Appendix L: Tree Protection and Conservation Guidelines

Appendix L

GUIDELINES FOR TREE PROTECTION AND CONSERVATION

By

Derek Yap

Lead Arborist

Camphora Pte Ltd

ISA certified

SG-0117A

CONTENT REQUIREMENTS

This document outlines specific measures to protect trees during construction or other site disturbance. The content and scope of the document will vary based on the site, type of construction, tree species, tree location and other factors.

TREE PROTECTION AND CONSERVATION GUIDELINES

This section outlines the general provisions for tree protection before, during and after construction. Additional measures may be added by the attending arborist on a case-by-case basis.

PRE-DEMOLITION/PILING/CONSTRUCTION

1. Pre-Construction Meeting

   The attending arborist shall attend a pre-construction meeting with the project contractor or construction supervisor to explain the tree protection and monitoring requirements as outlined in this document.

   In addition, the project contractor or construction supervisor shall complete the 'VERIFICATION OF TREE PROTECTION CHECKLIST' as attached in Annex A before the onset of the construction.

1.1 Tree Protection Zone

Prior to any site clearing (demolition works), piling works, grading, trenching or other soil disturbance, a tree protection zone (TPZ) must be installed as follows:

i. Type
   The barriers should be temporary, made of a hard material, 1.8-m tall and firmly installed into the ground.

ii. Ground protection
   Mulching material (can be compost or woodchips) at 100-mm thick to be laid within the TPZ. If woodchips are used, termicide treatment is necessary to prevent the introduction of harmful termites.

   Apply complete fertilizer (N:P:K 15:15:15) upon or together with the application of mulch.

iii. Signage

A readily-visible and waterproof sign shall be installed on all sides of the fencing around each individual protected tree. The size of each sign must be a minimum of 300mm wide and must contain the wording below:

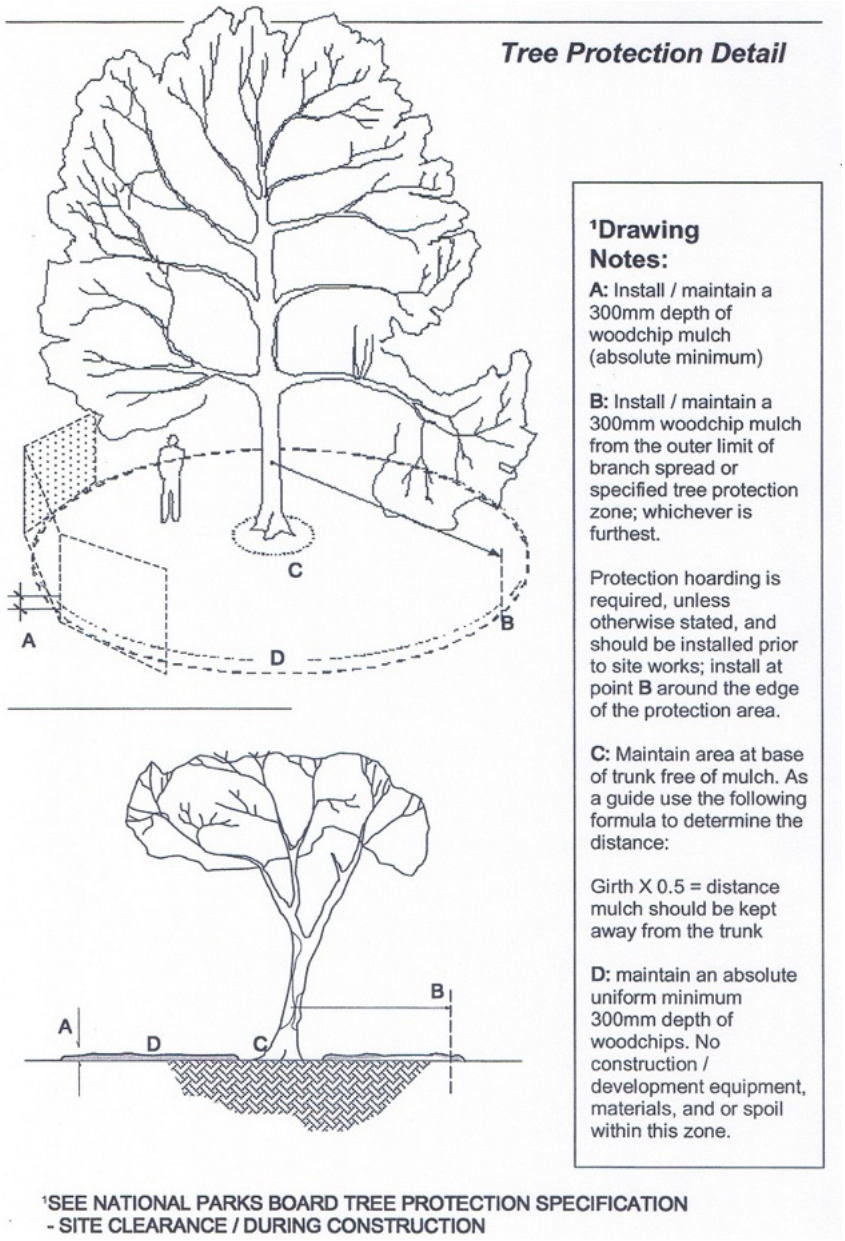
KEEP OUT!
TREE PROTECTION ZONE

Entry prohibited. This fence shall remain in place throughout the entire construction period.

iv. Fencing installation

Installation must be approved by the attending arborists and/or the approved authority prior to construction.

A diagrammatic representation of a proper Tree protection zone is presented below.



1.2 Tree pruning and removal

Various trees may need to be pruned away from structures or proposed construction activity. **Construction or contractor personnel shall not attempt pruning or removal.** Consultation and written approval with attending arborist must be obtained prior to pruning.

Removal of trees adjacent to trees that are to be retained requires planning and skilled arboriculture workers. Trees should not be removed by pushing with excavators/heavy machinery or with lumberjack (one cut) methods. Directional felling methods (notch and back-cut) should be deployed during removal of trees.

Removal of trees that extend into branches or roots of protected trees shall not be attempted by the demolition or construction crew, or by grading or other heavy equipment. Before removing tree stumps, the project manager shall seek the advice from the attending arborist determine if roots are entangled with trees that are to remain. If so, these stumps shall have their roots severed before extracting them.

1.3 Site Clearance

To avoid lumber jack felling of trees that may severely damage the canopy of conserved trees, it is recommended that qualified (see Point 4.3 Tree Conservation Guidelines) Arboriculture contractors be engage to fell trees adjacent to protected trees to ensure that the trees (when cut) fall away from the protected trees and their associated TPZs.

Contractors carry out tree felling works near assigned TPZs of conserved trees should

i. Employ directional felling through the use of notch and back cuts

ii. Deploy cranes to tension trunks in the direction of the drop

iii. Carry out pruning of canopy branches to remove entangling branches

iv. If trees to be removed are taller than neighbouring trees to be retained, removal of branches should be carried out in a controlled manner using ropes and cranes to avoid damaging canopy of the lower trees.

v. To avoid pruning of conserved trees at the proximity unless consultation and approval from attending arborist has been obtained.

vi. No tree should be removed by pushing with an excavator or heavy machinery.

DURING DEMOLITION/PILING/CONSTRUCTION

2. Tree Protection Zone Restrictions

- No ground disturbance, grading, trenching or other construction activities shall occur within the TPZ except as specified and/or approved by the attending arborist or authority.
- No construction material, debris, machinery (e.g. generators) or other construction waste shall be stored within the TPZ. Weight and presence of these materials increases soil compaction and reduces the area exposed for water infiltration and gaseous exchange.

Figure 1: Construction material and heavy machinery are prohibited within the TPZ

- Excavation works within the TPZ are strictly prohibited. Unless otherwise specified by the attending arborist, all work done within the TPZ shall be completed with manual trenching with hand tools or other hand held power tools that will not cause any root/tree damage.

  If roots need to be cut, it shall be done using proper equipment (e.g. pruning saw, chain saw) under the supervision of the attending arborist.

Figure 2: Trial trench by skilled workers using hand tools exposing root architecture

- Nailing, tying or pasting of materials on trees is prohibited. The tree shall not be used as an anchor for supporting structures during the construction.

Figure 3: Using tree as anchor may damage its bark.

Figure 4: No nails shall be driven into the tree as it promotes infiltration of pests/diseases

- Phytotoxic materials such as fuels, oils, cement, chemicals, and paint shall be kept away and stored/mixed at least 2.5m from the tree protection zone. Such chemicals can significantly change the cation exchange capacity and pH of the soil, rendering nutrient uptake inefficient and creating an environment too toxic for the roots to grow.

  Construction slug especially from piling works should not be deposited within the TPZ. Such sludge is usually high in clay content and when layered over and within the TPZ could significantly alter the water infiltration and gaseous exchange rates of the root absorption area of the tree.

  Canvass sheets/Eco-mat must be laid on the existing soil near the tree in view of soil protection during the demolition, drilling or other construction activities pertaining to concrete structures.

Figure 5: Construction cement deposited at tree base.

Figure 6: Tree showing signs of decline overtime.

- Lowering the grade around trees can have an immediate and long-term effect on trees.
  Typically, most roots are within the top 1m of soil, and most of the fine roots active in water and nutrient absorption are in the top 300mm.

  A) Grade changes within the TPZ are not permitted.

  B) Grade changes outside the TPZ shall not significantly alter drainage.

  C) Grade changes under specifically approved circumstances shall not allow more than 200mm of fill soil or allow more than 150mm of existing soil to be removed from

natural grade, unless mitigated.

D) Grade fills over 200mm or impervious overlay shall incorporate an approved permanent aeration system, permeable material, or other approved mitigation.

E) Grade cuts exceeding 150mm shall incorporate retaining walls or an appropriate transition equivalent.

No removal of the TPZ will be permitted under any circumstances.

Figure 7: Inappropriate installation/maintenance of TPZ during construction.

2.2 Proximity of Heavy machinery/vehicles

Heavy vehicles and machinery (e.g. excavators, piling cranes, 10 wheelers) movement should be limited near TPZs. Temporary access/passageways should be planned to avoid conserved trees.

Figure 8: Tree branches were severed due to the negligence of the crane operator.

2.3 Drainage Considerations

In the event that water ponding conditions develop in the course of construction due to change in grade/platform levels, construction events or any other unforeseeable factors, the contractor is required to improve drainage around or within the TPZ in consultation with the attending arborist.

2.4 Trenching, Excavation and Equipment use

Trenching, excavation or boring within the TPZ shall be limited to activities approved by the architect and/or attending Arborist. Explore alternatives for trenching outside the root zone. Avoid exposing roots during hot, dry weather. Backfill trenches as soon as possible with soil and soak with water the same day. Small roots can die in 10 to 15 minutes and large roots may not survive an hour of exposure. If the trench must be left open all roots must be kept moist by wrapping them in peat moss and burlap.

i. Root Severance

No roots greater than 0.2m in diameter shall be cut without approval of the attending Arborist. Tunneling under roots is the approved alternative. Prior to excavation for foundation/footing/walls, or grading or trenching within the TPZ, roots shall be severed cleanly outside the TPZ to the depth of the planned excavation. When roots must be cut, they shall be cut cleanly with a sharp saw to sound wood and flush with the trench site.

Figure 9: Tunneling under roots.

ii. Excavation

Any approved excavation, demolition, or extraction of material shall be performed with equipment that is placed outside the TPZ. Hand digging, hydraulic, or pneumatic excavation (e.g. air spading) are permitted methods for excavation within the TPZ.

Figure 10: Root exploratory works using an air spade. Air spading avoids damage of structural and even feeder roots of the tree.

iii. Heavy Equipment

Use of backhoes, Ditch-Witches, steal tread tractors or other heavy vehicles within the TPZ is prohibited unless approved by the attending Arborist. If allowed, a protective root buffer is required.

2.5 Tree Care

In the course of construction, the following measures may be necessary to reduce the effects of construction stress on protected trees. Quantum, duration and extent to be advised by attending arborist.

(A) Fertilization

A1 Vertical trenches and Nutrient Sinks

Create vertical trenching and nutrient sinks. These nutrient sinks should go down to at least 300mm deep and should be filled with high grade compost and 12% Humic acid (dilution 1:100). These sinks will act to reduce construction stress by conditioning the soil, increasing soil microbiological activity and increasing organic matter At least 24 numbers of vertical trenches / nutrient sinks are required for trees greater than 2m in girth. Vertical trenches for trees under 2m in girth will be determined empirically by the attending arborist and will take into account site conditions, tree species and its pre construction vigor. Top up nutrient sinks every 3 months.

A2 Soil Injection of Biostimulants

Mandatory if TPZ has been infringed into, soil compaction has occurred, tree condition has observed to have declined (indicators: reduction in Live crown ratios, twig die back at canopy and change in leaf colour/size/density)

- **Purpose:** To de-compact soil using a hydraulic pressurized delivery of biostimulants that both hydrates and aerates at the same time. Aim to reduce compaction to less than 400psi in the first 500mm of the soil.
- Mixed bio stimulants – serves 2 functions

  Decompaction
- Humic acid – as soil conditioner and chelating agent (Nutrients are mobilized in forms that the plants can accept), facilitate release of nutrients and reduces leaching. Also improves water holding capacities of soil.
- Liquid gypsum / Dolomite – soil conditioner, improve soil structure and facilitate release of nutrients in clay soils typical of local conditions.

To feed and increase soil microbiology to increase tree vigor post damage. Soil microbiology helps nutrient uptake and encourages healthy root growth critical to prevent construction stress.

- Mollases – High CE for immediate uptake,
- Fish Kelp – Protein source. Organic fertilisers
- Slow release fertilizers (Osmocote)

(B) Watering

- Water supplement during periods of drought.
- Watering duration and extent depends on site conditions and species.
- Watering is carried out until first signs of inundation are observed (i.e. water infiltration observe to slow down significantly).

(C) Myconate treatment

- To trigger and stimulate growth of existing mycorrhizae.

(D) Pesticide treatment

- To control pest (e.g. termites, borers, caterpillars etc) when it occurs.
- Fungicide or bacteriocide as required or as determined by attending arborist to control microbe pathogens.

(E) Additonal pruning

To be carried out in consultation with the attending Arborist. Trees are living things and may require some form of pruning during the course of the development.

- Crown cleansing- Prune to remove dead branches that may have developed through time.
- Crown lifting- Prune to lift crown to avoid new amenities.
- Crown thinning- Prune to reduce canopy branches and loading.

Structural pruning (including crown reduction) to remove branches that may obstruct new amenities and/or movement of critically necessary equipment may require the planning and standing supervision of the attending arborist.

2.6 Engaging Arboriculture Contractors

All arboriculture works should be carried out by skilled and trained arboriculture teams. As such, it is preferred that only Arboriculture contractors which have at least 8 years working

experience and must show previous work experience in developments of similar size or complexity. Arboriculture contractors should meet NParks safety requirements for work at height, LTA's requirements for temporary works along roadsides (where necessary) and have a certified arborist to supervise the pruning/felling/planting works.

All arboriculture workers engaged in tree climbing and chainsaw work shall possess a valid basic tree climbing certification base upon demonstrated competence in the WSQ module conducted by CUGE or an equivalent WSQ approved training organization.

Each Arboriculture crew shall possess the following VALID competences:
Operation of chainsaw for ground work (LS-MT-103E-1)
Chainsaw safety and maintenance (LS-MT-102E-1)
Perform formative pruning of young trees (LS-MT-114E-1)
Provide Arboriculture support on site (LS-MT-116E-1)
Workplace safety and health – operators (ES-WSH-101G-1)
Respond to Emergency (LS-HM-208E-1)
Perform advance rigging and climbing techniques (LS-HM-308S-1)
Perform aerial tree access and aerial rescue skills (Ls-HM-204S-1)
Implement and apply appropriate risk and safety management to sector practices (LS-BP-301S-1)
Prepare risk assessment report (LS-HM-406S-1)
Operate and work from an elevated work platform (CUGE-ARB-3501)

POST-CONSTRUCTION

3. Soft Landscaping

Ground works, site preparation and implementation of all landscaping near protected trees must be undertaken carefully.

TPZ barriers can only be removed at this juncture for the purpose. However, when working near trees, cultivation of soils in these areas must be cautiously handled using hand tools. Planting of shrubs shall be at a distance of at least 300mm away from existing root collar.

Avoid changes to ground levels or unnecessary compaction of soils within proximity to existing trees during the course.

Figure 10: New plantings at a minimum distance of 300mm (all round) from root collar

ANNEX A

VERIFICATION OF TREE PROTECTION CHECKLIST

Note: The project contractor or construction supervisor shall verify in writing that all **preconstruction** tree preservation conditions have been met as follows:

Submitted by: _____
Company/Project: _____
Date/Time: _____

S/N	Action	Checked (☑)	Remarks
1	Installation of tree fencing around identified trees within/near site (hard material at 1.8m tall)		
2	Tree protection zone (TPZ) dimensions meets specifications (from NParks and/or attending arborist)		
3	Warning signs prominently displayed on all sides of the fencing, including designated tree number		
4	Removal of construction material (ie machinery, debris, tools etc) within TPZ		
5	Mulching of high grade compost of 100mm thick around identified trees		
6	Completion of tree pruning (if necessary) under the supervision/written approval with the attending arborist		
7	Establishment of a tree maintenance schedule according to arborist recommendations (to be submitted to attending arborist)		

Verified by (attending arborist): _____

Date/Time: _____

Appendix M: Guidelines for Sapling Harvesting, Tree Transplantation and Tree Maintenance

Appendix M

Guidelines for Sapling and Tree Transplantation and Tree Maintenance

CONTENT REQUIREMENTS

This document outlines guidelines for sapling harvesting and tree transplantation prior to construction works, and guidelines to tree maintenance and care for retained trees during construction or other site disturbance. The content and scope of the document will vary based on the site, type of construction, tree species, tree location and other factors.

SAPLING HARVESTING AND TREE TRANSPLANTING

This section outlines the general guidelines for sapling harvesting and tree transplanting prior to construction. Additional measures may be added by the attending arborist on a case-by-case basis.

SPECIMEN SELECTION

Prior to site clearance works, any viable saplings and conservation significant trees that are suitable for harvesting shall be identified by the Arborist. Saplings or trees suitable for transplanting should:

I. Exhibit good physiological health and vigour
II. Have no structural defects
III. Have good branch form

As a guidance, the size of the root ball that is to be extracted shall be based on the girth of the saplings or trees to be harvested

Girth (m)	Minimum root ball diameter to extract (m)
<0.1	0.4
0.1–0.2	0.6
0.2–0.3	0.8
0.3–0.4	1.2
0.4–0.5	1.5
>0.5	To be determined by Arborist

Prior to transplanting, dead branches and climbers shall be cleared from the plant and canopy load and spread will be reduced where necessary, in consultation with the Arborist. Manual trenching shall be carried out to determine the shape and size of root ball to be extracted. Where possible, feeder roots shall be retained without cutting. The root ball shall be burlapped with cellophane sheet to reduce desiccation effects. When directed by the Flora specialist or Arborist, leaves of the canopy may also need to be enclosed and covered by cellophane or clear plastic bags. The root ball shall be secured to the trunk to reduce risk of root ball disintegrating. When handling/carrying the plant, care shall be taken not to damage any vegetative parts.

Where trees and vegetation are moved or translocated within the Project area, the Arborist shall review the method statement proposed by the tree transplanting contractor and advise on additional recommendations necessary to ensure the tree's health during transplanting. The transplanting contract shall ensure in their best effort, intact and secured root balls at the point of extraction, during the lifting processes and during the installation at the receiving site. The transplant effort shall be documented for each individual tree to show intact root balls at all the stages mentioned. Transplanted trees shall be managed through adequate watering and monitoring of their health to ensure their long-term survival. Advice shall be sought from the Arborist if the tree exhibit signs of stress, e.g., peeling bark, withered leaves.

TREE MAINTENANCE AND CARE

This section outlines the general guidelines for tree maintenance and care during construction works. Additional measures may be added by the attending arborist on a case-by-case basis.

Where disease outbreaks are identified, the Arborist shall advise measures to manage them. Measures can include using selected insecticides/fungicides to control outbreaks; reduction of stressors (dust, water, etc.). The plant may be removed or quarantined if it poses a threat to surrounding individuals.

Where forest edges are exposed following site clearance and where impacts to vegetation are evident (e.g., vegetation shows signs of drying out), additional watering shall be carried out to improve moisture differentials around forest edges.

The use of herbicides and pesticides shall be minimised. If herbicides or pesticides are used within the Project area, techniques that limit spray or non-target spray drift shall be used. These techniques include but are not limited to: cut and paint techniques and drilling injection. All use of herbicides and pesticides shall be conducted in accordance with the relevant Material Safety Data Sheet (MSDS). Any incidents of off label use, spillage or damage to non-target species shall be reported and investigated.

When the site experiences seven continuous days without rainfall, the Contractor shall carry out additional watering of conserved trees within the TPZs and at the forest edge (up to 10 m) around the development boundary. Post-heavy rainfall, any snapped hanging branches that pose imminent hazards to workers within the site should be removed immediately.

Appendix N: Wildlife Incident Form

Appendix N - Wildlife Incident Form

WILDLIFE INCIDENT FORM

Date (YYYY/MM/DD):	Time:	
Description of Location:	GPS Coordinates:	
Wildlife Observed:	Condition of Animal: ☐ Alive ☐ Killed ☐ Dead ☐ Injured	Animal Activity: ☐ Moving ☐ Resting ☐ Trapped
Photographs Taken (Yes or No):		
Describe Incident (e.g., activities being carried out; what animal was doing; personnel involved):		
Actions Taken:		
Reported by: _____ Contact #: _____	Reported to: _____ Contact #: _____	
Remarks:		

PHOTOGRAPHS:

Appendix O: Light Management in Night Works (NParks BIA Guidelines Technical Notes)

Light management in night works

Version: EIA-BIO-TN2024-01: Light management in night works
Published by:
National Biodiversity Centre
National Parks Board
Date of last update: May 2024

This technical note serves to complement the BIA guidelines on construction impacts and mitigation measures.

1. Impacts of light pollution on biodiversity

Previous studies have shown that light can be detrimental to sensitive biodiversity receptors such as nocturnal animals, migratory birds and seabirds, as well as sea turtles which come ashore to nest. Light can disorient animals and affect foraging behaviours of animals such as bats (Jägerbrand & Spoelstra, 2023). Animals such as light-opportunistic insectivorous bat species may be drawn out of the forest to feed on insects swarming at artificial light sources (Salinas-Ramos et al., 2021). This may increase human-wildlife conflict and fatality due to construction site works. Conversely, light-averse species are at a disadvantage as phototactic insect prey is being displaced from forested sites where they usually hunt, reducing food availability (Rowse et al., 2016). Marine species such as sea turtle are also negatively affected as they are driven out of nesting sites (Brei et al., 2016) and hatchlings are falsely oriented by artificial lights, moving further inland instead of towards the beach (Verutes et al., 2014). As such, there is a need to mitigate these impacts on biodiversity.

2. Light measurement and colour

The amount of light cast onto a surface (illuminance) will be used as measurement for the impact of light disturbance at construction sites, rather than the amount of light produced (lumen) or amount of energy used (watt). Luminance describes the amount of light emitted and is measured by candela/square meter (cd/m2). Illuminance is the amount of light cast onto a fixed surface area and is measured by lux (lx) and decreases with increasing distance between the light source and illuminated surface (Shaw et al., 2018). While luminance is fixed by the lamp's specifications, illuminance can change based on the number of lamps and position of the light source. Illuminance can be measured in the field with a lux meter or calculated with the inverse square law if the distance is known. Hence, it is recommended that level of illuminance is also considered.

Colour temperature of lamps can be measured in degrees Kelvin (K), and this indicates how 'warm' (2000 to 3000K) or 'cool' (4000 to 6000K) the colour is. Lights of higher colour temperature, which appear cooler due to its higher blue light content, should be avoided because they are known to affect bats (EDF Energy, 2020).

3. Light pollution and recommended lights to use

Lights commonly used at construction sites includes Portable tower lights, Perimeter/ambient lights, Equipment-mounted lights (e.g. crane lighting), Interior lights. Depending on the intended purpose and design, they can be installed with flood lights, light tubes or solar lights. Portable tower lights

fixed with flood lights are intense light sources and should be pointed downwards and only turned on at active work sites.

Lamp types typically used arranged in order of suitability for wildlife:

- Light Emitting Diode (LED)
- Low Pressure Sodium
- High Pressure Sodium
- Metal halide
- Mercury Vapor
- Fluorescent
- Halogen

Coloured in green and orange are preferred lamp types are that wildlife friendly while those in red should be avoided as outdoor lighting unless filtered against blue and UV light.

The blue spectral and ultra-violet (UV) component of light attracts insects and affects circadian rhythm of plants and animals and amber light is preferred (Australia Department of the Environment and Energy, 2020). Therefore, warm light with colour temperature of 2700K is optimum, although 3000K can be tolerated if lighting fixtures are properly shielded and spaced out (Dick, 2021).

LED light sources are preferred as they tend to have a specific wavelength. Metal halide and mercury lamps emit high UV levels which is especially harmful to wildlife and should not be used in construction sites. Lights such as fluorescent and halogens, as well as cool white LEDs are rich in blue light and should be avoided (Australia Department of the Environment and Energy, 2020). Low- and high-pressure sodium lamps have negligible and minimal effects respectively and high-pressure sodium lamps should be avoided whenever possible (EDF Energy, 2020).

4. Additional light mitigation measures

Housing design

To reduce glare and night sky pollution, lighting fixtures should be either cut-off or full cut-off. Alternatively, housing/shield/reflector-diffusers should be used to prevent glare, spillover, sky glow and light trespass into sensitive habitat.

Mounting of light source

Lamps should all face inwards and downwards towards the work site and mounted at the height of the hoarding or lower and at zero-degree angle to horizon, as much as possible. Perimeter lights should not be installed unnecessarily, and portable tower lights are preferred to directly illuminate active work areas. Low intensity ambient light for the safety of pedestrians can be mounted on railings or bollards and on higher lamp posts for vehicle access routes, while keeping to a height lower than hoarding and facing away from sensitive areas. Ensure as much as possible that housing/shield/reflector-diffusers are used to prevent uplight and backlight into the night sky or sensitive habitat.

Management of light pollution

I. Reduce production
   - Plan an optimum illumination layout to use the minimal number of lighting fixtures to achieve minimum lux required for safe outdoor works
   - Use portable tower lights as much as possible for targeted illumination of work site
   - Low intensity lights can be used for ambient lighting to facilitate the movement of pedestrians and to light up access routes
   - Limit hours of lighting as much as possible by switching off lights after use
   - Recommended standards from USA Department of Civil and Environmental Engineering Wisconsin-Madison (Shaw et al., 2018) as well as UK standards for outdoor workplace lighting (The British Standards Institution, 2014; EDF Energy, 2020) will be used as a suggested reference for local construction activities. The minimum lux recommended for pedestrian area is 5 lux, for access route is 10 lux, excavation is 20 lux, 40 lux for general construction, 80 lux for specialized construction and 160 lux for precision operations involving detailed works.

II. Attenuate light
   - Use non reflective and dark (i.e. matt paint) surfaces as much as possible within work site, especially for hoarding which should also be opaque
   - Use housing/shield/reflector-diffusers to reduce intrusive light outside of work site
   - Where light spillage into the adjacent forest cannot be avoided, an opaque tarp should be installed in a way that masks the light spill
   - Where possible, the illuminance layout should be planned such that planted vegetation and natural landscape can attenuate the light from the construction site

III. Reducing animal encounters with impact
   - Ensure that lighting fixture is installed at the lowest possible mounting height and at same height or lower than hoarding, with a downward tilt, preferably with a zero degree angle to horizon
   - Lights should only be on where and when works are necessary or for safety purpose
   - Adjustable and portable lights should be used as much as possible to restrict lighting within work zone
   - Lights should not be placed in the vicinity of an identified bat roost, or higher site hoarding should be used
   - Illumination mounted on tower cranes should be kept as low as possible below 12m (EDF Energy, 2020) and switched off outside of working hours, other than what is required for safe operation and obstacle avoidance
   - Shift worksite location to provide a 10 m dark buffer zone (EDF Energy, 2020) next to sensitive habitats or avoid night works entirely near ecologically sensitive areas
   - Where the dark buffer zone is not possible, high hoarding of at least 6 m should be installed along forest perimeter

Environmental Monitoring and Management Plan (EMMP)

Under the EMMP, a Light Management Plan (LMP) complete with illuminance layout plan, lighting fixture specifications and night work schedule should be supplemented. On the layout plan, the type of lighting (portable tower light/LED flood light/fluorescent light tubes) and height of mounting should also be indicated. Minimum, maximum and preferred illumination levels should preferably

be specified in construction work site light management plan and these levels should be adhered to for illumination layout (Shaw et al., 2018). Light spilling into adjacent sensitive receptors will need to be monitored. EMMP inspection should focus on ensuring that the guidelines stated above are met and corrective actions must be taken for any non-compliance.

Conclusion

In summary, light pollution can impact sensitive biodiversity. As such, proper implementation of mitigation measures will need to be in place to minimise such impacts.

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Appendix

Recommended wildlife friendly lighting

SPARTAN Flood FL48 Wildlife friendly floodlight zone 1/21 600nm 10,000 lumens

Siteco Floodlight FL 11 (colour temp of 3000K)

Killark VML-X Series LED Area light 55 Watt,120-277VAC, 7000 Lumen ¾" Wall Bracket (Option for migratory bird and marine life)

ASD LED Area Turtle Light (with shield)

Sunlite LED PAR38 Orange Floodlight Bulb

Viento Area Site LED Large Lighting fixture Wildlife Lighting

Coolon DLK2 LED Conveyor/Area Light (or any Dark Sky Compliant & Wildlife friendly product from their catalogue)

Schreder OMNIblast (adjusted to warm light and with hood installed)