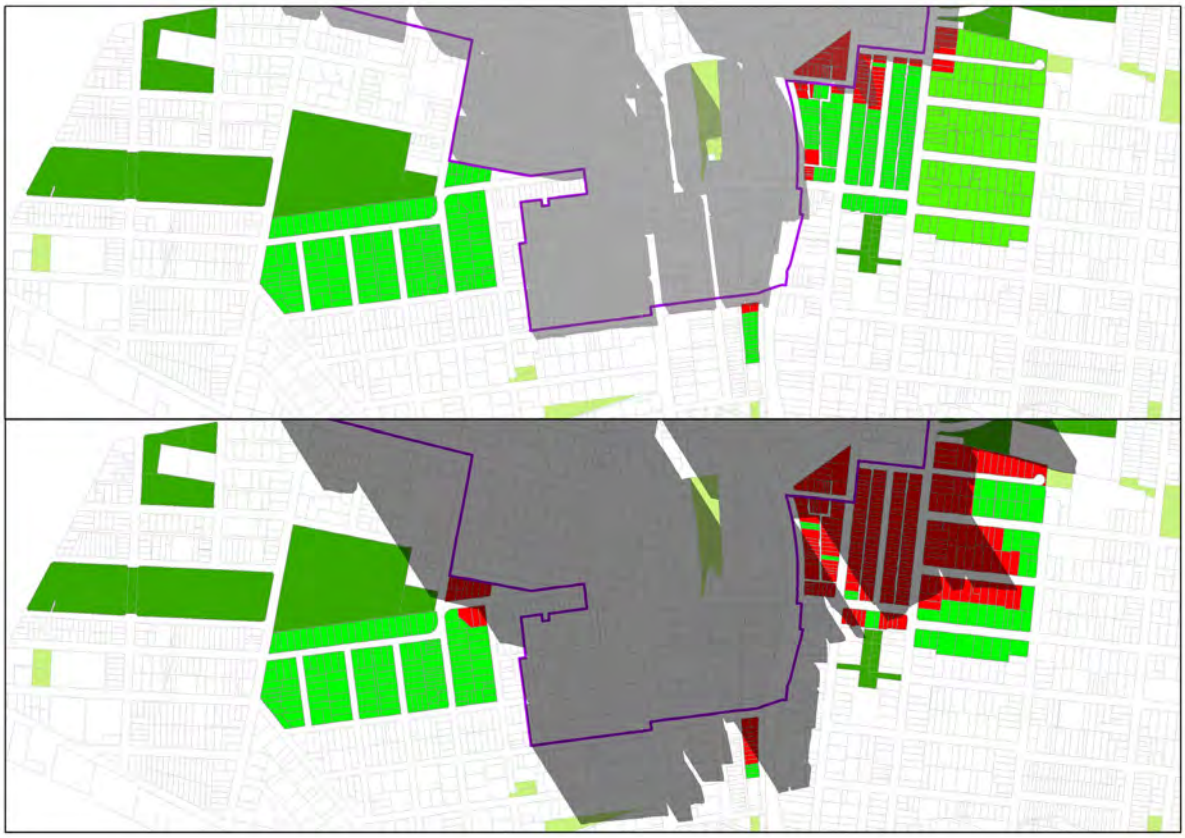


Figure 71 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 2pm

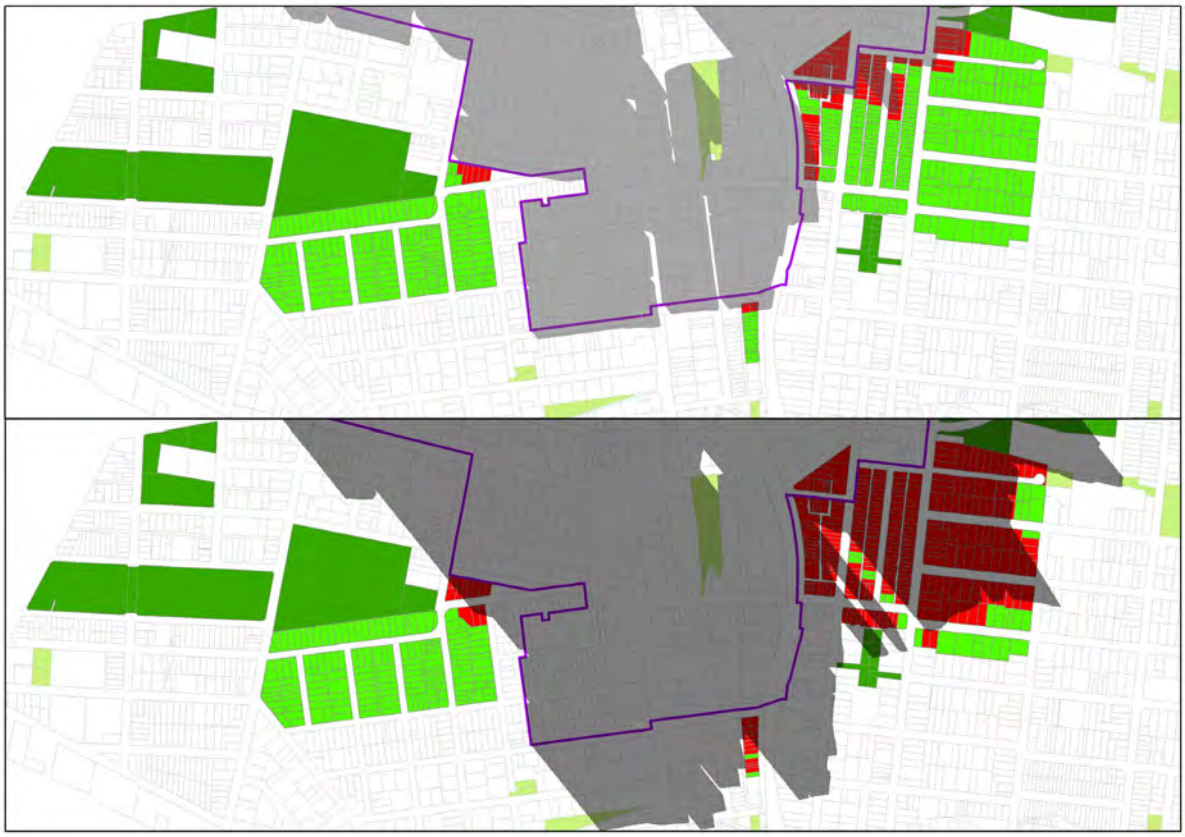


Figure 72 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 2:30pm

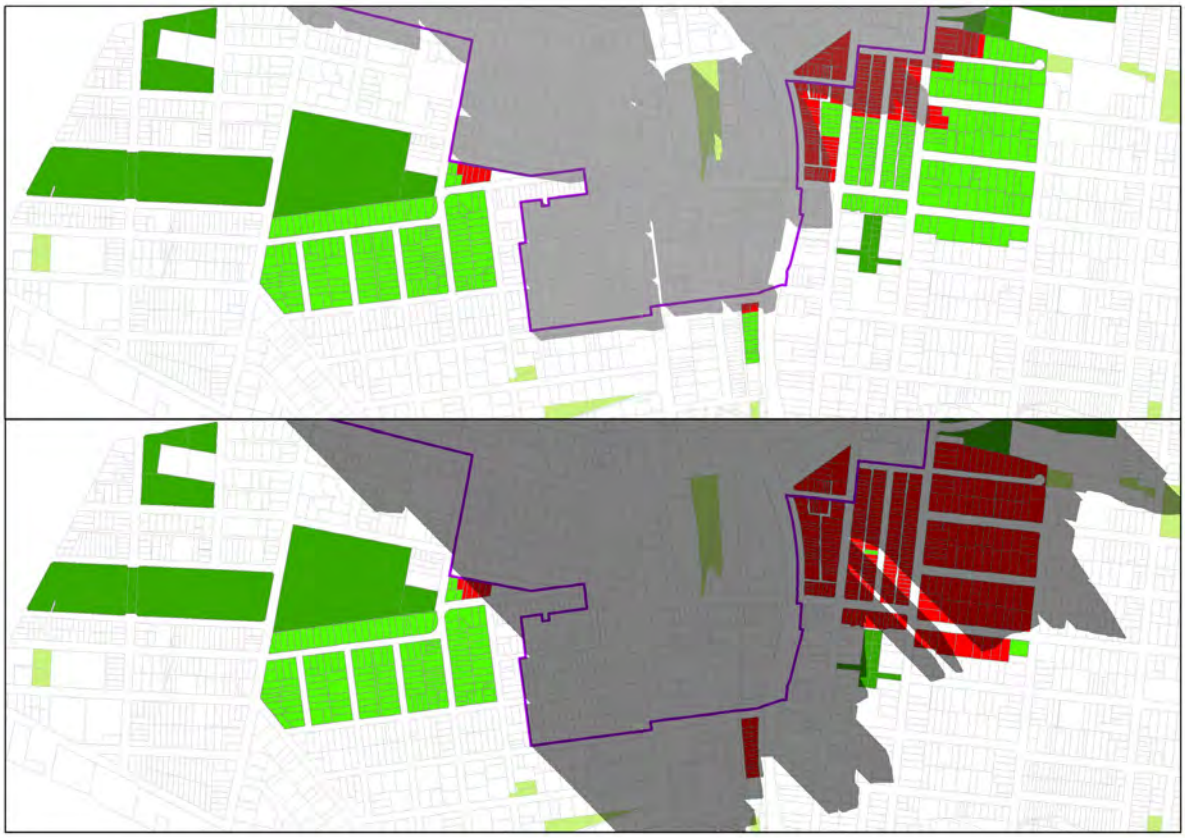


Figure 73 - Comparison of overshadowing between the Height of Buildings control in Parramatta LEP 2011 (top) and the Incentive Height of Buildings control of the CBD Planning Proposal (bottom) - 21 June - 3pm

Appendix 3 – Block Assessments

This Appendix contains the detailed assessments of the blocks for reviewing the Incentive Height of Buildings control to reduce the impacts of overshadowing on the heritage conservation areas.

Blocks A & B

Current Height: 28m

CBD PP Draft Height: 243m (RL) (NHC)

Image: NearMap

Blocks A & B

Current Height: 28m

CBD PP Draft Height: 243m (RL) (NHC)

Blocks A & B

Current Height: 28m

CBD PP Draft Height: 243m (RL) (NHC)

Images:
Google Street View

Blocks A & B

Current Height: 28m

CBD PP Draft Height: 243m (RL) (NHC)

Revised Height: 100m*

**** Revised height includes allowances for Design Excellence + HPB***

Current Height Controls

CBD PP Draft Height Controls

Revised Height Controls*

Overshadowing Analysis – June 2019

Blocks C & D

Current Height: 11m/12m

CBD PP Draft Heights: 92m (NHC)/26m/20m

Image: NearMap

Blocks C & D

Current Height: 11m/12m

CBD PP Draft Heights: 92m (NHC)/26m/20m

Overshadowing Analysis – June 2019

Blocks C & D

Current Height: 11m/12m

CBD PP Draft Heights: 92m (NHC)/26m/20m

Overshadowing Analysis – June 2019

Blocks C & D

Current Height: 11m/12m

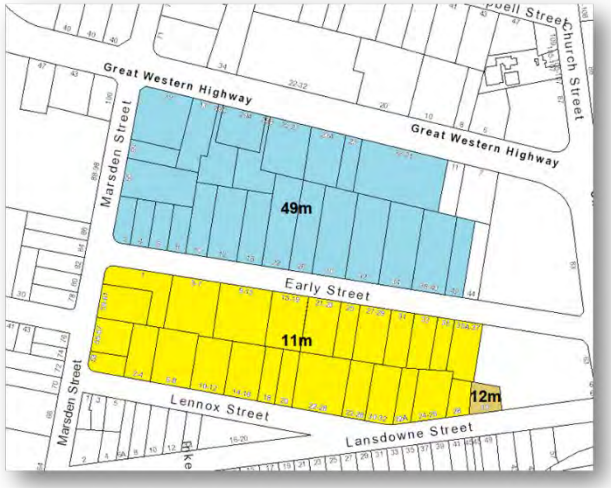
CBD PP Draft Heights: 92m (NHC)/26m/20m

Revised Heights: 49m/11m/12m*

**** Revised height includes allowances for Design Excellence + HPB***

Current Height Controls

CBD PP Draft Height Controls



Revised Height Controls*

Overshadowing Analysis – June 2019

Blocks E & F

Current Height: 12m

CBD PP Height: 12m/92m (NHC)

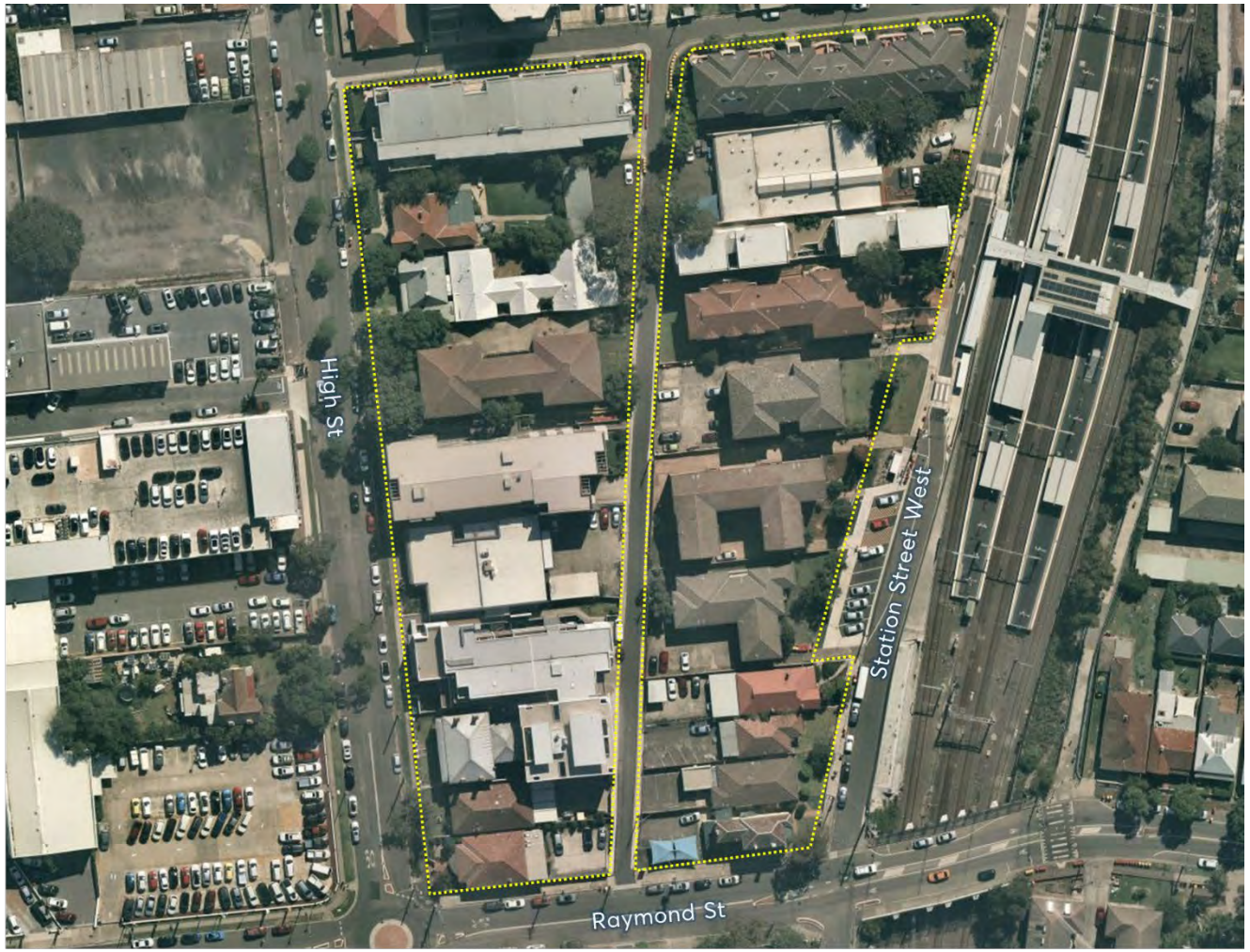
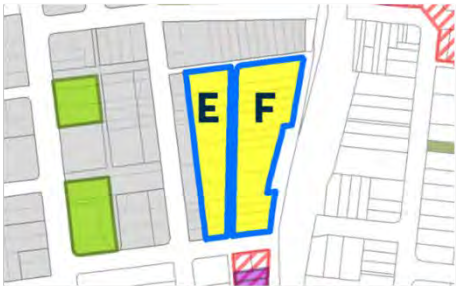


Image: NearMap

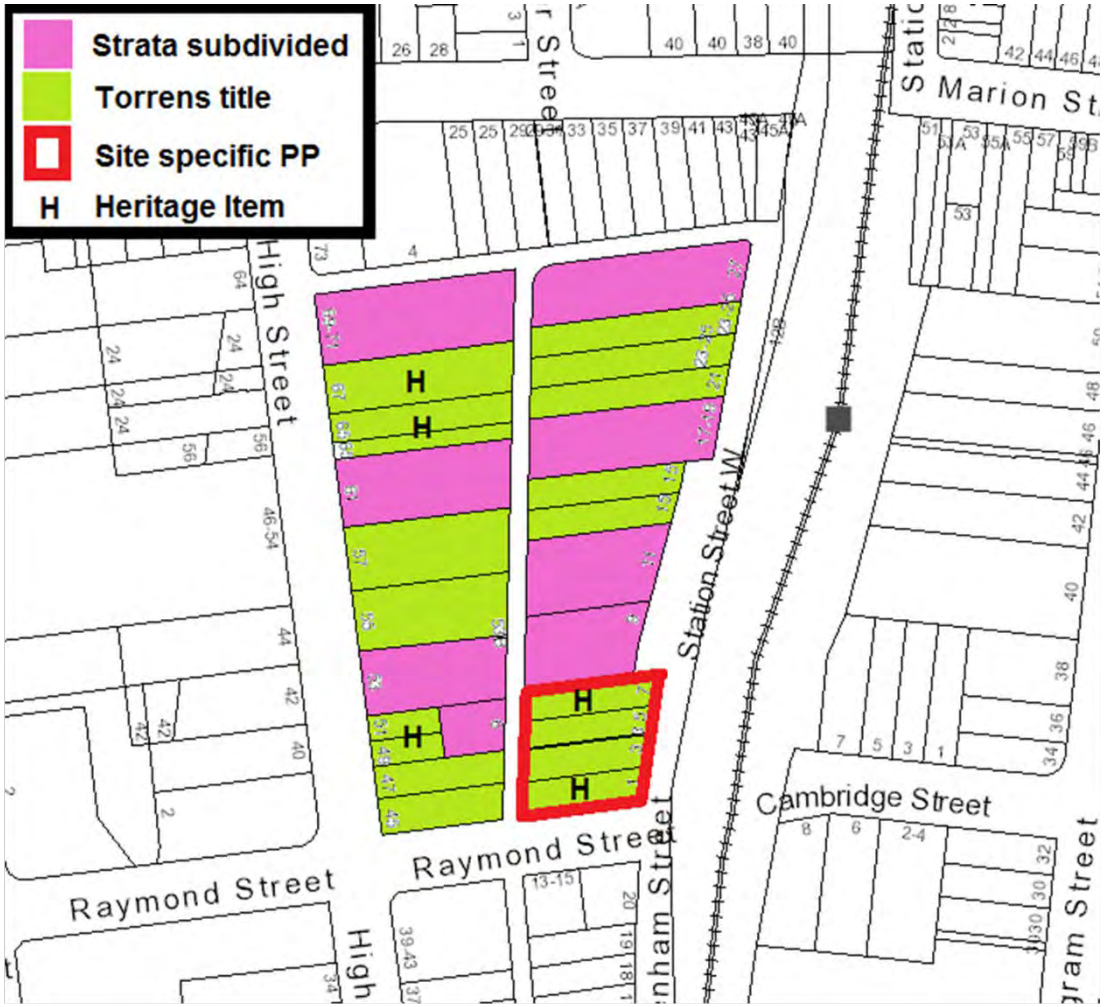
Overshadowing Analysis – June 2019

Blocks E & F



Current Height: 12m

CBD PP Height: 12m/92m (NHC)



Overshadowing Analysis – June 2019

Blocks E & F

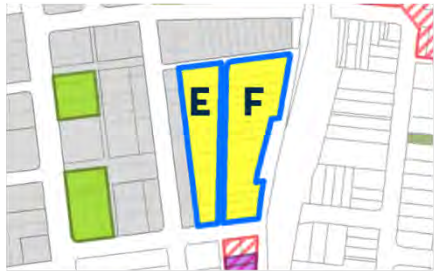
Current Height: 12m

CBD PP Height: 12m/92m (NHC)

Images: Google Street View

Overshadowing Analysis – June 2019

Blocks E & F



Current Height: 12m

CBD PP Height: 12m/92m (NHC)

Revised Height: 12m/54m/20m*

**** Revised height includes allowances for Design Excellence + HPB***

Current Height Controls

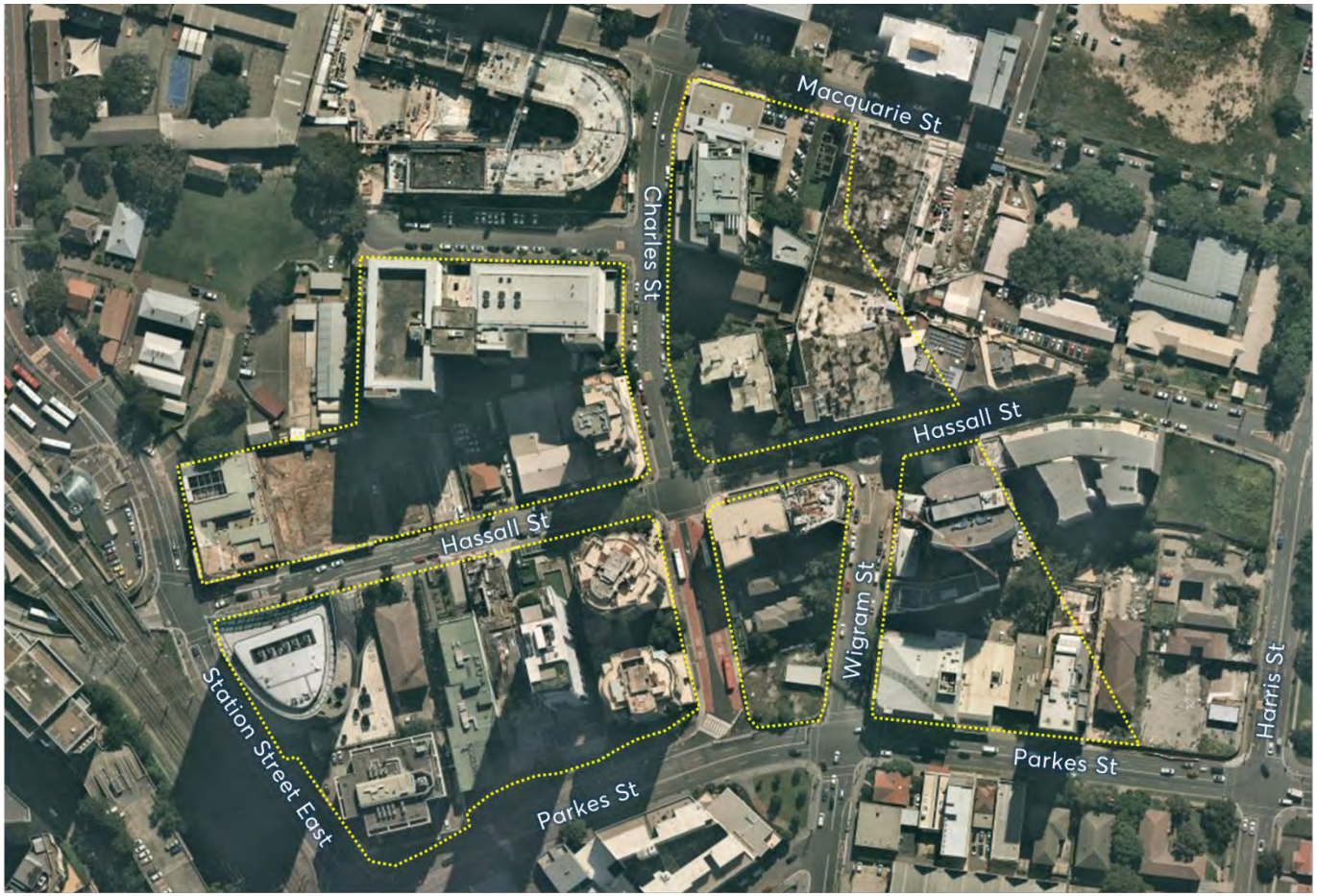
CBD PP Draft Height Controls

Revised Height Controls*

Blocks G-K

Current Height: 54m/72m/91.3m/130m

CBD PP Height: 243m (RL) (NHC)



Overshadowing Analysis – June 2019

Image: NearMap

Blocks G-K

Current Height: 54m/72m/91.3m/130m

CBD PP Height: 243m (RL) (NHC)

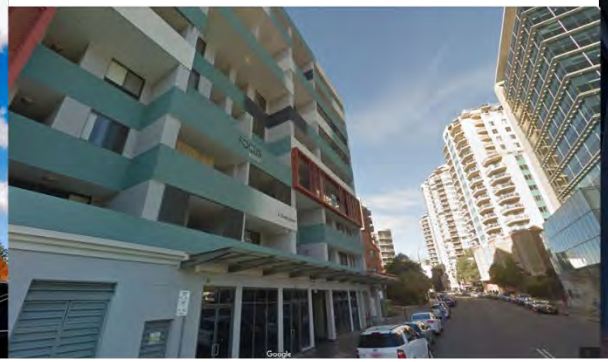
Overshadowing Analysis – June 2019

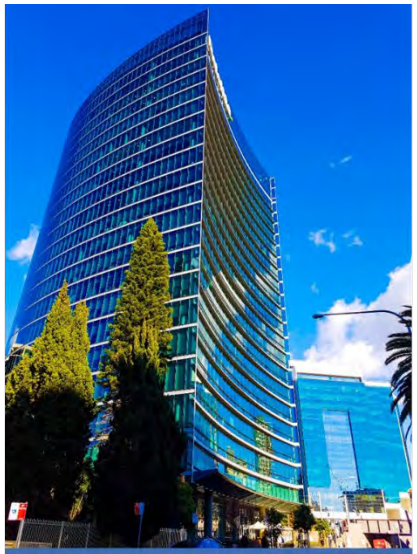
Blocks G-K

Current Height: 54m/72m/91.3m/130m

CBD PP Height: 243m (RL) (NHC)

Overshadowing Analysis – June 2019





Images:
Google Street View/Officers

Blocks G-K

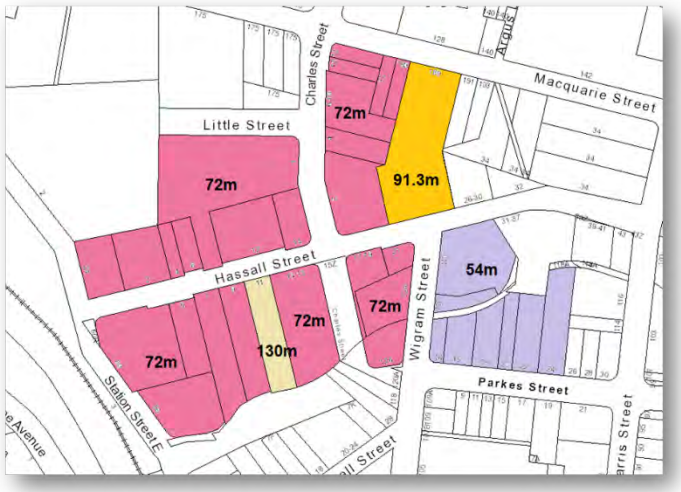
Current Height: 54m/72m/91.3m/130m

CBD PP Height: 243m (RL) (NHC)

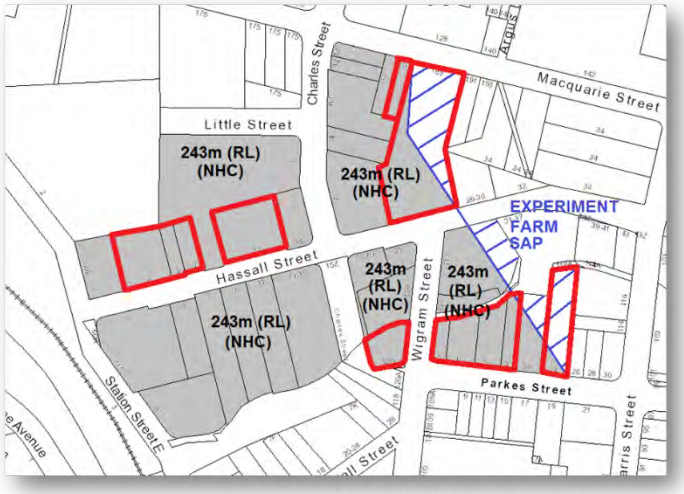
Revised Height: 72m/80m/ 90m/130m/167m/192m*

**** Revised height includes allowances for Design Excellence + HPB***

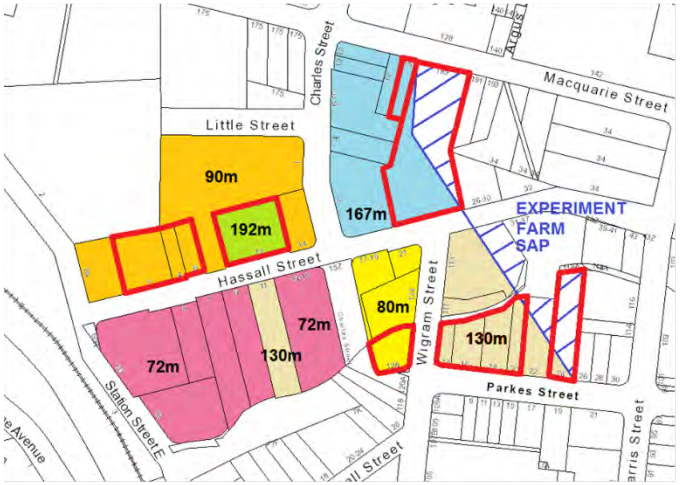
Overshadowing Analysis – June 2019



Current Height Controls



CBD PP Draft Height Controls



Revised Height Controls*

Appendix 4 – Parcel-based Assessment of Overshadowing of Heritage Conservation Areas with revised Incentive Height of Buildings controls

This Appendix contains the comparative shadow analysis for the Heritage Conservation Areas for the four heritage conservation areas to the south of the Parramatta CBD. This analysis models the overshadowing for the Incentive Height of Buildings controls (top row) within the CBD Planning Proposal against the revised Incentive Height of Buildings controls (bottom row) at 30-minute intervals between 9am and 3pm on 21 June.

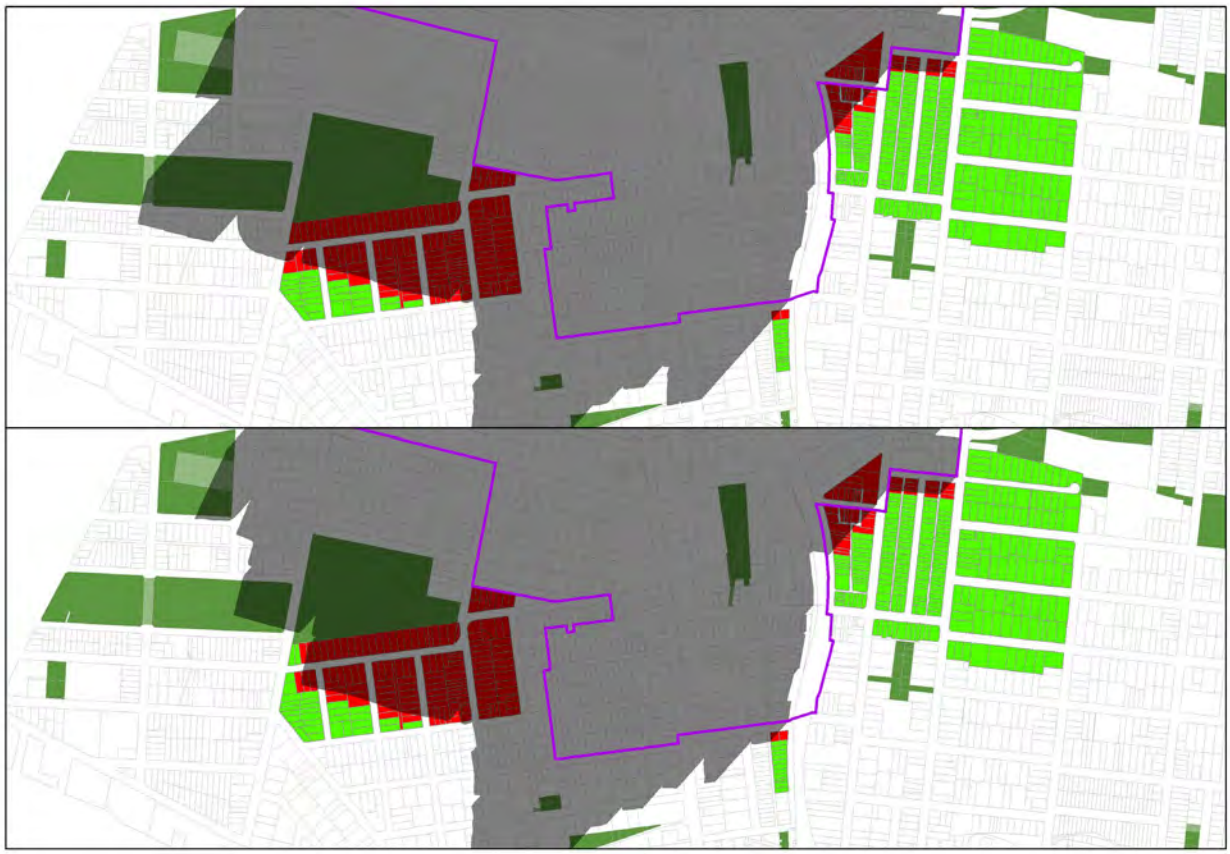


Figure 74 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 9am

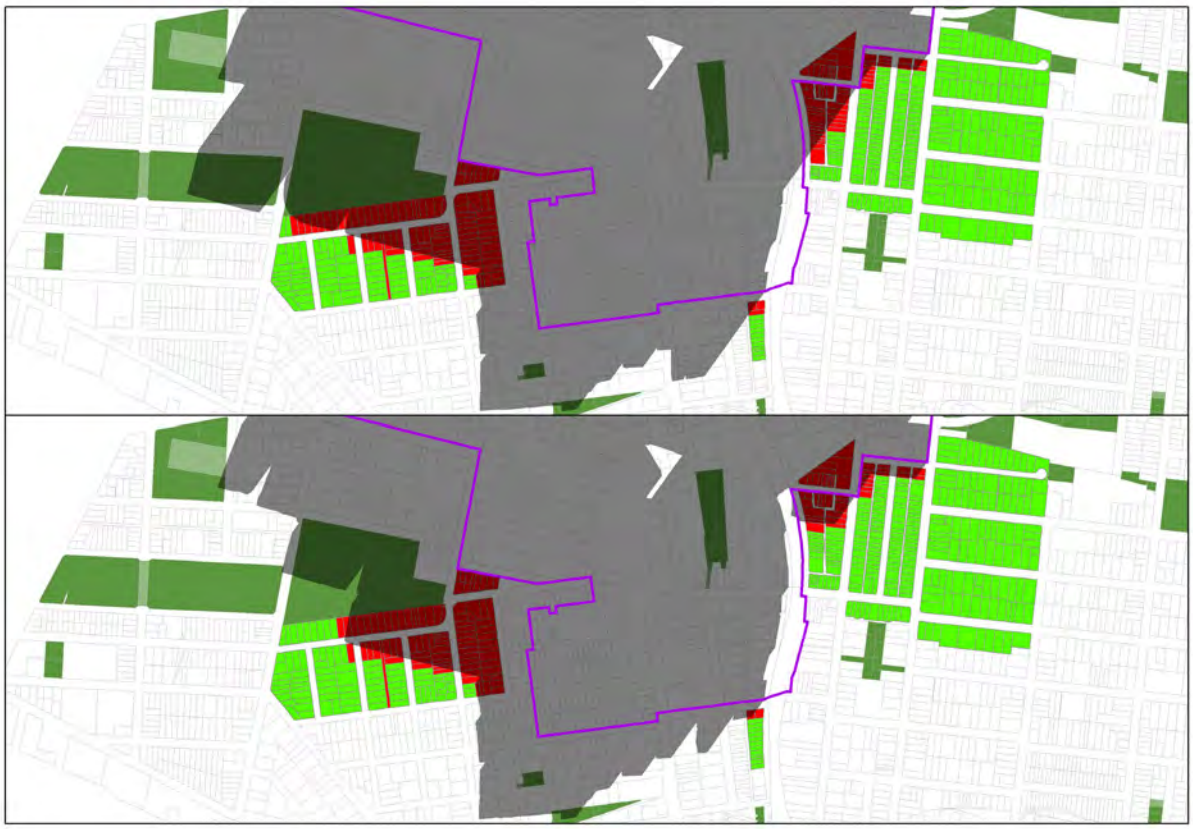


Figure 75 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 9:30am

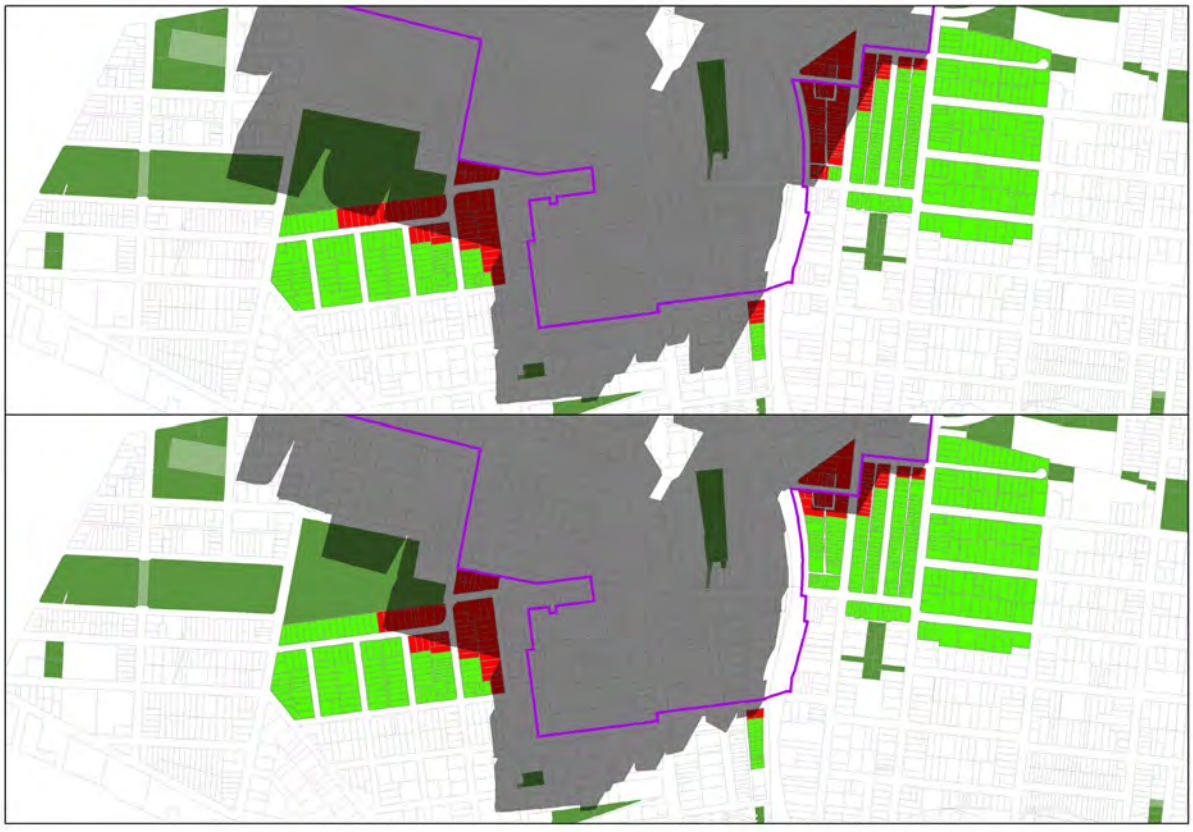


Figure 76 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 10am

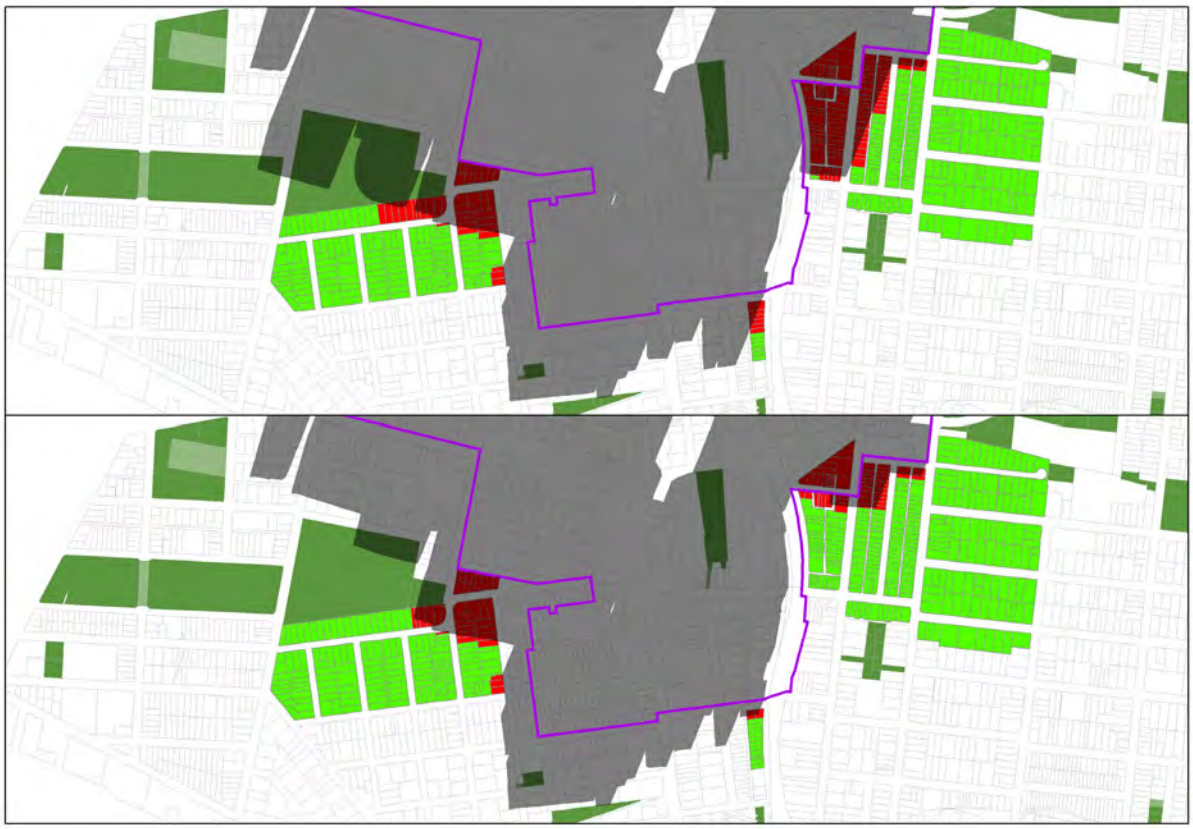


Figure 77 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 10:30am

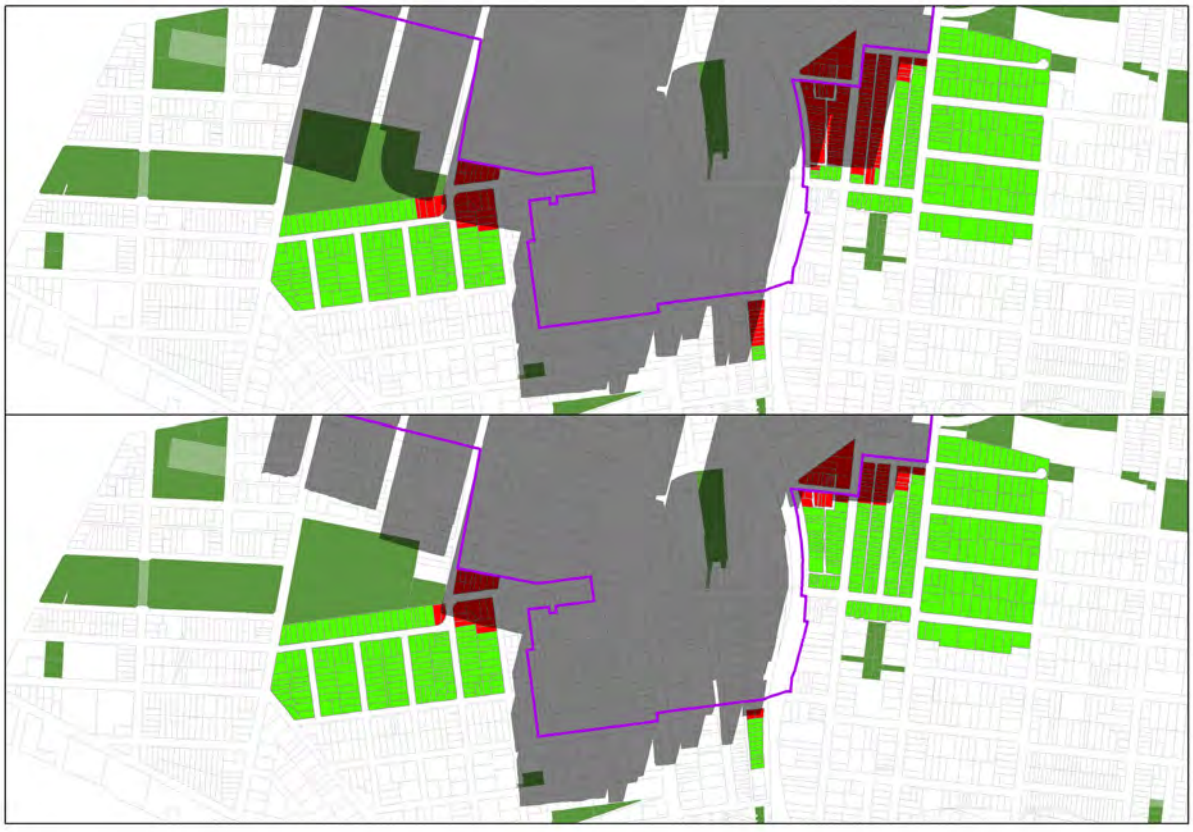


Figure 78 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 11am

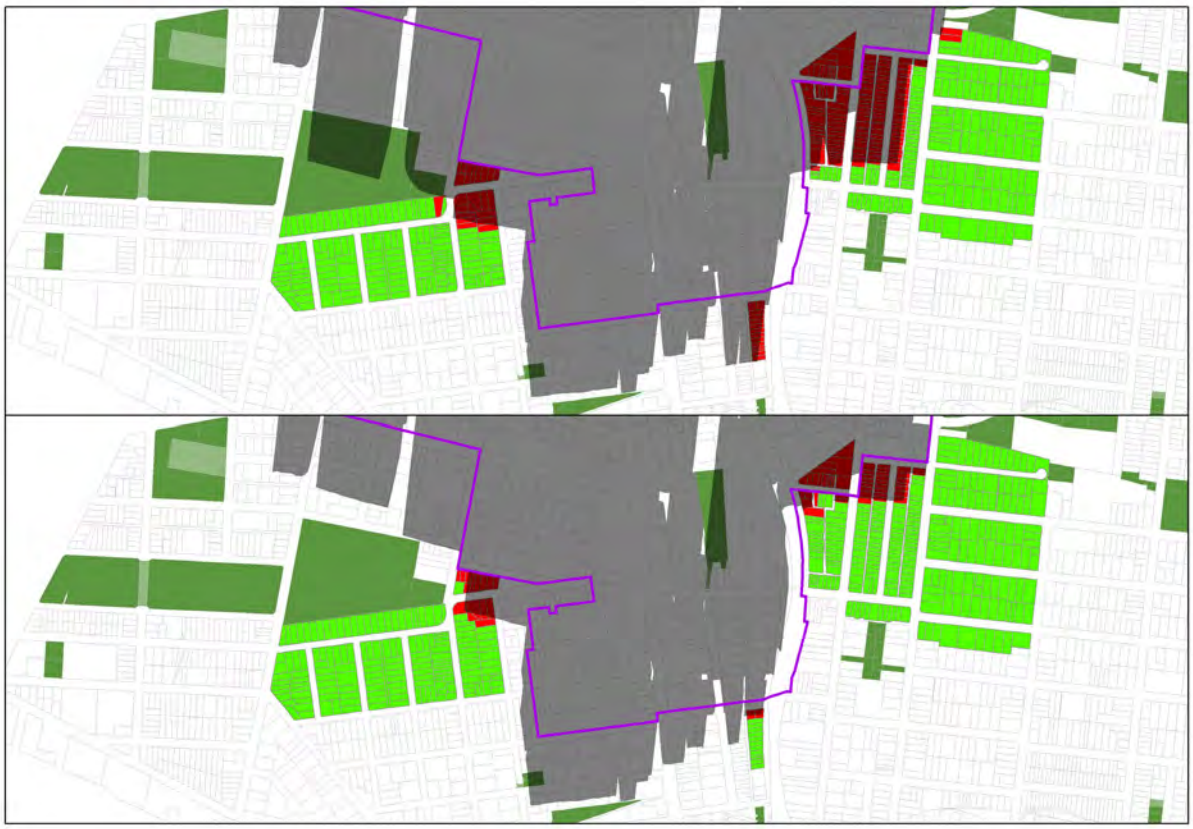


Figure 79 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 11:30am

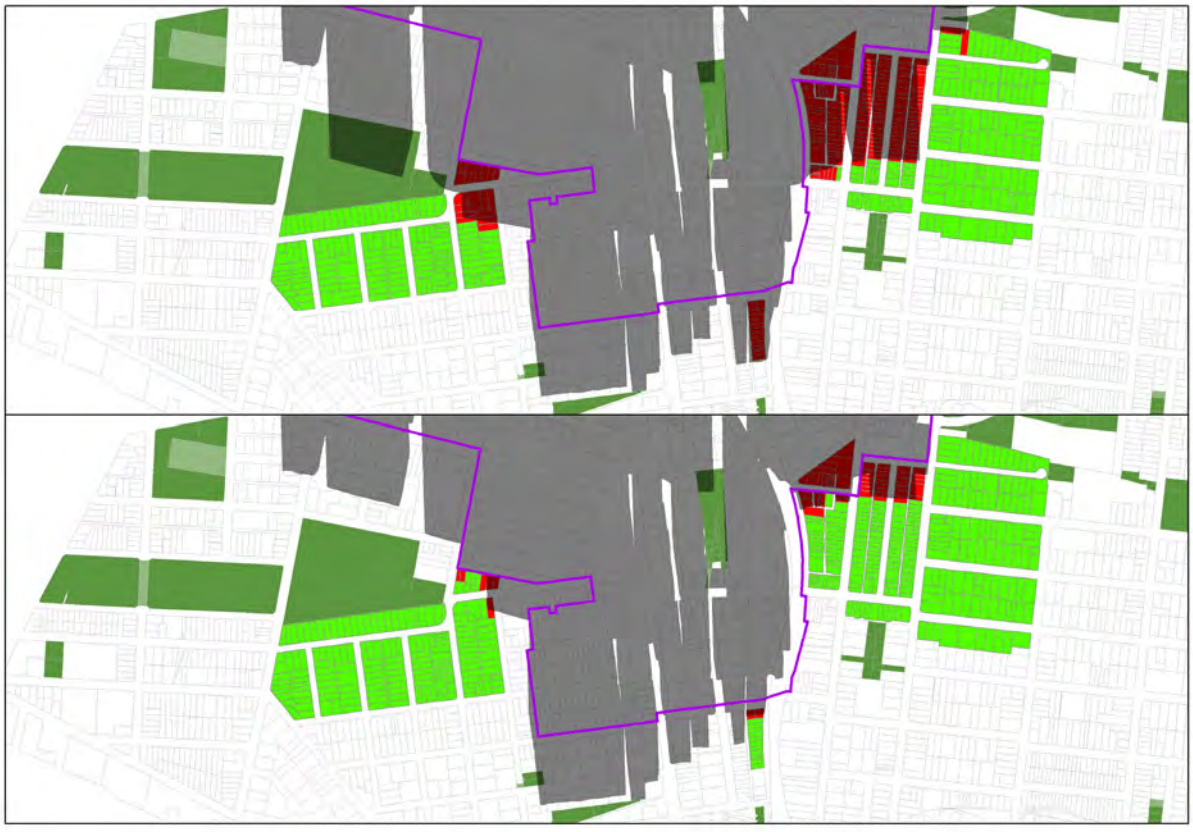


Figure 80 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 12-noon

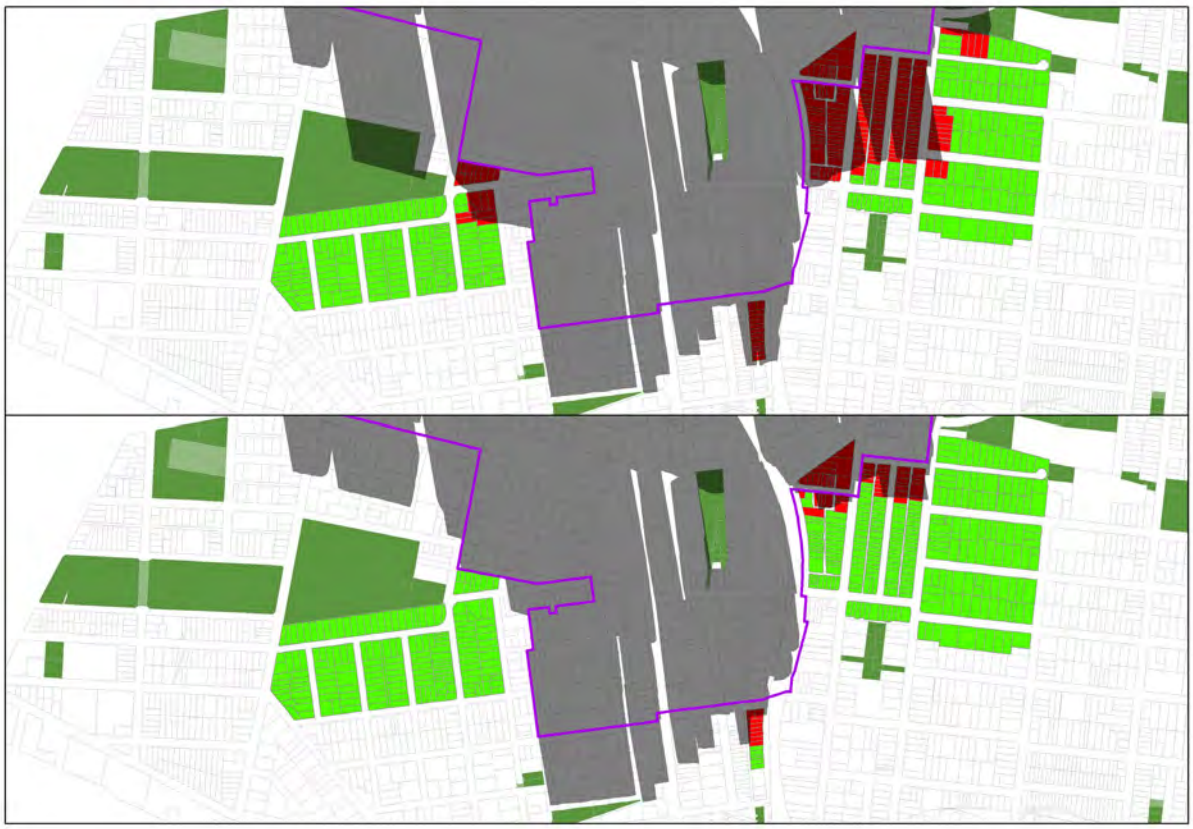


Figure 81 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 12:30pm

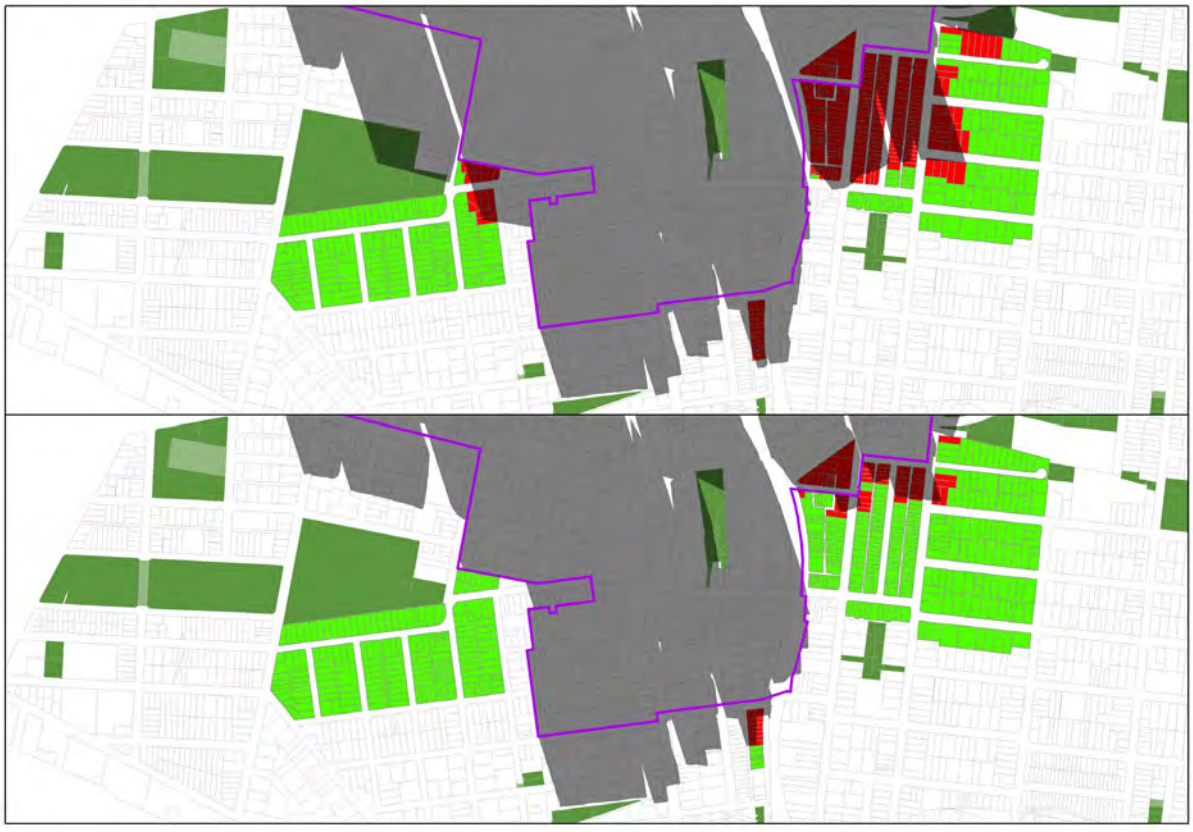


Figure 82 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 1pm

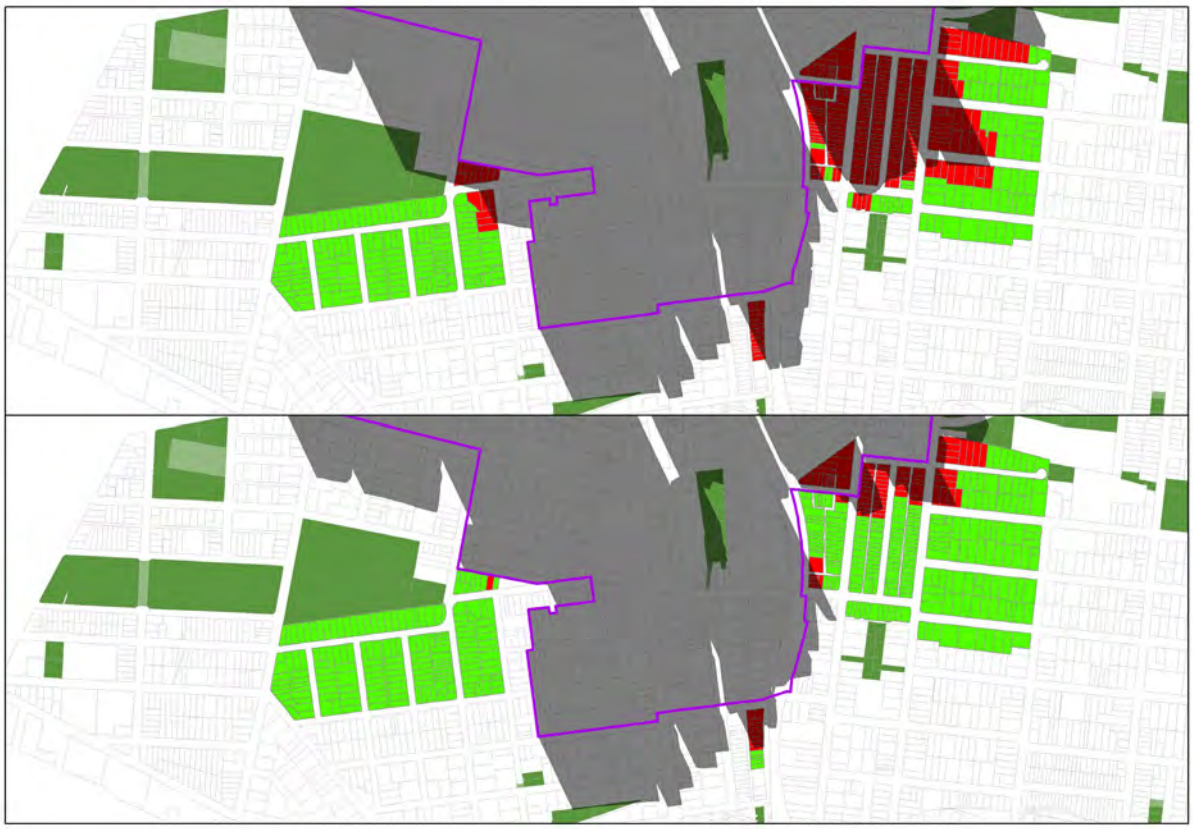


Figure 83 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 1:30pm

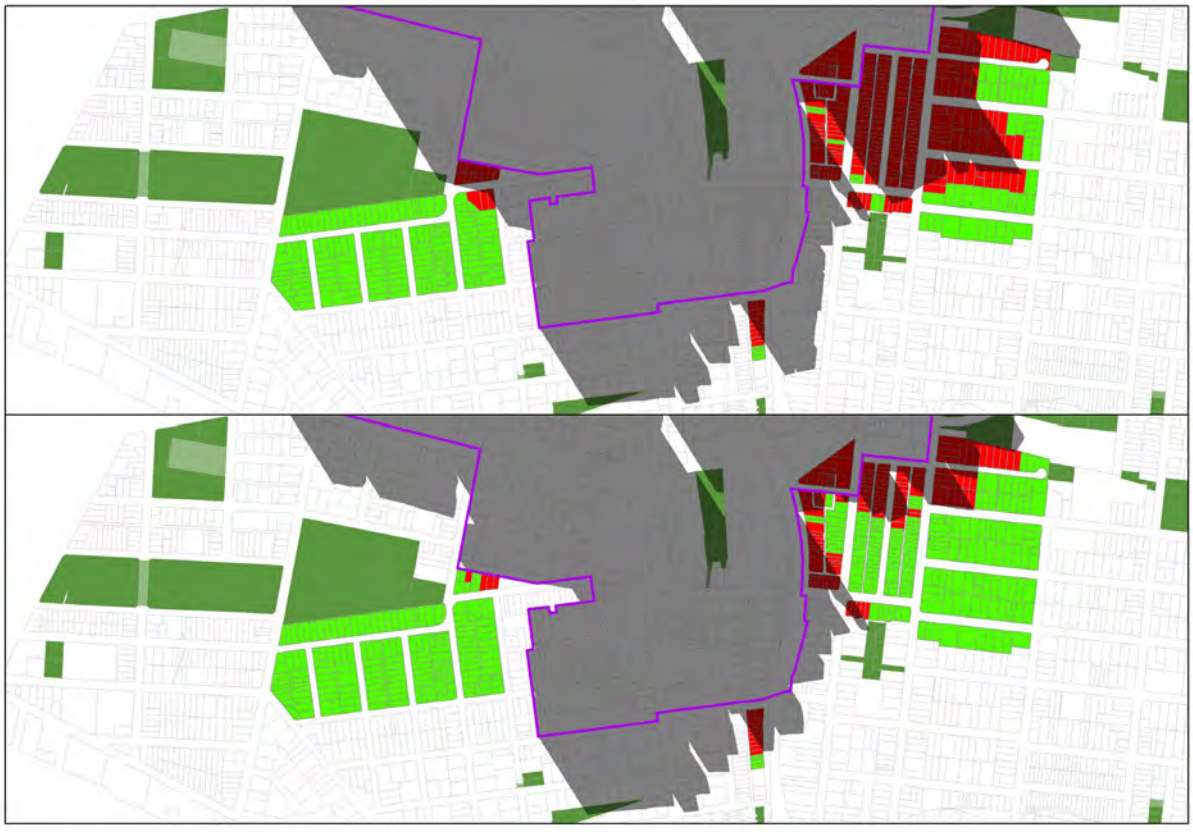


Figure 84 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 2pm

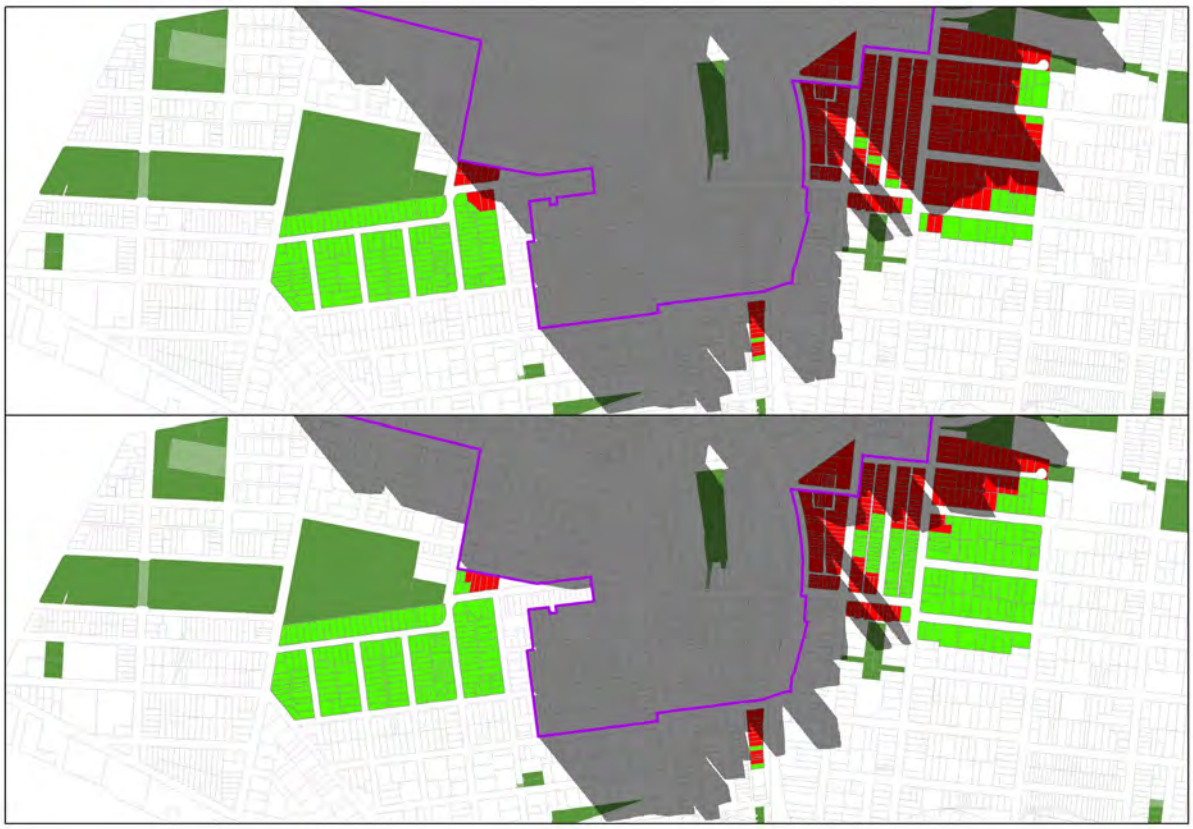


Figure 85 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 2:30pm

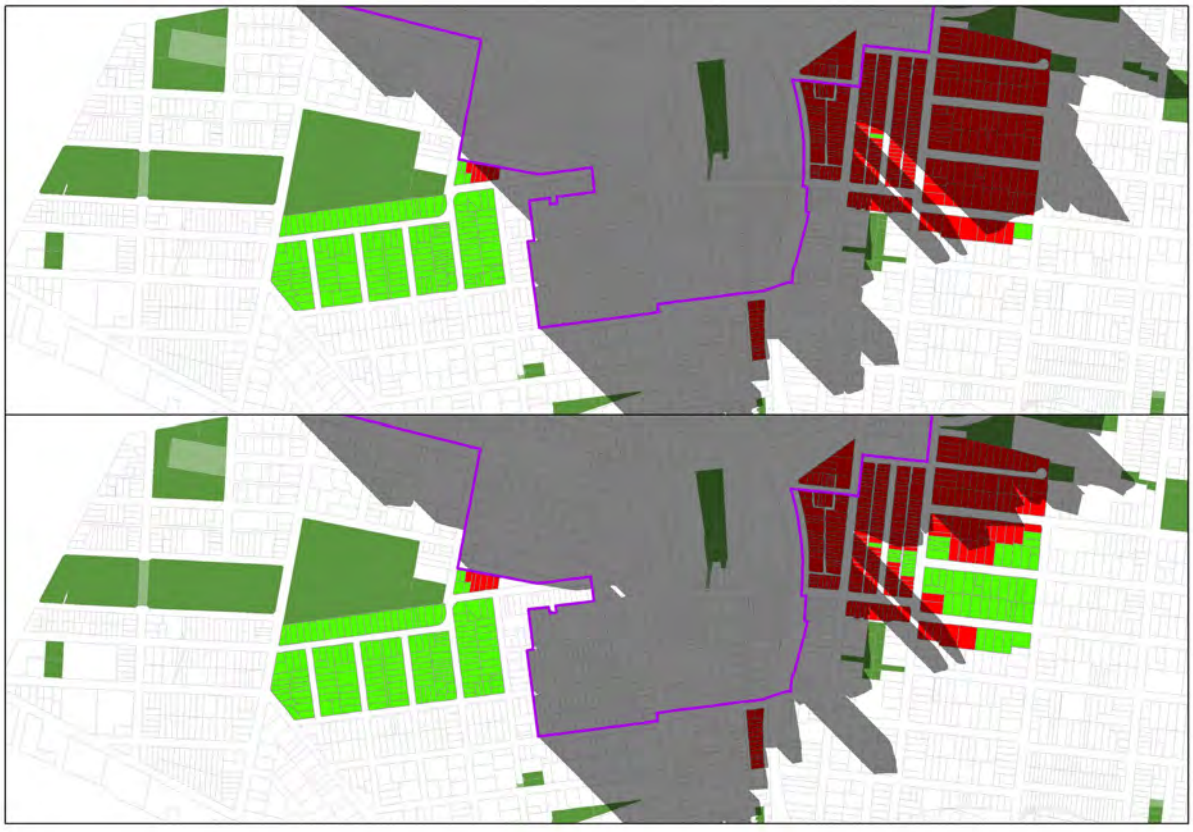


Figure 86 - Comparison of overshadowing between the Incentive Height of Buildings control in the CBD Planning Proposal (top) and the proposed revisions to the Incentive Height of Buildings control (bottom) - 21 June - 3pm

Appendix 5 – Overshadowing of Public Open Space areas

This Appendix contains the comparative shadow analysis for the ten public open spaces identified generally to the south of the Parramatta CBD. This analysis models the overshadowing for the current Height of Buildings controls (light grey) against the proposed Incentive Height of Buildings controls (dark grey) at 30-minute intervals between 9am and 3pm on 21 June.

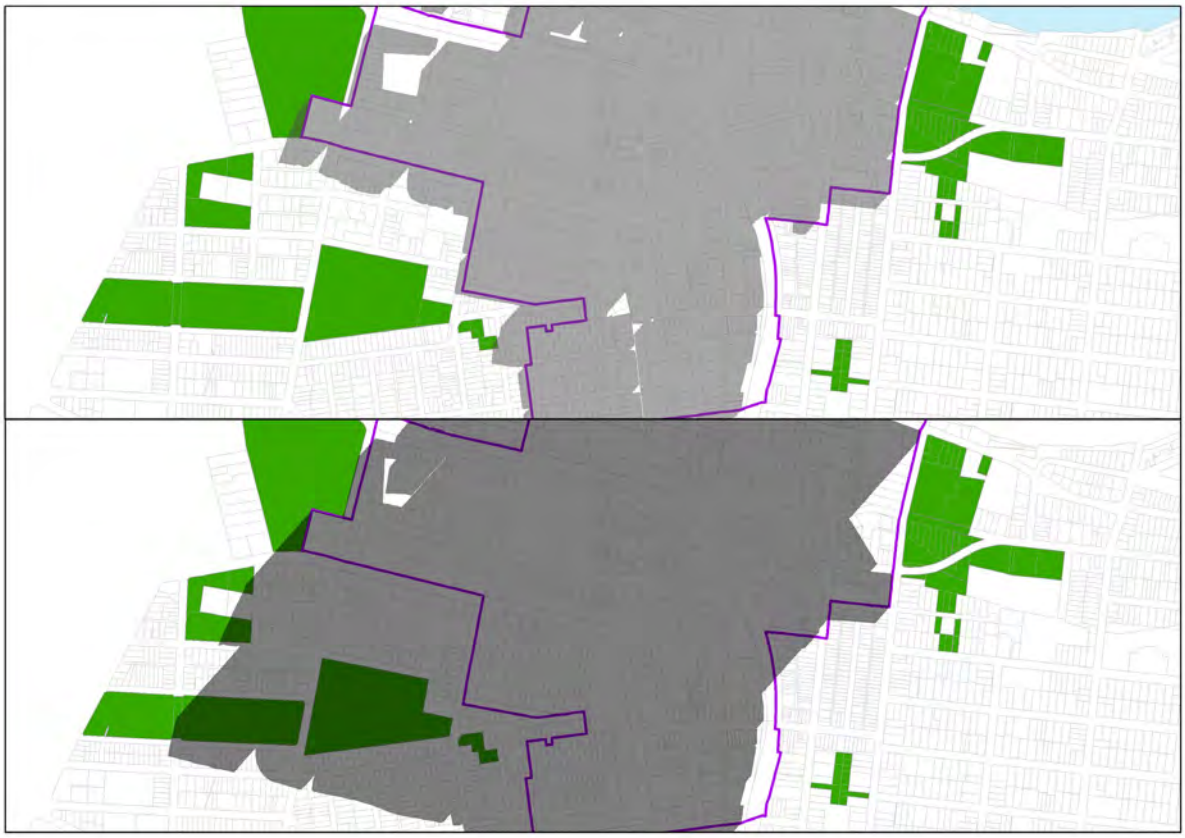


Figure 87 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 9am

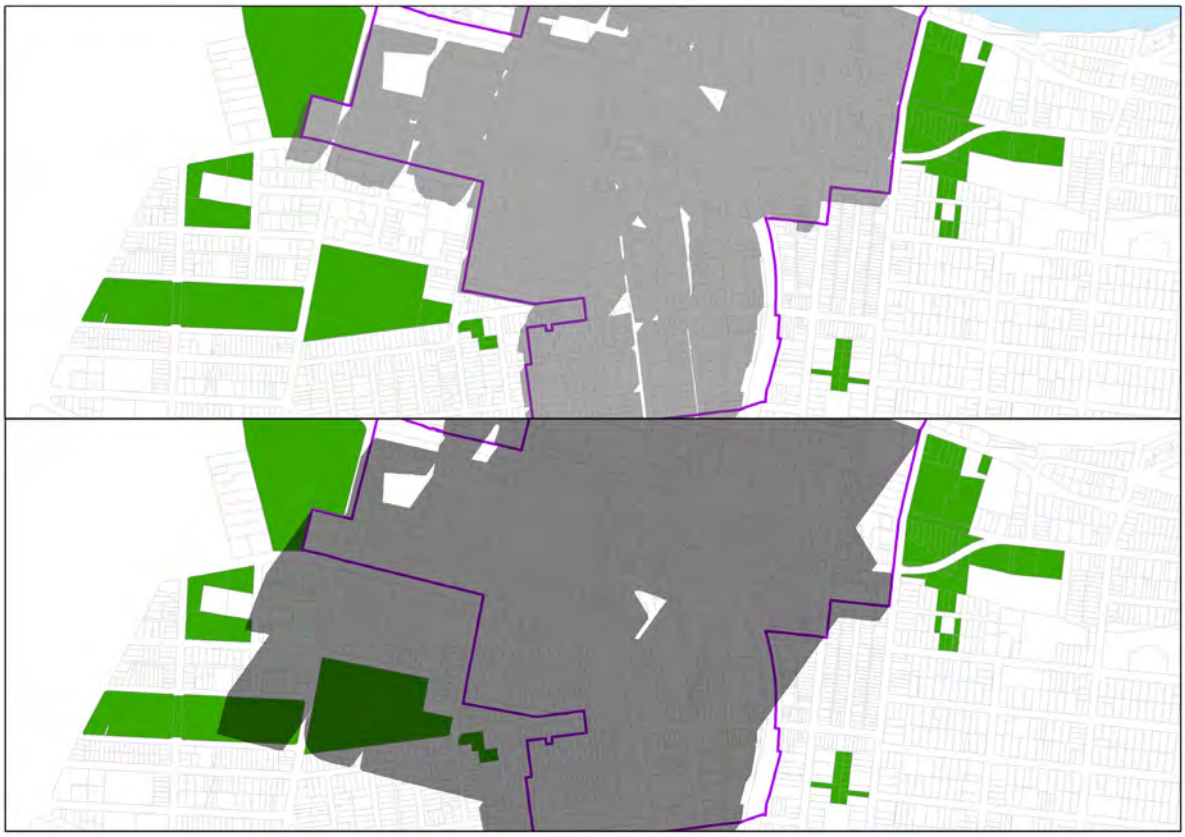


Figure 88 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 9:30am

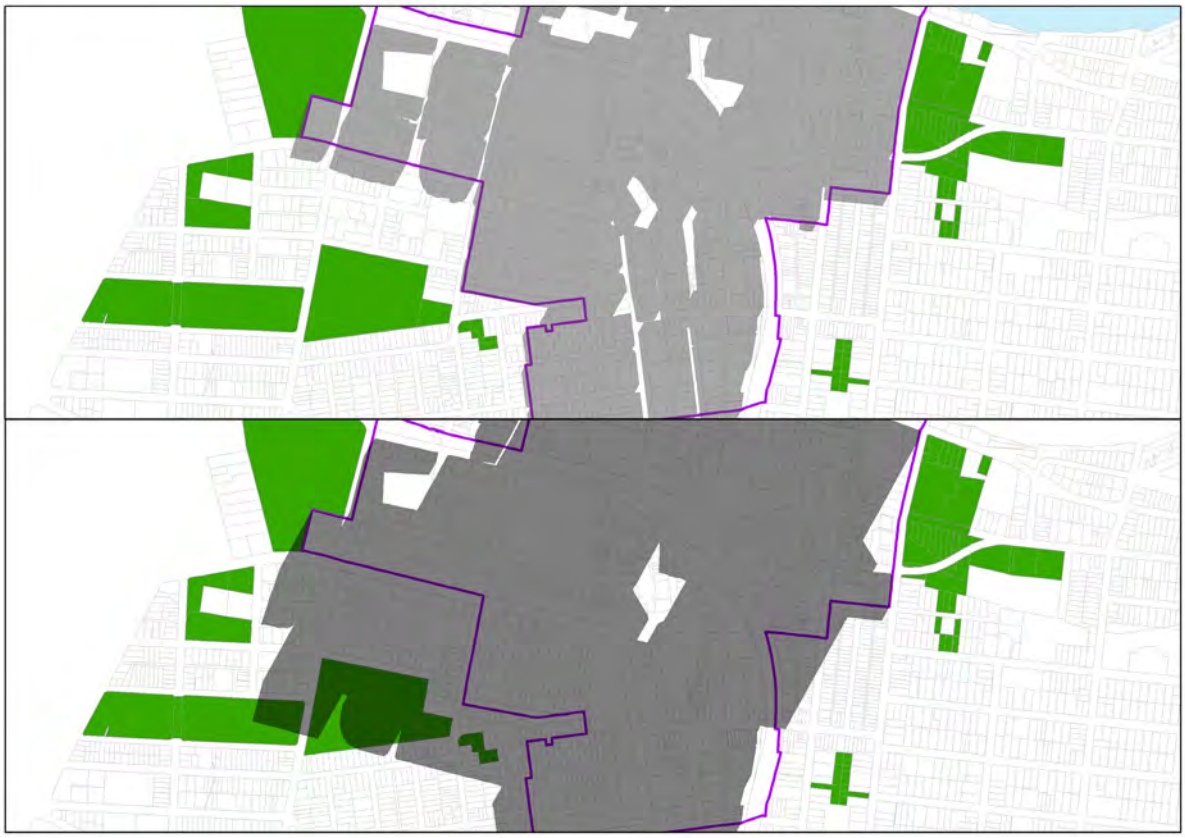


Figure 89 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 10am

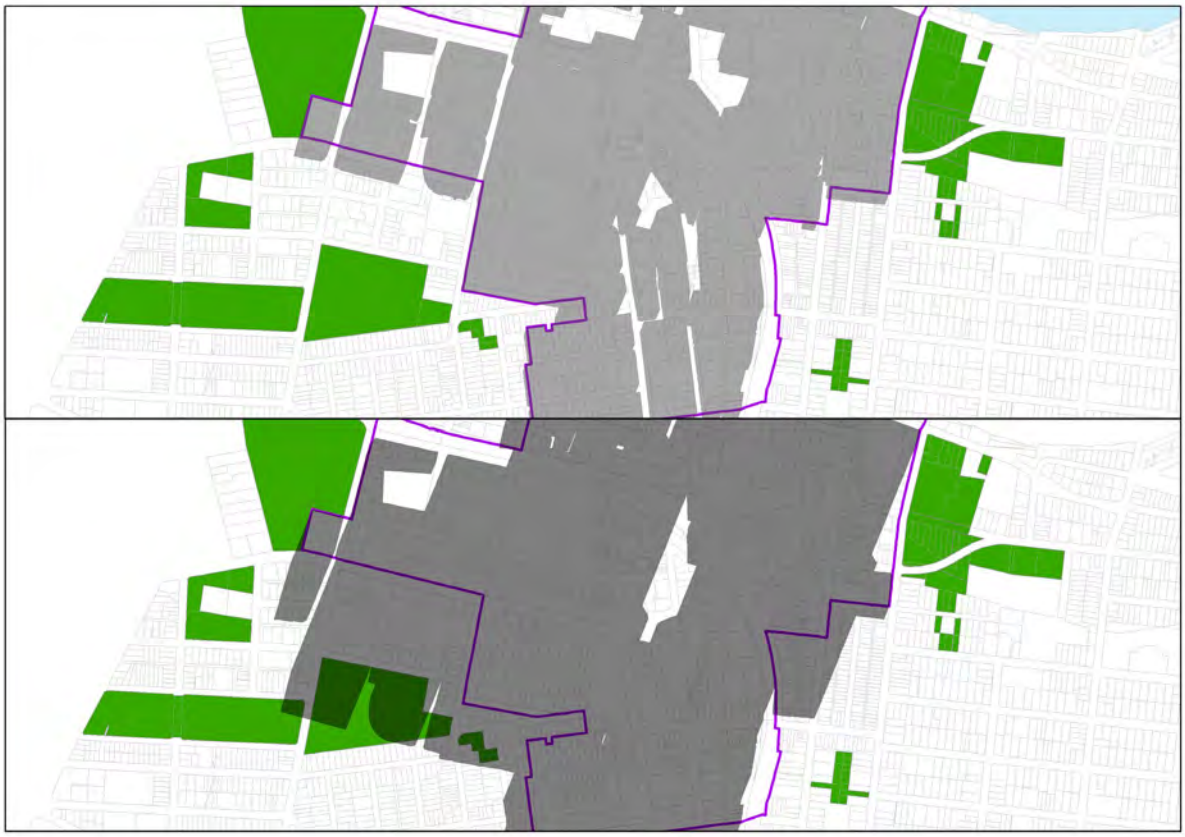


Figure 90 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 10:30am

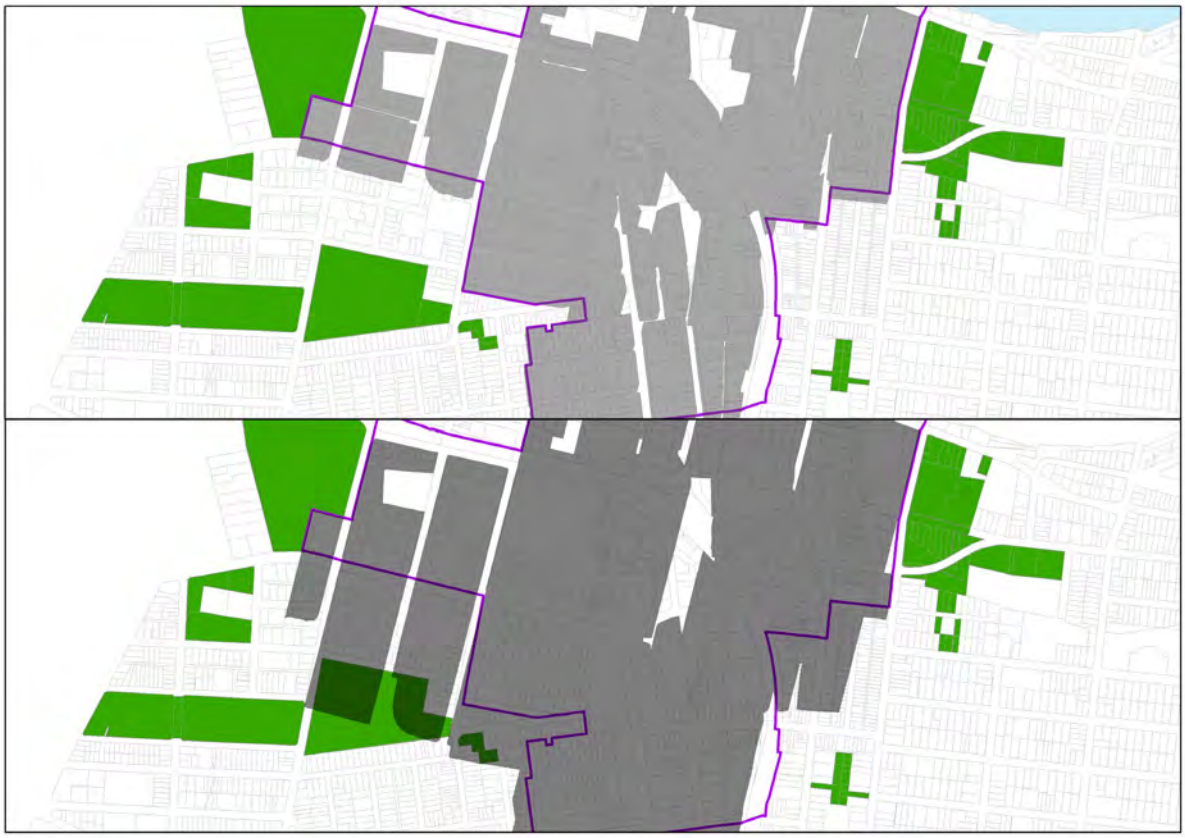


Figure 91 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 11am

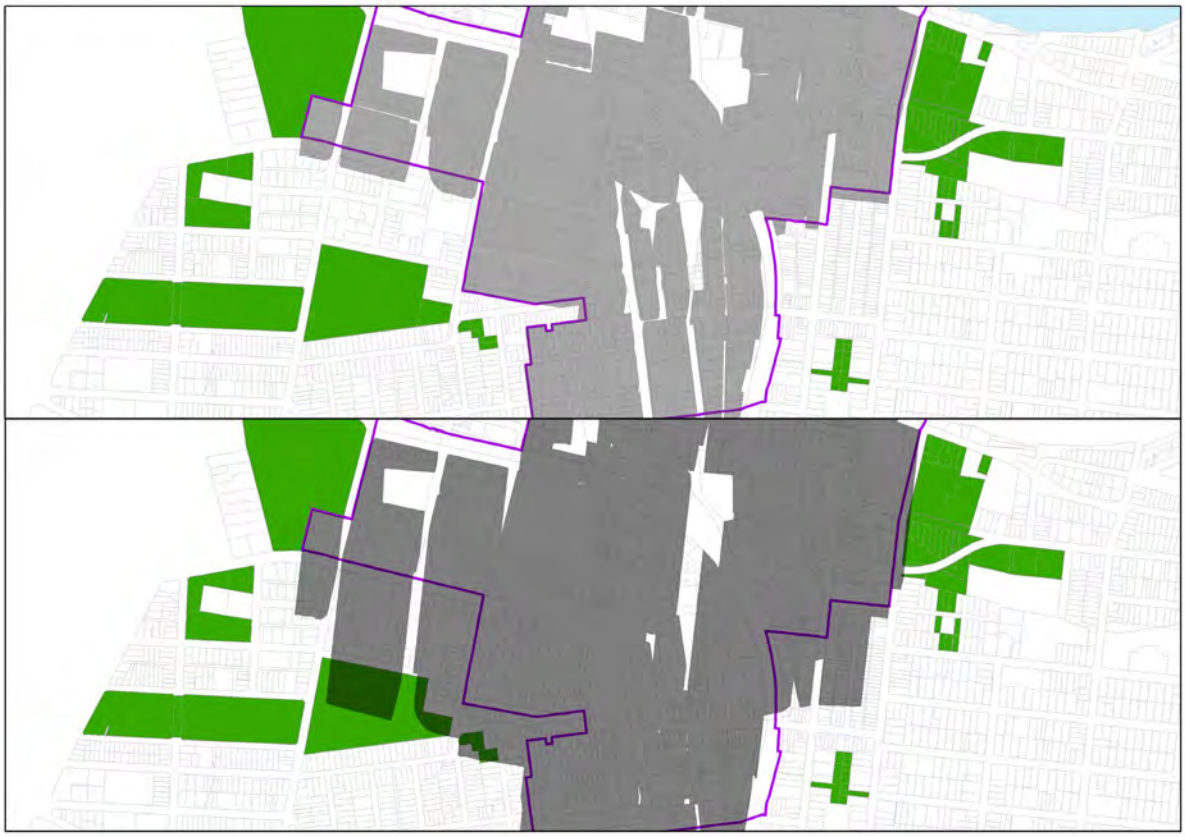


Figure 92 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 11:30am

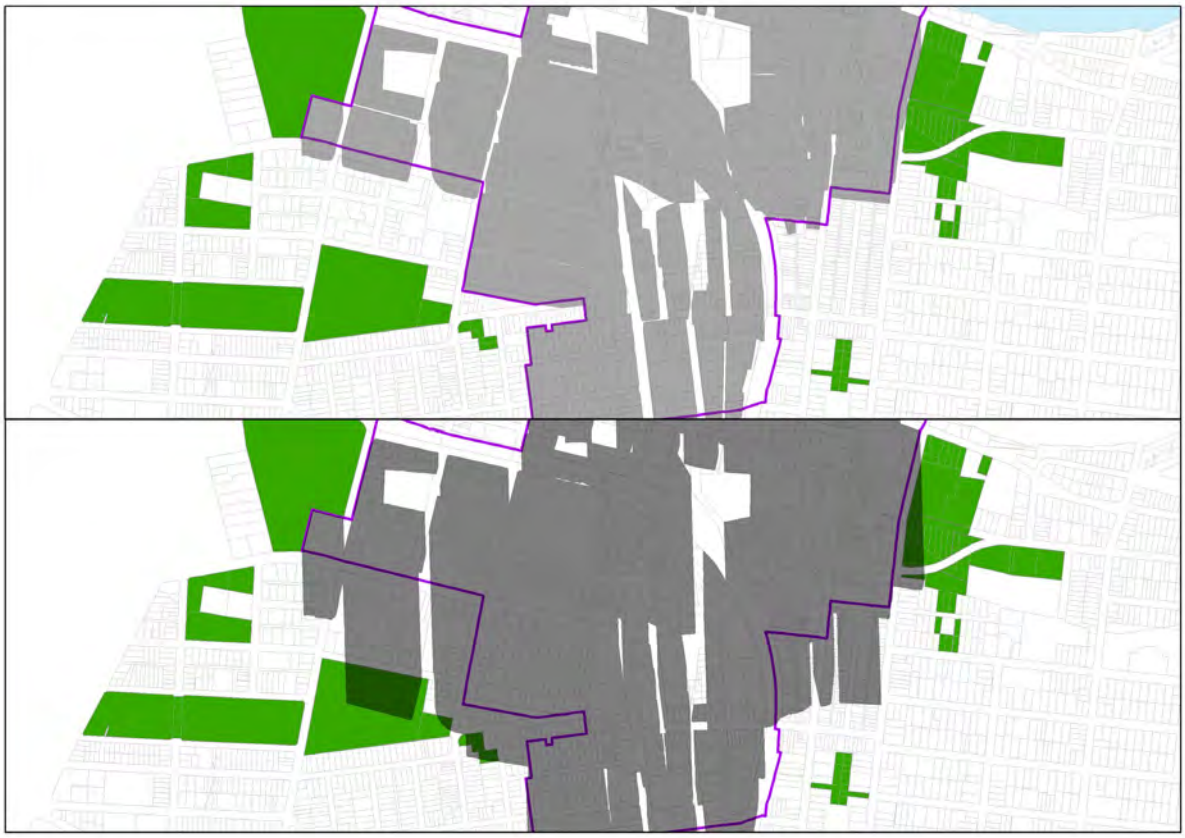


Figure 93 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 12-noon

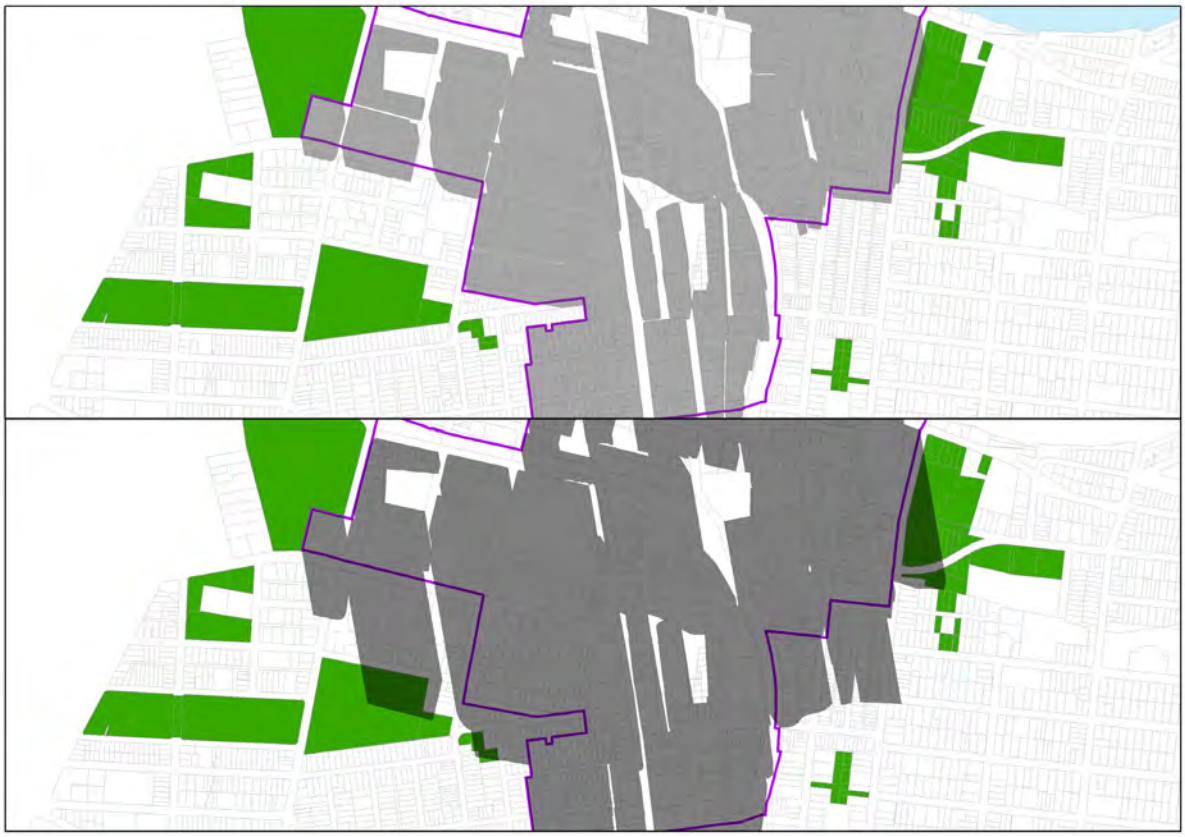


Figure 94 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 12:30pm

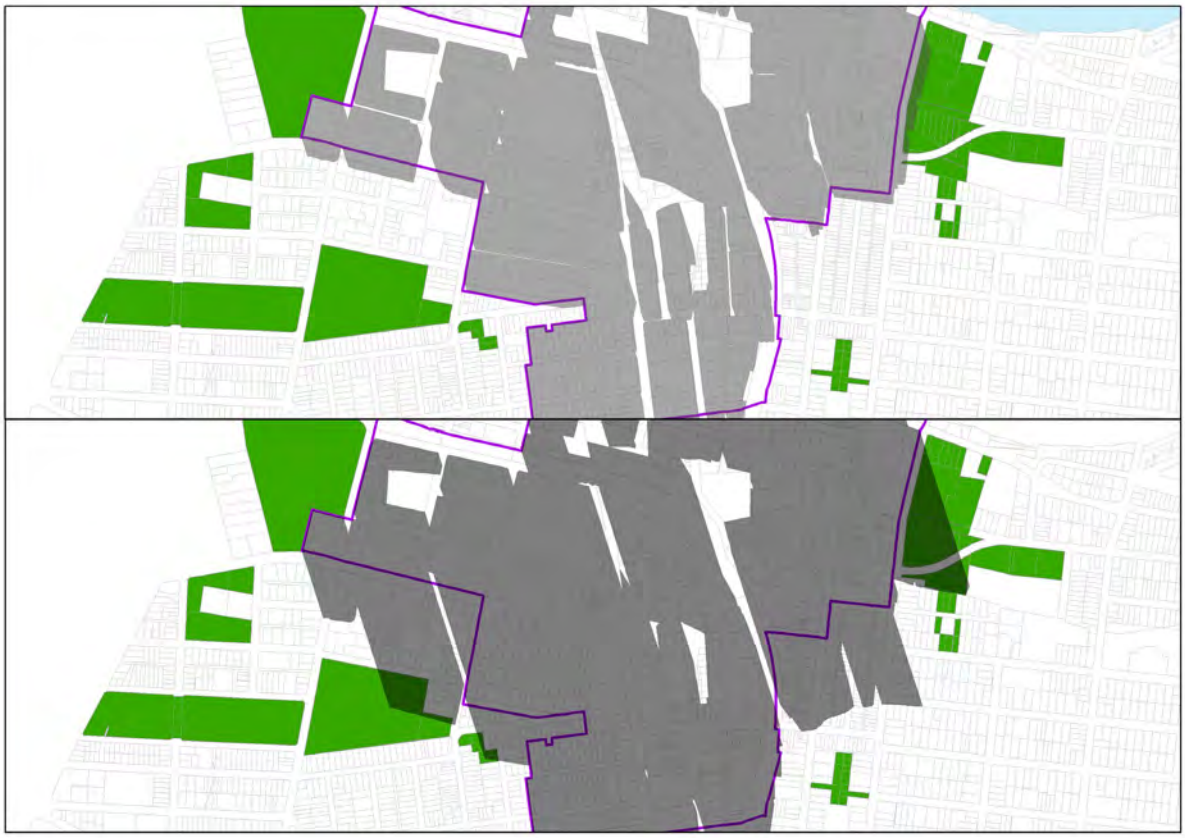


Figure 95 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 1pm

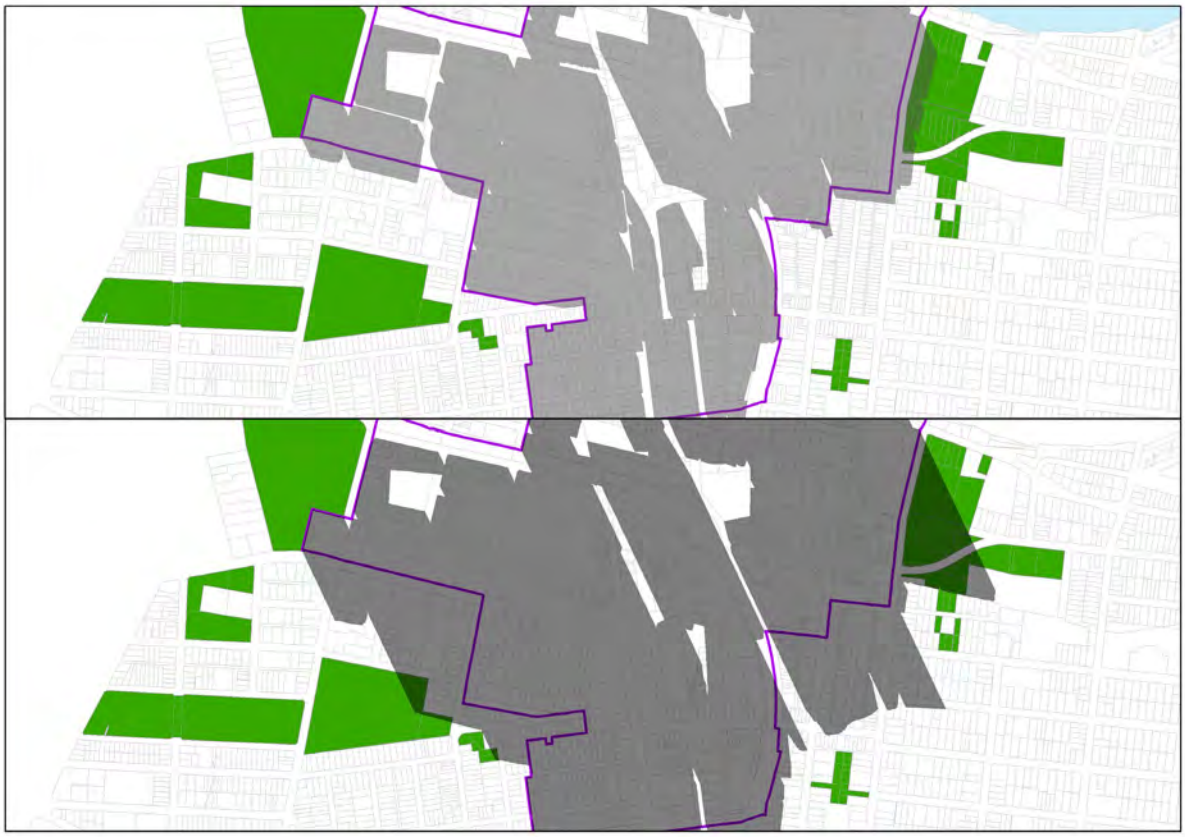


Figure 96 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 1:30pm

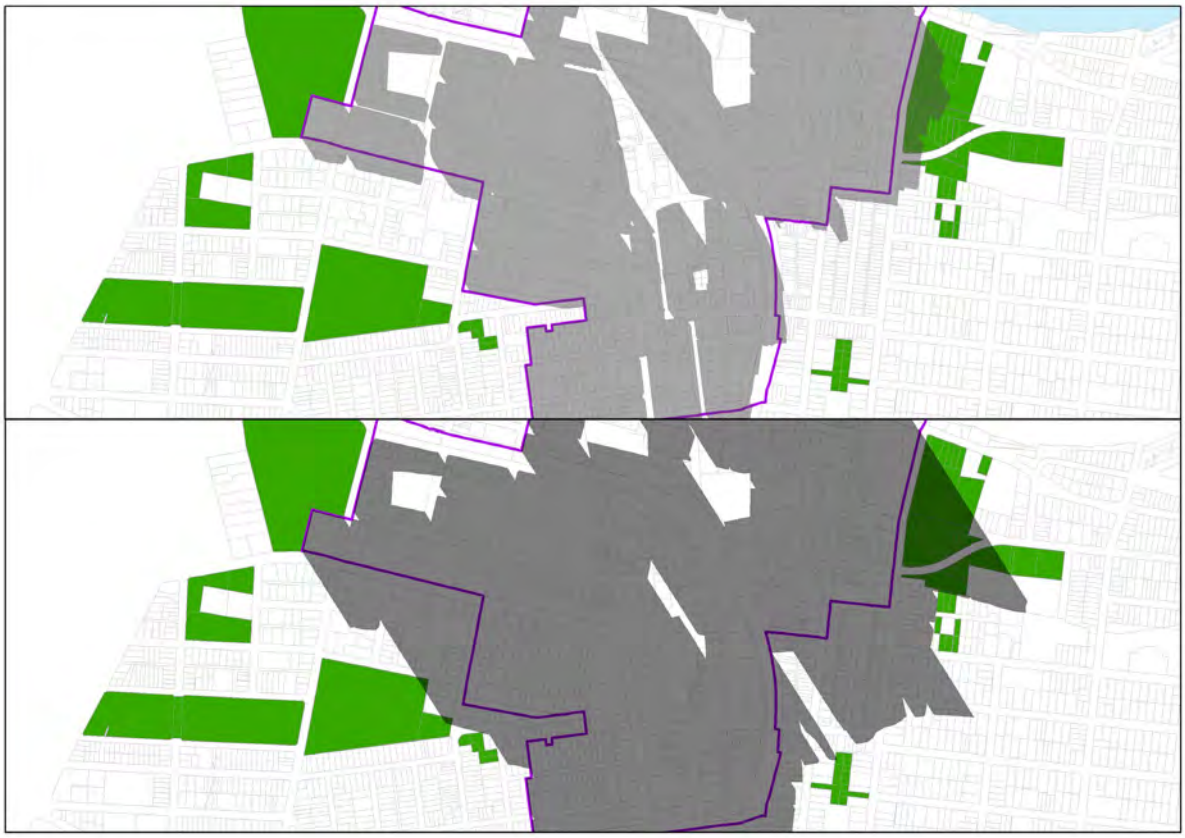


Figure 97 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 2pm

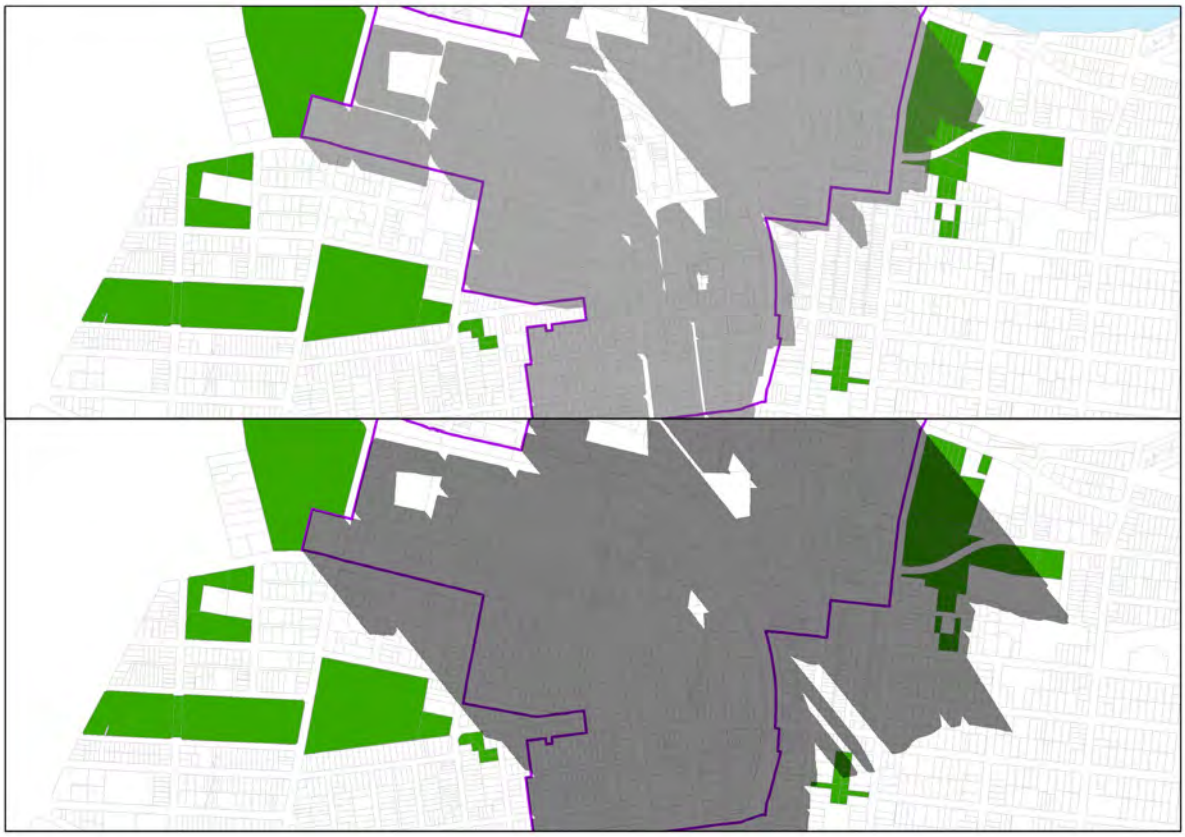


Figure 98 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 2:30pm

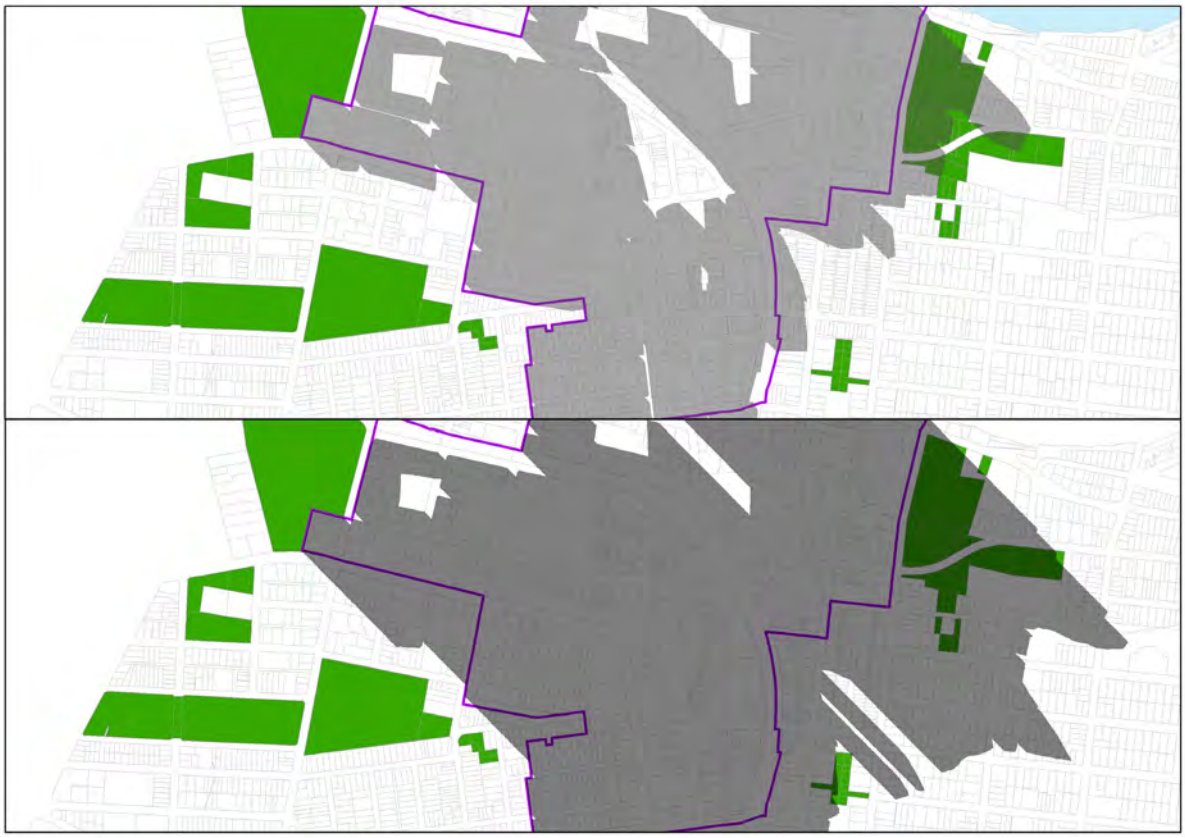


Figure 99 - Comparison of overshadowing between the current controls within Parramatta Local Environmental Plan 2011 (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal (bottom) – 21 June – 3pm

Appendix 6 – Overshadowing of Public Open Space areas with revised Incentive Height of Buildings controls

This Appendix contains the comparative shadow analysis for the ten public open spaces to the south of the Parramatta CBD. This analysis models the overshadowing for the Incentive Height of Buildings controls (top row) within the CBD Planning Proposal against the revised Incentive Height of Buildings controls (bottom row) at 30-minute intervals between 9am and 3pm on 21 June.

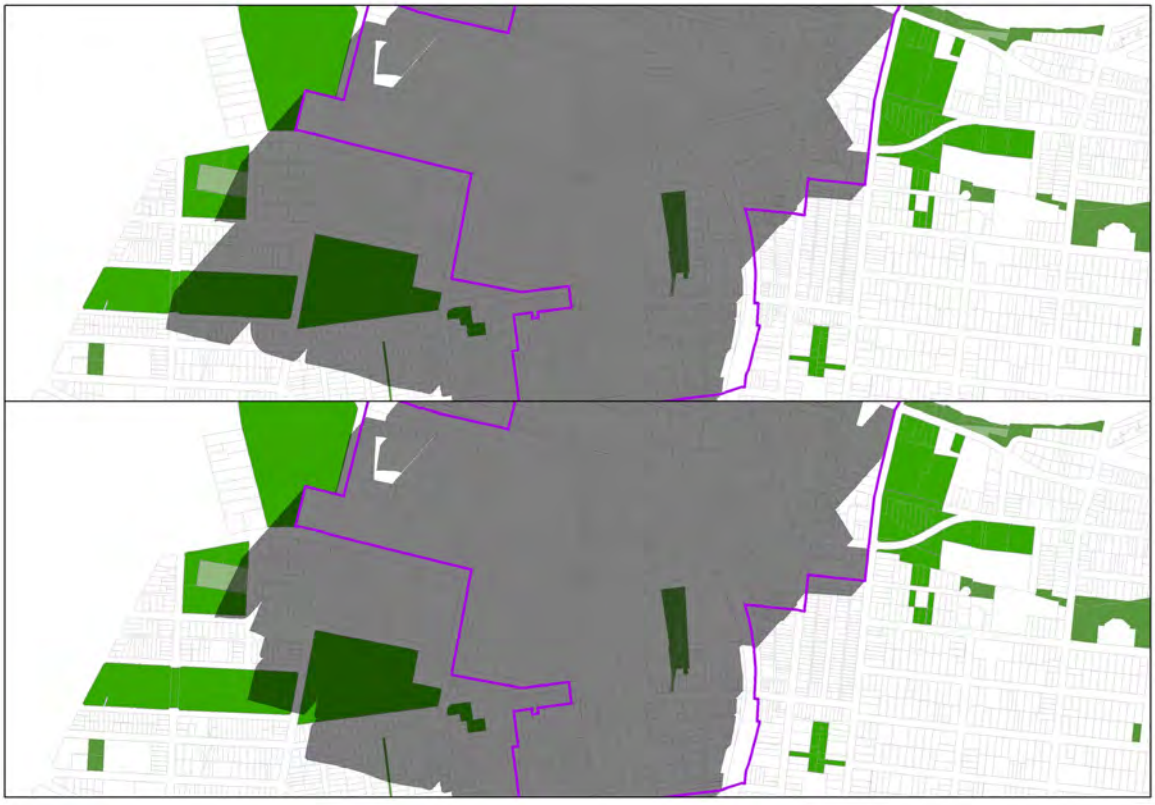


Figure 100 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 9am

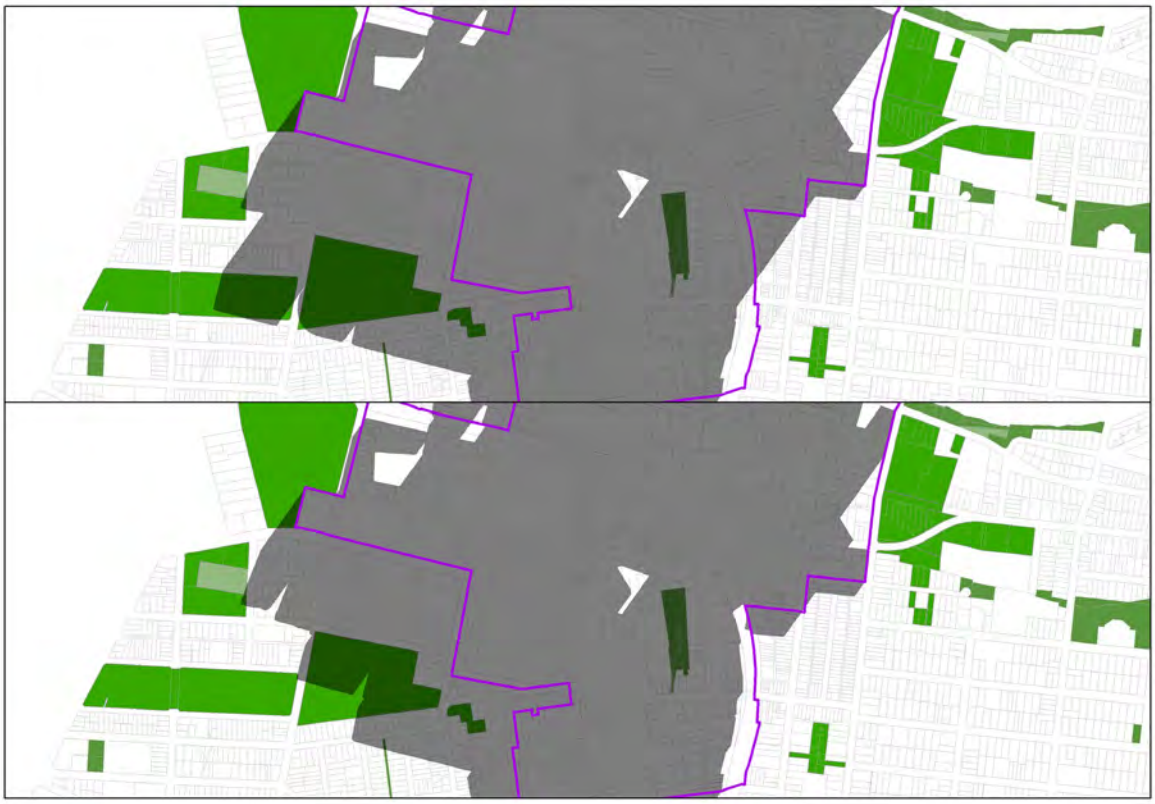


Figure 101 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 9:30am

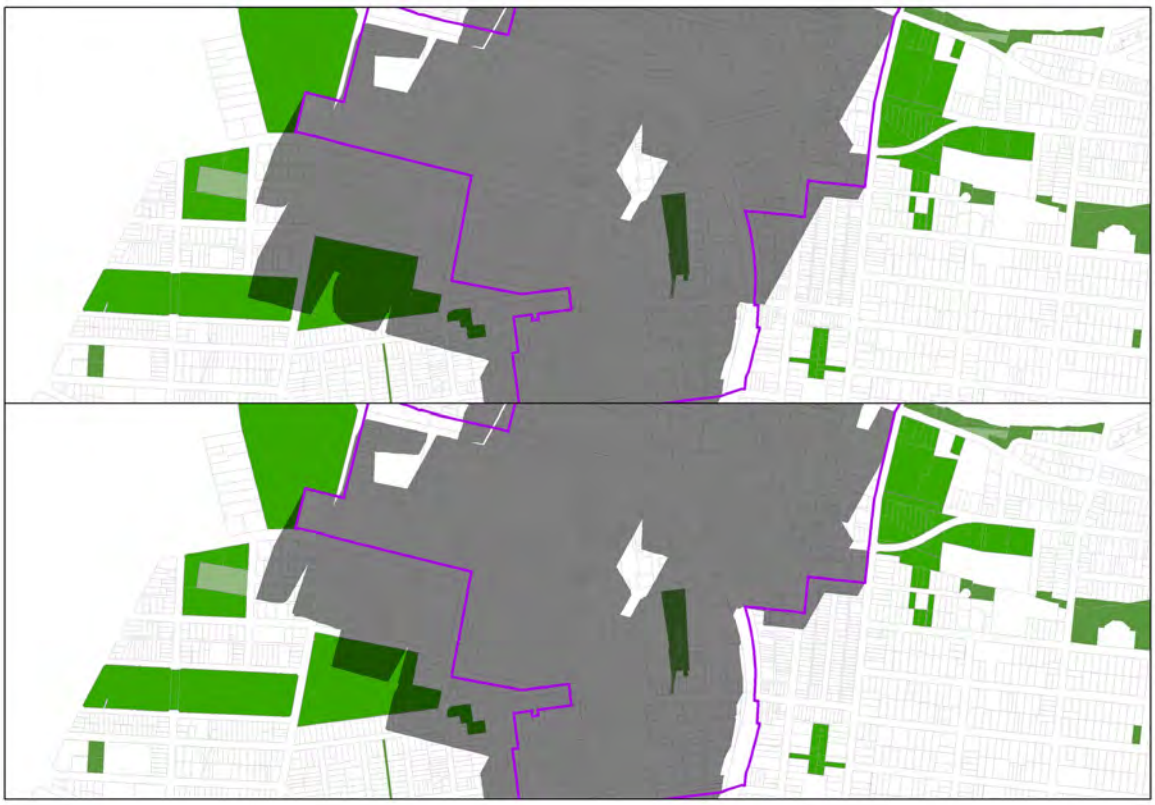


Figure 102 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 10am

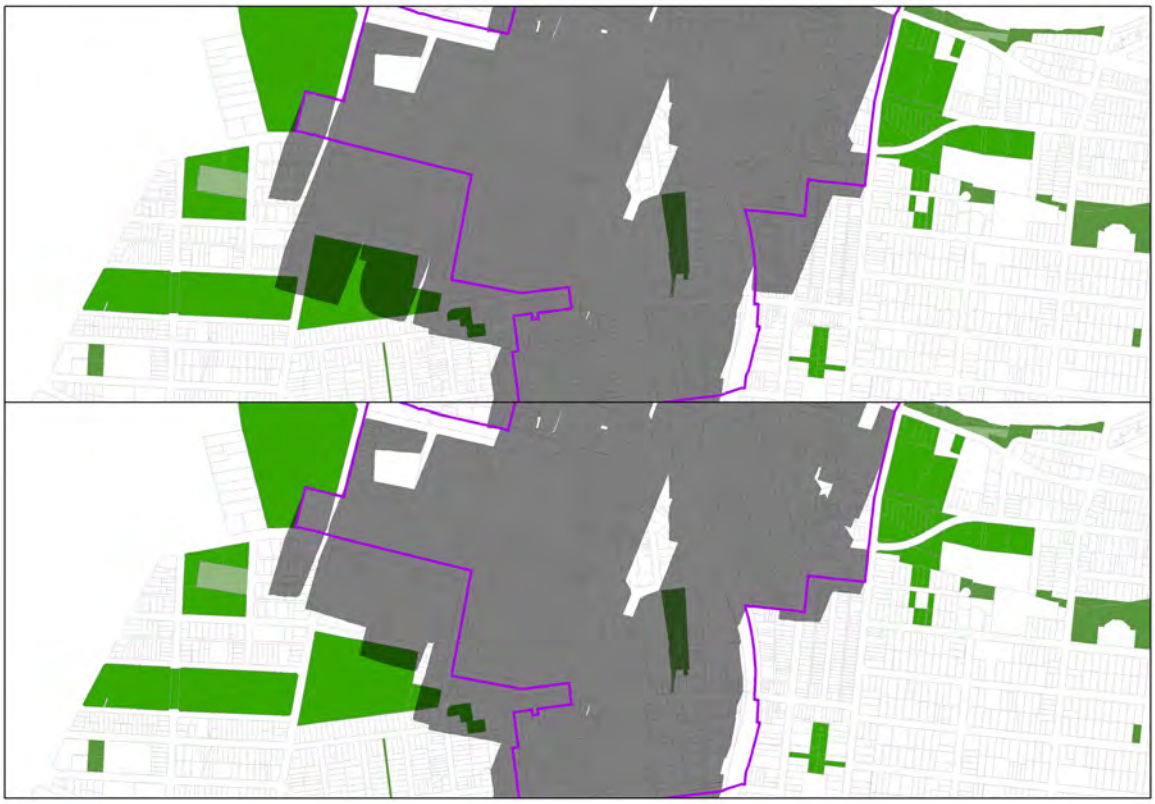


Figure 103 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 10:30am

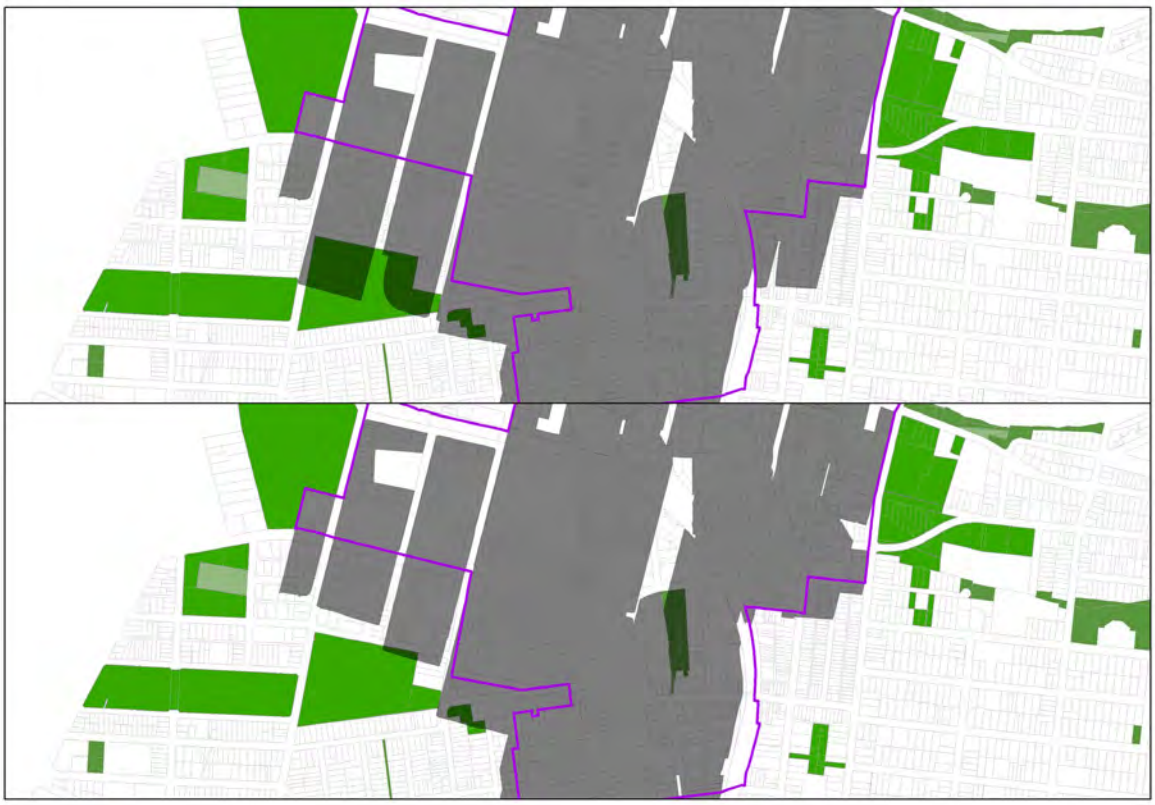


Figure 104 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 11am

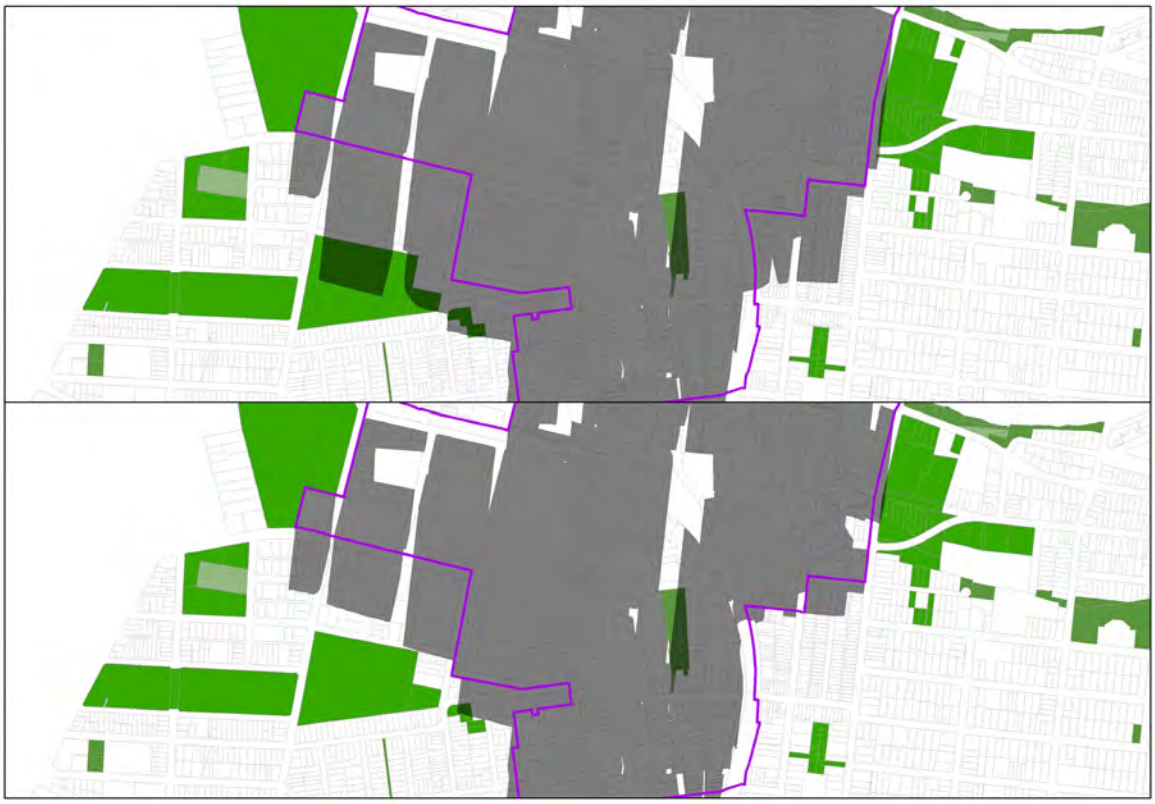


Figure 105 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 11:30am

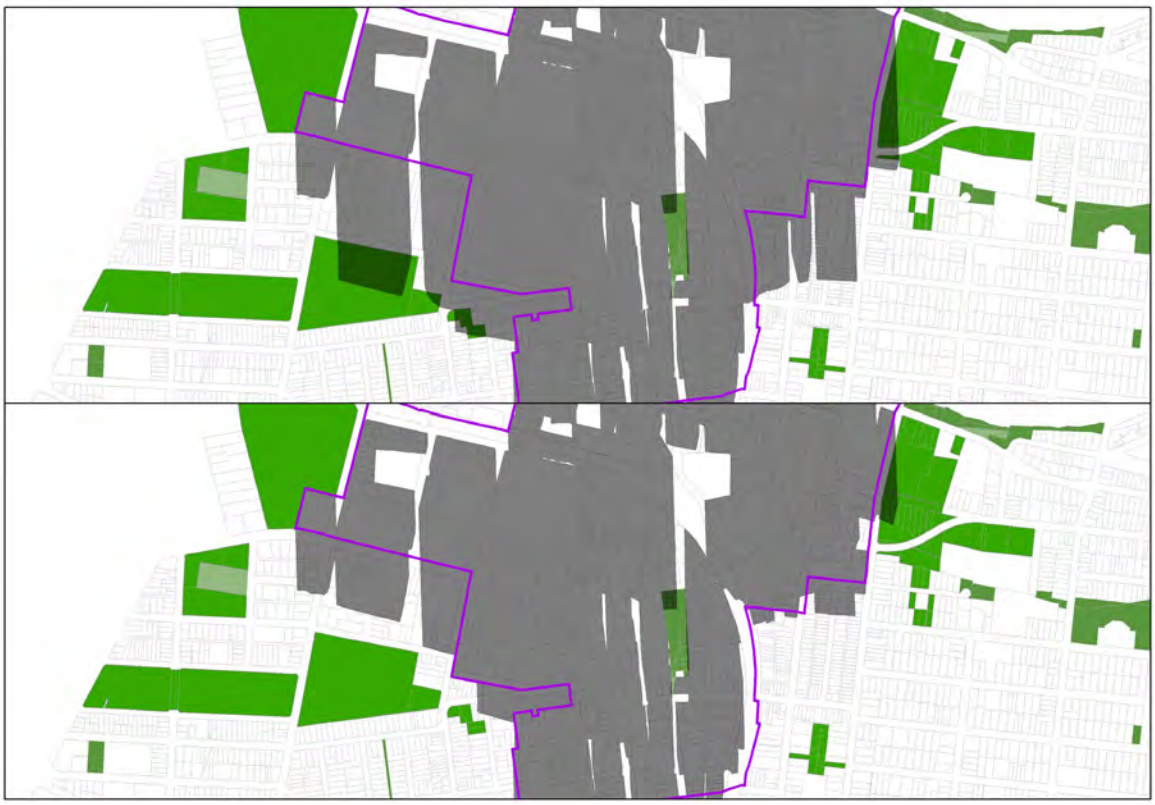


Figure 106 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 12-noon

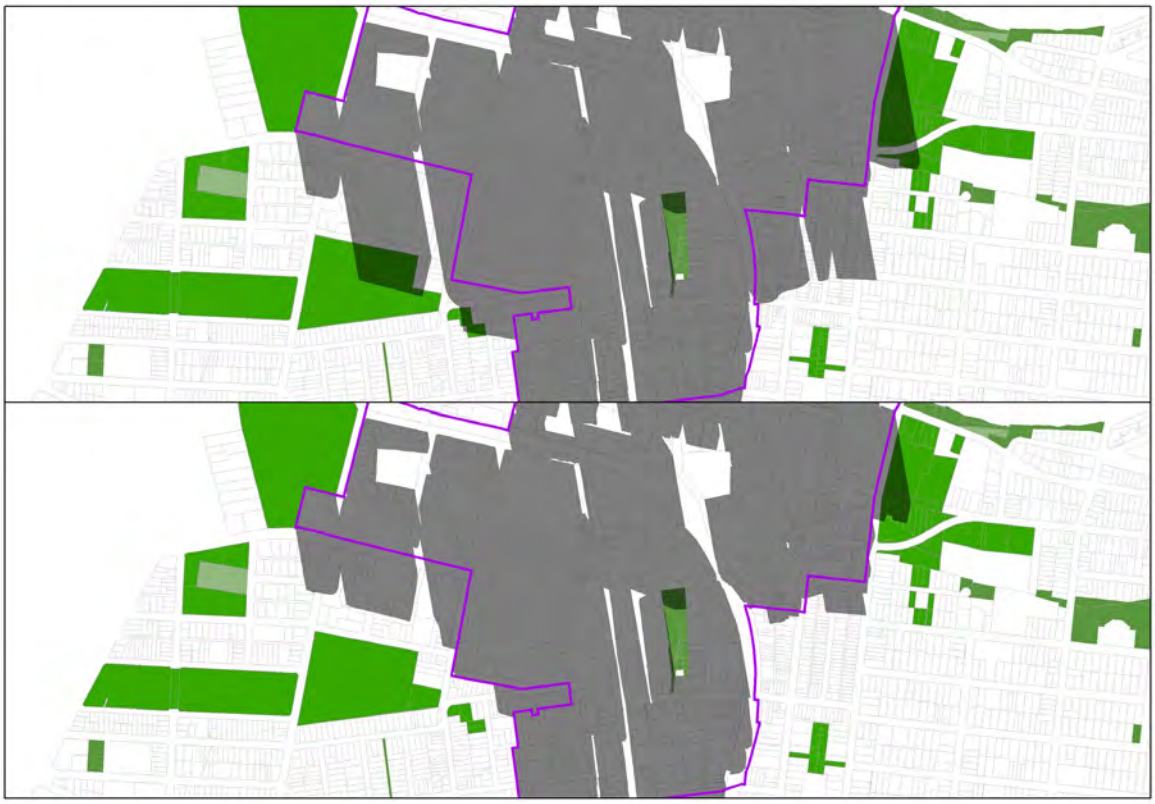


Figure 107 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 12:30pm

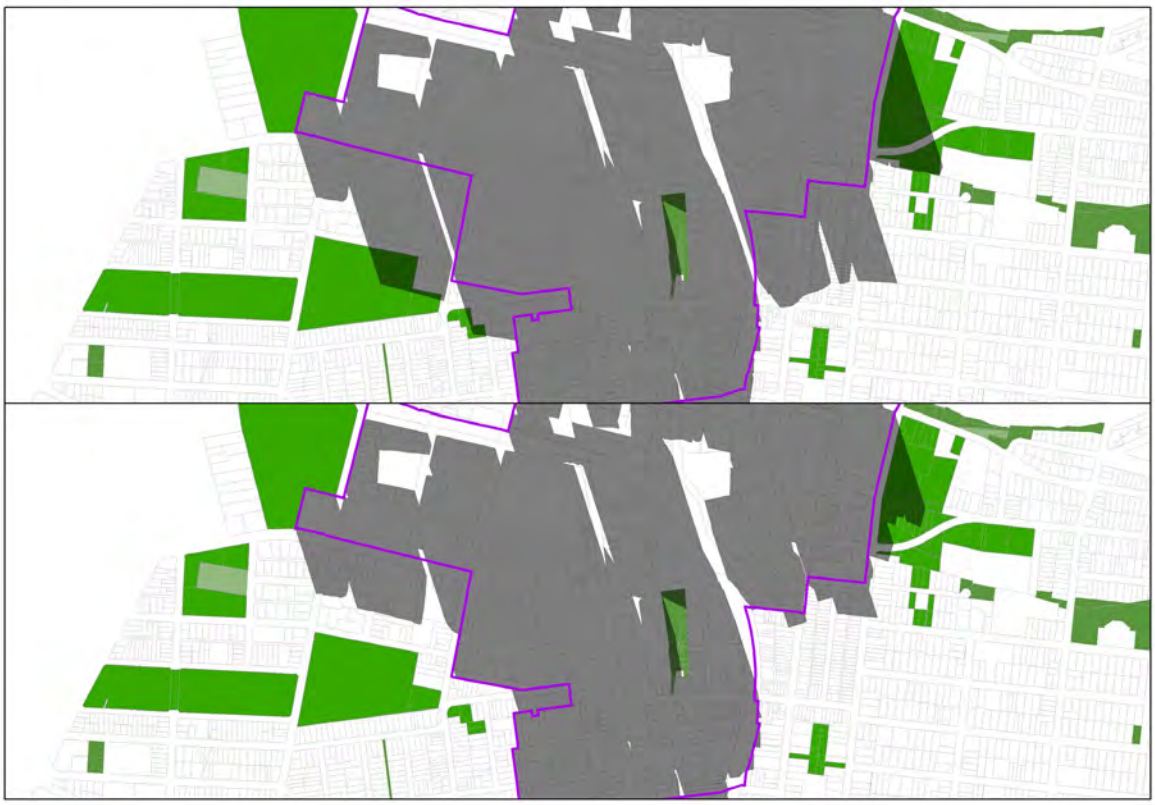


Figure 108 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 1pm

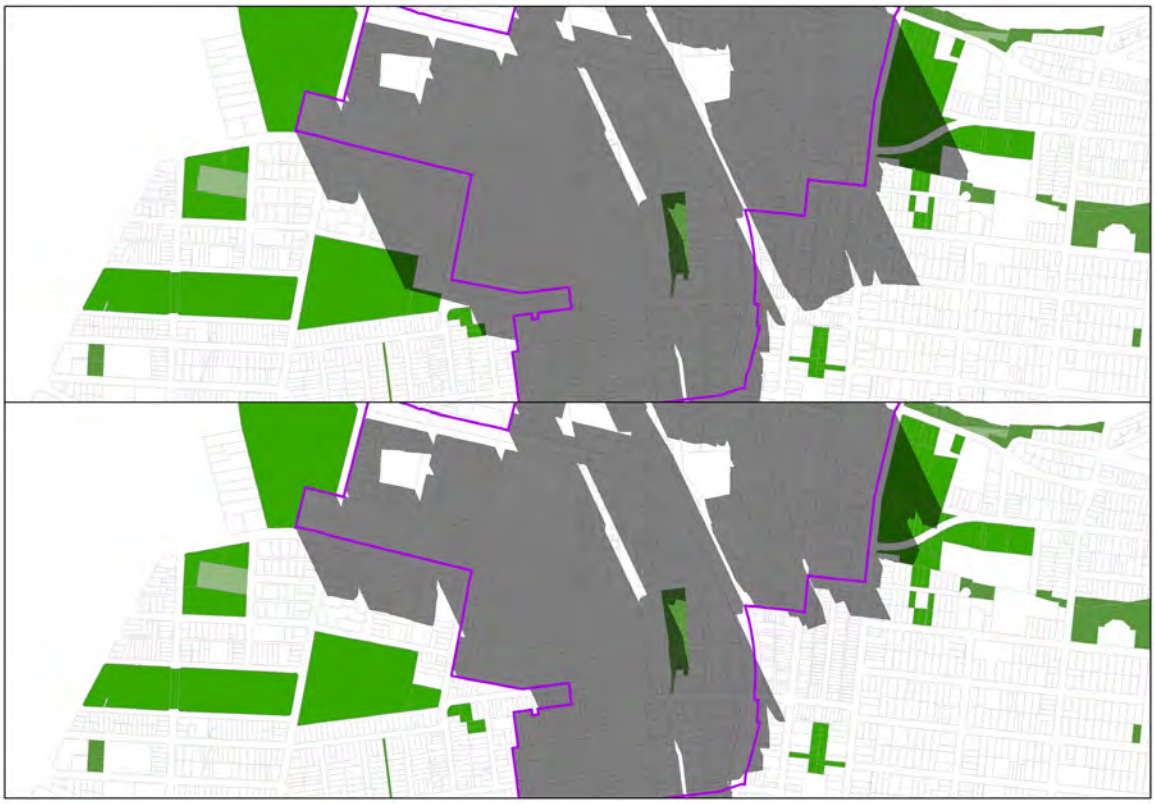


Figure 109 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 1:30pm

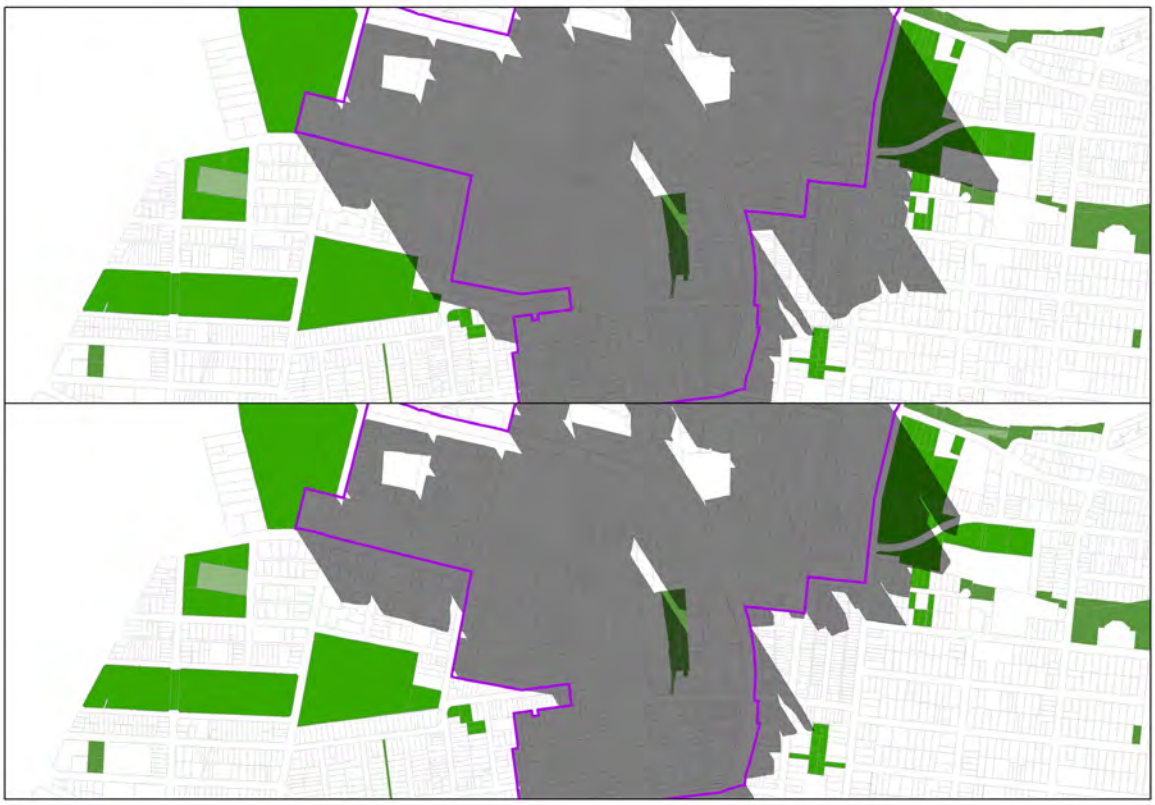


Figure 110 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 2pm

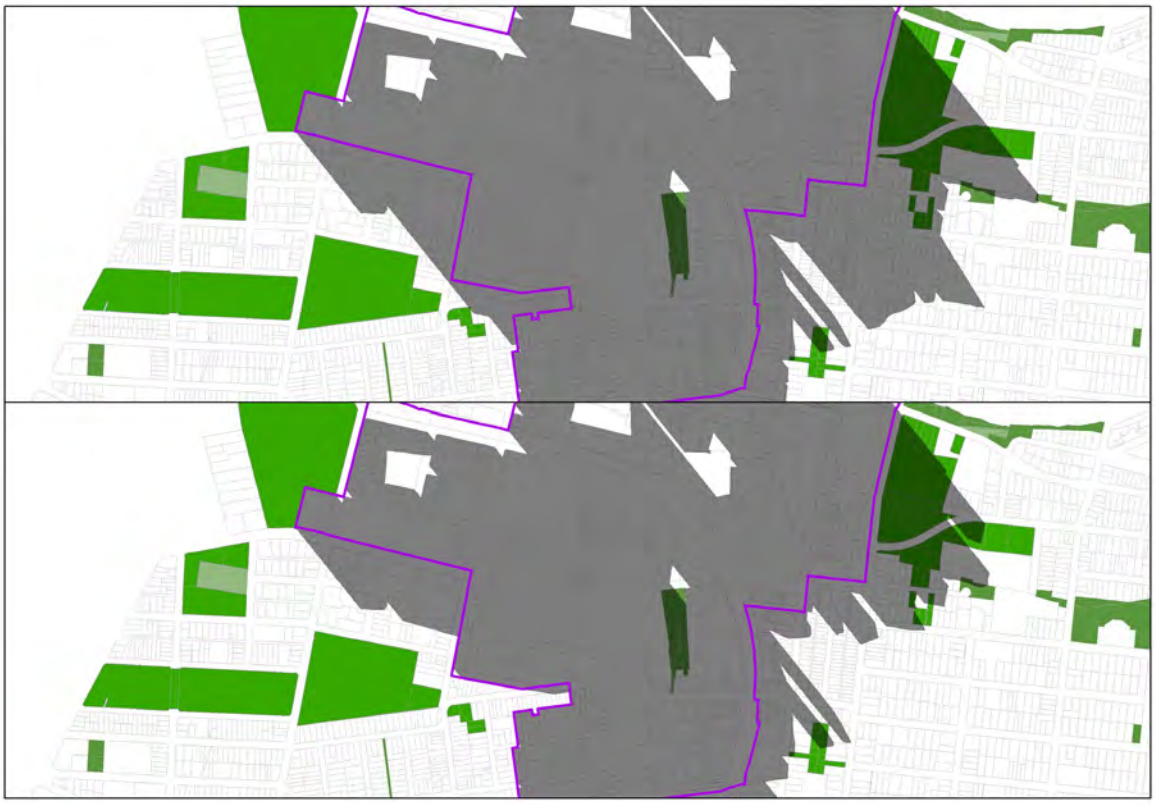


Figure 111 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 2:30pm

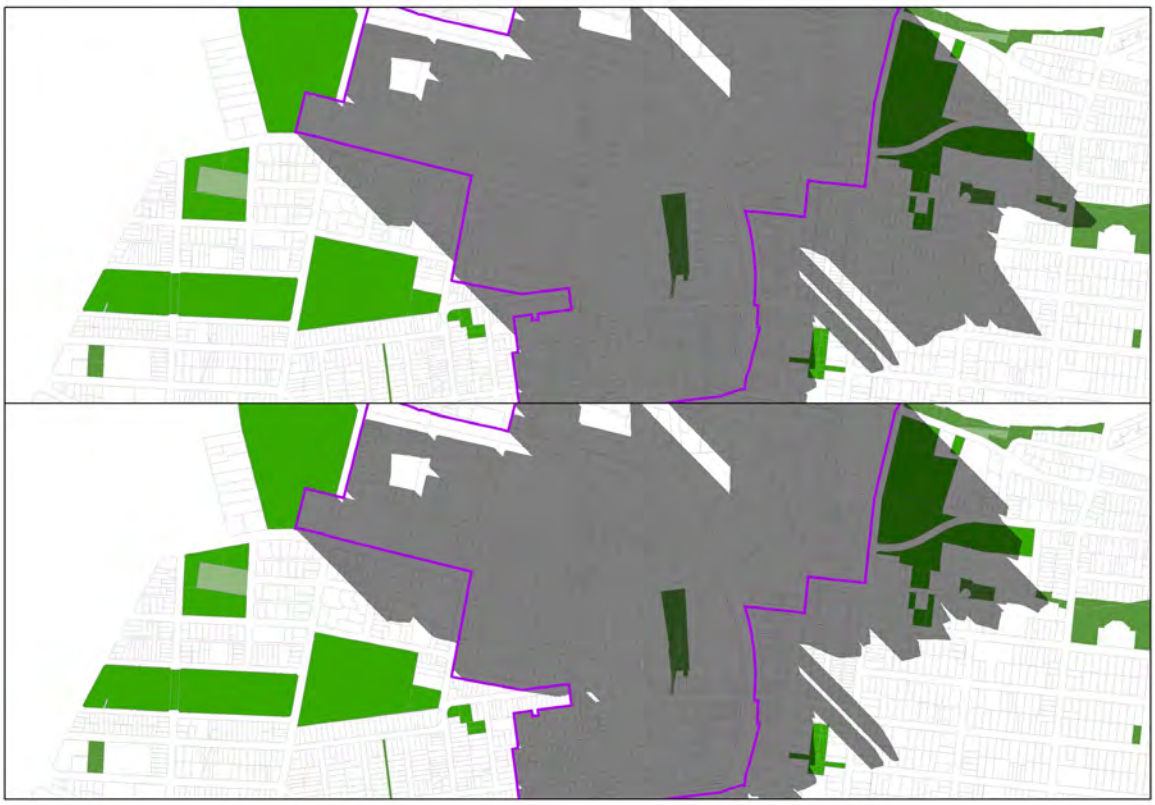


Figure 112 - Comparison of overshadowing between the Incentive Height of Buildings control for the CBD Planning Proposal (top) and the Incentive Height of Buildings controls for the CBD Planning Proposal after revisions have been made to improve sunlight access to heritage conservation areas and public open spaces (bottom) – 21 June – 3pm