

Dryad, LLC

October 8, 2018

County of Humboldt
 Hank Seemann, Deputy Director
 Department of Public Works – Environmental Services
 1106 Second Street
 Eureka, California, 95501

Project name: Humboldt Bay Trail South -Limited Visual Tree Risk Assessment
 Project no.: 715036

Mr. Seemann, et al;'

I am under contract, as a Consulting Arborist, with Humboldt County for the specific assessment of trees relative to the planned Humboldt Bay Trail (HBT) construction project (Segment 7). My assignment consists of evaluating a stand of bluegum trees (*Eucalyptus globulus*), parallel to the west edge of Highway 101 between the former CA Redwood Co. mill site (south) and the Indianola Cutoff intersection (north). This letter and the accompanying Attachments comprise my report.

Scope of Services: The contract Scope of Services includes the following (paraphrased and summarized):

- Conduct a Level 1 Basic¹, ground-level, visual, stand-level evaluation of the condition, risk, and mitigation potential for the northern group of *Eucalyptus* trees situated along Segment 7 of the proposed HBT.
- Review provided documents
- Field inspection of site and trees
- Identification (genus-species)
- Evaluate the trees as to condition including health, stability (structure), risk and species suitability
- Evaluate environmental and climatic conditions, effects of pruning and the potential for damage from trail construction
- Identify previous failure patterns
- Address potential mitigation options for health and risk
- Develop exhibits of typical conditions
- Provide a formal letter-report of data, observations, evaluations and exhibits
- Present an in-person summary report to a meeting of the Board of Supervisors and respond to questions

In preparation for the field work, I reviewed a number of internet sites that included historical images of the vicinity as well as documents you provided. The documents you provided included the following:

1. Department of Public Works County of Humboldt, Comment Evaluation Memo, dated July 16, 2018
2. Maps and Photographs of Eucalyptus Trees along the future segment of the Humboldt Bay Trail, dated August 2, 2018
3. Attachment C Examples of Eucalyptus Tree Safety Incidents in California (undated)
4. Humboldt Bay Trail eucalyptus exhibits 9-27-2018 (PowerPoint file)

I met briefly with you and previewed the site and trees on September 13, 2018. On September 14, 2018, I inspected the site and trees^A, selected and tagged example trees, recorded measurements and images and performed limited micro-resistance testing^B. Ten example trees were tagged with pre-numbered, blue aluminum tags installed at approximately eye-level, and highlighted with a spot of blue paint on the tree trunk. Katie Krebs, Consulting Arborist², assisted me with the field work.

¹ This description, quoted from the contract, combines two levels of inspection as defined in the referenced document *American National Standards Institute, 2017. Standard Practices for Tree, Shrub and other Woody Plant Maintenance, Tree Risk Assessment, a. Tree Failure*, American National Standards Institute (ANSI A300 Part 9, 2017), as follows: "95.9 limited visual assessment (Level 1): A visual assessment from a defined perspective... of an individual tree or a population of trees, to assess risk to specified targets from obvious defects or specified conditions." and "95.4 basic tree risk assessment (Level 2): A tree risk assessment that includes a 360-degree, ground-based visual inspection of the tree crown, trunk, trunk flare, aboveground roots, tree related site conditions, and significant targets. The assessment may include the use of common hand tools."

² Katie J. Krebs, Consulting Arborist; ISA Certified Arborist no. WE-8731A, ISA Tree Risk Assessment Qualified. K. Krebs is an independent Consulting Arborist under contract with and not an employee of Dryad, LLC.

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Field assessment process:

- A Level 1 Limited Visual Tree Risk Assessment^C was performed on all trees in the stand >8" diameter (dsh)^{D,3}.
- A Level 2 Basic Tree Risk Assessment^C was performed on all trees in the stand >8" diameter (dbh).
- A Level 3 Advanced Tree Risk Assessment^C was performed on six trees (nos. 1, 3, 5, 6, 9 & 10) of the ten trees selected as examples of typical tree condition within the stand. Advanced techniques included micro-resistance drilling, limited to one or two locations on the tree trunks of these six.
- Sampling: Samples collected included soil, water (drainage), foliage and wood (drillings). Samples were blended as per laboratory protocol, and not representational of specific individual trees.

I submitted the collected samples of soil, foliage and water to Perry Laboratory⁴ on September 17, 2018. I also collected wood samples, submitted on September 17, 2018 to the University of CA at Berkeley Forest Pathology and Mycology labs for DNA assay of wood decay fungi⁵. The reports from Perry Laboratory are included in the attachment documents. The UC lab typically takes many weeks to process samples and report findings, so those results will be forwarded when received. It is my opinion that the DNA assay results, even if no specific fungi are detected, cannot improve upon my opinions of the condition of the trees as presented in this report, but the presence of some species of wood decay fungi could enhance the urgency for risk mitigation.

SUMMARY: The contract cites approximately 219 individual trunks over 8" diameter and we counted approximately 129 separate trees, many of which are multi-trunked or growing too close to differentiate.

This stand of trees, combined with similar nearby stands of bluegums, provides a striking, unique and visually pleasing border between the highway and Humboldt Bay. At one time, they clearly provided a significant windbreak and screening of the railroad tracks and associated activities. The removal of many trees and virtually all primary limb architecture^E has resulted in negligible screening benefits. As the tracks are no longer in use and related activities in the vicinity no longer occurring, the trees now serve primarily as an obstruction to a view of Humboldt Bay.

Although I was provided no information on the maintenance activities or schedule for these trees, their proximity to the highway is the likely motivation for the severe and repeated pruning and topping. Pruning has included significant height reduction through topping^F and the removal of nearly all primary, lateral limbs and many codominant stems^G as well as the complete removal of many trees. It was also apparent that the profuse debris typically shed by bluegums, including exfoliated bark, declining leaves, seed capsules and branches has been regularly cleared from beneath the trees, along with the many benefits of organic soil cover (mulch^H; soil horizon O').

There is little variation in the condition of the trees or specific conditions. I selected ten trees as representational of typical overall condition and for illustration of specific conditions. The Attachments document accompanying this report includes exhibits for each of these ten example trees as well as the conditions described throughout this report.

The trees as a whole are in an advanced state of physiological decline^J, exhibiting little ability to compartmentalize^K wounds^L, very limited woundwood^M formation on the most recent pruning cuts, almost non-existent sprouting and profuse dieback of twigs and entire branches and stems^N. The foliage and soil testing indicates high concentrations of salts and low fertility⁴. The adjacent drainage water is also high in salts⁴. These conditions in combination with repeated and severe pruning, desiccation from frequent winds and the poor water-holding capacity of the soil are likely the combined cause of decline. I observed no signs of significant insects or diseases.

³ The protocol for each level is included in each successive level. *American National Standards Institute, 2017. Standard Practices for Tree, Shrub and other Woody Plant Maintenance, Tree Risk Assessment, a. Tree Failure*, American National Standards Institute (ANSI A300 Part 9, 2017).

⁴ Refer to the Perry Laboratory analyses and report in the Attachments document.

⁵ Wood decay fungi DNA assay: UC Forest Pathology and Mycology labs (https://nature.berkeley.edu/garbelottowp/?page_id=146); DNA analysis results typically take 60-90 days or more to be reported. The identification of any decay organisms only indicates their presence, and not the extent of damage or any judgment as to tree condition. Samples are collected by collecting drilling residue (sawdust) via a 1/8" diameter bit. The residue is typically collected at several locations on an individual tree and mixed to produce a single sample.

This stand of trees exhibits a number of structural^O weaknesses that can result in failures. These conditions include decay at the base of tree trunks, columns of decay on trunk interiors, decay at pruning wound sites, large dead limbs, weak attachments of limbs and tops^P and codominant stems. The targets^Q for such failures include the planned Humboldt Bay Trail⁶ to the west and the immediately adjacent Highway 101⁷ to the east. There is a high potential for both significant property damage and serious personal injury or death should whole trees or tree parts fail.

In my opinion, there is no reasonable method^R for mitigating these risks through pruning^R, cabling and bracing^S or the moving of targets. If allowed to remain, the risk of failures will increase over time. The health of these trees will continue to decline, as their growing environment is inherently inhospitable to plant growth due to soil structure and low fertility, salinity of both water and soil and the natural senescence of aged trees.

RECOMMENDATIONS: The following recommendations are listed in order of priority.

1. **I recommend removing the entire stand to grade.** The physiological and structural conditions that render these trees a risk will worsen over time and cannot be effectively mitigated except via removal.
2. **If removal of all of the trees is delayed or precluded,** at least perform promptly the recommended mitigation measures, for the example trees assessments that cite the Humboldt Bay Trail as a target for either Tree Part 1 or Tree Part 2 (tree nos. 2, 3-5, 7, 8 & 10)⁸.
3. **Perform a second risk assessment of all remaining trees** that present risk to the Humboldt Bay Trail promptly (trees other than the example trees), before construction or other activities take place within the striking distance of the trees. This is necessary to develop mitigation recommendations for these trees.
4. **Replacement:** If all or any of the trees are removed, in consideration of the risk presented by large trees in this location and the inhospitable growing environment, I recommend replacing only with native, coastal plants of smaller stature that are known to be tolerant of these site conditions⁴.

DISCUSSION:

Tree risk: Tree risk is defined in the industry standards⁹ as “*the likelihood of a tree failure impacting a target and the likely severity of the consequences.*” Trees are living, changing organisms affected by innumerable factors beyond human control. Trees fail in ways and because of conditions, we do not fully understand. Arborists cannot detect or anticipate every condition or event that could possibly lead to the structural failure of a tree. Conditions are often hidden within the trees and below ground. Arborists cannot guarantee that a tree will be healthy or safe under all circumstances, for any specific period or when a tree or its parts may fail. Further, all large landscape trees in proximity to people, structures, utilities or roadways present some degree of risk regardless of their condition. Such risk must be accepted in order to enjoy the benefits of large trees. To live near trees, regardless of their condition, is to accept some degree of risk. Tree removal is the only way to eliminate the risks associated with trees.

The example trees were selected to illustrate the range of typical conditions within the stand as a whole. To maintain the integrity of the stand-level assessment, potential targets and overall tree condition were not considered in the selection process. Although not the focus of this project, Highway 101 is included as it is the only target of potential tree failures other than the Humboldt Bay Trail¹⁰. In my opinion, eliminating Highway 101 as a target would result in a serious mischaracterization of overall stand condition and risk.

For assessing the risk from the example trees in this project, I assessed risk for the tree part I deemed most likely to fail first, within a time-frame of 1-3 years. In general, the most common first failure risk is from falling dead limbs. All risks were identified and rated based on existing condition at the time of the inspection.

⁶ For the purposes of the tree assessments and this report, the Humboldt Bay Trail is presumed constructed as described in provided documents.

⁷ These trees were not assessed for risk relative to Highway 101 as the primary target. A tree-by-tree formal risk assessment specifically relative to Highway 101 as the primary target must be performed in order to rate tree risk and recommend mitigation measures.

⁸ Refer to the Attachments document accompanying this report.

⁹ American National Standards Institute, 2017. *Standard Practices for Tree, Shrub and other Woody Plant Maintenance, Tree Risk Assessment, a. Tree Failure*, American National Standards Institute (ANSI A300 Part 9, 2017).

¹⁰ ANSI A300 Part 9, 2017, .pg. 9, “92.2 Tree risk assessors should consult with the owner, owner’s agent, or controlling authority to assess site use, and identify significant known and foreseeable targets within likely striking distance of the specified tree(s) or tree parts.”

The severity assessed for that risk is based upon the likelihood of those limbs striking users of the trail or the highway or their property (e.g., vehicles). However, the first part to fail may not be the most serious. Many of the trees are at risk of the collapse of entire stems or large tree portions, but I was not of the opinion that such failures are imminent. The potential to fail will increase over time and the consequences likely much more severe than the falling of dead limbs.

Therefore, the prescribed Tree Risk Assessment process¹¹ sometimes results in an overall risk rating (Tree Part 1) that may be low at the time of assessment and yet there may be a very serious risk looking forward (Tree Part 2). It is my opinion that this is the case with many of the trees in this stand and therefore, delaying their removal is ill-advised.

Stand density: It is likely that at one time, these trees provided an effective windbreak, but the cumulative effect of removing entire trees, stems and all lower limbs has reduced stand density to a fraction of what it once was. The small volume of remaining foliage is now concentrated at the tops. The foliage is declining and branches dying. There is almost no sprouting along the trunks and limbs in spite of *Eucalyptus* species having a propensity to produce profuse sprouting in response to severe pruning and exposure of limbs and trunks to sunlight. These are all signs of low vigor^T.

Physiological health: Bluegum trees (*Eucalyptus globulus*) are by character, extremely vigorous, fast growing and tolerant of severe pruning and difficult growing environments. They are noted as tolerant of seaside conditions, wet or dry soils, drought, full or partial sunlight and other typically detrimental conditions. Branch strength is considered typically weak and the species is not fire resistant. Bluegums also have the ability to grow to tremendous size and within a few decades, can achieve well over 100 feet in height with trunks of several feet in diameter¹².

This stand of trees is in advanced decline and many are near death with a tiny fraction of the necessary foliage to survive^U. Described as planted in 1921¹³, the trees have failed to achieve anything near even average size for nearly 100-year-old blue gum trees. The trees exhibit multiple signs of decline including branch dieback, extensive decay, lack of sprout growth, minimal response growth over pruning cuts and stunted overall growth. Undoubtedly, this is a result of the combined and continuous impact of repeated severe pruning, limited rooting space, impervious soil cover (highway), saline water and soil, low soil fertility, lack of organic soil cover (mulch) and regular significant winds.

Future impacts from the inevitable pruning and removal of additional trees required for highway safety and the clearing of organic soil cover ensures the rate of decline will continue and likely increase. Should climate change result in greater storm extremes and/or rising bay water levels, the effects of salinity in the wind spray, soil and available water will further exacerbate and increase the rate of decline as well. The low vigor of these trees will not allow them to adapt over time to increased wind stress and will inevitably result in an increased rate of failure.

Tree structure and architecture: I was provided images of severe pruning and topping of these trees, underway in 1969¹⁴. It was apparent the trees have been subsequently re-topped several times. Periodic pruning removed entire stems and virtually all primary, lateral limb architecture, which concentrates foliage at the tree tops. Branches well-spaced throughout the height of a tree and branches along the length of primary limbs are critical to the development of the taper^V of these parts. Stems and limbs with little taper, particularly when compromised by decay, lose dynamic strength and are more prone to failure. This condition is prevalent in this stand and the resulting risk enhanced by pruning and stand thinning that has increased wind exposure.

The canopies of these trees consist primarily of sprouts from topping cuts that have matured to significant size, but are weakly attached. Many of the topping cuts have decayed, further jeopardizing the strength of

¹¹ TRAQ: an International Society of Arboriculture (ISA) qualification program that trains arborists how to use the methodologies outlined in the ISA Best Management Practices for Tree Risk Assessment. This qualification promotes the safety of people and property by providing a standardized and systematic process for assessing tree risk. The results of a tree risk assessment can provide tree owners and risk managers with the information to make informed decisions to enhance tree benefits, health, and longevity.

¹² Urban Forestry Ecosystem Institute, Cal-Poly San Luis Obispo, SelecTree (<https://selectree.calpoly.edu/tree-detail/eucalyptus-globulus>).

¹³ Department of Public Works County of Humboldt, Comment Evaluation Memo, dated July 16, 2018.

¹⁴ Maps and Photographs of Eucalyptus Trees along the future segment of the Humboldt Bay Trail, dated August 2, 2018.

attachments. The majority of pruning cuts are flush cuts^w, which typically result in significant decay. Many of these cuts have resulted in internal columns of decay, weakening wood strength and reducing flexibility under wind stress.

Potential impact of trail construction: The rooting area for these trees is very limited, with asphalt within a few feet to the east and a saline drainage ditch to the west. Any medium that can support roots is therefore valuable. If roots exist in the berm of the railroad tracks, they will be lost to construction via removal or through the addition of substantial fill soil. Root loss will exacerbate the rate of decline of the trees. It is unlikely, based on current information available to me, that construction will result in root loss that will directly affect tree stability (i.e., supporting roots).

Mitigation options: The risk from some trees and certain conditions can sometimes be reduced via techniques such as pruning and/or cabling and bracing, preventing access within or moving the targets outside of the tree fall zone. It is my opinion that the trees in the subject stand offer no opportunity for viable long-term solutions such as these.

1. **Removal:** Removing all trees in this stand is the only method of eliminating the risk of their failure. Doing so would also present opportunity for landscape-redesign and open up the views of the adjacent Humboldt Bay.
2. **Pruning:** Due to the completely lacking primary limb structure, there is no opportunity for effective tree reduction pruning or restructuring.
3. **Heading (topping) for height reduction:** While risk could be temporarily reduced via repeating severe topping, as was performed in 1969, such pruning would hasten decline and the resulting regrowth, if any, would result in a new era of risk of failures via decay and weak attachment. Should the trees survive, high maintenance would be necessary to reduce or remove the resulting sprouting.
4. **Support systems (cabling and/or bracing)^s:** There is no support method that can provide reasonable risk reduction for the weak tops. While cables might reduce the risk of failure of some codominant stems, that risk cannot be eliminated, support systems are not permanent and are not a guarantee against failure. Cables would not provide protection against whole tree failure or uprooting.
5. **Phased, prioritized removals:** Removing selected trees deemed most likely to fail would alter the stand and reduce wind buffering between trees, exposing the remaining trees to a sudden increase in stresses they are not adapted to. The potential for failures would therefore increase and the need for removal of the remaining trees would remain inevitable. Further, the risk of various failures is so prevalent that attempting to prioritize removals would be substantially ineffective.



Stand & canopy density:



03/07/1949 (above): Historically , the stand was very dense with many more trees (Image excerpted from document 2.Maps and Photographs of Eucalyptus Trees along the future segment of the Humboldt Bay Trail, dated August 2, 2018.).
09/14/2018 (below): Similar view illustrating the current lack of density, increased height and top-heavy canopy, and trees devoid of lateral limbs and lower foliage.



Stand & canopy density:



09/14/18: The stand looks reasonably dense when the trees are viewed at an angle, in succession.



Stand & canopy density:



09/14/18: The stand's lack of density and sparse, top-heavy canopies are apparent in a perpendicular view. The smaller trees are saplings along the railroad tracks.



Example of viable bluegums (*Eucalyptus globulus*) in the vicinity:



A small stand of blue gums on the east side of Highway 101, adjacent to the middle of the subject tree stand. Illustrated is substantial growing space and distance from the highway, vigorous growth and viable architecture, rendering them good candidates for judicious pruning to mitigate any identified risk.



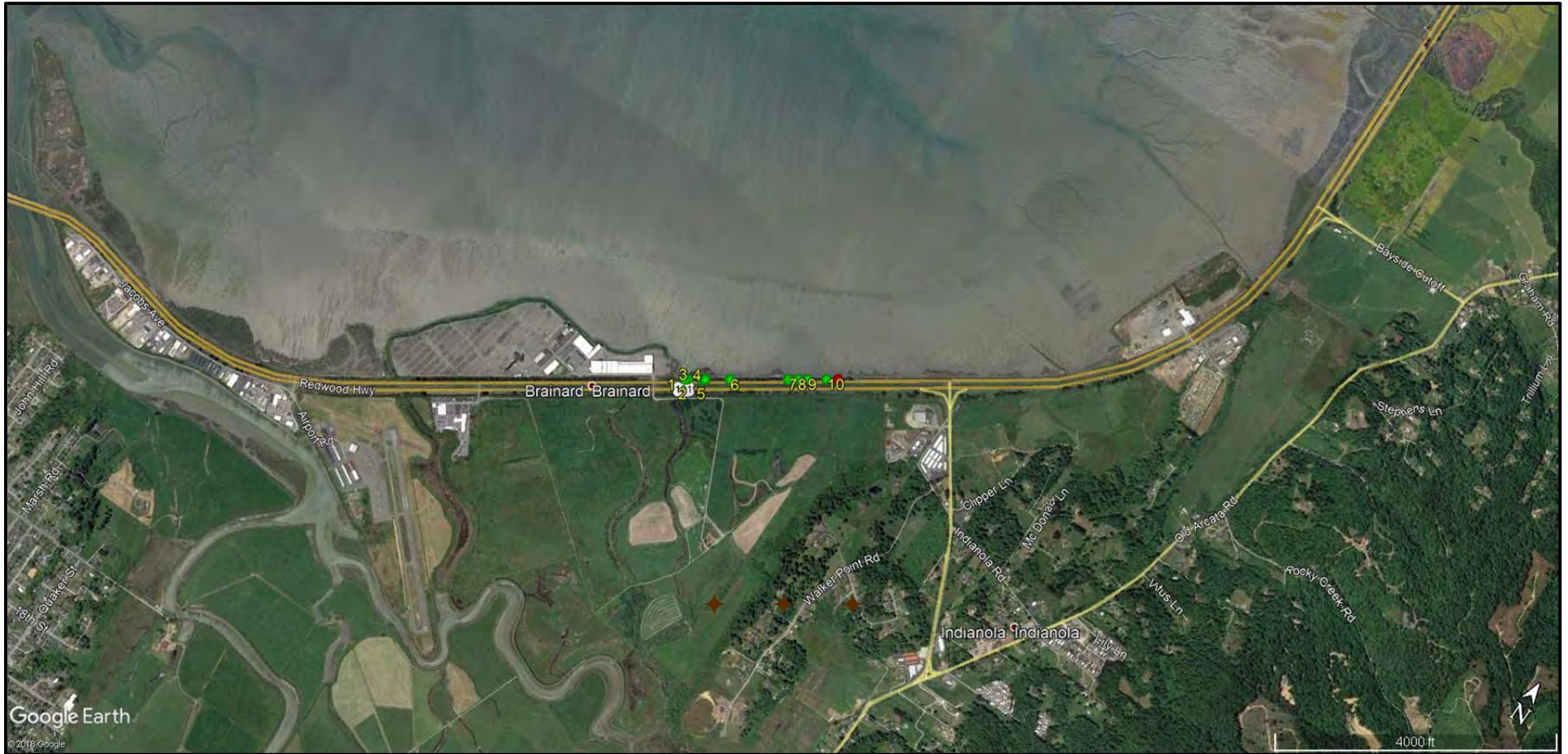
Example of viable bluegums (*Eucalyptus globulus*) in the vicinity:



A small stand of blue gums on the east side of Highway 101, adjacent to the south end of the subject tree stand. Illustrated is substantial growing space and distance from the highway, vigorous growth and viable architecture, rendering them good candidates for judicious pruning to mitigate any identified risk.



Site overview:



Locations of example trees:



Inventory, data & evaluations of example trees:

No.	Common name	Genus-species	Trunk diameters (dsh)					Risk rating ⁷ (Tree Part 1)	Residual risk (Tree Part 2)	Observations/Comments	Graph no.	Micro-resistance graph notes ¹⁵
			1	2	3	4	5					
1	Bluegum	<i>Eucalyptus globulus</i>	21					Low	N/A	Decayed pruning wounds on trunk (tension) & base (8-12" diameter) <5% canopy Trunk curvature & lean to east Major decay column at 11" depth	9	E-W (48" hgt.) decay column @ 11"... (w/anomalies)
2	Bluegum	<i>Eucalyptus globulus</i>	26	21				Low	Low	2 codominant stems @ 3' above grade 3 large wounds from stem removals (8-12" diameter) Large wounds on upper trunk (tension side) Lean to west Large dead branches at top <2% canopy	N/A	
3	Bluegum	<i>Eucalyptus globulus</i>	22	19	13			Low	Moderate	Substantially dead 3 codominant stems Large, dead limbs to west Decay at topping cut <2% canopy Excess soil over root flare	8	NE=SW (24" hgt.) sound (minor anomalies)
4	Bluegum	<i>Eucalyptus globulus</i>	42					Moderate	Low	2 codominant stems Decay column to west Lean to west ~20% canopy	N/A	
5	Bluegum	<i>Eucalyptus globulus</i>	25	20				Moderate	Moderate	Substantially dead Codominant stems w/weak attachments <2% canopy Decaying wounds Decay column north side, lower west stem Lean to west	6 & 7	6, East trunk: E-W (36" hgt.); decay @ 4.75-7" & 9-14" 7, West trunk: (N-S) (48" hgt.); decay @ 2-3.5" & 15"...

¹⁵ Refer to the Attachments document to view graphs.

No.	Common name	Genus-species	Trunk diameters (dsh)					Risk rating ⁷ (Tree Part 1)	Residual risk (Tree Part 2)	Observations/Comments	Graph no.	Micro-resistance graph notes ¹⁵
			1	2	3	4	5					
6	Bluegum	<i>Eucalyptus globulus</i>	25					High	N/A	Substantially dead <2% canopy Leans to east Codominant tops Decaying wound (15" diameter to east) Decaying wound (17" diameter to north) Interior decay column @ ~9" depth	4 & 5	4: N-S (48" hgt.) decay @ 8.5"..." 5: E-W (48" hgt.) decay @ 8.5"-19"
7	Bluegum	<i>Eucalyptus globulus</i>	39					Moderate	Moderate	5 large dead limbs to west 3 codominant stems w/weak attachments ~10% canopy	N/A	
8	Bluegum	<i>Eucalyptus globulus</i>	22	14				Low	High	Substantially dead <1% canopy Codominant stems Large, decaying wounds from stem removals	N/A	
9	Bluegum	<i>Eucalyptus globulus</i>	36					High	N/A	3 codominant stems with weak attachments 3 large wounds at base (stem removals) Lean to east Torsional stress and response growth <10% canopy	2 & 3	2: E-W (36" hgt.) decay @ 7.5"..." 3: NE-SW (24" hgt.) decay @ 16.5"..."
10	Bluegum	<i>Eucalyptus globulus</i>	27	24	20	20	11	Moderate	High	5 codominant stems w/weak attachments Large dead branches to west Excess soil over root flare Large wounds from stem removals to east Decaying stub on trunk to east <5% canopy	1	E-W (60" hgt.) decay @ 5.5"-9.5"; 11"-14"; 17.5"-19"



October 8, 2018
Torrey Young, Dryad, LLC
18024-40022 Humboldt County (Humboldt Bay Trail)

Respectfully submitted,



Torrey Young
Registered Consulting Arborist®

ASCA Registered Consulting Arborist, no. 282
ISA Board Certified Master Arborist, no. WE-0131BM
CUFC Certified Urban Forester, no. 121
ISA Tree Risk Assessment Qualified
CA P.C. Qualified License, no. 104772
CA Contractors License no. 363372 (C-27 & D-49; inactive)



ENDNOTES:

^A Arborist Disclosure Statement: Arborists are tree specialists who use their education, knowledge training and experience to examine trees, recommend measures to enhance their health and beauty and to attempt to reduce the risk of living near trees. Clients may choose to accept or disregard the recommendations of the arborist or to seek additional advice. Trees and other plantlife are living, changing organisms affected by innumerable factors beyond our control. Trees fail in ways and because of conditions we do not fully understand. Arborists cannot detect or anticipate every condition or event that could possibly lead to the structural failure of a tree. Conditions are often hidden within the trees and below ground. Arborists cannot guarantee that a tree will be healthy or safe under all circumstances, for any specific period or when a tree or its parts may fail. Further, remedial treatments, as with any treatment or therapy, cannot be guaranteed. Treatment, pruning, bracing and removal of trees may involve considerations beyond the scope of the arborists skills and usual services such as the boundaries of properties, property ownership, site lines, neighbor disputes and agreements and other issues. Therefore, arborists cannot consider such issues unless complete and accurate information is disclosed in a timely fashion. Then, the arborist can be expected, reasonably, to rely upon the completeness and accuracy of the information provided. Trees can be managed but not controlled. To live near trees, regardless of their condition, is to accept some degree of risk. Tree removal is the only way to eliminate the risks associated with trees.

^B Micro-resistance testing (resistance drilling; Resistograph®): An instrument used to detect internal wood decay and cracks. Such defects are detected by measuring relative resistance to drilling with a 3.0 mm drilling needle. The results are simultaneously recorded electronically and optionally printed on a paper graph. Dryad, LLC operates three devices: The RinnTech R650-EA employs a needle capable of drilling to a depth of approximately 20 inches while the IML Resi-F500S has a depth of about 19 inches (paper graph only) and F400 a needle of approximately 14 inches (paper & electronic options). The testing locations are determined dependent upon on-site observations and testing results, at the discretion of the consultant, unless otherwise specified. Micro-resistance testing provides information only, that is subject to interpretation, and therefore, the significance of testing results or evaluation of results cannot be anticipated or otherwise guaranteed. Such testing does not measure or determine overall tree condition or management conclusions. Resistograph® is a trademark of RinnTech.

^C Tree risk assessment inspection levels (ANSI A300, Part 9, 2017):

- Level 1, Limited Visual Assessment: A visual assessment from a defined perspective... of an individual tree or a population of trees, to assess risk to specified targets from obvious defects or specified conditions.
- Level 2, Basic tree risk Assessment: A tree risk assessment that includes a 360-degree, ground-based visual inspection of the tree crown, trunk, trunk flare, aboveground roots, tree related site conditions, and significant targets. The assessment may include the use of common hand tools.
- Level 3, Advanced Tree Risk Assessment: A tree risk assessment performed to provide detailed information about specific tree parts, defects, site conditions, targets, consequences or other factors relevant to the tree risk assessment.

^D Diameter: DSH - Diameter at Standard Height or DBH – Diameter at Breast Height, or approximately 4.5 feet (54 inches) above grade. These references are synonymous and commonly used as a point of reference in determining tree size and as the basis for a myriad of calculations.. Diameter measurement location may vary depending upon tree structural character, jurisdictional codes or project guidelines, etc. In some cases, diameters may be estimated due to inaccessibility or other limitations.

^E Architecture: (as employed in this report) the arrangement of the (external) parts of a tree; primarily refers to the foliage crown including major (scaffold) limbs, lateral branches and trunks.

^F Topping: A pruning cut that removes the main stem or stems between nodes, buds or laterals, or to a lateral branch or limb not large enough to assume the terminal role (e.g., less than ½ the diameter of parent limb/stem). Such cuts can result in serious decay and/or forcing growth of weakly attached upright sprouts below the cut. Topping cuts also generally result in permanent alteration of tree architecture and create structural weaknesses.

^G Codominant: Refers to branch, limbs or trunks of similar size and height or length competing for the same space and/or role within the tree's architecture; frequently originating at acute angles from each other, with bark remaining (included) between the components (in the crotch). Such attachments are inherently weak and worsen with time through the pressure of opposing growth and the increasing weight of wood and foliage, frequently resulting in the failure of one or both (all).

^H Mulch: Organic materials (e.g., brush chips, compost, processed wood chips, etc.) spread upon the soil for a variety of benefits: aesthetics, retains soil moisture, moderates soil temperatures, improves soil structure and increases fertility, protects against compaction, suppresses weeds, etc. Torrey Young, Dryad, LLC highly recommends fresh, brush chip mulch over processed materials. (Note: Elsewhere, the definition of *mulch* may include non-organic materials.).

^I Soil Horizon O, Organic matter: Surficial organic deposit with litter layer of plant residues in relatively non-decomposed form.

^J Decline: (in trees) The deteriorating condition of trees manifested most notably in chlorotic, thinning foliage and dying branch tips and entire twigs, branches and/or limbs. Decline is the deficit condition of various plant cells and tissues (roots, foliage, wood) becoming inactive at a faster rate than new tissue can be formed. Plant/tree decline can be indicative of pending plant death.

^K Compartmentalization: a subdivision of a larger space delineated by the development of boundaries (e.g., cabinet, room, cell). Compartmentalization of decay in trees (woody plants) is a dynamic tree defense process in response to injury that forms chemical boundaries ("walls") to resist the spread of pathogens.

^L Wound (on trees & plants): Any penetration of the outer bark of a tree or other woody plant, regardless of the source; may result from pruning cuts, traumatic injury, disease, limb failures, bird or animal damage, lightning strikes, etc. Such injuries may serve as avenues for infection by decay and other disease-causing pathogens or insect infestation.

^M Woundwood: When callus forms after the wounding of a tree, it becomes increasingly lignified and begins forming woundwood.

Woundwood differentiates into various cell types (vessels, fibers, parenchyma, etc.). Woundwood is not meristematic and is low in lignin.

^N Stem (trunk): The primary portion of a plant's supportive and transportive architecture (synonymous with 'trunk').

^O Structure: The nature, character, physical integrity and attachments of tree; primarily refers to the wood in limbs, branches, stems (trunks) and roots.

^P Acute-angle attachments (crotches): Branch/limb, limb/trunk, or codominant trunks originating at acute angles from each other. Bark remains between such crotches, preventing the development of a branch-bark ridge (branch collar). The inherent weakness of such attachments increases with time, through the pressure of opposing growth and increasing weight of wood and foliage, frequently resulting in failure.

^Q Target (as employed in tree risk assessment): People or property that could be injured or damaged by the failure of a tree or tree parts. (ANSI A300 (Part 9) *Tree Risk Assessment*, 2017).

^R Pruning: Proper pruning is performed in a manner intended to achieve a specific goal while minimizing the negative effects on the plant (tree). Improper pruning is that which may not be coupled with a specific goal, may not employ techniques consistent with the identified goal, or may result in significant negative physiological and/or structural impacts on the plant.

Pruning standards: The most current revisions of the following standards, developed by a consensus of representatives from various industry professional organizations; American National Standards Institute, *Standard Practices for Tree, Shrub and other Woody Plant Maintenance (Pruning)*, American National Standards Institute (ANSI A300 Part 1) and International Society of Arboriculture, *Best Management Practices, Tree Pruning*, International Society of Arboriculture.

^S Cabling & Bracing: The installation of hardware in and/or about trees for the purpose of providing supplemental support of weak, defective or otherwise suspect limbs and/or stems; supporting of newly planted trees; bracing cracks; propping trees or limbs, or otherwise providing support. The installation of cables, bolts and other hardware in trees is intended to reduce the potential for failure (breakage/uprooting). Such bracing does not permanently remedy structural weaknesses, and is not a guarantee against failure. The trees and hardware must be inspected periodically for hardware deterioration, adequacy and changes in the tree's and site condition.

Cabling & Bracing Standards: The most current revisions of *Best Management Practices, Tree Support Systems, Cabling, Bracing, Guying and Propping*, International Society of Arboriculture ; *Tree Care Operations Trees, Shrubs and Other Woody Plant Maintenance-Standard Practices (Supplemental Support Systems)*, American National Standards Institute [ANSI A300 (Part 3)].

^T Vigor: (as applied in this report) A measure of physiological condition; the genetic capacity to resist strain (A. Shigo); active growth and physiological strength. Does not relate directly to tree structure or architecture.

^U Photosynthesis: The process performed in the foliage of green plants that converts light energy, in the presence of chlorophyll, into chemical energy and ultimately carbohydrates, consumed in all the plant's life processes. This process is formulated as follows: $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

^V Taper (of stems & limbs): The increase in diameter towards the base of stems (trunks) and limbs that is typical and desirable in woody plants. Degree of taper is influenced by a variety of factors including foliage, limb and branch distribution, species, location (sunlight), wind patterns, pruning, etc. Insufficient taper results in a concentration of stress from movement towards the base of the limb or stem, resulting in a greatly increased potential for breakage or uprooting. Pruning that removes interior lateral branches from limbs and/or lower limbs from trunks, dramatically reduces taper development.

^W Flush cuts: The extremely damaging practice of cutting branches/limbs as close as possible to the limb/stem of origin. This practice removes the branch-bark-ridge or collar, and injures the limb or trunk wood. It greatly reduces, if not eliminates the ability of the tree to compartmentalize the wound. The long-term effects are many, including creating an entry point for pathogens, greatly increased decay potential, and often resulting in adjacent limb or trunk failure.

