Amendment C278: Sunlight to Public Parks
Spatial Modelling Statement of Evidence of Daniel Smith

City of Melbourne

Geographic Information Systems Team

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Melbourne, Victoria, Australia

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1.0 Introduction

1. My name is Daniel Smith, and I am a Geographic Information Systems (**GIS**) Specialist Analyst at the City of Melbourne (**CoM**). The GIS Specialist analyst role is a senior technical officer position that operates as part of the GIS Team at the CoM.

2. I have eleven years' professional experience as a GIS analyst with a focus on 3D technologies and spatial modelling to support urban planning and design. I hold a bachelor's degree in urban planning from the University of Queensland, a master's degree in creative industries majoring in computer animation from the Queensland University of Technology and a master's degree in architecture from the University of Melbourne. My CV is set out at **Appendix D**.

3. I have directly supported the development of Amendment C278 (Sunlight to Public Parks) since 2016. Beyond Amendment C278 I have provided specialised geospatial data and spatial modelling services to the CoM with a focus on strategic planning concerns.

4. The geospatial data and spatial modelling services I provided to support Amendment C278 is listed chronologically below:

   a. 3D sunlight study (2016-17) – Extracted, transformed, and provided 3D geospatial data to Harrison and White to enable the completion of the city-wide shadow and 'solar carve' modelling. An explanation of this modelling is set out at **Section 3.0** below.

   b. Updated winter solstice shadow modelling (2017-18) – Developed and executed additional shadow modelling to support the preparation of the Hodyl + Co. *Sunlight Access to Public Parks Modelling Analysis Report* (**Sunlight Access Report**). See **Section 4.0**.

   c. Identification of properties with potential to overshadow public parks (2018-20) – Developed and executed spatial modelling to identify which properties in the municipality had the potential to overshadow public parks based on existing planning controls. The aim of this modelling was to define which properties and areas of the municipality would be subject to the proposed Design and Development Overlay, Schedule 8 (**DDO8**). See **Section 5.0**.

   d. SGS Economics development impact modelling (2019-20) – Developed and executed spatial modelling to support SGS Economics' assessment of the potential impacts the proposed controls could have on future development heights. See **Section 6.0**.

   e. Comparative overshadowing study (2020-21) – Prepared a municipal wide comparative study to measure and visualise the impacts of overshadowing on public parks between 2015 and 2020 making use of new 3D data derived from aerial imagery of the municipality captured in May 2020. See **Section 7.0**.

5. Most of this work was undertaken by me. However, I did have assistance from other GIS team members as follows:

   a. James Regan, 3D Analyst – Assisted with planning data preparation and spatial data management on items 3a, 3b and 3c.

   b. Andrew Campbell, Spatial Developer – Assisted with calculating the solar ephemeris reference grid (item 3e).

2.0 Modelling Overview and Definitions

6. The following simplified definition of overshadowing was used to guide the making and analysis of all modelling undertaken for Amendment C278: *"A location is considered to be in shadow, if the line that is drawn from that location to the position of the sun in the sky, is obstructed by an object."* This definition is described visually in Figure 2.1 below:

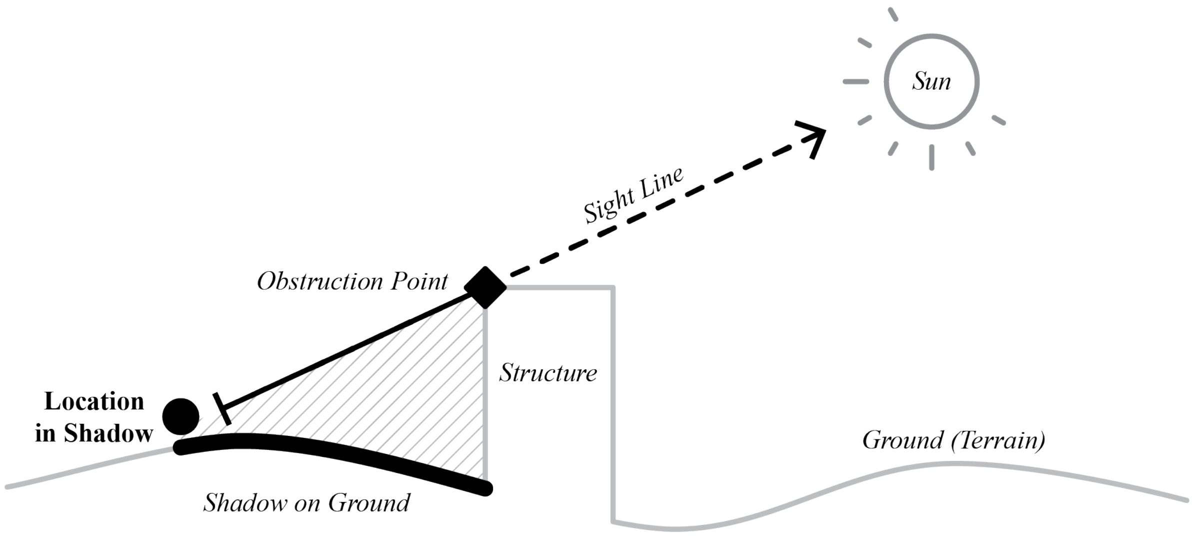

***Figure 2.1** – Simplified Definition of Overshadowing*

7. It is important to note that this definition of overshadowing was used as guide in interpreting all modelling outputs. For instance, if a model simulated additional information such as the intensity of a shadow, or solar energy, this additional information was not taken into consideration. In simple terms: all locations within parks were interpreted as having a binary value for shadowing at a given time: they were either in shadow (1) or not (0).

8. This definition of overshadowing reduces the number of variables down to three considerations:

   a. Obtaining an accurate location on the earth's surface.

   b. Accurately locating the sun in the sky relative to the given location.

   c. Having and accurate representation of the terrain and all obstructions in the locality (obstructions in this case being fixed built structures and excluding vegetation).

9. Unless otherwise stated in this document, I provide the following information on how the modelling that I undertook (not including modelling undertaken by others) addressed these considerations:

   a. ***Accurate location*** – All modelling was undertaken with GIS specific or GIS capable software using Australia's official geographic datums. These datums form part of the Australian Geospatial Reference System (AGRS). For more details on the AGRS see

Geoscience Australia's information pages online: https://www.ga.gov.au/scientific-topics/positioning-navigation/australian-geospatial-reference-system

b. ***Accurate sun position*** – All models and code libraries used to calculate the position of the sun in the sky, relative to a fixed location on the earth's surface, implement a version of the equations presented in the book *Astronomic Algorithms (Second Edition)* by Jean Meeus. This text is identified by organisations such as the United States National Oceanic and Atmospheric Administration (NOAA) as being an authoritative source for these equations, see: https://www.esrl.noaa.gov/gmd/grad/solcalc/calcdetails.html. It must be noted that Geoscience Australia has in the past advised officers of the GIS team that United States governmental bodies such as NASA and NOAA are an appropriate source for guidance on solar position calculations.

c. ***Accurate representation of the locality*** – The digital representation of the City of Melbourne municipal area, known as the City Model, has two main components: a dataset that describes of the terrain (the ground surface without structures and vegetation) and a dataset that describes discrete built and other fixed structures:

i. For the terrain, all models used a one metre resolution digital elevation model (DEM) of the municipality. This elevation dataset was derived from airborne lidar data captured by third party contractors in 2014 and again in 2018. The elevation models are generally accurate to 0.1 metre of true (real world) elevation.

ii. For permanent built structures, all models used 3D data that was derived from airborne lidar and high-resolution imagery captured by a variety of third-party contractors between 2008 and 2020. The 3D representations of each structure were generated from this base data using a process called photogrammetry. In 2018, and again in 2020, contractors delivered the 3D data as a photogrammetric 'photo mesh' product. Unlike the earlier deliveries, which were primarily discrete building objects, the photo mesh products contained a single, unified, 3D mesh surface representing all features in the municipality present during capture. This included elements such as trees, signs, and light poles. The discrete building objects were then derived from the photo meshes by manually tracing the buildings in a 3D GIS application. In general, all the 3D datasets that describe permanent built structures have a spatial accuracy of between 0.1 and 1.0 metre of true vertical and horizontal position.

10. There are several terms that I use in this statement that are easy to confuse if not understood from the correct context. These terms and their contextual meanings, as used in this statement, are listed below:

a. ***Model*** – Refers to an executable process, procedure or algorithm that has been developed to produce a single output, or a range of outputs.

b. ***Modelling*** – The process of building, executing, and maintaining a model.

c. ***Input*** – Any dataset or parameter that is required for model execution.

d. ***Output*** – Any dataset that is produced by a model process. As most of the modelling undertaken for Amendment C278 was geospatial, the output data is usually visualised on a map.

e. ***Fixed Output*** – An output that can only be visualised, or interacted with, in a singular, fixed, manner. An example of a fixed output would be any of the maps that accompany this statement. These are not able to be edited or visualised in any other way without altering or destroying the information they intend on communicating to the observer.

f. ***Static Output*** – Output data that is produced by a single model 'run'. Static outputs are best thought of as 'snapshots' produced by a unique combination of input datasets and model parameters. Static outputs can be transformed and visualised as fixed outputs in many different ways to communicate a certain aspect of, or insight embedded in, the data.

g. ***Dynamic Output*** – Output data that is produced by sequential model runs. A dynamic output is provided either as a collection of static outputs or as a single output that is updated, or 'overwritten', at the completion of each model run.

h. ***Solar Ephemeris*** - A solar ephemeris describes the location of the sun in the sky at a given time and location. It is expressed by two angles: altitude (vertical angle from ground to sun), and azimuth (horizontal angle from due north to sun). See Figure 2.2 below for a visual explanation of this concept:

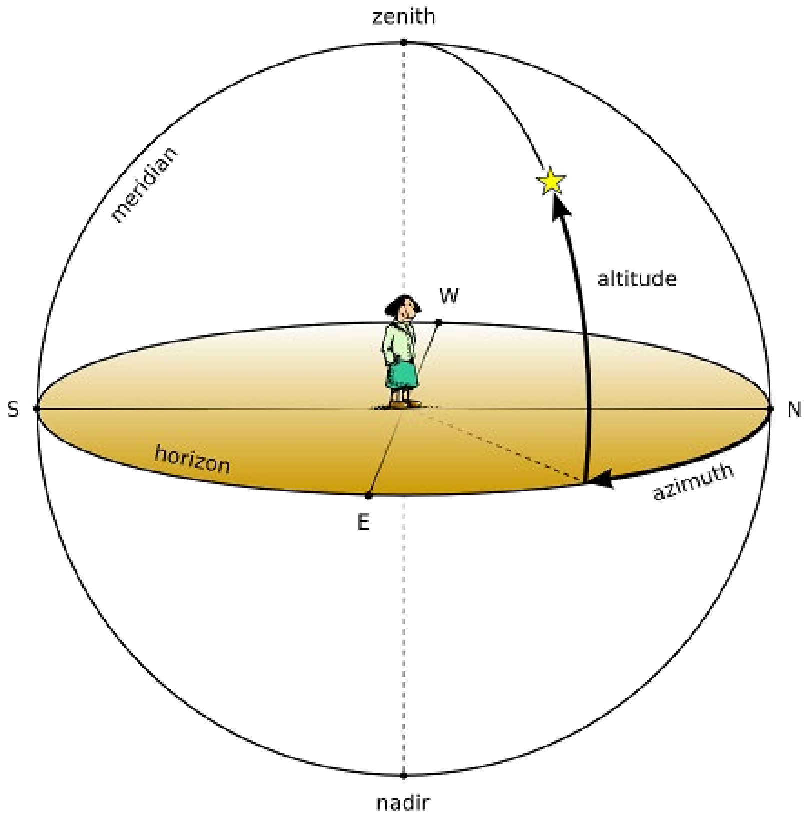

Figure 2.2 *– Ephemeris Diagram (sourced from:*
http://sciencedoing.blogspot.com/2012/11/astronomical-concepts.html)

i. ***Winter solstice*** – The equinoxes and solstices do not fall on the same day of the month each year. For instance, the winter solstice in the southern hemisphere generally falls between the dates of 20 and 22 June. Given the minute difference in solar ephemeris between these dates, running calculations for the purpose of measuring shadows on the winter solstice based on an input date of either 20, 21 or 22 June for a given year is appropriate.

3.0 3D Sunlight Study

3.1 Request

11. In late 2016, Harrison and White were engaged by the CoM to undertake a 3D Sunlight Study. The purpose of this consultancy was to: *"Understand the extent of sunlight in public space throughout the CoM in order to determine proposed built form to allow sunlight to be optimised."* (Sourced from consultancy brief, Internal Document Ref. 10019254).

12. I was required to extract and prepare a series of 3D datasets that would enable Harrison and White to complete their engagement.

13. I was also required to upload the fixed and static outputs from the Harrison and White modelling into GIS software so it could be viewed by council officers and overlayed with important information such as park and property boundaries.

3.2 Inputs

14. The datasets below we supplied to Harrison and White on 16 December 2016[1]:

    a. A 1 metre resolution digital elevation model of the municipality.

    b. A series of 3D files extracted from the 2015 3D 'city model' dataset describing all the permanent built structures in the municipality as of May 2015.

15. As Harrison and White were primarily using Autodesk 3ds Max 2017, an 3D application that cannot process geospatial data or datums (coordinate reference systems) natively, I was required to convert all the coordinates for each 3D feature into a basic cartesian system that preserved the spatial relationships between features. To enable the modelling outputs to be re-projected back into a recognised geospatial datum, in this the AGRS, I also provided Harrison and White with a table of datum transformation for each 3D file.

3.3 Model

16. Harrison and White provided a detailed breakdown of their model in the 'Solar Modelling Process and Assumptions Document' dated 6 July 2017 (Internal Document Ref. 10956260)

3.4 Outputs

17. The primary outputs of the Harrison and White modelling received by the GIS team are listed below:

[1] See paragraph 9.c. for a description of these datasets and their provenance.

a. Aggregate shadow study – A set of fixed outputs delivered as a set of raster[2] images that described the cumulative shadows across the municipality for each half hour between the hours of 9:00 am and 4:00 pm on 22 April 2015 (autumn equinox), 22 June 2015 (winter solstice), 22 September 2015 (spring equinox) and 22 December 2015 (summer solstice). The output for the winter solstice known as the 'red map' can be viewed online at:

  i. https://cityofmelbourne.maps.arcgis.com/apps/webappviewer/index.html?id=5e64cec86fb54803b88f50653bf53ad6

b. Solar-fan contours – A set of aerial contours derived from Harrison and White's 'solar carve' model that describe the profile that new buildings should be designed to fit within in order to protect sunlight access to public parks between the hours of 9:00 am and 4:00 pm on the equinoxes.

3.5 Use and interpretation

18. The only outputs from the Harrison and White modelling that were used for the purposes of Amendment C287 were the cumulative shadow rasters (the aggregate shadow study referred to at paragraph 17.a. above).

19. Each cumulative shadow raster output is a fixed accumulation of 16 incremental shadow rasters (not supplied to the CoM). The incremental shadow rasters were produced for each half hour between 9:00 am and 4:00 pm. To create the single unified output, each of the incremental rasters were overlayed using a multiply layer blending function[3] in an image editing application. This results in a darker image where more incremental shadow outputs overlap.

20. Being fixed outputs, these rasters were not able to be edited to improve their visualisation or 'readability'.

[2] A raster dataset is a matrix of cells organised into a regular gird of rows and columns. Each cell contains a value representing information such a height, temperature, density, colour, etc. Under this definition the simplest way of describing rasters is as an image. For a comprehensive description of rasters and raster data in a geospatial context, see the following article online: https://desktop.arcgis.com/en/arcmap/latest/manage-data/raster-and-images/what-is-raster-data.htm

[3] For a general overview of image blend modes in computer graphics, see the following Wikipedia article: https://en.wikipedia.org/wiki/Blend_modes.

4.0 Updated winter solstice cumulative shadow modelling

4.1 Request

21. In 2017 Hodyl + Co was engaged by the CoM to undertake an analysis of the modelling prepared by Harrison and White with the aim of guiding a review of the Sunlight to Public Parks Policy. The main deliverable from Hodyl + Co was the *Sunlight Access Report*.

22. During the analysis Hodyl + Co also advised Council that the shadows cast by built structures were hard to interpret on the Harrison and White cumulative shadow maps. Particularly for built up areas of the municipality.

23. As detailed in **Section 3.0**, the Harrison and White outputs were fixed. As such, the incremental shadows for each half hour could not be 'extracted' or isolated to improve the readability of the maps.

24. As a result of the above limitations, Hodyl + Co requested that the GIS team prepare additional cumulative shadow modelling with the following parameters:

    a. Utilise the same input geospatial datasets as those for the Harrison and White study.

    b. Consider only the 2015 winter solstice falling on 22 June.

    c. Provide incremental shadow outputs for each half hour, between the reduced hours of 10:00 am and 3:00 pm.

    d. Provide a single cumulative shadow output derived from the incremental outputs above.

4.2 Inputs

25. The same base data that was used for the Harrison and White study was used for this modelling.

4.3 Model

26. To undertake this modelling, I used ESRI ArcGIS Desktop. ArcGIS Desktop is an industry leading GIS solution with pre-built geo-processing tools that are supported by the vendor (ESRI) and could be used to execute the modelling.

27. The specific geo-processing tool employed to undertake the shadow modelling was the Area Solar Radiation tool, which is part of the Spatial Analyst toolbox. ESRI's documentation of the tool can be found at the following web link:

    a. https://desktop.arcgis.com/en/arcmap/10.6/tools/spatial-analyst-toolbox/area-solar-radiation.htm

28. A key reason for using this geo-processing tool was that it is designed to output a series of rasters from a single automated process that met the needs of the brief.

4.4 Outputs

29. The primary outputs from this modelling were:

    a. A single static cumulative shadow raster for the hours of 10:00 am to 3:00 pm on 22 June 2015. A fixed version of the cumulative output known as the 'blue map' can be viewed online at:

        i. https://cityofmelbourne.maps.arcgis.com/apps/webappviewer/index.html?id=748143e2ace94df0a3ff01a40b4acf1b

    b. A set of static incremental shadow rasters for each half hour between the hours of 10:00 am to 3:00 pm on 22 June 2015. A fixed version of the incremental outputs known as the 'grey maps' can be viewed online at:

        i. https://cityofmelbourne.maps.arcgis.com/apps/webappviewer/index.html?id=16e858b14a98490388419f01521748b7

30. These were provided as static outputs to Hodyl + Co to support the preparation of their Sunlight Access Report.

4.5 Use and interpretation

31. The Area Solar Radiation tool was designed to support uses such as locating solar power cells to increase productivity. As such it models shadows as a function of the amount of solar energy hitting a surface. This is the reason why the outputs of this modelling look different from the outputs of the Harrison and White work.

32. Where the Harrison and White work produced 'hard edged' shadows the ESRI tool produces 'soft edges' because it is calculating far more complicated aspects of solar energy such as the ambient or 'diffuse' behaviour of light.

33. As explained in paragraph 7 above, this additional information was not taken into consideration when analysing the outputs of this model. Instead the outputs were 'read' in accordance with the simplified definition of overshadowing referred to above.

5.0 Identification of properties with potential to overshadow public parks

5.1 Request

34. After the proposed planning controls for Amendment C278 had been drafted, the GIS Team was approached by the CoM's City Strategy branch in 2018 to develop a model that would identify properties that had the potential to overshadow public parks. These identified properties would then be subject to the proposed planning controls.

35. The modelling was required based on a decision to not pursue a municipal wide Design and Development Overlay (i.e., a DDO that would apply to all properties in the municipality regardless of their potential to overshadow a park or not).

5.2 Inputs

36. The key inputs for this modelling were:

    a. A 1 metre resolution digital elevation model of the municipality. This elevation model is the same as was used for the earlier modelling.

    b. A geospatial layer describing all base property parcels in the municipality[4]. This spatial layer also described the planning scheme zones and overlays that applied to each property.

    c. A dataset of the mandatory and discretionary heights for all zones and built form overlays in the Melbourne Planning Scheme.[5]

    d. A geospatial layer describing all the nominated public parks within the city.[6]

    e. A dataset describing the location of the sun in the sky, relative to the centre of each park, at 100 evenly space time intervals (every three minutes) between the hours of 10:00 am and 03:00 pm on the winter solstice being 21 June 2019.[7]

    f. A geospatial layer defining the areas of the central city that are not subject to the planning controls proposed by Amendment C278.

5.3 Model

37. At its core, the modelling developed to identify properties with a potential to overshadow public parks, is based on an analysis of the intersection of two volumes of airspace.

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[4] The base property geospatial layer is produced and maintained by licenced surveyors at the CoM as part of the GIS Team's Mapbase program of work. The base property parcels in this case are a view of the cadastral or title plan system that represent the property boundaries (or contiguous ownership) at ground level.
[5] This dataset was derived from the Melbourne Planning Scheme by officers of the CoM City Strategy branch.
[6] The geospatial features that describe the areas of the public parks were derived from the CoM Mapbase. The list of nominated parks was compiled by officers of the CoM City Strategy branch.
[7] This dataset was calculated using the Astropy code library: https://www.astropy.org/

38. The first volume, being the 'maximum developable volume' of a property, was defined by the property boundary on the ground and measured from this boundary directly up to the 'maximum developable height'. This does not take account of planning restrictions other than height that could limit the permissible extent of development.

39. To calculate this first volume all base properties in the city were assigned with a single 'maximum developable height' based on the current planning scheme controls.

40. To arrive at this height the following principles, developed by officers from the Urban Strategy branch, were applied to all properties:

    a. Where a mandatory height control exists, this control was applied.

    b. Where a mandatory height control exists, but the control is part of a residential zone (GRZ, NRZ, RGZ), add 30% was added to the height to account for the possible non-residential development in these zones.

    c. Where a discretionary height control exists, the maximum height cap of 320 metres was applied. The 320-metre cap was based on the approximate height of Australia 108 (115-131 City Road and 70 Southbank Boulevard), which at the time of modelling was the highest approved built structure in the municipality.

    d. Where no height control exists, the maximum height cap (320 metres) was applied.

    e. All heights were rounded to the nearest whole number.

41. The second volume, or 'Park Solar Volume', was defined by the boundary of the park on the ground and is measured outward along a line toward the position of the sun in the sky for all time intervals in the model.

42. The Park Solar Volume represents the volume or 'airspace' that would need to be preserved to ensure full sunlight access to the ground surface of the park across the year between the hours of 10:00am and 3:00pm. Any object that enters, or intersects, with this volume would therefore potentially overshadow the park. Please see Figure 5.1 below for a diagram that explains this condition:

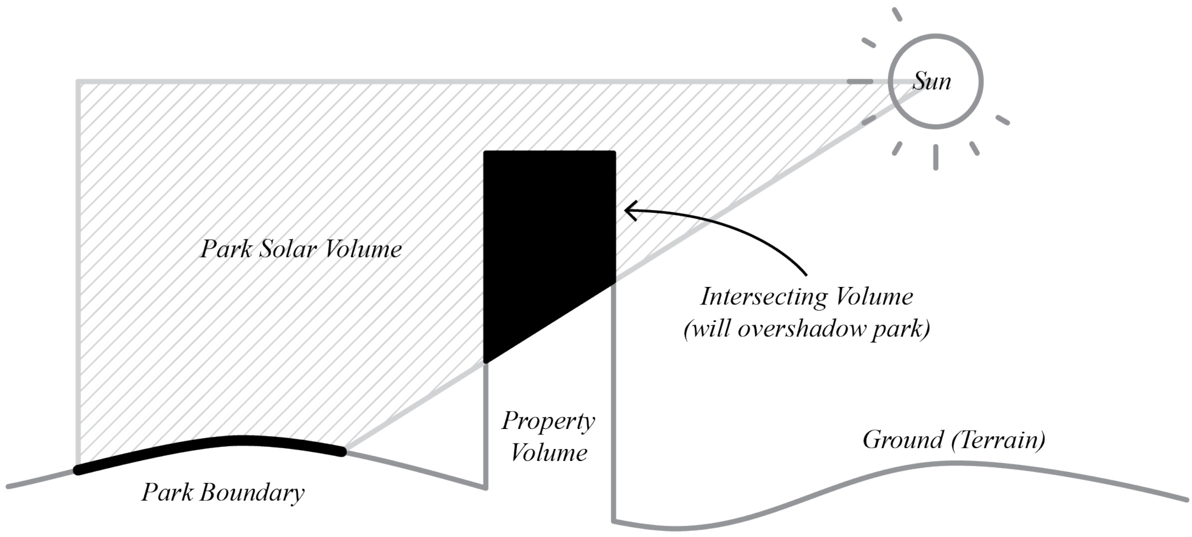

***Figure 4.1** – Park Solar Volume in profile (from side-on)*

43. The calculation and use of the Park Solar Volumes for this model was informed by the earlier 'solar carve' modelling undertaken by Harrison and White (paragraph 17.b.).

44. The best way to visualise these Park Solar Volumes is by drawing a surface that represents the 'underside' of the volume. Figures 5.2, 5.3 and 5.4 illustrate a solar surface in 3D.

45. With the two volumes calculated for all parks and base properties in the city, a comparison was run: If any property's maximum developable volume was identified as intersecting or being within a threshold distance of 10 metres underneath[8] the Park Solar Volumes, then the property was identified as having the potential to overshadow the public park.

46. The following software applications were used to perform the spatial modelling outlined above:

    a. ESRI ArcGIS Pro for desktop spatial data processing and visualisation.

    b. The ESRI ArcGIS Python Environment extended with the Python Astropy code library for sun position calculations.

    c. SideFX Houdini Core for maximum development height and park solar volume modelling and volume comparison calculations.

    d. Safe Software FME for pipeline and data management.

[8] This additional threshold distance was requested by officers from Urban Strategy.

***Figure 5.2** – Looking down on the solar surface for Gardiner Reserve (North is pointing to the top right of the image)*

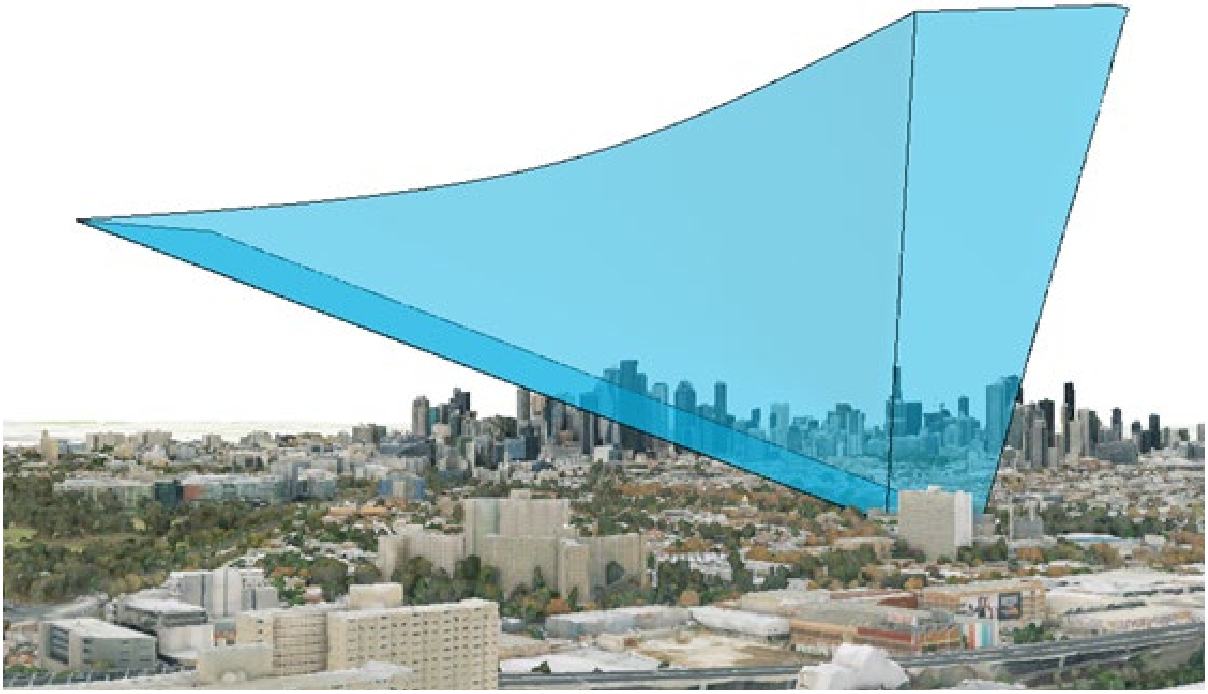

***Figure 5.3** – Looking across to the underside solar surface for Gardiner Reserve (North is pointing to the bottom left of the image)*

Figure 5.4 *– Detail of the solar surface for Gardiner Reserve (Note the buildings penetrating above the surface: these buildings therefore have the potential to overshadow the park)*

5.4 Outputs

47. The primary output of this model was a fixed map and data table that identified all the base properties which have the potential to overshadow public parks.

48. The model was run on two separate occasions first in May 2019 (before exhibition of Amendment C278) and again in March 2020 (considering items raised during and post exhibition). The maps outputs for both runs are included at **Appendix A.**

49. The May 2019 run identified 4,188 base properties as having overshadowing potential, whereas the March 2020 run identified 4,071 base properties. The difference in numbers is a result of two parks being removed from the study (Haymarket Roundabout and the Royal Society Gardens), as well as technical improvements to ensure the development height principles were being consistently applied to all base properties.

4.5 Use and interpretation

50. In some cases, properties to the immediate south of a park are identified as having the potential to overshadow that park. This, whilst counter intuitive, is a result in the shape of the park/property boundary. In these instances, small 'dog-legs' in the boundary, which are remnants of property

subdivisions and amalgamations, create a condition whereby the property is identified as having the potential to overshadow a small fraction the park to the north. See Figure 5.5 for a visual description of this 'dog-leg' condition.

***Figure 5.5** – Dog-leg boundary condition*

51. The model is sensitive to these boundary conditions as the property boundary is the main geometric feature that defines the shape of the property's maximum developable volume. Aspects of the planning scheme, such as setbacks, which may have reduced the impacts of these boundary conditions, were not modelled and as such could not be considered.

52. To reiterate, this primary aim of this modelling was to identify properties with the <u>potential</u> to overshadow public parks. It functions like 'casting a net' over the city to 'capture' a limited number of properties where future development should consider potential overshadowing and design accordingly. The modelling does not make assumptions on what this future built form will be or should be.

6.0 SGS Economics support modelling

6.1 Request

53. In late 2019 I was asked by Urban Strategy officers, as a result of a request from Marcus Spiller from SGS economics, to repurpose the overshadowing potential spatial modelling, detailed in **Section 5.0**, to consider the potential impacts of the proposed overshadowing controls on future development potential.

54. This modelling was developed expressly to inform the evidence being prepared by SGS Economics in relation Amendment C278.

6.2 Inputs

55. The model used the exact same inputs as the earlier overshadowing potential modelling (see **Section 5.2** of this statement).

6.3 Model

56. The primary difference between this modelling and the previous overshadowing potential modelling, were:

    a. Adjustments to the maximum developable height principles.

    b. A focus on measuring future development impact as a function of the loss of maximum developable height, rather than a focus on identifying overshadowing potential.

57. In conversation with Marcus Spiller and Urban Strategy officers of the CoM, the principles for generating the maximum developable height were adjusted as follows:

    a. Where a mandatory height control exists, this control is applied.

    b. Where a mandatory height control exists, but the control is part of a residential zone (GRZ, NRZ, RGZ), add 30% to the height to account for the possible non-residential development in these zones.

    c. Where a discretionary height control exists, add 30% to the height to account for discretion/uncertainty.[9]

    d. Where no height control exists, but the property is within the Capital City Zone (CCZ) or Docklands Zone (DZ) set the maximum height to be 80 metres.[10]

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[9] It is my understanding that the 30% variation in the heights is considered by officers of the CoM statutory planning branch to be the maximum acceptable exceedance of discretionary heights in areas with discretionary height controls.

[10] It is my understanding that this maximum height within the central city area is consistent with the 80m threshold height in the CCZ under the Melbourne Planning Scheme DDO10 controls.

e. Where no height control exists for properties outside of the zones above set the maximum height to be 40 metres.[11]

f. All heights are rounded to the nearest whole number.

58. Given these new principles, an updated maximum developable height was generated for each property.

59. These news height values were then compared against all the Park Solar Volumes to calculate what the loss of maximum developable height may be for each property.

6.4 Outputs

60. The primary output of this model was a fixed map output and data table that identified all the base properties which may see a reduction in maximum developable height because of the proposed Amendment C278. The data generated in September 2020 is included on the map at **Appendix B**.

61. Based on the updated maximum developable height rules: of 14,360 base properties in the municipality (at the time the model was run) only 1,730 could potentially see a reduction in maximum developable heights.

62. The average potential loss of maximum development height[12] for impacted properties was calculated at 30%. When this is extrapolated across all properties of the whole municipality there was observed to be a total loss of potential maximum developable height of approximately 4%.

6.5 Use and interpretation

63. To improve the way the potential loss of maximum development height for each property was calculated it was decided that height, from the ground to any of the Park Solar Volumes above, would be measured at multiple locations along the property boundary.

64. Properties are not always simple rectangular parcels. As such, by measuring heights along the boundary, a better picture of the impacts across the property can be gained. This is done as an alternative to taking a single measurement of height at the centre of the property.

65. It must be noted that height impacts will always be more pronounced at the boundary than at the centre of the property. This is a result of the angle the park solar volumes rise at (see back to Figure 5.3 which illustrates this condition).

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[11] It is my understanding that this maximum height for areas outside of the central city is consistent with the height of developments being observed by officers in City Strategy in growth areas such as Arden.

[12] See section 6.5 for a more detailed description of how this loss of development height was expressed and calculated.

66. It is my opinion that this measure of potential loss of maximum development height does not give a full and accurate picture of what the loss of development rights, or loss of yield, may be as a result of the proposed overshadowing controls. In fact, the loss of maximum development height calculated here potentially over inflates this impact.

67. Because of the discretionary nature of the planning scheme and the complexity involved in designing to minimise overshadowing whilst maximising development outcomes, I advised during the course of undertaking this exercise that the only reasonable method to measure the impact on development would be to undertake a detailed design exercise for all properties in the municipality (in review I think that this exercise would only need to be performed on properties identified as having the potential to overshadow, as identified by the overshadowing potential modelling explained in Section 5).

6.6 Post-delivery analysis of CoM data from Housing Needs Analysis

68. Based on the 'developable properties' dataset supplied by the CoM Research and Insights team, which is a snapshot of properties in 2017 and informed the CoM Housing Needs Analysis, there are a total of 1,462 properties identified as being "developable". These developable properties have a total combined site area of 4,623,595 square metres (approximately 462 ha.).

69. Of the 'developable properties' 1,210 are located wholly outside of the C278 exclusion area (generally being the CBD, Southbank and Docklands). These properties outside of the exclusion area have a total combined site area of 3,897,140 square metres (approximately 389 ha.)

70. The discrepancy in area between 389ha and the SGS figure of 385ha is probably explained because SGS did not have access to the specific boundary of the C278 exclusion area that has been developed since this analysis was undertaken.

71. Of the 1,210 properties contained within the 389ha, only 428 (or 35%) are subject to DDO8. A property that is subject to DDO8 is considered to be a property that has the potential to overshadow one or more of the nominated parks. This potential to overshadow is based on a very liberal interpretation of the planning scheme.

72. Of these 428 properties, only 198 (or 46%) are considered to experience a loss of development potential under the proposed DDO8 controls. The loss of development potential in this case is a measure of the loss of developable height at the perimeter of the property. Defining development potential using the perimeter is a conservative assumption in the application of the principles.

73. Of the 1,210 developable properties outside the exclusion area, 16.36% (198) are considered to experience a loss of development potential under the proposed DDO8 controls.

7.0 Comparative overshadowing study

7.1 Request

74. In mid-2020, with officers from the Urban Strategy branch, I decided to complete a comparative shadow study that would provide an updated understanding of the impacts of overshadowing on Melbourne's public parks over time.

75. This modelling was able to be performed due to the availability of new applications, updated input datasets, and due to a better understanding of the intricacies of shadow modelling in the intervening period.

76. The comparative shadow study was to measure the impacts of overshadowing in 2015 and again in 2020. The study was also to look at the possible impacts of future overshadowing caused by those developments that are currently under construction and those that have been approved but not yet constructed.

7.2 Inputs

77. The key inputs for this modelling were:

    a. A 1 metre resolution digital elevation model of the municipality.[13]

    b. A geospatial layer describing all the nominated public parks within the city.

    c. A 3D dataset describing all the permanent built structures in the municipality as of May 2015. This is the same dataset that was used for both the 3D Sunlight Study by Harrison and White and the subsequent updated winter solstice cumulative shadow modelling by the CoM.

    d. A new 3D dataset describing all the permanent built structures in the municipality constructed between 2015 and 2020.[14]

    e. A geospatial layer describing the footprints and heights of developments that are either under construction or approved to be constructed. The footprint and height information for this layer was manually derived from the latest building plans submitted as part of the development permit process.

78. In addition to the inputs above, a new dataset describing the location of the sun in the sky across the entire municipality was generated at 15-minute time intervals between the hours of 10:00 am

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[13] It was decided to use the same 2014 elevation model as was used for the earlier modelling, including the Harrison and White model, as it is observed that the terrain within the public parks has changed little between 2014 and 2020.

[14] As discussed in paragraph 9.c. this 3D dataset was derived from a photo mesh product (in this case the most recent 2020 capture).

and 03:00 pm on the winter solstice. This dataset is known herein as the 'solar ephemeris reference grid'.

79. The solar ephemeris reference grid differs from other sun position reference frames used for earlier modelling (such as referencing the position of the sun in the sky from the centre of a park) in that it divides the city up into a regular grid. The solar ephemeris is then computed from the centre point of each one of these grid cells independently.

80. For accuracy, the reference grid aligns directly with the underlying geographic datum (see Paragraph 9.a.). The grid is also spaced to minimise, to an exceedingly small degree, the difference in the calculated solar ephemeris between grid cells[15]. This not only ensures accuracy: it also reduces compute time and resources by an order of magnitude.

7.3 Model

81. The above inputs were run through the following model processes:

    a. For each park, generate an observation point for every square metre of the park. These points must align exactly with both the underlying datum and terrain model.

    b. For each observation point, obtain the solar ephemeris data from the underlying solar ephemeris reference grid.

    c. For each solar ephemeris observation point, project a line from the observation point to the location of the sun in the sky. This line is known as the 'solar vector'.

    d. For each solar vector, separately measure any intersections that occur along the vector with the following 3D datasets:

        i. The 2015 built structures 3D data (77.c.).

        ii. The 2020 built structures 3D data (77.d.) merged with the 2015 3D data (and considering any structure demolitions that have been recorded in the intervening period).

        iii. Simplified 3D representations of any structures that are currently under construction (77.e.).

        iv. Simplified 3D representations of any structures that are currently approved to be constructed (77.e.).

[15] See paragraph 10.h. for an explanation of what a solar ephemeris is.

82. Any intersection that is recorded along the solar vectors is recorded as a simple binary value for each dataset: '1' if there is any recorded intersection event (therefore the observation point is in shadow) or '0' for no intersections (not in shadow).

83. These observations are then compiled ready for output.

84. It must be noted that the method outlined above strongly aligns with the simplified definition of overshadowing that is presented in paragraph 6 of this statement.

85. The following software applications were used to perform the spatial modelling outlined above:

  a. ESRI ArcGIS Pro for desktop spatial data processing and visualisation.

  b. The ESRI ArcGIS Python Environment extended with the Python Skyfield code library for solar ephemeris reference grid calculations.

  c. SideFX Houdini Core for overshadowing analyses.

  d. Safe Software FME for pipeline and data management.

7.4 Outputs

86. The primary outputs of this modelling were:

  a. A static dataset of all compiled observations.

  b. A static data table describing the change in overshadowing for each park between 2015 and 2020.

  c. Four cumulative shadow rasters, one for each of the winter solstice dataset observations. A fixed version of the cumulative outputs can be viewed online at:

    i. https://cityofmelbourne.maps.arcgis.com/apps/webappviewer/index.html?id=8a406a7df5fd46f6a4d5766a7b79c8e8

  d. Four sets of incremental shadow rasters, one set for each of the winter solstice dataset observations. A fixed version of the incremental outputs can be viewed online at:

    i. https://cityofmelbourne.maps.arcgis.com/apps/webappviewer/index.html?id=8e5481533c1a46d29e268a3b2c64c8a7

87. I have attached a copy of the static data table describing the change in overshadowing for each park between 2015 and 2020. (86.b.) at **Appendix C**.

7.5 Use and interpretation

88. The comparative analysis of the shadows between 2015 and 2020 shows that there has been a clear increase in overshadowing caused by built structures to some parks in the municipality.

89. These impacted parks are primary found in areas where large residential developments have been built close to parklands. For instance, Galada Avenue Reserve and Gardiner Reserve experienced a 62% and a 47% increase in cumulative overshadowing on the winter solstice.

90. The impacts of overshadowing, whilst able to be modelled and managed at a municipal level, is a uniquely local issue. Therefore, I would recommend against any analysis that seeks to promote a 'global' or municipal wide comparison between time periods. For any analysis to be effective it must be considered at a local, and in this instance, park-by-park basis.

91. There is a significant limitation to the shadows modelled using the geospatial layer describing developments that are either under construction or approved to be constructed (77.e.). The primary purpose of this layer is to generate visualisations for the CoM's online Development Activity Model (**DAM**). The 3D representations of structures are derived from 2D footprints and heights that have been manually traced from the most recent building plans and documentation available from the planning permit system. Where possible these features match the general built form of the proposed building as closely as possible with representations of major mass elements such as podiums and towers. These 3D representations have been included in this study to provide a <u>general understanding</u> of what the future <u>potential</u> impacts of overshadowing <u>may</u> be. The shadows measured from these features are not exact and should not be analysed as such. Overall, the use of these simplified 3D representations illustrates that the trend of overshadowing from development may continue for some parks in the municipality.

Daniel Smith

04 February 2021

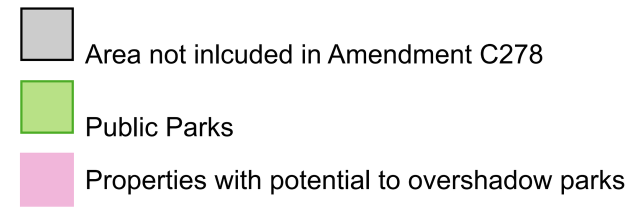
Appendix A

Map Outputs: Properties with potential to overshadow public parks

Appendix A - Map 1

Amendment C278: Sunlight to Public Parks

Properties identified as having the potential to overshadow public parks (Model Run 1 - May 2019)

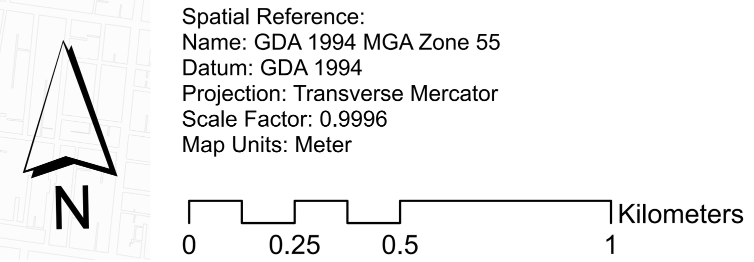


Cartographer:
Daniel Smith, GIS Specialist Analyst

Date Published:
25/01/2021 11:35 AM

Map Notes:
Please print this map on A1

Spatial Reference:
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator
Scale Factor: 0.9996
Map Units: Meter



CITY OF MELBOURNE

Appendix A - Map 2

Amendment C278: Sunlight to Public Parks

Properties identified as having the potential to overshadow public parks (Model Run 2 - March 2020)

- Area not inlcuded in Amendment C278
- Public parks

Properties with potential to overshadow public parks

- No change (has overshadowing potential)
- Remove from overshadowing list
- Add to overshadowing list

Cartographer:
Daniel Smith, GIS Specialist Analyst

Date Published:
25/01/2021 11:22 AM

Map Notes:
Please print this map on A1

Spatial Reference:
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator
Scale Factor: 0.9996
Map Units: Meter

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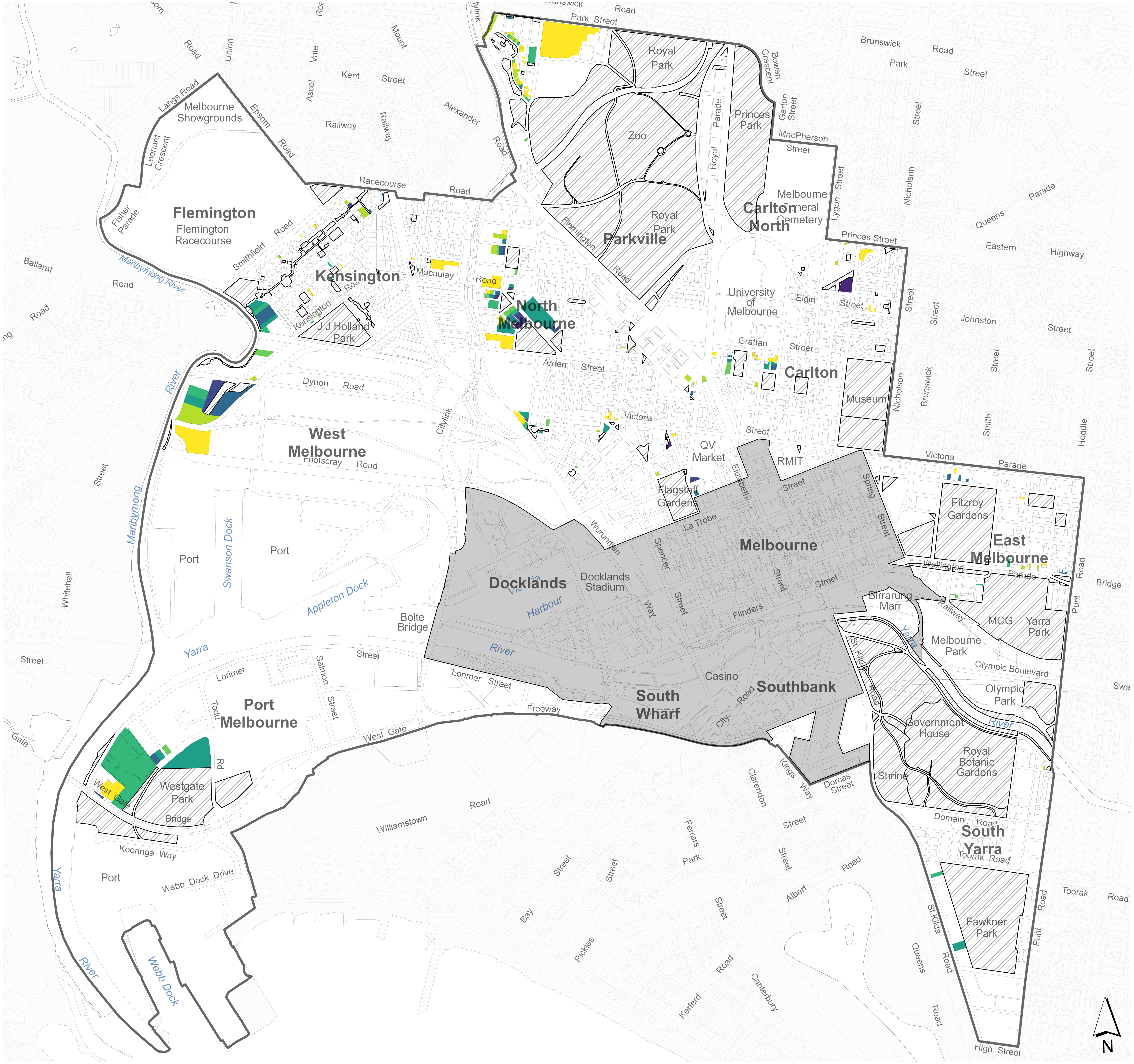
Appendix B

Map Outputs: Impacts to maximum developable heights

Appendix B - Map 1

Amendment C278: Sunlight to Public Parks

Possible loss of maximum developable height for properties with development potential



- Area not inlcuded in Amendment C278
- Public Parks

Possible loss of maximum developable height for properties with development potential

- 10% or under reduction at boundary (55)
- 20% (40)
- 30% (20)
- 30% - 40% reduction at boundary (18)
- 40% - 50% reduction at boundary (19)
- 50% - 60% reduction at boundary (12)
- 60% - 70% reduction at boundary (15)
- 70% - 80% reduction at boundary (12)
- 80% - 90% reduction at boundary (7)
- 90% or above reduction at boundary (0)

Cartographer:
Daniel Smith, GIS Specialist Analyst

Date Published:
4/02/2021 11:37 PM

Map Notes:
Please print this map on A1

Spatial Reference:
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator
Scale Factor: 0.9996
Map Units: Meter

N

0 0.25 0.5 1 Kilometers

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Appendix C

Data table output: Comparative shadow analysis 2015-2020

#	Park Name	Park Area	Area Shadow 2015	Area Shadow 2020	Area Shadow Terrain	Area Shadow 2015 (%)	Area Shadow 2020 (%)	Area Shadow Terrain (%)	2015-2020 % Difference
1	Kensington BanksCouncil Reserve No 10	807	525	525	0	0.65	0.65	0	0
2	Maribyrnong River Bike Trail	7753	148	148	0	0.02	0.02	0	0
3	Maribyrnong River Bike Trail	2041	656	656	0	0.32	0.32	0	0
4	Maribyrnong River Bike Trail	514	193	373	1	0.38	0.73	0	0.35
5	Maribyrnong River Bike Trail	2064	1285	1748	6	0.62	0.85	0	0.23
6	Riverside Park	44318	11936	11936	462	0.27	0.27	0.01	0
7	Shepherd Bridge Reserve	3236	342	342	24	0.11	0.11	0.01	0
8	Wildlife Sanctuary	24008	0	0	500	0	0	0.02	0
9	Bayswater Road Park	2933	601	601	0	0.2	0.2	0	0
10	J J Holland Park	103452	14024	14024	76	0.14	0.14	0	0
11	J J Holland Park	352	352	352	0	1	1	0	0
12	Kensington Banks Council Reserve No 1	4333	411	411	1	0.09	0.09	0	0
13	Kensington Banks Council Reserve No 1	398	349	349	0	0.88	0.88	0	0
14	Kensington Banks Council Reserve No 2	4689	1569	1569	0	0.33	0.33	0	0
15	Kensington Banks Council Reserve No 4	807	447	447	0	0.55	0.55	0	0
16	Kensington Banks Council Reserve No 5	3666	2460	2460	4	0.67	0.67	0	0

#	Park Name	Park Area	Area Shadow 2015	Area Shadow 2020	Area Shadow Terrain	Area Shadow 2015 (%)	Area Shadow 2020 (%)	Area Shadow Terrain (%)	2015-2020 % Difference
17	Kensington Banks Council Reserve No 6	2174	1204	1204	2	0.55	0.55	0	0
18	Kensington Banks Council Reserve No 7	309	301	301	0	0.97	0.97	0	0
19	Kensington Banks Council Reserve No 8	819	531	531	0	0.65	0.65	0	0
20	Kensington Banks Council Reserve No 9	550	503	503	0	0.91	0.91	0	0
21	Kensington BanksCouncil Reserve No 3	3471	560	573	1047	0.16	0.17	0.3	0.01
22	McCracken Street Reserve	440	229	229	0	0.52	0.52	0	0
23	Peppercorn Park	2482	1691	1691	79	0.68	0.68	0.03	0
24	Warun Biik Park	8448	7793	7793	2747	0.92	0.92	0.33	0
25	Westbourne Road Reserve	19423	12371	12463	102	0.64	0.64	0.01	0
26	Womens Peace Garden	6965	1600	1600	67	0.23	0.23	0.01	0
27	Kensington Hall Reserve	5295	2541	2541	0	0.48	0.48	0	0
28	Liddy Street Reserve	1371	134	134	0	0.1	0.1	0	0
29	Newmarket Reserve	22086	0	133	0	0	0.01	0	0.01
30	Reserve 5A Market Street Kensington	311	0	0	0	0	0	0	0
31	Stock Route Reserve	8095	4547	4547	66	0.56	0.56	0.01	0
32	Canning Street & Macaulay Road Reserve	1949	1263	1263	0	0.65	0.65	0	0
33	Clayton Reserve	6901	1267	1267	0	0.18	0.18	0	0

#	Park Name	Park Area	Area Shadow 2015	Area Shadow 2020	Area Shadow Terrain	Area Shadow 2015 (%)	Area Shadow 2020 (%)	Area Shadow Terrain (%)	2015-2020 % Difference
34	Eastwood & Rankins Road Reserve	2265	0	0	0	0	0	0	0
35	Gardiner Reserve	8898	236	4439	36	0.03	0.5	0	0.47
36	North Melbourne Community Centre	16564	10044	10044	0	0.61	0.61	0	0
37	North Melbourne Recreation Reserve/Centre	46125	7410	7621	296	0.16	0.17	0.01	0.01
38	Parsons Street Reserve	1994	132	132	0	0.07	0.07	0	0
39	Pleasance Gardens	4027	257	257	0	0.06	0.06	0	0
40	Robertson Street Reserve	1023	50	50	0	0.05	0.05	0	0
41	Bedford Street Reserve	1151	584	584	0	0.51	0.51	0	0
42	Chapman Street Reserve	1658	133	133	0	0.08	0.08	0	0
43	Courtney Street Reserve	564	421	421	0	0.75	0.75	0	0
44	Curzon Street Reserve	340	179	179	0	0.53	0.53	0	0
45	Eades Park	7412	615	615	10	0.08	0.08	0	0
46	Errol Street Reserve	5240	74	400	0	0.01	0.08	0	0.07
47	Flagstaff Gardens	74771	13752	13836	1681	0.18	0.19	0.02	0.01
48	Hawke & Adderley Street Park	2060	1037	1037	0	0.5	0.5	0	0
49	Hawke & Curzon Street Reserve	1495	436	898	0	0.29	0.6	0	0.31
50	Hawke & King Street Reserve	688	0	0	0	0	0	0	0
52	Howard & William Street Reserve	2289	920	919	0	0.4	0.4	0	0
53	King & Victoria Street Reserve	596	6	6	0	0.01	0.01	0	0

#	Park Name	Park Area	Area Shadow 2015	Area Shadow 2020	Area Shadow Terrain	Area Shadow 2015 (%)	Area Shadow 2020 (%)	Area Shadow Terrain (%)	2015-2020 % Difference
54	Leveson Street Reserve	1269	77	77	0	0.06	0.06	0	0
55	Railway Place & Miller Street Park	3704	1658	1858	48	0.45	0.5	0.01	0.05
56	Stawell Street Park	1382	28	32	108	0.02	0.02	0.08	0
57	Auckland Lane Reserve	448	448	448	0	1	1	0	0
58	Carrangall Place Reserve	486	359	359	0	0.74	0.74	0	0
59	Clunies Ross Reserve	1388	880	915	0	0.63	0.66	0	0.03
60	Galada Avenue Reserve	14072	20	8773	4	0	0.62	0	0.62
61	Garrard Street Reserve	1309	725	725	0	0.55	0.55	0	0
62	Ievers Reserve	14704	2944	2944	0	0.2	0.2	0	0
63	Manchester Lane Reserve	488	143	143	0	0.29	0.29	0	0
64	Park Street Reserve	4418	0	0	32	0	0	0.01	0
65	Parkville Gardens	7641	1886	1886	0	0.25	0.25	0	0
66	Princes Park	398889	48177	48179	205	0.12	0.12	0	0
67	Royal Park	1980935	178446	178402	19051	0.09	0.09	0.01	0
68	The Avenue Reserve (North)	2127	0	0	0	0	0	0	0
69	The Avenue Reserve (South)	3283	2133	2935	1479	0.65	0.89	0.45	0.24
70	Argyle Square	13765	695	824	4	0.05	0.06	0	0.01
71	Canning & Neill Street Reserve	2271	45	45	1	0.02	0.02	0	0
72	Canning & Palmerston Street Reserve	486	392	392	0	0.81	0.81	0	0
73	Cardigan Street Park	613	611	611	0	1	1	0	0
74	Carlton Gardens North	168059	66628	66628	329	0.4	0.4	0	0
75	Carlton Gardens South	89330	19844	19844	6	0.22	0.22	0	0

#	Park Name	Park Area	Area Shadow 2015	Area Shadow 2020	Area Shadow Terrain	Area Shadow 2015 (%)	Area Shadow 2020 (%)	Area Shadow Terrain (%)	2015-2020 % Difference
76	Eight Hour Reserve	1039	806	806	0	0.78	0.78	0	0
77	Keppel Street Park	450	370	370	0	0.82	0.82	0	0
78	Lincoln Square	13733	3325	3325	0	0.24	0.24	0	0
79	Macaurthur Square	3992	39	39	0	0.01	0.01	0	0
80	Murchison Square	4018	0	0	0	0	0	0	0
81	Neill Street Reserve	11052	9931	10617	44	0.9	0.96	0	0.06
82	Reeves Street Park	1815	1470	1815	0	0.81	1	0	0.19
84	Station Street Park	2870	295	1212	7	0.1	0.42	0	0.32
85	University Square	17027	7208	7208	0	0.42	0.42	0	0
86	Darling Square	8557	0	0	0	0	0	0	0
87	Fitzroy Gardens	264934	27560	32051	720	0.1	0.12	0	0.02
88	Gillott Reserve/Tianjin Gardens	1522	1521	1521	726	1	1	0.48	0
89	Jolimont Reserve	9415	730	725	751	0.08	0.08	0.08	0
90	Parliament Reserve	7741	7741	7741	0	1	1	0	0
91	Powlett Reserve	21086	2903	2903	0	0.14	0.14	0	0
92	St Andrews Place Reserve	1106	1106	1106	0	1	1	0	0
93	Treasury Gardens	59394	26087	26087	1355	0.44	0.44	0.02	0
94	Weedon Reserve	6884	824	824	0	0.12	0.12	0	0
95	Wellington Park	9533	1215	1626	1603	0.13	0.17	0.17	0.04
96	Yarra Park	375364	141546	141384	3517	0.38	0.38	0.01	0
97	Alexandra Gardens	62618	9926	9926	513	0.16	0.16	0.01	0
98	Alexandra Park	52887	747	747	36	0.01	0.01	0	0
99	Fawkner Park	417721	31456	31380	52	0.08	0.08	0	0
100	Golden Elm Reserve	873	415	415	0	0.48	0.48	0	0
101	Goschs Paddock	73199	368	368	56	0.01	0.01	0	0
102	Kings Domain	246352	7961	7961	2166	0.03	0.03	0.01	0
103	Kings Domain South	131724	5093	5093	254	0.04	0.04	0	0

#	Park Name	Park Area	Area Shadow 2015	Area Shadow 2020	Area Shadow Terrain	Area Shadow 2015 (%)	Area Shadow 2020 (%)	Area Shadow Terrain (%)	2015-2020 % Difference
104	Marquis of Linlithgow Memorial Reserve	2582	126	126	15	0.05	0.05	0.01	0
105	Queen Victoria Gardens	49566	1002	1002	146	0.02	0.02	0	0
106	River Bank Reserve	5509	309	309	2	0.06	0.06	0	0
107	Royal Botanic Gardens	500396	50603	50603	3915	0.1	0.1	0.01	0
108	Shrine of Remembrance Reserve	131653	10990	10990	1947	0.08	0.08	0.01	0
109	Stapely Parade Reserve	35139	3177	3177	1693	0.09	0.09	0.05	0
110	Melbourne International Karting Complex	53080	4722	4722	5770	0.09	0.09	0.11	0
111	Westgate Park	373832	86085	86085	2535	0.23	0.23	0.01	0

Appendix D

Daniel Smith Curriculum Vitae

Daniel Lee Smith

Curriculum Vitae

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E. danleesmith86@outlook.com
P. (+61) 0424281176

Career Statement

A natural leader and problem-solver with unique skills, education, and experience. Passionate about the role geography, data and design has in building better, more resilient communities. Striving to reconnect people with place.

Skills & Strengths

Spatial Modelling and Analytics, 3D Visualisation, Data, Coding, Systems Integration, Urban Planning and Design, Architectural Design, Ideation, Initiative, Agility, Design Thinking, Teamwork, Public Speaking, Leadership

Professional Experience

1

GIS Specialist Analyst / Melbourne City DNA Project Lead
Melbourne City Council | Melbourne VIC Australia
Nov 2016 – Present

Leading a multi-disciplinary team to create the award-winning Melbourne City DNA platform. Melbourne City DNA enables new modes of community engagement and participation using spatially focussed emerging technologies both in-place and on the web. Also, an in-house GIS consultant improving long term decision making and augmenting urban planning and design practice in the City of Melbourne by developing innovative spatial models using a mature Digital Twin stack.

2

GIS Officer (Urban Planning, Research and Visualisation)
Moonee Valley City Council | Melbourne VIC Australia
Apr 2014 - Nov 2016

Developed spatial models, analytics, and 3D visualisations to support the Strategic Planning team. The neighbourhood and transport accessibility modelling I developed independently in this role was crucial to the realisation of the Moonee Valley 2040 Strategy.

3 **Facilities Planning and Design Officer**

Brisbane City Council | Brisbane QLD Australia

Jun 2012 - Apr 2014

Explored new paths in my career and managed the design and maintenance of community and sporting facilities across Brisbane. Participated in the development of metropolitan scale community facility infrastructure and site-specific master planning. Worked hand in hand with community groups. Coordinated the skate sports portfolio.

4 **3D Urban Modeller**

Brisbane City Council | Brisbane QLD Australia

Jul 2009 - Jun 2012

Was one part of two-person Virtual Brisbane project one of Australia's first true Digital Twin projects. Oversaw initial planning, delivery and operations. Integrated 3D spatial analytics into Council's planning and assessment processes. Was an early adopter of CityEngine and the use of procedural modelling in urban design practice.

5 **Urban Planner (Graduate)**

Brisbane City Council | Brisbane QLD Australia

Jan 2008 - Jul 2009

Worked across a range of teams from open space policy through to infrastructure planning and urban research as part of the Brisbane City Council's graduate program.

6 **Town Planner (Student)**

KHA Development Managers | Sunshine Coast QLD Australia

Jan 2004 - Nov 2007

Supported consultancy on all stages of the development planning process for a wide range of clients.

Education

Master of Architecture | *The University of Melbourne* | Melbourne VIC Australia | 2014 - 2017

Master of Creative Industries (Animation) | *Queensland University of Technology* | Brisbane QLD Australia | 2010 - 2012

Bachelor of Regional and Town Planning | *The University of Queensland* | Brisbane QLD Australia | 2004 - 2007

Certificate IV in Project Management | *Australian Institute of Management* | Brisbane QLD Australia | 2012

Technology Competencies

	Competent	***Intermediate***	***Advanced***
ESRI ArcGIS Desktop (incl. arcpy) – *GIS*			✔
QGIS – *GIS*	✔		
ESRI ArcGIS Online and Portal – *Web GIS*		✔	
Mapbox – *Web GIS*	✔		
Safe Software FME – *ETL*		✔	
Python – *Code*			✔
JavaScript – *Code*	✔		
Microsoft SQL Server – *Database*	✔		
Postgres / PostGIS – *Database*	✔		
Microsoft Excel – *Data Management*		✔	
Microsoft Power BU – *Data Visualisation*		✔	
Trimble SketchUp – *3D*			✔
Autodesk 3ds Max – *3D*		✔	
SideFX Houdini – *3D*			✔
Blender 3D – *3D*		✔	
Unity – Game Engine	✔		
Unreal Engine – Game Engine	✔		
Autodesk Revit - *BIM*	✔		
Autodesk AutoCAD - *CAD*	✔		
McNeel Rhino 3D (incl. Grasshopper) - *CAD*		✔	
Adobe Photoshop - *Design*		✔	
Adobe Illustrator - *Design*		✔	
Adobe InDesign - *Design*		✔	

Actively Learning: *React (JavaScript), Svelte (JavaScript), D3 (JavaScript), Rust (Code)*