Arbor Carbon *Creating Sustainable Ecosystems*

Advice Regarding the Continued Planting of Norfolk Island Pine

Town of Cottesloe

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Company Name: ArborCarbon Pty Ltd

ACN: 145 766 472

ABN: 62 145 766 472

Address: ROTA Trans 1, Murdoch University, Murdoch WA 6150

Post: PO Box 1065 Willagee Central, WA 6163

Phone: +61 408 907 152

Website: **www.arborcarbon.com.au**

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1 Viability of Norfolk Island Pines

The Town of Cottesloe has a significant number (approx. 1300) of Norfolk Island Pines (NIP) (*Araucaria heterophylla*) planted throughout the Council, in both streetscapes and public parks, and they are considered significant and iconic to the City's amenity. Many of the Town's streets are planted with NIP as avenue plantings, such as Broome and Eric Streets, and the foreshore also includes numerous mature NIP. Since 2019, the health of NIP throughout WA has shown symptoms of decline, including crown thinning and top-down dieback. Multiple trees within the Town have died and been removed.

Top-down dieback of the crowns is caused by the fungal pathogen *Neofusicoccum parvum*. The fungus is probably common in the environment, but it only causes disease in trees under extreme stress. Extreme causes of stress include:

- Increased air temperature and severe temperature fluctuations
- Decreased access to water e.g., drought
- Nutrient deficiencies
- Mechanical injuries e.g., severed roots due to development, sunscald

The extended summer-autumn drought in 2019 is believed to have triggered the observed outbreak in 2020-21 (ArborCarbon 2020). Mild La Niña summer conditions since this period have reduced disease incidence. Many trees appear to have improved in health. For example, many trees appear to have died back, and branches have resprouted at the branch-trunk unions.

Other factors were associated with the premature decline of mature NIP throughout the Town, including the presence of *Phytophthora* species.

To assess the increase or decrease in the health of NIP over time, analysis was undertaken to determine the range and change in Vegetation Condition Index (VCI) value of each NIP throughout the Town. The VCI is an algorithm derived from ArborCarbon's airborne ArborCam™ multispectral imagery, and it is highly sensitive to fluctuations in crown condition. ArborCarbon have successfully used it to benchmark the condition of more than 40,000 trees throughout the City of Melbourne, including 1500 of their iconic Elm trees. The median VCI was calculated for each NIP crown in 2020 and 2023 (Figure 1). The 2017 imagery was not used as a baseline measure due to the variation in sensor and acquisition parameters during that year. The lower the VCI value, the poorer the crown condition of the tree.

Of the 903 NIP in the Town, 72.5% had increased in health, and 27.5% had decreased in health over a period of three years between 2020 and 2023 (Figure 1). This could be considered a positive indication of their viability as an amenity tree in the Town of Cottesloe. However, as discussed, the health of NIP is impacted greatly by stress, and environmental factors are often responsible for such stress. Environmental factors result from general seasonal fluctuations, larger scale climate patterns such as El Niño and La Niña, and long-term forecast predictions such as global warming and reduced rainfall due to climate change. While the NIP health appears to have improved in the short term, they will likely experience similar decline patterns again because of environmental stressors. The general outlook for Western Australia's climate is increasing temperature, reduced rainfall, and increased severe weather pattens (Figure 2).

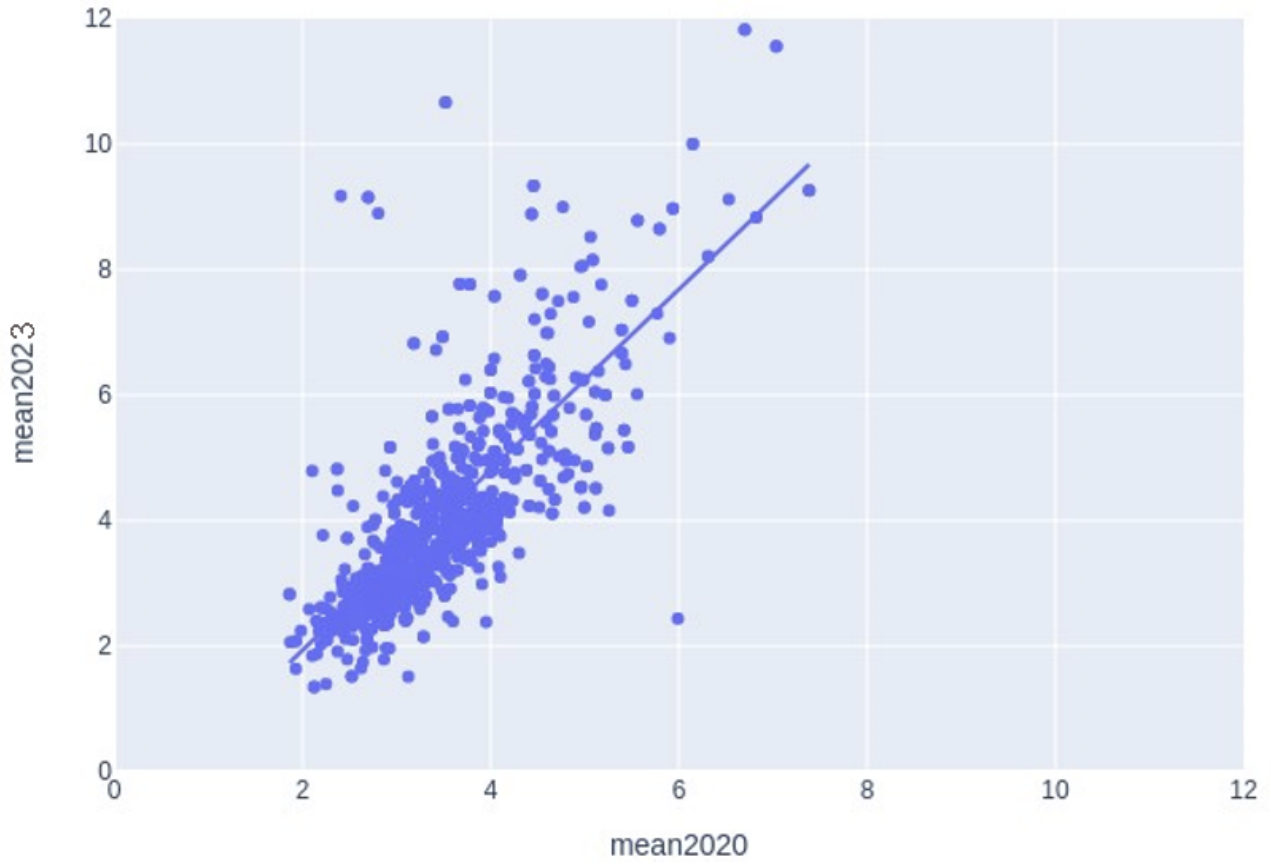

Figure 1: Scatter plot showing the relationship between VCI in 2020 and VCI in 2023.

Variable		Current (1986–2005)	2030		2090	
			RCP4.5	RCP8.5	RCP4.5	RCP8.5
Annual rainfall			-13 to 0% (minor difference between scenarios)		-22 to -1%	-36 to -2%
Extreme rainfall and drought			Under all emissions scenarios, the time spent in drought is projected to increase. The intensity of heavy rainfall events is also projected to increase with medium confidence.			
Average temperatures			+0.8 °C (0.5 to 0.9)	+0.8 °C (0.5 to 1.1)	+1.7 °C (1.2 to 2.0)	+3.4 °C (2.6 to 4.0)
Frequency of hot days in Perth	**Days over 35 °C**	28 days	36 days	-	43 days	63 days
	Days over 40 °C	4 days	6.7 days	-	9.7 days	20 days
Fire weather (average number of days with a 'severe' fire danger rating)		4.2 days	5 days (19% ↑)	4.7 days (12% ↑)	5.3 days (26% ↑)	6.9 days (64% ↑)
Sea level rise			+0.07 to 0.17 m (minor difference between scenarios)		+0.28 to 0.65 m	+0.39 to 0.85 m

Figure 2: Projected climate change indicators for the South-west region of Western Australia. Image source Department of Water and Environmental Regulation (2021).

Increasing temperatures and reduced rainfall due to climate change are reducing the suitability of Norfolk Island Pine trees to the town and is likely to lead to disease recurrence in the future. The tree water

requirements and limited groundwater availability in the area mean that the species is not consistent with the Town's status as a waterwise council. In addition, the Department of Water and Environmental Regulation recently released the *Gnangara groundwater allocation plan*, which proposes significant changes to Perth water usage, including:

- A 27 per cent reduction (30 gigalitres per year) in 2028 to groundwater licensed to the Water Corporation for Perth's Integrated Water Supply Scheme (drinking water).
- A 10 per cent reduction for most groundwater licensees from 2028, to give people time to adjust to the changes.
- Alignment of the sprinkler roster for garden bores and scheme users from September 2022 – the State Government is proposing that all households across Perth and Mandurah will have a two-days-per-week sprinkler roster between 1 September and 31 May each year, regardless of the water source.

It is advised that the City phases out the replanting of NIPs and replaces them with a suitable amenity species more resilient to environmental stressors.

1.1 Alternative Species

A range of alternative species can be considered to replace the NIP throughout the Town. Species selection must consider the 17 criteria outlined in the Town of Cottesloe Street Tree Masterplan 2023 Update (ArborCarbon 2023). An extensive list of proposed trees has been provided in the Masterplan, including replacements for NIP along many of the streets. Proposed replacement species include *Eucalyptus todtiana, Casuarina equisetifolia, Triadica sebifera, Eucalyptus nicholii, Melaleuca lanceolata, Olea europaea, Eucalyptus gomphocephala,* and *Eucalyptus decipiens.* Other medium to tall tree species with a history of good growth throughout Perth and could be considered include *Corymbia maculata, Corymbia eximia* and *Eucalyptus cladocalyx.* Regardless of the species chosen, the quality of the nursery stock, the method of planting, and resources allocated to establishment and maintenance, will greatly impact the contribution these trees make towards the Town's urban forest over the coming decades.

As an aside, it will be important to consider the likely arrival of Myrtle Rust into the southern regions of WA. Members of the Myrtaceae vary in their susceptibility to Myrtle Rust, and selection of species within this family should be considered carefully before planting. Also, the recent arrival of the Polyphagous Shot Hole Borer (PSHB) into the Metropolitan area will likely influence the selection of some native species, as the native host range is increasing. Increasing evidence shows that stressed trees are predisposed to PSHB. Therefore, selecting drought and heat tolerant species will be increasingly important in the future, particularly as regulations around irrigation use are implemented.

1.2 Management Recommendations

If the Town chooses to continue planting NIP, and manage the existing NIP population, the Council should follow the following management recommendations:

- Supplement irrigation across the late summer-autumn period particularly during predicted drought years and anticipated high temperatures.
- Maintain good hygiene while pruning trees to avoid spread of disease.
- Care for the root-zone around the trees. Avoid root damage and compaction during development. Consider mulching and excluding car parking under trees.

- Monitor the health of the NIP population annually to better determine long-term health patterns (less impacted by seasonal change), using a combination of VCI derived from airborne ArborCam imagery, and field-based validation. Such an approach can be used as an early warning system for detecting declining individual trees across the population.
- Establish an experimental trial to identify treatments that may be used to respond to trees identified in the early-warning system.
- Following the establishment of the early warning system, and identification of treatments, develop a comprehensive NIP Health Management Plan.

2 References

ArborCarbon (2020). *Investigation into the cause(s) of premature decline of Norfolk Island Pine.* Report No. J20490 prepared for the Town of Cottesloe. 2nd November 2020. 37 pp.

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