Appendix H:
Noise and Vibration Impact Analysis

NOISE AND VIBRATION IMPACT ANALYSIS

HAWTHORNE RESIDENTIAL DEVELOPMENT PROJECT
9170 INDIANA AVENUE, RIVERSIDE, CALIFORNIA

LSA

August 2017

NOISE AND VIBRATION IMPACT ANALYSIS

HAWTHORNE RESIDENTIAL DEVELOPMENT PROJECT

9170 INDIANA AVENUE, RIVERSIDE, CALIFORNIA

Submitted to:

Steven Walker Communities, Inc.
7111 Indiana Avenue, Suite 300
Riverside, CA 92504

Prepared by:

LSA
20 Executive Park, Suite 200
Irvine, CA 92614
(949) 553-0666

Project No. SWK1502

LSA

August 2017

TABLE OF CONTENTS

APPENDICES

FIGURES AND TABLES

FIGURES

TABLES

HAWTHORNE RESIDENTIAL DEVELOPMENT PROJECT

INTRODUCTION

This noise impact analysis has been prepared to evaluate the potential noise impacts and mitigation measures associated with the proposed residential development project (project) located at 9170 Indiana Avenue in the City of Riverside (City), Riverside County (County), California. This report is intended to satisfy the City's requirement for a project-specific noise and vibration impact analysis by examining the impacts of the proposed uses on adjacent noise-sensitive uses as well as the noise impacts on the proposed uses on the project site, and evaluating the mitigation measures required as part of the project design.

Project Location

The project site is a former elementary school located south of Indiana Avenue and north of existing railroad tracks, between Gibson Street and Jackson Street in the City of Riverside, Riverside County. Figure 1 shows the project location map.

Land Uses in the Project Vicinity

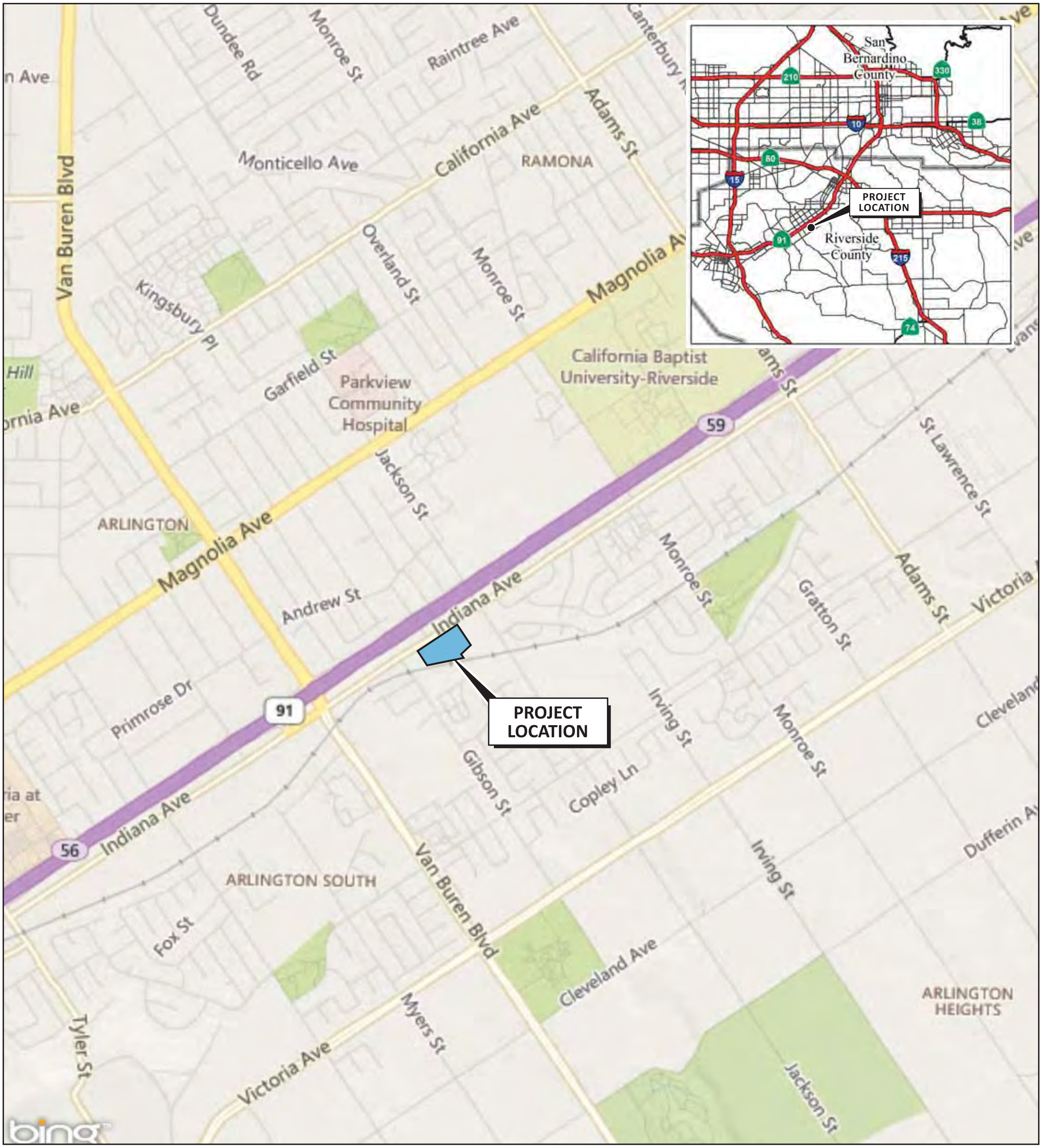
The project site is surrounded primarily by residential development, with the nearest residential use east of the project site having a garage located approximately 7.5 feet (ft) from the property line and the residence located approximately 25 ft from the property line. The areas adjacent to the project site include the following uses:

- **North:** Residential uses on the north side of Indiana Avenue
- **East:** Vacant land and single-family residential development
- **South:** Burlington Northern Santa Fe (BNSF) Railway right-of-way with substation, vacant land, and single-family residential development farther south
- **West:** Vacant land and single-family residential development farther west

Project Description

The project consists of the construction of 54 single-family dwelling units on approximately 6.85 acres (ac). The proposed single-family lot sizes range from 2,853 square feet (sf) to 5,434 sf. Three floor plans are proposed that range in size from 1,835 to 2,107 sf. Figure 2 illustrates the site plan.

The proposed uses are not consistent with the current Zoning and General Plan designation. Thus, a Rezone (P16-0113) and General Plan Amendment (P16-0112) are being processed along with the Planned Residential Development (P16-0111), Tentative Tract Map (P16-0114), and Variance (P16-0883) applications.



LSA

FIGURE 1

0 1000 2000
FEET

SOURCE: Bing Maps

Hawthorne Residential Development Project

Project Location Map

I:\SWK1502\G\Location.cdr (8/8/2017)

FIGURE 2

0 70 140
FEET

SOURCE: SDH and Associates, Inc. February, 2016.

Hawthorne Residential Development Project

Site Plan

I:\SWK1502\G\Site Plan.cdr (8/8/2017)

METHODOLOGY

The evaluation of noise and vibration impacts associated with the proposed project included the following:

- Conducted short-term ambient noise measurements at representative noise-sensitive locations.
- Determined the short-term construction noise and vibration impacts on off-site noise-sensitive uses.
- Determined the long-term traffic and train noise impacts on on-site noise-sensitive uses.
- Determined the long-term traffic and train vibration impacts on on-site noise-sensitive uses.
- Determined the long-term stationary source noise impacts on off-site noise-sensitive uses.
- Determined the required mitigation measures to reduce long-term on-site and off-site noise and vibration impacts.

CHARACTERISTICS OF SOUND

Sound is increasing to such disagreeable levels in the environment that it can threaten quality of life. Noise is usually defined as unwanted sound. Noise consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, and sleep.

To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect the ability to hear. Pitch is the number of complete vibrations, or cycles per second, of a wave resulting in the tone's range from high to low. Loudness is the strength of a sound that describes a noisy or quiet environment and is measured by the amplitude of the sound wave. Loudness is determined by the intensity of the sound waves combined with the reception characteristics of the human ear. Sound intensity refers to how hard the sound wave strikes an object, which in turn produces the sound's effect. This characteristic of sound can be precisely measured with instruments. The analysis of a project defines the noise environment of the project area in terms of sound intensity and its effect on adjacent sensitive land uses.

Measurement of Sound

Sound intensity is measured through the A-weighted scale to correct for the relative frequency response of the human ear. That is, an A-weighted noise level de-emphasizes low and very high frequencies of sound similar to the human ear's de-emphasis of these frequencies. Unlike linear units (e.g., inches or pounds) decibels are measured on a logarithmic scale representing points on a sharply rising curve.

For example, 10 decibels (dB) is 10 times more intense than 1 dB, 20 dB is 100 times more intense than 1 dB, and 30 dB is 1,000 times more intense than 1 dB. Thirty decibels (30 dB) represents 1,000 times as much acoustic energy as 1 dB. The decibel scale increases as the square of the change, representing the sound pressure energy. A sound as soft as human breathing is about 10 times greater than 0 dB. The decibel system of measuring sound gives a rough connection between the physical intensity of sound and its perceived loudness to the human ear. A 10 dB increase in sound level is perceived by the human ear as only a doubling of the loudness of the sound. Ambient sounds generally range from 30 dB (very quiet) to 100 dB (very loud).

Sound levels are generated from a source, and their decibel level decreases as the distance from that source increases. Sound dissipates exponentially with distance from the noise source. For a single-point source, sound levels decrease approximately 6 dB for each doubling of distance from the source. This drop-off rate is appropriate for noise generated by stationary equipment. If noise is produced by a line source (e.g., highway traffic or railroad operations), the sound decreases 3 dB for each doubling of distance in a hard site environment. Line source (noise in a relatively flat environment with absorptive vegetation) decreases 4.5 dB for each doubling of distance.

There are many ways to rate noise for various time periods, but an appropriate rating of ambient noise affecting humans also accounts for the annoying effects of sound. The equivalent continuous sound level (L_{eq}) is the total sound energy of time-varying noise over a sample period. However, the predominant rating scales for human communities in the State of California are the L_{eq} and Community Noise Equivalent Level (CNEL) or the day-night average noise level (L_{dn}) based on A-weighted decibels (dBA). CNEL is the time-varying noise over a 24-hour period, with a 5 dBA weighting factor applied to the hourly L_{eq} for noises occurring from 7:00 p.m. to 10:00 p.m. (defined as relaxation hours), and a 10 dBA weighting factor applied to noises occurring from 10:00 p.m. to 7:00 a.m. (defined as sleeping hours). L_{dn} is similar to the CNEL scale but without the adjustment for events occurring during the evening hours. CNEL and L_{dn} are within 1 dBA of each other and are normally interchangeable. The City uses the CNEL noise scale for long-term noise impact assessment.

Other noise rating scales of importance when assessing the annoyance factor include the maximum instantaneous noise level (L_{max}), which is the highest exponential time-averaged sound level that occurs during a stated time period. The noise environments discussed in this analysis for short-term noise impacts are specified in terms of maximum levels denoted by L_{max}, which reflects peak operating conditions and addresses the annoying aspects of intermittent noise. It is often used together with another noise scale, or noise standards in terms of percentile noise levels, in noise ordinances for enforcement purposes. For example, the L_{10} noise level represents the noise level exceeded 10 percent of the time during a stated period. The L_{50} noise level represents the median noise level. Half the time the noise level exceeds this level, and half the time it is less than this level. The L_{90} noise level represents the noise level exceeded 90 percent of the time and is considered the background noise level during a monitoring period. For a relatively constant noise source, the L_{eq} and L_{50} are approximately the same.

Noise impacts can be described in three categories. The first category includes audible impacts that refer to increases in noise levels noticeable to humans. Audible increases in noise levels generally refer to a change of 3 dB or greater because this level has been found to be barely perceptible in exterior environments. The second category, potentially audible, refers to a change in the noise level between 1 dB and 3 dB. This range of noise levels has been found to be noticeable only in laboratory environments. The last category includes changes in noise levels of less than 1 dB, which are inaudible to the human ear. Only audible changes in existing ambient or background noise levels are considered potentially significant.

Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to noise levels higher than 85 dBA. Exposure to high noise levels affects the entire system, with prolonged noise exposure in excess of

75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. In comparison, extended periods of noise exposure above 90 dBA would result in permanent cell damage. When the noise level reaches 120 dBA, a tickling sensation occurs in the human ear, even with short-term exposure. This level of noise is called the threshold of feeling. As the sound reaches 140 dBA, the tickling sensation is replaced by the feeling of pain in the ear (the threshold of pain). A sound level of 160–165 dBA will result in dizziness or loss of equilibrium. The ambient or background noise problem is widespread and generally more concentrated in urban areas than in outlying, less developed areas. Table A lists definitions of acoustical terms, and Table B shows common sound levels and their sources.

FUNDAMENTALS OF VIBRATION

Vibration refers to ground-borne noise and perceptible motion. Ground-borne vibration is almost exclusively a concern inside buildings and is rarely perceived as a problem outdoors, where the motion may be discernible but without the effects associated with the shaking of a building, there is less adverse reaction. Vibration energy propagates from a source through intervening soil and rock layers to the foundations of nearby buildings. The vibration then propagates from the foundation throughout the remainder of the structure. Building vibration may be perceived by occupants as the motion of building surfaces, the rattling of items on shelves or hanging on walls, or a low-frequency rumbling noise. The rumbling noise is caused by the vibration of walls, floors, and ceilings that radiate sound waves. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by 10 vibration velocity decibels (VdB). This is an order of magnitude below the damage threshold for normal buildings.

Typical sources of ground-borne vibration are construction activities (e.g., blasting, pile driving, and operating heavy-duty earthmoving equipment), steel-wheeled trains, and occasional traffic on rough roads. Problems with both ground-borne vibration and noise from these sources are usually localized to areas within approximately 100 ft of the vibration source, although there are examples of ground-borne vibration causing interference out to distances greater than 200 ft (FTA 2006). When roadways are smooth, vibration from traffic, even heavy trucks, is rarely perceptible. It is assumed for most projects that the roadway surface will be smooth enough that ground-borne vibration from street traffic will not exceed the impact criteria; however, both construction of a project and freight train operations on railroad tracks could result in ground-borne vibration that may be perceptible and annoying.

Ground-borne noise is not likely to be a problem because noise arriving via the normal airborne path will usually be greater than ground-borne noise. Ground-borne vibration has the potential to disturb people and damage buildings. Although it is very rare for train-induced ground-borne vibration to cause even cosmetic building damage, it is not uncommon for heavy-duty construction processes (e.g., blasting and pile driving) to cause vibration of sufficient amplitudes to damage nearby buildings (FTA 2006). Ground-borne vibration is usually measured in terms of vibration velocity, either the root-mean-square (RMS) velocity or peak particle velocity (PPV). The RMS is best for characterizing human response to building vibration, and PPV is used to characterize potential for damage. Decibel notation acts to compress the range of numbers required to describe vibration. Vibration velocity level in decibels is defined as:

$$L_v = 20 \log_{10} [V/V_{ref}]$$

Table A: Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A unit of level that denotes the ratio between two quantities proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in one second (i.e., number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of A-weighting. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless reported otherwise.
L_{01}, L_{10}, L_{50}, L_{90}	The fast A-weighted noise levels equaled or exceeded by a fluctuating sound level for 1 percent, 10 percent, 50 percent, and 90 percent of a stated time period.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 dB to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 dB to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dB to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast time averaging.
Ambient Noise Level	The all-encompassing noise associated with a given environment at a specified time, usually a composite of sound from many sources at many directions, near and far; no particular sound is dominant.
Intrusive	The noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: *Handbook of Acoustical Measurements and Noise Control* (Harris 1991).

Table B: Common Sound Levels and Their Noise Sources

Noise Source	A-Weighted Sound Level (dB)	Noise Environment	Subjective Evaluation
Near Jet Engine	140	Deafening	128 times as loud
Civil Defense Siren	130	Threshold of Pain	64 times as loud
Hard Rock Band	120	Threshold of Feeling	32 times as loud
Accelerating Motorcycle a few ft away	110	Very Loud	16 times as loud
Pile Driver; Noisy Urban Street/Heavy City Traffic	100	Very Loud	8 times as loud
Ambulance Siren; Food Blender	95	Very Loud	
Garbage Disposal	90	Very Loud	4 times as loud
Freight Cars; Living Room Music	85	Loud	
Pneumatic Drill; Vacuum Cleaner	80	Loud	2 times as loud
Busy Restaurant	75	Moderately Loud	
Near Freeway Auto Traffic	70	Moderately Loud	Reference Level
Average Office	60	Quiet	1/2 as loud
Suburban Street	55	Quiet	
Light Traffic; Soft Radio Music in Apartment	50	Quiet	1/4 as loud
Large Transformer	45	Quiet	
Average Residence Without Stereo Playing	40	Faint	1/8 as loud
Soft Whisper	30	Faint	
Rustling Leaves	20	Very Faint	
Human Breathing	10	Very Faint	Threshold of Hearing

Source: Compiled by LSA (2004).
dB = decibels

where L_v is the VdB, "V" is the RMS velocity amplitude, and "V_{ref}" is the reference velocity amplitude, or 1 x 10^{-6} inches/second (in/sec) used in the United States. Table C illustrates human response to various vibration levels, as described in the *Transit Noise and Vibration Impact Assessment* (FTA 2006).

Table C: Human Response to Different Levels of Ground-Borne Noise and Vibration

Vibration Velocity Level	Noise Level		Human Response
	Low-Frequency[1]	Mid-Frequency[2]	
65 VdB	25 dBA	40 dBA	Approximate threshold of perception for many humans. Low-frequency sound usually inaudible; mid-frequency sound excessive for quiet sleeping areas.
75 VdB	35 dBA	50 dBA	Approximate dividing line between barely perceptible and distinctly perceptible. Many people find transit vibration at this level annoying. Low-frequency noise acceptable for sleeping areas, mid-frequency noise annoying in most quiet occupied areas.
85 VdB	45 dBA	60 dBA	Vibration acceptable only if there are an infrequent number of events per day. Low-frequency noise annoying for sleeping areas, mid-frequency noise annoying even for infrequent events with institutional land uses such as schools and churches.

Source: *FTA Transit Noise and Vibration Impact Assessment* (FTA 2006).
[1] Approximate noise level when vibration spectrum peak is near 30 Hz.
[2] Approximate noise level when vibration spectrum peak is near 60 Hz.
dBA = A-weighted decibels   Hz = Hertz
FTA = Federal Transit Administration   VdB = vibration velocity decibels

Factors that influence ground-borne vibration and noise include the following:

- **Vibration Source:** Vehicle suspension, wheel types and condition, railroad track/roadway surface, railroad track support system, speed, transit structure, and depth of vibration source
- **Vibration Path:** Soil type, rock layers, soil layering, depth to water table, and frost depth
- **Vibration Receiver:** Foundation type, building construction, and acoustical absorption

Among the factors listed above, there are significant differences in the vibration characteristics when the source is underground compared to at the ground surface. In addition, soil conditions are known to have a strong influence on the levels of ground-borne vibration. Among the most important factors are the stiffness and internal damping of the soil and the depth to bedrock.

Experience with ground-borne vibration indicates: (1) vibration propagation is more efficient in stiff, clay soils than in loose, sandy soils; and (2) shallow rock seems to concentrate the vibration energy close to the surface and can result in ground-borne vibration problems at large distances from a railroad track. Factors including layering of the soil and the depth to the water table can have significant effects on the propagation of ground-borne vibration. Soft, loose, sandy soils tend to attenuate more vibration energy than hard, rocky materials. Vibration propagation through groundwater is more efficient than through sandy soils.

Regulatory Setting

To limit population exposure to physically and/or psychologically damaging as well as intrusive noise levels, the federal government, the state of California, various county governments, and most municipalities in the State have established standards and ordinances to control noise. In most areas, automobile and truck traffic is the major source of environmental noise. Traffic activity generally produces an average sound level that remains fairly constant with time. Air and rail traffic, and commercial and industrial activities are also major sources of noise in some areas. Federal, state, and local agencies regulate different aspects of environmental noise. Federal and state agencies generally set noise standards for mobile sources such as aircraft and motor vehicles, while regulations of stationary sources is left to local agencies.

Federal Regulations

Federal Transit Administration. Vibration standards included in the Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Assessment* (FTA 2006) are used in this analysis for ground-borne vibration impacts on human annoyance, as shown in Table D. The criteria presented in Table D account for variation in project types as well as the frequency of events, which differ widely among projects. It is intuitive that when there will be fewer events per day, it should take higher vibration levels to evoke the same community response. This is accounted for in the criteria by distinguishing between projects with frequent and infrequent events, in which the term "occasional events" is defined as between 30 and 70 events per day.

Table D: Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for General Assessment

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 µin/sec)			Ground-Borne Noise Impact Levels (dB re 20 µPa)		
	Frequent[1] Events	Occasional[2] Events	Infrequent[3] Events	Frequent[1] Events	Occasional[2] Events	Infrequent[3] Events
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB[4]	65 VdB[4]	65 VdB[4]	N/A[5]	N/A[5]	N/A[5]
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Source: Table 8-1. FTA *Transit Noise and Vibration Impact Assessment* (FTA 2006).

1 "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.

2 "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.

3 "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.

4 This criterion limit is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

5 Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

µin/sec = microinches per second
dB = decibels
HVAC = heating, ventilation, and air conditioning
µPa = micropascals
dBA = A-weighted decibels
VdB = vibration velocity decibels

The criteria for environmental impact from ground-borne vibration and noise are based on the maximum levels for a single event. Table E lists the potential vibration building damage criteria associated with construction activities, as suggested in the FTA *Transit Noise and Vibration Impact Assessment* (2006).

Table E: Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	Approximate L_v (RMS VdB re 1 µin/sec)
Reinforced concrete, steel, or timber (no plaster)	0.5	102
Engineered concrete and masonry (no plaster)	0.3	98
Nonengineered timber and masonry buildings	0.2	94
Buildings extremely susceptible to vibration damage	0.12	90

Source: Table 12-3, *FTA Transit Noise and Vibration Impact Assessment* (FTA 2006).
µin/sec = microinches per second
in/sec = inches per second
$L_v = 20 \log_{10} (V/V_{ref})$, i.e., vibration velocity in decibels
PPV = peak particle velocity
RMS = root-mean-square
VdB = vibration velocity decibels

FTA guidelines show that a vibration level of up to 102 VdB (equivalent to 0.5 in/sec in PPV) (FTA 2006) is considered safe for buildings consisting of reinforced concrete, steel, or timber (no plaster), and would not result in any construction vibration damage. For a non-engineered timber and masonry building, the construction building vibration damage criterion is 94 VdB (0.2 in/sec in PPV).

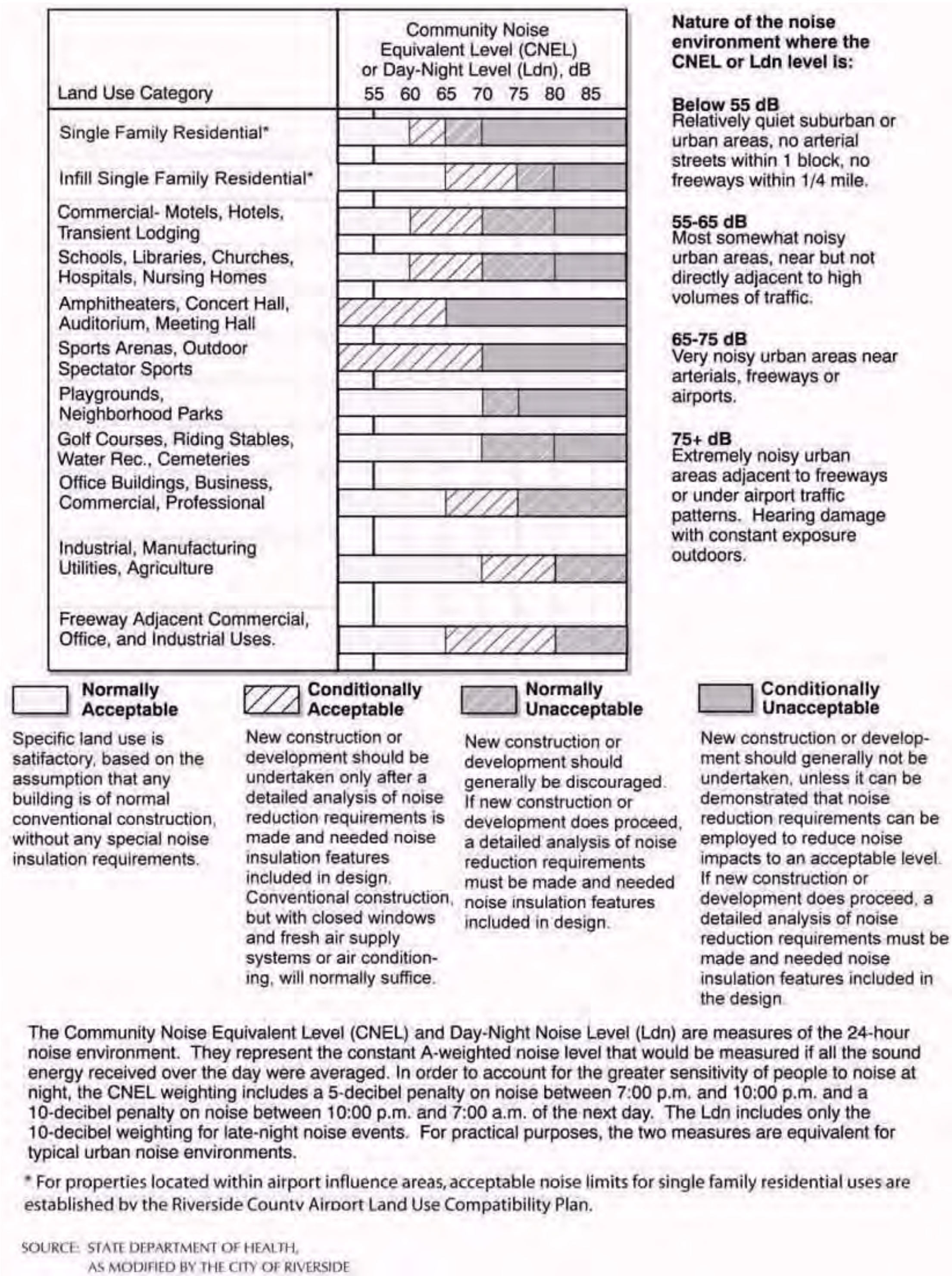
Local Regulations

City of Riverside.

Noise Element of the General Plan. The City has adopted a Noise Element of the General Plan to control and abate environmental noise, and to protect the citizens of the City from excessive exposure to noise. The Noise Element specifies the maximum allowable unmitigated exterior noise levels for new developments impacted by transportation noise sources such as arterial roads, freeways, airports, and railroads. In addition, the Noise Element identifies several policies to minimize the impacts of excessive noise levels throughout the community, and establishes noise level requirements for all land uses.

In its land use decisions, the City may consider its noise/land use compatibility guidelines. The *Noise/Land Use Compatibility Criteria* describes categories of compatibility and not specific noise standards. The Noise/Land Use Noise Compatibility Criteria in the City's General Plan Noise Element provides guidelines to evaluate the land use compatibility of transportation-related noise and is shown in Table F. These guidelines generally identify conditions where development of a particular use may be "Normally Acceptable", "Conditionally Acceptable", "Normally Unacceptable" or "Conditionally Unacceptable." The development of infill residential uses is "Normally Acceptable" in areas with noise levels of 65 dBA CNEL or less, and "Conditionally Acceptable" in areas with a noise levels between 65 and 75 dBA CNEL. For "Conditionally Acceptable" single-family residential uses, new development should only be undertaken after an analysis of noise reduction requirements and identification of noise reduction/insulation feature.

Table F: Noise/Land Use Noise Compatibility Criteria



Source: Figure N-10, *General Plan Noise Element* (City of Riverside 2007).

As stated in the City's General Plan 2025 Noise Element, ". . . Depending on the ambient environment of a particular community, these basic guidelines may be tailored to reflect existing noise and land use characteristics."

The City's General Plan 2025 identifies policies to address noise/land use compatibility issues, including:

- Policy N–1.1: Continue to enforce noise abatement and control measures particularly within residential neighborhoods.
- Policy N–1.2: Require the inclusion of noise-reducing design features in development consistent with standards in the Municipal Code.
- Policy N–1.3: Enforce the City of Riverside Noise Control Code to ensure that stationary noise and noise emanating from construction activities, private developments/residences and special events are minimized.
- Policy N–1-5: Avoid locating noise-sensitive land uses in existing and anticipated noise-impacted areas.
- Policy N–1.7: Evaluate noise impacts from roadway improvement projects by using the City's Acoustical Assessment Procedure.
- Policy N–1.8: Continue to consider noise concerns in evaluating all proposed development decisions and roadway projects.
- Policy N–4.1: Ensure that noise impacts generated by vehicular sources are minimized through the use of noise reduction features (e.g., earthen berms, landscaped walls, lowered streets, improved technology).
- Policy N–4.2: Investigate and pursue innovative approaches to reducing noise from railroad sources.

For the purposes of this noise impact analysis, single-family residential uses with outdoor active use areas (e.g., backyards or balconies) exposed to noise levels exceeding 65 dBA CNEL would require mitigation. In addition, interior noise levels for new residential development is required to comply with standards set forth in Title 24 of the State Health and Safety Code. New construction is required to incorporate special insulation, windows and sealants in order to ensure that interior noise levels meet Title 24 standards. The interior noise standard for residences is 45 dBA CNEL.

In addition, interior noise levels for new residential development, regardless of location within the Planning Area, will be required to comply with standards set forth in Title 24 of the State Health and Safety Code. New construction may need to incorporate special insulation, windows, and sealants in order to ensure that interior noise levels meet Title 24 standards. The interior noise standard for residences is 45 dBA CNEL.

Municipal Code. The purpose of the City's Municipal Code Noise Ordinance is to control unnecessary, excessive, and/or annoying noises in the City by prohibiting such noise generated by the sources specified in Title 7 of the City's Municipal Code. It is the goal of the City to minimize noise levels and mitigate the effects of noise to provide a safe and healthy living environment.

The City has incorporated the following standards in its Municipal Code to control loud, unnecessary, and unusual nuisance noises:

Exterior Sound Level Limits. Unless a variance has been granted, it shall be unlawful for any person to cause or allow the creation of any noise that exceeds the following:

- The exterior noise standard of the applicable land use category (Table G), up to 5 dB, for a cumulative period of more than 30 minutes in an hour; or
- The exterior noise standard of the applicable land use category, plus 5 dB, for a cumulative period of more than 15 minutes in any hour; or
- The exterior noise standard of the applicable land use category, plus 10 dB, for a cumulative period of more than 5 minutes in any hour; or
- The exterior noise standard of the applicable land use category, plus 15 dB, for a cumulative period of more than 1 minute in any hour; or
- The exterior noise standard of the applicable land use category, plus 20 dB or the maximum measured ambient noise level, for any period of time.

Table G: City of Riverside Sound Level Limits

Land Use Category	Time Period	Exterior Noise Standard (dBA)	Interior Noise Standard (dBA)
Residential	Night (10:00 p.m. to 7:00 a.m.) Day (7:00 a.m. to 10:00 p.m.)	45 55	35 45
School	7:00 a.m. to 10:00 p.m. (while school is in session)	N/A[1]	45
Hospital	Anytime	N/A	45
Office/Commercial	Anytime	65	N/A
Industrial	Anytime	70	N/A
Community Support	Anytime	60	N/A
Public Recreation Facility	Anytime	65	N/A
Non-Urban	Anytime	70	N/A

Source: Municipal Code Noise Ordinances (City of Riverside 2005).
[1] The City of Riverside has not established a sound level limit for this land use.
dBA = A-weighted decibels
N/A = not applicable

Interior Sound Level Limits. No person shall operate or cause to be operated, any source of sound indoors which causes the noise level, when measured inside another dwelling unit, school or hospital, to exceed:

- The interior noise standard for the applicable noise category (Table G), up to 5 dB, for a cumulative period of more than 5 minutes in any hour; or
- The interior noise standard for the applicable land use category, plus 5 dB, for a cumulative period of more than 1 minute in any hour; or
- The interior noise standard for the applicable land use category, plus 10 dB, or the maximum measured ambient noise level, for any period of time.

Based on Table G and Sections 7.25.010 and 7.30.015 of the City's Municipal Code, maximum exterior noise level for residential uses is 75 dBA L_{max} (i.e., 55 dB plus 20 dB) during daytime hours and 65 dBA L_{max} (i.e., 45 dB plus 20 dB) during nighttime hours, or the maximum measured ambient noise level for any period of time. Similarly, maximum interior nuisance noise level for residential uses is 55 dBA L_{max} (i.e., 45 dB plus 10 dB) during daytime hours and 45 dBA L_{max} (i.e., 35 dB plus 10 dB) during nighttime hours, or the maximum measured ambient noise level for any period of time.

Construction Noise. Section 7.35.020.G, Exemptions, of the City's Municipal Code Noise Ordinance states that "Noise sources associated with construction, repair, remodeling, or grading of any real property; provided a permit has been obtained from the City as required; and provided said activities do not take place between the hours of 7:00 p.m. and 7:00 a.m. on weekdays, between the hours of 5:00 p.m. and 8:00 a.m. on Saturdays, or at any time on Sunday or a federal holiday" are exempt from the noise level limits of the Municipal Code. The proposed construction activities will comply with the allowable days and hours for construction and therefore is exempt from the City's Municipal Code Noise Ordinance.

EXISTING SETTING

Overview of the Existing Noise Environment

The primary existing noise sources in the project area are transportation facilities. Traffic on Indiana Avenue and State Route 91 (SR-91) is the dominant source of ambient noise. Train operations to the south along the BNSF tracks also contribute to the ambient noise in the project vicinity.

Ambient Noise Level Measurement

The project site is adjacent to SR-91, Indiana Avenue, and the BNSF railroad tracks. Noise associated with these mobile sources would potentially affect the project site. To assess the existing noise environment, LSA conducted four short-term (15 minutes each) noise measurements using the Larson Davis 824 sound level meter to establish the existing noise environment within the project area. The sound level meter was calibrated with Cal200 field calibrator before and after noise level measurements. The noise level measurements were conducted at four representative locations in the project area, as identified by City staff. The short-term monitoring locations are shown on Figure 3.

The noise level measurement survey sheets are provided in Appendix A. Noise level measurements at these times show the typical baseline ambient noise level.

The summary below and Table H list the measured noise levels. These noise levels represent the noise environment in a snapshot of time at the identified locations during that time period. These measurements should not be used for the determination of future noise impacts or used as the basis for mitigation measures.

- **ST-1:** The measurements taken at this location were conducted at the southwest corner of the project site, near the railroad tracks. The noise levels measured at ST-1 were 67.2 dBA L_{eq} and 83.9 dBA L_{max}, with the primary noise sources coming from traffic on SR-91 and the railroad tracks. Another ambient noise measurement at this location was taken without a train passing by

LSA

FIGURE 3

LEGEND

Project Site

ST-1 Noise Monitoring Location

N

0 70 140
FEET

SOURCE: SDH and Associates, Inc. February, 2016.

Hawthorne Residential Development Project

Noise Monitoring Locations

I:\SWK1502\G\Noise Monitoring Locations.cdr (8/9/2017)

Table H: Summary of Short-Term Noise Level Measurements

Monitor No.	Location	Date	Start Time	Duration	Measured Ambient Noise Level (dBA) L_{eq} With Train Noise	L_{eq} No Train Noise	L_{max} With Train Noise	L_{max} No Train Noise
ST-1	9170/9174 Indiana Avenue; southwest corner	12/13/16	11:30 AM	15 minutes	67.2	53.6	83.9	66.9
ST-2	9170/9174 Indiana Avenue; northwest corner	12/13/16	11:56 AM	15 minutes	N/A	61.4	N/A	79.4
ST-3	9126 Indiana Avenue; north of project site	12/13/16	12:39 PM	15 minutes	58.8	56.4	79.3	70.1
ST-4	3418 Donald Avenue; outside of back yard	12/13/16	12:59 PM	15 minutes	67.5	67.9	82.6	81.4

Source: Compiled by LSA (August 2017).
dBA = A-weighted decibels
N/A = not applicable (no train pass-by)
L_{eq} = equivalent continuous sound level
L_{max} = maximum instantaneous noise level
ST = short-term

the site. The noise levels measured at this location without the train noise were 53.6 dBA L_{eq} and 66.9 dBA L_{max}, with the noise sources coming from traffic on SR-91.

- **ST-2:** The measurements taken at this location were conducted at the northwestern corner of the project site, south of Indiana Avenue near SR-91. The noise levels measured at ST-2 were 61.4 dBA L_{eq} and 79.4 dBA L_{max}, with primary noise sources coming from SR-91 and Indiana Avenue. No train pass-by noise was recorded.
- **ST-3:** The measurements taken at this location were conducted north of the project site along the north side of Indiana Avenue. The noise levels at ST-3 were 58.8 dBA L_{eq} and 79.3 dBA L_{max} with train noise and 56.4 dBA L_{eq} and 70.1 dBA L_{max} without train noise. Noise sources contributing to this measurement site included distant train noise and traffic on SR-91 and Indiana Avenue.
- **ST-4:** The measurements taken at this location were conducted at the northeastern corner of the project site next to the back yard of the residence located at 3418 Donald Avenue. The noise levels measured at this location were 67.5 dBA L_{eq} and 82.6 dBA L_{max} from vehicular and train noise adjacent to the project site, and 67.9 dBA L_{eq} and 81.4 dBA L_{max} without train noise.

Existing Traffic Noise

The Federal Highway Administration (FHWA) highway traffic noise prediction model (FHWA RD-77-108) was used to evaluate highway traffic-related noise conditions along the roadway segments in the project vicinity. Traffic volumes on Indiana Avenue in the Traffic Impact Analysis (LSA 2017) prepared for the proposed project and traffic volumes for SR-91 from the California Department of Transportation (Caltrans) *2015 Traffic Volumes on California State Highways* were used to assess the existing traffic noise impacts. Traffic volumes on SR-91 were used for the existing and extrapolated for the future (2017 and 2040) scenarios. Table I provides the existing traffic noise levels along the roadways adjacent to the project site. These noise levels represent the worst-case scenario, which assumes that no shielding is provided between the traffic and the location where the

Table I: Existing Traffic Noise Levels

Roadway Segment	ADT	Centerline to 70 dBA CNEL (ft)	Centerline to 65 dBA CNEL (ft)	Centerline to 60 dBA CNEL (ft)	CNEL (dBA) 50 ft from Centerline[1] of Outermost Lane
Indiana Avenue east of Donald Avenue	8,800	36[1,2]	78	167	67.2
Indiana Avenue west of Donald Avenue	8,700	36[1,2]	77	166	67.1
SR-91	176,500	1,022[2]	2,199	4,736	85.7

Source: Compiled by LSA (August 2017).
1 Traffic noise within 50 ft of the roadway centerline was calculated manually.
2 Indiana Avenue and SR-91 was modeled using Riverside County's traffic mix based on their roadway classification.
ADT = average daily traffic
CNEL = Community Noise Equivalent Level
dBA = A-weighted decibels
ft = foot/feet
SR-91 = State Route 91

noise contours are drawn. The specific assumptions used in developing these noise levels and model printouts are provided in Appendix B.

Table I shows that traffic noise levels in the project vicinity vary from moderate (Indiana Avenue) to high (SR-91), with the 70 dBA CNEL extending to 36 ft from the centerline of Indiana Avenue and to 1,022 ft from the SR-91 centerline. Figure 4 shows that the project site is approximately 44 ft from the centerline of Indiana Avenue and would be impacted by traffic noise from Indiana Avenue that reaches 69 dBA CNEL. Figure 4 also shows that the project site is approximately 350 ft from the centerline of SR-91 and would be potentially exposed to traffic noise from SR-91 that reaches 77 dBA CNEL. However, SR-91 in this area is approximately 20 ft below the project site, and existing residences are located between the project site and SR-91. There is an existing noise barrier along the edge of the freeway that is measured approximately 20 ft high on the freeway side and 8 to 10 ft high on the existing residence side. The elevation difference between the freeway and the project site and the existing residences between SR-91 and the project site would function as noise barriers and would provide a noise reduction minimum of 15 dBA, thereby reducing the freeway traffic noise to 62 dBA CNEL or lower. When combined together, traffic on SR-91 and Indiana Avenue would result in a noise level of 70 dBA CNEL.

Existing Train Noise

The FTA's 2006 *Transit Noise and Vibration Impact Assessment* manual was used to evaluate train-related noise and vibration impacts. Based on the January 2017 comment letter received by Metrolink, approximately 25 Metrolink passenger trains, 2 Amtrak passenger trains, and 74 BNSF freight trains operate on the rail line immediately adjacent to the proposed project. These trains operate 7 days per week, 24 hours per day.[1] Similar to vehicular traffic on roadways, train noise is also a line source that would be assumed to have the train along the centerline of the train tracks so that it covers both directions and balances the train noise emissions. Train noise projected from the edge of the train tracks would be the same as train noise projected from the centerline of the train

1 Metrolink, 2017. *Planning Cases P16-0112 (GPA), P16-0113 (ZC), P16-0114 (TTM), P16-0111 (PRD).* January 10.

LSA

FIGURE 4

N

0 70 140

FEET

SOURCE: SDH and Associates, Inc. February, 2016.

Hawthorne Residential Development Project

Existing Traffic and Train Noise Levels

I:\SWK1502\G\Exist_Traffic&Train Noise Levels.cdr (8/22/2017) tracks, with a slight modification to the calculation process for the noise source and distance attenuation. Using the FTA's guidelines, it is calculated that train operations in the study area would result in a noise level of 74.8 dBA CNEL at 50 ft from the train tracks. The project site is approximately 100 to 200 ft from the centerline of the train tracks. Train noise is a line source with 4.5 dBA reduction per doubling of distance (noise reduction from a line source is based on 15Log (D_2/D_1), where D_1 in this case is 50 ft and D_2 is the distance from the line source to the location of concern. At this distance, train noise would be reduced to 70.3 dBA CNEL and 65.8 dBA CNEL, respectively, south of the project site. Figure 4 shows the distances from the centerline of the train tracks to the proposed on-site residential properties. Currently, there is no noise barrier or other intervening structure between the railroad tracks and the project site. Figure 4 also shows the projected train noise levels.

IMPACTS

Short-Term Construction Noise Impacts

Two types of short-term noise impacts could occur during the construction of the proposed project. First, construction crew commutes and the transport of construction equipment and materials to the site for the proposed project would incrementally increase noise levels on access roads leading to the site. Although there would be a relatively high single-event noise exposure potential causing intermittent noise nuisance (passing trucks at 50 ft would generate up to a maximum of 84 dBA L_{max}), the effect on longer term (hourly or daily) ambient noise levels would be small. Therefore, short-term construction-related impacts associated with worker commute and equipment transport to the project site would be less than significant.

The second type of short-term noise impact is related to noise generated during demolition, grading, and construction of the buildings on the project site. Construction is completed in discrete steps, each of which has its own mix of equipment, and consequently, its own noise characteristics. These various sequential phases would change the character of the noise generated on the site, and therefore the noise levels surrounding the site, as construction progresses. Despite the variety in the type and size of construction equipment, similarities in the dominant noise sources and patterns of operation allow construction-related noise ranges to be categorized by work phase. Table J lists typical construction equipment noise levels recommended for noise impact assessments, based on a distance of 50 ft between the equipment and a noise receptor.

Typical noise levels range up to 86 dBA L_{max} at 50 ft during the noisiest construction phases. The site preparation phase, which includes the excavation and grading of the site, tends to generate the highest noise levels because the noisiest construction equipment is earthmoving equipment. Earthmoving equipment includes excavating machinery (e.g., backfillers, bulldozers, draglines, and front loaders). Earthmoving and compacting equipment includes compactors, scrapers, and graders. Typical operating cycles for these types of construction equipment may involve 1 or 2 minutes of full power operation followed by 3 or 4 minutes at lower power settings.

Project construction is expected to require the use of bulldozers, a front-end loader, and water trucks/ pickup trucks. Noise associated with the use of construction equipment is estimated to be between 55 and 85 dBA L_{max} at a distance of 50 ft from the active construction area for the grading phase.

Table J: RCNM Default Noise Emission Reference Levels and Usage Factors

Equipment Description	Impact Device?	Acoustical Usage Factor[1] (%)	Spec. 721.560 L_{max} at 50 ft (dBA, slow)[2]	Actual Measured L_{max} at 50 ft (dBA, slow)[3]	Number of Actual Data Samples (Count)
All other Equipment > 5 HP	No	50	85	N/A	0
Auger Drill Rig	No	20	85	84	36
Backhoe	No	40	80	78	372
Bar Bender	No	20	80	N/A	0
Blasting	Yes	N/A	94	N/A	0
Boring Jack Power Unit	No	50	80	83	1
Chain Saw	No	20	85	84	46
Clam Shovel (dropping)	Yes	20	93	87	4
Compactor (ground)	No	20	80	83	57
Compressor (air)	No	40	80	78	18
Concrete Batch Plant	No	15	83	N/A	0
Concrete Mixer Truck	No	40	85	79	40
Concrete Pump Truck	No	20	82	81	30
Concrete Saw	No	20	90	90	55
Crane	No	16	85	81	405
Dozer	No	40	85	82	55
Drill Rig Truck	No	20	84	79	22
Drum Mixer	No	50	80	80	1
Dump Truck	No	40	84	76	31
Excavator	No	40	85	81	170
Flat Bed Truck	No	40	84	74	4
Front End Loader	No	40	80	79	96
Generator	No	50	82	81	19
Generator (< 25 kVA, VMS Signs)	No	50	70	73	74
Gradall	No	40	85	83	70
Grader	No	40	85	N/A	0
Grapple (on backhoe)	No	40	85	87	1
Horizontal Boring Hydraulic Jack	No	25	80	82	6
Hydra Break Ram	Yes	10	90	N/A	0
Impact Derive	Yes	20	95	101	11
Jackhammer	Yes	20	85	89	133
Man Lift	No	20	85	75	23
Mounted Impact Hammer (hoe ram)	Yes	20	90	90	212
Pavement Scarifier	No	20	85	90	2
Paver	No	50	85	77	9
Pickup Truck	No	40	55	75	1
Pneumatic Tools	No	50	85	85	90
Pumps	No	50	77	81	17
Refrigerator Unit	No	100	82	73	3
Rivit Buster/Chipping Gun	Yes	20	85	79	19
Rock Drill	No	20	85	81	3
Roller	No	20	85	80	16
Sand Blasting (single nozzle)	No	20	85	96	9
Scraper	No	40	85	84	12
Sheers (on backhoe)	No	40	85	96	5
Slurry Plant	No	100	78	78	1
Slurry Trench Machine	No	50	82	80	75
Soil Mix Drill Rig	No	50	80	N/A	0
Tractor	No	40	84	N/A	0
Vacuum Excavator (Vac-Truck)	No	40	85	85	149

Table J: RCNM Default Noise Emission Reference Levels and Usage Factors

Equipment Description	Impact Device?	Acoustical Usage Factor[1] (%)	Spec. 721.560 L_{max} at 50 ft (dBA, slow)[2]	Actual Measured L_{max} at 50 ft (dBA, slow)[3]	Number of Actual Data Samples (Count)
Vacuum Street Sweeper	No	10	80	82	19
Ventilation Fan	No	100	85	79	13
Vibrating Hopper	No	50	85	87	1
Vibratory Concrete Mixer	No	20	80	80	1
Vibratory Pile Driver	No	20	95	101	44
Warning Horn	No	5	85	83	12
Welder/Torch	No	40	73	74	5

Source: Table 9.1, FHWA *Highway Construction Noise Handbook* (FHWA 2006).

1 Usage factor is the percentage of time during a construction noise operation that a piece of construction equipment is operating at full power.

2 Maximum noise levels were developed based on Specification (Spec.) 721.560 from the Central Artery/Tunnel (CA/T) program to be consistent with the City of Boston's Noise Code for the "Big Dig" project.

3 The maximum noise level was developed based on the average noise level measured for each piece of equipment during the CA/T program in Boston, Massachusetts.

4 Since the maximum noise level based on the average noise level measured for this piece of equipment was not available, the maximum noise level developed based on Spec 721.560 would be used.

dBA = A-weighted decibels
ft = foot/feet
HP = horsepower
kVA = kilovolt-amperes
L_{max} = maximum instantaneous noise level
N/A = Not Applicable
RCNM = Roadway Construction Noise Model
VMS = variable-message sign

These construction equipment noise levels were selected from the Specification (Spec.) 721.560 noise levels as a worst-case scenario because construction equipment noise levels associated with grading are typically higher than the actual measured noise levels shown in Table J.

As seen in Table J, the maximum noise level generated by each dozer is assumed to be approximately 85 dBA L_{max} at 50 ft from the dozer in operation. Each front-end loader would generate approximately 80 dBA L_{max} at 50 ft. The maximum noise level generated by water trucks/pickup trucks is approximately 55 dBA L_{max} at 50 ft from these vehicles. Each doubling of the sound source with equal strength increases the noise level by 3 dBA. Each piece of construction equipment operates as an individual point source. The worst-case composite noise level at the nearest residence during this phase of construction would be 86 dBA L_{max} (85 dBA + 80 dBA + 55 dBA = 86 dBA) at a distance of 50 ft from an active construction area. Based on a usage factor of 40 percent, the worst-case combined noise level during this phase of construction would be 82 dBA L_{eq} at a distance of 50 ft from the active construction area.

Construction-related, short-term noise levels would be higher than existing ambient noise levels in the project area today, but would no longer occur once construction of the project is completed. Section 7.35.020.G, Exemptions, of the City's Noise Ordinance states that "Noise sources associated with construction, repair, remodeling, or grading of any real property; provided a permit has been obtained from the City as required; and provided said activities do not take place between the hours of 7:00 p.m. and 7:00 a.m. on weekdays, between the hours of 5:00 p.m. and 8:00 a.m. on Saturdays, or at any time on Sunday or a federal holiday" are exempt from the noise level limits of the Municipal Code. Construction activities would occur in accordance with the dates and times allowed as described in Section 7.35.020.G, Exemptions, of the City's Noise Ordinance; therefore, no significant construction noise impact would occur.

Short-Term Construction Vibration Impacts

This construction vibration impact analysis discusses the level of human annoyance using vibration levels in VdB and will assess the potential for building damages using vibration levels in PPV (in/sec) because vibration levels calculated in RMS are best for characterizing human response to building vibration while vibration level in PPV is best used to characterize potential for damage. As shown in Table E, the FTA guidelines indicate that a vibration level up to 102 VdB (an equivalent to 0.5 in/sec in PPV) (FTA 2006) is considered safe for buildings consisting of reinforced concrete, steel, or timber (no plaster), and would not result in any construction vibration damage. For a non-engineered timber and masonry building, the construction vibration damage criterion is 94 VdB (0.2 in/sec in PPV).

Table K shows the PPV and VdB values at 25 ft from the construction vibration source. As shown in Table K, bulldozers and other heavy-tracked construction equipment (except for pile drivers and vibratory rollers) generate approximately 87 VdB of ground-borne vibration when measured at 25 ft, based on the Transit Noise and Vibration Impact Assessment (FTA 2006). This level of ground-borne vibration levels would result in potential annoyance to residences and workers located adjacent to the project site, but would not cause any damage to the buildings. Construction vibration, similar to vibration from other sources, would not have any significant effects on outdoor activities (e.g., those outside of residences in the project vicinity). Outdoor site preparation for the project is expected to use a bulldozer and loaded truck. The greatest levels of vibration are anticipated to occur during the site preparation phase. All other phases are expected to result in lower vibration levels. The distance to the nearest buildings for vibration impact analysis is measured between the nearest off-site buildings and the project boundary (assuming the construction equipment would be used at or near the project boundary) because vibration impacts occur normally within the buildings. The formula for vibration transmission is provided below.

$$L_v dB\ (D) = L_v dB\ (25\ ft) - 30\ Log\ (D/25)$$

$$PPV_{equip} = PPV_{ref} \times (25/D)^{1.5}$$

Table L lists the respective projected vibration level from various construction equipment expected to be used on the project site to the nearest buildings in the project vicinity. For typical construction activity, the equipment with the highest vibration generation potential is the large bulldozer, which would generate 87 VdB (0.089 PPV [in/sec]) at 25 ft. The closest residential property is located east of the project site and includes a garage located approximately 7.5 ft from the project construction boundary (property line). The residential building is located approximately 25 ft from the property line. As shown in Table L, the garage building and residential building at the closest residential property would experience vibration levels of up to 103 VdB (0.54 PPV [in/sec]). Other adjacent buildings in the project area are farther away and would experience lower vibration levels.

Table K: Vibration Source Amplitudes for Construction Equipment

Equipment	Reference PPV/L_V at 25 ft	
	PPV (in/sec)	L_V (VdB)[1]
Pile Driver (Impact), Typical	0.644	104
Pile Driver (Sonic), Typical	0.170	93
Vibratory Roller	0.210	94
Hoe Ram	0.089	87
Large Bulldozer[2]	**0.089**	**87**
Caisson Drilling	0.089	87
Loaded Trucks	**0.076**	**86**
Jackhammer	0.035	79
Small Bulldozer	0.003	58

Source: FTA *Transit Noise and Vibration Impact Assessment* (FTA 2006).
1 RMS vibration velocity in decibels (VdB) is 1 μin/sec.
2 Equipment shown in **bold** is expected to be used on site.
μin/sec = microinches per second
ft = feet
FTA = Federal Transit Administration
in/sec = inches per second
L_V = velocity in decibels
PPV = peak particle velocity
RMS = root-mean-square
VdB = vibration velocity decibels

Table L: Summary of Construction Equipment and Activity Vibration

Receptor	Construction Equipment	Reference Vibration Level (VdB) at 25 ft	Reference Vibration Level (PPV) at 25 ft	Distance (ft)	Vibration Level (VdB)	Vibration Level (PPV)
Garage Building	Large Bulldozer	87	0.089	7.5	103	0.542
	Loaded Truck	86	0.076	7.5	102	0.463
Residential Building	Large Bulldozer	87	0.089	25	87	0.089
	Loaded Truck	86	0.076	25	86	0.076

Source: Compiled by LSA (August 2017).
Note: The FTA-recommended building damage threshold is 0.2 PPV (in/sec) or approximately 94 VdB at the receiving property structure or building.
ft = feet
in/sec = inches per second
FTA = Federal Transit Administration
PPV = peak particle velocity
VdB = vibration velocity decibels

Construction vibration levels at the garage building of the closest residential property would exceed the FTA threshold of 94 VdB (0.2 in/sec PPV) for building damage when bulldozers and loaded trucks operate within 7.5 ft of the property line. The implementation of mitigation measures to use light construction equipment (e.g. small bulldozers and trucks) within 15 ft from the eastern property line would ensure that construction vibration levels would be below the FTA threshold of 94 VdB (0.2 in/sec PPV) for building damage. Although construction vibration levels at residential uses would have the potential to result in annoyance, these vibration levels would no longer occur once construction of the project is completed. Therefore, construction vibration levels would be less than significant with the implementation of mitigation measures that use light construction equipment (e.g. small bulldozers and trucks) within 15 ft from the eastern property line.

Long-Term Train Noise Impacts

It must be noted that the project site is located in an area currently subjected to high levels of noise from adjacent roadways and rail operations. CEQA Guidelines section 15126.2(a) generally requires an evaluation of environmental conditions and hazards existing on a proposed project site if such conditions and hazards may cause substantial adverse impacts to future residents or users of the project. CEQA calls upon an agency to evaluate existing conditions in order to assess whether a project could exacerbate hazards that are already present.

In *California Building Industry Association v. Bay Area Air Quality Management District* (2015), the California Supreme Court held that ". . .agencies subject to CEQA generally are not required to analyze the impact of existing environmental conditions on a project's future users or residents. But when a proposed project risks exacerbating those environmental hazards or conditions that already exist, an agency must analyze the potential impact of such hazards on future residents or users. In those specific instances, it is the project's impact on the environment -– and not the environment's impact on the project – that compels an evaluation of how future residents or users could be affected by exacerbated conditions."

While existing on-site ambient noise levels from traffic and rail operations exceed the City's exterior noise standard of 65 dBA CNEL for residential uses, the incorporation of the recommended sound attenuation features (walls and building facade improvements), would implement City policies for reducing noise impacts at a "Conditionally Acceptable" use by, 1) enforcing noise abatement and control measures particularly within residential neighborhoods, 2) requiring the inclusion of noise-reducing design features in development consistent with standards in the Municipal Code, and 3) ensuring that noise impacts generated by transportation (vehicular and rail) noise sources are minimized through the use of noise reduction features. Thus, installation of these walls would improve the livability and quality of life for these residences.

The FTA's 2006 *Transit Noise and Vibration Impact Assessment* manual was used to evaluate train-related noise and vibration impacts. Based on the January 2017 comment letter received by Metrolink, approximately 25 Metrolink, 2 Amtrak passenger trains, and 74 BNSF freight trains operate on the rail line immediately adjacent to the proposed project. These trains operate 7 days per week, 24 hours per day.[1] The current Metrolink schedule at the La Sierra train station shows that 15 trains run during daytime hours (between 7:00 a.m. and 7:00 p.m.), 2 trains run during evening hours (between 7:00 p.m. and 10:00 p.m.), and 8 trains run during nighttime hours (between 10:00 p.m. and 7:00 a.m.) each day on weekdays. Similar to vehicular traffic on roadways, train noise is a line source that would be assumed to have the train along the centerline of the train tracks so that it covers both directions and balances the train noise emissions. Train noise projected from the edge of the train tracks would be the same as train noise projected from the centerline of the train tracks, with a slight modification to the calculation process for the noise source and distance attenuation. Using the FTA's guidelines, it is calculated that train operations in the study area would result in a noise level of 74.8 dBA CNEL at 50 ft from the train tracks.

[1] Metrolink, 2017. *Planning Cases P16-0112 (GPA), P16-0113 (ZC), P16-0114 (TTM), P16-0111 (PRD).* January 10.

The project site is approximately 100 to 200 ft from the centerline of the train tracks. Train noise is a line source with 4.5 dBA reduction per doubling of distance (noise reduction from a line source is based on 15Log (D_2/D_1), where D_1 in this case is 50 ft and D_2 is the distance from the line source to the location of concern. At this distance, train noise would be reduced to 70.3 and 65.8 dBA CNEL, respectively, south of the project site. Figure 4 shows the distances from the centerline of the train tracks to the proposed on-site residential properties. Noise from a train horn occurs in much shorter time periods, usually seconds. Based on the FTA *Transit Noise and Vibration Impact Assessment* (2006), transit car horns could generate 78 to 90 dBA L_{max} at 50 ft, and a train horn can generate up to 110 dBA L_{max} at 50 ft. Even though it is higher in peak or maximum noise level, train horn noise usually is not used to determine the required noise mitigation due to the feasibility and lack of noise regulations associated with it. In addition, the project is located in an existing Federal Railroad Administration (FRA) approved quiet zone where locomotive engineers are not required to sound the train horns unless in case of emergencies (e.g., when tracks are obstructed).

The noise level reduction from the shielding of train noise with noise barriers was calculated using the guidelines in the FTA *Transit Noise and Vibration Impact Assessment* (2006). Playgrounds on the south side of the project property line facing the railroad tracks would require a minimum noise barrier height of 10 ft while backyards and/or balconies associated with residential structures on the south, east, and west side of the project facing the railroad tracks that would not be shielded from proposed on-site residential structures would require a minimum noise barrier height of 8 ft to reduce train noise levels to the City's exterior noise standard of 65 dBA CNEL or below. Backyard and/or balconies associated with residential structures on the south side of the project that face the railroad tracks would be shielded by a minimum 10 ft high noise barrier at the project property line but would also require an additional minimum 6 ft high noise barrier at the residential property line in order to reduce train noise levels at those residences to the City's exterior noise standard of 65 dBA CNEL or below. Figure 5 shows the required noise barrier location for each residential lot and playground area. It should be noted that the proposed noise barrier would not result in noise increases to off-site residences located south of the project from reflection because the reflected noise would be attenuated through distance and would not add to the direct noise.

Based on the data provided in the United States Environmental Protection Agency (EPA) Protective Noise Levels (1979), standard homes in Southern California provide at least 12 dBA of exterior-to-interior noise attenuation with windows and doors open and 24 dBA with windows and doors closed. Based on the above discussion, the closest residences located on the southern edge of the project site would be exposed to an interior noise level of 58 dBA CNEL (70.3 dBA – 12 dBA = 58.3 dBA) with windows and doors open. With windows and doors closed, the closest residence on the southern edge of the project site would be exposed to an interior noise level of 46.3 dBA CNEL (70.3 dBA - 24 dBA = 46.3 dBA). The interior noise level with windows and doors open and closed would exceed the City's interior noise standard of 45 dBA CNEL. Therefore, building facade upgrades (e.g., windows with sound transmission class [STC] ratings higher than the STC-28 provided by standard building construction) and air conditioning would be required to ensure that windows and doors can remain closed for a prolonged period of time to maintain the interior noise standard.

Residential buildings in the middle of the project site would be shielded by the proposed on-site residential buildings, which would function as noise barriers and provide at least 10 dBA in noise attenuation. Exterior noise levels for residential buildings or units in the middle of the project site would be reduced to 60.3 dBA CNEL (70.3 dBA – 10 dBA = 60.3 dBA) and would not exceed the

LSA

FIGURE 5

LEGEND

- Minimum 10 ft High Noise Barrier
- Minimum 8 ft High Noise Barrier
- Minimum 6 ft High Noise Barrier
- STC-28 or Higher Windows

0 70 140
FEET

SOURCE: SDH and Associates, Inc. February, 2016.

Hawthorne Residential Development Project

Noise Barrier Locations and Building Facade Upgrades

I:\SWK1502\G\Barriers-Upgrades.cdr (8/17/2017)

City's exterior noise standard of 65 dBA CNEL. In addition, interior noise levels would be 48.3 dBA and 36.3 dBA CNEL, respectively, with windows and doors open and closed. Therefore, air conditioning would be required to ensure that windows and doors can remain closed for a prolonged period of time to maintain the interior noise standard.

Each air conditioning unit will be designed to comply with the City's Municipal Code noise standards regulating the heating, ventilation, and air conditioning (HVAC) equipment noise. The mitigation measure applies to both first floor and second floor noise-sensitive rooms. It should be noted that, noise mitigation for the building facades should be based on the windows and doors closed scenario for practical and feasibility reasons, and not windows and doors open scenario regardless of whether future residents prefer windows and doors open or not. Figure 5 shows the required building facade upgrade for each residential lot. If any residents choose to leave the windows and doors open, their interior noise would be higher than when the windows and doors are closed.

Long-Term Traffic Noise Impacts

The FHWA highway traffic noise prediction model (FHWA RD-77-108) was used to evaluate highway traffic-related noise conditions along the roadway segments in the project vicinity. Traffic volumes on Indiana Avenue projected in the Traffic Impact Analysis (LSA 2017) for the proposed project were used to assess the potential traffic noise impacts along the street segments in the project vicinity. The project-related changes would be small enough to not have any significant impacts on off-site land uses along these roadway segments. Existing traffic volumes on SR-91 were projected to the future scenarios (2017 and 2040).

Tables M, N, and O provide the traffic noise levels for the existing, 2017, and 2040, respectively, with project scenarios. These noise levels represent the worst-case scenario, which assumes that no shielding is provided between the traffic and the location where the noise contours are drawn. The specific assumptions used in developing these noise levels and model printouts are provided in Appendix A.

Based on the Traffic Impact Analysis, the proposed project is expected to generate 514 average daily vehicle trips (ADT). Generally, a doubling of traffic is required to generate a perceptible increase (3 dBA) in noise. As detailed in Tables M, N and O, the project-related traffic is not sufficiently extreme to generate a perceptible increase in noise in the project area. Project-related traffic noise level increases would be 0.2 dBA or less and would not be discernible to the human ear in an outdoor environment. In addition, Table O shows that in the 2040 scenario, traffic volumes on Indiana Avenue and SR-91 would be the highest among the three scenarios, and that traffic noise levels under this scenario are used to determine the potential traffic noise impacts on the proposed on-site land uses.

Table O shows that in the 2040 with project scenario, the 70 dBA CNEL noise contour along Indiana Avenue would extend to 45 ft from the centerline of Indiana Avenue. The 70 dBA CNEL noise contour from SR-91 would continue to extend to 1,198 ft from the centerline of the freeway. The project site is approximately 44 ft from the centerline of Indiana Avenue and would be impacted by traffic noise from Indiana Avenue reaching 70 dBA CNEL. The project site is approximately 350 ft from the centerline of SR-91 and would be potentially exposed to traffic noise from SR-91 reaching

Table M: Existing (2016) Traffic Noise Levels Without and With Project

Roadway Segment	Existing Without Project (Baseline)					Existing With Project						
	ADT	Centerline to 70 dBA CNEL (ft)	Centerline to 65 dBA CNEL (ft)	Centerline to 60 dBA CNEL (ft)	CNEL (dBA) 50 ft from Centerline of Outermost Lane	ADT	Change in ADT	Centerline to 70 dBA CNEL (ft)	Centerline to 65 dBA CNEL (ft)	Centerline to 60 dBA CNEL (ft)	CNEL (dBA) 50 ft from Centerline of Outermost Lane	Increase over Baseline CNEL (dBA) 50 ft from Centerline of Outermost Lane
Indiana Avenue east of Donald Avenue	8,800	36[1,2]	78	167	67.2	8,900	0	36	78	168	67.2	0.0
Indiana Avenue west of Donald Avenue	8,700	36[1,2]	77	166	67.1	9,100	400	37	80	171	67.3	0.2
State Route 91	176,500	1,022	2,199	4,736	85.7	176,500	0	1,022	2,199	4,736	85.7	0.0

Source: *Compiled by LSA (August 2017).*
[1] Traffic noise within 50 ft of the roadway centerline was calculated manually.
[2] Indiana Avenue and SR-91 was modeled using Riverside County's traffic mix based on their roadway classification.
ADT = average daily traffic
CNEL = Community Noise Equivalent Level
dBA = A-weighted decibels
ft = feet
SR-91 = State Route 91

Table N: 2017 Traffic Noise Levels Without and With Project

Roadway Segment	2017 Cumulative Without Project (Baseline)					2017 Cumulative With Project						
	ADT	Centerline to 70 dBA CNEL (ft)	Centerline to 65 dBA CNEL (ft)	Centerline to 60 dBA CNEL (ft)	CNEL (dBA) 50 ft from Centerline of Outermost Lane	ADT	Change in ADT	Centerline to 70 dBA CNEL (ft)	Centerline to 65 dBA CNEL (ft)	Centerline to 60 dBA CNEL (ft)	CNEL (dBA) 50 ft from Centerline of Outermost Lane	Increase over Baseline CNEL (dBA) 50 ft from Centerline of Outermost Lane
Indiana Avenue east of Donald Avenue	9,800	39[1,2]	84	179	67.6	10,000	200	39	85	182	67.7	0.1
Indiana Avenue west of Donald Avenue	9,800	39[1,2]	84	179	67.6	10,200	400	40	86	184	67.8	0.2
State Route 91	178,300	1,029	2,214	4,768	85.7	178,300	0	1,029	2,214	4,768	85.7	0.0

Source: *Compiled by LSA (August 2017).*
[1] Traffic noise within 50 ft of the roadway centerline was calculated manually.
[2] Indiana Avenue and SR-91 was modeled using Riverside County's traffic mix based on their roadway classification.
ADT = average daily traffic
CNEL = Community Noise Equivalent Level
dBA = A-weighted decibels
ft = feet
SR-91 = State Route 91

Table O: 2040 Traffic Noise Levels Without and With Project

Roadway Segment	2040 Cumulative Without Project (Baseline)					2040 Cumulative With Project						
	ADT	Centerline to 70 dBA CNEL (ft)	Centerline to 65 dBA CNEL (ft)	Centerline to 60 dBA CNEL (ft)	CNEL (dBA) 50 ft from Centerline of Outermost Lane	ADT	Change in ADT	Centerline to 70 dBA CNEL (ft)	Centerline to 65 dBA CNEL (ft)	Centerline to 60 dBA CNEL (ft)	CNEL (dBA) 50 ft from Centerline of Outermost Lane	Increase over Baseline CNEL (dBA) 50 ft from Centerline of Outermost Lane
Indiana Avenue east of Donald Avenue	11,900	44[1,2]	95	204	68.5	12,000	100	45	96	205	68.5	0.0
Indiana Avenue west of Donald Avenue	11,900	44[1,2]	95	204	68.5	12,200	300	45	97	208	68.6	0.1
State Route 91	224,100	1,198	2,579	5,553	86.7	224,100	0	1,198	2,579	5,553	86.7	0.0

Source: *Compiled by LSA (August 2017).*
[1] Traffic noise within 50 ft of the roadway centerline was calculated manually.
[2] Indiana Avenue and SR-91 was modeled using Riverside County's traffic mix based on their roadway classification.
ADT = average daily traffic
CNEL = Community Noise Equivalent Level
dBA = A-weighted decibels
ft = feet
SR-91 = State Route 91

78 dBA CNEL. SR-91 in this area is approximately 20 ft below the project site, and existing residences are located between the project site and SR-91. There is an existing noise barrier that is approximately 20 ft high and 8 to 10 ft high on the residence side. The elevation difference between the freeway and the project site and the existing residences between SR-91 and the project site would function as noise barriers and would provide a noise reduction minimum of 15 dBA, thereby reducing the freeway traffic noise to 63 dBA CNEL or lower. When combined together, traffic on SR-91 and Indiana Avenue would result in a noise level of 71 dBA CNEL, and mitigation measures would be required.

Indiana Avenue. The proposed residential buildings closest to Indiana Avenue are approximately 44 ft from the centerline of Indiana Avenue and would be potentially exposed to traffic noise reaching 70 dBA CNEL from traffic on Indiana Avenue. Any outdoor active use areas (e.g., backyards or balconies) on the north side of the residential buildings facing Indiana Avenue would need to be protected by a noise barrier with a minimum height of 6 ft. Outdoor active use areas located on the south side of the residential buildings would not be exposed to traffic noise exceeding the 65 dBA CNEL noise standards, and no mitigation measures would be required.

Based on the data provided in the EPA *Protective Noise Levels* (1979), standard homes in Southern California provide at least 12 dBA of exterior-to-interior noise attenuation with windows open and 24 dBA with windows closed. The residential units with bedrooms and/or living rooms facing north would be exposed to a noise level of 58 dBA CNEL (70 dBA – 12 dBA = 58 dBA) with windows and doors open, which is higher than the interior noise standard of 45 dBA CNEL. Therefore, air conditioning would be required to ensure that windows and doors can remain closed for a prolonged period of time to maintain the interior noise standard. Each air conditioning unit will be designed to comply with the City's Municipal Code noise standards regulating HVAC equipment noise. This mitigation measure applies to both first floor and second floor noise-sensitive rooms.

The residential units with north-facing bedrooms and/or living rooms would be exposed to a noise level of 46 dBA CNEL (70 dBA – 24 dBA = 46 dBA) with windows and doors closed, which would exceed the City's interior noise standard of 45 dBA CNEL. Therefore, building facade upgrades (e.g., windows with STC ratings higher than the STC-28 provided by standard building construction) would be required for dwelling units on the north side of the buildings along Indiana Avenue that are not protected by the proposed on-site residential structures from noise generated along SR-91 and Indiana Avenue. This mitigation measure applies to both first floor and second floor noise-sensitive rooms.

It should be noted that noise mitigation for the building facades should be based on the closed windows and doors scenario for practical and feasibility reasons rather than on the open windows and doors scenario regardless of whether future residents prefer windows and doors open or not. If any residents choose to leave the windows and doors open, their interior noise would be higher than when the windows and doors are closed and would not meet the City's interior noise standard of 45 dBA CNEL.

State Route 91. The proposed residential buildings are approximately 350 ft from the SR-91 centerline to the north and would be exposed to up to 78 dBA CNEL when no shielding is considered, which is a worst-case scenario. SR-91 in this area is approximately 20 ft below the project site and the existing residences between the project site and SR-91. There is an existing noise barrier that is approximately 20 ft high and 8 to 10 ft high on the residence side. The elevation differences between the freeway and the project site and the existing residences between SR-91 and the project site would function as noise barriers and would provide a noise reduction minimum of 15 dBA, thereby reducing the freeway traffic noise to 63 dBA CNEL or lower. When combined together, traffic on SR-91 and Indiana Avenue would result in a noise level of 71 dBA CNEL. Any outdoor active use areas (e.g., backyards and/or balconies) on the north side of the residential buildings facing Indiana Avenue and SR-91 that are not shielded by the proposed on-site residential structures would require a noise barrier with a minimum height of 6 ft. Therefore, a noise barrier with a minimum height of 6 feet is required along the perimeter of each backyard or balcony for residences that have these outdoor active use areas facing north and that are directly exposed to the traffic noise. With the noise barrier along the perimeter, each backyard and/or balcony would have exterior noise levels reduced to 65 dBA CNEL or lower and would meet the City's exterior noise standard of 65 dBA CNEL for residential uses. Since residential units at the eastern and western ends of the project site would be potentially exposed to traffic and train noise, an 8 ft high noise barrier along the private property line would be required. Figure 5 depicts the residential lots that would be affected by the required noise barriers.

Based on the data provided in the EPA *Protective Noise Levels* (1979), standard homes in Southern California provide at least 12 dBA of exterior-to-interior noise attenuation with windows and doors open and 24 dBA with windows and doors closed. The residential units with bedrooms and/or living rooms facing north would be exposed to a noise level of 59 dBA CNEL (71 dBA – 12 dBA = 59 dBA) with windows and doors open, which is higher than the interior noise standard of 45 dBA CNEL. Therefore, air conditioning would be required to ensure that windows and doors can remain closed for a prolonged period of time to maintain the interior noise standard. Each air conditioning unit will be designed to comply with the City's Municipal Code noise standards regulating HVAC equipment noise. This mitigation measure applies to both first floor and second floor noise-sensitive rooms.

The residential units with bedrooms and/or living rooms facing north would be exposed to a noise level of 47 dBA CNEL (71 dBA – 24 dBA = 47 dBA) with windows and doors closed, which would exceed the City's interior noise standard of 45 dBA CNEL. Therefore, building facade upgrades (e.g., windows with STC ratings higher than the STC-28 provided by standard building construction) would be required for dwelling units on the north side of the buildings along Indiana Avenue that are not protected by the proposed on-site residential structures from noise generated along SR-91 and Indiana Avenue. This mitigation measure applies to both first floor and second floor noise-sensitive rooms. Figure 5 depicts the residential lots that would be affected by the required building facade upgrades.

It should be noted that noise mitigation for the building facades should be based on the closed windows and doors scenario for practical and feasibility reasons rather than on the open windows and doors scenario regardless of whether future residents prefer windows and doors open or not. If any residents choose to leave the windows and doors open, their interior noise would be higher than when the windows and doors are closed and would not meet the City's interior noise standard of 45 dBA CNEL.

Long-Term Stationary Noise Impacts

Potential long-term noise impacts would be associated with stationary sources. These activities are potential point sources of noise that could affect on-site residences. On-site noise-producing activities include heating, ventilation, and air-conditioning equipment (HVAC).

HVAC equipment associated with the project would be the project's primary noise source. HVAC equipment is often mounted on rooftops, located on the ground, or located within mechanical rooms. The noise sources could take the form of fans, pumps, air compressors, chillers, or cooling towers. HVAC operations would be required to meet all noise standards. For the purpose of this analysis, HVAC equipment was assumed to be located on the ground floor in the backyard area of the single-family residential units.

Precise details of HVAC equipment, including future location and sizing, are unknown at this time; therefore, for purposes of this analysis, 75 dBA at 3 ft was assumed to represent HVAC-related noise.[1] As identified above, off-site noise-sensitive receptors would be located approximately 25 ft from the proposed project. Adjusted for distance to the nearest off-site sensitive receptors, the off-site residences would be exposed to a noise level of 57 dBA L_{eq} generated by HVAC equipment. This noise level would exceed the City's exterior daytime L_{50} standard of 55 dBA and nighttime L_{50}, L_{25}, and L_8 standard of 45, 50, and 55 dBA, respectively. This noise level would not exceed the City's interior daytime and nighttime noise standard. Mitigation measures to construct an 8 ft high wall on the east side of the project would be required to reduce noise levels by 12 dBA so noise levels generated from HVAC equipment would be reduced to a noise level of 45 dBA L_{eq} (57 dBA – 12 dBA = 45 dBA). This noise level would not exceed the City's exterior daytime and nighttime noise standard. Therefore, long-term noise impacts from HVAC equipment would be less than significant with the implementation of an 8 ft high wall on the east side of the project.

Long-Term Vehicular Traffic Vibration Impacts

Operations of the proposed project (i.e., a residential project) would not involve any vibration sources that would cause exposure of persons to or generation of excessive ground-borne vibration or ground-borne noise levels. Vehicles with rubber tires on roadways segments surrounding the project site would not generate any significant ground-borne vibration that would exceed the 65 VdB perception threshold for such uses. No significant ground-borne vibration impacts would occur. No mitigation is required.

Long-Term Train Vibration Impacts

The FTA 2006 *Transit Noise and Vibration Impact Assessment* manual was used to evaluate train-related vibration impacts. Based on the January 2017 comment letter received by Metrolink, approximately 25 Metrolink passenger trains, 2 Amtrak passenger trains, and 74 BNSF freight trains operate on the rail line immediately adjacent to the proposed project. These trains operate 7 days per week, 24 hours per day.[2] Based on the FTA's 2006 *Transit Noise and Vibration Impact Assessment*

---

1 Trane. 2002. Sound Data and Application Guide for the New and Quieter Air-Cooled Series R Chiller.
2 Metrolink, 2017. *Planning Cases P16-0112 (GPA), P16-0113 (ZC), P16-0114 (TTM), P16-0111 (PRD).* January 10.

(Figure 10-1, Generalized Ground Surface Vibration Curves), at a distance of 60 ft from the train tracks, rapid transit or light rail vehicles (50 miles per hour [mph]) would result in a vibration level of 72 VdB. At the same distance, locomotive-powered passenger or freight trains (50 mph) would result in 83 VdB of ground vibration.

Table E shows that vibration levels reaching 90 VdB or higher would result in potential building damages. None of the predicted vibration levels (all below 90 VdB) for buildings or structures in the vicinity of the project site would reach this threshold level. Thus, no significant vibration impacts are anticipated, and no mitigation is required.

MINIMIZATION MEASURES

Construction Noise Impacts

The following measures would reduce short-term construction-related noise impacts resulting from the proposed project:

- Construction activities are restricted within the City of Riverside to the hours between 7:00 a.m. and 7:00 p.m. Monday through Friday and between 8:00 a.m. and 5:00 p.m. on Saturdays, and are prohibited on Sundays and federal holidays.
- During all project site demolition, excavation, and grading on site, the project contractors shall equip all construction equipment, fixed or mobile, with properly operating and maintained mufflers consistent with manufacturers' standards.
- The project contractor shall place all stationary construction equipment so that emitted noise is directed away from sensitive receptors nearest the project site.
- The construction contractor shall locate equipment staging in areas that shall create the greatest distance between construction-related noise sources and noise-sensitive receptors nearest the project site during all project construction.

MITIGATION MEASURES

The following mitigation measures are required:

Short-Term Construction Vibration Impacts

1. The construction contractor shall use light construction equipment (e.g., small bulldozers and trucks) within 15 ft of the eastern property line.

Long-Term Traffic/Train Noise Impacts

2. An interior noise analysis shall be required upon completion of detailed floor plans and prior to issuance of building permits to ensure compliance with the noise standard and with installation of an air conditioning unit. If noise standards are not met, the Applicant shall be required to enhance the building facades (e.g., double-paned windows) to comply with the interior noise standards.

3. Air conditioning, a form of mechanical ventilation, shall be required for all dwelling units to ensure that windows and doors can remain closed for a prolonged period of time to maintain the interior noise standard.
4. A minimum noise barrier height of 10 ft shall be required along the southern project property line and a portion of the east and west property lines around the recreational area to shield the playground and residences closest to the southern property line (Lots 10 through 16) from train related noises.
5. A minimum noise barrier height of 8 ft shall be required along the rear private property lines of Lots 1 through 9 and Lots 17 through 21; and south private property lines of Lots 8, 9 and 17 to shield outdoor active use areas (e.g., backyards or balconies) from train related noises.
6. A minimum 6 ft high noise barrier shall be required along the south private property lines of Lots 10 through 16 and west private property line of Lot 16 to shield the outdoor active use areas (e.g., backyards or balconies) from train related noises.
7. A minimum noise barrier height of 6 ft shall be required along the private property line immediately south of Indiana Avenue (Lots 1, and 21 through 30) to shield outdoor active use areas such as backyards or balconies from traffic noise along Indiana Avenue and State Route 91 freeway.
8. Building facade upgrades (e.g., double-paned windows with a sound transmission class rating of STC-28 or higher) shall be required for all residences located south of Indiana Avenue (Lots 1, 21 through 30).
9. Building facade upgrades (e.g., double-paned windows with a STC-28 or higher) shall be required for all residences facing the BNSF railroad tracks (Lots 1 through 21 and 43 through 48).

On-Site Operational Noise Impacts

10. A minimum noise barrier height of 8 ft along the east side of the project (Lots 1 through 8) shall be required to shield on-site ground-floor HVAC equipment.

On-Site Operational Vibration Impacts

No mitigation measures are required.

LEVEL OF SIGNIFICANCE AFTER MITIGATION

With mitigation measures implemented, the project would result in a less than significant impact for noise and vibration.

REFERENCES

Bolt, Beranek & Newman. 1987. Noise Control for Buildings and Manufacturing Plants.

California Department of Health, Office of Noise Control. 1977. Model Community Noise Control Ordinance.

California Department of Transportation (Caltrans). *2015 Traffic Volumes on California State Highways*. Website: http://www.dot.ca.gov/trafficops/census/docs/2015_aadt_truck.pdf, accessed August 2017.

City of Riverside. 2005. Municipal Code Noise Ordinances. Website: https://www.riversideca.gov/municode/title7.asp, accessed August 2017.

_____. 2007. Noise Element of *General Plan 2025*. November. Website: https://www.riversideca.gov/planning/gp2025program/GP/11_Noise_Element.pdf, accessed August 2017.

Federal Highway Administration (FHWA). 1977. Highway Traffic Noise Prediction Model, FHWA RD-77-108. Website: http://www.fhwa.dot.gov/environment/noise/traffic_noise_model, accessed August 2017.

_____. August 2006. *FHWA Highway Construction Noise Handbook*, FHWA-HEP-06-015, DOT-VNTSC-FHWA-06-02, NTIS No. PB2006-109012. Website: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook, accessed August 2017.

Federal Transit Administration (FTA), Office of Planning and Environment. May 2006. *Transit Noise and Vibration Impact Assessment*, FTA-VA-90-1003-06. Website: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Noise_and_Vibration_Manual.pdf, accessed August 2017.

Harris, Cyril M. (ed.). 1991. *Handbook of Acoustical Measurements and Noise Control*.

LSA Associates, Inc. 2017. *Traffic Impact Analysis for Hawthorne Residential Development*. April.

Metrolink, 2017. Planning Cases P16-0112 (GPA), P16-0113 (ZC), P16-0114 (TTM), P16-0111 (PRD). January 10.

Trane. 2002. Sound Data and Application Guide for the New and Quieter Air-Cooled Series R Chiller.

United States Environmental Protection Agency (EPA). 1979. *Protective Noise Levels, Condensed Version of EPA Levels Document*, EPA-550/9-79-100. Website: http://nepis.epa.gov/Exe/ZyPDF.cgi/20012HG5.PDF?Dockey=20012HG5.PDF, accessed August 2017.

APPENDIX A

NOISE MEASUREMENT SURVEY SHEETS

Noise Measurement Survey

Project Number: SWK 1502
Project Name: Tentative Tract Map No. 37032

Test Personnel: Daniel Kaufman
Equipment: Larson Davis 824

Site Number: ST-1 Date: 12/13/2016

Time: From 11:12 AM To 11:27 AM

Site Location: 9174 Indiana Avenue. At the southwest portion of the site, behind the former school.

Primary Noise Sources: Freight train, SR-91, and Indiana Avenue.

Comments: Freight train pass-by at 11:12 AM.

Adjacent Roadways: Indiana Avenue.

Measurement Results	
L_{eq}	67.2
L_{max}	83.9
L_{min}	49.7
L_2	77.1
L_8	74.4
L_{25}	53.5
L_{50}	52.4
L_{90}	51.2
L_{99}	50.5

Atmospheric Conditions	
Average Wind Velocity (mph)	1.4
Maximum Wind Velocity (mph)	3.6
Temperature (F)	63.4
Relative Humidity (%)	63.8

Location Photo:

Noise Measurement Survey

Project Number: SWK 1502
Test Personnel: Daniel Kaufman
Project Name: Tentative Tract Map No. 37032
Equipment: Larson Davis 824

Site Number: ST-1 B Date: 12/13/2016
Time: From 11:30 AM To 11:47 AM

Site Location: 9174 Indiana Avenue. At the southwest portion of the site, behind the former school.

Primary Noise Sources: SR-91 and Indiana Avenue.

Comments: Filtered train.

Adjacent Roadways: Indiana Avenue.

Measurement Results	
L_{eq}	53.6
L_{max}	66.9
L_{min}	49.8
L_2	59.2
L_8	55.0
L_{25}	53.1
L_{50}	52.3
L_{90}	51.2
L_{99}	50.4

Atmospheric Conditions	
Average Wind Velocity (mph)	1.6
Maximum Wind Velocity (mph)	5.1
Temperature (F)	64.6
Relative Humidity (%)	61.9

Location Photo:

Noise Measurement Survey

Project Number: SWK 1502
Test Personnel: Daniel Kaufman
Project Name: Tentative Tract Map No. 37032
Equipment: Larson Davis 824

Site Number: ST-2 Date: 12/13/2016
Time: From 11:56 AM To 12:11 PM

Site Location: 9174 Indiana Avenue. At the north portion of the site, in the parking lot area of the former school.

Primary Noise Sources: Indiana Avenue and SR-91.

Comments: No trains.

Adjacent Roadways: Indiana Avenue.

Measurement Results	
L_{eq}	61.4
L_{max}	79.4
L_{min}	54.4
L_2	66.7
L_8	64.5
L_{25}	62.1
L_{50}	59.4
L_{90}	56.1
L_{99}	55.1

Atmospheric Conditions	
Average Wind Velocity (mph)	1.1
Maximum Wind Velocity (mph)	2.8
Temperature (F)	66.1
Relative Humidity (%)	74.1

Location Photo:

Noise Measurement Survey

Project Number: SWK 1502
Test Personnel: Daniel Kaufman
Project Name: Tentative Tract Map No. 37032
Equipment: Larson Davis 824

Site Number: ST-3 Date: 12/13/2016
Time: From 12:39 AM To 12:54 PM

Site Location: East side of the site, next to the backyard of the house at 9126 Indiana Avenue.

Primary Noise Sources: SR-91, Indiana Avenue, and trains.

Comments: Short train pass-by at 12:39 PM. Second short pass-by at 12:48.

Adjacent Roadways: Indiana Avenue.

Measurement Results	
L_{eq}	58.8
L_{max}	79.3
L_{min}	53.3
L_2	65.0
L_8	60.3
L_{25}	58.2
L_{50}	57.1
L_{90}	55.3
L_{99}	53.9

Atmospheric Conditions	
Average Wind Velocity (mph)	1.7
Maximum Wind Velocity (mph)	5.1
Temperature (F)	68.4
Relative Humidity (%)	53.5

Location Photo:

Noise Measurement Survey

Project Number: SWK 1502
Test Personnel: Daniel Kaufman
Project Name: Tentative Tract Map No. 37032
Equipment: Larson Davis 824

Site Number: ST-3 B Date: 12/13/2016
Time: From 12:59 PM To 1:14 PM

Site Location: East side of the site, next to the backyard of the house at 9126 Indiana Avenue.

Primary Noise Sources: SR-91 and Indiana Avenue.

Comments: Filtered train.

Adjacent Roadways: Indiana Avenue.

Measurement Results	
L_{eq}	56.4
L_{max}	70.1
L_{min}	51.9
L_2	60.3
L_8	58.0
L_{25}	56.8
L_{50}	55.9
L_{90}	53.8
L_{99}	52.7

Atmospheric Conditions	
Average Wind Velocity (mph)	1.1
Maximum Wind Velocity (mph)	3.3
Temperature (F)	70.4
Relative Humidity (%)	54.0

Location Photo:

Noise Measurement Survey

Project Number: SWK 1502
Test Personnel: Daniel Kaufman
Project Name: Tentative Tract Map No. 37032
Equipment: Larson Davis 824

Site Number: ST-4 Date: 12/13/2016
Time: From 10:26 AM To 10:41 AM

Site Location: 3418 Donald Avenue. At the front yard of the house on the northwest corner of Indiana Avenue and Donald Avenue.

Primary Noise Sources: Indiana Avenue and SR-91.

Comments: Metrolink pass-by, near the beginning of the measurement.

Adjacent Roadways: Indiana Avenue.

Measurement Results	
L_{eq}	67.5
L_{max}	82.6
L_{min}	54.5
L_2	75.2
L_8	72.0
L_{25}	67.4
L_{50}	63.8
L_{90}	58.9
L_{99}	56.6

Atmospheric Conditions	
Average Wind Velocity (mph)	1.1
Maximum Wind Velocity (mph)	3.0
Temperature (F)	67.1
Relative Humidity (%)	57.2

=

Location Photo:

Noise Measurement Survey

Project Number: SWK 1502
Test Personnel: Daniel Kaufman
Project Name: Tentative Tract Map No. 37032
Equipment: Larson Davis 824

Site Number: ST-4 B Date: 12/13/2016
Time: From 11:46 AM To 11:03 AM

Site Location: 3418 Donald Avenue. At the front yard of the house on the northwest corner of Indiana Avenue and Donald Avenue.

Primary Noise Sources: Indiana Avenue and SR-91.

Comments: Filtered train.

Adjacent Roadways: Indiana Avenue.

Measurement Results	
L_{eq}	67.9
L_{max}	81.4
L_{min}	53.0
L_2	75.8
L_8	73.0
L_{25}	67.7
L_{50}	63.3
L_{90}	58.8
L_{99}	56.7

Atmospheric Conditions	
Average Wind Velocity (mph)	1.1
Maximum Wind Velocity (mph)	4.3
Temperature (F)	68.2
Relative Humidity (%)	65.4

Location Photo:

APPENDIX B

FHWA TRAFFIC NOISE MODEL PRINTOUTS

TABLE Existing-01

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016

ROADWAY SEGMENT: Indiana Avenue east of Donald Avenue

NOTES: TENTATIVE TRACT MAP NO. 37032 - Existing

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 8800   SPEED (MPH): 40   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 67.16

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	77.7	167.0	359.6

TABLE Existing-02
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue west of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - Existing

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 8700 SPEED (MPH): 40 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6 SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 67.11

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	77.1	165.8	356.9

TABLE Existing-03
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Freeway
NOTES: TENTATIVE TRACT MAP NO. 37032 - Existing

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 176500   SPEED (MPH): 65   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	69.50	12.90	9.60
M-TRUCKS	1.44	0.06	1.50
H-TRUCKS	2.40	0.10	2.50

ACTIVE HALF-WIDTH (FT): 60   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 85.66

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
1022.4	2199.4	4736.0	10200.8

TABLE Existing with Project-01
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue east of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - Existing with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 8900   SPEED (MPH): 40   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 67.20

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	78.3	168.3	362.3

TABLE Existing with Project-02

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue west of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - Existing with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 9100   SPEED (MPH): 40   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 67.30

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	79.5	170.8	367.7

TABLE Existing with Project-03

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Freeway
NOTES: TENTATIVE TRACT MAP NO. 37032 - Existing with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 176500   SPEED (MPH): 65   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	69.50	12.90	9.60
M-TRUCKS	1.44	0.06	1.50
H-TRUCKS	2.40	0.10	2.50

ACTIVE HALF-WIDTH (FT): 60   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 85.66

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
1022.4	2199.4	4736.0	10200.8

TABLE 2017 Cumulative w/o Project-01

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue east of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2017 Cumulative w/o Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 9800 SPEED (MPH): 40 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6 SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 67.62

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	83.5	179.4	386.3

TABLE 2017 Cumulative w/o Project-02

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue west of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2017 Cumulative w/o Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 9800   SPEED (MPH): 40   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 67.62

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	83.5	179.4	386.3

TABLE 2017 Cumulative w/o Project-03

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Freeway
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2017 Cumulative w/o Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 178300 SPEED (MPH): 65 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	69.50	12.90	9.60
M-TRUCKS	1.44	0.06	1.50
H-TRUCKS	2.40	0.10	2.50

ACTIVE HALF-WIDTH (FT): 60 SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 85.71

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
1029.4	2214.3	4768.2	10270.0

TABLE 2017 Cumulative with Project-01
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue east of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2017 Cumulative with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 10000 SPEED (MPH): 40 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6 SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 67.71

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	84.6	181.9	391.6

TABLE 2017 Cumulative with Project-02

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016

ROADWAY SEGMENT: Indiana Avenue west of Donald Avenue

NOTES: TENTATIVE TRACT MAP NO. 37032 - 2017 Cumulative with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 10200   SPEED (MPH): 40   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 67.80

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	85.7	184.3	396.8

TABLE 2017 Cumulative with Project-03
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Freeway
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2017 Cumulative with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 178300   SPEED (MPH): 65   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	69.50	12.90	9.60
M-TRUCKS	1.44	0.06	1.50
H-TRUCKS	2.40	0.10	2.50

ACTIVE HALF-WIDTH (FT): 60   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 85.71

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
1029.4	2214.3	4768.2	10270.0

TABLE 2040 Cumulative without Project-01
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue east of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2040 Cumulative without Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 11900   SPEED (MPH): 40   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 68.47

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	95.0	204.2	439.7

TABLE 2040 Cumulative without Project-02

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue west of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2040 Cumulative without Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 11900 SPEED (MPH): 40 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6 SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 68.47

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	95.0	204.2	439.7

TABLE 2040 Cumulative without Project-03

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Freeway
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2040 Cumulative without Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 224100   SPEED (MPH): 65   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	69.50	12.90	9.60
M-TRUCKS	1.44	0.06	1.50
H-TRUCKS	2.40	0.10	2.50

ACTIVE HALF-WIDTH (FT): 60   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 86.70

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
1198.3	2578.6	5553.1	11960.8

TABLE 2040 Cumulative with Project-01
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue east of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2040 Cumulative with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 12000   SPEED (MPH): 40   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 68.50

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	95.5	205.3	442.2

TABLE 2040 Cumulative with Project-02
FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Indiana Avenue west of Donald Avenue
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2040 Cumulative with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 12200 SPEED (MPH): 40 GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	73.60	13.60	10.22
M-TRUCKS	0.90	0.04	0.90
H-TRUCKS	0.35	0.04	0.35

ACTIVE HALF-WIDTH (FT): 6 SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 68.57

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	96.5	207.6	447.1

TABLE 2040 Cumulative with Project-03

FHWA ROADWAY NOISE LEVEL ANALYSIS

RUN DATE: 12/19/2016
ROADWAY SEGMENT: Freeway
NOTES: TENTATIVE TRACT MAP NO. 37032 - 2040 Cumulative with Project

---

* * ASSUMPTIONS * *

AVERAGE DAILY TRAFFIC: 224100   SPEED (MPH): 65   GRADE: .5

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	69.50	12.90	9.60
M-TRUCKS	1.44	0.06	1.50
H-TRUCKS	2.40	0.10	2.50

ACTIVE HALF-WIDTH (FT): 60   SITE CHARACTERISTICS: SOFT

---

* * CALCULATED NOISE LEVELS * *

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE (dB) = 86.70

DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL

70 CNEL	65 CNEL	60 CNEL	55 CNEL
1198.3	2578.6	5553.1	11960.8

<u>Appendix I:</u>
<u>Traffic Impact Analysis</u>

TRAFFIC IMPACT ANALYSIS

HAWTHORNE RESIDENTIAL DEVELOPMENT PROJECT

CITY OF RIVERSIDE

RIVERSIDE COUNTY, CALIFORNIA

This traffic study has been prepared under the supervision of
Donson H. Liu, T.E.

Signed ______________________

LICENSED PROFESSIONAL ENGINEER
DONSON H. LIU
TR 2743
EXP. 3/31/19
TRAFFIC
STATE OF CALIFORNIA

LSA

April 26, 2017

TRAFFIC IMPACT ANALYSIS

HAWTHORNE RESIDENTIAL DEVELOPMENT PROJECT
CITY OF RIVERSIDE
RIVERSIDE COUNTY, CALIFORNIA

Prepared for:

Mr. Steve Berzansky
Steven Walker Communities, Inc.
7111 Indiana Avenue, Suite 300
Riverside, CA 92504

Prepared by:

LSA Associates, Inc.
1500 Iowa Avenue, Suite 200
Riverside, California 92507
(951) 781-9310

LSA Project No. SWK1603

LSA

April 26, 2017

TABLE OF CONTENTS

APPENDICES

FIGURES AND TABLES

FIGURES

TABLES

INTRODUCTION

This traffic impact analysis (TIA) has been prepared for the proposed Hawthorne Residential Development Project to be located at 9170 Indiana Avenue, in the City of Riverside (City). The proposed project will include 54 single-family residential units. Figure 1 illustrates the regional and project location. Figure 2 illustrates the conceptual site plan.

This report is intended to satisfy the requirements established by the City of Riverside "Traffic Impact Preparation Guide," dated January 2016, as well as the requirements for the disclosure of potential impacts and mitigation measures pursuant to the California Environmental Quality Act (CEQA). The scope of work for this TIA, including trip generation, trip distribution, study area, and analysis methodologies have been approved by City staff. A copy of the City Scoping Agreement is included as Appendix A.

This TIA examines traffic operations in the vicinity of the proposed project, which were analyzed under the following scenarios:

- Existing traffic conditions;
- Existing with project traffic conditions;
- Project completion (2017) conditions;
- Project completion (2017) with project traffic conditions;
- Cumulative (2017) traffic conditions; and
- Cumulative (2017) with project traffic conditions.

Because the project requires a General Plan Amendment and Zone Change, a build-out analysis is required as stated in the City's "Traffic Impact Preparation Guide," dated January 2016. Therefore, the following analysis scenarios were also analyzed:

- Build-out 2040 Without Project Conditions; and
- Build-out 2040 With Project Conditions.

For each scenario, traffic operations at study intersections are evaluated for the a.m. and p.m. peak hours. The a.m. peak hour is defined as the one hour of highest traffic volumes occurring between 7:00 and 9:00 a.m. The p.m. peak hour is defined as the one hour of highest traffic volumes occurring between 4:00 and 6:00 p.m.

STUDY AREA DETERMINATION

The study area was approved by City staff via the City's scoping agreement process (Appendix A). Study intersections were selected based on discussion with City staff. The study includes locations where project traffic has potential to cause a significant impact. As such, one intersection was identified for analysis: Donald Avenue-Project Driveway/Indiana Avenue. Figure 3 illustrates the location of the study area intersection.

LSA

FIGURE 1

N

0 1000 2000
FEET

SOURCE: Bing Aerial, 2016: Streetmap, 2013/Riverside County, 2015.

Hawthorne Residential Development
Traffic Impact Analysis

Regional and Project Location

I:\SWK1603\Reports\Traffic\fig1_RegLoc.mxd (9/23/2016)

FIGURE 2

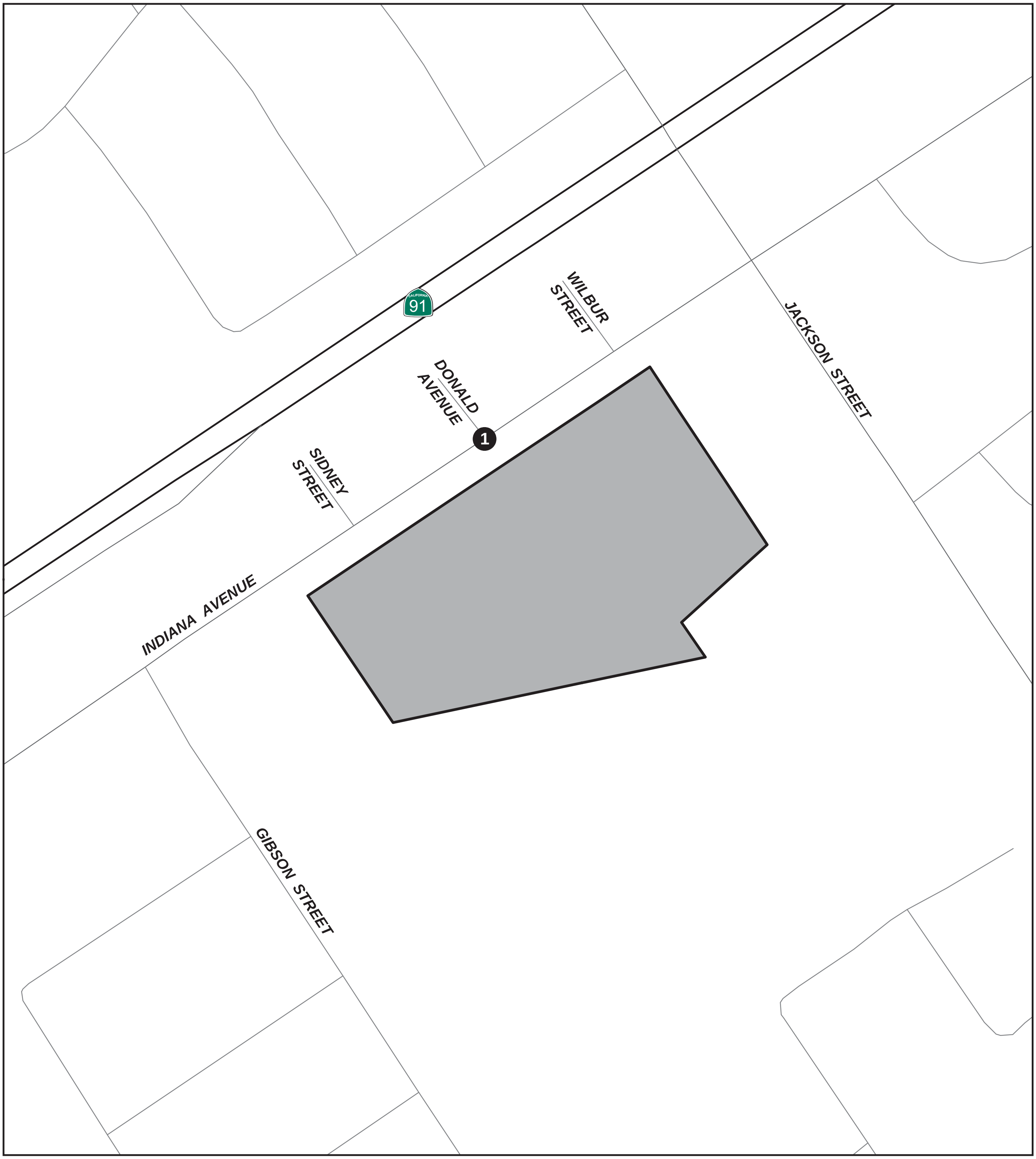
Hawthorne Residential Development
Traffic Impact Analysis

Conceptual Site Plan

0 70 140
FEET

SOURCE: SDH and Associates, Inc. February, 2016.

I:\SWK1603\Reports\Traffic\fig2_ConceptSP.mxd (9/23/2016)



LSA

Legend

Project Boundary

Study Area Intersection

N

0 125 250
FEET

SOURCE: Streetmap, 2013/Riverside County, 2015.

FIGURE 3

Hawthorne Residential Development
Traffic Impact Analysis

Study Area Intersection

I:\SWK1603\Reports\Traffic\fig3_StudyAreaInters.mxd (9/23/2016)

PROJECT DESCRIPTION

As previously discussed, the proposed project will include 54 single-family residential units. Access to the project site will be provided via the south leg of the intersection of Donald Avenue/Indiana Avenue. Current General Plan and Zoning designations for the site are Business/Office Park (B/OP) and PF (Public Facilities), respectively. The project includes processing of a General Plan Amendment (GPA) (P16-0112) to Medium Density Residential (MDR) and Zone Change (P16-0113) to Single-Family Residential (R-1-7000). The project site was previously occupied by the Hawthorne Elementary School. The school was originally founded in 1923 and rebuilt in 1959. However, the school has been vacant for more than two years, and therefore, no trip credits were taken. Development of the site will necessitate the removal of existing on-site structures and features. Previously referenced Figure 2 illustrates the site plan for the proposed project.

ANALYSIS METHODOLOGY

Level of Service Definitions and Procedures

Roadway operations and the relationship between capacity and traffic volumes are generally expressed in terms of levels of service (which are defined using the letter grades A through F). These levels recognize that, while an absolute limit exists as to the amount of traffic traveling through a given intersection (the absolute capacity), the conditions that motorists experience rapidly deteriorate as traffic approaches the absolute capacity. Under such conditions, congestion is experienced. There is general instability in the traffic flow, which means that relatively small incidents (e.g., momentary engine stall) can cause considerable fluctuations in speeds and delays. This near-capacity situation is labeled Level of Service (LOS) E. Beyond LOS E, capacity has been exceeded, and arriving traffic will exceed the ability of the intersection to accommodate it. An upstream queue will then form and continue to expand in length until the demand volume again declines.

A complete description of the meaning of level of service can be found in the Transportation Research Board Special Report 209, *Highway Capacity Manual* (HCM). The HCM establishes levels of service A through F as shown in Table A.

Table A: Level of Service Definitions

LOS	Description
A	No approach phase is fully utilized by traffic and no vehicle waits longer than one red indication. Typically, the approach appears quite open, turns are made easily and nearly all drivers find freedom of operation.
B	This service level represents stable operation, where an occasional approach phase is fully utilized and a substantial number are approaching full use. Many drivers begin to feel restricted within platoons of vehicles.
C	This level still represents stable operating conditions. Occasionally drivers may have to wait through more than one red signal indication, and backups may develop behind turning vehicles. Most drivers feel somewhat restricted, but not objectionably so.

Table A: Level of Service Definitions

LOS	Description
D	This level encompasses a zone of increasing restriction approaching instability at the intersection. Delays to approaching vehicles may be substantial during short peaks within the peak period; however, enough cycles with lower demand occur to permit periodic clearance of developing queues, thus preventing excessive backups.
E	Capacity occurs at the upper end of this service level. It represents the most vehicles that any particular intersection approach can accommodate. Full utilization of every signal cycle is seldom attained no matter how great the demand.
F	This level describes forced flow operations at low speeds, where volumes exceed capacity. These conditions usually result from queues of vehicles backing up from a restriction downstream. Speeds are reduced substantially and stoppages may occur for short or long periods of time due to the congestion. In the extreme case, both speed and volume can drop to zero.

Table B shows the level of service criteria for unsignalized and signalized intersections.

Table B: Level of Service Criteria for Unsignalized and Signalized Intersections

Level of Service	Unsignalized Intersection Average Delay per Vehicle (sec.)	Signalized Intersection Average Delay per Vehicle (sec.)
A	≤ 10	≤ 10
B	> 10 and ≤ 15	> 10 and ≤ 20
C	> 15 and ≤ 25	> 20 and ≤ 35
D	> 25 and ≤ 35	> 35 and ≤ 55
E	> 35 and ≤ 50	> 55 and ≤ 80
F	> 50	> 80

Consistent with the City's TIA guidelines, the 2010 HCM analysis methodologies were used to determine intersection levels of service for all study area intersections. All levels of service were calculated using Synchro 9.1 software, which uses the HCM 2010 methodologies.

Level of Service Threshold

The City uses LOS D as its minimum level of service criteria for intersections and roadways of Collector or higher classification; while LOS C is to be maintained on local street intersections. The study intersection (Donald Avenue-Project Driveway/Indiana Avenue) analyzed in this TIA is located on Indiana Avenue, which is designated as a 4-lane arterial by the City's General Plan. Therefore, LOS D is used as the minimum level of service standard.

Project Significance Threshold

The City's significance criteria are used to determine circulation impacts. Because the project requires a General Plan Amendment and Zone Change, a significant impact occurs when the addition of project-related trips causes either peak hour LOS to degrade from acceptable (LOS A through D) to unacceptable LOS (E or F) or the peak hour delay to increase as follows:

- LOS A/B: by 10.0 seconds.
- LOS C: by 8.0 seconds.
- LOS D: by 5.0 seconds.
- LOS E: by 2.0 seconds.
- LOS F: by 1.0 second.

TRAFFIC VOLUMES WITHOUT PROJECT SCENARIOS

Existing Traffic Volumes

Existing traffic volumes are based on peak hour intersection turn movement counts collected by National Data and Surveying Services in September 2016. Count sheets are included in Appendix B. Figure 4 illustrates existing peak hour traffic volumes at study intersections.

Project Completion (2017) Traffic Volumes

Project completion traffic volumes were developed by applying an annual growth rate of 1.5 percent per year (2016 to 2017) to existing without project traffic volumes. All assumptions, including the growth rate, used for opening year analyses are outlined in the City-approved scoping letter (Appendix A). Figure 4 illustrates project completion without project peak hour traffic volumes. Detailed volume development worksheets are included in Appendix C.

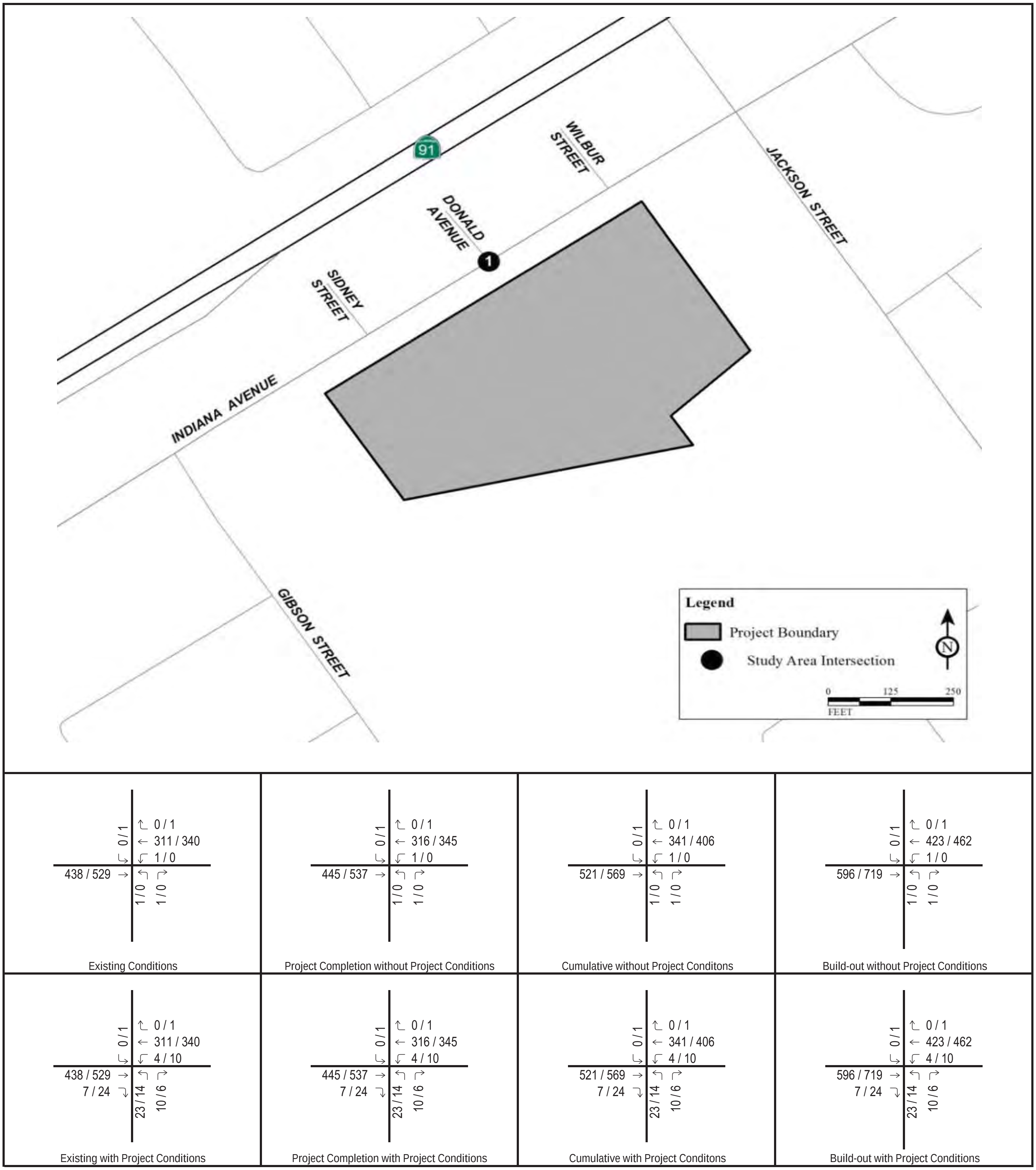
Cumulative (2017) Traffic Volumes

Information concerning cumulative projects in the vicinity of the proposed project was obtained from City staff. Table C lists the cumulative projects included in this analysis. Figure 5 illustrates the cumulative project locations.

The trip generation for cumulative projects was developed using rates from the Institute of Transportation Engineers (ITE) *Trip Generation*, 9th Edition. As shown in Table C, cumulative projects are expected to generate 8,589 net daily trips, 761 net a.m. peak hour trips, and 735 net p.m. peak hour trips. Figure 6 illustrates the total cumulative project trips at study intersections. Cumulative traffic volumes were added to the project completion volumes to develop cumulative without project traffic volumes. Figure 4 illustrates cumulative without project peak hour traffic volumes at study intersections. Detailed volume development worksheets are included in Appendix C.

Build-out (2040) Traffic Volumes

Build-out traffic volumes were developed by applying an annual growth rate of 1.5 percent per year (2016 to 2040) to the existing volumes at the intersection of Donald Avenue-Project Driveway/ Indiana Avenue. All assumptions, including the growth rate, used for build-out analyses, are outlined in the City-approved scoping letter (Appendix A). Figure 4 illustrates build-out without project peak hour traffic volumes. Detailed volume development worksheets are included in Appendix C.



LSA

FIGURE 4

XXX / YYY

AM / PM Peak Hour Volumes

Hawthorne Residential Development

Traffic Impact Analysis

Peak Hour Traffic Volumes - All Analysis Scenarios

(Intersection of Donald Avenue-Project Driveway/Indiana Avenue)

Table C - Cumulative Projects Trip Generation

Project Number	Location	Land Use	Units	Rate	AM Peak Hour			PM Peak Hour			Daily
					In	Out	Total	In	Out	Total	
1 .	8432 Magnolia Ave.	CBU Specific Plan Amendment	146.0 TSF	Trips/Unit[1]	3.30	0.93	4.24	1.15	2.45	3.60	38.22
	Riverside, CA	(University/College Campus)		Trip Generation	**482**	**136**	**618**	**168**	**357**	**525**	**5,580**
2 .	10050 Magnolia Ave.	Retail	5.2 TSF	Trips/Unit[2]	0.60	0.36	0.96	1.78	1.93	3.71	42.70
	Riverside, CA	(Shopping Center)		Trip Generation	3	2	5	9	10	19	222
				Pass-by Trips[3]	0	0	0	(4)	(4)	(7)	(7)
				Total Net Trips	**3**	**2**	**5**	**6**	**6**	**12**	**215**
3 .	Northeast Corner of	Single Family Residential	18 DU	Trips/Unit[4]	0.19	0.56	0.75	0.63	0.37	1.00	9.52
	Gibson and Lincoln			Trip Generation	**3**	**10**	**13**	**11**	**7**	**18**	**171**
4 .	9644 Magnolia Ave.	Commercial	10.3 TSF	Trips/Unit[2]	0.60	0.36	0.96	1.78	1.93	3.71	42.70
	Riverside, CA	(Shopping Center)		Trip Generation	6	4	10	18	20	38	438
				Pass-by Trips[3]	0	0	0	(6)	(7)	(13)	(13)
				Total Net Trips	**6**	**4**	**10**	**12**	**13**	**25**	**425**
		Restaurant	2.0 TSF	Trips/Unit[5]	5.95	4.86	10.81	5.91	3.94	9.85	127.15
		High-Turnover (Sit-Down)		Trip Generation	12	10	22	12	8	20	260
				Pass-by Trips[6]	0	0	0	(4)	(5)	(9)	(9)
				Total Net Trips	**12**	**10**	**22**	**8**	**3**	**11**	**251**
5 .	8505-8543 Indiana Ave.	Car Dealership	41.0 TSF	Trips/Unit[7]	1.44	0.48	1.92	1.05	1.57	2.62	32.30
	Riverside, CA	(Automobile Sales)		Trip Generation	**59**	**20**	**79**	**43**	**64**	**107**	**1,324**
6 .	9471 Magnolia Ave.	Commercial	15.0 TSF	Trips/Unit[2]	0.60	0.36	0.96	1.78	1.93	3.71	42.70
	Riverside, CA	(Shopping Center)		Trip Generation	9	5	14	27	29	56	641
				Pass-by Trips[3]	0	0	0	(10)	(9)	(19)	(19)
				Total Net Trips	**9**	**5**	**14**	**17**	**20**	**37**	**621**
				Gross Trip Generation	**574**	**187**	**761**	**288**	**495**	**783**	**8,636**
				Total Pass-by Trips	**0**	**0**	**0**	**(24)**	**(24)**	**(48)**	**(48)**
				Total Net Trip Generation	**574**	**187**	**761**	**264**	**471**	**735**	**8,589**

Notes:

TSF = Thousand Square Feet, DU=Dwelling Units

[1]There are no rates for a University/College Campus based on square footage in the Institute of Transportation Engineers (ITE) *Trip Generation* Manual, therefore student rates for Land Use 540 "Junior/Community College" from ITE Trip Generation Manual were factored to develop square footage rate.

[2]Rates based on Land Use 820 "Shopping Center" from the ITE *Trip Generation* Manual, 9th Edition.

[3]Pass-by trips are based on rates for Land Use 820 "Shopping Center" from the ITE *Trip Generation Handbook*, 2nd Edition. Since there is no data available for daily pass-by trips, p.m. pass-by trips have been applied to the daily trip generation.

[4]Rates based on Land Use 210 "Single-Family Detached Housing" from the ITE *Trip Generation* Manual, 9th Edition.

[5]Rates based on Land Use 932 "High-Turnover (Sit-Down) Restaurant" from the ITE *Trip Generation* Manual, 9th Edition.

[6]Pass-by trips are based on rates for Land Use 932 "High-Turnover (Sit-Down) Restaurant" from the ITE *Trip Generation Handbook*, 2nd Edition. Since there is no data available for daily pass-by trips, p.m. pass-by trips have been applied to the daily trip generation.

[7]Rates based on Land Use 841 "Automobile Sales" from the Institute of Transportation Engineers (ITE *) Trip Generation* Manual, 9th Edition.

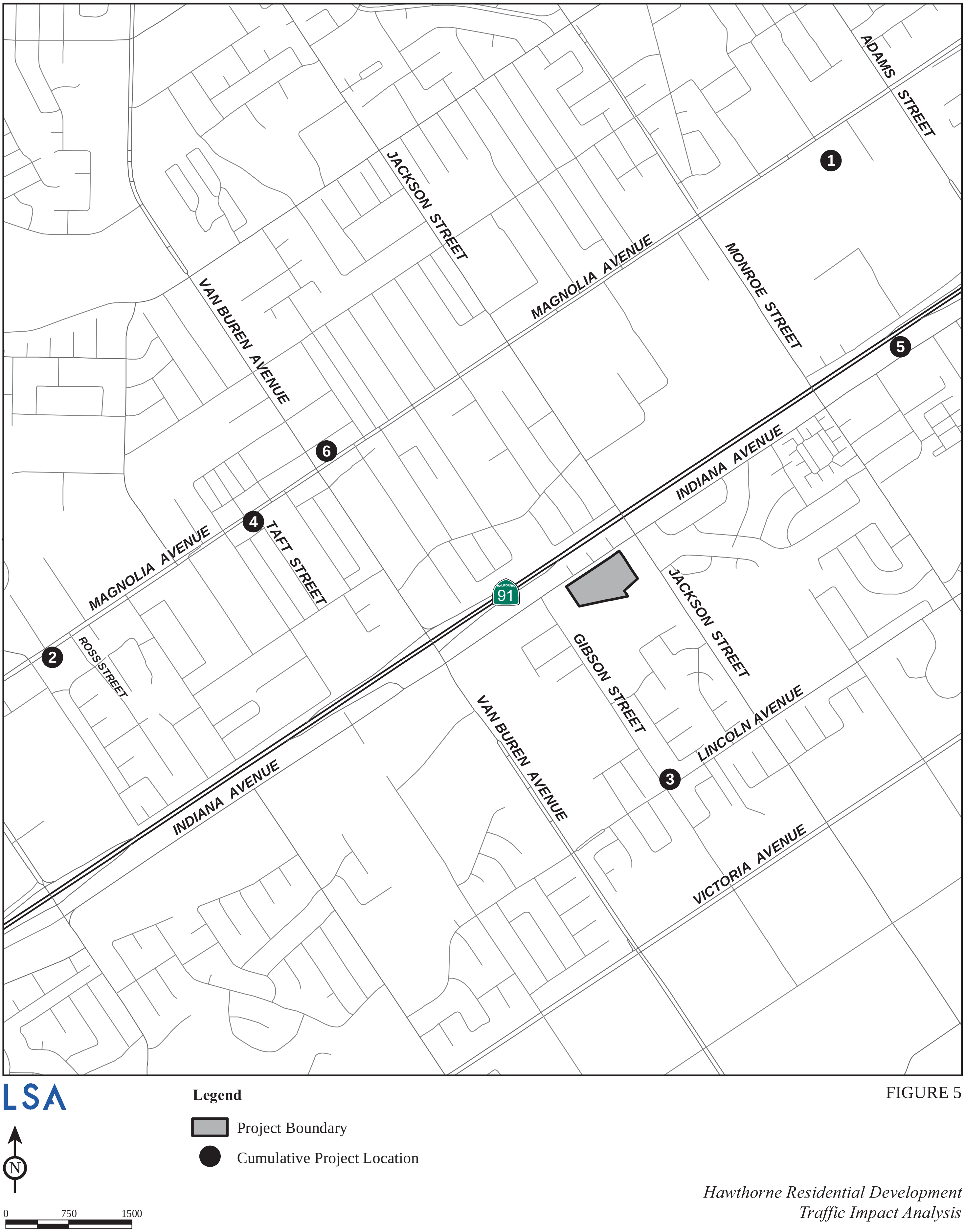


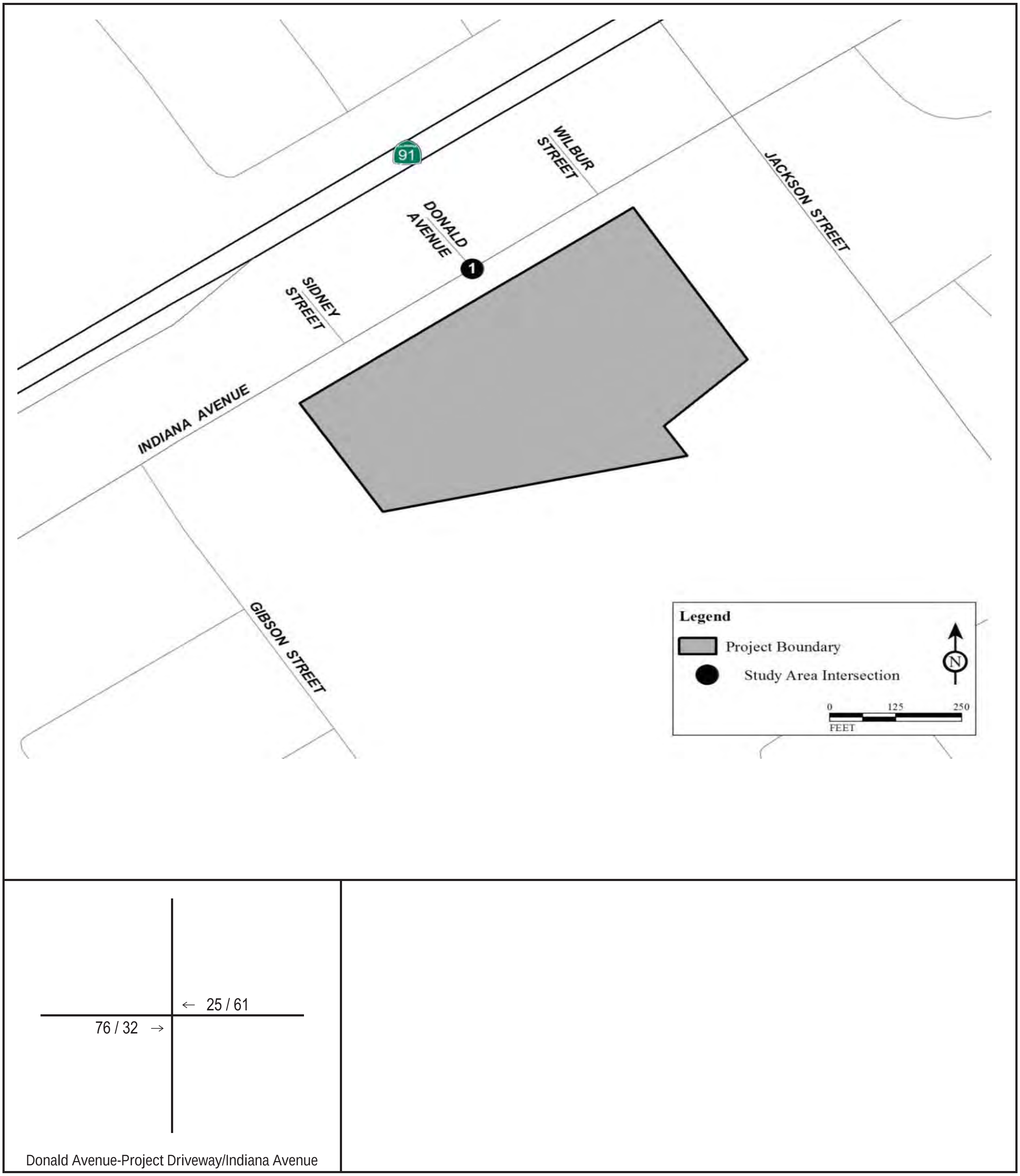
FIGURE 5

Hawthorne Residential Development
Traffic Impact Analysis

Cumulative Project Locations

SOURCE: Streetmap, 2013/Riverside County, 2015.

I:\SWK1603\Reports\Traffic\fig5_CumulativeProjs.mxd (10/17/2016)



LSA

FIGURE 6

XX / YY

AM / PM Peak Hour Trips

Hawthorne Residential Development

Traffic Impact Analysis

Cumualtive Project Trips

PROJECT TRAFFIC

Project Trip Generation

Total vehicle trip generation for the proposed project was developed using rates from the ITE *Trip Generation* (9th Edition) for Land Use 210 "Single-Family Detached Housing." As shown in Table D, the proposed project is anticipated to generate 514 daily trips with 41 trips occurring during the a.m. peak hour, 54 trips occurring during the p.m. peak hour.

Project Trip Distribution and Assignment

Generalized trip distribution patterns were developed based on the location of the proposed project in relation to surrounding land uses and the regional roadway network. The project trip distributions were approved by City staff via the City's scoping agreement process. Figure 7 illustrates the trip distribution and assignment for proposed project.

TRAFFIC VOLUMES WITH PROJECT SCENARIOS

Existing, project completion, cumulative, and build-out (2040) with project traffic volumes were developed by adding project traffic to the corresponding without project scenarios. Previously referenced Figure 4 illustrates existing, project completion, cumulative, and build-out with project traffic volumes.

INTERSECTION LEVELS OF SERVICE

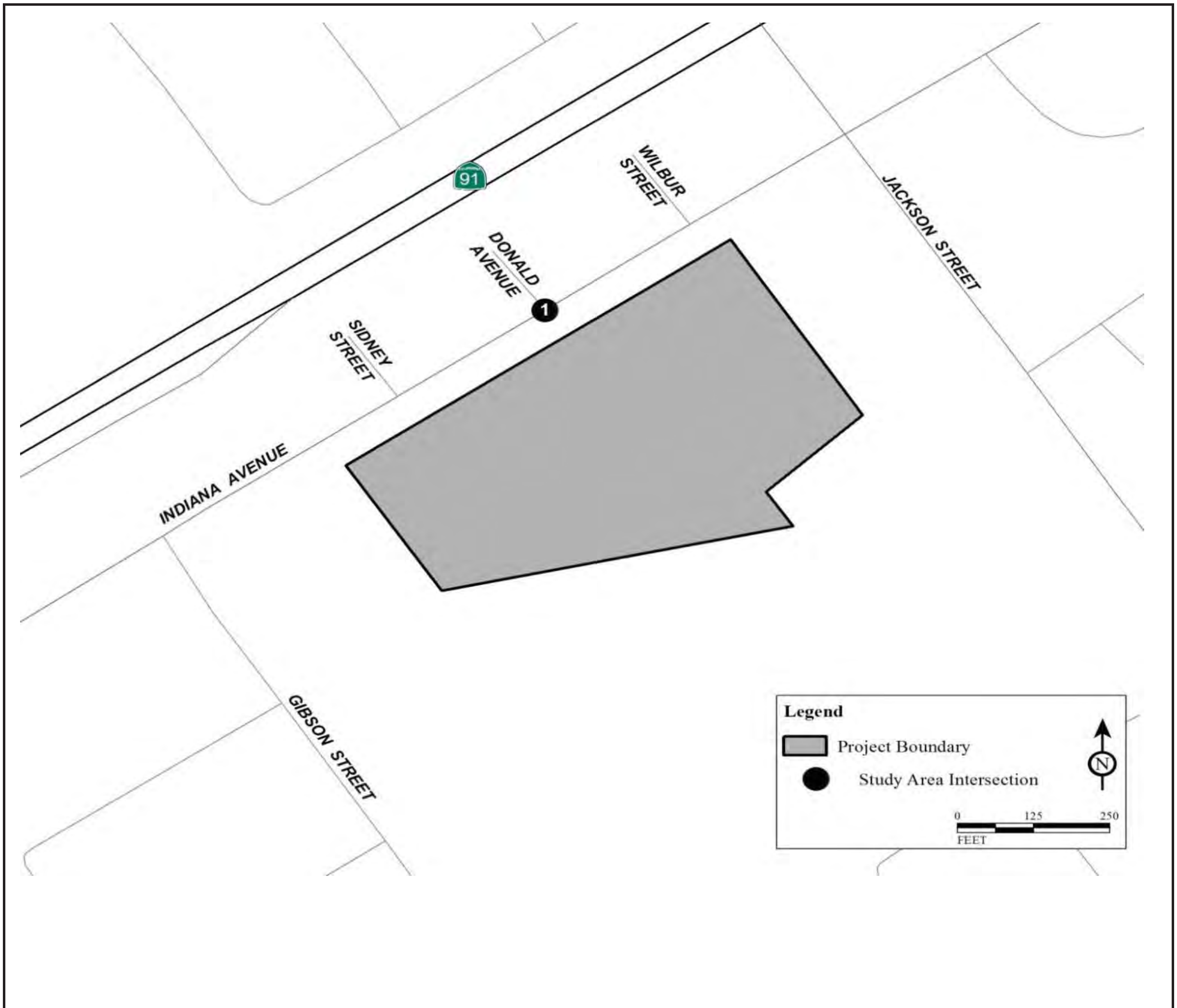
Existing, Project Completion (2017), Cumulative (2017), and Build-out (2040) Levels of Service

Figure 8 illustrates existing and future year without and with project study intersection geometrics. Existing, project completion, cumulative, and build-out traffic volumes were developed using the approach discussed in the traffic forecast section of this report. An intersection level of service analysis was conducted for each scenario to determine intersection performance. LOS calculation worksheets are included in Appendix D. Table E summarizes the results of these analyses and shows that the intersections of Donald Avenue-Project Driveway/Indiana Avenue would operate at satisfactory levels of service without and with the project under all scenarios analyzed in this report.

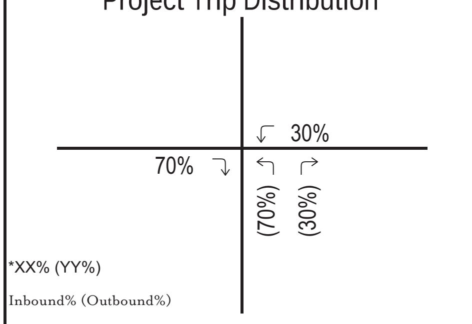
Based on the City's significant impact criteria as defined in the "Project Significance Threshold" section of this report, significant circulation impact occurs at the intersection Donald Avenue-Project Driveway/Indiana under build-out with project conditions (a.m. peak hour).

CIRCULATION IMPROVEMENTS AND RECOMMENDATIONS

At intersections where the level of service is forecast to be unsatisfactory or where the project would have a significant impact as defined in the "Project Significant Threshold" section of this report, improvements have been identified to maintain conformance with City level of service standards.

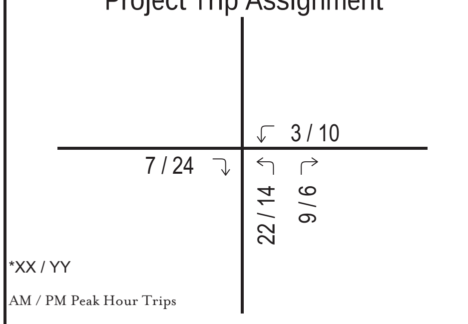


Project Trip Distribution



Donald Avenue-Project Driveway/Indiana Avenue

Project Trip Assignment



Donald Avenue-Project Driveway/Indiana Avenue

LSA

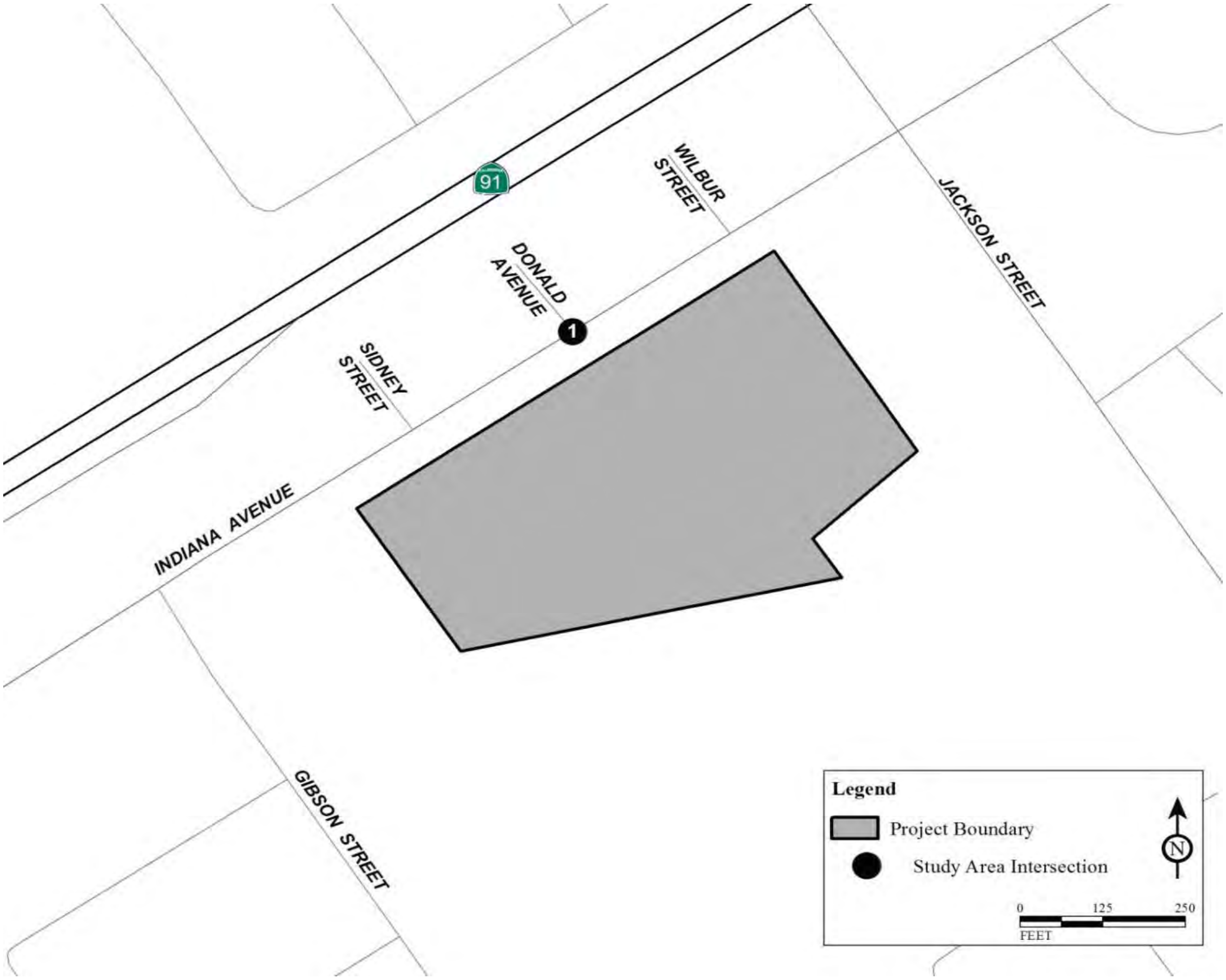
FIGURE 7

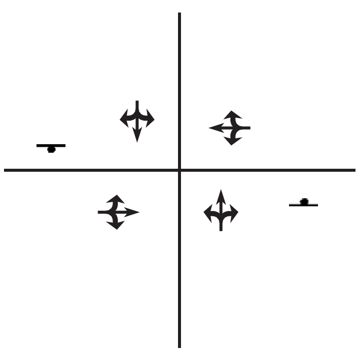
Hawthorne Residential Development

Traffic Impact Analysis

Project Trip Distribution and Assignment

R:\SWK1603\2016_09\z12_Project Dist and Assign 10/18/2016





Donald Avenue-Project Driveway/Indiana Avenue

FIGURE 8

Legend

Stop Sign

Hawthorne Residential Development

Traffic Impact Analysis

Existing and Future Intersection Geometrics and Stop Control

Table D - Project Trip Generation

Land Use	Units	A.M. Peak Hour In	A.M. Peak Hour Out	A.M. Peak Hour Total	P.M. Peak Hour In	P.M. Peak Hour Out	P.M. Peak Hour Total	Daily
Single-Family Residentia	54 DU							
Trips/Unit[1]		0.19	0.56	0.75	0.63	0.37	1.00	9.52
Trip Generation		10	31	41	34	20	54	514
Total Trip Generation		**10**	**31**	**41**	**34**	**20**	**54**	**514**

Notes:

DU = Dwelling Units

[1] Rates based on Land Use 210 - "Single Family Detached Housing" from the Institute of Transportation Engineers (ITE) *Trip Generation* Manual, 9th Edition.

Table E - Study Intersection Level of Service
(Intersection of Donald Avenue-Project Driveway/Indiana Avenue)

		Without Project				With Project				With Project With Recommended Improvements			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		A. Peak Hour		PM Peak Hour	
Scenario	Control	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS
Existing Conditions	TWSC	15.4	C	19.6	C	18.9	C	20.9	C	*No Improvements Required*			
Project Completion (2017) Conditions	TWSC	15.6	C	19.9	C	19.2	C	21.2	C	*No Improvements Required*			
Cumulative (2017) Conditions	TWSC	17.6	C	22.5	C	22.6	C	24.1	C	*No Improvements Required*			
Build-Out (2040) Conditions	TWSC	21.2	C	30.4	D	**30.0**	**D** *	32.7	D	16.2	C	16.7	D

Notes:

TWSC = Two-Way Stop Control, AWSC = All-Way Stop Control

For TWSC intersections, reported delay is for worst-case movement.

LOS = Level of Service

* A significant circulation impact occurs as the addition of project related trips causes the a.m. peak hour delay to increase by more than 8.0 seconds when operating at LOS C.

Build-out (2040) Improvements

- **Donald Avenue-Project Driveway/Indiana Avenue:** Restripe Indiana Avenue to provide a two-way left-turn lane along the project frontage. This improvement will be provided by the project. As such, the cumulative LOS deficiency at this location does not constitute a significant impact. A copy the proposed striping plan is included in Appendix E.

Previously referenced Table D summarizes levels of service at the intersection of Donald Avenue-Project Driveway/Indiana Avenue with the recommended improvements under build-out (2040) with project conditions. As shown in Table D, the intersection of Donald Avenue-Project Driveway/Indiana Avenue would operate at a satisfactory LOS with the implementation of the recommended improvements. As previously mentioned, this improvement will be provided by the project.

SUMMARY AND CONCLUSIONS

The proposed project will include 54 single-family residential units. Access to the project site will be provided via the south leg of the intersection of Donald Avenue/Indiana Avenue. Under all scenarios analyzed in this TIA, the intersection of Donald Avenue-Project Driveway/Indiana Avenue is forecast to operate at an acceptable LOS during the a.m. and p.m. peak hours.

Based on the City’s significant impact criteria as defined in the “Project Significance Threshold” section of this report, significant circulation impact occurs at the intersection Donald Avenue-Project Driveway/Indiana under build-out with project conditions (a.m. peak hour). As discussed in the “Circulation Improvements and Recommendations” section of this report, a two-way left-turn lane along the project frontage would be required to improve intersection performance to satisfactory conditions. Because this improvement will be provided in order to facilitate access to the project, a cumulative LOS deficiency at this location does not constitute a significant impact.

APPENDIX A:

SCOPING AGREEMENT

LSA
LSA ASSOCIATES, INC.
1500 IOWA AVENUE, SUITE 200
RIVERSIDE, CALIFORNIA 92507
951.781.9310 TEL
951.781.4277 FAX
BERKELEY
CARLSBAD
FRESNO
IRVINE
PALM SPRINGS
PT. RICHMOND
ROCKLIN
SAN LUIS OBISPO

September 23, 2016

Mr. Nathan Mustafa, P.E.
City of Riverside
3900 Main Street
Riverside, California 92522

Subject: Scope of Work for Hawthorne Residential Development Project Traffic Impact Analysis (LSA Project No. SWK1603)

Dear Mr. Mustafa:

LSA will be preparing a traffic impact analysis (TIA) for the proposed Hawthorne Residential Development Project to be located at 9170 Indiana Avenue, in the City of Riverside (City). Attached is Exhibit B, the "Scoping Agreement for Traffic Impact Study" form of the City's Traffic Impact Analysis Preparation Guide, dated January 2016, for your review.

The proposed project will include 54 single-family residential units. Access to the project site will be provided via of the south leg of the intersection of Donald Avenue/Indiana Avenue. Figure 1 (all figures and tables attached) illustrates the regional and project location. Figure 2 illustrates a conceptual site plan of the proposed project. Figure 3 illustrates the proposed study area intersection.

LSA anticipates that the following scope of work will be required to conduct the traffic study for proposed project.

SCOPE OF WORK

Trip Generation

Total vehicle trip generation for the proposed project will be developed using rates from the Institute of Transportation Engineers (ITE) *Trip Generation* (9th Edition) for Land Use 210 "Single-Family Detached Housing." As shown in Table A, the proposed project is anticipated to generate 41 gross trips in the a.m. peak hour, 54 gross trips in the p.m. peak hour, and 514 gross daily trips.

Project trip distribution patterns are based on the locations of residential, employment, and commercial centers in relation to the proposed project. Figure 4 illustrates the project trip distribution. The project trip generation was applied to the trip distribution patterns to develop the project trip assignments. Figure 5 illustrates the project trip assignment.

The TIA will be prepared to satisfy the requirements established by the City of Riverside "Traffic Impact Preparation Guide," dated January 2016, as well as the requirements for the disclosure of potential impacts and mitigation measures pursuant to the California Environmental Quality Act (CEQA). Based on the City's TIA guidelines, the study area shall generally include any intersection of "Collector" or higher classification street on which the proposed project will add 50 or more peak hour trips. As such, LSA proposes include the following intersection:

1. Donald Avenue-Project Driveway/Indiana Avenue.

Analysis Scenarios

The TIA for the proposed project will be prepared to meet the requirements of the City. LSA proposes to analyze a.m. and p.m. peak hour traffic operations at the study intersection for the following scenarios:

- Existing Conditions;
- Existing Year plus Project Conditions;
- Project Completion without Project Conditions;
- Project Completion with Project Conditions;
- Cumulative Without Project Conditions; and
- Cumulative Plus Project Conditions.

Because the project requires a General Plan Amendment, the following scenarios will be analyzed as well:

- Build-out 2040 Without Project Conditions; and
- Build-out 2040 With Project Conditions.

Volume Development and Analysis Methodology

Traffic volumes for existing year traffic conditions will be based on existing a.m. and p.m. peak hour traffic counts collected the intersections identified for analysis. The a.m. peak hour is defined as the one hour of highest traffic volumes occurring between 7:00 and 9:00 a.m., while the p.m. peak hour is defined as the one hour of highest traffic volume occurring between 4:00 and 6:00 p.m.

Project completion without project traffic volumes will be developed by applying an annual growth rate of 1.5 percent per year (2016 to 2017) to existing peak hour traffic volumes. Cumulative project traffic volumes will be added to the project completion volumes to develop cumulative without project traffic volumes. Traffic volumes for future build-out year (2040) base traffic conditions will be developed 1.5 percent per annum to existing traffic volumes.

Existing, project completion, cumulative, and build-out year (2040) with project traffic volumes will be developed by adding project traffic to the corresponding without project scenarios.

The TIA will analyze study intersections during the a.m. and p.m. peak hours. Intersection levels of service (LOS) will be calculated using the *Highway Capacity Manual 2010* (HCM 2010) analysis methodologies and using *Synchro 9.0* software.

Project Impact Assessment and Mitigation Measures

Intersection LOS without the project will be compared to the intersection LOS plus the project for each of the analysis scenarios to determine potential project impacts. Determination of the significance of project impacts will be made based on City's LOS and threshold of significance criteria. At significantly affected intersections, mitigation measures will be recommended to improve intersection performance to satisfactory conditions. Mitigation measures may include intersection turn lanes, signalization, and segment lane additions. The LOS with mitigation will be calculated and summarized, along with a comparison of the LOS without mitigation.

Fair Share

For improvements not included in any fee program, LSA will calculate project's fair-share percentage to total new traffic. A table with recommended mitigation will be prepared and will include mitigation measures required under future build-out year (2040) conditions. The fair share will be based on project traffic as a percentage of total growth from existing to year 2040.

Sincerely,

LSA ASSOCIATES, INC.

Joe Urzua
Senior Transportation Planner

Attachments: Exhibit B: Scope of Study Form
Table A: Project Trip Generation
Figure 1: Regional and Project Location
Figure 2: Site Plan
Figure 3: Study Area Intersection
Figure 4: Project Trip Distribution
Figure 5: Project Trip Assignment

Exhibit B

SCOPING AGREEMENT FOR TRAFFIC IMPACT STUDY

This letter acknowledges the City of Riverside Public Works Traffic Engineering Division requirements for traffic impact analysis of the following project. The analysis must follow the City Traffic Impact Analysis Preparation Guide dated January 2016.

Case No. P16-0112, P16-0113 ,p16-0114 & p16-0111
Related Cases -
SP No.
EIR No.
GPA No.
CZ No.
Project Name: Hawthome Residentail Development
Project Location: 9170 Indiana Avenue, Riverside
Project Description: The project is proposed to develop 54 single-family residential dwelling units in occupied land.

	Consultant	Developer
Name:	LSA Associates, Inc.	Steve Berzansky, Steven Walker Communities, Inc.
Address:	1500 Iowa Avenue, Suite 200	7111 Indiana Avenue, Suite 300
	Riverside, CA 92507	Riverside, CA 92504
Telephone:	951-781-9310	(951) 784-0840

A. Trip Generation Source: ITE *Trip Generation Manual*, most recent edition

Existing Land Use: School
Existing Zoning: Public Facilities/Institutional
Total Daily Trips: 514
Proposed Land Use: Single-Family Residential
Proposed Zoning: Single-Family Residential

	In	Out	Total
AM Trips	10	31	41
PM Trips	34	20	54

Internal Trip Allowance ☐ Yes ☒ No (% Trip Discount)
Pass-By Trip Allowance ☐ Yes ☒ No (% Trip Discount)
(Attach additional sheet if this is a multi-use site with a breakdown of trips generated)

B. Trip Geographic Distribution: N 0 % S 0 % E 25 % W 75 %
(See attached exhibit for detailed assignment)

C. Background Traffic

Project Completion Year: 2016 Annual Ambient Growth Rate: 1.5 %
Other area projects to be included: See attached Table B

Please contact Planning Division or use the most recently provided data

Model/Forecast methodology if required Not Applicable

D. Build-out Studies: Does this project require a Build-out Study per TIA Guidelines Section 7.2?

■ Yes ☐ No

E. Study Intersections: (NOTE: Subject to revision after other projects, trip generation and distribution are determined, or comments from other agencies.)

1. Donald Avenue-Project Driveway/Indiana Avenue
2.
3.
4.
5.
6.
7.
8.

F. Study Roadway Segments (For Build-out Studies):

1.
2.
3.
4.
5.
6.
7.
8.

G. Other Jurisdictional Impacts

Is this project within any other Agency's Sphere of Influence or one-mile radius of boundaries? ☐ Yes ■ No

If so, name of Jurisdiction:

H. Site Plan (please attach a legible 11'X17' copy)

I. Specific Issues to be addressed in the Study (in addition to the standard analysis described in the Guideline) (To be filled out by Public Works Traffic Department)

PLEASE INCLUDE RECOMMENDED TRAFFIC CONTROL AT INTERSECTION OF INDIANA & DONALD

Recommended by:

Joe Urzua
Consultant's Representative

09/23/2016
Date

Scoping Agreement Submitted on

09/23/2016
Date

Scoping Agreement Resubmitted on

Date

Approved Scoping Agreement:

City of Riverside
Traffic Engineering Division

10/11/16
Date

cc: Planning Division

Table A - Project Trip Generation

Land Use		Units	A.M. Peak Hour In	A.M. Peak Hour Out	A.M. Peak Hour Total	P.M. Peak Hour In	P.M. Peak Hour Out	P.M. Peak Hour Total	Daily
Single-Family Residentia	54	Dwelling							
Trips/Unit[1]			0.19	0.56	0.75	0.63	0.37	1.00	9.52
Trip Generation			10	31	41	34	20	54	514
Total Trip Generation			**10**	**31**	**41**	**34**	**20**	**54**	**514**

1 Rates based on Land Use 210 - "Single Family Detached Housing" from the *Institute of Transportation Engineers (ITE) Trip Generation* Manual, 9th Edition.

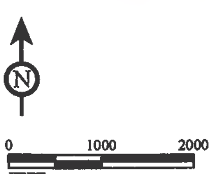
Table B - Proposed Cumulative Projects

No.	Project (Case #)	Land Use	Location	Units
1	P15-0988, P15-098, P15-087 P15-0990	CBU Specific Plan Amendment University/College Campus)	8432 Magnolia Avenue	146,000 SF
2	P15-0894, P16-0004, P16-0297	Retail	10050 Magnolia Avenue	5,200 SF
3	P15-0957	Single Family Residential	Northeast Corner of Gibson and Li	18 DU
4	P16-301	Commercial Restaurant	9644 Magnolia Avenue	10,265 SF 2,043 SF
5	P16-0404, 0545-0546	Car Dealership	8505-8543 Indiana Avenue	41,000 SF
6	P16-0238, P16-0104	Commercial	9471 Magnolia Avenue.	15,000 SF

Notes: SF = Square Feet; DU = Dwelling Units

LSA

FIGURE 1

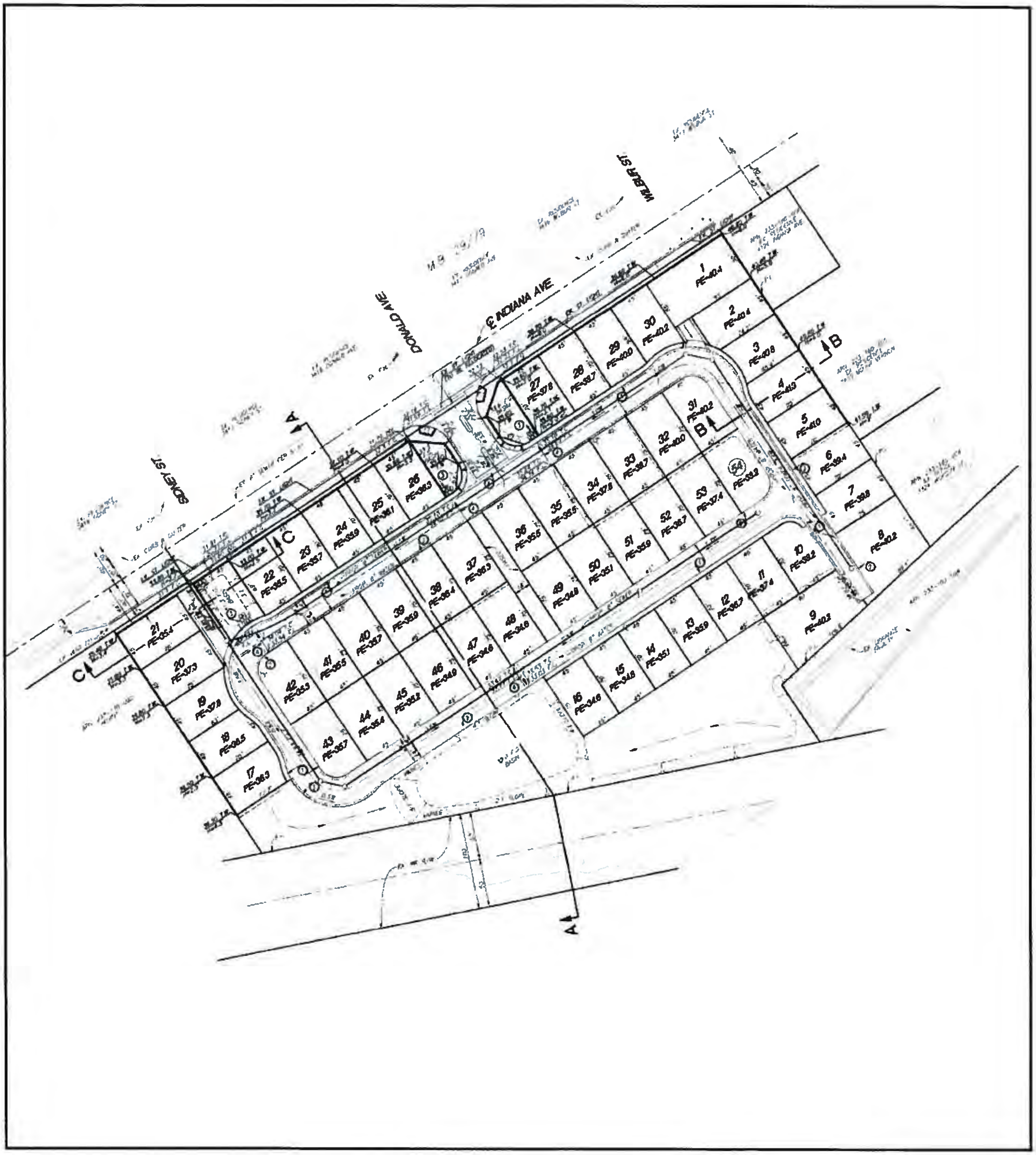


SOURCE: Bing Aerial, 2016: Streetmap, 2013/Riverside County, 2015.

Hawthorne Residential Development
Traffic Impact Analysis

Regional and Project Location

I:\SWK1603\Reports\Traffic\fig1_RegLoc.mxd (9/23/2016)



LSA

FIGURE 2

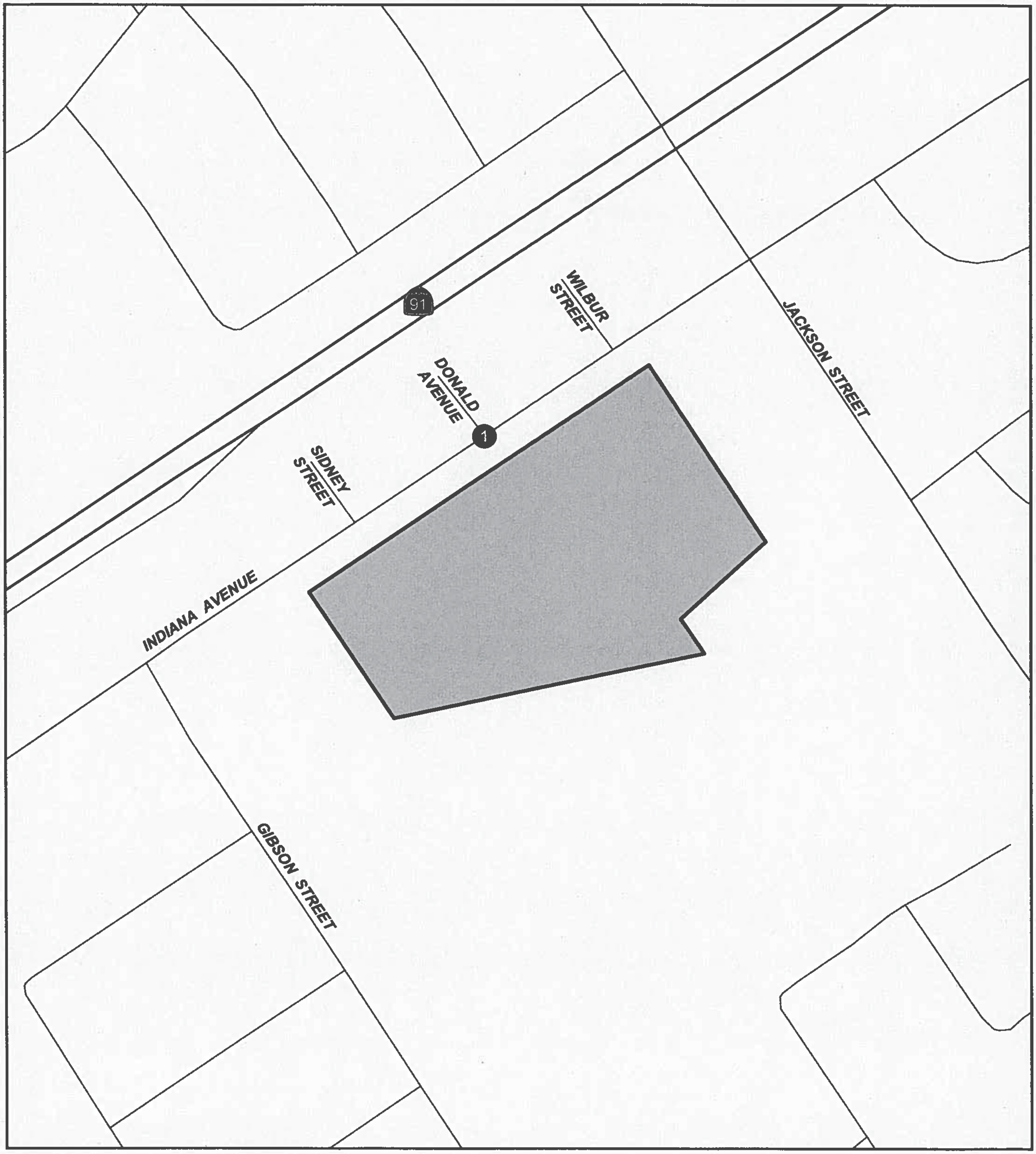
0 70 140
FEET

SOURCE: SDH and Associates, Inc. February, 2016.

Hawthorne Residential Development
Traffic Impact Analysis

Conceptual Site Plan

I:\SWK1603\Reports\Traffic\fig2_ConceptSP.mxd (9/23/2016)



LSA

Legend

Project Boundary

Study Area Intersection

0 125 250
FEET

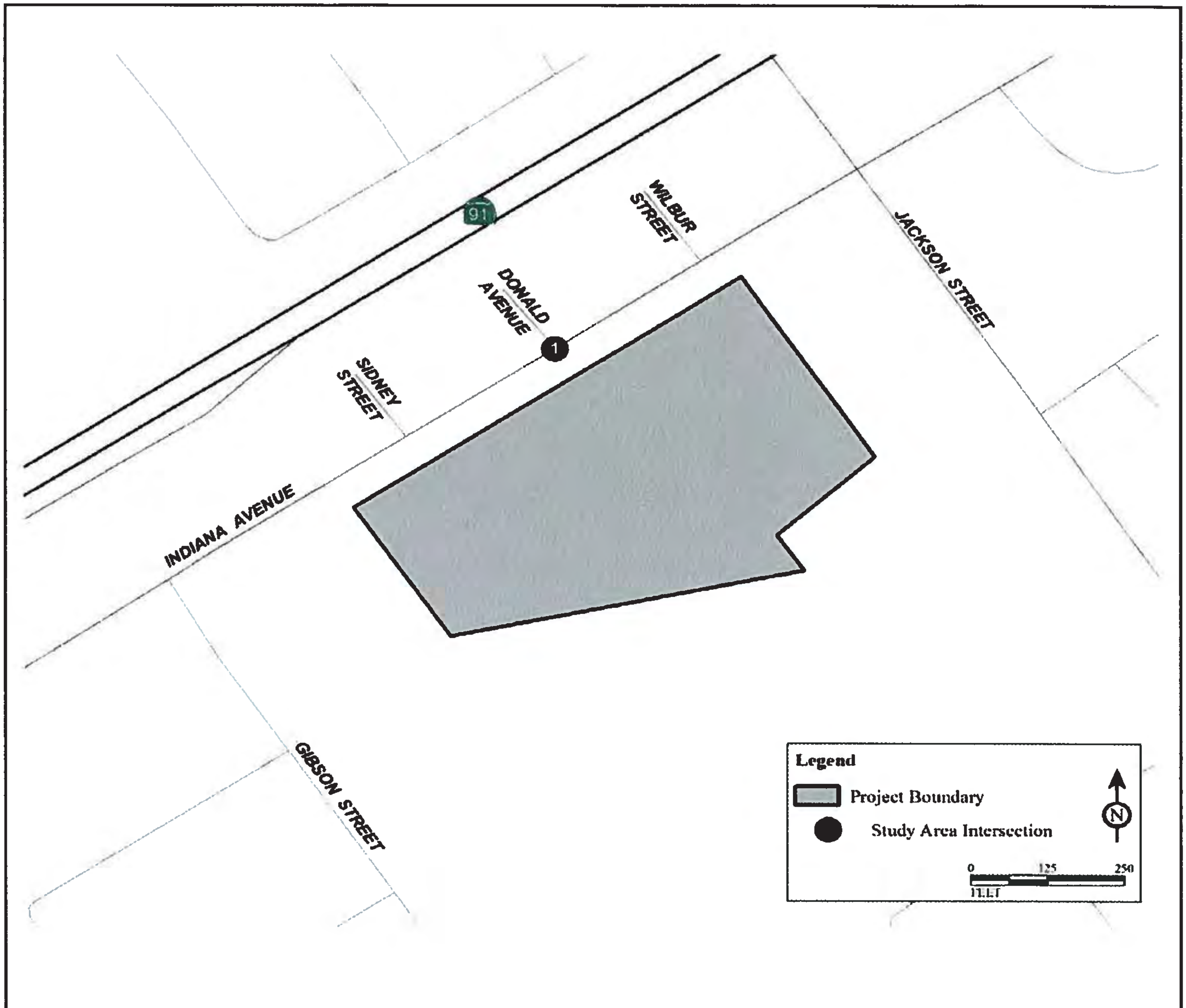
SOURCE: Streetmap, 2013/Riverside County, 2015.

FIGURE 3

Hawthorne Residential Development
Traffic Impact Analysis

Study Area Intersection

I:\SWK1603\Reports\Traffic\fig3_StudyAreaInters.mxd (9/23/2016)



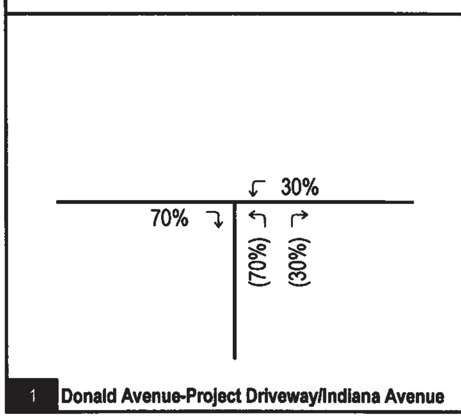


FIGURE 4

LSA

XX% (YY%)

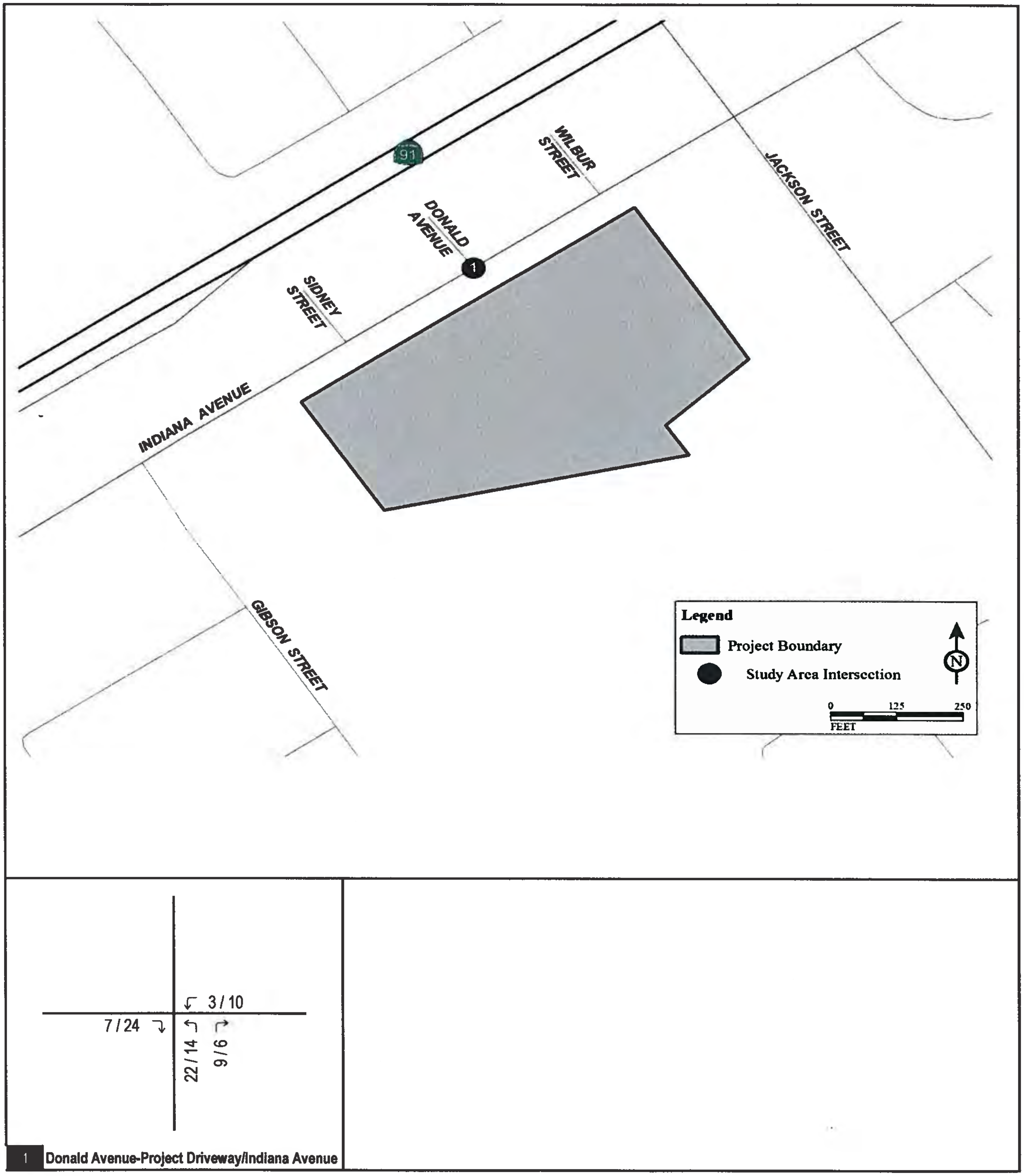
Inbound% (Outbound%) Trip Distribution

Hawthorne Residential Development

Traffic Impact Study

Project Trip Distribution

R:\SWK1603\Scope\z12 - Dist 9/23/2016



LSA

FIGURE 5

XX / YY

AM / PM Peak Hour Trips

Hawthorne Residential Development

Traffic Impact Analysis

Project Trip Assignment

R:\SWK1603\Scope\z12 - Assn 9/23/2016

APPENDIX B:

TRAFFIC COUNT SHEETS

ITM Peak Hour Summary

Prepared by:

National Data & Surveying Services

Donald Ave and Indiana Ave , Riverside

Date:	9/8/2016
Day:	Thursday
Project #:	16-6124-002
City:	Riverside

AM Peak Hour	730 AM
NOON Peak Hour	
PM Peak Hour	445 PM

N

Donald Ave

Indiana Ave

Peak Hour Summary

Southbound Approach

	Lanes 0	Lanes 1	Lanes 0	
AM	0	0	0	0
NOON	0	0	0	0
PM	0	0	1	1

Eastbound Approach

	Lanes	AM	NOON	PM
Departing		312	0	340
Left	0	0	0	0
Through	1	438	0	529
Right	0	0	0	0

Westbound Approach

	AM	NOON	PM	Lanes
Right	0	0	1	0
Through	311	0	340	1
Left	1	0	0	0
Departing	439	0	530	

CONTROL

1-Way Stop(SB)

Northbound Approach

	Departing	Left	Through	Right	
AM	1	1	0	1	AM
	0	0	0	0	
	0	0	0	0	
Lanes		0	1	0	

Count Periods	Start	End
AM	7:00 AM	9:00 AM
NOON	NONE	NONE
PM	4:00 PM	6:00 PM

APPENDIX C:

VOLUME DEVELOPMENT WORKSHEETS

Table C-1 - Existing Peak Hour Volume Summary

	AM Peak Hour			PM Peak Hour		
	Existing Volume	Project Trips	With Project Volume	Existing Volume	Project Trips	With Project Volume
1 Donald Avenue-Project Driveway/Indiana Avenue						
NBL	1	22	23	0	14	14
NBT	0	0	0	0	0	0
NBR	1	9	10	0	6	6
SBL	0	0	0	1	0	1
SBT	0	0	0	0	0	0
SBR	0	0	0	0	0	0
EBL	0	0	0	0	0	0
EBT	438	0	438	529	0	529
EBR	0	7	7	0	24	24
WBL	1	3	4	0	10	10
WBT	311	0	311	340	0	340
WBR	0	0	0	1	0	1
North Leg						
Approach	0	0	0	1	0	1
Departure	0	0	0	1	0	1
Total	0	0	0	2	0	2
South Leg						
Approach	2	31	33	0	20	20
Departure	1	10	11	0	34	34
Total	3	41	44	0	54	54
East Leg						
Approach	312	3	315	341	10	351
Departure	439	9	448	530	6	536
Total	751	12	763	871	16	887
West Leg						
Approach	438	7	445	529	24	553
Departure	312	22	334	340	14	354
Total	750	29	779	869	38	907
Total Approaches						
Approach	752	41	793	871	54	925
Departure	752	41	793	871	54	925
Total	1,504	82	1,586	1,742	108	1,850

Table C-2-Year 2017 Peak Hour Volume Summary

	Existing Volume	Ambient Growth	Existing (+) Ambient W/O Project	Project Trips	Existing (+) Ambient W/ Project	Existing Volume	Ambient Growth	Existing (+) Ambient W/O Project	Project Trips	Existing (+) Ambient W/ Project
1 Donald Avenue-Project Driveway/Indiana Avenue										
NBL	1	0	1	22	23	0	0	0	14	14
NBT	0	0	0	0	0	0	0	0	0	0
NBR	1	0	1	9	10	0	0	0	6	6
SBL	0	0	0	0	0	1	0	1	0	1
SBT	0	0	0	0	0	0	0	0	0	0
SBR	0	0	0	0	0	0	0	0	0	0
EBL	0	0	0	0	0	0	0	0	0	0
EBT	438	7	445	0	445	529	8	537	0	537
EBR	0	0	0	7	7	0	0	0	24	24
WBL	1	0	1	3	4	0	0	0	10	10
WBT	311	5	316	0	316	340	5	345	0	345
WBR	0	0	0	0	0	1	0	1	0	1
North Leg										
Approach	0	0	0	0	0	1	0	1	0	1
Departure	0	0	0	0	0	1	0	1	0	1
Total	0	0	0	0	0	2	0	2	0	2
South Leg										
Approach	2	0	2	31	33	0	0	0	20	20
Departure	1	0	1	10	11	0	0	0	34	34
Total	3	0	3	41	44	0	0	0	54	54
East Leg										
Approach	312	5	317	3	320	341	5	346	10	356
Departure	439	7	446	9	455	530	8	538	6	544
Total	751	12	763	12	775	871	13	884	16	900
West Leg										
Approach	438	7	445	7	452	529	8	537	24	561
Departure	312	5	317	22	339	340	5	345	14	359
Total	750	12	762	29	791	869	13	882	38	920
Total Approaches										
Approach	752	12	764	41	805	871	13	884	54	938
Departure	752	12	764	41	805	871	13	884	54	938
Total	1,504	24	1,528	82	1,610	1,742	26	1,768	108	1,876

Table C-3-Year 2017 Cumulative Conditions Peak Hour Volume Summary

	Existing (+) Ambient W/O Project	Cumulative Projects	Cumulative NP	Project Trips	Cumulative WP	Existing (+) Ambient W/O Project	Cumulative Projects	Cumulative NP	Project Trips	Cumulative WP
1 Donald Avenue-Project Driveway/Indiana Avenue										
NBL	1	0	1	22	23	0	0	0	14	14
NBT	0	0	0	0	0	0	0	0	0	0
NBR	1	0	1	9	10	0	0	0	6	6
SBL	0	0	0	0	0	1	0	1	0	1
SBT	0	0	0	0	0	0	0	0	0	0
SBR	0	0	0	0	0	0	0	0	0	0
EBL	0	0	0	0	0	0	0	0	0	0
EBT	445	76	521	0	521	537	32	569	0	569
EBR	0	0	0	7	7	0	0	0	24	24
WBL	1	0	1	3	4	0	0	0	10	10
WBT	316	25	341	0	341	345	61	406	0	406
WBR	0	0	0	0	0	1	0	1	0	1
North Leg										
Approach	0	0	0	0	0	1	0	1	0	1
Departure	0	0	0	0	0	1	0	1	0	1
Total	0	0	0	0	0	2	0	2	0	2
South Leg										
Approach	2	0	2	31	33	0	0	0	20	20
Departure	1	0	1	10	11	0	0	0	34	34
Total	3	0	3	41	44	0	0	0	54	54
East Leg										
Approach	317	25	342	3	345	346	61	407	10	417
Departure	446	76	522	9	531	538	32	570	6	576
Total	763	101	864	12	876	884	93	977	16	993
West Leg										
Approach	445	76	521	7	528	537	32	569	24	593
Departure	317	25	342	22	364	345	61	406	14	420
Total	762	101	863	29	892	882	93	975	38	1,013
Total Approaches										
Approach	764	101	865	41	906	884	93	977	54	1,031
Departure	764	101	865	41	906	884	93	977	54	1,031
Total	1,528	202	1,730	82	1,812	1,768	186	1,954	108	2,062

Table C-4-Year 2040 Peak Hour Volume Summary

		2040 NP	Project Trips	2040 WP	2040 NP	Project Trips	2040 WP
1	**Donald Avenue-Project Driveway/Indiana Avenue**						
NBL		1	22	23	0	14	14
NBT		0	0	0	0	0	0
NBR		1	9	10	0	6	6
SBL		0	0	0	1	0	1
SBT		0	0	0	0	0	0
SBR		0	0	0	0	0	0
EBL		0	0	0	0	0	0
EBT		596	0	596	719	0	719
EBR		0	7	7	0	24	24
WBL		1	3	4	0	10	10
WBT		423	0	423	462	0	462
WBR		0	0	0	1	0	1
North Leg							
	Approach	0	0	0	1	0	1
	Departure	0	0	0	1	0	1
	Total	0	0	0	2	0	2
South Leg							
	Approach	2	31	33	0	20	20
	Departure	1	10	11	0	34	34
	Total	3	41	44	0	54	54
East Leg							
	Approach	424	3	427	463	10	473
	Departure	597	9	606	720	6	726
	Total	1,021	12	1,033	1,183	16	1,199
West Leg							
	Approach	596	7	603	719	24	743
	Departure	424	22	446	462	14	476
	Total	1,020	29	1,049	1,181	38	1,219
Total Approaches							
	Approach	1,022	41	1,063	1,183	54	1,237
	Departure	1,022	41	1,063	1,183	54	1,237
	Total	2,044	82	2,126	2,366	108	2,474

APPENDIX D:

LOS CALCULATION WORKSHEETS

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	438	0	1	311	0	1	0	1	0	0	0
Future Vol, veh/h	0	438	0	1	311	0	1	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	534	0	1	379	0	1	0	1	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	379	0	0	534	0	0	916	916	534	917	916	379
Stage 1	-	-	-	-	-	-	534	534	-	382	382	-
Stage 2	-	-	-	-	-	-	382	382	-	535	534	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1191	-	-	1044	-	-	255	274	550	255	274	672
Stage 1	-	-	-	-	-	-	534	528	-	645	616	-
Stage 2	-	-	-	-	-	-	645	616	-	533	528	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1191	-	-	1044	-	-	255	274	550	254	274	672
Mov Cap-2 Maneuver	-	-	-	-	-	-	255	274	-	254	274	-
Stage 1	-	-	-	-	-	-	534	528	-	645	615	-
Stage 2	-	-	-	-	-	-	644	615	-	532	528	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	15.4	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	348	1191	-	-	1044	-	-	-
HCM Lane V/C Ratio	0.007	-	-	-	0.001	-	-	-
HCM Control Delay (s)	15.4	0	-	-	8.5	0	-	0
HCM Lane LOS	C	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	0	529	0	0	340	1	0	0	0	1	0	0
Future Vol, veh/h	0	529	0	0	340	1	0	0	0	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	569	0	0	366	1	0	0	0	1	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	367	0	0	569	0	0	935	936	569	935	935	366
Stage 1	-	-	-	-	-	-	569	569	-	366	366	-
Stage 2	-	-	-	-	-	-	366	367	-	569	569	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1203	-	-	1013	-	-	248	267	525	248	267	684
Stage 1	-	-	-	-	-	-	511	509	-	657	626	-
Stage 2	-	-	-	-	-	-	657	626	-	511	509	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1203	-	-	1013	-	-	248	267	525	248	267	684
Mov Cap-2 Maneuver	-	-	-	-	-	-	248	267	-	248	267	-
Stage 1	-	-	-	-	-	-	511	509	-	657	626	-
Stage 2	-	-	-	-	-	-	657	626	-	511	509	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	19.6
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1203	-	-	1013	-	-	248
HCM Lane V/C Ratio	-	-	-	-	-	-	-	0.004
HCM Control Delay (s)	0	0	-	-	0	-	-	19.6
HCM Lane LOS	A	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	438	7	4	311	0	23	0	10	0	0	0
Future Vol, veh/h	0	438	7	4	311	0	23	0	10	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	534	9	5	379	0	28	0	12	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	379	0	0	543	0	0	927	927	538	934	932	379
Stage 1	-	-	-	-	-	-	538	538	-	389	389	-
Stage 2	-	-	-	-	-	-	389	389	-	545	543	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1191	-	-	1036	-	-	251	270	547	248	269	672
Stage 1	-	-	-	-	-	-	531	526	-	639	612	-
Stage 2	-	-	-	-	-	-	639	612	-	526	523	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1191	-	-	1036	-	-	250	268	547	241	267	672
Mov Cap-2 Maneuver	-	-	-	-	-	-	250	268	-	241	267	-
Stage 1	-	-	-	-	-	-	531	526	-	639	608	-
Stage 2	-	-	-	-	-	-	635	608	-	514	523	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.1	18.9	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	299	1191	-	-	1036	-	-	-
HCM Lane V/C Ratio	0.135	-	-	-	0.005	-	-	-
HCM Control Delay (s)	18.9	0	-	-	8.5	0	-	0
HCM Lane LOS	C	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0.5	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	529	24	10	340	1	14	0	6	1	0	0
Future Vol, veh/h	0	529	24	10	340	1	14	0	6	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	569	26	11	366	1	15	0	6	1	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	367	0	0	595	0	0	970	970	582	973	983	366
Stage 1	-	-	-	-	-	-	582	582	-	388	388	-
Stage 2	-	-	-	-	-	-	388	388	-	585	595	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1203	-	-	991	-	-	235	255	517	233	251	684
Stage 1	-	-	-	-	-	-	502	502	-	640	612	-
Stage 2	-	-	-	-	-	-	640	612	-	501	496	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1203	-	-	991	-	-	232	251	517	228	247	684
Mov Cap-2 Maneuver	-	-	-	-	-	-	232	251	-	228	247	-
Stage 1	-	-	-	-	-	-	502	502	-	640	603	-
Stage 2	-	-	-	-	-	-	631	603	-	495	496	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.2	19	20.9
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	278	1203	-	-	991	-	-	228
HCM Lane V/C Ratio	0.077	-	-	-	0.011	-	-	0.005
HCM Control Delay (s)	19	0	-	-	8.7	0	-	20.9
HCM Lane LOS	C	A	-	-	A	A	-	C
HCM 95th %tile Q(veh)	0.2	0	-	-	0	-	-	0

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	445	0	1	316	0	1	0	1	0	0	0
Future Vol, veh/h	0	445	0	1	316	0	1	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	543	0	1	385	0	1	0	1	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	385	0	0	543	0	0	931	931	543	931	931	385
Stage 1	-	-	-	-	-	-	543	543	-	388	388	-
Stage 2	-	-	-	-	-	-	388	388	-	543	543	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1185	-	-	1036	-	-	249	269	544	249	269	667
Stage 1	-	-	-	-	-	-	528	523	-	640	612	-
Stage 2	-	-	-	-	-	-	640	612	-	528	523	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1185	-	-	1036	-	-	249	269	544	248	269	667
Mov Cap-2 Maneuver	-	-	-	-	-	-	249	269	-	248	269	-
Stage 1	-	-	-	-	-	-	528	523	-	640	611	-
Stage 2	-	-	-	-	-	-	639	611	-	527	523	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	15.6	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	342	1185	-	-	1036	-	-	-
HCM Lane V/C Ratio	0.007	-	-	-	0.001	-	-	-
HCM Control Delay (s)	15.6	0	-	-	8.5	0	-	0
HCM Lane LOS	C	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	537	0	0	345	1	0	0	0	1	0	0
Future Vol, veh/h	0	537	0	0	345	1	0	0	0	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	577	0	0	371	1	0	0	0	1	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	372	0	0	577	0	0	949	949	577	949	949	372
Stage 1	-	-	-	-	-	-	577	577	-	372	372	-
Stage 2	-	-	-	-	-	-	372	372	-	577	577	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1198	-	-	1006	-	-	242	262	520	242	262	678
Stage 1	-	-	-	-	-	-	506	505	-	653	622	-
Stage 2	-	-	-	-	-	-	653	622	-	506	505	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1198	-	-	1006	-	-	242	262	520	242	262	678
Mov Cap-2 Maneuver	-	-	-	-	-	-	242	262	-	242	262	-
Stage 1	-	-	-	-	-	-	506	505	-	653	622	-
Stage 2	-	-	-	-	-	-	653	622	-	506	505	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	19.9
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1198	-	-	1006	-	-	242
HCM Lane V/C Ratio	-	-	-	-	-	-	-	0.004
HCM Control Delay (s)	0	0	-	-	0	-	-	19.9
HCM Lane LOS	A	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	445	7	4	316	0	23	0	10	0	0	0
Future Vol, veh/h	0	445	7	4	316	0	23	0	10	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	543	9	5	385	0	28	0	12	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	385	0	0	551	0	0	942	942	547	948	946	385
Stage 1	-	-	-	-	-	-	547	547	-	395	395	-
Stage 2	-	-	-	-	-	-	395	395	-	553	551	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1185	-	-	1029	-	-	245	265	541	243	264	667
Stage 1	-	-	-	-	-	-	525	521	-	634	608	-
Stage 2	-	-	-	-	-	-	634	608	-	521	519	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1185	-	-	1029	-	-	244	263	541	236	262	667
Mov Cap-2 Maneuver	-	-	-	-	-	-	244	263	-	236	262	-
Stage 1	-	-	-	-	-	-	525	521	-	634	604	-
Stage 2	-	-	-	-	-	-	630	604	-	509	519	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.1	19.2	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	293	1185	-	-	1029	-	-	-
HCM Lane V/C Ratio	0.137	-	-	-	0.005	-	-	-
HCM Control Delay (s)	19.2	0	-	-	8.5	0	-	0
HCM Lane LOS	C	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0.5	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	537	24	10	345	1	14	0	6	1	0	0
Future Vol, veh/h	0	537	24	10	345	1	14	0	6	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	577	26	11	371	1	15	0	6	1	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	372	0	0	603	0	0	983	984	590	987	996	372
Stage 1	-	-	-	-	-	-	590	590	-	393	393	-
Stage 2	-	-	-	-	-	-	393	394	-	594	603	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1198	-	-	984	-	-	230	250	511	228	246	678
Stage 1	-	-	-	-	-	-	497	498	-	636	609	-
Stage 2	-	-	-	-	-	-	636	609	-	495	492	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1198	-	-	984	-	-	228	247	511	223	243	678
Mov Cap-2 Maneuver	-	-	-	-	-	-	228	247	-	223	243	-
Stage 1	-	-	-	-	-	-	497	498	-	636	600	-
Stage 2	-	-	-	-	-	-	627	600	-	489	492	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.2	19.3	21.2
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	273	1198	-	-	984	-	-	223
HCM Lane V/C Ratio	0.079	-	-	-	0.011	-	-	0.005
HCM Control Delay (s)	19.3	0	-	-	8.7	0	-	21.2
HCM Lane LOS	C	A	-	-	A	A	-	C
HCM 95th %tile Q(veh)	0.3	0	-	-	0	-	-	0

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	521	0	1	341	0	1	0	1	0	0	0
Future Vol, veh/h	0	521	0	1	341	0	1	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	635	0	1	416	0	1	0	1	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	416	0	0	635	0	0	1053	1053	635	1054	1053	416
Stage 1	-	-	-	-	-	-	635	635	-	418	418	-
Stage 2	-	-	-	-	-	-	418	418	-	636	635	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1154	-	-	958	-	-	206	228	482	206	228	641
Stage 1	-	-	-	-	-	-	470	476	-	616	594	-
Stage 2	-	-	-	-	-	-	616	594	-	469	476	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1154	-	-	958	-	-	206	228	482	205	228	641
Mov Cap-2 Maneuver	-	-	-	-	-	-	206	228	-	205	228	-
Stage 1	-	-	-	-	-	-	470	476	-	616	593	-
Stage 2	-	-	-	-	-	-	615	593	-	468	476	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	17.6	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	289	1154	-	-	958	-	-	-
HCM Lane V/C Ratio	0.008	-	-	-	0.001	-	-	-
HCM Control Delay (s)	17.6	0	-	-	8.8	0	-	0
HCM Lane LOS	C	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	0	569	0	0	406	1	0	0	0	1	0	0
Future Vol, veh/h	0	569	0	0	406	1	0	0	0	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	612	0	0	437	1	0	0	0	1	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	438	0	0	612	0	0	1049	1050	612	1049	1049	437
Stage 1	-	-	-	-	-	-	612	612	-	437	437	-
Stage 2	-	-	-	-	-	-	437	438	-	612	612	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1133	-	-	977	-	-	207	229	497	207	229	624
Stage 1	-	-	-	-	-	-	484	487	-	602	583	-
Stage 2	-	-	-	-	-	-	602	582	-	484	487	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1133	-	-	977	-	-	207	229	497	207	229	624
Mov Cap-2 Maneuver	-	-	-	-	-	-	207	229	-	207	229	-
Stage 1	-	-	-	-	-	-	484	487	-	602	583	-
Stage 2	-	-	-	-	-	-	602	582	-	484	487	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	22.5
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1133	-	-	977	-	-	207
HCM Lane V/C Ratio	-	-	-	-	-	-	-	0.005
HCM Control Delay (s)	0	0	-	-	0	-	-	22.5
HCM Lane LOS	A	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0

Intersection	
Int Delay, s/veh	0.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	521	7	4	341	0	23	0	10	0	0	0
Future Vol, veh/h	0	521	7	4	341	0	23	0	10	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	635	9	5	416	0	28	0	12	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	416	0	0	644	0	0	1066	1066	640	1072	1070	416
Stage 1	-	-	-	-	-	-	640	640	-	426	426	-
Stage 2	-	-	-	-	-	-	426	426	-	646	644	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1154	-	-	951	-	-	202	224	479	200	223	641
Stage 1	-	-	-	-	-	-	467	473	-	610	589	-
Stage 2	-	-	-	-	-	-	610	589	-	464	471	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1154	-	-	951	-	-	201	222	479	194	221	641
Mov Cap-2 Maneuver	-	-	-	-	-	-	201	222	-	194	221	-
Stage 1	-	-	-	-	-	-	467	473	-	610	585	-
Stage 2	-	-	-	-	-	-	606	585	-	452	471	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.1	22.6	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	244	1154	-	-	951	-	-	-
HCM Lane V/C Ratio	0.165	-	-	-	0.005	-	-	-
HCM Control Delay (s)	22.6	0	-	-	8.8	0	-	0
HCM Lane LOS	C	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0.6	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	569	24	10	406	1	14	0	6	1	0	0
Future Vol, veh/h	0	569	24	10	406	1	14	0	6	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	612	26	11	437	1	15	0	6	1	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	438	0	0	638	0	0	1084	1084	625	1087	1097	437
Stage 1	-	-	-	-	-	-	625	625	-	459	459	-
Stage 2	-	-	-	-	-	-	459	459	-	628	638	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1133	-	-	956	-	-	196	219	488	195	215	624
Stage 1	-	-	-	-	-	-	476	480	-	586	570	-
Stage 2	-	-	-	-	-	-	586	570	-	474	474	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1133	-	-	956	-	-	194	216	488	190	212	624
Mov Cap-2 Maneuver	-	-	-	-	-	-	194	216	-	190	212	-
Stage 1	-	-	-	-	-	-	476	480	-	586	561	-
Stage 2	-	-	-	-	-	-	577	561	-	468	474	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.2	21.7	24.1
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	237	1133	-	-	956	-	-	190
HCM Lane V/C Ratio	0.091	-	-	-	0.011	-	-	0.006
HCM Control Delay (s)	21.7	0	-	-	8.8	0	-	24.1
HCM Lane LOS	C	A	-	-	A	A	-	C
HCM 95th %tile Q(veh)	0.3	0	-	-	0	-	-	0

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	596	0	1	423	0	1	0	1	0	0	0
Future Vol, veh/h	0	596	0	1	423	0	1	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	727	0	1	516	0	1	0	1	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	516	0	0	727	0	0	1245	1245	727	1245	1245	516
Stage 1	-	-	-	-	-	-	727	727	-	518	518	-
Stage 2	-	-	-	-	-	-	518	518	-	727	727	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1060	-	-	886	-	-	152	176	427	152	176	563
Stage 1	-	-	-	-	-	-	419	432	-	544	536	-
Stage 2	-	-	-	-	-	-	544	536	-	419	432	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1060	-	-	886	-	-	152	176	427	151	176	563
Mov Cap-2 Maneuver	-	-	-	-	-	-	152	176	-	151	176	-
Stage 1	-	-	-	-	-	-	419	432	-	544	535	-
Stage 2	-	-	-	-	-	-	543	535	-	418	432	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	21.2	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	224	1060	-	-	886	-	-	-
HCM Lane V/C Ratio	0.011	-	-	-	0.001	-	-	-
HCM Control Delay (s)	21.2	0	-	-	9.1	0	-	0
HCM Lane LOS	C	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	719	0	0	462	1	0	0	0	1	0	0
Future Vol, veh/h	0	719	0	0	462	1	0	0	0	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	782	0	0	502	1	0	0	0	1	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	503	0	0	782	0	0	1285	1285	782	1285	1285	503
Stage 1	-	-	-	-	-	-	782	782	-	503	503	-
Stage 2	-	-	-	-	-	-	503	503	-	782	782	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1072	-	-	845	-	-	143	166	397	143	166	573
Stage 1	-	-	-	-	-	-	390	408	-	555	545	-
Stage 2	-	-	-	-	-	-	555	545	-	390	408	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1072	-	-	845	-	-	143	166	397	143	166	573
Mov Cap-2 Maneuver	-	-	-	-	-	-	143	166	-	143	166	-
Stage 1	-	-	-	-	-	-	390	408	-	555	545	-
Stage 2	-	-	-	-	-	-	555	545	-	390	408	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	30.4
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1072	-	-	845	-	-	143
HCM Lane V/C Ratio	-	-	-	-	-	-	-	0.008
HCM Control Delay (s)	0	0	-	-	0	-	-	30.4
HCM Lane LOS	A	A	-	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0

Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	596	7	4	423	0	23	0	10	0	0	0
Future Vol, veh/h	0	596	7	4	423	0	23	0	10	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	727	9	5	516	0	28	0	12	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	516	0	0	735	0	0	1257	1257	731	1263	1261	516
Stage 1	-	-	-	-	-	-	731	731	-	526	526	-
Stage 2	-	-	-	-	-	-	526	526	-	737	735	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1060	-	-	879	-	-	149	173	425	148	172	563
Stage 1	-	-	-	-	-	-	416	430	-	539	532	-
Stage 2	-	-	-	-	-	-	539	532	-	413	428	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1060	-	-	879	-	-	148	172	425	143	171	563
Mov Cap-2 Maneuver	-	-	-	-	-	-	148	172	-	143	171	-
Stage 1	-	-	-	-	-	-	416	430	-	539	528	-
Stage 2	-	-	-	-	-	-	535	528	-	401	428	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.1	30	0
HCM LOS			D	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	184	1060	-	-	879	-	-	-
HCM Lane V/C Ratio	0.219	-	-	-	0.006	-	-	-
HCM Control Delay (s)	30	0	-	-	9.1	0	-	0
HCM Lane LOS	D	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0.8	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	719	24	10	462	1	14	0	6	1	0	0
Future Vol, veh/h	0	719	24	10	462	1	14	0	6	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	782	26	11	502	1	15	0	7	1	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	503	0	0	808	0	0	1319	1320	795	1322	1332	503
Stage 1	-	-	-	-	-	-	795	795	-	524	524	-
Stage 2	-	-	-	-	-	-	524	525	-	798	808	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1072	-	-	826	-	-	135	158	391	135	156	573
Stage 1	-	-	-	-	-	-	384	402	-	540	533	-
Stage 2	-	-	-	-	-	-	540	533	-	382	397	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1072	-	-	826	-	-	133	155	391	131	153	573
Mov Cap-2 Maneuver	-	-	-	-	-	-	133	155	-	131	153	-
Stage 1	-	-	-	-	-	-	384	402	-	540	523	-
Stage 2	-	-	-	-	-	-	530	523	-	376	397	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.2	29.9	32.7
HCM LOS			D	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	166	1072	-	-	826	-	-	131
HCM Lane V/C Ratio	0.131	-	-	-	0.013	-	-	0.008
HCM Control Delay (s)	29.9	0	-	-	9.4	0	-	32.7
HCM Lane LOS	D	A	-	-	A	A	-	D
HCM 95th %tile Q(veh)	0.4	0	-	-	0	-	-	0

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	596	7	4	423	0	23	0	10	0	0	0
Future Vol, veh/h	0	596	7	4	423	0	23	0	10	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	2	-	-	2	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	82	82	82	82	82	82	82	82	82
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	727	9	5	516	0	28	0	12	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	516	0	0	735	0	0	1257	1257	731	1263	1261	516
Stage 1	-	-	-	-	-	-	731	731	-	526	526	-
Stage 2	-	-	-	-	-	-	526	526	-	737	735	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1060	-	-	879	-	-	149	173	425	148	172	563
Stage 1	-	-	-	-	-	-	416	430	-	539	532	-
Stage 2	-	-	-	-	-	-	539	532	-	413	428	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1060	-	-	879	-	-	148	172	425	143	171	563
Mov Cap-2 Maneuver	-	-	-	-	-	-	339	351	-	328	347	-
Stage 1	-	-	-	-	-	-	416	430	-	539	528	-
Stage 2	-	-	-	-	-	-	535	528	-	401	428	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.1	16.2	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	361	1060	-	-	879	-	-	-
HCM Lane V/C Ratio	0.111	-	-	-	0.006	-	-	-
HCM Control Delay (s)	16.2	0	-	-	9.1	0	-	0
HCM Lane LOS	C	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0.4	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	719	24	10	462	1	14	0	6	1	0	0
Future Vol, veh/h	0	719	24	10	462	1	14	0	6	1	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	2	-	-	2	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	782	26	11	502	1	15	0	7	1	0	0

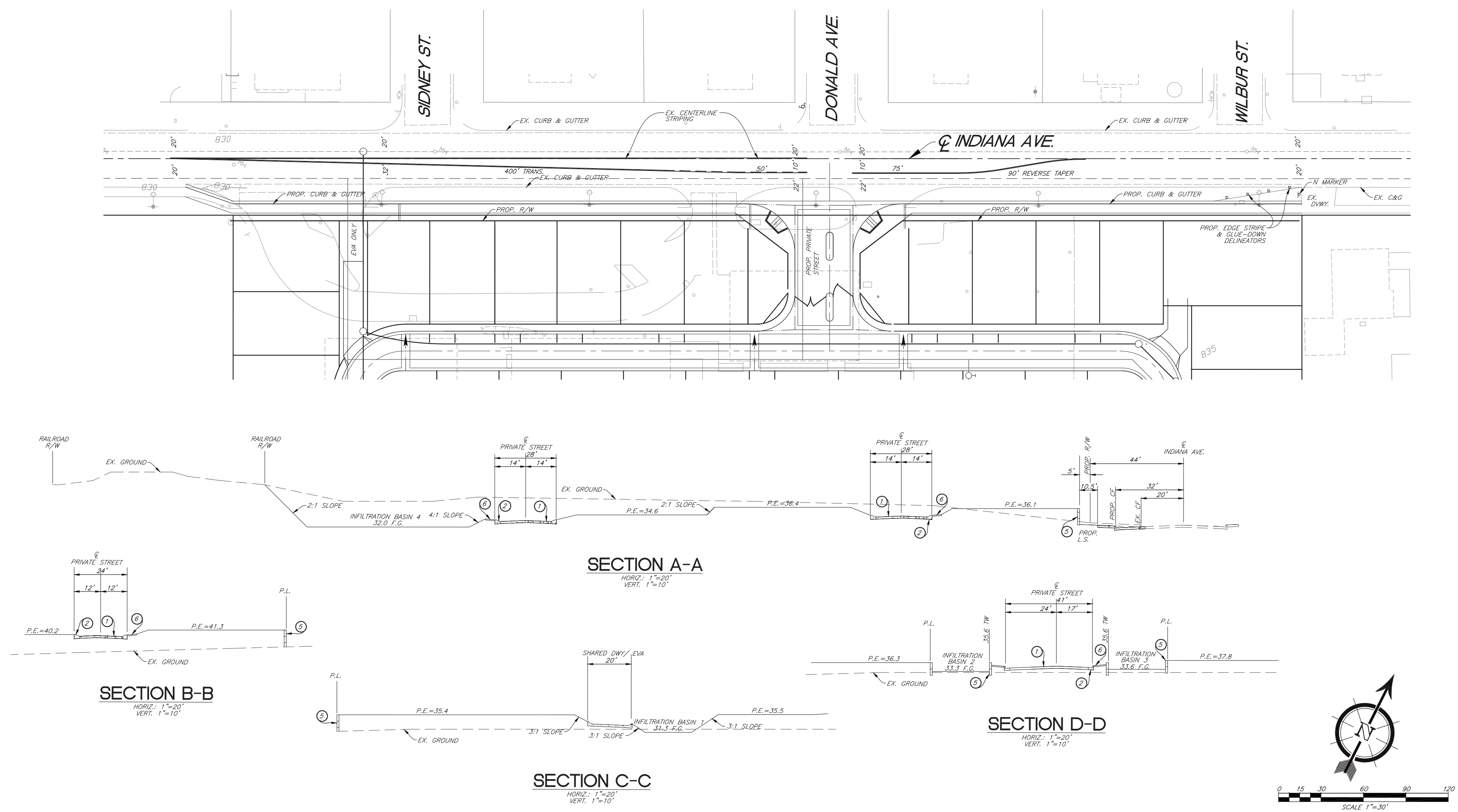
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	503	0	0	808	0	0	1319	1320	795	1322	1332	503
Stage 1	-	-	-	-	-	-	795	795	-	524	524	-
Stage 2	-	-	-	-	-	-	524	525	-	798	808	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1072	-	-	826	-	-	135	158	391	135	156	573
Stage 1	-	-	-	-	-	-	384	402	-	540	533	-
Stage 2	-	-	-	-	-	-	540	533	-	382	397	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1072	-	-	826	-	-	133	155	391	131	153	573
Mov Cap-2 Maneuver	-	-	-	-	-	-	318	332	-	308	323	-
Stage 1	-	-	-	-	-	-	384	402	-	540	523	-
Stage 2	-	-	-	-	-	-	530	523	-	376	397	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.2	16.4	16.7
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	337	1072	-	-	826	-	-	308
HCM Lane V/C Ratio	0.065	-	-	-	0.013	-	-	0.004
HCM Control Delay (s)	16.4	0	-	-	9.4	0	-	16.7
HCM Lane LOS	C	A	-	-	A	A	-	C
HCM 95th %tile Q(veh)	0.2	0	-	-	0	-	-	0

APPENDIX E:

STRIPING PLAN (TTM 37032)



CONSTRUCTION NOTES

1. CONSTRUCT 3" OVER 5" BASE PAVING
2. CONSTRUCT 6" CURB & GUTTER
3. CONSTRUCT 6"–12" DIA RIP RAP
4. CONSTRUCT CROSS GUTTER
5. CONSTRUCT RETAINING WALL (5' MAX)
6. CONSTRUCT CONCRETE SIDEWALK

BUSINESS TAX CERTIFICATE NO. 107994 EXP. 6–13–16

SEAL: REGISTERED PROFESSIONAL ENGINEER ROBERT C. VAN VOOREN No. 6 5 EXP. 9-30-17 CIVIL STATE OF CALIFORNIA

PREPARED BY:
SDH AND ASSOCIATES INC.
5225 CANYON CREST DRIVE 71439
Riverside, California 92507
TEL: (951) 683-3691 FAX (951) 788-2314

BENCHMARK

SCALE: 1"=30'
DATE: JANUARY 2016

CITY OF RIVERSIDE

TTM 37032
STRIPING STUDY
9170 INDIANA AVENUE

2 OF 2 SHEETS