ARBOR GLOBAL
Arboriculture & Vegetation Management Consulting

November 1, 2016

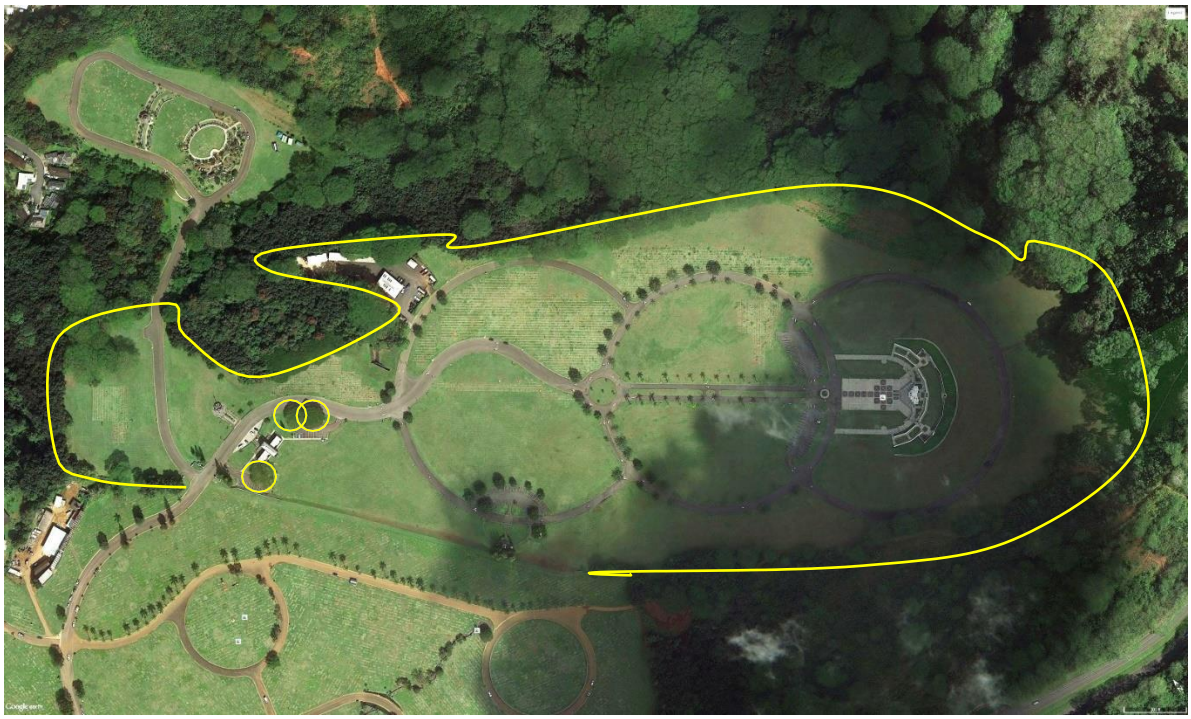
Report of: Kevin K. Eckert
ISA Board Certified Master Arborist WE-1785BU

Project: Tree Risk Assessment and Risk Reduction Recommendations
Job No. CA-1601

Project Site: Hawaii State Veterans Cemetery
45-349 Kamehameha Highway Kaneohe

1.0 Introduction

Arbor Global (AG), a Hawaii-based arboricultural consulting company, has been retained by the State of Hawaii, Department of Defense, Office of Veterans Services (OVS), to provide tree inventory and risk assessment services for designated areas around the perimeter of the Cemetery property, the Administration building, and the water tank site in the southeast corner of the property, where large trees may threaten public safety and/or property. AG also provided an assessment and recommendations to manage encroaching woody vegetation around the perimeter of the Cemetery property. This inventory and risk assessment is limited to trees that are most likely to present a hazard to people within the maintained landscape, grave sites, vehicles on roadways and structures within the Cemetery property.



Tree Inventory and Assessment Area
(Yellow line defines perimeter assessed)

Field inspections were conducted on May 18 and June 26, 2016 by Kevin K. Eckert, International Society of Arboriculture (ISA) Board Certified Master Arborist WE-1785BU, and Walter Warriner, ISA Certified Arborist WE-407AM.

This report provides AG's general findings, conclusions and recommendations for risk reduction and brush management according to conditions at the time of inspection.

2.1 Definitions

- Crown Cleaning: Removal of dead, dying, diseased, broken, hanging, damaged and defective branches in the tree's crown. Also includes removal of invasive plants or vines.
- Crown Raising: Removal of lowest branches, side branches or parts of branches to lift or shorten the ends of the lower portion of the tree crown and avoid or clear obstacles.
- Crown Reduction: Removal of the outer portions of the branches and/or the top of the subject tree to shorten tree height and branch length and end weight. Pruning cuts must be made back to the parent stem or a lateral branch that is at least 1/3 the diameter of the parent branch.
- Deadwood: Branch or part of a tree that is dead.
- Dieback: Condition in which a tree begins to die from the tip of its branches backward due to disease, pests, damage or other conditions.
- Directional Pruning: Removal of branches and tree tops in a manner that will retain growing points that will result in tree growth in a desired direction. Pruning cuts must be made back to the parent stem or a lateral branch that is at least 1/3 the diameter of the parent branch.
- Phloem: Innermost layer of the bark portion of a tree where transport of soluble organic material made during photosynthesis is conducted.
- Root Collar: Area where roots join the main stem or trunk. This area is where the trunk flares out and enters the soil then transitions into the major roots. The root collar is part of the tree's trunk.
- Stand: Aggregation of trees or other growth occupying a specific area and sufficiently uniform in species composition, size, age, arrangement, and condition as to be distinguished from the forest or other growth on adjoining areas.
- Windthrow: Refers to trees uprooted or broken by wind. Also called "blowdown".
- Xylem: Woody part of the tree trunk.

3.1 Assessment Procedure

3.2 Tree Inventory and Mapping

AG conducted a visual inventory and mapping of the location of large trees that are most likely to fall onto the maintained, turfgrass covered grounds along the Cemetery perimeter or Maintenance Area. AG also inspected three large monkeypod trees located near to the Administration Building. Each tree was

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

assigned a unique numerical identifier that was manually placed on a Google Earth map as close as could be reasonably accomplished to each tree's field location by using visual references. This numerical identifier serves as a reference to data recorded for each tree on the attached Appendix 1 - Tree Location and Management Recommendations Map – June 2016.

Inventory data was recorded within an Excel spreadsheet and included tree species, tree height, targets (people, gravesites, vehicles on roadways, and/or structures), recommendations for management, management time frame and descriptive comments as AG determined appropriate.

3.3 Tree Risk Assessment

Tree risk assessment was conducted in conformance with the standards and practices described within the "American National Standard Institute (ANSI) A300 (Part 9) Tree Risk Assessment; a. Tree Structure Assessment - Standard Practices", Level 1, ground-based Limited Visual Assessment (LVA). A LVA includes a ground-based, visual inspection from one side of the subject tree as the assessor walked by the tree on the accessible portions of the property. During the inspection and assessment, obvious signs of defects and conditions that could be observed and assessed from the side of the tree inspected included:

- Tree species;
- Tree height visually estimated and periodically verified on selected trees with a TruPulse hypsometer. Crown spread was visually observed where it overhung targets to help define likely fall zone of tree parts;
- Tree health and vigor as observed through visible indicators of foliage and growth condition;
- Root, root collar, trunk and crown defects that were readily visible on the date of the inspection and that were determined to provide clear signs or symptoms of conditions that would significantly increase likelihood of tree or tree part failure. These defects included, but may not be limited to structural defect assumptions based on experience with that species' failure characteristics (e.g. albizia), large, external cavities, included bark, large cracks or splits and significantly over-extended branches; and
- Obvious visual signs of recent site disturbance that may have damaged roots and compromised the tree's structural stability.

Photographs were recorded of selected groups of subject trees assessed.

3.4 Risk Reduction Recommendations

As applicable, for trees that possessed signs or symptoms of defects that may pose an unreasonable risk of failure and high likelihood of striking a target during the defined time frame of 12 months, AG has recommended practical, cost-effective risk reduction measures. AG has provided recommendations for work that should be conducted within the next 24 months. Risk reduction measures that were considered included:

- Relocation of movable targets to outside the fall zone;

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

- Restriction of access to the fall zone of the tree;
- Crown cleaning and/or crown reduction pruning;
- Installation of tree or branch support systems; or
- Tree removal.

AG prioritized risk reduction work according to the magnitude of the defect and an estimate of the earliest time frame of its most likely risk of failure and impact to an identified target during normal weather conditions.

Estimated costs for proposed mitigation measures were calculated through AG's experience and interviews with tree management contractors familiar with this site, and removal and pruning of these types of trees.

Recommendations for measures that can prevent regrowth of the subject trees and young seedlings that may attempt to repopulate the open site have been developed based on AG's extensive experience with vegetation management of undesirable vegetation throughout Hawaii, Mainland US, a number of Pacific Rim Islands and Asia.

3.5 Woody Vegetation Assessment and Management

AG conducted a ground-based, visual inspection and assessment of the perimeter of the landscaped Cemetery grounds to identify the primary woody plant species community and condition (density, general heights, and site). Based on the information collected and according to AG's extensive experience with vegetation management of undesirable vegetation, AG developed a recommended management plan to remove and most cost-effectively manage woody vegetation that is currently encroaching upon the landscaped turf within the designated inspection areas.

3.6 Assessment Limitations and Further Information

This report, its findings and recommendations are submitted with the following understanding:

- Arborists are specialists in tree management and care who use their education, knowledge, training and experience to inspect and assess tree health and condition, and identify measures that reduce risk of personal injury or property damage from trees exhibiting defects.
- This assessment is based upon the information provided by the Client, and AG's education, knowledge, training, experience and diligent field investigation. Arborists cannot detect every condition that could possibly lead to the structural failure or decline in the health of a tree. Trees are living organisms that fail in ways we do not fully understand and cannot always predict. Conditions are often hidden within trees and below ground. Arborists cannot guarantee that a tree will be healthy or safe under all circumstances, or for a specified period of time. Likewise, remedial treatments, like any medicine, cannot be guaranteed.
- This assessment is based on predictions of tree behavior during normal weather conditions and the condition of the tree at the time of the field

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

inspection. Normal weather conditions are defined as wind less than 47mph in speed and rainfall that does not saturate the soil and destabilize the tree root system. Changes to tree or site conditions after completion of the field inspection that are caused by severe weather, construction, tree clearing or removal, insects, disease or other agents may change the structural integrity of a tree or tree part and increase risk. These types of future changes in condition and their impact on the tree cannot be reasonably predicted during a risk assessment.

- This assessment is restricted to the designated trees and did not assess any other nearby trees that may present potential hazards to people or property.
- Recommendations for risk reduction treatments may involve considerations beyond the scope of the arborist's services such as cost, public sensitivity, property management considerations, and other issues. This assessment did not consider these factors, but focused on the structural integrity of this tree and its relative risk to the public at the time of this inspection and during normal weather conditions.
- Trees can be managed, but they cannot be controlled. To live, work and play near trees is to accept some degree of risk. The only way to eliminate risk from trees is to remove trees, but this is not recommended unless required by a Qualified Arborist and based on recognized tree defects and defined thresholds of risk because it also eliminates the multitude of benefits provided by trees.
- Clients may choose to accept or disregard the recommendation of the arborist, or to seek additional advice.

4.1 Findings and Conclusions

AG's significant findings and risk ratings for each tree inspected are included within Appendix 1, attached. A discussion of general findings and conclusions is provided below.

AG identified and assessed 201 trees or related clusters of trees that appeared to be most likely to directly strike an identified target (people, grave sites, vehicles on roadways and/or structures) should the whole subject tree or a tree part fall onto the Cemetery property (Appendix 1, Tree Location and Management Recommendations Map – June 2016).

4.2 Tree Species

AG has identified the majority of the large trees around the perimeter of the lawn area to be albizia (*Falcataria moluccana*) with a smaller number of Java plum (*Syzygium cumini*), rainbow eucalyptus (*Eucalyptus deglupta*), monkeypod (*Albizia saman*) and African tulip (*Spathodea campanulata*). Small numbers of kukui (*Aleurites moluccana*), macaranga (*Macaranga tanarius*), octopus (*Schefflera actinophylla*), false kamani (*Terminalia catappa*), Formosa koa (*Acacia confusa*) and fiddlewood (*Citharexylum caudatum*) trees were also identified within these sites.

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

Albizia is a fast growing, very large tree with trunk diameters exceeding 4 feet and heights that can exceed 200 feet. It is native to the Molucca Islands of Indonesia and has been cultivated in Hawaii since 1917.They possess an upright, wide spreading, open crown with foliage generally concentrated at the top and ends of long branches. Because of its rapid growth habit and tendency to develop over-extended and end-heavy branches, this species possesses a tendency to break apart or uproot during windy periods. Even on calm days, when conditions increase end loads, long branches can break and fall. Because of its invasive nature and failure habits, this tree species has been identified as one of the most problematic invasive trees affecting communities throughout Hawaii.

Java plum can grow over 80 feet tall with trunk diameters over 24 inches. It is a common, non-native and widespread, invasive tree throughout wet low-lands of Hawaii. It is native to southern Asia and has been cultivated in Hawaii since 1871. It possesses a brittle branch structure that readily breaks in strong winds.

Rainbow eucalyptus can grow up to 150 feet in height with trunk diameters up to 8 feet. It is native to the Philippines and was introduced in 1929 at the Wahiawa Botanical Gardens. It is a common species planted in landscapes and in some forest plantations. This species of tree is known to possess a weak structure and susceptible to breaking of tree parts in strong winds. This species also possesses a weak internal barrier defense system which often results in extensive internal decay where large wounds occur. These structurally weak structural characteristics generally increase the likelihood of tree part failure, especially for trees with high wind exposure.

African tulip can grow over 75 feet in height with trunk diameters over 4 feet. It is native to Western and Central Africa. It was introduced as an ornamental tree on Oahu in 1915. It is a common and invasive species throughout the State found naturalized in forests, along roadsides and residential areas. It has also been planted in parks, home landscapes and along road sides. This species of tree is known to possess a weak structure that breaks in storms with a poor defense system that results in decay at wound sites.

Monkeypod trees generally grow up to 75 feet in height with trunk diameters over 4 feet. It is native to Central and South America and was introduced in 1847 in Honolulu and Kauai. It is a common species planted in parks, home landscapes and road sides. This species of tree is known to possess a strong structure with an exceptionally strong defense system that resists decay.

4.3 Tree Size

Heights of the trees assessed ranged from approximately 35 feet to 150 feet. Major tree species heights were observed as follows:

- Albizia trees primarily ranged from approximately 70 to 150 feet with the average being around 100 feet tall.
- Java plum trees ranged from approximately 35 to 70 feet tall with the average being around 55 feet tall.

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

- Rainbow eucalyptus trees ranged from approximately 70 to 125 feet tall with the average being around 105 feet tall.
- African tulip trees ranged from approximately 45 to 70 feet tall with the average being around 55 feet tall.
- Monkeypod trees ranged from approximately 40 to 65 feet tall with the average being around 55 feet tall.

4.4 Tree Form and Crown Class

This site is dominated by very large, upright albizia trees. Upright African tulip trees were scattered throughout the site, and a stand of large, single-trunk, rainbow eucalyptus were growing near the Maintenance Shop. All of these large trees, with the exception of the monkeypod trees near to the Administration Building, are located within unmanaged, naturalized areas.

Most of the albizia and rainbow eucalyptus trees were in large stands lining the perimeter of the grounds and growing close together in a codominant or intermediate crown position. These groups of codominant and intermediate trees provide some level of wind screening for each other, reducing their likelihood of windthrow. Some trees were dominant extending above the crown of nearby trees. These dominant trees are more exposed to winds and are more susceptible to failure of the whole tree or tree parts. Some of the trees in the understory possessed significant lean towards the Cemetery lawn as they attempted to grow out into the sun.

Representative photos of the typical condition of the primary subject tree species are as follows:

Albizia

Rainbow Eucalyptus

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

Java Plum

African Tulip

Monkeypod Trees

4.5 Tree Health

The majority of the trees assessed were observed to be in reasonably good health.

Some of the African tulip trees (28, 29, 30 and 31) were covered in vines and in declining health due to competition from the vines. A few albizia trees in the southeast corner of the property showed signs of significant decline and deadwood. Tree 178 were observed to be dead.

4.6 Defective Root Conditions

Most of these trees did not show symptoms of root defects. Root systems were generally not visible due to restrictive, heavy growth of competitive understory vegetation. Dieback or crown restriction attributed to root defects or disease was not generally observed except as mentioned in the Tree Health section. The root systems of the trees that are growing closely together are expected to be significantly restricted in distribution and size resulting in low structural support for single trees.

Trees grown in dense stands are protected from wind loads by neighboring trees. Wind loads cause trees to produce stronger structural root systems whereas lack of wind loads generally does not find extended and strong structural root systems. Reduction of wind stress restricts the trees' need to produce these strong root systems. When trees fall or are removed, nearby trees that remain are then exposed to increased wind are at increased risk for whole tree or tree part failure.

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

4.7 Trunk Defects

No significant trunk defects that would be expected to significantly increase likelihood of failure were observed in most trees at the time of this inspection.

4.8 Scaffold branch/tree crown defects

No significant dead branches or scaffold branch or tree crown defects were observed on most of the trees at the time of the inspection that would be expected to significantly increase likelihood of failure and striking a target within the designated time frame.

Monkeypod trees 74, 75 and 76 possessed moderate amounts of large deadwood. Formation of deadwood in monkeypod trees is a natural progression and should be managed on a cycle based on the formation of this deadwood, usually approximately every 24 months.

Albizia trees are recognized to possess a natural, structural defect whereby they may shed large branches at unexpected intervals or fall over in whole during strong winds. This structural defect is caused by their exceptionally tall growth habit with long branches and foliage typically loaded at the end of these branches. This conditions produces an exceptional lever arm load that can exceed the carrying capacity of this relatively weak structured wood and sometimes inadequate structural root systems.

Rainbow eucalyptus trees are recognized to possess generally weaker structural integrity and branches may fail in strong winds. The rainbow eucalyptus near to the Maintenance Shop generally are protected from strong winds by nearby large trees and therefore their likelihood of failure is reduced.

4.9 Adverse site conditions

The sites in which most of these trees are growing are naturalized, unmaintained areas that have been left to regenerate vegetation. The result has been the establishment of the current, undesirable, invasive tree and brush species population. No native tree species were observed at the time of this general inspection. The only generally desirable, landscape tree species that were observed within the subject sites are kukui and monkeypod.

The majority of the subject trees encircle the perimeter of the Cemetery and Maintenance Shop and are generally protected from strong winds by adjacent trees. However, the close spacing of many of these trees generally restricts development of a structural root system that would support the subject tree if it were more exposed to strong winds. This potentially inadequate root system increases risk of failure of the whole tree or newly exposed tree parts and must be considered and mitigated when trees are removed or fall on their own.

The 3 monkeypod trees near to the Administration Building are located in a generally open area within the landscaped site. Two of these trees are near to a parking lot and

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

the access road while the third tree is sited near a garden and infrastructure equipment. The turfgrass competes for space, nutrients and water and increases health stress on these trees. Further, the soil within this landscaped and maintained area is compacted, which restricts root growth and further stresses these trees. Occupancy of people and vehicles within the fall zone of these trees is expected to be generally low with occupancy of equipment high within the fall zone of the third monkeypod at the rear of the Administration Building.

4.10 Targets

Primary, valuable targets that were identified and assessed included people at gravesites, the currently developed gravesites themselves, vehicles and people on roadways and parking areas, Maintenance Shop structures, the fence and stone wall at the main entrance of the Cemetery, and the water tank in the wooded area in the southeast corner of the property.

4.11 Risk Rating

AG calculates the general risk rating for each tree based on observations and measurements of structural defects within the tree and site, the value and frequency of exposure of targets within the fall zone of that tree, and the tree's exposure to environmental factors that could cause failure. The risk rating is not a definitive value, but rather a guide to better understand relative risk based on known factors. It is important to understand that arborists cannot detect every condition that could possibly lead to the structural failure or decline in the health of a tree. Trees are living organisms that fail in ways we sometimes do not fully understand and cannot always predict. Defects are often hidden within trees and below ground. Environmental factors and load stresses cannot be reasonably measured or predicted for each tree. Arborists cannot guarantee that a tree will be safe under all circumstances, or for a specified period of time. The risk rating helps arborists to understand the general risk and develop recommendations for mitigation, and decision-makers to make informed decisions on how best to manage these risks.

4.11 Woody Vegetation Conditions

Small trees, vines, woody shrubs and tall-growing grass have established along the perimeter of the Cemetery. These invasive plants are encroaching upon the landscaped turfgrass and facilities around almost the entire perimeter that was assessed. Tree species, if unmanaged, will grow large and likely dominate the area, further encroaching upon the landscaped areas and likely requiring management in the future. Removal and management of tree species before they get large is considered to be much more cost-effective than deferring action until required.

Five (5) distinct woody vegetation (brush) areas were identified around the perimeter of the Cemetery property that was assessed as follows:

- Brush 1: Located behind the Flag Plaza, this area includes trees up to approximately 55 feet in height. Most common tree species within this area are Java plum, fiddlewood and Formosa koa. Guinea grass (*Megathyrsus*

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

maximus) was also observed within this site. Trees and vegetation on this site are growing on a slope that declines steeply from the lawn area. This restricts safe access to this area.

- Brush 2: Located next to the Maintenance Shop on the north side of the Duty Circle Road, this area includes octopus, fiddlewood and Java plum trees up to approximately 30 feet in height. These trees and vegetation are growing behind the fence at the Maintenance Shop and along the edge of the lawn area.

- Brush 3: Located on the northeast side of the property near to the Honor Circle and Country Circle areas, this area primarily includes small albizia trees and Guinea grass. These trees and vegetation are growing within what appears to be a previously cleared and generally level site along the edge of the lawn area.

- Brush 4: Located on the southeast side of the property off the end of the Country Circle area, this area primarily includes small albizia, fiddlewood, Java plum and Formosa koa trees that generally range from approximately 10 to 30 feet tall. These trees and vegetation are growing within a generally level site along the edge of the lawn area.

- Brush General: The remainder of the perimeter area not specifically identified above and in the understory of the large trees assessed is generally covered with small to medium trees and woody vegetation. Species include albizia, octopus, Java plum, fiddlewood, African tulip and haole-koa. Topography of these areas varies from steep slopes to generally level.

4.12 Water Tank Trees

A water tank is located in the southeast corner of the property accessed by a paved road near to the Country Circle area.

Twenty-eight (28) albizia trees were identified surrounding the tank and as presenting potential risks to the access road in this area. The dense growth of this area prevents meaningful mapping of individual trees.

These trees ranged in height from 90 to 130 feet tall. The water tank is in a depressed topographical area surrounded by higher terrain with the subject trees growing on the slopes. Most of these trees leaned downhill toward the water tank or possessed asymmetrical crowns that caused them to favor a fall toward the water tank.

A large number of broken branches were observed on the ground around the water tank that had fallen from these trees. No significant damage to the water tank was observed.

The density of the trees around the water tank reduces wind loads on individual trees and reduces the likelihood of whole tree or tree part failure. However, the

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

observations of previous branch failure indicate that branches are falling. It is probable that branches will fall in the next 12 to 24 months and possible that a whole tree may fail in this time frame.

The likelihood of failure of large branches or whole trees, and impact and significant damage to the water tank is considered to be low during the next 12 months.

5.1 Recommendations

Mitigation measures recommended to reasonably reduce the risk of tree or tree part failure and/or striking a recognized target within a 24 month time frame is provided for each assessed tree within Appendix 2, Tree Inventory and Mitigation Recommendations, July 2016.

Mitigation recommendations assume that conditions will not change within the next 24 months from the date of the field inspection. A new inspection and assessment should be conducted if tree or site conditions change within the next 24 months as described within section 2.5 Assessment Limitations and Further Information.

5.2 Albizia Trees

Albizia trees are recommended to be felled (F) whenever practical or crown reduced pruned (CR) if felling is not practical. This invasive species should be removed or managed whenever practical when it is in a location where it is capable of striking and significantly injuring persons or damaging property because of its common failure characteristics, exceptionally large size, exceptionally fast growth rate, and location on sites with relatively challenging access for management. However, felling and disposal of the great amount of debris generated from large trees can be prohibitively expensive in some instances. In these instances, other, less expensive alternatives may be applied. These alternatives may only reduce risk in the short-term, but they may permit better cost distribution within limited budgets.

Stumps and roots may be left in the ground, but freshly cut stumps should be treated with an herbicide solution to control and minimize resprouting. Herbicide treatment should be applied as a solution of 20% triclopyr herbicide in 80% mineral oil. Stumps should be treated immediately after cutting is conducted. Only the outer area of the stump, where the phloem is located, requires treatment. Applications should be made around the entire outer circumference of the stump to saturate the outer sapwood permitting the herbicide solution to saturate the upper portion of the bark of the remaining stump. Treatment of the xylem, which is the woody inner portion of the stump, is not effective and wastes herbicide. Resprouting of stumps or new seedlings should be controlled on a regular cycle, at least once per year, using selective herbicide applications applied to the foliage and young woody growth of the undesirable species. This will effectively control new and resprout growth of the target plants and permit establishment of a dense community of desirable vegetation that will inhibit the establishment of undesirable plants and significantly reduce maintenance time and costs.

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

Felling of the subject albizia trees will significantly modify the appearance of the area surrounding the Cemetery. These trees currently provide a sheltered, forested setting for Cemetery visitors. Although the perimeter will still be composed of vegetation, the vegetation will be much shorter in stature.

It is further recommended that desirable tree species, favoring native trees, be considered for planting around the perimeter to replace the undesirable trees that are removed and provide an environment that is comparable, but of higher natural value.

Crown reduction pruning that correctly removes approximately 20% to 25% of the top and/or ends of target branches will reduce the structural load on the whole tree or target branch and reduce the likelihood of tree or tree part failure. Where practical, shortening tree tops or long branches may also result in a reduced tree height and/or branch length such that a tree part is less likely to strike the subject target. However, additional pruning must be conducted in the future to manage continuing tree growth.

5.2.1 Alternate Albizia Mitigation Recommendations: Alternative mitigation can effectively reduce risk to targets at a reduced, short-term cost. However, these alternatives include disadvantages that must be considered when determining how best to mitigate potential risks. Alternate mitigation recommendations for the subject albizia trees are as follows:

5.2.1.1 Fall Modification Pruning: Certain tall trees that should be removed that possess broad crowns and/or overextended branches may sometimes be initially pruned to redirect the tree or branch fall away from targets. This technique serves to adequately reduce risk and costs in the short-term, delaying the ultimate removal of the subject tree. The primary disadvantage to this technique is that the subject tree continues to grow and may require further pruning or removal in the future.

5.2.1.2 Fall Modification Pruning/Herbicide Treatments: In conjunction with fall modification pruning as described above, after subject trees are pruned, they are then treated with herbicide to kill the subject tree. Over time, after it dies, the subject tree will naturally fall apart into areas below the tree that are at low risk to strike a recognized target. This method may be the most cost-effective to remove large trees as the tree will not resprout and disposal challenges and costs are usually significantly reduced if debris can be left where it falls. The primary disadvantage to this technique is that the dead subject tree continues to stand for an extended time and is very visible to those who visit the Cemetery. People may object to the aesthetics of dead trees near to the site. Further, as the tree deteriorates and fall apart, it may reach a condition where its fall direction may change and it could fall into an area where targets may be located. Additional work may be required to reduce that risk.

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

5.3 Crown Reduction Pruning

Crown reduction pruning, where recommended, requires that subject trees be pruned to reduce the ends of branches and the tops of the trees approximately 20% to 25% unless otherwise specified. Pruning cuts must be made in conformation to the most recent version of the ANSI A300 Pruning Standard. This reduction in the height of trees and/or ends of long branches should clear obstacles and obstructions, and has been demonstrated to significantly reduce the risk of whole tree or tree part failure. The primary advantage is that desirable subject trees that may be too tall, wide or otherwise in conflict with infrastructure or site safety are retained and can provide amenity values to the site. The primary disadvantage of this technique is that the subject tree continues to grow and will likely require further pruning in the future.

5.4 Monkeypod Trees Near Administration Building

The 3 monkeypod trees, (Trees 74, 75 and 76), near to the Administration Building should be crown cleaned and crown raised. Crown raising should be conducted to lift lower branches such that they do not interfere with vehicles or pedestrians for an approximate 5 year pruning cycle. Pruning cuts must be made in conformation to the most recent version of the ANSI A300 Pruning Standard.

5.5 Woody Vegetation Management

It is recommended that all small woody vegetation (brush) around the perimeter of the Cemetery be cut and controlled by the application of an herbicide solution.

Tree species that are greater than 4 inches in diameter are likely best removed by cutting with a chainsaw. Smaller woody plants can be cut with a chainsaw, brush saw or woody brush mowing machine. Given the terrain and conditions observed on the site, an articulating boom, side mounted mower is likely the most cost-effective tool for this project.

The freshly cut stumps of all woody vegetation that is cut should be treated with a solution of 20% triclopyr herbicide in a solution of 80% mineral oil. Stumps should be treated immediately after cutting is conducted. Resprouting of stumps or new seedlings should be controlled on a regular cycle, at least once per year, using selective herbicide applications applied to the foliage and young woody growth of the undesirable species. This will effectively control new and resprout growth of the target plants and permit establishment of a dense community of desirable vegetation that will inhibit the establishment of undesirable plants and significantly reduce maintenance time and costs.

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

5.6 Water Tank Trees

No mitigation work is recommended for the trees surrounding the water tank within the next 12 months. It is recommended that this area be re-inspected and assessed in 12 months.

When management of this area is conducted, it is recommended that all trees capable of striking the water tank be removed at one time. Removal of only a limited number of trees that can strike the water tank will expose remaining trees to winds and significantly increase the likelihood of failure of those remaining trees.

Please contact Kevin K. Eckert at keckert@arborglobal.com with any questions regarding this inspection, assessment or report.

Arbor Global PO Box 1343, Kailua, Hawaii 96734
Tel: 808-254-4161, Email: keckert@arborglobal.com, Website: www.arborglobal.com

Tree Inventory and Mitigation Recommendations, July 2016

Tree #	Species	HT	Targets	Mit. Rec.	Mit. Time (mon.)	Comments
1	Java Plum	55	wall/fence,vehicles, people on lawn	CR	24	off property, consider remove and replace in long term
2	Java Plum	55	wall/fence, people on lawn	CR	24	off property
3	Java Plum	55	people on lawn	CR	24	consider remove and replace in long term
4	Java Plum	55	people on lawn	CR/F	24+	consider remove and replace in long term
5	Java Plum	65	people on lawn	CR/F	24+	off property, consider remove and replace in long term
6	Java Plum	65	people on lawn	CR/F	24+	off property, consider remove and replace in long term
7	Java Plum	65	people on lawn	CR/F	24+	off property, consider remove and replace in long term
8	Af.Tulip	60	people on lawn	CR/F	24+	consider remove and replace in long term
9	Albizia	75	people on lawn	F/CR	12	consider remove and replace in long term
10	Java Plum	55	people on lawn	F	24+	
11	Java Plum	70	people on lawn	F	24+	
12	Java Plum	65	people on lawn	F	24+	
13	Mango	50	people on lawn	CR	24+	
14	Java Plum	45	people on lawn	F	24+	
15	Java Plum	45	people on lawn	F	24+	off property
16	Java Plum	55	people on lawn	F	24+	off property
17	Java Plum	50	people on lawn	F	24+	off property
18	Java Plum	65	people on lawn	F	24+	off property
19	Java Plum	60	people on lawn	F	24+	off property
20	Albizia	75	people on lawn	F	24	Felling may be deferred if development within fall zone defered
21	Albizia	75	people on lawn	F	24	Felling may be deferred if development within fall zone defered
22	Albizia	70	people on lawn	F	24	Felling may be deferred if development within fall zone defered
23	Albizia	70	people on lawn	F	24	Felling may be deferred if development within fall zone defered
24	Albizia	70	people on lawn	F	24	Felling may be deferred if development within fall zone defered
25	Albizia	70	people on lawn	F	24	Felling may be deferred if development within fall zone defered
26	Albizia	85	people on lawn	F	24	Felling may be deferred if development within fall zone defered
27	Af.Tulip	50	people on lawn	F	24+	covered in vines, on slope
28	Af.Tulip	45	people on lawn	F	24+	covered in vines, on slope
29	Af.Tulip	65	people on lawn	CR	12	covered in vines, on slope
30	Af.Tulip	65	people on lawn	CR	12	covered in vines, on slope
31	Af.Tulip	70	grave sites	CR	12	covered in vines, on slope
32	M.Pod	60	grave sites	CR	12	Prune long branches extending over grass and graves
33	M.Pod	60	grave sites	CR	12	Prune long branches extending over grass and graves
34	M.Pod	60	grave sites	CR	12	Prune long branches extending over grass and graves
35	M.Pod	60	grave sites	CR	12	Prune long branches extending over grass and graves

Tree Inventory and Mitigation Recommendations, July 2016

Tree #	Species	HT	Targets	Mit. Rec.	Mit. Time	Comments
36	Af.Tulip	55	drainage	F/CR	24+	
37	Af.Tulip	55	people on lawn	F/CR	24+	
38	Af.Tulip	55	people on lawn	F/CR	24+	
39	Af.Tulip	55	people on lawn	F/CR	24+	
40	Albizia	130	drainage	F	24+	
41	Af.Tulip	55	drainage	CR/F	24+	
42	Eucalyptus	70	vehicles, people	CR	24	
43	Eucalyptus	70	vehicles, people	CR	24	
44	Eucalyptus	70	vehicles, people	CR	24	
45	Eucalyptus	95	vehicles, people	CR	24	
46	Eucalyptus	120	people, storage area	CR	24	
47	Albizia	95	people, storage area	F/CR	12	
48	Albizia	130	vehicles, people	F/CR	6	
49	Albizia	130	vehicles, people, building	F/CR	6	
50	Albizia	130	vehicles, people, building	F/CR	24	
51	Albizia	130	vehicles, people, building	F/CR	6	
52	Eucalyptus	100	vehicles, people, building	CR/F	12	
53	Eucalyptus	125	vehicles, people, building	CR/F	12	
54	Eucalyptus	125	vehicles, people, building	CR	12	
55	Eucalyptus	125	vehicles, people, building	F	24	
56	Eucalyptus	125	vehicles, people, building	F	24	
57	Eucalyptus	125	vehicles, people, building	CR	12	
58	Eucalyptus	125	vehicles, people, building	F	24	
59	Eucalyptus	125	vehicles, people, building	CR	12	
60	Af.Tulip	65	vehicles, people, building	F	24	
61	Albizia	100	vehicles, people, building	F/CR	24	
62	Java Plum	35	vehicles, people, building	CR/F	24	
63	Octopus	45	vehicles, people, building	F/CR	24	
64	Albizia	120	vehicles, people, building	F/CR	3	
65	Albizia	120	vehicles, people, building	TBD	3	review after work on 64 and 66 complete
66	Albizia	50	vehicles, people, building	F/CR	3	
67	Albizia	130	vehicles, people, building	F/CR	3	
68	Albizia	130	vehicles, people, building	F/CR	3	
69	Albizia	60	vehicles, people, building	F/CR	3	
70	Albizia	130	vehicles, people, building	TBD	3	review after work on 68 and 69 complete

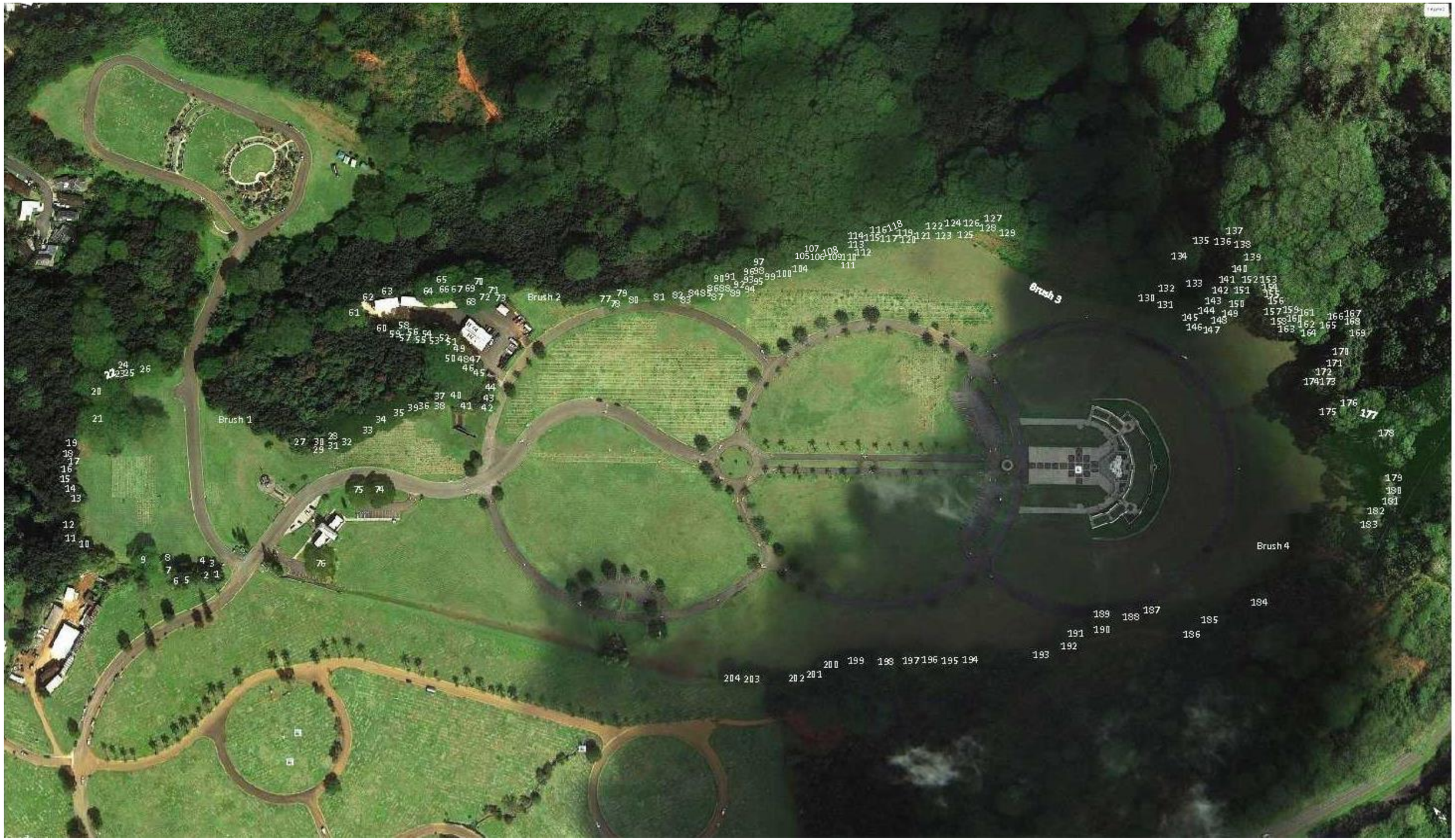
Tree #	Species	HT	Targets	Mit. Rec.	Mit. Time	Comments
71	Albizia	130	vehicles, people, building	F/CR	3	
72	Albizia	70	vehicles, people, building	TBD	3	review after work on 68 and 71 complete
73	Albizia	50	vehicles, people, building	TBD	3	review after work on 68 and 71 complete
74	M.Pod	40	vehicles, people	CC	3	4" Diameter Deadwood
75	M.Pod	40	vehicles, people	CC	3	4" Diameter Deadwood
76	M.Pod	40	vehicles, people	CC	3	4" Diameter Deadwood
77	Albzia	100	vehicles, people, grave sites	F/CR	12	
78	Albzia	85	vehicles, people, grave sites	F	12	Leans toward lawn
79	Albzia	100	vehicles, people, grave sites	F/CR	12	
80	Albzia	70	vehicles, people, grave sites	F	12	Leans toward lawn
81	Albzia	100	people on lawn, vehicles	F/CR	12	
82	Albzia	100	people on lawn, vehicles	F/CR	12	
83	Albzia	70	people on lawn, vehicles	F/CR	12	
84	Albzia	60	people on lawn, vehicles	F/CR	12	
85	Albzia	50	people on lawn, vehicles	F/CR	12	
86	Albzia	105	people on lawn, vehicles	F/CR	12	
87	Albzia	105	people on lawn, vehicles	F/CR	12	
88	Albzia	105	people on lawn, vehicles	F/CR	12	
89	Albzia	105	people on lawn, vehicles	F/CR	12	
90	Albzia	120	people on lawn, vehicles	F/CR	12	
91	Albzia	120	people on lawn, vehicles	F/CR	12	
92	Albzia	100	people on lawn	F/CR	24	
93	Albzia	100	people on lawn	F/CR	24	Leans toward lawn
94	Albzia	100	people on lawn	F/CR	24	
95	Albzia	50	people on lawn	F/CR	24	small tree, lean
96	Albzia	115	people on lawn, grave sites	F/CR	12	
97	Albzia	50	people on lawn, grave sites	F/CR	12	small tree, lean
98	Albzia	50	people on lawn	F/CR	12	small tree, lean
99	Albzia	115	people on lawn, grave sites	F/CR	12	
100	Albzia	115	people on lawn, grave sites	F/CR	12	
104	Albzia	75	people on lawn, grave sites	F/CR	12	
105	Albzia	90	people on lawn, grave sites	F/CR	12	
106	Albzia	120	people on lawn, grave sites	TBD	12	leans away from graves, behind front trees, review after work on
107	Albzia	120	people on lawn, grave sites	F/CR	12	90' from graves
108	Albzia	120	people on lawn, grave sites	TBD	12	leans away from graves, behind front trees, review after work on

Tree #	Species	HT	Targets	Mit. Rec.	Mit. Time	Comments
109	Albzia	120	people on lawn, grave sites	F/CR	12	
110	Albzia	80	people on lawn	F/CR	24+	
111	Albzia	100	people on lawn	F/CR	24+	
112	Albzia	100	people on lawn, grave sites	F/CR	24+	
113	Albzia	100	people on lawn	F/CR	24+	lean
114	Albzia	50	people on lawn	F/CR	24+	small tree
115	Albzia	140	people on lawn	F/CR	24+	
116	Albzia	50	people on lawn	F/CR	24+	small tree
117	Albzia	150	people on lawn	F/CR	24+	
118	Albzia	150	people on lawn	F/CR	24+	
119	Albzia	150	people on lawn	F/CR	24+	
120	Albzia	150	people on lawn	F/CR	24+	
121	Albzia	150	people on lawn	F/CR	24+	
122	Albzia	140	people on lawn	F/CR	24+	
123	Albzia	140	people on lawn	F/CR	24+	
124	Albzia	140	people on lawn	F/CR	24+	
125	Albzia	100	people on lawn	F/CR	24+	understory tree
126	Albzia	100	people on lawn	F/CR	24+	understory tree
127	Albzia	100	people on lawn	F/CR	24+	understory tree
128	Albzia	100	people on lawn	F/CR	24+	understory tree
129	Albzia	100	people on lawn	F/CR	24+	
130	Albzia	100	people on lawn	F/CR	24+	
131	Albzia	55	people on lawn	F/CR	24+	
132	Albzia	100	people on lawn	F/CR	24+	
133	Albzia	140	people on lawn	F/CR	24+	
134	Albzia	130	people on lawn	F/CR	24+	
135	Albzia	130	people on lawn	F/CR	24+	
136	Albzia	85	people on lawn	F/CR	24+	leans toward lawn
137	Albzia	160	people on lawn	F/CR	24+	
138	Albzia	160	people on lawn	F/CR	24+	
139	Albzia	120	people on lawn	F/CR	24+	
140	Albzia	120	people on lawn	TBD	24+	leans away from lawn
141	Albzia	100	people on lawn	F/CR	24+	understory tree
142	Albzia	160	people on lawn	F/CR	24+	
143	Albzia	100	people on lawn	F/CR	24+	

Tree #	Species	HT	Targets	Mit. Rec.	Mit. Time	Comments
144	Albzia	130	people on lawn	F/CR	24+	
145	Albzia	140	people on lawn	F/CR	24+	
146	Albzia	150	people on lawn	F/CR	24+	Monstera vine covering most of stem
147	Albzia	150	people on lawn	F/CR	24+	Monstera vine covering most of stem
148	Albzia	150	people on lawn	F/CR	24+	
149	Albzia	150	people on lawn	F/CR	24+	
150	Albzia	120	people on lawn	F/CR	24+	
151	Albzia	100	people on lawn	F/CR	24+	
152	Albzia	110	people on lawn	F/CR	24+	leans toward lawn
153	Albzia	110	people on lawn	F/CR	24+	
154	Albzia	125	people on lawn	F/CR	24+	
155	Albzia	110	people on lawn	F/CR	24+	
156	Albzia	125	people on lawn	F/CR	24+	
157	Albzia	125	people on lawn	F/CR	24+	
158	Albzia	90	people on lawn	F/CR	24+	understory tree
159	Albzia	125	people on lawn	F/CR	24+	
160	Albzia	125	people on lawn	F/CR	24+	
161	Albzia	60	people on lawn	F/CR	24+	understory tree
162	Albzia	120	people on lawn	F/CR	24+	
163	Albzia	120	people on lawn	F/CR	24+	
164	Albzia	145	people on lawn	F/CR	24+	
165	Albzia	65	people on lawn	F/CR	24+	
166	Albzia	110	people on lawn	F/CR	24+	leans toward lawn
167	Albzia	80	people, vehicles on service road	F/CR	24+	leans toward lawn
168	Albzia	80	people, vehicles on service road	F/CR	24+	understory tree at entrance of road to the water tank
169	Albzia	80	people, vehicles on service road	F/CR	24+	understory tree at entrance of road to the water tank
170	Af. Tulip	45	people, vehicles on service road	F/CR	24+	understory tree at entrance of road to the water tank
171	Macaranga	60	people, vehicles on service road	F/CR	24+	understory tree at entrance of road to the water tank
172	Albzia	90	people, vehicles on service road	F/CR	24+	entrance of road to the water tank
173	Af. Tulip	50	people, vehicles on service road	F/CR	24+	understory tree at entrance of road to the water tank
174	M. Pod	65	people, vehicles on service road	CC	24	deadwood
175	Albizia	125	people on lawn	F/CR	24+	
176	Albizia	125	people on lawn	F/CR	24+	
177	Albizia	135	people on lawn	F/CR	24+	3 trees: 2-~20" DSH, 1~18" DSH
178	Albizia	120	people on lawn	F/CR	24+	2 dead trees

Tree #	Species	HT	Targets	Mit. Rec.	Mit. Time	Comments
179	Albizia	70	people on lawn	F/CR	24+	5 small trees <8" DSH
180	Albizia	100	people on lawn	F/CR	24+	
181	Albizia	75	people on lawn	F/CR	24+	
182	Albizia	60	people on lawn	F/CR	24+	
183	Albizia	60	people on lawn	F/CR	24+	4 small trees: 8"-10" Dia
184	Albizia	50-75	people on lawn	F/CR	24+	6 small trees: 8"-12" DSH
185	Albizia	40-75	people on lawn	F/CR	24+	6 small trees: 6"-12" DSH
186	Albizia	60-75	people on lawn	F/CR	24+	13 small trees: 4"-10" Dia
187	Albizia	75	people on lawn, vehicles	F/CR	24	
188	Albizia	60	people on lawn, vehicles	F/CR	24	small A/S rear
189	Albizia	75	people on lawn, vehicles	F/CR	24	
190	Albizia	75	people on lawn, vehicles	F/CR	24	3 trees
191	Albizia	75	people on lawn, vehicles	F/CR	24	
192	Albizia	90	people on lawn, vehicles	F/CR	24	
193	Albizia	70	people on lawn	F/CR	24+	lean into brush
194	Albizia	50	people on lawn	F/CR	24+	
195	Albizia	75	people on lawn	F/CR	24+	
196	Albizia	65	people on lawn	F/CR	24+	
197	Albizia	85	people on lawn	F/CR	24+	
198	Albizia	85	people on lawn	F/CR	24+	
199	F.Kamani	50	people on lawn	CR	24+	
200	F.Kamani	50	people on lawn	CR	24+	
201	F.Kamani	50	people on lawn	CR	24+	
202	Kukui	40	people on lawn	F/CR	24+	
203	F.Kamani	40	people on lawn	F/CR	24+	
204	Fiddlewood	20	people on lawn	F/CR	24+	

Legend:
CR-Crown Reduction
CC-Crown Clean
F- Fell
F/CR-Tree needs to be Felled, but if not practical at this time, correct Crown Reduction should adequately reduce risk.
CR/F-Crown Reduction is most practical at this time but, tree should be Felled in future.
TBD-To Be Determined after work on nearby trees is completed.


Brush 1
Brush 2
Brush 3
Brush 4