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1341 Archer Street, PO Box 924, Alviso, CA 95002-0924
Tel: 408-449-5178 Fax 408-449-5147

MEMO – Revision 3.0

DATE:	September 23, 21	TO:	Ms. Ruta Jariwala, Mr. Ian Lin, & Mr. Rutvij Patel
FROM:	Robert Asuncion	COMPANY:	TJKM
PHONE:	(408) 717-2448	EMAIL:	@TJKM.com

PROJECT: **Street Lighting Lumen Study – East Avenue (Livermore St to S. Vasco Rd) Livermore, California**

Number of pages including cover page: 12 plus Lighting Study Exhibits and Submittal Sheets

Note regarding this revision:

This memo is Revision 3.0 from the original memo submitted on June 30, 2020.

This memo has been revised to include the following:

Revision 1.0 (due to discussion with Joanna Liu):

- List of National and State Standards and reference guides used to develop this memo along with a narrative of each standard usage.
- RP8 - Previous memo was based on using Caltrans standards as the only lighting basis for this study. Subsequent to meeting with City staff, City desires a discussion on RP8 standards and how it is related to current conditions.
- List of updated exhibits to reflect RP8 standards.
- List of updated recommended product submittals.

Revision 2.0 (due to discussion with Carlo Sendaydiego and the introduction of the Downtown Memo):

- Discussion of findings relative to City's "Lighting Standard" – **Kimley Horn City of Livermore Downtown Lighting Recommended Lighting Guidelines and Requirement dated August 7, 2017**
- Updated field observations performed week of April 7th on East Avenue

Revision 2.5 (due to comments from the City dated May 11)

Revision 3.0 (due to comments from the City dated September 10)

National and State Standards and Reference Guides:

Following are the standards and references used to develop this technical memo.

National Standards:

Illuminating Engineering Society Roadway Lighting—IES RP-8-18

http://www.ies.org/store/product/roadway-lighting-1028.cfm

Per the IES website, "This Recommended Practice provides the design basis for lighting roadways, adjacent bikeways, and pedestrian ways. It deals entirely with lighting and does not give advice on construction. It is not intended to be applied to existing lighting systems until such systems are redesigned."

"Following an introduction that covers background material on the design criteria, there are three general subject areas discussed in this Practice:

- "Classification definitions that carefully defines key words/concepts as they are used in the Practice with caveats regarding alternate definitions found elsewhere.

- "Design criteria that thoroughly analyzes and illustrates the design process involving illuminance, luminance, and small target visibility (STV).
- "Design considerations that identifies major roadway issues (rural and urban) affecting driver visibility, discusses design aesthetics (coordination of light poles with landscaping), and weighs public scrutiny of glare and sky glow that can lead to lighting ordinances."

Lighting Handbook: Reference and Application, 10th Edition, 2011
http://www.ies.org/handbook/
The IES website states that this handbook presents "the current state of knowledge as it relates to lighting and lighting design." While it addresses the complete range of lighting frameworks, designs and applications, one chapter is dedicated to "Lighting for Transport."

Guidelines for The Implementation of Reduced Lighting on Roadways
https://www.fhwa.dot.gov/publications/research/safety/14050/14050.pdf
The guidelines presented in this 2014 report address the need to maintain the safety effects of roadway lighting while alleviating the budgetary strains associated with the maintenance of the lighting infrastructure. This report establishes a new set of criteria for practitioners to apply to their roadway environment that will identify appropriate lighting levels for given roadway characteristics and usage.

State Standards:
Caltrans Traffic Manual—Chapter 9, Traffic Signals and Lighting
www.dot.ca.gov/hq/traffops/signtech/signdel/chp9/chap9.htm

- Section 9-06 - Highway Safety Lighting
- Section 9-07 - Freeway Lighting
- Section 9-08 - Conventional Highway Lighting
- Section 9-09 - Highway Safety Lighting Development Procedures
- Section 9-10 - Highway Safety Lighting Design Standards
- Section 9-11 - Lighting Standards

Key Terms and Definitions:
SI – International System of units – also known as the metric system

IES – Illuminating Engineering Society

Luminance – Photometric measure of the luminous intensity per unit area of light traveling in a given direction. The SI unit luminance is candela per square meter (cd/m^2).

Lux – SI unit of illuminance, measuring luminous flux per unit area. It is a measure of how much light falls on a surface.

Lumens – SI unit of luminous flux, a measure of the total quantity of visible light emitted by a source per unit of time.

Candela – SI unit of luminous intensity; that is, luminous power per unit solid angle emitted by a point light source in a particular direction.

Foot-candle – a unit of illuminance or light intensity in US customary units. The SI equivalent is Lux.

Foot-lamberts – a unit of measurement of luminance in US customary units. The SI equivalent is candela per square meter.

APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl

List of Exhibits for this Memo:

1. *Exhibit No. 1 – "East Avenue Light Study Results"* – Exhibit showing existing light lumen readings and existing fixture types.

2. *Exhibit No. 2 – "Livermore RP8 max updated"* – Exhibit showing recommended upgraded fixtures that closely meets RP8 standards utilizing existing pole infrastructure. (No new proposed streetlight pole infrastructure)

3. *Exhibit No. 3 – "Livermore RP8 with new infra updated"*- Exhibit showing recommended upgraded streetlight fixtures and proposed new pole infrastructure meeting RP8 standards. (New streetlight pole infrastructure proposed)

4. *Exhibit No. 4 – "City of Livermore Downtown Lighting Recommended Lighting Guidelines and Requirements" dated August 7, 2017.*

List of Proposed Products:

1. Submittal Sample 1 – Type AA-AA2-AATL
2. Submittal Sample 2 – Type BB,BBTL
3. Submittal Sample 3 – Type CC-CCTL

EXECUTIVE SUMMARY

An existing lumen study was performed on East Avenue in June 2020. Data collected from the lumen study proved the following points:

- **Point #1 – Caltrans Intersection Analysis** - Under Caltrans intersection guideline methodology – light levels at 10 of 27 intersections along the project corridor are compliant with Caltrans. The other 17 intersections are sub-standard to the Caltrans methodology.
- **Point #2 – Livermore Intersection Guideline Analysis -** Under the City of Livermore "Downtown Lighting Guideline and Requirements, dated August 7, 2017 – all intersections studied **DID NOT** meet City lighting guidelines for **all intersections** (per Table 6 – Lighting Design Criteria – Medium Pedestrian Area Classification).
- **Point #3 - Livermore Roadway Guideline Analysis -** Under the City of Livermore "Downtown Lighting Guideline and Requirements, dated August 7, 2017 – the East Avenue roadway **DOES NOT** meet City lighting guidelines for **roadways 100%.** The highest roadway illuminance reading captured on East Avenue was 0.5 fc whereas the minimum requirement is 0.8 fc (per Table 3 – AASHTO Roadway Lighting Design Guide Lighting Criteria for Streets).
- **Point #4 - Livermore Pedestrian and Bikeway Guideline Analysis -** Under the City of Livermore "Downtown Lighting Guideline and Requirements, dated August 7, 2017 – the pedestrian and bikeway areas were not specifically studied as part of this study as no readings were taken at the sidewalk area; however based on data collected it seems that **light levels barely meet** the 0.5 fc illuminance for pedestrian and bikeways throughout the corridor (per Table 8 – Recommended Lighting Design Criteria for Pedestrian Areas and Bikeways)

It is strongly recommended that a formal lighting design for this corridor be performed if City guidelines are to be met.

At a minimum, the following enhancements are recommended:

- Upgrade all existing safety lighting fixtures to the newer model LED technology;
- Add 10 new streetlight pole locations;

All light readings captured for this study were performed by the illuminance method. No luminance readings were conducted.

BACKGROUND

East Avenue between Livermore Street and S. Vasco Road (approximately 2.5-mile-long segment) is predominantly an east-west, level-grade, little to no horizontal curve, multi-lane collector roadway. The adjacent land uses along East Avenue are mostly residential (single & multi-residential) with some commercial, school, and vacant land parcels. Posted speed limit(s) along East Avenue are 30 MPH (between Livermore St. and Loyola Way) and 40 MPH (between Loyola Way and S. Vasco Rd.).

Streetlighting along the study corridor consists of 72 LED cobra-head style fixtures (for roadway lighting) all mounted on either power-utility owned wood poles or Caltrans Type 15 type galvanized metal poles. These fixtures are generally mounted on either 8-ft or 12-ft luminaire arms at an approximately 30-ft height level relative to the roadway surface. Safety lighting at signalized intersections along the study corridor also consist of LED cobra-head style fixtures.

Streetlight fixtures along the project corridor were observed to be comprised of mainly Bridgelux and Leotek Brands fixtures ranging from 29W to 158W for roadway and safety lighting, respectively. Model years of the fixtures are estimated to be at 11-12 years old. (NOTE: Actual model/brand/specifics of fixtures were not taken for this study as all observations were made from ground level). All light sources in the project corridor appear to be LED.

The lighting studies were performed on June 11, June 12, June 13 & June 19, 2020. All nights of study were non-full or non-new Moon conditions. Light measurements were taking per IES LM-50-13 guidelines through the project corridor. All reading captured for this study were performed by the illuminance method. No luminance readings were conducted.

Pedestrian and vehicle activity during the study was low to moderate.

Weather conditions during the time of study were clear and dry with little to no wind.

LIGHTING METHODOLOGY and ANALYSIS BACKGROUND

Methodology No. 1 - Caltrans

Under Caltrans, lighting guidelines are shown on Chapter 9 of the Caltrans Traffic Manual – Traffic Signals and Lighting. In general terms, Caltrans provides warrants and guidelines for safety lighting at intersections but not along the roadway corridor. Those lighting guidelines at intersections are as follows:

"9-10.3 Conventional Highways

Where highway safety lighting is to be in-stalled at intersections on conventional highways,(including the intersection of a freeway ramp with a local street), the minimum maintained horizontal illuminance should be as follows: In urban areas and expressways, 1.6 horizontal lux on the area normally bounded by the crosswalks, and 6.5 horizontal lux at the intersection of centerlines of the entering streets. In rural areas, 1.1 horizontal lux on the

area normally bounded by the crosswalks, and 3.2 horizontal lux at the intersection of centerlines of the entering streets."

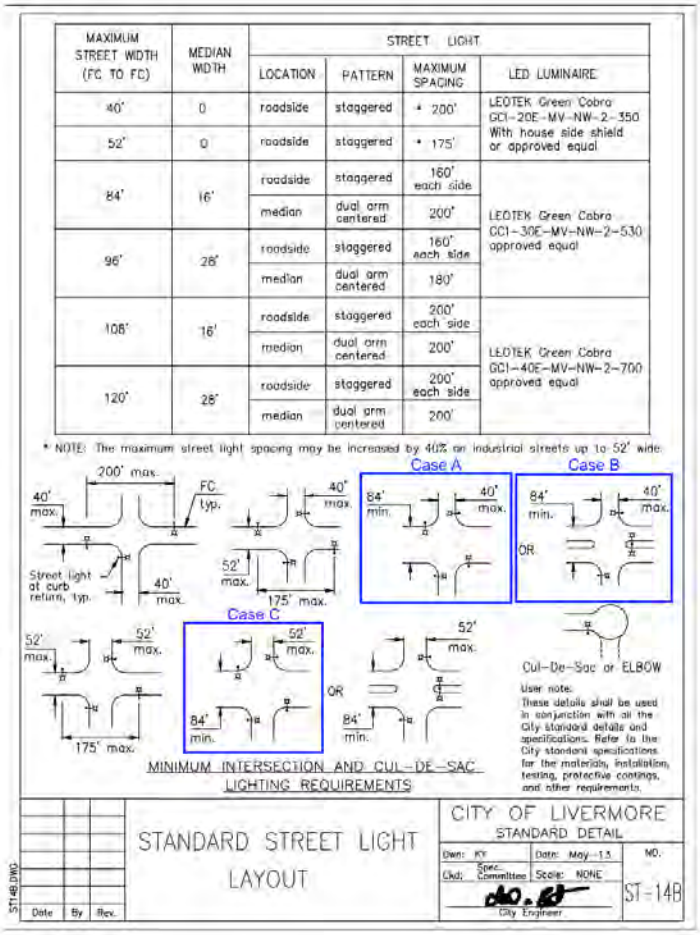
Methodology No 2. – City of Livermore Downtown Lighting Guidelines (LDLG)

Under the City of Livermore Downtown Lighting Guidelines Memo dated August 7, 2017 the following tables were utilized as a basis of reference for this corridor – Table 6.0 Lighting Design Criteria for Intersections in Downtown District, Table 3 – AASHTO Roadway Lighting Design Guide Lighting Criteria for Streets, and Table 8 – Recommended Lighting Design Criteria for Pedestrian Areas and Bikeways.

Intersection and Roadway Lighting were reviewed per the data collected on June 2020, respectively. Pedestrian and Bikeway Lighting was not specifically captured in June 2020 but empirically analyzed based on field data collected (See Notes for Revision 2.0).

Comparing the City of Livermore Downtown Guidelines to the Current ST-14B City of Livermore Standard Street Light Layout Detail:

As part of this lighting study, the current City of Livermore Standard Street Light Layout (ST-14B) was reviewed on whether the ST-14B layout conforms with the City of Livermore Downtown Guidelines. This was done by using East Avenue as a test case; particularly, Case A and Case C (see ST-14B below) intersections and road segments with maximum street widths of 40', 52' and 84', were reviewed.



MAXIMUM STREET WIDTH (FC TO FC)	MEDIAN WIDTH	STREET LIGHT			
		LOCATION	PATTERN	MAXIMUM SPACING	LED LUMINAIRE
40'	0	roadside	staggered	* 200'	LEOTEK Green Cobra GC1-20E-MV-NW-2-350 With house side shield or approved equal
52'	0	roadside	staggered	* 175'	
84'	16'	roadside	staggered	160' each side	LEOTEK Green Cobra GC1-30E-MV-NW-2-530 approved equal
		median	dual arm centered	200'	
96'	28'	roadside	staggered	160' each side	
		median	dual arm centered	180'	
108'	16'	roadside	staggered	200' each side	LEOTEK Green Cobra GC1-40E-MV-NW-2-700 approved equal
		median	dual arm centered	200'	
120'	28'	roadside	staggered	200' each side	
		median	dual arm centered	200'	

* NOTE: The maximum street light spacing may be increased by 40% on industrial streets up to 52' wide.

In order to meet LDLG, the following LED specifications need to be updated – see Table 1.0.

MAXIMUM STREET WIDTH (FC TO FC)	MEDIAN WIDTH	STREET LIGHT			
		LOCATION	PATTERN	MAXIMUM SPACING	LED LUMINAIRE
40'	0	roadside	staggered	* 200'	LEOTEK Green Cobra GC1-20E-MV-NW-2-350 With house side shield or approved equal
52'	0	roadside	staggered	* 175'	
84'	16'	roadside	staggered	160' each side	LEOTEK Green Cobra GC1-30E-MV-NW-2-530 approved equal
		median	dual arm centered	200'	
96'	28'	roadside	staggered	160' each side	
		median	dual arm centered	180'	
108'	16'	roadside	staggered	200' each side	LEOTEK Green Cobra GC1-40E-MV-NW-2-700 approved equal
		median	dual arm centered	200'	
120'	28'	roadside	staggered	200' each side	
		median	dual arm centered	200'	

* NOTE: The maximum street light spacing may be increased by 40% on industrial streets up to 52' wide.

Table 1.0 with proposed LED Model Upgrade (in blue)

By updating the current ST-14B with the proposed LED models shown in Table 1.0, ST-14B will meet the LDLG.

Intersection Lighting

For this assessment, East Avenue was classified as a "medium pedestrian area" with Major/Major, Major/Collector, and Major/ Local functional classifications. (Below is Table 6 from the Livermore Downtown Lighting Guideline).

Table 6 – Lighting Design Criteria for Intersections in Downtown District

Functional Classification	Average Maintained Illumination at Pavement in High Pedestrian Area Classification) (fc)	Average Maintained Illumination at Pavement in Medium Pedestrian Area Classification) (fc)	Average Uniformity Ratio (average/ minimum)
Major/Major	3.4	2.6	3.0
Major/Collector	2.9	2.2	3.0
Major/Local	2.6	2.0	3.0
Collector/Collector	2.4	1.8	4.0
Collector/Local	2.1	1.6	4.0
Local/Local	1.4	1.4	6.0

Roadway Lighting

For this light study, East Avenue was classified as a major (principal arterial) roadway with residential off-roadway light sources. Per Table 3 of the Livermore Downtown Lighting Guideline (below), an average 0.8 fc illuminance is recommended for lighting levels along the roadway.

Table 3 – AASHTO Roadway Lighting Design Guide Lighting Criteria for Streets

Roadway and Walkway Classification	Off-Roadway Light Sources	Illuminance Method						Luminance Method			Additional Values (both Methods)
		Average Maintained Illuminance				Minimum Illuminance	Illuminance Uniformity Ratio	Average Maintained Luminance			Veiling Luminance Ratio
		R1	R2	R3	R4			Lavg	Uniformity		
	General Land Use	(foot-candles) (min)	(foot-candles) (min)	(foot-candles) (min)	(foot-candles) (min)	(foot-candles)	avg/min (max) (6)	cd/m2 (min)	Lavg/Lmin (max)	Lmax/Lmin (max)	Lvmax/Lavg (max) (3)
Principal Arterials											
Interstate and other freeways	Commercial	0.6 to 1.1	0.6 to 1.1	0.6 to 1.1	0.6 to 1.1	0.2	3:1 or 4:1	0.4 to 1.0	3:1	6:1	0.3:1
	Intermediate	0.6 to 0.9	0.6 to 0.9	0.6 to 0.9	0.6 to 0.9	0.2	3:1 or 4:1	0.4 to 0.8	3:1	6:1	0.3:1
	Residential	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8	0.2	3:1 or 4:1	0.4 to 0.6	3:1	6:1	0.3:1
Other Principal Arterials (partial or no control of access)	Commercial	1.1	1.1	1.1	1.1	As uniformity ratio allows	3:1	1.2	3:1	6:1	0.3:1
	Intermediate	0.8	1.2	1.2	1.0		3:1	0.8	3:1	6:1	0.3:1
	Residential	0.6	0.6	0.6	0.6		3:1	0.6	3:1	6:1	0.3:1
Minor Arterials	Commercial	0.9	1.1	1.1	1.0		4:1	1.0	3:1	6:1	0.3:1
	Intermediate	0.6	1.0	1.0	0.8		4:1	0.6	3:1	6:1	0.3:1
	Residential	0.5	0.7	0.7	0.7		4:1	0.5	3:1	6:1	0.3:1
Collectors	Commercial	0.8	1.1	1.1	0.9		4:1	0.8	3:1	6:1	0.4:1
	Intermediate	0.6	0.8	0.8	0.6		4:1	0.6	3:1	6:1	0.4:1
	Residential	0.4	0.6	0.6	0.5		4:1	0.4	3:1	6:1	0.4:1
Local	Commercial	0.6	0.8	0.8	0.6		6:1	0.6	6:1	10:1	0.4:1
	Intermediate	0.5	0.7	0.7	0.6		6:1	0.5	6:1	10:1	0.4:1
	Residential	0.3	0.4	0.4	0.4		6:1	0.3	6:1	10:1	0.4:1
Alleys	Commercial	0.4	0.6	0.6	0.5		6:1	0.4	6:1	10:1	0.4:1
	Intermediate	0.3	0.4	0.4	0.4		6:1	0.3	6:1	10:1	0.4:1
	Residential	0.2	0.3	0.3	0.3		6:1	0.2	6:1	10:1	0.4:1
Sidewalks	Commercial	0.6	1.0	1.0	1.0		3:1	Use illuminance requirements			
	Intermediate	0.5	0.6	0.6	0.6		4:1				
	Residential	0.3	0.4	0.4	0.4		6:1				
Pedestrian Ways and Bicycle Ways (2)	All	1.1	2.0	3.0	1.5		3:1				

Notes:
1. Meet either the Illuminance design method requirements or the Luminance design method requirements and meet veiling luminance requirements for both the Illuminance and the Luminance design methods.
2. Assumes a separate facility. For Pedestrian Ways and Bicycle Ways adjacent to roadway, use roadway design values. Use R3 requirements for walkway/bikeway surface materials other than the pavement types shown.
Other design guidelines such as IESNA or CIE may be used for pedestrian ways and bikeways when deemed appropriate.
3. Lv(max) refers to the maximum point along the pavement, not the maximum at lamp top. The Maintenance Factor applies to both the Lv term and the Lavg term.
4. There may be situations when a higher level of illuminance is justified. The higher values for walkways may be justified when deemed advantageous by the agency to mitigate off-roadway access.
5. Physical roadway conditions may require adjustment of spacing determined from the base levels of illuminance indicated above.
6. Higher uniformity ratios are acceptable for elevated values near high-mast poles.
7. See AASHTO publication entitled, "A Policy on Geometric Design of Highways and Streets" for roadway and walkway classifications.

Pedestrian Areas and Bikeway

Pedestrian and bikeway area light readings were not collected for this study due to the fact that it was not initially requested as part of the original project scoping. However, from the data collected, light readings can be empirically deduced. Per Table 8 (below) of the Livermore Downtown Lighting Guideline, an average illuminance of 0.5 fc is recommended for a roadway like East Avenue.

Table 8 – Recommended Lighting Design Criteria for Pedestrian Areas and Bikeways

Maintained Illumin[illegible]estrian Areas and Bikeways			
	Average Illuminance, EV_{avg} (fc)	Minimum Vertical Illuminance, EV_{min} (fc)	Average Uniformity Ratio* (E_{avg}/E_{min})
High Pedestrian Conflict Areas			
Sidewalks Adjacent to Roadway	2.0	1.0	4.0
Separated Pathways	1.0	0.5	4.0
Medium Pedestrian Conflict Areas			
Sidewalks and Pathways	0.5	0.2	4.0
Low Pedestrian Conflict Areas			
Sidewalks and Pathways	0.4	0.1	4.0

DISCUSSION

Intersection Lighting (Caltrans Method and Livermore Guidelines)

Caltrans

The project corridor consists of 27 intersections (9-signalized intersections, 3-marked crossings with RRFB or enhanced Xing signs, 2-marked crossings only, and 13-unmarked crossings). Light readings were taken at all 27 intersections and 10 intersections met Caltrans Lighting Guidelines.

Livermore Guidelines

Per the City of Livermore guidelines, intersections must have an average illumination of 2.6, 2.2, and 2.0 fc, for Major/Major, Major/Collector, and Major/Local, respectively. All intersections did not meet this criterion. New lighting retrofit/replacement is recommended at all intersections.

Results of this comparison is shown on Exhibit A -Intersection Analysis (page 9-11) of this memo.

Roadway Lighting (Caltrans Method and Livermore Guidelines)

Caltrans

Under the Caltrans/California MUTCD Chapter 9 Traffic Signals and Lighting, warrants and conditions for non-intersection locations are currently compliant with light levels ranging from 0.00 – 0.5fc. However, roadway lighting was NOT met under the LDLG.

Livermore Guidelines

Per the City of Livermore guidelines, roadway illuminance should be 0.8 fc for a corridor such as East Avenue.; throughout the entire corridor the highest reading was 0.5 fc.

Pedestrian Lighting

Pedestrian lighting was not studied for this project as pedestrian lighting does not exist along this corridor. However, per field data captured, pedestrian lighting was empirically deduced and it was found that illuminance for pedestrian

and bicyclists barely meets the city of Livermore guidelines for pedestrian area and bikeways of 0.5 fc illuminance. As 0.5 fc was generally observed at the base of streetlight. Of note, illuminance uniformity was not studied (per revision 2.0)

Recommended Enhancements and Observations

Based on our review of the corridor and our knowledge of new advancements in LED technology, we recommend replacement of the existing streetlight system within the next 2-5 years. The replacement and upgrade of fixtures along this corridor can address the deficiencies at the intersections as well as enhance existing lighting along the roadway corridor.

Based on Exhibit 2, by upgrading ALL existing lighting fixtures along the East Avenue corridor between S. Livermore Avenue and S. Vasco Road, all intersections except for the intersection of East Avenue and Mines Road would meet the Livermore Downtown Lighting Standards (within ten percent of the criteria) for both average luminance and uniformity ratio. The average luminance at the intersection of East Avenue and Mines Road would be within 15 percent of the criteria. All the roadway segments would meet the Livermore Downtown Lighting Standards for average Luminance (within ten percent of the criteria).

Based on Exhibit 3, by installing 10 new street lights in addition to upgrading ALL existing lighting fixtures along the East Avenue corridor, all intersections except for the intersection of East Avenue and Mines Road would meet the Livermore Downtown Lighting Standards (within ten percent of the criteria) for both average luminance and uniformity ratio. The average luminance at the intersection of East Avenue and Mines Road would be within 15 percent of the criteria. All the roadway segments would meet the Livermore Downtown Lighting Standards for average Luminance. The uniformity ratio would also be significantly improved reducing the variations between dark areas and light areas.

Recommended Costs of Upgrades for East Avenue

- The estimated total costs of upgrading the existing (72) fixtures to new models (@ approx. $500/fixture) is about $36k;
- The estimated total costs of installing (10) new streetlight poles, fixtures, and associated infrastructure is approximately $125K. See “Exhibit 3 – Livermore RP8 with new infra final” for proposed locations.

SPECIAL NOTES:

At the time of this study the following luminaires were not operational:

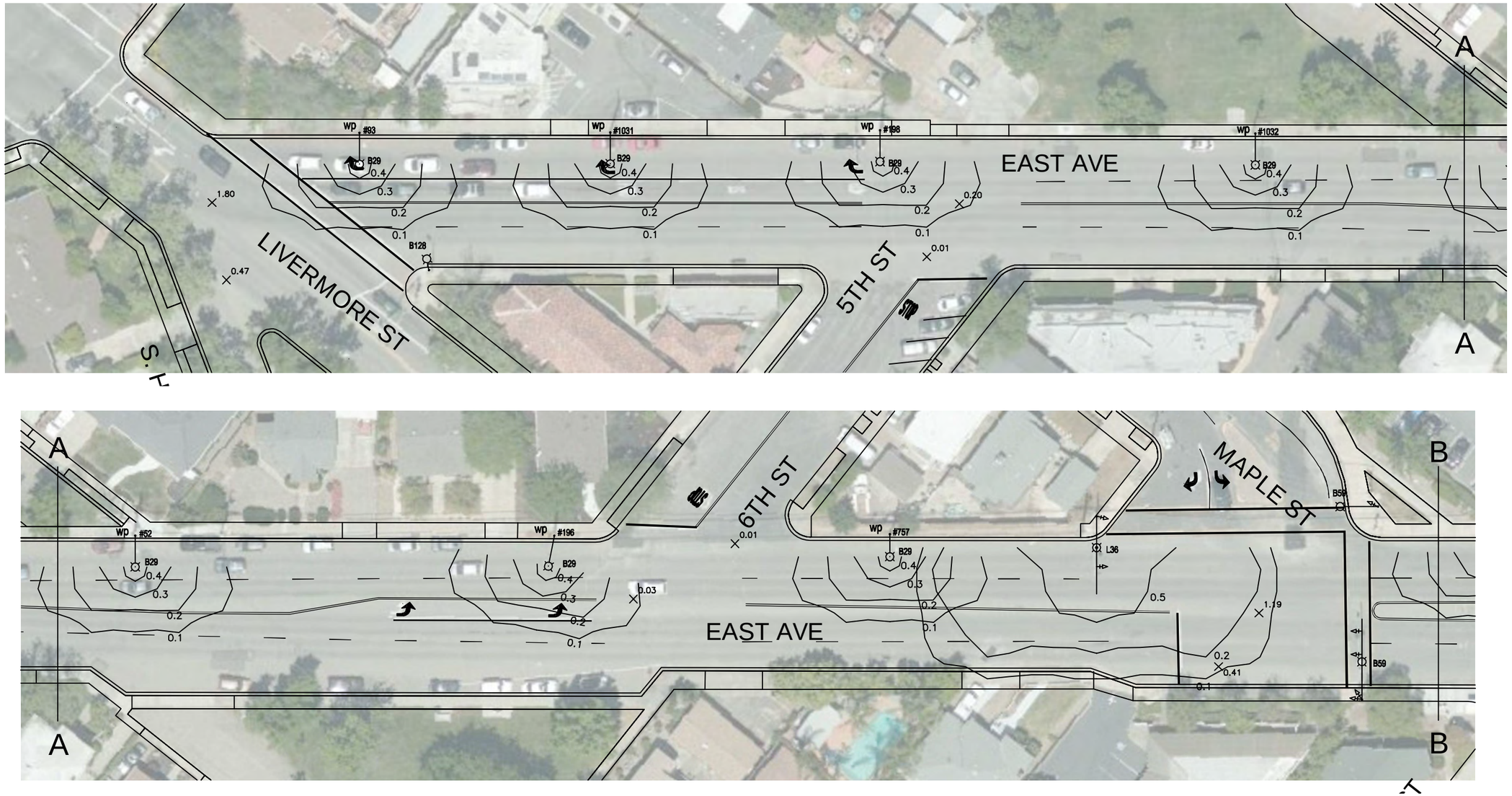
- #3480 (at Almond Avenue)
- #4457 (between Research and Charlotte, N/S of East Avenue)
- #8194(just west of Research, N/S of East Avenue)
- #204238(just east of Rovello Loop, S/S of East Avenue)

Exhibit A – Intersection Analysis (Caltrans and Livermore Guidelines)

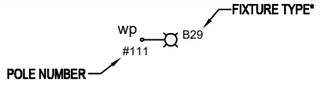
#	Intersection Name	Functional Classifications	Average Maintained Illumination at Pavement in Medium Area Classifications (per Table 6)	Meets City Intersection Guidelines? (Y/N)	Centerline Reading (fc)	Lowest Reading (fc)	Meet Caltrans Lighting Guidelines? (Y/N)	Crossing East Avenue (Marked Crossing)	Recommendations to Mitigate Deficiency
	Minimum Values Per Caltrans Section 9-10.3				**0.60**	**0.14**	-		-
1	East Avenue at Livermore St	Major/Major	2.6	N	1.80	0.47	Y	Signal	
2	@ 5th Street	Major/Local	2.0	N	0.20	0.01	N	Unmarked	Replace fixture with new with proper distribution
3	@ 6th Street	Major/Local	2.0	N	0.03	0.01	N	Unmarked	Replace fixture with new with proper distribution
4	@ Maple Street	Major/Local	2.0	N	1.19	0.10	Y	Signal / School Xing	
5	@ 7th Street	Major/Local	2.0	N	0.46	0.08	N	School Xing - Crossing 7th Only. (no marked East Avenue Xing)	Replace fixture with new with proper distribution
6	@Dolores Street	Major/Collector	2.2	N	1.29	0.26	Y	Signal	
7	@ Jensen Street	Major/Collector	2.2	N	0.58	0.10	Y-close	Ped Xing / LED Enchanced Signs	Replace fixture with new with proper distribution

8	@Estates Street	Major/Collector	2.2	N	0.10	0.01	N	School Xing / RRFB	Replace fixture with new with proper distribution
9	@ Hillcrest Avenue	Major/Collector	2.2	N	1.15	0.81	Y	Signal / School Xing	
10	@ Xavier Way	Major/Collector	2.2	N	0.18	0.05	N	Unmarked	Replace (2) fixtures with new with proper distribution
11	@ Hayes Avenue	Major/Collector	2.2	N	0.22	0.05	N	Unmarked	Replace fixture with new with proper distribution
12	@ Nielson Lane	Major/Collector	2.2	N	0.15	0.03	N	RRFB Xing	Replace fixture with new with proper distribution
13	@ Jefferson Avenue	Major/Collector	2.2	N	0.06	0.01	N	Unmarked	Replace fixture with new with proper distribution
14	@Madison Avenue	Major/Collector	2.2	N	0.97	0.24	Y	Signal / School Xing	
15	@ Auburn Street	Major/Local	2.0	N	0.36	0.04	N	Unmarked	Replace fixture with new with proper distribution
16	@ Almond Avenue	Major/Collector	2.2	N	0.01	0.01	N	Unmarked	Replace (2) fixtures with new with proper distribution
17	@Loyola Avenue	Major/Collector	2.2	N	0.64	0.59	Y	Signal	

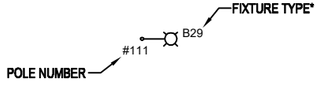
18	@Pegan Common	Major/Local	2.0	NOT STUDIED	Excluded - GATED	Excluded - GATED	N/A	Gated	
19	@Buena Vista Avenue	Major/Collector	2.2	N	0.16	0.01	N	Unmarked	Replace fixture with new with proper distribution
20	@Cavalry Lane	Major/Local	2.0	N	0.03	0.01	N	Unmarked	Replace fixture with new with proper distribution
21	@ N. Mines Road	Major/Major	2.6	N	0.94	0.60	Y	Signal	
22	@ Mitra Street	Major/Collector	2.2	N	0.31	0.16	N	Marked Crosswalk (non-signalized)	Replace fixture with new with proper distribution
23	@ Charlotte Way	Major/Collector	2.2	N	0.71	0.57	Y	Signal	
24	@ Research Drive	Major/Collector	2.2	N	0.09	0.06	N	Unmarked	Replace fixture with new with proper distribution
25	@ Birchwood Common	Major/Collector	2.2	N	0.16	0.01	N	Unmarked	Replace fixture with new with proper distribution
26	@ Rovello Loop	Major/Local	2.0	N	0.16	0.09	N	Unmarked	Repair OUTAGE #204238
27	@ S. Vasco Road	Major/Major	2.6	N	0.48	0.28	N	Signal	Replace (4) fixtures with new with proper distribution



STREETLIGHT ON WOOD UTILITY POLE



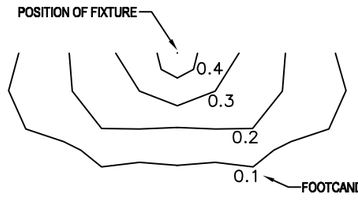
STREETLIGHT ON TYPE 15 POLE



* SEE FIXTURE SCHEDULE

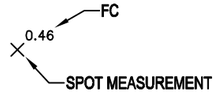
FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53/59	BRIDGELUX 53/59 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS



NOTE: ISOFOOTCANDLE CONTOURS ARE APPROXIMATIONS BASED ON SAMPLE FIELD MEASUREMENTS

SPOT LIGHT MEASUREMENT



SCALE: 1" =50'
ACCURATE FOR
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EAST AVENUE LIGHTING STUDY
LIVERMORE, CA
JUNE 2020

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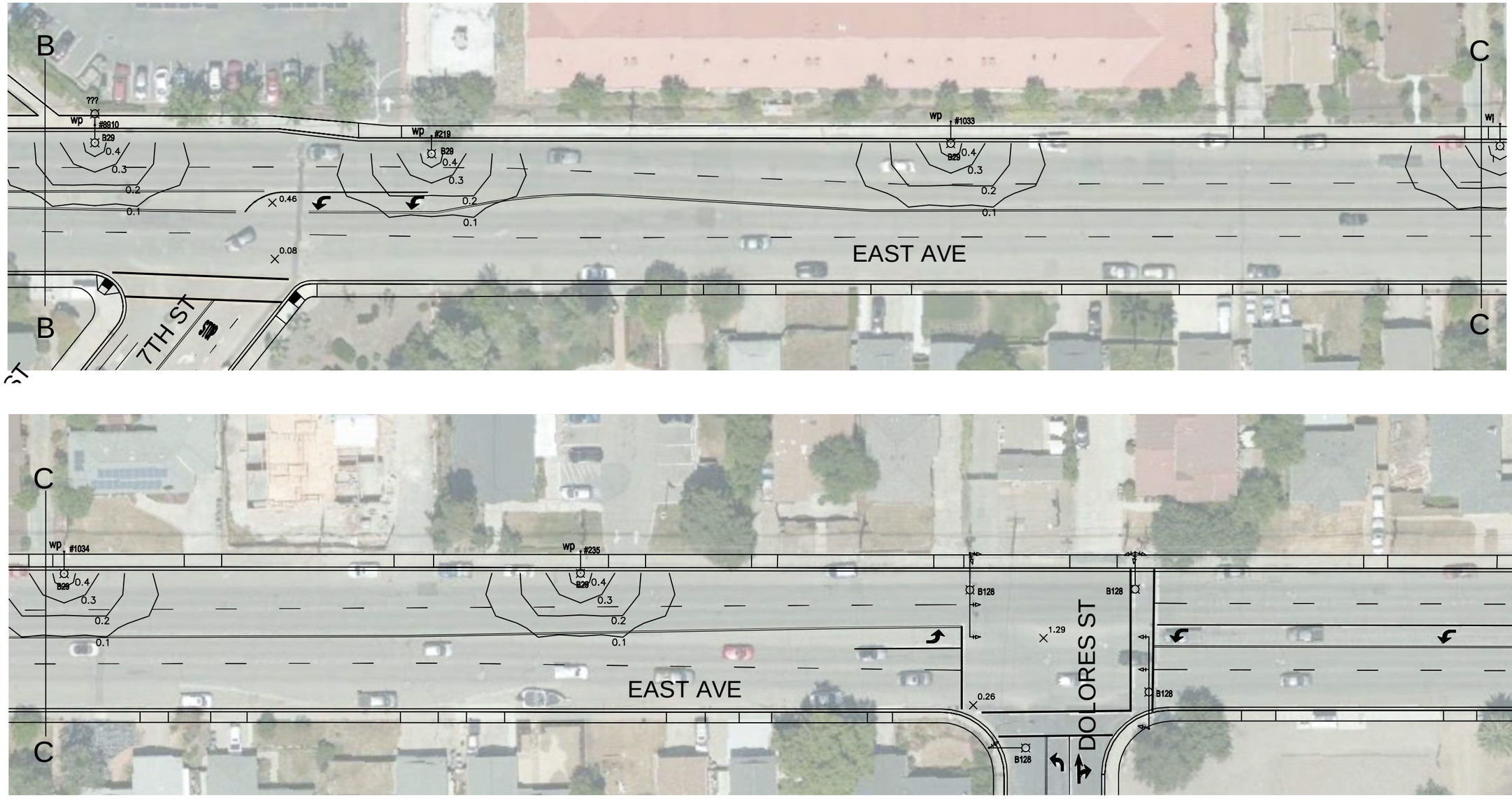

STREETLIGHT ON WOOD UTILITY POLE

STREETLIGHT ON TYPE 15 POLE

* SEE FIXTURE SCHEDULE

FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS

NOTE: ISOFOOTCANDLE CONTOURS ARE APPROXIMATIONS BASED ON SAMPLE FIELD MEASUREMENTS

SPOT LIGHT MEASUREMENT

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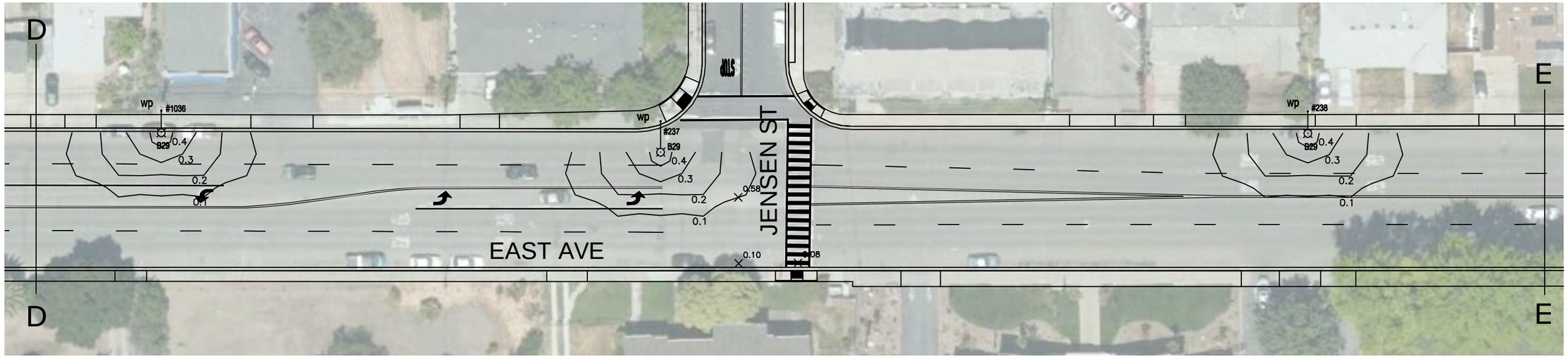
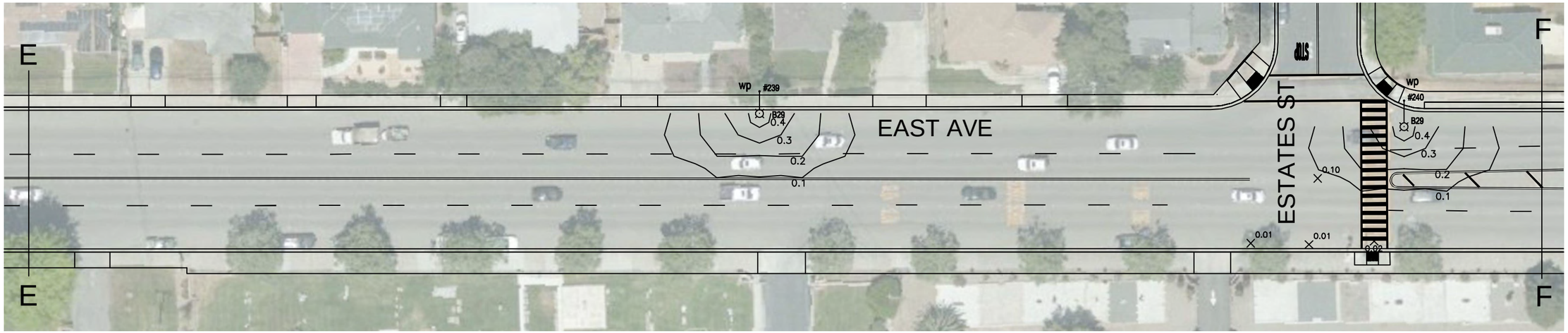




STREETLIGHT ON WOOD UTILITY POLE

wp #111 B29 — FIXTURE TYPE* — POLE NUMBER

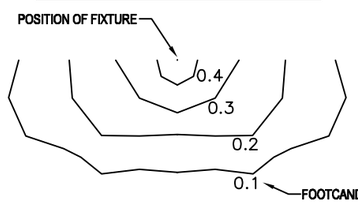
STREETLIGHT ON TYPE 15 POLE

#111 B29 — FIXTURE TYPE* — POLE NUMBER

* SEE FIXTURE SCHEDULE

FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS



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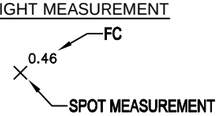
SPOT LIGHT MEASUREMENT



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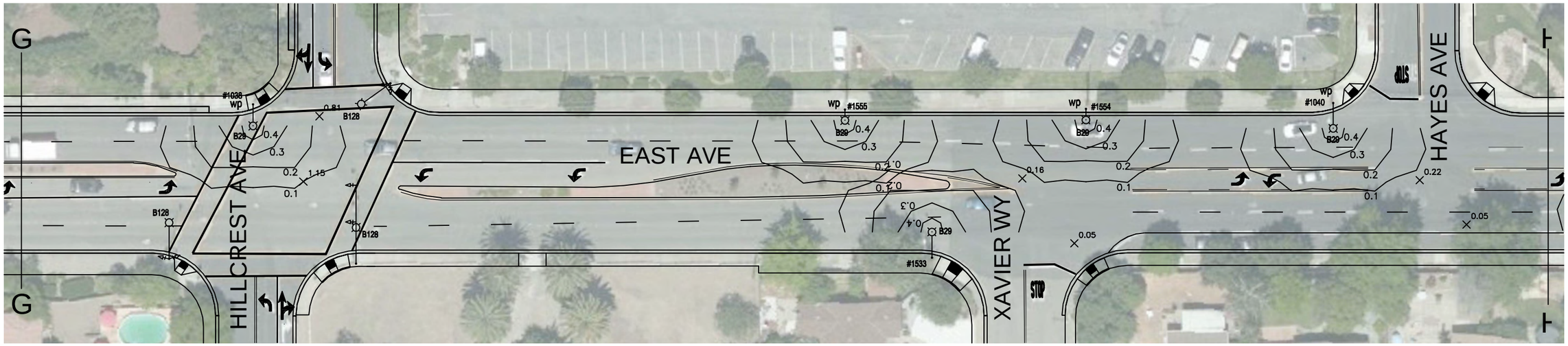
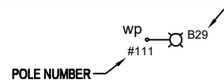
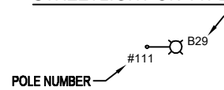


STREETLIGHT ON WOOD UTILITY POLE



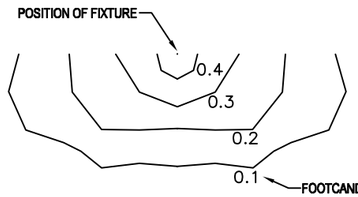
STREETLIGHT ON TYPE 15 POLE



* SEE FIXTURE SCHEDULE

FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS



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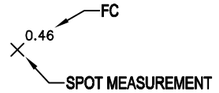
SPOT LIGHT MEASUREMENT



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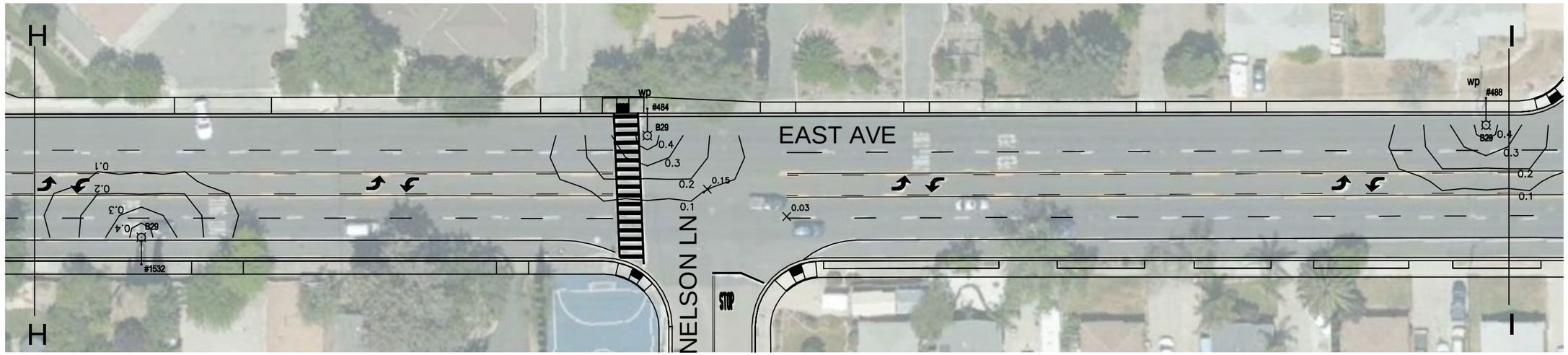
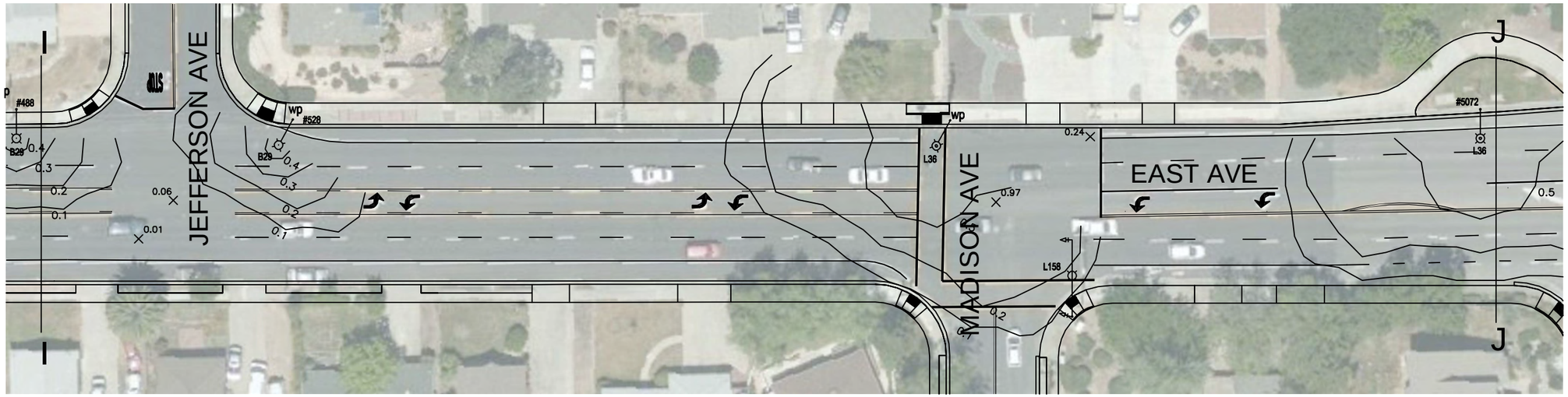
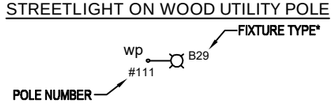
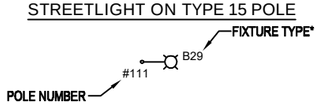




STREETLIGHT ON WOOD UTILITY POLE



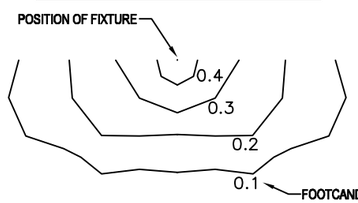
STREETLIGHT ON TYPE 15 POLE



* SEE FIXTURE SCHEDULE

FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS



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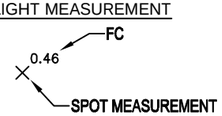
SPOT LIGHT MEASUREMENT



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EAST AVENUE LIGHTING STUDY
LIVERMORE, CA
JUNE 2020

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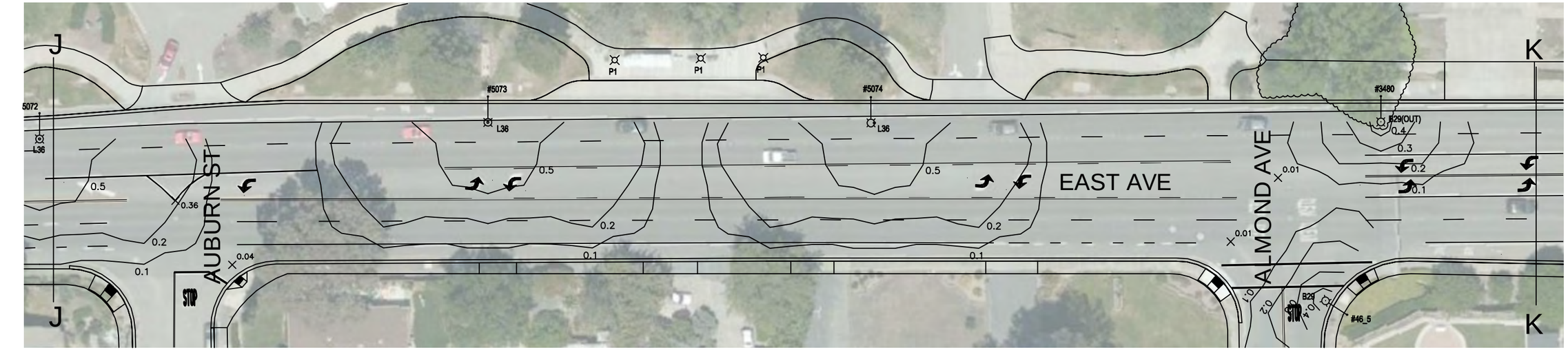
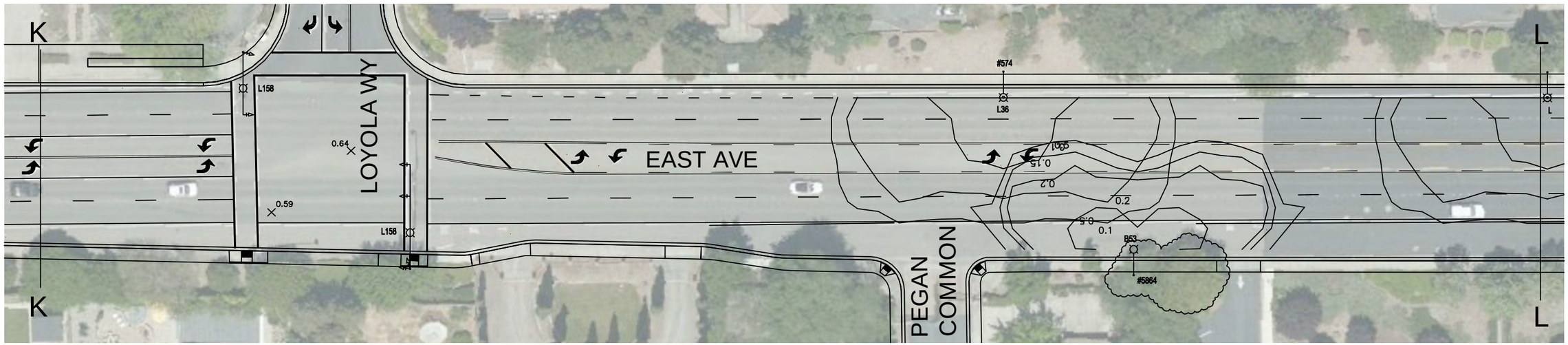
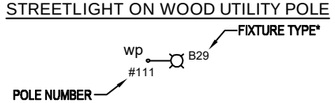
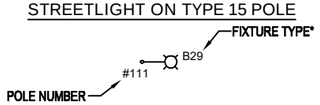




STREETLIGHT ON WOOD UTILITY POLE



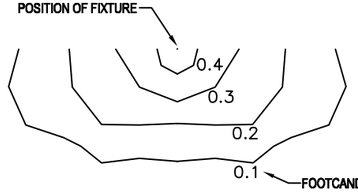
STREETLIGHT ON TYPE 15 POLE



* SEE FIXTURE SCHEDULE

FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS



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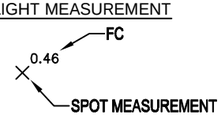
SPOT LIGHT MEASUREMENT



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LIVERMORE, CA
JUNE 2020

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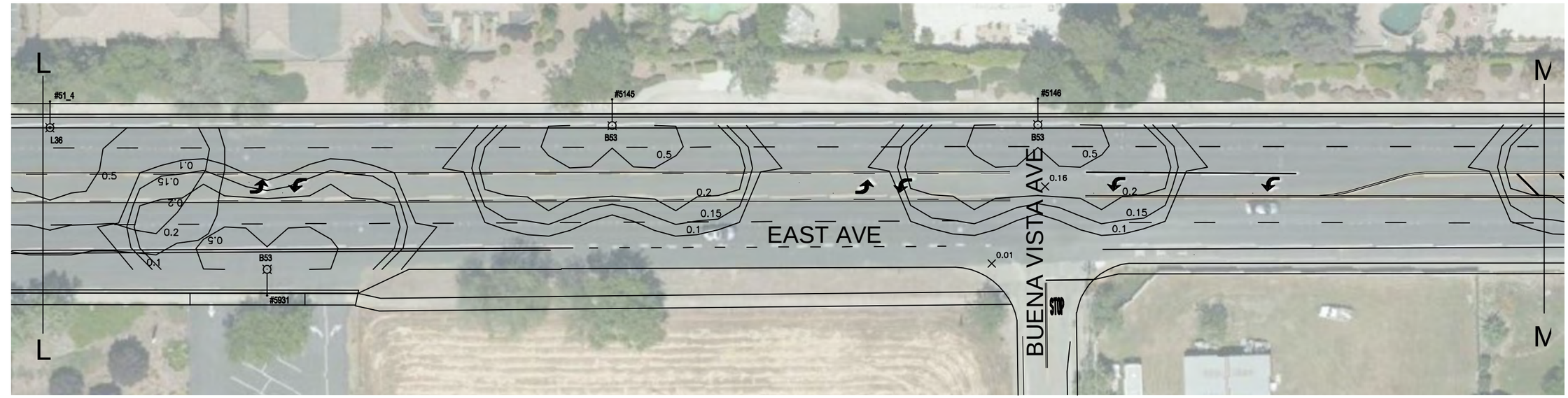
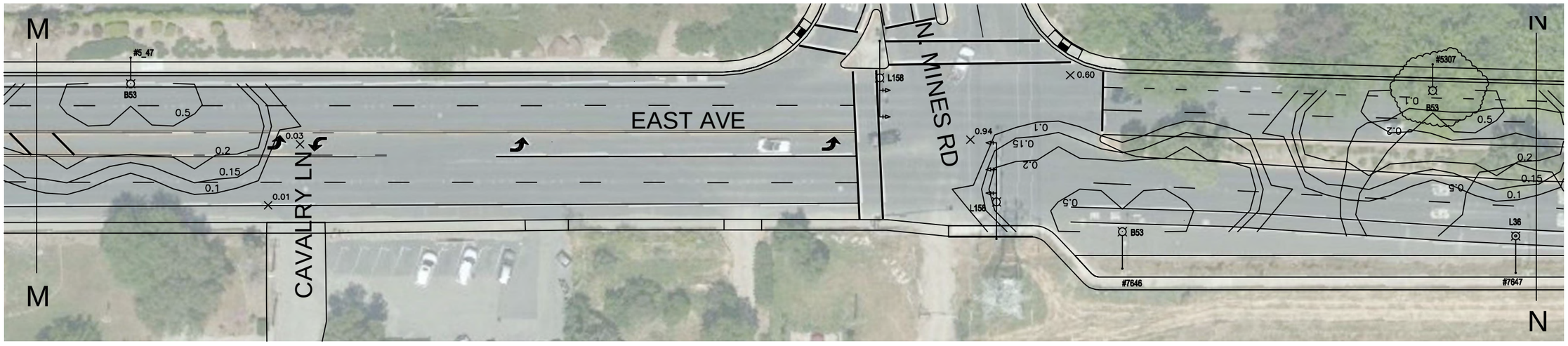
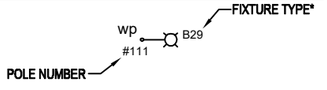
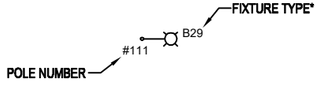




STREETLIGHT ON WOOD UTILITY POLE



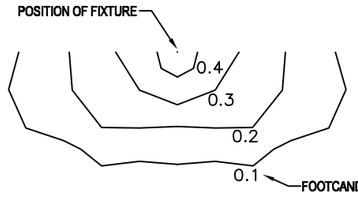
STREETLIGHT ON TYPE 15 POLE



* SEE FIXTURE SCHEDULE

FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS



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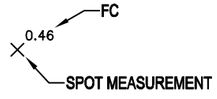
SPOT LIGHT MEASUREMENT



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JUNE 2020

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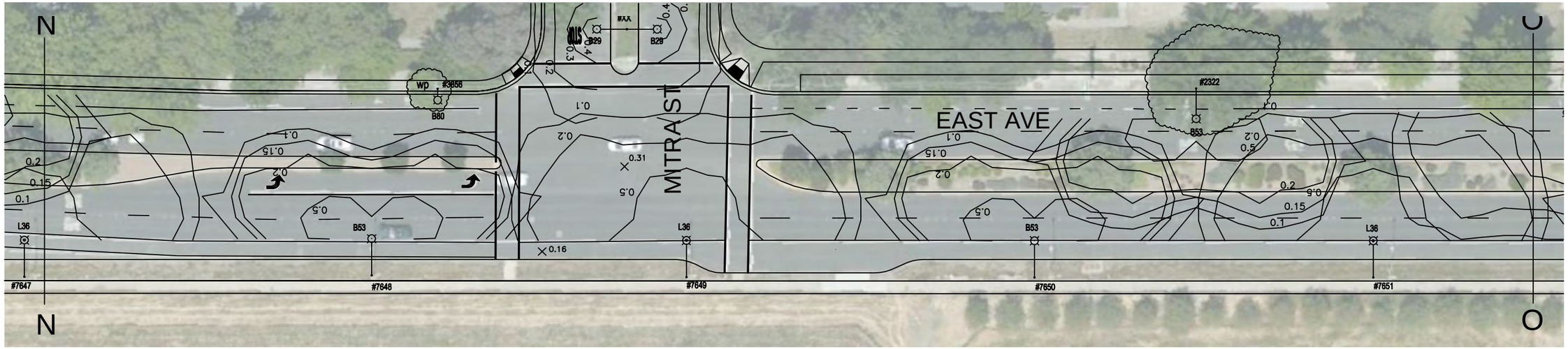
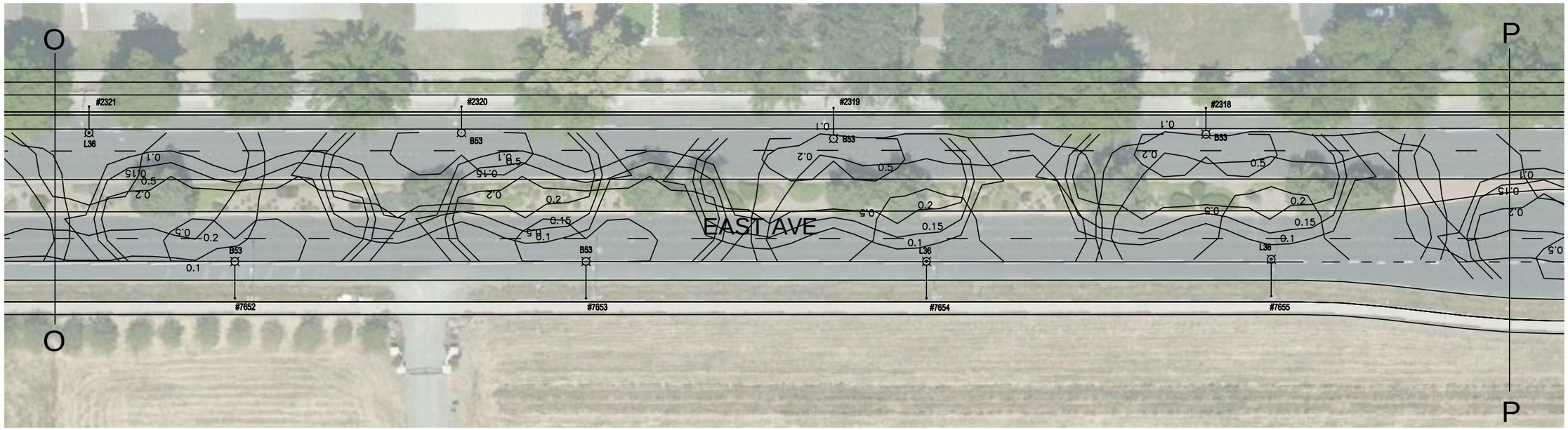
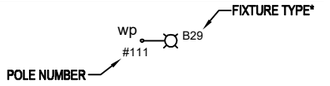
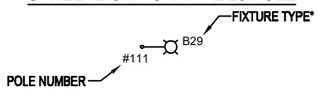




STREETLIGHT ON WOOD UTILITY POLE



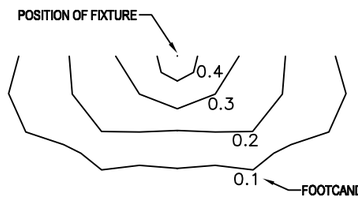
STREETLIGHT ON TYPE 15 POLE



* SEE FIXTURE SCHEDULE

FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS



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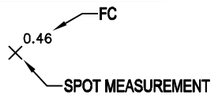
SPOT LIGHT MEASUREMENT



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JUNE 2020

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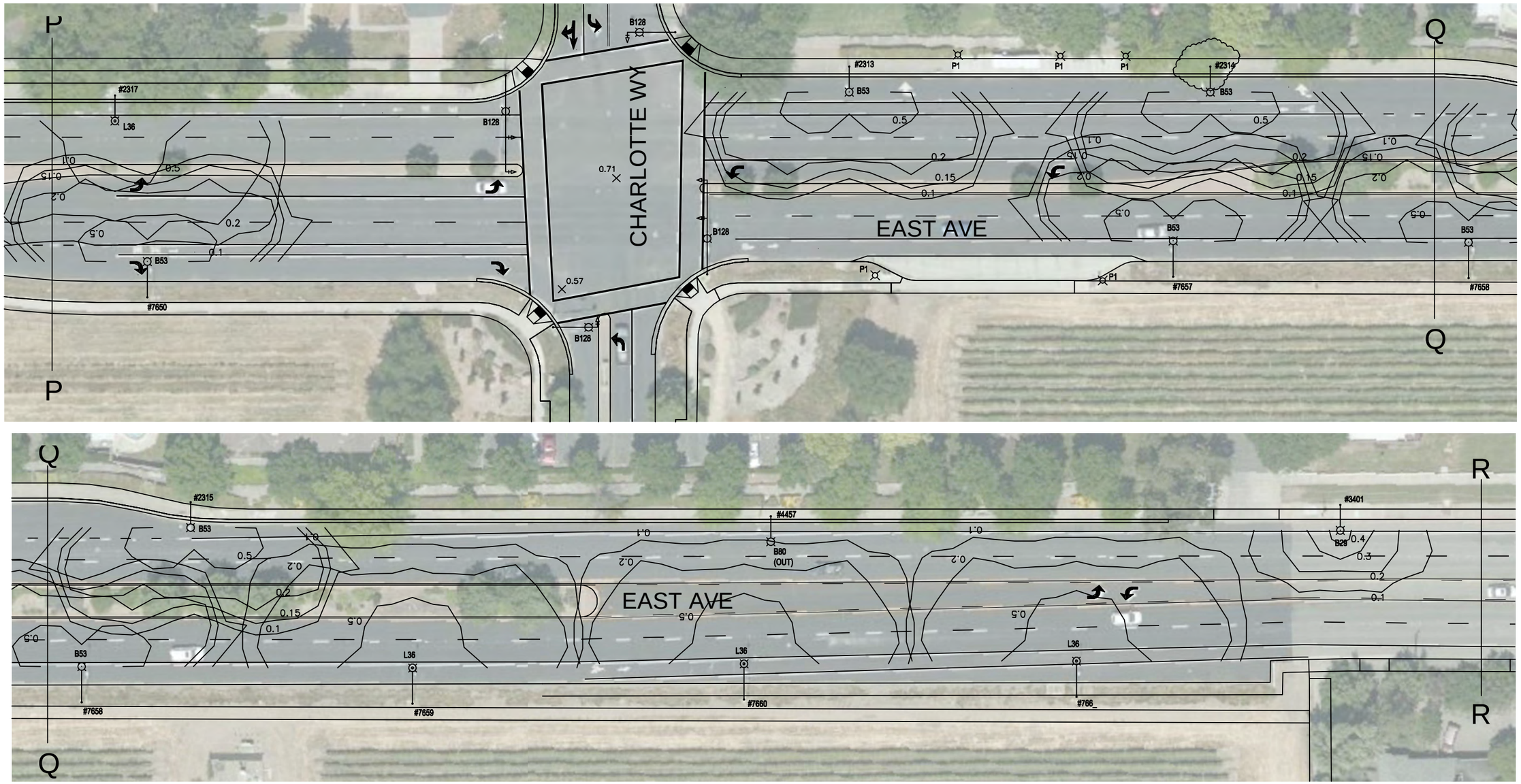
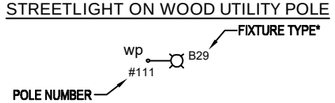
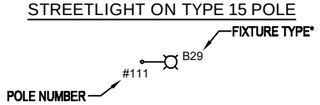


STREETLIGHT ON WOOD UTILITY POLE



STREETLIGHT ON TYPE 15 POLE



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FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
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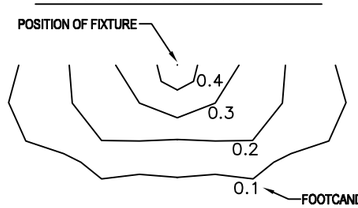
ISOFOOTCANDLE CONTOURS



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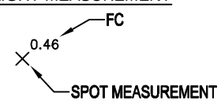
SPOT LIGHT MEASUREMENT



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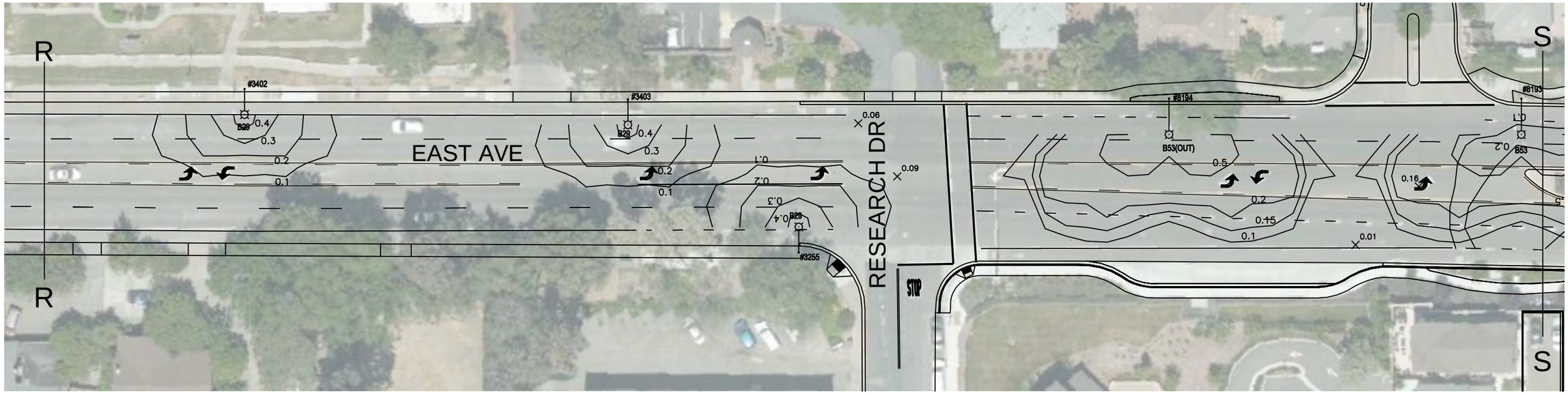
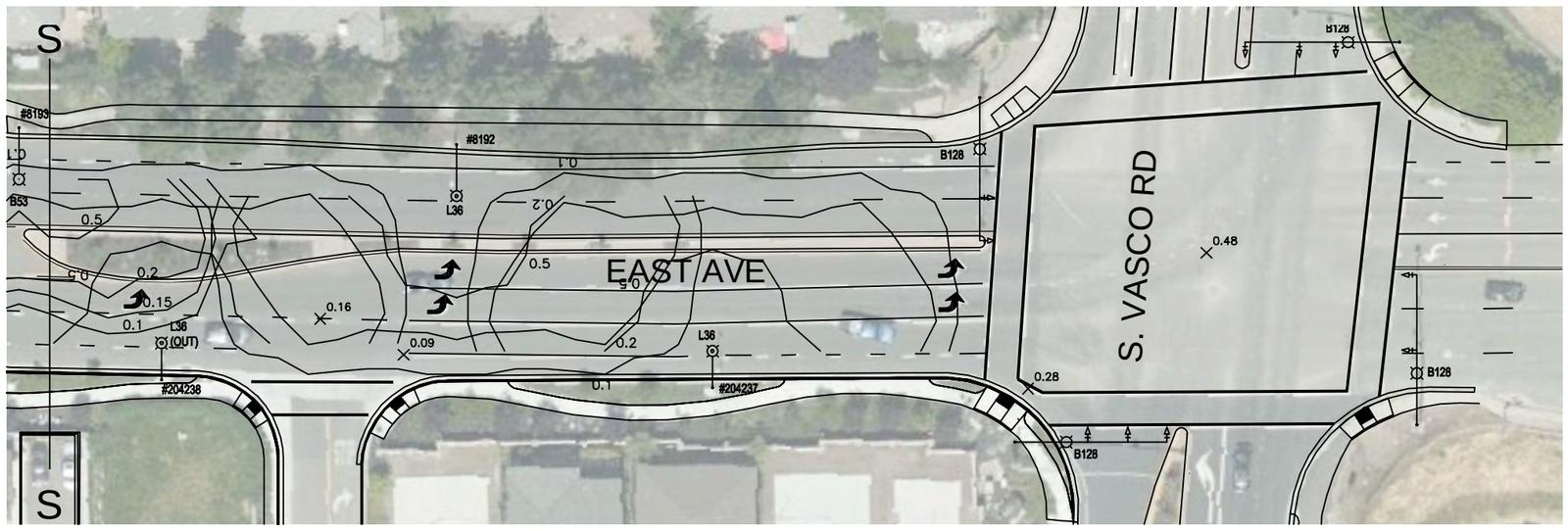
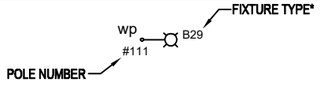
PREPARED FOR TJKM BY
BEAR ELECTRICAL SOLUTIONS

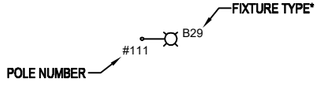




STREETLIGHT ON WOOD UTILITY POLE



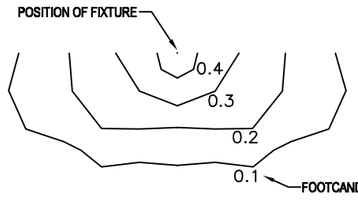
STREETLIGHT ON TYPE 15 POLE



* SEE FIXTURE SCHEDULE

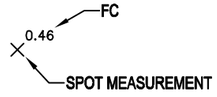
FIXTURE SCHEDULE	
B29	BRIDGELUX 29 LED
B53	BRIDGELUX 53 LED
B80	BRIDGELUX 80 LED
B128	BRIDGELUX 128 LED
L36	LEOTEK 36 LED
L158	LEOTEK 158 LED
P1	UNKNOWN LUMEC PED SCALE

ISOFOOTCANDLE CONTOURS



NOTE: ISOFOOTCANDLE CONTOURS ARE APPROXIMATIONS BASED ON SAMPLE FIELD MEASUREMENTS

SPOT LIGHT MEASUREMENT



SCALE: 1" =50'
ACCURATE FOR
LIGHTING STUDY ONLY

EAST AVENUE LIGHTING STUDY
LIVERMORE, CA
JUNE 2020

PREPARED FOR TJKM BY
BEAR ELECTRICAL SOLUTIONS

Luminaire Schedule - LED											
Project: EAST AVE - LIVERMORE											
Symbol	Qty	Label	Arrangement	Lum. Watts	Lum. Lumens	LLF	LLD	LDD	UDF	Description	Filename
	23	AA	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	5	AA-TL	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	1	AA2	BACK-BACK	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	47	BB	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	5	BB-TL	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	11	CC	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	1	CC-TL	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	8	DD	SINGLE	123	17807	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	4	DD-TL	SINGLE	123	17807	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	2	EE	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	3	EE-TL	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 34'-3" +15' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	11	FF	Single	89	13437	0.900	0.900	1.000	1.000	LEOTEK GCM2-60J-MV-40K-3R-XX-140 S @ 30' + 6' ARM	GCM2-60J-MV-40K-3R-XX-140 S.ies
	4	GG-TL	SINGLE	206.772	30557	0.900	0.900	1.000	1.000	LEOTEK GCL2-80J-MV-40K-3R-XX-295 @ 34'-3" + 15' ARM	GCL2-80J-MV-40K-3R-XX-295.ies

Calculation Summary								
Project: EAST AVE - LIVERMORE								
Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND 5TH ST	MAJOR/LOCAL - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.18	4.04	0.79	2.76	5.11
INTERSECTION AT EAST AVE AND 6TH ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	1.96	3.80	0.78	2.51	4.87
INTERSECTION AT EAST AVE AND 7TH ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.01	4.40	0.81	2.48	5.43
INTERSECTION AT EAST AVE AND ALMOND AVE	MAJOR/LOCAL: 2.2FC. 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.08	0.74	2.77	5.51
INTERSECTION AT EAST AVE AND AUBURN ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.21	0.67	3.01	6.28
INTERSECTION AT EAST AVE AND BIRCHWOOD COMMON	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMI	Illuminance	Fc	2.08	4.25	0.69	3.01	6.16
INTERSECTION AT EAST AVE AND BUENA VISTA AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.16	3.92	0.73	2.96	5.37
INTERSECTION AT EAST AVE AND CHARLOTTE WAY	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMI	Illuminance	Fc	2.31	3.33	0.78	2.96	4.27
INTERSECTION AT EAST AVE AND DOLORES ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	3.03	3.92	1.56	1.94	2.51
INTERSECTION AT EAST AVE AND ESTATES ST	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORITY	Illuminance	Fc	2.34	4.20	0.80	2.93	5.25
INTERSECTION AT EAST AVE AND HAYES AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.06	3.95	0.66	3.12	5.98
INTERSECTION AT EAST AVE AND HILLCREST AVE	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	3.04	4.65	0.97	3.13	4.79
INTERSECTION AT EAST AVE AND JEFFERSON AVE	MAJOR/LOCAL:2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.10	3.81	0.86	2.44	4.43
INTERSECTION AT EAST AVE AND JENSEN ST	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.86	0.68	3.28	5.68
INTERSECTION AT EAST AVE AND LOYOLA WAY	MAJOR/LOCAL:2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.07	3.85	0.66	3.14	5.83
INTERSECTION AT EAST AVE AND MADISON AVE	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.12	3.44	0.78	2.72	4.41

Calculation Summary								
Project: EAST AVE - LIVERMORE								
Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND MAPLE ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.04	3.82	0.76	2.68	5.03
INTERSECTION AT EAST AVE AND MITRA ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.26	1.04	1.97	4.10
INTERSECTION AT EAST AVE AND N MINES ROAD	MAJOR/COLLECTOR: 2.6FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.81	0.76	2.93	5.01
INTERSECTION AT EAST AVE AND NELSON LANE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.03	4.15	0.71	2.86	5.85
INTERSECTION AT EAST AVE AND PEGAN COMMON	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.07	0.87	2.32	4.68
INTERSECTION AT EAST AVE AND RESEARCH DR	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.27	3.61	0.92	2.47	3.92
INTERSECTION AT EAST AVE AND S VASCO ROAD	MAJOR/MAJOR: 2.6FC. - 3:1 UNIFORMI	Illuminance	Fc	2.74	6.11	1.08	2.54	5.66
INTERSECTION AT EAST AVE AND XAVIER WAY	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.08	3.76	0.76	2.74	4.95
TYPICAL BETWEEN N MINES ROAD AND AND CHARLOTTE WAY	0.8FC	Illuminance	Fc	1.44	4.12	0.23	6.26	17.91
TYPICAL BETWEEN LOYOLA WAY AND N MINES RD	0.8FC	Illuminance	Fc	0.84	4.07	0.01	84.00	407.00
TYPICAL BETWEEN LIVERMORE ST AND MAPLE ST	0.8FC	Illuminance	Fc	1.60	4.10	0.26	6.15	15.77
TYPICAL BETWEEN HILLCREST AVE AND LOYOLA WAY	0.8FC	Illuminance	Fc	1.21	4.21	0.02	60.50	210.50
TYPICAL BETWEEN DOLORES ST AND HILLCREST AVE	0.8FC	Illuminance	Fc	0.74	4.20	0.00	N.A.	N.A.
TYPICAL BETWEEN CHARLOTTE WAY AND S VASCO RD	0.8FC	Illuminance	Fc	1.42	4.25	0.27	5.26	15.74
TYPICAL BETWEEN 7TH ST AND DOLORES ST	0.8FC	Illuminance	Fc	0.79	4.06	0.07	11.29	58.00

ALL VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT GRADE

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP, RATINGS, FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL, AND SITE CHARACTERISTICS.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

Associated Lighting Representatives, Inc.

ASSOCIATED LIGHTING REPRESENTATIVES, INC
7777 PARDEE LANE
P.O. BOX 2265
OAKLAND, CA 94621
PHONE: (510) 638-0158 - FAX (510) 638-2908

REPORT FOR: MICHAEL KATP
BY: APPLICATIONS ENGINEERING; RAMON ZAPATA
SALES REPRESENTATIVE: ALR; CHARLIE FAIN

AGI32 VERSION 19.14
AGI (C) 2020 LIGHTING ANALYSTS, INC.
10268 W. CENTENNIAL ROAD, SUITE 202
LITTLETON, CO 80127

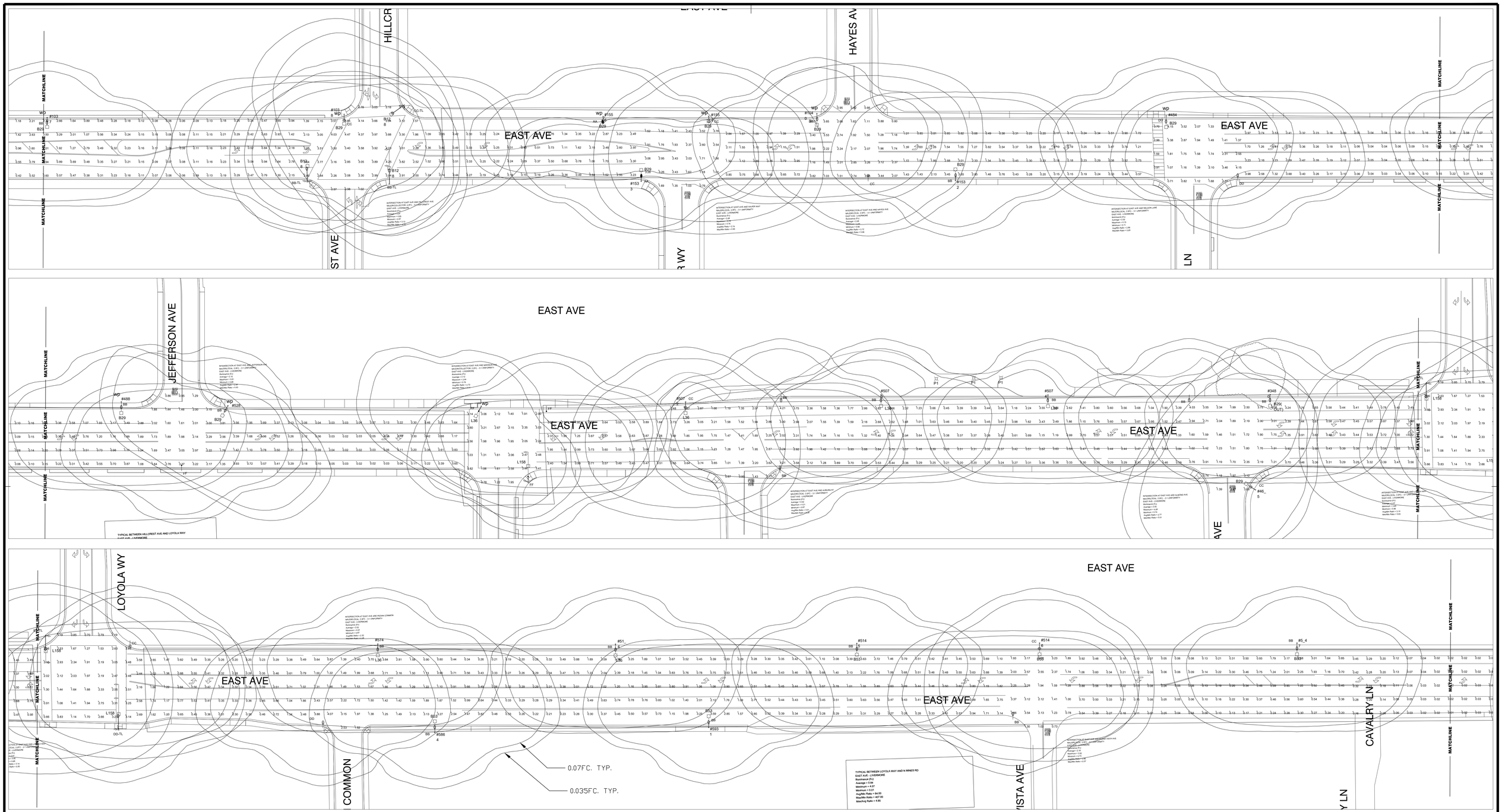
PROJECT DESCRIPTION

EAST AVE

CITY OF LIVERMORE

DRAWING NO. / INPUT FILE
18147FAI-R4.DWG / 18147FAI-R4.A32

SCALE	SHEET	DATE	REV
1" = 40'	1 OF 3	07.27.2021	4



Luminaire Schedule - LED										
Project: EAST AVE - LIVERMORE										
Symbol	Qty	Label	Arrangement	Lum. Watts	Lum. Lumens	LLF	LLD	LDD	UDF	Description	Filename
	23	AA	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	5	AA-TL	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	1	AA2	BACK-BACK	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	47	BB	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	5	BB-TL	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	11	CC	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	1	CC-TL	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	8	DD	SINGLE	123	17807	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	4	DD-TL	SINGLE	123	17807	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	2	EE	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	3	EE-TL	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	11	FF	Single	89	13437	0.900	0.900	1.000	1.000	LEOTEK GCM2-60J-MV-40K-3R-XX-140 S @ 30' + 6' ARM	GCM2-60J-MV-40K-3R-XX-140 S.ies
	4	GG-TL	SINGLE	206.772	30557	0.900	0.900	1.000	1.000	LEOTEK GCL2-80J-MV-40K-3R-XX-295 @ 34'-3" + 15' ARM	GCL2-80J-MV-40K-3R-XX-295.ies

Calculation Summary								
Project: EAST AVE - LIVERMORE								
Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND 5TH ST	MAJOR/LOCAL - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.18	4.04	0.79	2.76	5.11
INTERSECTION AT EAST AVE AND 6TH ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	1.96	3.80	0.78	2.51	4.87
INTERSECTION AT EAST AVE AND 7TH ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.01	4.40	0.81	2.48	5.43
INTERSECTION AT EAST AVE AND ALMOND AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.08	0.74	2.77	5.51
INTERSECTION AT EAST AVE AND AUBURN ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.21	0.67	3.01	6.28
INTERSECTION AT EAST AVE AND BIRCHWOOD COMMON	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMI	Illuminance	Fc	2.08	4.25	0.69	3.01	6.16
INTERSECTION AT EAST AVE AND BUENA VISTA AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.16	3.92	0.73	2.96	5.37
INTERSECTION AT EAST AVE AND CHARLOTTE WAY	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMI	Illuminance	Fc	2.31	3.33	0.78	2.96	4.27
INTERSECTION AT EAST AVE AND DOLORES ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	3.03	3.92	1.56	1.94	2.51
INTERSECTION AT EAST AVE AND ESTATES ST	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORITY	Illuminance	Fc	2.34	4.20	0.80	2.93	5.25
INTERSECTION AT EAST AVE AND HAYES AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.06	3.95	0.66	3.12	5.98
INTERSECTION AT EAST AVE AND HILLCREST AVE	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	3.04	4.65	0.97	3.13	4.79
INTERSECTION AT EAST AVE AND JEFFERSON AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.10	3.81	0.86	2.44	4.43
INTERSECTION AT EAST AVE AND JENSEN ST	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.86	0.68	3.28	5.68
INTERSECTION AT EAST AVE AND LOYOLA WAY	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.07	3.85	0.66	3.14	5.83
INTERSECTION AT EAST AVE AND MADISON AVE	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.12	3.44	0.78	2.72	4.41

Calculation Summary								
Project: EAST AVE - LIVERMORE								
Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND MAPLE ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.04	3.82	0.76	2.68	5.03
INTERSECTION AT EAST AVE AND MITRA ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.26	1.04	1.97	4.10
INTERSECTION AT EAST AVE AND N MINES ROAD	MAJOR/COLLECTOR: 2.6FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.81	0.76	2.93	5.01
INTERSECTION AT EAST AVE AND NELSON LANE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.03	4.15	0.71	2.86	5.85
INTERSECTION AT EAST AVE AND PEGAN COMMON	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.07	0.87	2.32	4.68
INTERSECTION AT EAST AVE AND RESEARCH DR	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.27	3.61	0.92	2.47	3.92
INTERSECTION AT EAST AVE AND S VASCO ROAD	MAJOR/MAJOR: 2.6FC. - 3:1 UNIFORMI	Illuminance	Fc	2.74	6.11	1.08	2.54	5.66
INTERSECTION AT EAST AVE AND XAVIER WAY	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.08	3.76	0.76	2.74	4.95
TYPICAL BETWEEN N MINES ROAD AND AND CHARLOTTE WAY	0.8FC	Illuminance	Fc	1.44	4.12	0.23	6.26	17.91
TYPICAL BETWEEN LOYOLA WAY AND N MINES RD	0.8FC	Illuminance	Fc	0.84	4.07	0.01	84.00	407.00
TYPICAL BETWEEN LIVERMORE ST AND MAPLE ST	0.8FC	Illuminance	Fc	1.60	4.10	0.26	6.15	15.77
TYPICAL BETWEEN HILLCREST AVE AND LOYOLA WAY	0.8FC	Illuminance	Fc	1.21	4.21	0.02	60.50	210.50
TYPICAL BETWEEN DOLORES ST AND HILLCREST AVE	0.8FC	Illuminance	Fc	0.74	4.20	0.00	N.A.	N.A.
TYPICAL BETWEEN CHARLOTTE WAY AND S VASCO RD	0.8FC	Illuminance	Fc	1.42	4.25	0.27	5.26	15.74
TYPICAL BETWEEN 7TH ST AND DOLORES ST	0.8FC	Illuminance	Fc	0.79	4.06	0.07	11.29	58.00

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Associated Lighting Representatives, Inc.

ASSOCIATED LIGHTING REPRESENTATIVES, INC
7777 PARDEE LANE
P.O. BOX 2265
OAKLAND, CA 94621
PHONE: (510) 638-0158 - FAX (510) 638-2908

REPORT FOR: MICHAEL KATP
BY: APPLICATIONS ENGINEERING; RAMON ZAPATA
SALES REPRESENTATIVE: ALR; CHARLIE FAIN

AGI32 VERSION 19.14
AGI (C) 2020 LIGHTING ANALYSTS, INC.
10268 W. CENTENNIAL ROAD, SUITE 202
LITTLETON, CO 80127

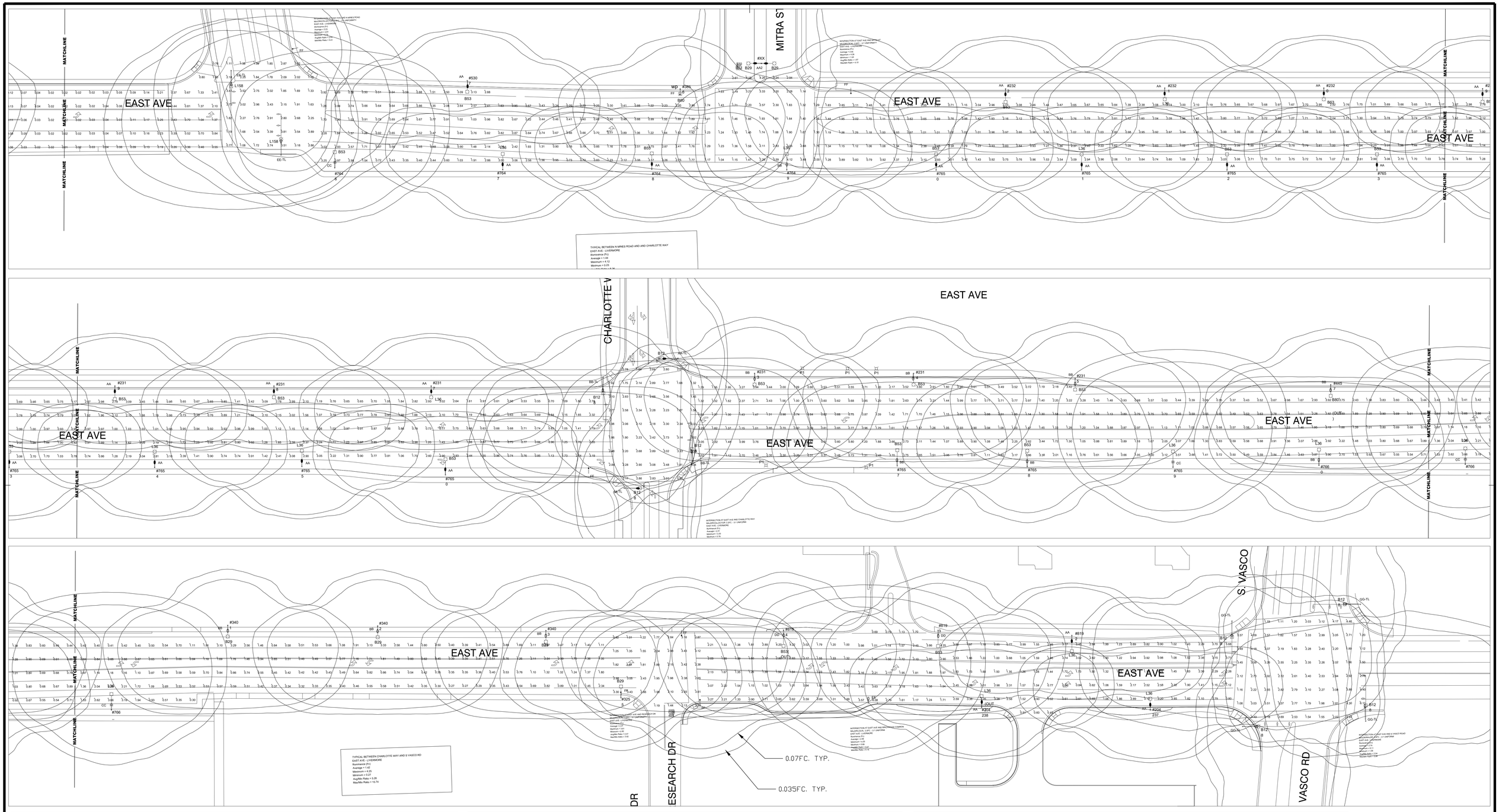
PROJECT DESCRIPTION

EAST AVE

CITY OF LIVERMORE

DRAWING NO. / INPUT FILE
18147FAI-R4.DWG / 18147FAI-R4.A32

SCALE	SHEET	DATE	REV
1" = 40'	2 OF 3	07.27.2021	4



Luminaire Schedule - LED

Project: EAST AVE - LIVERMORE

Symbol	Qty	Label	Arrangement	Lum. Watts	Lum. Lumens	LLF	LLD	LDD	UDF	Description	Filename
	23	AA	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	5	AA-TL	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	1	AA2	BACK-BACK	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	47	BB	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	5	BB-TL	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	11	CC	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	1	CC-TL	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	8	DD	SINGLE	123	17807	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	4	DD-TL	SINGLE	123	17807	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	2	EE	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	3	EE-TL	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 34'-3" +15' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	11	FF	Single	89	13437	0.900	0.900	1.000	1.000	LEOTEK GCM2-60J-MV-40K-3R-XX-140 S @ 30' + 6' ARM	GCM2-60J-MV-40K-3R-XX-140 S.ies
	4	GG-TL	SINGLE	206.772	30557	0.900	0.900	1.000	1.000	LEOTEK GCL2-80J-MV-40K-3R-XX-295 @ 34'-3" + 15' ARM	GCL2-80J-MV-40K-3R-XX-295.ies

Calculation Summary

Project: EAST AVE - LIVERMORE

Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND 5TH ST	MAJOR/LOCAL - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.18	4.04	0.79	2.76	5.11
INTERSECTION AT EAST AVE AND 6TH ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	1.96	3.80	0.78	2.51	4.87
INTERSECTION AT EAST AVE AND 7TH ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.01	4.40	0.81	2.48	5.43
INTERSECTION AT EAST AVE AND ALMOND AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.08	0.74	2.77	5.51
INTERSECTION AT EAST AVE AND AUBURN ST	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.21	0.67	3.01	6.28
INTERSECTION AT EAST AVE AND BIRCHWOOD COMMON	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMI	Illuminance	Fc	2.08	4.25	0.69	3.01	6.16
INTERSECTION AT EAST AVE AND BUENA VISTA AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.16	3.92	0.73	2.96	5.37
INTERSECTION AT EAST AVE AND CHARLOTTE WAY	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMI	Illuminance	Fc	2.31	3.33	0.78	2.96	4.27
INTERSECTION AT EAST AVE AND DOLORES ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	3.03	3.92	1.56	1.94	2.51
INTERSECTION AT EAST AVE AND ESTATES ST	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORITY	Illuminance	Fc	2.34	4.20	0.80	2.93	5.25
INTERSECTION AT EAST AVE AND HAYES AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.06	3.95	0.66	3.12	5.98
INTERSECTION AT EAST AVE AND HILLCREST AVE	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	3.04	4.65	0.97	3.13	4.79
INTERSECTION AT EAST AVE AND JEFFERSON AVE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.10	3.81	0.86	2.44	4.43
INTERSECTION AT EAST AVE AND JENSEN ST	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.96	0.68	3.28	5.68
INTERSECTION AT EAST AVE AND LOYOLA WAY	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.07	3.85	0.66	3.14	5.83
INTERSECTION AT EAST AVE AND MADISON AVE	MAJOR/COLLECTOR: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.12	3.44	0.78	2.72	4.41

Calculation Summary

Project: EAST AVE - LIVERMORE

Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND MAPLE ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.04	3.82	0.76	2.68	5.03
INTERSECTION AT EAST AVE AND MITRA ST	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.26	1.04	1.97	4.10
INTERSECTION AT EAST AVE AND N MINES ROAD	MAJOR/COLLECTOR: 2.6FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.81	0.76	2.93	5.01
INTERSECTION AT EAST AVE AND NELSON LANE	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.03	4.15	0.71	2.86	5.85
INTERSECTION AT EAST AVE AND PEGAN COMMON	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.07	0.87	2.32	4.68
INTERSECTION AT EAST AVE AND RESEARCH DR	MAJOR/LOCAL: 2.0FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.27	3.61	0.92	2.47	3.92
INTERSECTION AT EAST AVE AND S VASCO ROAD	MAJOR/MAJOR: 2.6FC. - 3:1 UNIFORMI	Illuminance	Fc	2.74	6.11	1.08	2.54	5.66
INTERSECTION AT EAST AVE AND XAVIER WAY	MAJOR/LOCAL: 2.2FC. - 3:1 UNIFORMITY	Illuminance	Fc	2.08	3.76	0.76	2.74	4.95
TYPICAL BETWEEN N MINES ROAD AND AND CHARLOTTE WAY	0.8FC	Illuminance	Fc	1.44	4.12	0.23	6.26	17.91
TYPICAL BETWEEN LOYOLA WAY AND N MINES RD	0.8FC	Illuminance	Fc	0.84	4.07	0.01	84.00	407.00
TYPICAL BETWEEN LIVERMORE ST AND MAPLE ST	0.8FC	Illuminance	Fc	1.60	4.10	0.26	6.15	15.77
TYPICAL BETWEEN HILLCREST AVE AND LOYOLA WAY	0.8FC	Illuminance	Fc	1.21	4.21	0.02	60.50	210.50
TYPICAL BETWEEN DOLORES ST AND HILLCREST AVE	0.8FC	Illuminance	Fc	0.74	4.20	0.00	N.A.	N.A.
TYPICAL BETWEEN CHARLOTTE WAY AND S VASCO RD	0.8FC	Illuminance	Fc	1.42	4.25	0.27	5.26	15.74
TYPICAL BETWEEN 7TH ST AND DOLORES ST	0.8FC	Illuminance	Fc	0.79	4.06	0.07	11.29	58.00

ALL VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT GRADE

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP, RATINGS, FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL, AND SITE CHARACTERISTICS.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

Associated Lighting Representatives, Inc.

ASSOCIATED LIGHTING REPRESENTATIVES, INC
7777 PARDEE LANE
P.O. BOX 2265
OAKLAND, CA 94621
PHONE: (510) 638-0158 - FAX (510) 638-2908

REPORT FOR: MICHAEL KATP
BY: APPLICATIONS ENGINEERING; RAMON ZAPATA
SALES REPRESENTATIVE: ALR; CHARLIE FAIN

AGI32 VERSION 19.14
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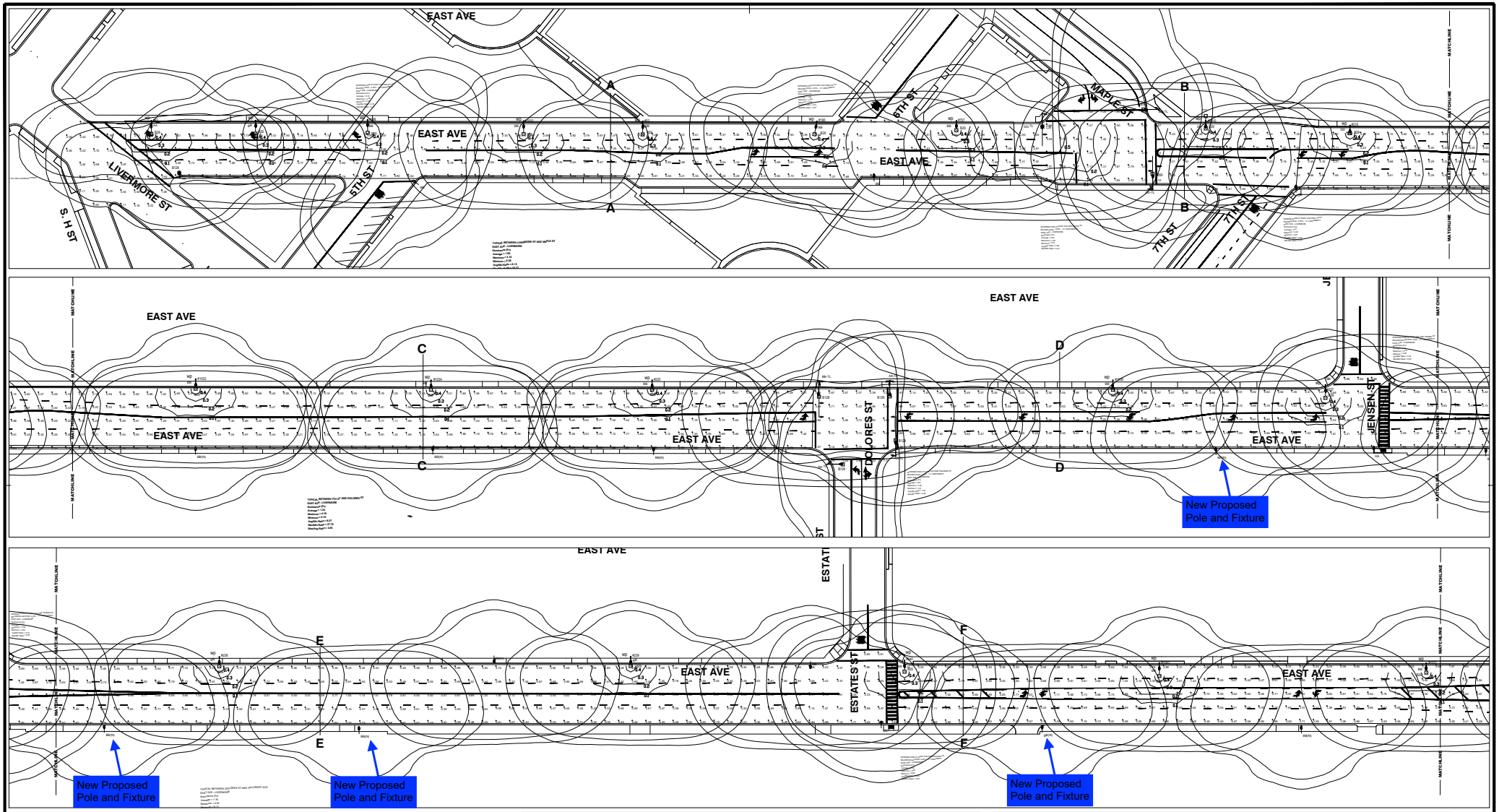

Luminaire Schedule - LED

Project: EAST AVE - LIVERMORE

Symbol	Qty	Label	Arrangement	Lum. Watts	Lum. Lumens	LLF	LLD	LDD	UDF	Description	Filename
	23	AA	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	5	AA-TL	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	1	AA2	BACK-BACK	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	44	BB	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	18	BB(N)	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	5	BB-TL	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	11	CC	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	1	CC-TL	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	8	DD	SINGLE	123	17907	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	4	DD-TL	SINGLE	123	17907	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	2	EE	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	3	EE-TL	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	11	FF	Single	99	13437	0.900	0.900	1.000	1.000	LEOTEK GCM2-60J-MV-40K-3R-XX-140 S @ 30' + 6' ARM	GCM2-60J-MV-40K-3R-XX-140 S.ies
	4	GG-TL	SINGLE	206.772	30057	0.900	0.900	1.000	1.000	LEOTEK GCL2-80J-MV-40K-3R-XX-260 @ 34'-3" + 15' ARM	GCL2-80J-MV-40K-3R-XX-260.ies

Calculation Summary

Project: EAST AVE - LIVERMORE

Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND 5TH ST	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.18	4.04	0.79	2.76	5.11
INTERSECTION AT EAST AVE AND 6TH ST	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	1.86	3.80	0.78	2.51	4.87
INTERSECTION AT EAST AVE AND 7TH ST	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.01	4.40	0.81	2.48	5.43
INTERSECTION AT EAST AVE AND ALMOND AVE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.08	0.74	2.77	5.51
INTERSECTION AT EAST AVE AND AUBURN ST	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.22	0.67	3.01	6.30
INTERSECTION AT EAST AVE AND BIRCHWOOD COMMON	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.08	4.25	0.69	3.01	6.16
INTERSECTION AT EAST AVE AND BUENA VISTA AVE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.19	3.94	0.77	2.84	5.12
INTERSECTION AT EAST AVE AND CHARLOTTE WAY	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.31	3.33	0.79	2.96	4.27
INTERSECTION AT EAST AVE AND DOLORES ST	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	3.03	3.92	1.57	1.93	2.50
INTERSECTION AT EAST AVE AND ESTATES ST	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.34	4.20	0.80	2.93	5.25
INTERSECTION AT EAST AVE AND HAYES AVE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.06	3.95	0.66	3.12	5.98
INTERSECTION AT EAST AVE AND HILLCREST AVE	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	3.98	4.66	0.99	5.09	4.71
INTERSECTION AT EAST AVE AND JEFFERSON AVE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.11	3.84	0.86	2.45	4.47
INTERSECTION AT EAST AVE AND JENSEN ST	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.21	4.32	0.66	3.35	6.55
INTERSECTION AT EAST AVE AND LOYOLA WAY	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.07	3.85	0.66	3.14	5.83

Calculation Summary

Project: EAST AVE - LIVERMORE

Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND MADISON AVE	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.14	3.44	0.79	2.71	4.35
INTERSECTION AT EAST AVE AND MAPLE ST	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.04	3.82	0.76	2.68	5.03
INTERSECTION AT EAST AVE AND MITRA ST	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.26	1.04	1.97	4.10
INTERSECTION AT EAST AVE AND N MINES ROAD	MAJOR/COLLECTOR: 2.6FC - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.81	0.77	2.90	4.95
INTERSECTION AT EAST AVE AND NELSON LANE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.03	4.16	0.72	2.82	5.78
INTERSECTION AT EAST AVE AND PEGAN COMMON	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.07	0.87	2.32	4.68
INTERSECTION AT EAST AVE AND RESEARCH DR	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.27	3.61	0.92	2.47	3.92
INTERSECTION AT EAST AVE AND S VASCO ROAD	MAJOR/MAJOR: 2.6FC - 3:1 UNIFORMITY	Illuminance	Fc	3.74	6.11	1.08	3.54	5.66
INTERSECTION AT EAST AVE AND VAISER WAY	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.08	3.76	0.76	2.74	4.95
TYPICAL BETWEEN N MINES ROAD AND AND CHARLOTTE WAY	0.6FC	Illuminance	Fc	1.44	4.12	0.23	6.26	17.91
TYPICAL BETWEEN LOYOLA WAY AND N MINES RD	0.6FC	Illuminance	Fc	1.02	4.07	0.14	7.29	29.07
TYPICAL BETWEEN LIVERMORE ST AND MAPLE ST	0.6FC	Illuminance	Fc	1.60	4.10	0.26	6.15	15.77
TYPICAL BETWEEN HILLCREST AVE AND LOYOLA WAY	0.6FC	Illuminance	Fc	1.39	4.22	0.14	9.93	30.14
TYPICAL BETWEEN DOLORES ST AND HILLCREST AVE	0.6FC	Illuminance	Fc	1.18	4.32	0.17	6.94	25.41
TYPICAL BETWEEN CHARLOTTE WAY AND S VASCO RD	0.6FC	Illuminance	Fc	1.42	4.25	0.27	5.26	15.74
TYPICAL BETWEEN 7TH ST AND DOLORES ST	0.6FC	Illuminance	Fc	1.24	4.16	0.15	8.27	27.73

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7777 PARDEE LANE
P.O. BOX 2265
OAKLAND, CA 94621
PHONE: (510) 638-0158 - FAX (510) 638-2908

REPORT FOR: MICHAEL KATP
BY: APPLICATIONS ENGINEERING; RAMON ZAPATA
SALES REPRESENTATIVE: ALR; CHARLIE FAIN

AG032 VERSION 19.14
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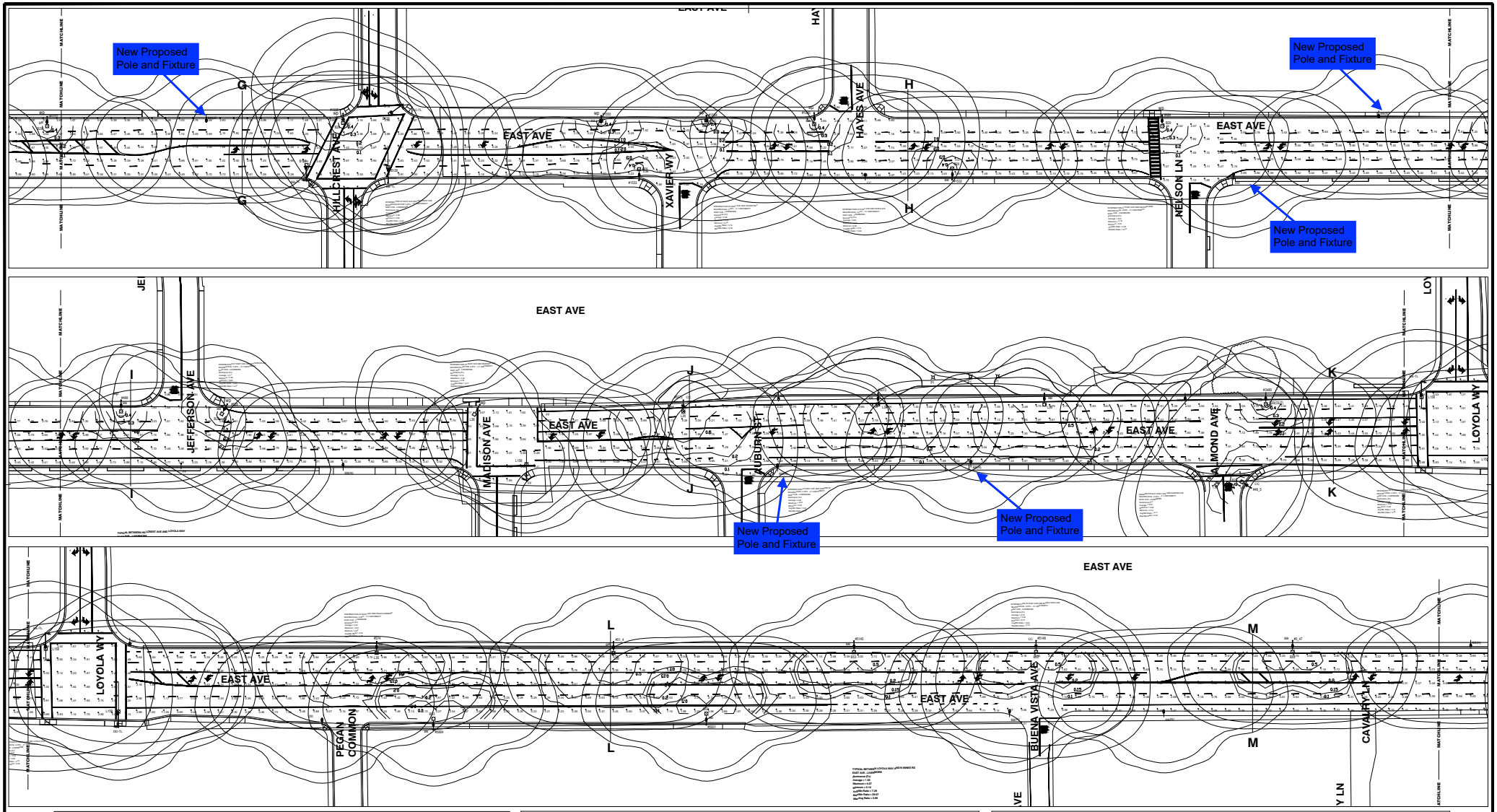

Luminaire Schedule - LED

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	44	BB	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	18	BB(N)	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	5	BB-TL	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	11	CC	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	1	CC-TL	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	8	DD	SINGLE	123	17907	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	4	DD-TL	SINGLE	123	17907	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	2	EE	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	3	EE-TL	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	11	FF	Single	69	13407	0.900	0.900	1.000	1.000	LEOTEK GCM2-60J-MV-40K-3R-XX-140 S @ 30' + 6' ARM	GCM2-60J-MV-40K-3R-XX-140 S.ies
	4	GG-TL	SINGLE	206.772	30507	0.900	0.900	1.000	1.000	LEOTEK GCL2-80J-MV-40K-3R-XX-295 @ 34'-3" + 15' ARM	GCL2-80J-MV-40K-3R-XX-295.ies

Calculation Summary

Project: EAST AVE - LIVERMORE

Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND 5TH ST	MAJOR/LOCAL - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.18	4.04	0.79	2.76	5.11
INTERSECTION AT EAST AVE AND 6TH ST	MAJOR/LOCAL - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	1.96	3.80	0.78	2.51	4.87
INTERSECTION AT EAST AVE AND 7TH ST	MAJOR/LOCAL - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.01	4.40	0.81	2.48	5.43
INTERSECTION AT EAST AVE AND ALMOND AVE	MAJOR/LOCAL - 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.65	4.08	0.74	3.77	5.51
INTERSECTION AT EAST AVE AND AUBURN ST	MAJOR/LOCAL - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.22	0.67	3.01	6.30
INTERSECTION AT EAST AVE AND BIRCHWOOD COMMON	MAJOR/LOCAL - 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.68	4.25	0.89	3.01	6.16
INTERSECTION AT EAST AVE AND BUENA VISTA AVE	MAJOR/LOCAL - 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.19	3.94	0.77	2.84	5.12
INTERSECTION AT EAST AVE AND CHARLOTTE WAY	MAJOR/COLLECTOR - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.31	3.33	0.78	2.96	4.27
INTERSECTION AT EAST AVE AND DOLORES ST	MAJOR/LOCAL - 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	3.03	3.92	1.57	1.93	2.50
INTERSECTION AT EAST AVE AND ESTATES ST	MAJOR/COLLECTOR - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.34	4.20	0.80	2.93	5.25
INTERSECTION AT EAST AVE AND HAYES AVE	MAJOR/LOCAL - 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.66	3.95	0.66	3.12	5.98
INTERSECTION AT EAST AVE AND HILLCREST AVE	MAJOR/COLLECTOR - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	3.66	4.98	0.99	3.69	4.71
INTERSECTION AT EAST AVE AND JEFFERSON AVE	MAJOR/LOCAL - 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.11	3.84	0.86	2.45	4.47
INTERSECTION AT EAST AVE AND JENSEN ST	MAJOR/COLLECTOR - 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.21	4.32	0.66	3.35	6.55
INTERSECTION AT EAST AVE AND LOYOLA WAY	MAJOR/LOCAL - 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.07	3.65	0.66	3.14	5.83

Calculation Summary

Project: EAST AVE - LIVERMORE

Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND MADISON AVE	MAJOR/COLLECTOR: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.14	3.44	0.79	2.71	4.35
INTERSECTION AT EAST AVE AND MAPLE ST	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.04	3.82	0.76	2.68	5.03
INTERSECTION AT EAST AVE AND MITRA ST	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.05	4.26	1.04	1.97	4.10
INTERSECTION AT EAST AVE AND N MINES ROAD	MAJOR/COLLECTOR: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.81	0.77	2.90	4.95
INTERSECTION AT EAST AVE AND NELSON LANE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.03	4.16	0.72	2.82	5.78
INTERSECTION AT EAST AVE AND PEGAN COMMON	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.07	0.87	2.32	4.68
INTERSECTION AT EAST AVE AND RESEARCH DR	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.27	3.61	0.92	2.47	3.92
INTERSECTION AT EAST AVE AND S VASCO ROAD	MAJOR/MAJOR: 2.6FC - 3:1 UNIFORMITY	Illuminance	Fc	2.74	4.11	1.08	2.54	5.66
INTERSECTION AT EAST AVE AND XAVIER WAY	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.08	3.76	0.76	2.74	4.95
TYPICAL BETWEEN N MINES ROAD AND AND CHARLOTTE WAY	0.6FC	Illuminance	Fc	1.44	4.12	0.23	6.26	17.91
TYPICAL BETWEEN LOYOLA WAY AND N MINES RD	0.6FC	Illuminance	Fc	1.02	4.07	0.14	7.29	29.07
TYPICAL BETWEEN LIVERMORE ST AND MAPLE ST	0.6FC	Illuminance	Fc	1.60	4.10	0.26	6.15	15.77
TYPICAL BETWEEN HILLCREST AVE AND LOYOLA WAY	0.6FC	Illuminance	Fc	1.39	4.22	0.14	9.93	30.14
TYPICAL BETWEEN DOLORES ST AND HILLCREST AVE	0.6FC	Illuminance	Fc	1.18	4.32	0.17	6.94	25.41
TYPICAL BETWEEN CHARLOTTE WAY AND S VASCO RD	0.6FC	Illuminance	Fc	1.42	4.25	0.27	5.26	15.74
TYPICAL BETWEEN 7TH ST AND DOLORES ST	0.6FC	Illuminance	Fc	1.24	4.16	0.13	8.27	27.73

ALL VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT GRADE

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP, RATINGS, FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL, AND SITE CHARACTERISTICS.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

Associated Lighting Representatives, Inc.

ASSOCIATED LIGHTING REPRESENTATIVES, INC
7777 PARDEE LANE
P.O. BOX 2265
OAKLAND, CA 94621
PHONE: (510) 638-0158 - FAX (510) 638-2908

REPORT FOR: MICHAEL KATP
BY: APPLICATIONS ENGINEERING; RAMON ZAPATA
SALES REPRESENTATIVE: ALR; CHARLIE FAIN

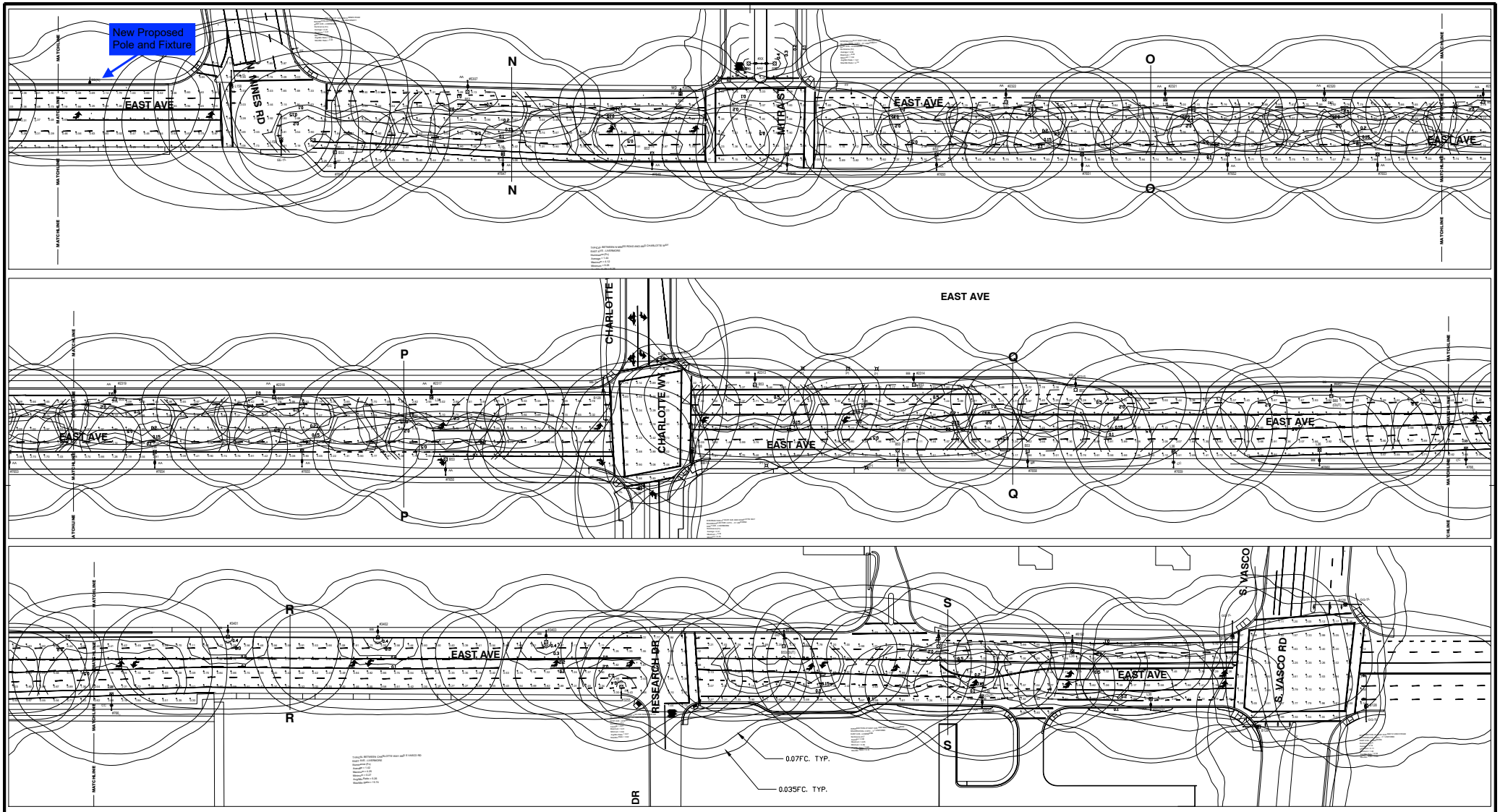
AGI32 VERSION 19.14
AGI (C) 2020 LIGHTING ANALYSTS, INC.
10268 W. CENTENNIAL ROAD, SUITE 202
LITTLETON, CO 80127

EAST AVE

CITY OF LIVERMORE

DRAWING NO. / INPUT FILE: 18147FAI-R5.DWG / 18147FAI-R5.A32

SCALE	SHEET	DATE	REV
1" = 40'	2 OF 3	07.28.2021	5



Luminaire Schedule - LED											
Project: EAST AVE - LIVERMORE											
Symbol	Qty	Label	Arrangement	Lum. Watts	Lum. Lumens	LLF	LLD	LDD	LDF	Description	Filename
	23	AA	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30° + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	5	AA-TL	SINGLE	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	1	AA2	BACK-BACK	111	17125	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-170 S @ 30° + 6' ARM	GCM3-60J-MV-40K-2R-XX-170 S.ies
	44	BB	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30° + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	18	BB(N)	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 30° + 6' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	5	BB-TL	SINGLE	130.195	16269	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-170 S.ies
	11	CC	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	1	CC-TL	SINGLE	111	16458	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-170 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-170 S.ies
	3	DD	SINGLE	123	17607	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-2R-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-2R-XX-185 S.ies
	4	DD-TL	SINGLE	123	17607	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-3R-XX-185 S.ies
	1	EE	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 30' + 6' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	3	EE-TL	SINGLE	123	18016	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-4-XX-185 S @ 34'-3" + 15' ARM	GCM3-60J-MV-40K-4-XX-185 S.ies
	11	FF	Single	89	13437	0.900	0.900	1.000	1.000	LEOTEK GCM3-60J-MV-40K-3R-XX-140 S @ 30' + 6' ARM	GCM3-60J-MV-40K-3R-XX-140 S.ies
	4	GG-TL	SINGLE	266.772	36057	0.900	0.900	1.000	1.000	LEOTEK GCL2-60J-MV-40K-3R-XX-285 @ 34'-3" + 15' ARM	GCL2-60J-MV-40K-3R-XX-285.ies

Calculation Summary								
Project: EAST AVE - LIVERMORE								
Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND 5TH ST	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.18	4.04	0.79	2.76	5.11
INTERSECTION AT EAST AVE AND 6TH ST	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	1.96	3.89	0.78	2.51	4.97
INTERSECTION AT EAST AVE AND 7TH ST	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.01	4.40	0.81	2.48	5.43
INTERSECTION AT EAST AVE AND ALMOND AVE	MAJOR/LOCAL: 2.2FC, 3:1 UNIFORMITY	Illuminance	Fc	2.65	4.08	0.74	3.77	5.51
INTERSECTION AT EAST AVE AND AUBURN ST	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.52	4.22	0.67	3.01	6.30
INTERSECTION AT EAST AVE AND BIRCHWOOD COMMON	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.68	4.25	0.69	3.01	6.16
INTERSECTION AT EAST AVE AND BUENA VISTA AVE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.19	3.94	0.77	2.84	5.12
INTERSECTION AT EAST AVE AND CHARLOTTE WAY	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.31	3.33	0.79	2.96	4.27
INTERSECTION AT EAST AVE AND DOLORES ST	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	3.03	3.92	1.57	1.93	2.50
INTERSECTION AT EAST AVE AND ESTATES ST	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORITY	Illuminance	Fc	2.34	4.20	0.80	2.93	5.25
INTERSECTION AT EAST AVE AND HAYES AVE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.66	3.95	0.66	3.12	5.98
INTERSECTION AT EAST AVE AND HILLCREST AVE	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	3.06	4.66	0.99	3.09	4.71
INTERSECTION AT EAST AVE AND JEFFERSON AVE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.11	3.84	0.86	2.45	4.47
INTERSECTION AT EAST AVE AND JENSEN ST	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.31	4.32	0.66	3.35	6.55
INTERSECTION AT EAST AVE AND LOYOLA WAY	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.07	3.85	0.66	3.14	5.83

Calculation Summary								
Project: EAST AVE - LIVERMORE								
Label	Description	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
INTERSECTION AT EAST AVE AND MADISON AVE	MAJOR/COLLECTOR: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.14	3.44	0.79	2.71	4.35
INTERSECTION AT EAST AVE AND MAPLE ST	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.64	3.82	0.76	2.68	5.03
INTERSECTION AT EAST AVE AND MITRA ST	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.65	4.26	1.04	1.97	4.10
INTERSECTION AT EAST AVE AND N MINES ROAD	MAJOR/COLLECTOR: 2.6FC - 3:1 UNIFORMITY	Illuminance	Fc	2.23	3.81	0.77	2.90	4.95
INTERSECTION AT EAST AVE AND NELSON LANE	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.03	4.18	0.72	2.82	5.78
INTERSECTION AT EAST AVE AND PEGAN COMMON	MAJOR/LOCAL: 2.0FC - 3:1 UNIFORMITY	Illuminance	Fc	2.02	4.07	0.87	2.32	4.68
INTERSECTION AT EAST AVE AND RESEARCH DR	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.27	3.61	0.92	2.47	3.92
INTERSECTION AT EAST AVE AND S VASCO ROAD	MAJOR/MAJOR: 2.6FC - 3:1 UNIFORMITY	Illuminance	Fc	2.74	5.11	1.06	2.54	5.66
INTERSECTION AT EAST AVE AND XAVIER WAY	MAJOR/LOCAL: 2.2FC - 3:1 UNIFORMITY	Illuminance	Fc	2.08	3.76	0.76	2.74	4.95
TYPICAL BETWEEN N MINES ROAD AND AND CHARLOTTE WAY	0.9FC	Illuminance	Fc	1.44	4.12	0.23	6.26	17.91
TYPICAL BETWEEN LOYOLA WAY AND N MINES RD	0.9FC	Illuminance	Fc	1.02	4.07	0.14	7.29	29.07
TYPICAL BETWEEN LIVERMORE ST AND MAPLE ST	0.9FC	Illuminance	Fc	1.60	4.10	0.26	6.15	15.77
TYPICAL BETWEEN HILLCREST AVE AND LOYOLA WAY	0.9FC	Illuminance	Fc	1.39	4.22	0.14	9.93	30.14
TYPICAL BETWEEN DOLORES ST AND HILLCREST AVE	0.9FC	Illuminance	Fc	1.18	4.32	0.17	6.94	25.41
TYPICAL BETWEEN CHARLOTTE WAY AND S VASCO RD	0.9FC	Illuminance	Fc	1.42	4.25	0.27	5.26	15.74
TYPICAL BETWEEN 7TH ST AND DOLORES ST	0.9FC	Illuminance	Fc	1.24	4.16	0.15	8.27	27.73

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ASSOCIATED LIGHTING REPRESENTATIVES, INC
7777 PARDEE LANE
P.O. BOX 2265
OAKLAND, CA 94621
PHONE: (510) 638-0158 - FAX (510) 638-2908

REPORT FOR: MICHAEL KATP
BY: APPLICATIONS ENGINEERING; RAMON ZAPATA
SALES REPRESENTATIVE: ALR; CHARLIE FAIN

AGI32 VERSION 19.14
AGI (C) 2020 LIGHTING ANALYSTS, INC.
10268 W. CENTENNIAL ROAD, SUITE 202
LITTLETON, CO 80127

Lighting Analysts
www.agi32.com

PROJECT DESCRIPTION
EAST AVE
CITY OF LIVERMORE

DRAWING NO. / INPUT FILE
18147FAI-R5.DWG / 18147FAI-R5.A32

SCALE	SHEET	DATE	REV
1" = 40'	3 OF 3	07.28.2021	5

Kimley»Horn

TECHNICAL MEMORANDUM

To:	Kevin Duffus, P.E., City of Livermore
From:	Ryan Dole, P.E. Robert Paderna, P.E.
Date:	August 7, 2017
Subject:	**City of Livermore Downtown Lighting** **Recommended Lighting Guidelines and Requirements - *DRAFT***

The City of Livermore desires to develop an in-depth and comprehensive evaluation to optimize and upgrade the existing downtown district street light system. The primary objectives of the evaluation are to develop and update standards that balance cost with technology, to understand capital and maintenance costs, and to provide a roadmap for transitioning to energy efficient Light Emitting Diode (LED) street lights. The overall downtown lighting evaluation will provide a comprehensive and planned approach to street lighting that provides a safe and secure streetscape for pedestrians, bicyclists, and motorists while reinforcing the City's unique character.

The intent of this technical memorandum is to present recommendations for street lighting guidelines and requirements for the City of Livermore's Downtown District (the "study area"). These have been developed to aid City staff in implementing new project lighting and to retrofit existing street lights within the study area to meet the City's design goals.

BACKGROUND

The primary purpose for providing roadway and intersection lighting is to allow for sufficient visibility at night to allow motorists and pedestrians to identify and react to obstacles and hazards. Adequate roadway and intersection lighting has been shown to significantly reduce accidents during nighttime. The installation of lighting along streets, sidewalks, and pedestrian plazas (i.e. parks) contributes to developing these priorities. Appropriate lighting should be considered when designing all street and pedestrian facilities. Special attention should be given to areas with high pedestrian conflict such as at intersections and mid-block crossings.

Enhancing the driver and pedestrian experience are priorities for the City of Livermore. During an earlier phase of the project, Kimley-Horn performed an assessment of existing lighting conditions within the study area and created a calibrated photometric lighting model. As presented in the *Existing Conditions Memorandum*, many streets within the study area do not currently have lighting or only provide minimal lighting. As the City installs new lights and retrofits existing lights, the City can utilize the lighting requirements presented here.

LIGHTING DESIGN RESOURCES

ANSI/IES RP-8-14 Roadway Lighting

Since 1928, the Illuminating Engineering Society (IES) of North America has published guidelines and standards for the lighting design of roadway, streets, bikeways, and pedestrian walk ways. IES is recognized as the nation's lead authority on illumination due to its numerous technical publications providing recommended lighting practices for applications such as healthcare, security, offices, sports and recreation, tunnels, and many more. The ANSI/IES RP-8-14, *Roadway Lighting* (Approved by IES Board of Directors June 2014), is generally recognized as the industry standard for roadway lighting. This recommended practice document provides illuminance criteria for lighting on roadways, freeways, intersections, bikeways, and pedestrian walkways (lighting criteria is presented later in this document).

AASHTO Roadway Lighting Design Guide (October 2005 Version)

The *Roadway Lighting Design Guide*, published by the American Association of State Highway and Transportation Officials (AASHTO), provides overall lighting guidance to design staff of public transportation departments. The document discusses lighting master plans, lighting warranting conditions, lighting design criteria, electrical systems and maintenance for a variety of applications including freeways, roadways, rest areas, and tunnels. AASHTO recommended lighting design values for roadways and walkways are based on roadway classification and nearby land use. The AASHTO lighting criteria are discussed further later in this memo. The AASHTO guide does not provide separate lighting design values for intersections (i.e. pedestrian conflict areas).

ANSI/IES RP-20-14(Revised 2016) Lighting for Parking Facilities

Also, produced by IES, this recommended practice document provides minimum illuminance criteria for active parking lots (i.e. surface lots) and parking garages that serve the public and/or employees. Minimum lighting criteria are given for "Pre-Curfew" and "Post-Curfew" time periods. Parking lot lighting criteria focuses on providing sufficient light to allow a driver (or pedestrian) looking at the brightest spot in a field of view to be able to detect an object in the dark areas within the field of view. As such, the uniformity of light is of high importance. The IES parking lighting criteria are discussed further in a following section.

LIGHTING DESIGN GUIDELINES AND STANDARDS

Intersection Lighting

Intersection lighting criteria are focused on providing sufficient light in areas where there are potential conflicts between pedestrians and motorists, or motorists and other motorists. The lighting calculation method of *illuminance* at pavement (in footcandles, fc) is a measure of the intensity of light falling onto the roadway surface.

Recommended illumination for intersections as presented in ANSI/IES RP-8-14 is shown in **Table 1** below.

Table 1 – Illumination Criteria for Intersections

Illumination for Intersections				
Functional Classification	**Average Maintained Illumination at Pavement by Pedestrian Area Classification (fc)**			**Average Uniformity Ratio (E_{avg}/E_{min})**
	High	**Medium**	**Low**	
Major/Major	3.4	2.6	1.8	3.0
Major/Collector	2.9	2.2	1.5	3.0
Major/Local	2.6	2.0	1.3	3.0
Collector/Collector	2.4	1.8	1.2	4.0
Collector/Local	2.1	1.6	1.0	4.0
Local/Local	1.8	1.4	0.8	6.0

Source: ANSI/IES RP-8-14 Table 8

Average illuminance at Pavement values *higher* than those shown in **Table 1** meet the guidelines. The uniformity ratio is the ratio between the average-to-minimum illumination light levels. Average Uniformity Ratios *lower* than those given in **Table 1** meet the guidelines.

Per guidance in ANSI/IES RP-8-14, the pedestrian conflict area classifications are determined based on the following criteria:

- **High** – areas with significant numbers (over 100 pedestrians an hour) of pedestrians expected to be on the sidewalks or crossing the streets during dark conditions. Common examples of high pedestrian conflict areas are in downtown districts.
- **Medium** – areas where lesser numbers (10 to 100 pedestrians an hour) of pedestrians utilize the streets at night. Common examples of median pedestrian conflict areas are downtown office areas, industrial, and parks.
- **Low** – areas with very low volumes of nighttime pedestrian usage. Common examples of low pedestrian conflict areas are in suburban streets with single family dwellings, low density residential developments, and rural areas.

Roadway classifications are determined based on the following criteria:

- **Major** – part of the roadway system that serves as the principal network for through-traffic flow. These routes are often referred to as “arterial” streets. Typical average daily traffic (ADT) is over 3,500 vehicles per day.
- **Collector** – part of the roadway system that serves traffic between major and local streets. Typical average daily traffic (ADT) is between 1,500 and 3,500 vehicles per day.
- **Local** – part of the roadway system that provides direct access to residential, commercial, industrial, or other abutting property. Typical average daily traffic (ADT) is between 100 and 1,500 vehicles per day.

Street Lighting

As previously noted, street lighting is primarily for motorist identification of obstacles, and for visibility of pedestrians and cyclists. The referenced design documents do not "require" street lighting along all roadways since there are times where lighting may be adverse to the natural environment (i.e. light pollution); however, the AASHTO Roadway Lighting Design Guide states street lighting is appropriate where "lighting would contribute substantially to the safety, efficiency, and comfort of vehicular or pedestrian traffic."[1]

Street lighting design in ANSI/IES RP-08-14, as opposed to intersection lighting design (which uses illuminance), follows the *luminance* methodology for establishing light level criteria. The average luminance (candelas per square meter) measures how "bright" the roadway surface appears to the motorist by determining the amount of light reflected from the pavement. Luminance is a very effective design method for straight sections of roadway which have consistent luminaire placement and roadway pavement types, since only one representative segment is evaluated then extrapolated along the entire road. However, since luminance is dependent on a specific observer position, it is more difficult to measure and calculate, particularly on roadways with horizontal curvature.

Table 2 – ANSI/IES Luminance Criteria for Streets

Street Classification	Pedestrian Area Classification	Average Luminance L_{avg} (cd/m^2)	Average Uniformity Ratio
Major	High	1.2	3.0
	Medium	0.9	3.0
	Low	0.6	3.5
Collector	High	0.8	3.0
	Medium	0.6	3.5
	Low	0.4	4.0
Local	High	0.6	6.0
	Medium	0.5	6.0
	Low	0.3	6.0

Source: ANSI/IES RP-8-14, Table 3

The AASHTO Roadway Lighting Design Guide gives recommended light criteria for street lighting luminance levels, as well as illuminance levels. It is noted, the luminance values provided by AASHTO are consistent with the luminance levels presented in ANSI/IES RP-8-14, though AASHTO provides more roadway classifications. Lighting criteria for street segments, based on AASHTO guidelines, is presented in **Table 3.**

Average Illuminance and Luminance values *higher* than those shown in **Tables 3 and 4** meet the guidelines. Average Uniformity Ratios *lower* than those shown in **Tables 3 and 4** meet the guidelines.

[1] AASHTO Roadway Lighting Design Guide, Page 23

Table 3 – AASHTO Roadway Lighting Design Guide Lighting Criteria for Streets

Roadway and Walkway Classification	Off-Roadway Light Sources	Illuminance Method						Luminance Method			Additional Values (both Methods)
		Average Maintained Illuminance				Minimum Illuminance	Illuminance Uniformity Ratio	Average Maintained Luminance			Veiling Luminance Ratio
		R1	R2	R3	R4			Lavg	Uniformity		
	General Land Use	(foot-candles) (min)	(foot-candles) (min)	(foot-candles) (min)	(foot-candles) (min)	(foot-candles)	avg/min (max) (6)	cd/m2 (min)	Lavg/Lmin (max)	Lmax/Lmin (max)	Lv(max)/Lavg (max) (3)
Principal Arterials											
Interstate and other freeways	Commercial	0.6 to 1.1	0.6 to 1.1	0.6 to 1.1	0.6 to 1.1	0.2	3:1 or 4:1	0.4 to 1.0	3.5:1	6:1	0.3:1
	Intermediate	0.6 to 0.9	0.6 to 0.9	0.6 to 0.9	0.6 to 0.9	0.2	3:1 or 4:1	0.4 to 0.8	3.5:1	6:1	0.3:1
	Residential	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8	0.2	3:1 or 4:1	0.4 to 0.6	3.5:1	6:1	0.3:1
Other Principal Arterials (partial or no control of access)	Commercial	1.1	1.6	1.6	1.4	As uniformity ratio allows	3:1	1.2	3:1	5:1	0.3:1
	Intermediate	0.8	1.2	1.2	1.0		3:1	0.9	3:1	5:1	0.3:1
	Residential	0.6	0.8	0.8	0.8		3:1	0.6	3.5:1	6:1	0.3:1
Minor Arterials	Commercial	0.9	1.4	1.4	1.0		4:1	1.2	3:1	5:1	0.3:1
	Intermediate	0.8	1.0	1.0	0.9		4:1	0.9	3:1	5:1	0.3:1
	Residential	0.5	0.7	0.7	0.7		4:1	0.6	3.5:1	6:1	0.3:1
Collectors	Commercial	0.8	1.1	1.1	0.9		4:1	0.8	3:1	5:1	0.4:1
	Intermediate	0.6	0.8	0.8	0.8		4:1	0.6	3.5:1	6:1	0.4:1
	Residential	0.4	0.5	0.6	0.5		4:1	0.4	4:1	8:1	0.4:1
Local	Commercial	0.6	0.8	0.8	0.8		6:1	0.6	6:1	10:1	0.4:1
	Intermediate	0.5	0.7	0.7	0.6		6:1	0.5	6:1	10:1	0.4:1
	Residential	0.3	0.4	0.4	0.4		6:1	0.3	6:1	10:1	0.4:1
Alleys	Commercial	0.4	0.5	0.5	0.5		6:1	0.4	6:1	10:1	0.4:1
	Intermediate	0.3	0.4	0.4	0.4		6:1	0.3	6:1	10:1	0.4:1
	Residential	0.2	0.3	0.3	0.3		6:1	0.2	6:1	10:1	0.4:1
Sidewalks	Commercial	0.9	1.3	1.3	1.2		3:1	Use illuminance requirements			
	Intermediate	0.6	0.8	0.8	0.8		4:1				
	Residential	0.3	0.4	0.4	0.4		6:1				
Pedestrian Ways and Bicycle Ways (2)	All	1.4	2.0	2.0	1.8		3:1				

Notes:
1. Meet either the Illuminance design method requirements or the Luminance design method requirements and meet veiling luminance requirements for both the Illuminance and the Luminance design methods.
2. Assumes a separate facility. For Pedestrian Ways and Bicycle Ways adjacent to roadway, use roadway design values. Use R3 requirements for walkway/bikeway surface materials other than the pavement types shown. Other design guidelines such as IESNA or CIE may be used for pedestrian ways and bikeways when deemed appropriate.
3. Lv(max) refers to the maximum point along the pavement, not the maximum in lamp life. The Maintenance Factor applies to both the Lv term and the Lavg term.
4. There may be situations when a higher level of illuminance is justified. The higher values for freeways may be justified when deemed advantageous by the agency to mitigate off-roadway sources.
5. Physical roadway conditions may require adjustment of spacing determined from the base levels of illuminance indicated above.
6. Higher uniformity ratios are acceptable for elevated ramps near high-mast poles.
7. See AASHTO publication entitled, "A Policy on Geometric Design of Highways and Streets" for roadway and walkway classifications.

Source: AASHTO Roadway Lighting Design Guide, Table 3-5a

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Bikeways, Pathways, and Sidewalks

Lighting for pedestrian and bicycle facilities (including bike paths, mixed-use paths and sidewalks) serves to provide visibility of pedestrians adjacent to roadways, enhance safety and comfort, and provide pedestrians the ability to navigate in their surroundings. Lighting for bikeways, pathways, and sidewalks may be applied to pedestrian paths through parks and plazas.

ANSI/IES RP-8-14 lighting recommendations for pedestrian areas are based on the high, medium, or low pedestrian activity classification defined for roadway/street lighting. The recommended illumination criteria for pedestrian areas and bikeways are shown in **Table 4**. The minimum vertical illuminance is the illuminance measured perpendicular to the roadway, at 5 feet above the pavement or sidewalk. Vertical illuminance measures how much light falls on the "face" of an object, making the object visible to an on-coming vehicle. The other values in **Table 4** are horizontal illuminance, which is the illuminance on the pavement surface. High pedestrian conflict areas with mixed vehicle and pedestrian areas are areas where the sidewalk is directly next to the roadway without a physical separation (i.e. wall).

Table 4 – Lighting Design Criteria for Pedestrian Areas and Bikeways

Maintained Illuminance Values for Pedestrian Areas and Bikeways			
	Average Illuminance, EV_{avg} (fc)	**Minimum Vertical Illuminance, EV_{min} (fc)**	**Average Uniformity Ratio* (E_{avg}/E_{min})**
High Pedestrian Conflict Areas			
Mixed Vehicle and Pedestrian Areas	2.0	1.0	4.0
Pedestrian Only	1.0	0.5	4.0
Medium Pedestrian Conflict Areas			
Pedestrian Areas	0.5	0.2	4.0
Low Pedestrian Conflict Areas			
Rural/Semi-rural Areas	0.2	0.6	10.0
Low Density Residential	0.3	0.08	6.0
Medium Density Residential	0.4	0.1	4.0

Source: ANSI/IES RP-8-14, Tables 4, 5, and 6
*Horizontal illuminance only

AASHTO provides horizontal illuminance and uniformity guidelines for sidewalks and pedestrian/bike ways; but does not provide vertical illuminance recommendations. The AASHTO pedestrian lighting criteria are included in **Table 3** in the previous section.

Parking Lot Lighting

ANSI/IES RP-20-14 summarizes illumination values for active parking lots open to customers, employees, or the general public accounting for pavement material, pedestrian lighting zone type, and time of night. Parking lot lighting criteria are focused on providing sufficient light to allow a driver (or pedestrian) looking at the brightest spot in the field of view to also be able to detect an object in the dark areas within the field of view. Therefore, the maximum-to-minimum illuminance uniformity

ratio is of greater importance than the average-to-minimum ratio. ANSI/IES RP-2014 recommended illumination criteria for parking lots are presented in **Table 5.**

Table 5 – Recommended Maintained Illuminance Values for Parking Lots

	Pavement Type	Units	Horizontal Illuminance	Vertical Illuminance	Uniformity Ratio (Max:Min)
Minimum Illuminance (Pre-Curfew)	Asphalt	fc	0.5	0.25	15:1
	Concrete		1.0	0.5	15:1
Minimum Illuminance (Post-Curfew)	Asphalt	fc	0.2	0.1	15:1
	Concrete		0.2	1.0	15:1

Source: ANSI/IES RP-20-14 Table 2

Curfew times are characterized by nighttime pedestrian activity associated with nighttime attraction hours of operation. For locations with a larger business presence and later hours of operation like a theatre, for example, the pre-curfew criteria should be used. In areas where there is substantially less nighttime pedestrian activity due to lack of businesses or attractions the post-curfew criteria should be used.

RECOMMENDEDATIONS

Intersection Lighting

Based on illumination criteria presented in ANSI/IES *RP-8-14*, it is our recommendation to adopt the following intersection lighting requirements presented in **Table 6**. In the downtown district, it is recommended that all streets be considered as medium or high pedestrian areas. Refer to **Table 7** for street classifications within the downtown area.

Table 6 – Lighting Design Criteria for Intersections in Downtown District

Functional Classification	Average Maintained Illumination at Pavement in High Pedestrian Area Classification) (fc)	Average Maintained Illumination at Pavement in Medium Pedestrian Area Classification) (fc)	Average Uniformity Ratio (average/ minimum)
Major/Major	3.4	2.6	3.0
Major/Collector	2.9	2.2	3.0
Major/Local	2.6	2.0	3.0
Collector/Collector	2.4	1.8	4.0
Collector/Local	2.1	1.6	4.0
Local/Local	1.4	1.4	6.0

Street Lighting

Based on luminance criteria presented in AASHTO Lighting Design Guide and ANSI/IES RP-8-14, it is our recommendation to adopt the street lighting requirements of the AASHTO *Roadway Lighting Design Guide,* presented in **Table 3** above. For consistency of design methodology with other lighting categories, it is recommended to use illumination criteria for street lighting, not the luminance method. The luminance method is not recommended because calculating and measuring luminance will be difficult in the downtown district due to the variety of existing luminaire types, inconsistent spacing between luminaires, and street segments with horizontal curvature.

Street classifications were determined for each of the streets within the Downtown District study area and are presented in **Table 7**. The *major* streets were identified based on Chapter 9 (Streets) of the *City of Livermore Design Standards and Guidelines,* adopted in June 2004. The remaining *collector* and *local* streets were identified based on street characteristics and adjacent land uses.

Table 7 –Downtown District Street Classifications

Street	Street Classification
First Street [1]	Major
Railroad Avenue	
Fourth Street	
Livermore Avenue	
Chestnut Street	Collector
P Street	
L Street	
Second Street	Local
Third Street	
Fifth Street	
O Street	
N Street	
M Street	
K Street	
J Street	
I Street	
McLeod Street	
Maple Street	

Bikeways, Pathways, and Sidewalks

Based on illumination criteria presented in ANSI/IES RP-8-14, it is our recommendation to adopt the bikeway, pathway, and sidewalk lighting presented in **Table 8** below. Nighttime pedestrian activity in the Livermore downtown district is anticipated to be medium to high, with some low pedestrian usage along the borders of the downtown study area.

Table 8 – Recommended Lighting Design Criteria for Pedestrian Areas and Bikeways

Maintained Illuminance Values for Pedestrian Areas and Bikeways			
	Average Illuminance, EV_{avg} (fc)	**Minimum Vertical Illuminance, EV_{min} (fc)**	**Average Uniformity Ratio* (E_{avg}/E_{min})**
High Pedestrian Conflict Areas			
Sidewalks Adjacent to Roadway	2.0	1.0	4.0
Separated Pathways	1.0	0.5	4.0
Medium Pedestrian Conflict Areas			
Sidewalks and Pathways	0.5	0.2	4.0
Low Pedestrian Conflict Areas			
Sidewalks and Pathways	0.4	0.1	4.0

Parking Lot Lighting

Based on illumination criteria presented in ANSI/IES RP-20-14, it is our recommendation to adopt the parking lot lighting requirements previously presented in **Table 4** above. In the absence of lighting control systems that will allow for the adjustment of light levels pre- and post- business hours (i.e. curfew), it is recommended to design to post-curfew light levels to prevent provided excessive light. For parking lots with particularly high usage and/or safety concerns, pre-curfew lighting levels should be followed.

NEXT STEPS

Using the recommendations presented above and the previously completed existing conditions analysis, a night-time field meeting will be conducted with the City and its project stakeholders to demonstrate recommended lighting levels. The field meeting will be utilized to receive input and feedback from stakeholders regarding existing light fixtures, existing lighting deficiencies, and desired future lighting. The feedback will be used to refine the lighting guidelines presented above, and will ultimately be used in the evaluation of existing lighting upgrades and the envisioning of new lighting projects.