605 THIRD STREET
ENCINITAS, CALIFORNIA 92024
T 760.942.5147 F 760.632.0164

January 17, 2019 10407

John Ugrob, CPM
Operations Superintendent
City of Encinitas Public Works
160 Calle Magdalena
Encinitas, California

92024

Subject: Level 3 Assessment of Blue Gum Eucalyptus – 916 North Coast Highway 101, Encinitas, California 92024

Dear Mr. Ugrob:

On December 3, 2018, Dudek was contacted by the City of Encinitas (City) to assess a blue gum eucalyptus (*Eucalyptus globulus*) tree located within the North Coast Highway 101 median near the address of 916 North Coast Highway in Encinitas, California. Due to the observation of a large **sulfur conk**[1] at the base of the tree, the City had concerns about the structural integrity of the tree. As such, the City requested that an International Society of Arboriculture (ISA)-certified arborist and ISA-qualified tree risk assessor perform a **Level 3 advanced assessment** to collect information related to the structure of the tree and associated hazards to the surrounding community. To that end, a Dudek arborist performed a Level 3 advanced assessment of the subject blue gum tree on December 13, 2018, using **best management practices** for tree risk assessment. During the inspection, the Dudek arborist used a **PiCUS sonic tomograph** to assess potential trunk decay and/or internal degradation.

The evaluation focused on collecting information that could be used to determine the tree's current internal structural condition to help formulate recommendations for short- and long-term tree management. This letter report summarizes the results of Dudek's assessment and provides recommendations for tree management.

Overview

Dudek's assessment and evaluation consisted of the following:

1. Perform a Level 2 basic tree risk assessment of one blue gum eucalyptus tree located within the North Coast Highway 101 median near the address of 916 North Coast Highway.

[1] For definitions of all words in bold type herein, see the glossary in Attachment 1 to this report.

2. Evaluate the surrounding growing site factors to determine whether they are contributing to the potential structural decline of the tree.
3. Perform a Level 3 advanced assessment of the tree with the use of sonic tomography.
4. Develop a letter report summarizing the results of the assessment, and provide recommendations for tree management.

Evaluation Methods

Chris LaCroix, a Dudek ISA-certified arborist and qualified tree risk assessor, evaluated the blue gum eucalyptus tree located in the median near 916 North Coast Highway on December 13, 2018. The evaluation was a Level 3 advanced assessment with the use of a PiCUS sonic tomograph (sonic tomography) to assess potential trunk decay and/or internal wood degradation. Tree health and structure were evaluated using best management practices for **tree risk assessment**. The following section details the methods used during the evaluation.

Level 2 Basic Tree Risk Assessment

The Level 2 basic tree risk assessment is a 360° visual assessment that evaluates the tree's crown, trunk, and trunk flare; visible aboveground roots; and site conditions. The assessment involves inspection of the tree's crown, branches, trunk, and root collar for the presence of structural defects such as **included bark**, **cavities**, **fungal fruiting bodies**, and/or **decay**. The assessment also includes evaluation of the likelihood of an observed defect that could fail, the likelihood of the defect impacting a specific **target** should failure occur, and the subsequent damage that may occur should failure and impact occur. Through this evaluation, the level of risk for a tree and/or a specific tree part is determined through the use of ISA's tree risk matrix (Exhibit 1). The tree risk matrix consists of two matrices that are used to estimate the likelihood of a tree impacting a specific target (e.g., automobile, person, house) and to determine the level of risk as a combination of likelihood of tree or tree part failing and impacting a target, as well as the severity of the consequences from that failure. Through the use of the risk matrix, the qualified arborist is able to determine if the observed defect and/or tree has a low, moderate, high, or extreme risk of failure.

Matrix 1. Likelihood matrix.

Likelihood of Failure	Likelihood of Impact			
	Very low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

Matrix 2. Risk rating matrix.

Likelihood of Failure & Impact	Consequences of Failure			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Exhibit 1. Tree Risk Matrix

Level 3 Advanced Assessment

A Level 3 advanced assessment is performed in conjunction with or after a Level 2 basic tree risk assessment to provide detailed information about specific tree parts, defects, targets, or site conditions. Specialized equipment, data analysis, and expertise are usually required for advanced assessments. Due to the presence and location of an observed sulfur conk at the base of the tree and an increased likelihood of wood degradation occurring as indicated by the presence of the sulfur conk, a Level 3 advanced assessment of the tree's lower trunk was conducted with the use of sonic tomography. The tool provides a detailed analysis of the structural integrity of the tree/defect at the location evaluated. The advanced evaluation method is discussed in the following section.

Sonic Tomography

Sonic tomography detects decay, cavities, and **fractures** in trees by measuring the velocity of sound waves as they pass through wood. Differences in velocity help determine areas of healthy wood and areas of damaged wood, which has less elasticity and density than healthy wood. This reduction in elasticity results in the inability of sound waves to take a direct path through the wood, indicating the presence of damaged wood. The speed of sound in wood correlates with wood quality and is, therefore, a measure of the breaking safety of the trunk (acceptable level of trunk damage/hollowness) and **residual wall thickness** (remaining undamaged wood). Due to the location of an observed sulfur conk at the base of the tree and the associated potential for internal decay at that specific height above ground in the tree, the evaluation was performed at a height above ground level of 3 inches (the approximate height of the observed conk).

Based on previous eucalyptus evaluation studies conducted by Dudek arborists throughout Southern California and based on professional observations of eucalyptus tree failures throughout the region, blue gum trees have been observed to fail at higher frequencies near the base of the tree. This failure location appears to be linked to past agricultural practices and the subsequent development of an area. Area development has resulted in varying levels of root-related impacts, including those associated with grading; soil compaction; trenching for installation of sewer, electrical, and irrigation utilities; and sidewalk/street replacement and installation. The development and landscaping process has impacted roots by root removal, structural root damage and/or removal, and soil compaction. The root impacts have resulted in many of the trees being susceptible to secondary diseases, with fungal pathogens typically the most commonly occurring.

To evaluate the presence and level of decay, cavities, and/or fractures within trees, a series of evenly spaced **measuring points** (MPs) are installed. MPs consist of pins that are tapped into the tree with a hammer. The MPs are tapped into the tree until they make contact with the wood and are past the tree's bark layer. Contact with wood allows for accurate sound transmission. For this evaluation, 14 MPs were used. Upon completion of MP placement, the geometry of the tree was recorded using PiCUS calipers and a **triangulation method** (Exhibits 2 and 3). During the triangulation method, the MP positions are split into triangles, and the lengths of all sides are measured. The resulting measurements provide a detailed image of the tree's geometry, which is essential for calculating the sonic tomogram of the tree.

Exhibit 2. Calculating a Tree's Geometry

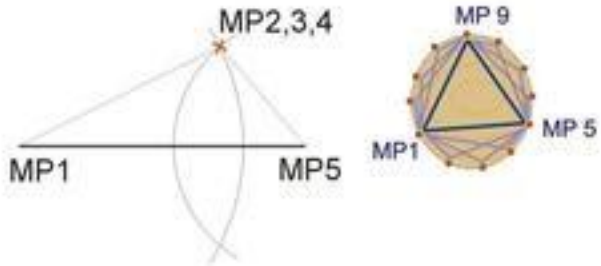

Exhibit 3. Triangulation Method

Once the tree's geometry has been calculated and recorded, sensors are attached to the MPs, and sonic measurements are taken. The sonic measurements are taken by tapping each MP with an electronic hammer that creates sonic waves (Exhibit 4).

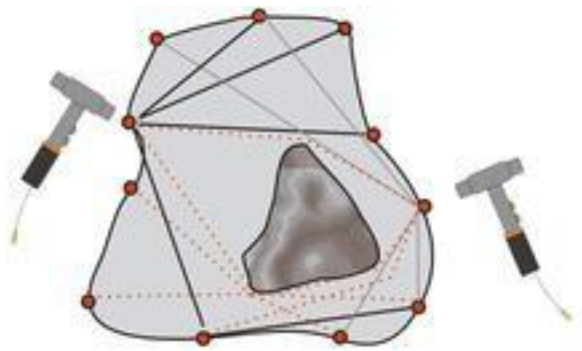

Exhibit 4. Graphic Representation of Sonic Measurement Method

These sonic waves reverberate through the tree and the velocity of each wave is recorded at each of the MPs. This process is repeated until all MPs have been tapped and the corresponding velocities are recorded. The sonic tomograph's main unit (a computer) records and calculates the sonic tomogram when all readings have been taken. The tomogram then shows the relative and apparent ability of the wood to transmit acoustic waves. This representation displays different colors that represent the various properties of the wood (Exhibit 5). The colors displayed and their corresponding properties are as follows:

- Dark browns – Areas of healthy wood, where the fastest velocities occur
- Green – Varies, but describes the distance between healthy and damaged wood, and can be indicative of early fungus infection
- Violets and blues – Damaged wood

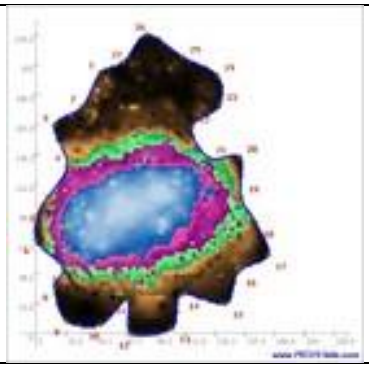

Exhibit 5. Graphic Representation of Sonic Tomogram Reading (not subject tree)

Following the sonic tomography sampling, all data was electronically transferred into the PiCUS 3 software program (custom software created for the analysis and presentation of sonic tomograph data) for detailed analysis. The software calculates 2D tomograms that show the ability of wood to transmit sonic waves,

which allows the user to measure residual wall thickness. During the analysis, the extent and level of decay within the tree was calculated, and the structural integrity of the tree was analyzed.

Observations/Analysis

Level 2 Basic Tree Risk Assessment

The following section describes the results of the Level 2 basic tree risk assessment.

Targets

During the Level 2 basic tree risk assessment, the Dudek arborist recorded targets located within **striking distance** of the tree and/or tree defects that could be injured, damaged, or disrupted by a tree failure. Targets observed at the time of the evaluation included train tracks, parked automobiles, pedestrians, bicyclists, restaurants, commercial buildings, and vehicular traffic. All of the observed targets were within 1.5 times the height of the tree. **Occupancy rates** ranged from **occasional** to **constant**. It would not be considered practical to move or restrict access for these targets.

Growing Environment

The tree is a large-sized blue gum eucalyptus located in a street median (approximately 10 feet wide) in Encinitas, California. Specifically, the tree is located near 916 North Coast Highway 101. Approximately 90% of the tree's root system is covered by poured asphalt and concrete. Asphalt (public roadway) is located on the eastern and western sides of the tree. The tree's is bound by a median planter with a concrete curb containing irrigated landscaping. The distance from the trunk of the tree to the adjacent hardscaping ranges from 36 to 72 inches.

The site was evaluated and includes factors such as compaction and potentially cut/damaged roots from road and driveway maintenance over the years. Wind exposure for the tree is considered to be fully exposed. In general, the prevailing wind direction is from the southwest to west, with common occurrences of high wind events from Santa Ana wind conditions. Attachment 2 provides a detailed photographs of the tree and its growing conditions.

Crown and Branches

The tree's reaches approximately 75 feet in height and extends approximately 40 feet across at its widest point. On average, the tree has a **live crown ratio** of approximately 95% (the ratio of the height of the live crown to the height of the entire tree) and is composed of larger- and smaller-diameter **scaffold branches** and occasional occurrences of **epicormic sprouts** from previous pruning activities. Observable pruning history consisted of crown cleaning and thinning. The scaffold branches vary with regard to their evaluated "weak" or "strong" attachments. Examples of weak attachment points include **co-dominant stems** and epicormic sprouts that have grown to large size and included bark from acute attachment angles. Conversely, stronger attachments consisted of accommodating attachment angles with no included bark and sound branch architecture.

Additional maladies observed within the tree's crown included small-diameter (less than 1 inch) dead branches in the upper crown. Overall, less than 5% of the tree's branches were observed to be dead. Based on the observed crown and branch conditions, the tree's crown is considered to be in good to fair condition. The main concerns observed in the tree's crown and branches are the small-diameter dead branches, epicormics sprouts, and weakly attached 8-inch branch located 15 feet up on the northeast side. The loads on the observed defects ranged from minor to significant. The likelihood of failure for the observed defects is considered to be **possible to probable**.

Note that the crown and branch evaluations were limited at times by visual obstructions. Aerial crown evaluations of the tree was beyond the scope of this work.

Trunk

The tree has a **diameter at standard height** of 60.8 inches. No signs of cracks and/or splits were observed on the trunk. The main concern observed on the tree's trunk was the occurrence of sulfur conks at the base. The load on the observed defect was significant, and the likelihood of failure is considered to be possible. Photographs of the observed sulfur conks can be seen in Attachment 2.

Roots and Root Collar

The tree's root collar was partially buried, and no evidence of stem girdling was observed. No evidence of root pruning was observed. However, due to the proximity of the asphalt and concrete curb, there is a high likelihood that root damage previously occurred. The main concern observed during the root and root collar inspection was the previously noted presence of sulfur conks on the trunk and the potential for root damage and decay. The load on the observed defects are considered to be significant, and the likelihood of failure is considered to be possible. However, due to the presence of the observed sulfur conks and potential for root damage, the initial assessment of the root and root collar is considered preliminary. Further details discussing the advanced assessment of the observed defects are found in the following section.

Level 3 Advanced Assessment

The following section describes the findings of the Level 3 advanced assessment.

Sonic Tomography

Due to the presence of sulfur conks at the base of the tree and a high likelihood of internal decay, the Dudek arborist performed an internal decay/damaged wood analysis of the tree on December 13, 2018. As seen in Exhibit 6, the sonic tomography analysis found approximately 58% damaged/degraded wood (purple), 10% incipient decay, and 32% solid wood. Exhibit 6 further illustrates the location of damaged wood with incipient decay. Based on the results of sonic tomography evaluation, the internal structure of the tree at the cross-sectional area of evaluation is considered in poor health and exhibiting signs of advanced decay.

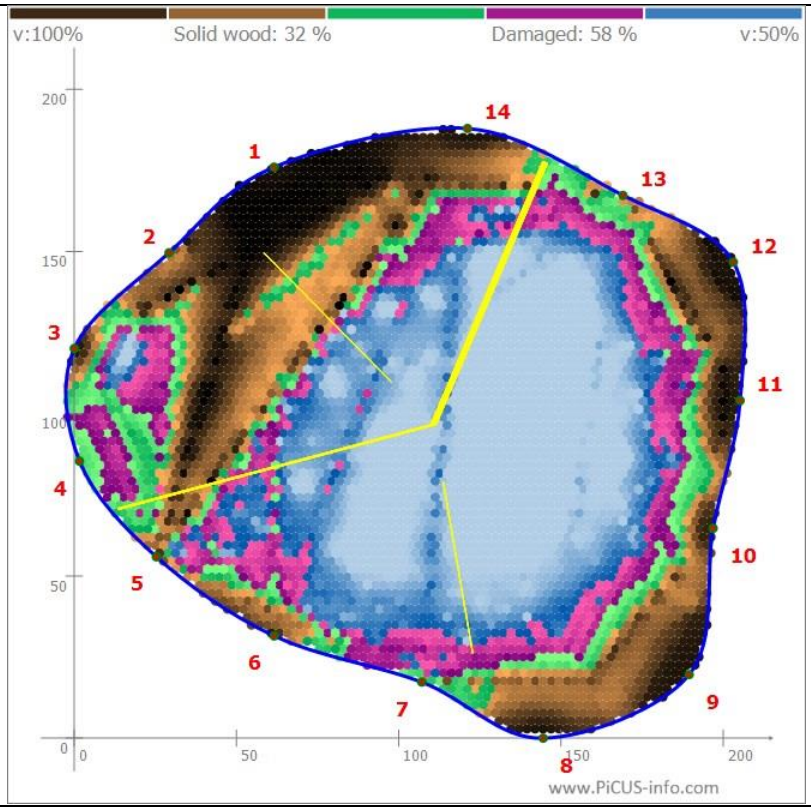

Exhibit 6. Sonic Tomograph

Risk Categorization

After performing the Level 2 basic assessment, the defect of greatest concern was found to be the presence of sulfur conks, and high levels of decay/rot were observed within the trunk. Upon completion of the Level 3 advanced assessment, the likelihood of failure for the defect was assessed to evaluate the tree's probable likelihood of failure. This potential failure would be most likely to occur during common weather conditions, which may include seasonal rains and high wind events such as Santa Ana winds. The main targets, should failure and impact occur, were found to be parked automobiles, pedestrians, bicyclists, and

vehicular traffic located at North Coast Highway 101. The likelihood of impacting vehicular traffic located at North Coast Highway 101 was assessed as high due to the frequency of occupancy. Due to the potential fall distance and mass of the tree, the consequences of this probable failure would be severe. As such, based on the ISA Tree Risk Matrix seen in Exhibit 8, the tree is currently presenting an overall high risk.

Matrix 1. Likelihood matrix.

Likelihood of Failure	Likelihood of Impact			
	Very low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

Matrix 2. Risk rating matrix.

Likelihood of Failure & Impact	Consequences of Failure			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Exhibit 8. Risk Assessment Matrix

Discussion

Based on the observations and findings of the Level 2 and Level 3 assessments, which use industry-standard protocols for evaluating tree condition, it is the Dudek arborist's opinion that the tree does not exhibit indicators of imminent failure. However, it was found that the risk associated with trunk, root, and root collar failure was high. With a high rating, the likelihood of failure at some point is considered to be likely. The location and extent of the detected internal degradation and/or decay significantly reduces the mitigation options available to reduce the risk associated with the tree. Based on this, Dudek recommends that the tree be removed and replaced with a species that is appropriate for the location. The residual risk associated with the tree following its removal is considered to be no risk.

Concluding Notes

This letter report provides conclusions and recommendations based on the Level 2 and Level 3 assessments of the blue gum eucalyptus tree located on a median near the address of 916 North Coast Highway by an ISA-certified and qualified tree risk assessor arborist. The conclusions and findings discussed in this report and the associated tree or tree-part risk opinions are valid for no longer than 12 months and only under normal weather conditions. Arborists are tree specialists who use their education, knowledge, training, and experience to examine trees, recommend measures to enhance the beauty and health of trees, and attempt to reduce the risk of living near trees. Extensive internal, aerial, and subterranean evaluations were not conducted as part of this assessment. Therefore, the full extent of any internal rot conditions of the trunk and roots cannot be fully determined.

Arborists cannot detect every condition that could possibly lead to the failure of a tree. Trees are living organisms that fail in ways not fully understood. 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. There are no guarantees that a tree's condition will not change over a short or long period due to climatic, cultural, or environmental conditions. Trees provide many benefits to those who live near them. They also include inherent risk that can be minimized but not eliminated.

I would be pleased to answer any questions or respond to any comments regarding this tree evaluation. Feel free to contact me at 949.482.5115 or ckallstrand@dudek.com.

Sincerely,

Christopher J. Kallstrand
Certified Arborist No. WE-8208A

Attachment 1: Glossary
Attachment 2: Photograph Log

Attachment 1

Glossary

Glossary Terms

Occasional Occupancy	The target zone is occupied by targets infrequently or irregulary.
Occupancy Rates	An estimated amount of time the target is within the target zone.
Picus Sonic Tomograph	The PiCUS Sonic Tomograph is used for tree risk assessments in order to measure the thickness of the residual wall of trees with internal defects such as cavities or decay non-invasively.
Possibe	Failure may be expected in extreme weather conditions, but is unlikley under normal weather conditions within the specified time frame.
Probable	Failure may be expected under normal weather conditions within the specified time frame.
Residual Wall Thickness	Amount of un-damaged wood remaining in a tree that is structurally supportive.
Scaffold Branches	Primary limbs that form a tree's canopy.
Striking Distance	The distance from which something may be hit should failure occur.
Sulfur Conk	Laetiporus sulphureus is a species of bracket fungus found in Europe and North America
Target	People, property, or activities that could be injured, damaged, or disrupted by a tree
Tree Risk Assessment	The overall process of tree risk analysis and risk evaluation.
Triangulation Method	During the triangulation method, the MP positions are split into triangles, and the lengths of all sides are measured to accurately measure tree dimensions.

Attachment 2

Photograph Log

Attachment 2

Photograph Log

Photograph 1 – Overview of large blue gum eucalyptus facing north.

Photograph 2 – View of growing conditions facing southwest. Nearby potential targets in the background.

Photograph 3 – Close-up view of sulfur conks on the trunk.

Photograph 4 – Overview of east side of trunk with sulfur conks.

Photograph 5 – View of lower and root crown evaluation area. Tags indicate measuring points where the tree was trunkevaluated.

Photograph 6 – Close-up view of east side of trunk with sulfur conks.