



## **Memorandum**

Date: September 18, 2015

To: Ms. Mikaela Klein, Mt. San Antonio College

From: Fred Greve, Greve & Associates, LLC

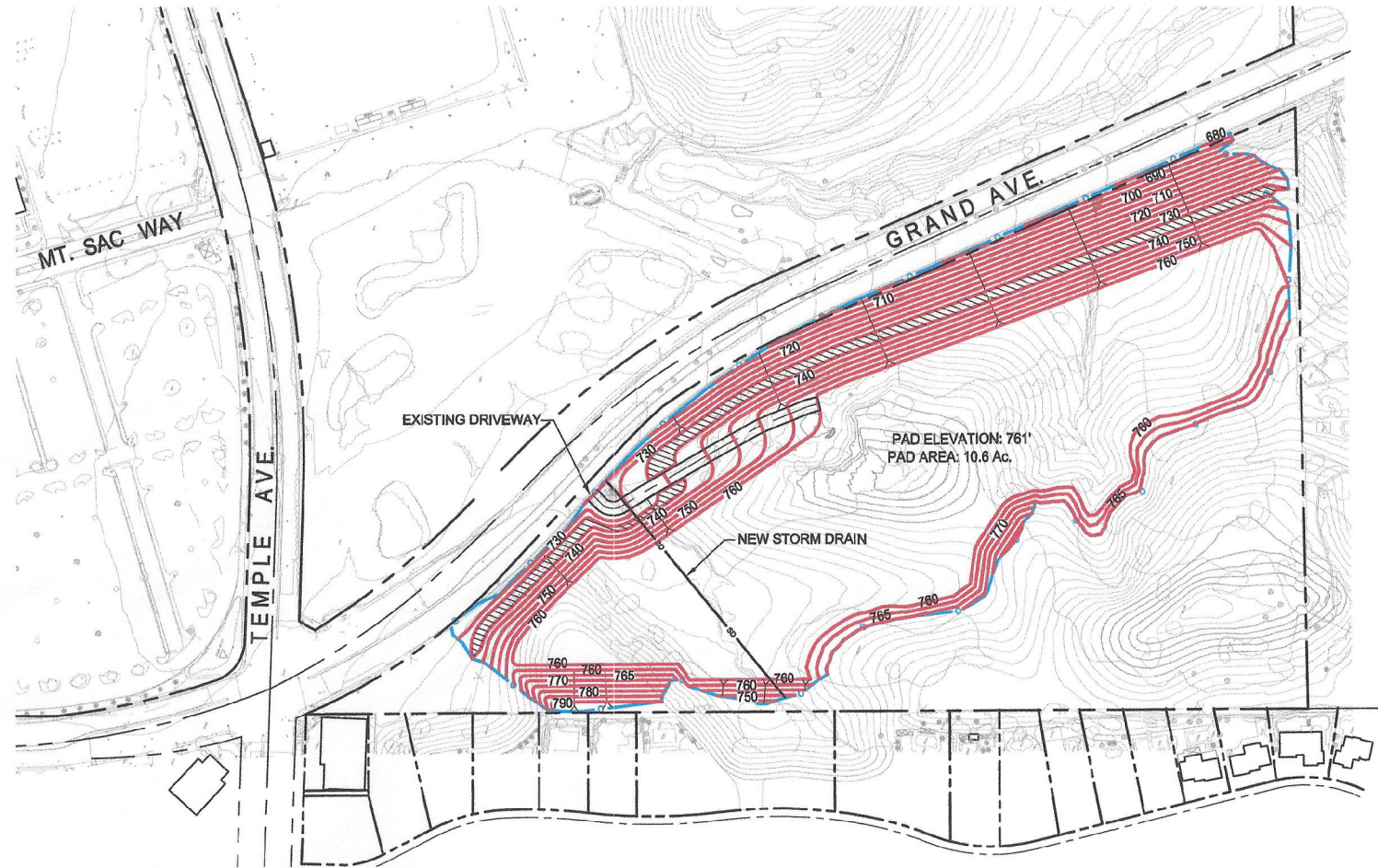
Subject: West Parcel Solar Project - Vibration Analysis (Report #15-107A)

The analysis presented below examines the potential vibration impacts of the construction of the West Parcel Solar (WPS) project. The project will construct solar panels with a capacity of approximately 2.0 MW. The entire site is approximately 27.7 acres, and approximately 17.7 acres of the site will be graded. Substantial grading and import of dirt will be required for the project. The current grading estimates are 172,708 cubic yards of cut, 336,279 cubic yards of fill with a net import of 163,571 cubic yards. The import fill will come from the Athletic Complex East (ACE) area. The WPS site is a triangular parcel southwest of North Grand Avenue, east of homes along Regal Canyon Drive, and north of homes along Stonybrook Drive (refer to Exhibit 1). The main pad for the solar pads will be lower in elevation than the nearby homes, but some grading close to homes along Regal Canyon Drive will be necessary to construct slopes.

### **VIBRATION CRITERIA**

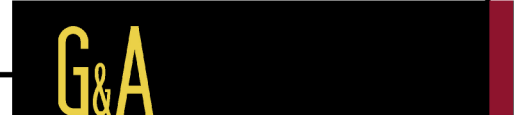
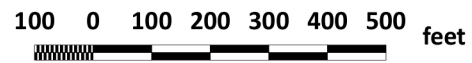
In describing vibration in the ground and in structures, the motion of a particle (i.e., a point in or on the ground or structure) is used. The concepts of particle displacement, velocity, and acceleration are used to describe how the ground or structure responds to excitation. Although displacement is generally easier to understand than velocity or acceleration, it is rarely used to describe ground and structure borne vibration because most transducers used to measure vibration directly measure velocity or acceleration, not displacement. Accordingly, vibratory motion is commonly described by identifying the peak particle velocity (PPV). PPV is generally accepted as the most appropriate descriptor for evaluating the potential for building damage. The usual units of PPV are inches per second (in/sec).

# Exhibit 1 - Site Plan



## LEGEND

-  NEW CONTOUR LINE
-  DAYLIGHT LINE
-  EXISTING BUILDING
-  NEW STORM DRAIN



The California Department of Transportation (Caltrans) has published the "Transportation and Construction-Induced Vibration Guidance Manual" (June 2004). This document has become the standard by which construction projects are evaluated for their vibration potential in California.

The most critical concern is whether the use of heavy equipment will cause damage to surrounding buildings. The Caltrans manual identifies threshold criteria for vibration damage potential for various building types. Six categories are identified ranging from extremely fragile historic buildings to modern industrial buildings. The buildings surrounding the project site fall into one of two categories; new residential structures or modern commercial buildings. Both of these categories have a PPV threshold of 0.5 in/sec. Any vibration above this threshold would be considered as a significant impact.

The Caltrans manual also discusses the potential for feeling the vibration generated by the pile driving. Since the ability to feel the vibration is a short-term impact, this is considered to be more of an annoyance issue rather than an impact. The manual provides four categories for annoyance potential criteria. The criteria are presented in Table 1 .

**Table 1 Vibration Annoyance Potential Criteria**

<b>Human Response</b>	<b>Maximum PPV (in/sec)</b>
Barely Perceptible	0.01
Distinctly Perceptible	0.04
Strongly Perceptible	0.10
Severe	0.40

## **PROJECT INFORMATION/METHODOLOGY**

The likely equipment to be used for the grading of the site includes scrapers, dozers, loaders and trucks. Outside of grading activities, very little heavy equipment will be used and vibration will not be a concern.

The Caltrans manual (referenced previously) provides a methodology for estimating the PPV value at a nearby receptor. The methodology uses (1) the distance from the equipment to the receptor, (2) the PPV of the equipment at 25 feet, and (3) an "n" value for the intervening ground. The distance to the receptors were measured off of the site plan and Google Earth. PPV values for a few pieces of equipment are provided in the Caltrans manual. Values for a large dozer, loaded truck, and a small dozer are provided in the manual, and probably cover

the range of heavy equipment that might be used during the grading phase. For these equipment Caltrans recommends an n value of 1.1. Caltrans points out that vibration from this equipment originates near the ground surface, and therefore modifying the n value may not be applicable. Caltrans also points out that an n value of 1.1 is very conservative (worst-case), and that other agencies such as the Federal Transit Administration (FTA) use a less conservative value of 1.5. The Caltrans equations were then used to project the vibration level at four distances. Specifically, the distances from equipment to homes modeled were 50, 200, and 500 feet. The 50 foot distance represents equipment operating very close to the homes which would happen on a very limited basis. Equipment may operate for extended periods of time at around 200 feet from residences. A 500 foot distance represents roughly the distance from the center of the solar panel site to the residences along Regal Canyon Drive.

## RESULTS AND DISCUSSION

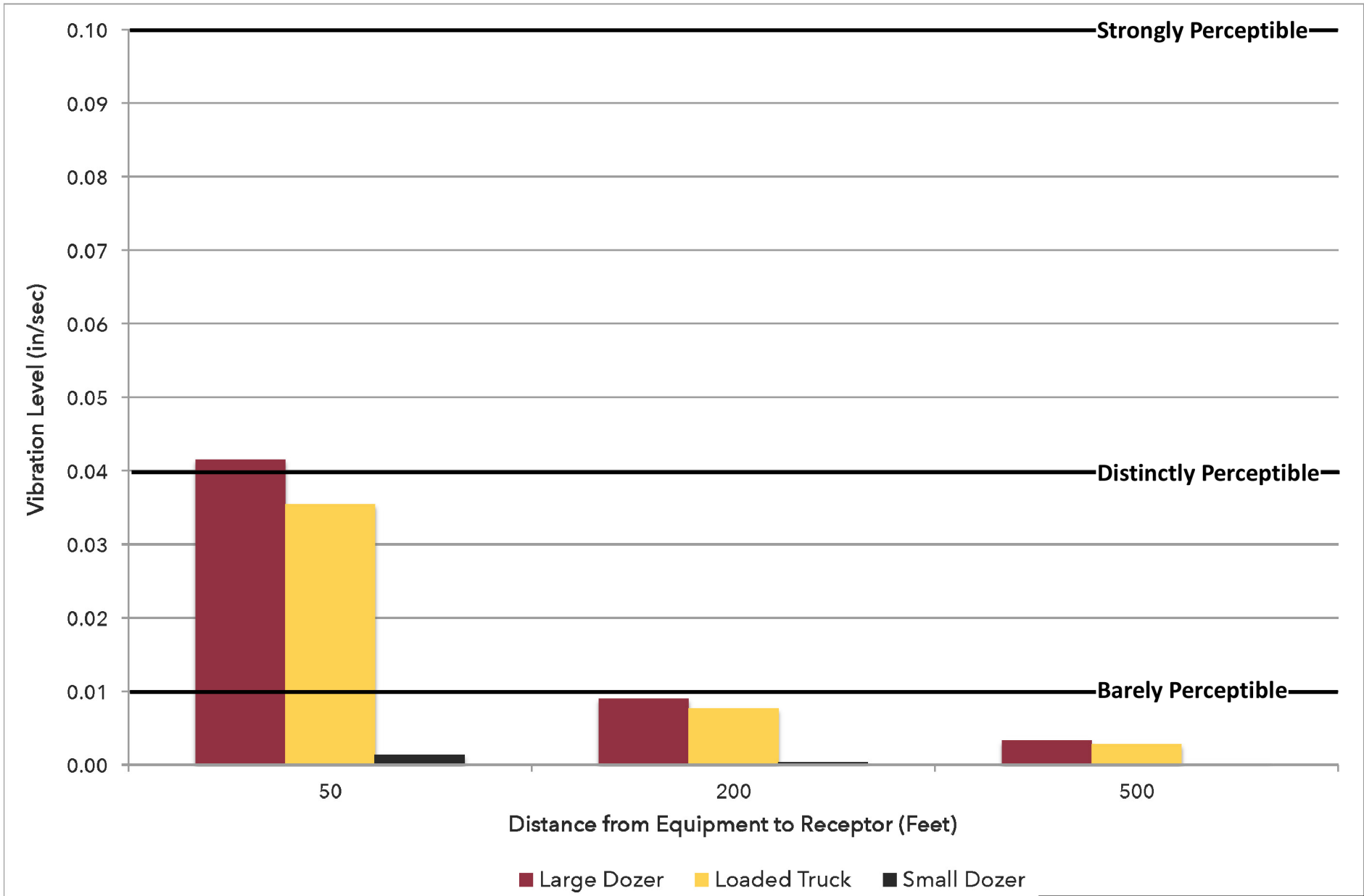
The PPV was calculated for three types of heavy equipment at three distances. The results are presented in Table 2 and in Exhibit 2. The PPV values range from 0.0001 to 0.04 inches per second.

**Table 2 Vibration Potential at Key Sites**

Equipment	Distance from Equipment to Receptor (Feet)		
	50	200	500
Large Dozer	0.04	0.01	0.003
Loaded Truck	0.04	0.01	0.003
Small Dozer	0.001	0.0003	0.0001

The vibration potential levels can be compared to the threshold for structural damage. The structural damage threshold is 0.50 in/sec. The highest forecast vibration level is 0.04 in/sec, and might occur when a large piece of heavy equipment must come near a residence. This level is well below the 0.50 in/sec threshold, and therefore, no structural damage is anticipated and no significant impacts will occur.

# Exhibit 2 - Vibration Levels



The ability to detect vibration is also considered because of its potential for annoyance. On those occasions where a large piece of heavy equipment must operate near a home, the vibration is projected to reach 0.04 inches per second, which would be "distinctly perceptible." Smaller pieces of equipment, such as a small dozer, could operate within a 50 of a residence and it would have a vibration level of 0.001 inch per second and not be perceptible. The larger heavy equipment operating at 200 feet would be barely perceptible, and smaller equipment would not be perceptible at all. All equipment operating at 500 feet or more would not be perceptible. Since the pile driving activities are short term in nature, annoyance due to the ability to detect vibration is usually not used as the determinant for impacts. Few options are available for reducing vibration levels if it is desired.

### **MITIGATION MEASURES**

No significant impacts are projected, and therefore, no mitigation measures are proposed.

## **Appendix**

### **Vibration Calculation Sheet**

### ***Vibration Calculations for West Parcel Solar***

<b>Equipment</b>	<b>Distance from Equipment to Receptor (Feet)</b>		
	<b>50</b>	<b>200</b>	<b>500</b>
Large Dozer	0.04	0.01	0.003
Loaded Truck	0.04	0.01	0.003
Small Dozer	0.001	0.0003	0.0001

### ***General Data***

"n" value		1.1	
Large Dozer	Reference PPV	0.089	in/sec @ 25 feet
Loaded Truck	Reference PPV	0.076	in/sec @ 25 feet
Small Dozer	Reference PPV	0.003	in/sec @ 25 feet