Lake Claremont Management Plan 2016 - 21

BIOPHYSICAL WETLAND VALUES - APPENDIX 1

TOWN OF CLAREMONT
Est 1898

Development

Natural Area Holdings Pty Ltd, trading as Natural Area Consulting Management Services (Natural Area), wrote the first four drafts of this management plan with guidance and assistance from officers of the Town. The Lake Claremont Advisory Committee, Friends of Lake Claremont and the Claremont Council revised those drafts.

Officers of the Town of Claremont completed subsequent drafts of this management plan and appendices.

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Natural Area Holdings Pty Ltd, trading as Natural Area Consulting Management Services (Natural Area), has prepared Drafts 1 to 4 of this plan for the sole use of the Client to assist with assessing the suitability of our proposed solution/s and engaging our services. This document may not be relied upon by any other party without the express written agreement of Natural Area.

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1.0 Biophysical Environment

1.1 Location

Lake Claremont is approximately 10 km southwest of the Perth Central Business District. The Lake Claremont site (Figure 1), including Cresswell Oval and Mackenzie Bushland, are defined by Alfred Road to the north, Davies Road to the east, private property and Shenton Road to the south and Strickland Street, Lakeway Estate and Narla Road to the west.

1.2 Regional Context

Perth is located within the Swan Coastal Plain region of the Interim Biogeographical Regionalisation of Australia (IBRA). The Swan Coastal Plain comprises of two major divisions, namely Swan Coastal Plain 1 – Dandaragan Plateau and Swan Coastal Plain 2 – Perth Coastal Plain. The site is located in the Perth subregion, which is broadly characterised as including areas of Jarrah and Banksia woodlands on sandy soils in a series of sand dunes, along with wetland areas, often within the interdunal swales (Mitchell, Williams and Desmond, 2002).

According to Mitchell, Williams and Desmond (2002) the Perth metropolitan area comprises approximately 20% of the Swan Coastal Plain Subregion and was the subject of a comprehensive assessment to determine reservation status and protection requirements as part of Bush Forever. This assessment identified regionally significant bushland areas, with Lake Claremont site recognised as Bush Forever site 220.

Less than 20% of the wetlands on the Swan Coastal Plain remain. In the western suburbs there are only a few protected conservation category wetlands, which include Lake Monger, Perry Lakes, Herdsman Lake, Lake Gwelup and Lake Claremont.

1.3 Linkages

The Lake Claremont site act as an ecological link between bushland areas to the east, including Kings Park and Shenton Park Bushland. The main western linkage is the coastal foreshore reserve. (WALGA, 2004). There is also a linkage north to Bold Park and south to the Swan River foreshore. Lake Claremont and its surrounds are Target Area 2 in the *Capital City Planning Framework – Support Document* with the objective of improving habitat values and connectivity to the Swan River and Bold Park (Perth Biodiversity Project, 2013). The importance of Lake Claremont as an ecological link to other sites is reported in the Western Suburbs Greening Plan (Ecoscape, 2002). Lake Claremont meets essential criteria for consideration as a Locally Significant Natural Area (WALGA 2004) and Environmentally Sensitive Area.

1.4 Climate

The climate experienced in the area is Mediterranean, with dry, hot summers and cooler, wetter winters. The Bureau of Meteorology (2014) describes the climate at Swanbourne (Station 009215) as:

- The majority of the average annual rainfall of 729.1 mm falls between May and August.
- Average daily maximum temperature ranges from 18.4 ^{o}C in July to 30.7 ^{o}C in February, with the highest recorded maximum being 44.3 ^{o}C.
- Average daily minimum temperatures range from 9.6 ^{o}C in July to 18.7 ^{o}C in February, with the lowest recorded minimum being 2.4 ^{o}C.

- Wind directions are predominately morning easterlies and afternoon southwesterly sea breezes, especially in the summer months.
- The average wind speed at 9 am is 19.2 km/h (10.4 knots) and at 3 pm the average wind speed is 23.0 km/h (12.4 knots) with gusts of more than 100 km/h (54.0 knots) occurring in storms event.

1.5 Geology

Lake Claremont occurs on the boundary of the Quindalup and Spearwood Dune Systems. The Quindalup Dunes are calcareous sands associated with beach ridges and parabolic dunes (Churchward and McArthur, 1980). The Spearwood Dune System consists of a limestone core overlain by yellow sand. Wind erosion has produced two different landscapes, with the shallow yellow brown sands and exposed limestone of the Cottesloe unit along the west and the deep yellow brown sands of the Karrakatta unit to the east (Churchward and McArthur, 1980).

1.6 Topography

Lake Claremont sits in the swale of a Quindalup Dune along its western side and lower Spearwood dunes to the east. The older and more weathered Spearwood Dune System to the east and south of the lake is largely flat at an elevation of 4-6 m Australian Height Datum (AHD – Above sea level). To the northwest of the lake, the land rises quickly from 4 m to 14 m AHD (Department of Environment, 2004).

1.7 Soils

Soils typically have a close association with vegetation present at a site. Natural resource information provided by the Department of Agriculture WA (2014) indicates there are five soil types in and around Lake Claremont (Figure 2 and Table 1). Variations in the soil types present are associated with previous disturbance activities including use as a landfill and construction of the golf course.

Table 1: Lake Claremont Soil Types

Label	Name	Description
211Qu_S2	Quindalup S2 Phase	Safety Bay Sands. Calcareous sand, white, fine to medium grained, sub-rounded quartz and shell debris, of eolian origin
211Sp_Cps	Spearwood Cps Phase	Holocene damp deposits. Peaty, clay – dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin
211Sp_LS1	Spearwood soils, LS1 Phase	Tamala Limestone, light yellowish brown, fine to coarse-grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin, some minor heavy minerals
211Sp_S7	Spearwood soils, S7 Phase	Sands derived from Tamala Limestone. Sand, pale and olive yellow, medium to coarse-grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, of residual origin
211SpW_Lake	Spearwood wet, Lake Phase	Lake, open water

(Sources: Department of Agriculture, 2014; Government of Western Australia, 2000)

1.7.1 Erosion

The steeper areas of the lake banks and portions of the slope below the Lakeway Estate on the western side of the water body are areas where the steeper slopes have the greatest potential for erosion. There is also the potential for erosion during storm events in steeper areas, such as the path leading from the Lakeway Estate to the lake. Revegetated and/or fenced areas have been effective in stabilising slopes. However, where there are gaps in the fence people and dogs can gain access and contribute to erosion.

Simpson (2014) advised Natural Area that erosion has occurred:

- When open gates within the northern vegetated areas permitted uncontrolled access, which created goat tracks that acted as channels for stormwater runoff.
- As the historical removal of large shrubs destabilised soil on steeper areas of the site.

The installation of rock revetments, brushing with logs and replanting are the most common methods of erosion control applied within the Lake Claremont. Installing jute matting and/or choir logs are not favoured due to a range of safety issues.

1.7.2 Acid Sulphate Soils

Potential acid sulphate soils are present at Lake Claremont. These soils are presently stable and not resulting in contamination, as evidenced by pH readings from the water body of 7 to 8.5 (Simpson, 2013). Figure 3 shows the indicative extent of acid sulphate soils within the Lake Claremont site.

1.8 Vegetation Associations

Lake Claremont is located within the Karrakatta Complex – Central and South vegetation complex, which consists of open forest of Tuart-Jarrah-Marri (Heddle, Lonergan and Havel, 1980). Other species typical of this complex include *Banksia attenuata*, *Banksia menziesii*, *Banksia grandis*, *Jacksonia sternbergiana*, *Jacksonia furcellata*, *Acacia cyclops*, *Acacia saligna*, *Hibbertia* spp, and *Calothamnus quadrifidus*.

According to the Environmental Planning Tool (WALGA, 2014), a 2.4 hectare remnant of this vegetation type is located in the western portion of the Lake Claremont site. Between 10% and 30% of this vegetation type remains within the IBRA subregion.

2.0 Lake Claremont Wetland Values

Wetland management considers the presence of the water body itself, the source of the water, its quality and its influences on flora and fauna. Lake Claremont is an ephemeral Conservation Category Wetland (Number 8199) that has surface water in the wetter winter months and dries out in summer.

2.1 Groundwater Aquifer

Lake Claremont is located on the southwestern edge of the Gnangara groundwater mound, the shallow unconfined superficial aquifer that underlies much of the northern suburbs within the Perth Metropolitan area (Department of Water 2014). Depth to groundwater around Lake Claremont varies according to the season. Levels rise in winter when infiltration from rainfall exceeds horizontal flow through the Gnangara system. As discussed below, groundwater flow in the proximity of Lake Claremont is from the north-northeast, fanning out through and under the lake, before heading south where the groundwater enters the

Swan River through surface springs and seepage directly into the river. Rümmleret al. (2005) report the fresh superficial aquifer sits as a freshwater lens over saline groundwater with an interface area ranging from 5 m to 15 m thick.

2.2 Water Body

The waterbody of Lake Claremont is a surface expression of groundwater, drying out in summer and filling in the cooler wetter winter months when the groundwater level rises, the waterbody works as a stormwater retention basin. As with almost all lakes on the Swan Coastal Plain, Lake Claremont is a 'flow-through lake' meaning that the groundwater flows from the up-gradient capture zone to the down-gradient release zone (Townley et al. 1993). The capture zone for the present day Lake Claremont is northeast corner of the lake and the release zone is southern end of the lake, from where it ultimately flows towards the Swan River. When surface water is present in winter, the depth within the lake ranges from centimetres in the northern portion to 0.5 m and deeper in the southern end. Seasonal and topographical variation in water depth provides a variety of habitats suited to water birds with differing feeding habits, including those that forage in shallow water (e.g. Avocets and Banded Stilts) and those that dive to the bottom of a lake for food (e.g. Australian and Hoary-headed Grebe).

2.3 Water Quality

The TOC reviewed a decade of water quality monitoring data in 2013 and the Lake Claremont Advisory Committee endorsed the report for the period 2004-2013 (Simpson 2013). Key parameters included in the water monitoring program are electrical conductivity (as a surrogate for salinity), pH, turbidity, nutrients (total nitrogen, oxides of nitrogen, ammonia/ammonium, phosphorous and orthophosphate) and algal bloom indicators (chlorophyll-α and phaeophytin -α). As improvements have occurred to the broader environment at Lake Claremont, water quality has also improved, as shown by reducing trends for orthophosphate, ammonia and chlorophyll-α.

2.3.1 Ammonia

Given the direction of groundwater flow, there is the potential for contamination from waste materials, dissolved contaminants and breakdown products such as ammonia from the old Brockway Road landfill site to the north, to be transported to Lake Claremont. The Brockway Road landfill site was decommissioned in 1991. The decomposition processes associated with the breakdown of household wastes will be in their final stages, with only small amounts of landfill gas and other breakdown products generated. Landfill Gas and Power (2014) indicated that gas extraction from the landfill at the Brockway site ceased in 2004 due to the limited amount of gases available. Since 2004 the ammonia/ammonium levels of the main waterbody at Lake Claremont have (at worst) remained stable between approximately 90-100 µg/L (Simpson 2013). While this level is approximately twice the 40 µg/L trigger vale of the ANZECC 2000 water quality guidelines, it comparable to other coastal urban wetlands of Perth and is below levels of 300-700 µg/L found in the groundwater linked Swan River Estuary (Thompson et al. 2001; Searle et al. 2011). Higher levels of ammonia can on occasion occur after flushing from rainfall events and other natural processes.

2.3.2 Alkalinity

The alkaline pH at Lake Claremont ranges from 7 – 8.5 (Simpson 2013), which is considered normal for Swan Coastal Plain wetlands associated with alkaline soils in the presence of Tamala limestone (Davis et al. 1993). Acidic pH valued below 6.5 or alkalinity greater than 9 are an indication of water quality issues.

High alkalinities are often associated with algal blooms. The alkaline pH readings for the lake indicate that the mobilisation of heavy metals from materials buried fill portions of Lake Claremont in the 1950s and 1960s is not likely, as that process requires acidic conditions. Alkaline levels also indicate that actual or potential acid sulphate soils present within the site are stable and not causing contamination, as they would produce acidic conditions if mobilised.

2.3.3 Orthophosphate

Orthophosphate is the inorganic form of phosphorous that is available for uptake by plants and contributes to their growth. Monitoring of orthophosphate levels within Lake Claremont indicate that while they are higher than preferred for a water body on the Swan Coastal Plain, they are declining over time (Simpson 2014). When looked at in conjunction with the decline in chlorophyll-α readings over the same period, this indicates the lake is returning from being a eutrophic (nutrient enriched) system to a healthier low nutrient system. This improvement in is also reflected in the abundance and diversity of aquatic flora and fauna found at the site (Appendix 3).

2.3.4 Sediment Sampling

Sediment sampling for metals, pesticides and hydrocarbons carried out by TOC in 2007 indicated slightly elevated levels of arsenic, lead and zinc. The source of these contaminates is likely to be associated with stormwater runoff, with a less likely explanation being leaching from nearby landfills. Cadmium, chromium, copper, mercury and nickel were below the relevant low-level trigger values. Alkaline soils and environmental water (pH approximately 8.5) makes it unlikely that heavy metals would be mobilised and are unlikely to be negatively impacting the aquatic flora and fauna within the lake. Similarly, indicators of Organochlorine (OC) Pesticides and Poly Aromatic Hydrocarbons (PAHs) s were below the detection limits of the analytical techniques. Occasional sampling will provide a review mechanism to confirm the current situation with contaminant levels.

2.3.5 Electrical Conductivity (EC)

There has been no change in the conductivity of the surface waters of the lake since water quality monitoring commenced in 2004 (Simpson 2013; Simpson 2014).

However, Lake Claremont is a surface expression of the superficial aquifer and changes in the groundwater have the potential to change salinity levels in the lake. The proximity saline marine and estuarine waters to the Claremont peninsular combined with history of over extraction from domestic, production and public open space bores under conditions of declining rainfall is southwest Western Australia has increased saltwater intrusion into the superficial aquifer. The Perth Urban Water Balance Study: Volume 1 (Cargeeg et al. 1987) documents this saltwater intrusion under the Claremont peninsular. For this reason, the Western Australian Department of Water (2011) and Water Corporation Water (DoW 2013) declare the peninsular as being unsuitable for garden bores.

2.4 Aquatic Vegetation

Lake Claremont includes a range of aquatic and emergent vegetation. Removal of large areas of *Typha orientalis* (Bulrush) from within the lakebed has occurred and replaced with a range of native sedges and rushes including *Bolboschoenus caldwellii*, *Ficinia nodosa* and *Schoenoplectus validus* (Figure 4). Benefits of the Typha removal include a reduced fire risk during summer months along with a greater diversity of water flora species. The replacement vegetation provides habitat and refuge for nesting aquatic bird species (Figure 5). Species that tolerate wet but not permanently inundated conditions occur around the edge of the water body, and include *Melaleuca rhaphiophylla* (Swamp Paperbark) and *Eucalyptus rudis* (Flooded Gum). The tree stumps are present in the lake are the remains of Swamp Paperbarks killed by permanent inundation when water levels rose and the lake became a permanent water body in the first part of last century. While these stumps are breaking down naturally, they currently provide safe roosting locations for the birdlife of the lake.

Figure 4: Removal of *Typha orientalis* at Lake Claremont

Figure 5: Aquatic vegetation used in nesting material

2.4.1 Charophyte Flora

Charophytes are a group of multi-cellular green algae found in temporary and permanent water bodies. Ranging in height from 1-200 mm, they appear similar in structure to land plants with a 'trunk' from which multiple branches develop. The charophytes are a pioneer species that colonise inundated areas, provide stability to sediments in the lakebed, contribute to improved water quality and provide an important food source for wetland fauna. This plant group is an indicator of good water quality, preferring low nutrient levels and moderate alkalinity (Trend n.d.). Species of Charophyte recorded at Lake Claremont in 2010, are *Lamptothamnia macropogon*, *Protochara inflata*, and *Chara globularis* var. *globularis* (Trend n.d.).

2.5 Algae

A NatureMap report compiled by Natural Area indicates the potential for 14 species of algae. Many of these are marine species common in the nearby Swan River. Marine species may establish in Lake Claremont for a short time under specific conditions as the waterbody dries. However, algal species are ubiquitous and the possibility of their occurrence in Lake Claremont from propagules transported by water birds cannot be ruled out.

Algal blooms of Blue-Green Algae (Cyanobacteria) and unknown species of string/rope algae have occurred in Lake Claremont under nutrient rich conditions. With improvements to water quality, revegetation and declines in the levels of orthophosphate at the site, algal blooms are less frequent and less severe than previously recorded (Head 2014 pers comm).

2.6 Stormwater

Stormwater runoff can negatively impact wetlands through the transport of contaminants such as heavy metals, hydrocarbons and propagules of weedy plants. Historically six drains carried stormwater from surrounding areas directly into the lake, including from an agricultural style drain along the eastern side of the Scotch College playing fields. Improvements at Lake Claremont have seen the creation of nutrient stripping basins and ponds that allow the inflow of stormwater into areas where reeds and aquatic plants act to remove nutrients and other materials from the water before it enters the main wetland area (Figure 6). These nutrient stripping basins also act to treat stormwater flowing into the Lake Claremont catchment from Claremont and Nedlands.

Figure 6: Vegetated nutrient stripping basins

The Henshaw drain infiltration swale recommended under the 2010 Lake Claremont Management Plan is yet to be constructed. This swale should be constructed as a priority during summer/warmer months when the lake is dry to minimise short and long-term impacts to the water body.

2.7 Botulism

Botulism has previously occurred at Lake Claremont, with the last known recording more than ten years ago (Haynes et al. 1998). Improvements to water quality, particularly reduced levels of orthophosphate and the regeneration of native sedges and rushes in the Lake is likely to have contributed to the reduced incidence of botulism.

2.8 Waterwise Council Program

The Town of Claremont is a member of the Waterwise Council Program run by the Department of Water and the Water Corporation with the support of the International Council for Local Environmental Initiatives (ICLEI). The aim of the waterwise program is to encourage and assist local government improve water efficiency measures. TOC's Local Action Plan (Head 2008) identified strategies to assess water usage and suggest areas where efficiencies were possible. Strategies implemented included auditing water use in all council buildings, review management of scheme and groundwater and reporting to the community. Additional strategies include the use of 'Waterwise' plants, with a focus on local natives and the removal of irrigation from some bushland areas. Water practices and revegetation activities within Lake Claremont are consistent with the Town's commitment to being Waterwise, as well as Lake Claremont's classification as a Conservation Category Wetland.

2.9 WESROC Total Water Cycle Management Program

JDA Consultant Hydrologists (2002) carried out investigations with the Western Suburbs Regional Organisation of Councils (WESROC) to review stormwater management practices and identify common approaches on a catchment (regional) scale. Within the Town of Claremont, stormwater is managed through infiltration at the source, rather than being piped to locations such as Lake Claremont. With additional measures including street sweeping, the installation of nutrient stripping basins and ongoing management of the lake, nutrient levels associated with stormwater inflows and other contributing sources have declined. Similar measures have been adopted in other WESROC member councils, with improvements within the region noted in relation to stormwater quality and management (Western Suburbs Regional Organisation of Councils 2010).

2.10 Nutrient and Irrigation Management Plans

Scotch College have installed a naturally vegetated nutrient-stripping swale to remove nutrients and other materials prior to it entering Lake Claremont. Scotch College has prepared and implemented a Nutrient and Irrigation Management Plan (NIMP) with the aim of minimising impacts from the campus, in particular the playing fields. The 2010 Lake Claremont Management Plan (North Metro Conservation Group, 2007) recommended annual auditing of the NIMP by the Town, which has not occurred. A possible alternative is the provision of an annual report that Scotch College provides to the Town of Claremont for tabling with the Lake Claremont Advisory Committee.

The Town of Claremont has not developed the nutrient and irrigation plans recommended in the 2010 Lake Claremont Management Plan. Turf in the east and northeast portion of the site and at Stirling Road Park are managed as an almost closed systems to minimise the introduction of additional and/or unnecessary nutrients and trace elements to the lake environment. These areas are a mown without using a catcher, which allows grass clippings to decompose naturally in situ and return existing carbon and nutrients to the soil to maintain the turf into the future. Annual analysis of nutrient and trace elements in leaf tissue and soil samples from this turf facilitates the targeted application of the minimum amount of the most appropriate fertiliser required to maintain healthy growth. Excessive growth of turf is discouraged in these areas by the controlled application of fertiliser and water. An irrigation schedule compliant with the ICLEI and Waterwise Council Programs has been prepared and implemented for the Lake Claremont site.

Townley et al. (1993) report that the contaminant capture zone of lakes on the Swan Coastal Plain is an area approximately double the width of the wetland. As a result, watering and nutrient application practices at the Lake Claremont Golf Course, Claremont Lawn Tennis Club, Claremont Aquatic Centre, Mt Claremont Oval and Cresswell Oval also have the potential to impact the lake.

It is recommended that:

- Fertilising and irrigation of turf areas at the Lake Claremont Golf Course and Claremont Aquatic Centre occur under the regime applied in other TOC managed areas.
- That an annual report on soil and leaf tissue nutrient levels, on fertiliser applications and on turf and garden irrigation consumption/rates for the aquatic centre, golf course and TOC managed turf areas around the lake be provided to the Lake Claremont Advisory Committee.
- For areas of the site leased to a third party (e.g. Claremont-Nedlands Cricket Club and Claremont Lawn Tennis Club) the lease conditions should include the preparation and implementation of a NIMP to ensure management of the site remains consistent with that undertaken by the Town of Claremont.
- An annual report provided by the lessee as means of demonstrating compliance with the lease condition and such reports are tabled with the Lake Claremont Advisory Committee.

2.11 Regional Nutrient Surveys

The Town of Claremont participates in the nutrient surveys carried out by the South East Regional Centre for Urban Landcare (SERCUL) in association with the Swan River Trust. The survey investigate a range of management practices carried out in within local government boundaries, including those relating to the type of turf used in grassed areas, the application of fertiliser, along with soil, moisture and leaf tissue testing to determine the most appropriate type and application rate of fertiliser for a given situation.

3.0 Geographical Information and Mapping

Site location, Lake Claremont

Client: Town of Claremont
Project: Lake Claremont
Image Date: 2013
Image Source: Town of Claremont
Datum: GDA94
Projection: MGA Zone 50

N

0 200
Metres

Figure 1: Site location, Lake Claremont

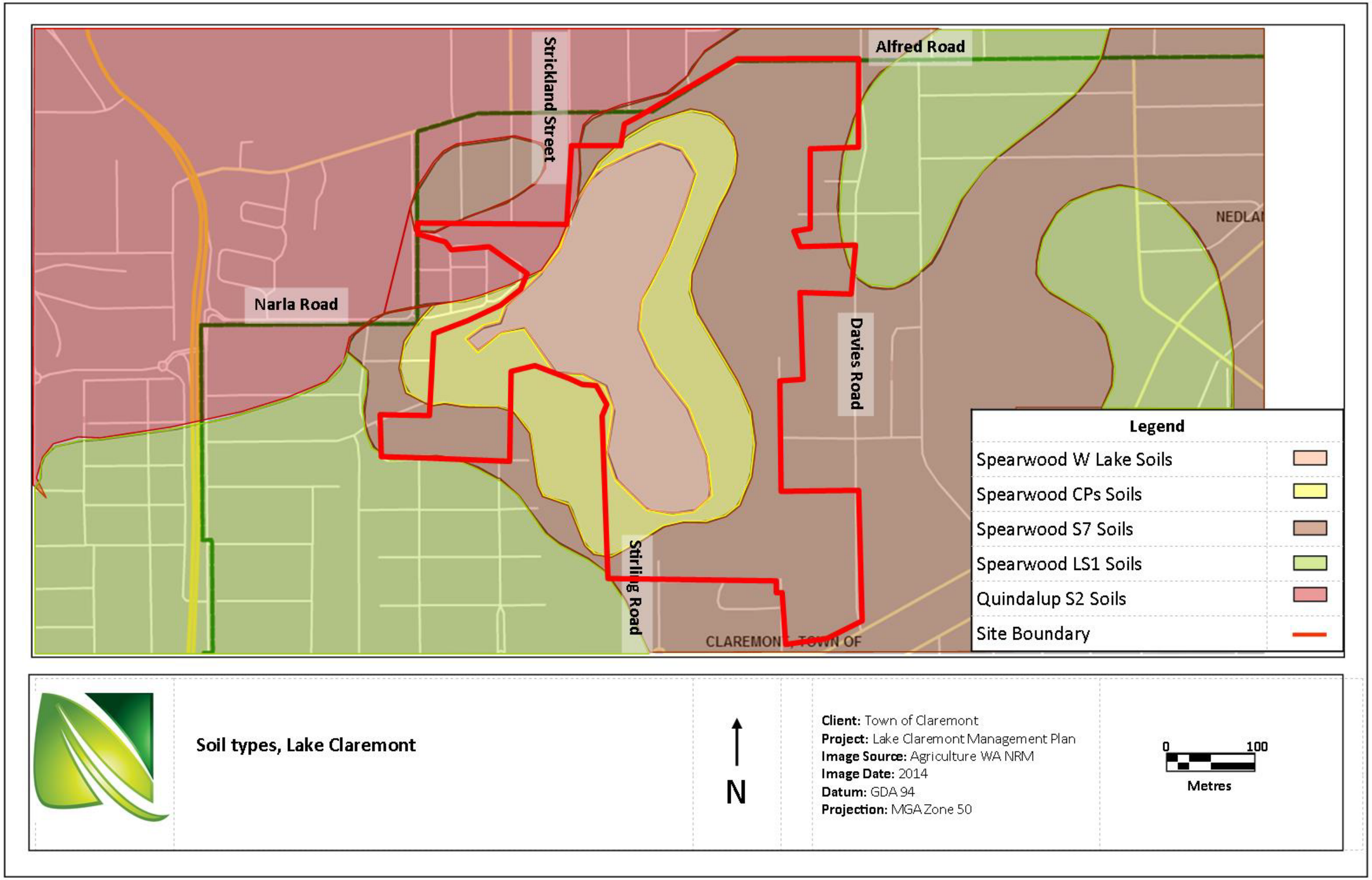

Figure 2: Soil types, Lake Claremont

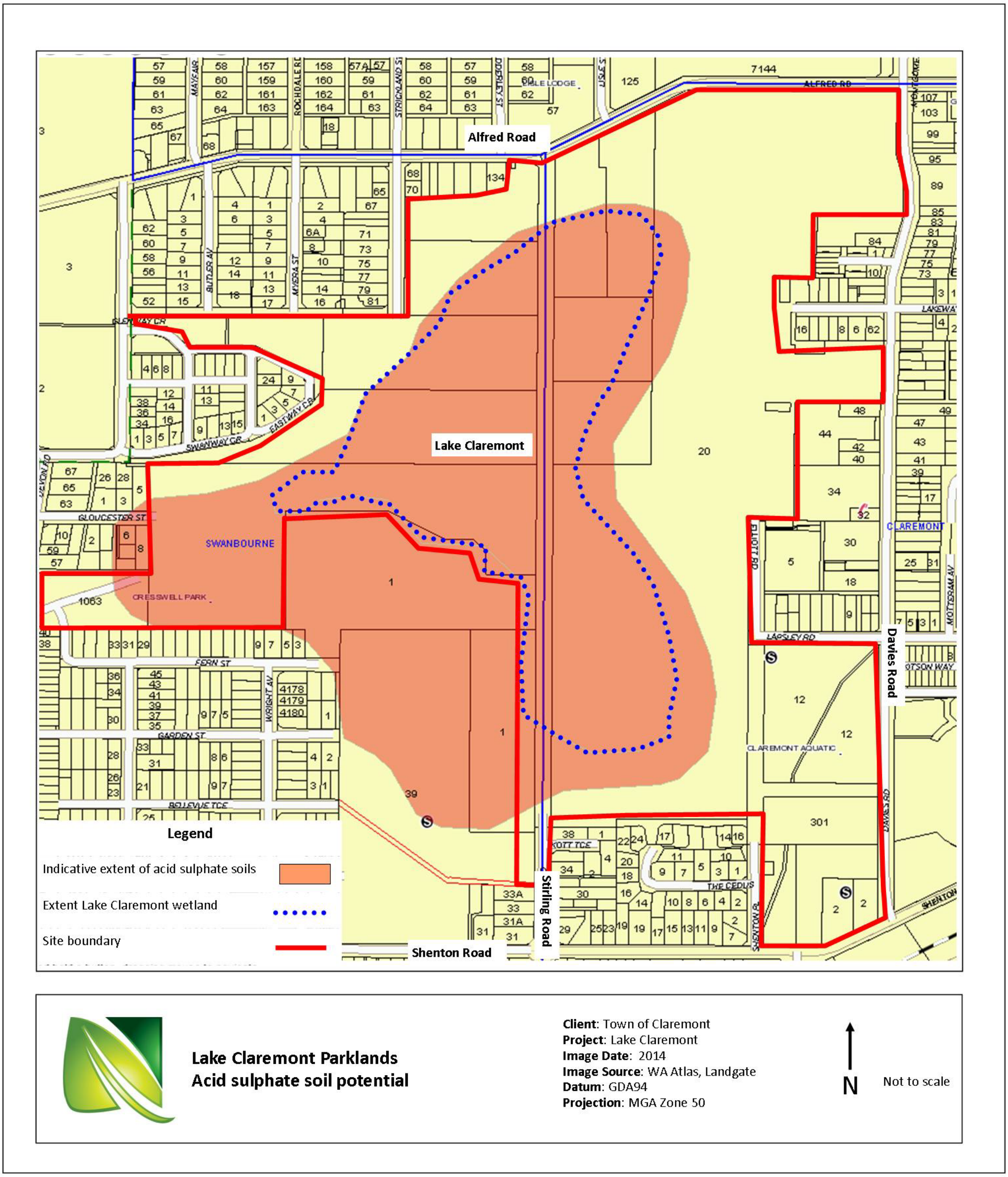

Figure 3: Acid sulphate soil potential within the Lake Claremont

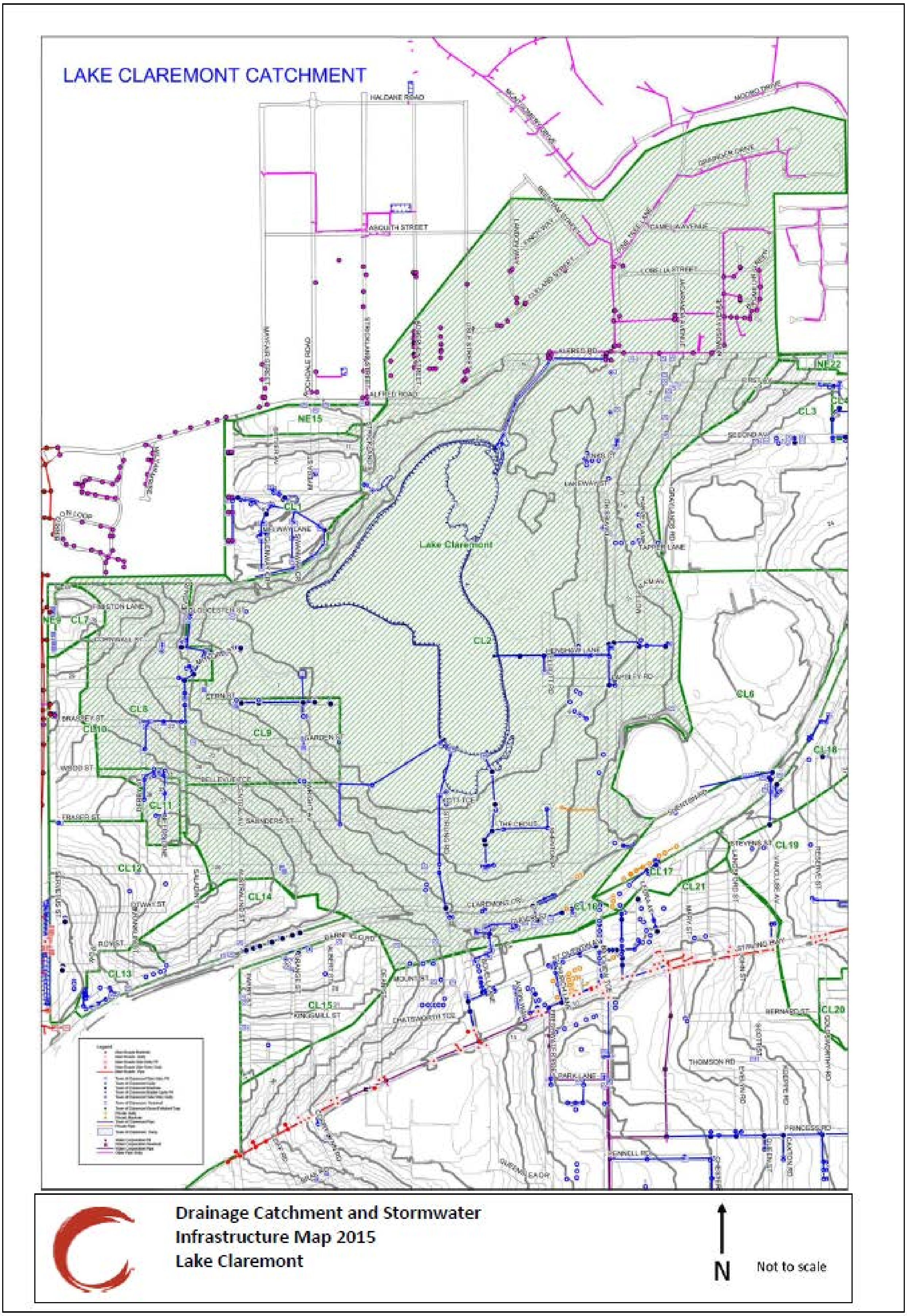

Figure 4: Drainage catchment area for Lake Claremont

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