CALIFORNIA ENERGY COMMISSION

Outdoor Lighting Survey Reports

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TECHNICAL REPORT

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Gray Davis, *Governor*

CALIFORNIA ENERGY COMMISSION

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PREFACE

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

This document is one of 33 technical attachments to the final report of a larger research effort called *Integrated Energy Systems: Productivity and Building Science Program* (Program) as part of the PIER Program funded by the California Energy Commission (Commission) and managed by the New Buildings Institute.

As the name suggests, it is not individual building components, equipment, or materials that optimize energy efficiency. Instead, energy efficiency is improved through the integrated design, construction, and operation of building systems. The *Integrated Energy Systems: Productivity and Building Science Program* research addressed six areas:

- Productivity and Interior Environments
- Integrated Design of Large Commercial HVAC Systems
- Integrated Design of Small Commercial HVAC Systems
- Integrated Design of Commercial Building Ceiling Systems
- Integrated Design of Residential Ducting & Air Flow Systems
- Outdoor Lighting Baseline Assessment

The Program's final report (Commission publication #P500-03-082) and its attachments are intended to provide a complete record of the objectives, methods, findings and accomplishments of the *Integrated Energy Systems: Productivity and Building Science Program*. The final report and attachments are highly applicable to architects, designers, contractors, building owners and operators, manufacturers, researchers, and the energy efficiency community.

This attachment, "Outdoor Lighting Survey Reports" (Attachment A-32) provides supplemental information to the program's final report within the **Outdoor Lighting Baseline Assessment** research area. It includes the following reports:

1. **Annotated Bibliography and Summary.** Provides bibliographies and summaries of the previous research related to outdoor lighting.

2. **Sample Design.** Summarizes the sample design used to select the 1,000 sites surveyed by telephone as part of the study.

3. **Phone Survey Instrument.** Tool used to gather survey responses via telephone.

4. **Phone Survey Tracking Report.** Outlines survey approach and intent and includes tables of data gathered by zip code.

5. **Summary of Phone Survey Reponses.** Summarizes the survey responses collected from 1,000 businesses.

6. **Summary Trip Report: 40 Pilot Outdoor Lighting Surveys.** Summarizes the research team's experience and findings while conducting 40 pilot site surveys.

7. **Surveyor Training Presentation.** PowerPoint presentation used at two-day session to train field personnel to conduct outdoor lighting surveys.

8. **Onsite Survey Instrument.** Tool used for gathering outdoor lighting data during onsite visits.

The Buildings Program Area within the Public Interest Energy Research (PIER) Program produced these documents as part of a multi-project programmatic contract (#400-99-413). The Buildings Program includes new and existing buildings in both the residential and the non-residential sectors. The program seeks to decrease building energy use through research that will develop or improve energy efficient technologies, strategies, tools, and building performance evaluation methods.

For other reports produced within this contract or to obtain more information on the PIER Program, please visit www.energy.ca.gov/pier/buildings or contact the Commission's Publications Unit at 916-654-5200. All reports, guidelines and attachments are also publicly available at www.newbuildings.org/pier.

ABSTRACT

The "Outdoor Lighting Survey Reports" is a set of eight reports produced as part of the Outdoor Lighting Baseline Assessment project. This was one of six research projects within the *Integrated Energy Systems: Productivity and Building Science* Program, funded by the California Energy Commission's Public Interest Energy Research (PIER) Program.

The California Outdoor Lighting Baseline Assessment is the first major study to provide real data about commercial building outdoor lighting in the state. The report identifies statewide outdoor lighting design practices; estimates energy demand and consumption; and provides a framework for outdoor lighting standards in California and future investigations of outdoor lighting.

This attachment consists of eight documents:

1. **Annotated Bibliography and Summary.** Provides bibliographies and summaries of the previous research related to outdoor lighting.

2. **Sample Design.** Summarizes the sample design used to select the 1,000 sites surveyed by telephone as part of the study.

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Key words: outdoor lighting, lighting design, building lighting, façade lighting, lighting controls, lighting power density, light trespass, exterior lighting, lighting code, lighting survey

Exterior Lighting Baseline Study

Literature Review Bibliography

The following topics were isolated in the proposal to have related material researched. Bibliographies and short summaries of the pertinent article, presentation, technical paper, book, or web site are provided below.

Topic 1 Research on Nighttime Visibility Including Lighting Levels, Lighting Uniformity, Visual Adaptation, Reaction Time, Effects of Spectral Distribution on Mesopic and Scotopic Vision Sensitivity

Mark S Rea Ph.D FIES., Editor in Chief. 2000. The IESNA Lighting Handbook – ninth edition. IESNA Chapter 3: Vision and Perception

This chapter was completely restructured and rewritten. It covers the visual system structure, threshold and suprathreshold performance, visual comfort, perception of lighting, and effects of lighting on behavior. Emphasis is on issues most relevant to lighting design, giving practical examples and anecdotes wherever possible. This radically overhauled chapter provides the technical foundations for many of the new guidelines proposed in later application and design chapters including the IESNA Lighting Design Guide, which will replace the present IESNA Illuminance Selection Procedure. The chapter includes, for the first time, IESNA discussion and guidance in regards to the Unified Glare Rating (UGR) used widely around the world in lieu of VCP. The chapter also includes many new illustrations and covers such contemporary topics as:

- *Mesopic vision*
- *Full spectrum lighting*
- *Pupil size and scotopically enhanced lighting*
- *Considerations for aged, partially sighted, and color-abnormal observers*

Medical Testimony about Glare and Night Vision

Louis S. Binder, O.D. Doctor of Optometry. Houston, Texas
http://users2.ev1.net/~mmccants/eolc/test916g.html

A poorly aimed, bright light can cause glare-related problems well beyond the light's effective illumination distance. Even after the light has passed out of the field of vision, the effects of glare persist. The human eye tries to adapt to the new brighter illumination, then must re-adapt to the normal dark conditions. During this adaptation and re-adaptation period, one's ability to distinguish objects or edges of the road is impaired.

Glare can also cause discomfort or annoyance, without necessarily interfering with visual performance. As one drives along the highway, the glare from a continuous string of lights can strain or fatigue the eyes that are constantly adjusting to lighting conditions. For our population 55 and up with slight to significant cataracts, this problem is compounded.

Vision that has been corrected to 20/20 drops to 20/25 at night. A slight tint in the windshield drops the vision at night to 20/30. Once vision has reached 20/40, Texas statutes require an eye exam or the issuance of a restricted drivers license.

Imagine a 57 year old driver with corrected vision and a slight cataract. When faced with glare of any sort, vision is impaired to the point where this driver could no longer pass a drivers license test.

Research on light trespass evaluation methods

Lighting Research Center, School of Architecture, Rensselaer Polytechnic Institute, Troy, NY 12180 USA. http://www.lrc.rpi.edu/Projects/toolkit97.html

These people have put a exterior lighting tool kit to measure several light parameters. The kit costs $500 per unit and appears relatively easy to operate. (Requires one day training seminar) The Exterior Lighting Evaluation Toolkit allows the user to measure or estimate the following:

- *Power density of the installation*
- *Average illuminance on the pavement*
- *Illuminance uniformity on the pavement*
- *Level of glare*
- *Color rendering of the light source*
- *State of maintenance of the installation*
- *Perceived safety of the lighted space.*

Carl Shaflik. August 1997 "Environmental Effects of Roadway Lighting" Technical Paper prepared at University of British Columbia, Department of Civil Engineering IDA Information Sheet 125, August 1998

Light trespass is easily quantifiable as a measure of illuminance and easily measured in the field by a standard light meter (similar to a meter purchased from a camera store). Some limits have been developed by San Diego County in California regarding light trespass. The county ordinance placed the limit of stray light at 0.21 lux (equivalent to bright moonlight) on the horizontal and vertical planes at a point 1.5 m inside an owner's property line. An ordinance from Skokie, Illinois classifies light falling on residences from a roadway lighting system in excess of 3 lux as a public nuisance. Although these limits cover a wide range of values they serve to illustrate that light trespass is being taken seriously as an environmental problem.

Mark S Rea Ph.D FIES., Editor in Chief. 2000. The IESNA Lighting Handbook – ninth edition. IESNA Chapter 2: Measurement of Light and Other Radiant Energy

This chapter was revised with contributions from members of the IESNA Technical Procedures Committee. The chapter includes, for the first time, a discussion on the validation and limitations of the long-used IESNA Illuminance Survey Method. It also includes a new section on traceability of reference standards in regards to the much-touted ISO 9000 quality system standards. If you've ever wondered how to select a recognized competent provider of calibrations or tests with verified traceability to national measurement standards and documented uncertainties at every step of the chain, the chapter now includes a discussion on laboratory accreditation to ISO/IEC Guide 25 for providing this assurance. Other updated areas include:

- *Instruments for measuring light, including many new photos*
- *Standard lamps including new guidelines for the handling, operation, and storage of laboratory standard lamps to help ensure continued accuracy*
- *CIE parameters for comparing the performance of luminance and illuminance meters*
- *AC measurement techniques with considerations for harmonic distortion and power factor*

He, Y., M. S. Rea, A. Bierman and J. Bullough. 1997. Evaluating light source efficacy under mesopic conditions using reaction times. *Journal of the Illuminating Engineering Society* 26(1): 125-138.

Topic 2 IESNA Recommended Practices

The IESNA Lighting Handbook will be used by RLW to ascertain all IESNA recommended practices. Initially, these chapters in the Handbook will be the focus of our research.

Chapter 21: Exterior Lighting
Chapter 21 has been completely rewritten. The Committee responsible has done a very commendable job of bringing the chapter up to date and has included much information on responsible exterior

lighting to limit light trespass beyond the site property. You will find this chapter to be extremely useful in providing exterior lighting which not only is effective and economical but also compatible with the growing trends in urban legislation.

Chapter 22: Roadway Lighting
While little has changed in the way of roadway lighting in this edition of the Handbook, there have been some important revisions and additions. The material on care of trees within the line of roadway luminaires has been completely rewritten to more effectively cover this topic. Walkway and bikeway lighting has also been covered here for those areas close to roadways and highways. The coverage of these topics for off-road way locations is now included in Chapter 21. The most extensive revisions have been in the material on lighting for parking facilities. This material has been completely rewritten and the new text reflects the most current recommendations of the IESNA.

Topic 3 Statements on Light Pollution and Trespass

Light pollution occurs when too much artificial illumination enters the night sky and reflects off of airborne water droplets and dust particles causing a condition known as skyglow. It occurs when glare from improperly aimed and unshielded light fixtures cause uninvited illumination to cross property lines or shines into drivers' eyes. When this happens, the safety of pedestrians is often placed in jeopardy. That pedestrian put in this condition may be you or your child someday. Light pollution also occurs when too much artificial illumination causes nighttime visual performance to be impaired. It is completely unnecessary and as a result causes damage and confusion for both flora and fauna alike.

http://members.aol.com/ctstarwchr/
On December 2, 2000, the Light Pollution Awareness Website was selected as a featured site in Lightspan's StudyWeb® as one of the best educational resources on the Web! StudyWeb® is one of the Internet's premier sites for educational resources for students and teachers. Since 1996, Lightspan's expert reviewers have scoured the Internet to select only the finest sites to be included in StudyWeb's listing of educational links.

Cliff Haas "Where has the night sky gone, and why should we care?" ***World Congress on Managing and Measuring Sustainable Development.*** **August 2000. http://members.aol.com/ctstarwchr/nightsky.htm**

Mark S Rea Ph.D FIES., Editor in Chief. 2000. The IESNA Lighting Handbook – ninth edition. IESNA

Evaluation of sky brightness

Carl Shaflik." Environmental Effects of Roadway Lighting" Technical Paper prepared at University of British Columbia, Department of Civil Engineering IDA Information Sheet 125, August 1997

An empirical formula has been developed in California by Merle Walker known as Walker's Law (Ref. 5) which is used to estimate the sky glow at an observing site, looking at a zenith angle of 45 degrees toward an urban source r kilometers away.

$$I = 0.01 \times P \times r^{-2.5}$$

where:
I = *the increase in sky glow level above the ambient background*
P = *the population of the urban center*
r = *distance in kilometers from the urban center*

For a city with a population of 300,000 (Greater Victoria) and an observing site 25 km away (Sannich Observatory):

I = 0.01 x 300,000 x 25-2.5 = 0.96

The increase in sky brightness, at a 45 degree angle, over the natural background is approximately 96%, half of which may be caused by roadway lighting.

Another source of sky glow, possibly of greater consequence (although studies to date are scarce), is the direct luminance from the luminaires above the horizontal plane. Many of the poor non-cutoff luminaires emit up to 10% of their light above the vertical angle of 90 degrees, with up to 30% of their light above a vertical angle of 80 degrees. Full-cutoff luminaires on the other hand emit no light above 90 degrees and considerably reduce the contribution to sky glow.

Other problems related to sky glow comes from the radiation outside the visual spectrum emitted by roadway luminaires. The traffic engineering profession has been mostly concerned with visible light, however astronomers observe the sky in many wavelengths. Some "full spectrum" lights, such as mercury vapor, emit a lot of ultraviolet radiation. High pressure sodium lights emit more of a monochromatic light and low pressure sodium lights emit essentially only monochromatic light, which can be easily filtered out by astronomical equipment.

Although urban sky glow has been difficult to quantify, some jurisdictions, particularly those around observatories such as Tucson, Arizona, have enacted ordinances requiring the use of full-cutoff luminaires and glare shields for roadway lighting.

Light Pollution Educational & Associations

International Dark Sky Association (IDA)
International Astronomical Union Commission 50 working group on Light Pollution
Light Pollution Awareness Website (LiPAW)
Illuminating Engineering Society of North America (IESNA)
IESNA Regions and Sections
DarkSky List Forum -- interactive resource library and discussion group
StudyWeb: Light Pollution Links
Illuminating Engineering Society of Australia And New Zealand (IESANZ)

Light Pollution Articles

Light Pollution: Efforts to Bring Back the Night Sky -- Environmental Building News 9/98
The Massachusetts Medical Society Before the Joint Committee on Energy Supports House Bill 3990 -- 3/30/99
Sky Darkness and the Contrast Illusion - by Tim Hunter and James McGaha
Proposed Ballpark Threatens Dark Skies...
Light Pollution - A Move in the Right Direction -- Auckland Astronomical Society Journal 10/98
Working Within the Community, a Success Story - CTIO Newsletter 9/99
Dark Skies are Holy - by John Dobson
Oh, Say Can You See ... -- Realty Times - 12/23/99
Keeping light where it belongs -- Iowa State Daily - 2/24/97
The starry nights of old are fading into twilight -- The Charlotte Observer - 3/18/2000
Dark skies forecast -- Idaho Mountain Press - 3/15/2000
The Sky I hate - and the Sky I love.. -- Mogens Winther, teacher of Physics, Astronomy and Maths - Denmark
Maui's Light Pollution Wastes Taxes -- The Maui News 2-28-98
Sky Lights: Planetary Superstars -- Discover Magazine - October 1999
DOE Unveils Revolutionary 21st Century Lighting Technology -- Enviroene 10-20-94

Integrated lighting brings high returns -- Seattle Daily Journal of Commerce 3-31-98
Let there (not) be light -- Hoosier Times 10-27-98
Campaign for less light may bring back starry nights - Bergin Record 12-26-97
Environmental Journalism Tip Sheet 2/10/99
Lighting Our Streets: Planning Commissioner's Journal - May/June 1992
Parking Lot Design: Planning Commissioner's Journal - March 2000
Light Pollution Report: Chartered Institute of Environmental Health 11/25/96
Caltech Astronomy: Light pollution movie
A new look at sound and light pollution in the news - Sound Matters May 1999
Nevada duo fights light pollution - Idaho Post Register 7-31-99
Outdoor Lighting Control: A Win-Win Situation!
Light Pollution: When the night never gets dark -- Charlotte Observer 1/4/96
A fight for the night -- Denver Rocky Mountain News 11/21/99
The Dark Side of Light -- Audubon Magazine March-April, 2000
State Commission Reports on Light Pollution
Night, Light & Sight...Gettin' It Right by Bob Crelin
Action Line: Rage at night, go gentle into that good light -- Tulsa World - 3-3-2000
Star light, star bright? It's hard to see those stars at night -- Greeley Tribune 3-2-2000
Raliegh Appearance Commission proposes changes in light regulations -Light Trespass -- Raliegh Daily News 12-24-99
Letter to Raliegh Daily News Appearance Commission Article: Tighter Lighting by Phyllis Lang
Myopia: Room Light In Early Childhood and Nearsightedness - Fathering Magazine
ICOLE Media Archives -- A number of good articles on Light Pollution issues
Light Pollution: The Neglected Problem By John Batinsey
Security Director's Report -- Institute of Management and Administration October 1999
Ogden Valley's Starry Skies Will Shine On -- Salt Lake Tribune 2-12-2000
'Dark Sky' Ordinance Draws Little Protest -- Salt Lake Tribune 9-21-99
Understanding, Assessing and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches -- Florida Marine Research Institute
Light pollution is changing astronomy, the environment, and our experience of nature - NDRC Amicus 1996
Bag Those Beams -- Time Magazine 1-31-2000
Nobody wants to see stars in an intersection -- Tulsa World - 1-22-2000
`Light pollution' could be next safety issue -- Tulsa World - 1-21-2000
IDA sheds light on luminescent trespassers -- North Raliegh News 1-21-2000
Fernley board wants to dim lights to allow stars to shine through -- 1-14-2000
Living On Earth: Dark Sky Preserve -- Torrance Barrens Conservation Reserve 11-12-99
Starlight has been replaced by searchlights -- Cambridge Chronicle 1-5-2000
Fighting Light Blight: States, Communities Battle to See the Stars - Outdoors Jan/Feb-2000
Restaurants, better paying jobs on city agenda -- Pharos-Tribune 1-2-2000
Lights, camera ... millennium -- Seattle Times 12-31-99
Too much light would lessen Needle's charm -- Seattle Times 12-30-99
Manchester group targets light glare - Union Leader NH 12-28-99
Stargazers Urge Better City Lighting -- The Times & Free Press 12-26-99
The stars are out for a city blighted by light -- The Age, Melborne 12-26-99
Big moon Illuminating a pollution problem -- Star Tribune Editorial 12-25-99
'Dark-sky' groups want to see stars, not streetlights -- Chicago Tribune/Seattle Times 12-22-99
1999 Closes Warmest Decade and Warmest Century of the Millennium -- Environment News Serv. 12-22-99
Bridge project faintly flickering -- Seattle Times 12-20-99
Sky beams will glow from Space Needle -- Seattle Times 12-16-99
Big beam for Space Needle is protested -- Seattle Times 11-30-99
A Fight For The Night -- Denver Rocky Mountain News 11-21-99
In Sandy, spotlight is on darkness -- Utah Dessert News 9-7-99
Towns direct efforts to clear sky -- USA Today, 8-30-99
Our window on the universe is slowly shutting -- the Begen County Record 7-5-99

Stars Vanishing From National Park Night Skies (NPCA) 3-24-99
Light Pollution: Efforts to Bring Back the Night Sky - Environmental Building News 9-98
The Floodlit Night Sky -- Harvard Magazine Jan/Feb 1997
First Results from the Light Pollution Project - Astronomy Online Newspaper 11-22-96
City Lights Conference - Ottawa Canada -- RASC AstroNotes 11-96
Cities' Glow Snuffs Out View of Stars -- Richmond Times Dispatch 4-29-96
Light Pollution and its Solutions -- Astronomical Society of Las Cruces 1995
Encyclopedia Britannica - Lighting
Light Pollution Issues in New Jersey
Light Pollution and Sky Beams -- Astronomical Society of Victoria
*S*T*A*R Astronomy Library*
Light Pollution - The Bane of Astronomers (Amateur and Professional) 1-10-99
Light Pollution Abatement Program - Ottawa Centre RASC

Topic 4 CIE Recommended Practices and Standards

Our research was unable to turn up any CIE recommended practices or standards relating to outdoor lighting.

Topic 5 IESNA and CIE Mesopic Lumen Evaluation Criteria

Mesopic Photometry: History, Special Problems, and Practical Solutions. Publication CIE 81-1989. ISBN 3 900 734 16 X. http://www.ping.at/cie/publ/abst/81-89.html

This report summarizes the information that is currently available on the measurement of light at mesopic levels of intensity. Mesopic refers to light levels covering a range of several log units, which are neither completely photopic (for which use of V(lambda) may be appropriate) or scotopic (for which V'(lambda) should be employed). This covers an approximate range of luminance from some hundredths or less of a cd/m2 to at least several cd/m2.

Since there is today no system recommended by the CIE for mesopic photometry, ordinary photopic photometers are commonly used for the measurement of light at mesopic levels. This practice results in a misleading evaluation of certain lights, due primarily to the shift in the luminous efficiency of the eye toward the short wavelengths at mesopic levels.

Low pressure sodium provides an excellent example. The spectral power is concentrated near 589 nm, wavelengths to which the photopic eye is quite sensitive; if measured with a photopic light meter this sensitivity is reflected in relatively high readings. With a decrease in light to mesopic levels, the sensitivity of the eye is dramatically reduced; the resultant appearance is much dimmer than expected from the photopic values. Even greater discrepancies can be found in the measurement of red lights such as are employed in ship or plane control-rooms.

Five systems of mesopic photometry are currently available. These systems are based upon either the measurement of photopic and scotopic luminances or upon tristimulus or chromaticity values and scotopic luminance; equipment for these measures is available today. Each of the systems is described in the report and examples of the necessary calculations are provided. Each of the systems has its own advantages and disadvantages, but all give a better assessment of light at mesopic levels than does the use of photopic photometry alone. It is hoped that these systems will be tried by many users and data on their effectiveness made available so that a CIE system can be recommended in the near future.

He, Y., M. S. Rea, A. Bierman and J. Bullough. 1997. Evaluating light source efficacy under mesopic conditions using reaction times. *Journal of the Illuminating Engineering Society* 26(1): 125-138.

Bullough, J. 1997. Mesopic photometry: Issues and implications. *Joint USNC/CNC Commission Internationale de l'Eclairage Technical Conference*, Cleveland, OH, October 31-November 2.

Bullough, J. D. 2000. Roadway and outdoor lighting and mesopic vision. *Illuminating Engineering Society of North America*, Milwaukee Section, Milwaukee, WI, March 9.

Eloholma, M. & Halonen, L. Vision at Mesopic Light Levels - The Effects of Light Spectrum. Proceedings of CIE-UK Colour and Visual Scales 2000

Topic 6 Existing Local and Proposed Model Exterior Lighting Ordinances

Several cities in California are actively pursuing the adoption of light pollution regulations because of several reasons including concerns for professional and amateur astronomers, private property light trespassing cases, and energy efficiency. However, there is not a statewide or county code that is in place or in the planning phase. The Intl. Dark Sky association has produced an Outdoor Lighting Code Handbook, which discusses all issues of planning, implementation, and enforcement of exterior lighting codes. A link to an electronic format is below:

http://www.nofs.navy.mil/about_NOFS/staff/cbl/LC_Handbook_v10.html#gener

There is a web page at www.skykeepers.org that lists all California city ordinances in which light trespass, sky glow, and glare are assessed. The site is

http://www.skykeepers.org/califord.htm.

The city of San Diego has aggressively pursued regulation of exterior lighting and the following is a section of the ordinance.

SEC. 101.1302 PURPOSE AND INTENT

It is the purpose and intent of this division to minimize light pollution for the enjoyment of the citizens of the City of San Diego, the benefit of amateur astronomers within the City of San Diego, the astronomical research of Palomar Observatory and Mount Laguna Observatory thereby fostering the potential of the City of San Diego with regard to public and private scientific research and development and to conserve energy by:

1. *Using fixtures with good optical control to distribute light in the most effective and efficient manner;*
2. *Using minimum amount of light to meet the lighting criteria;*
3. *Using shielded outdoor light fixtures where required and wherever else feasible;*
4. *Using low pressure sodium outdoor light fixtures where required and wherever else feasible;*
5. *Energizing light fixtures only when necessary, by means of automatic timing devices; and*
6. *Requiring that certain outdoor light fixtures be turned off between 11:00 p.m. and sunrise.*

California Title 24

Currently Title 24 does not regulate exterior lighting in California.

Cities in California with Ordinances

City of Davis, (Nov. 98)
City of Indian Wells, Title 22 Resources Management, 1996
Riverside County, Ordinance No. 655, Regulating Light Pollution (Adopted: 6-7-88) (Ref.)
City of San Diego, California, (IDA Information Sheet 37, Jan. 91)
San Diego County, (IDA Information Sheet 57, May 92) (Cal-IDA scan)
Santa Barbara , (Dec 97) (Cal-IDA scan) includes the following Ordinance No. 5035 & Resolution No. 97-149
San Juan Capistrano , (Sep 96) (Cal-IDA scan) part of the General Plan

Palm Desert, Chapter 24.16 OUTDOOR LIGHTING REQUIREMENTS
Yucca Valley, (Mar. 98) (Cal-IDA scan)

Statewide Assessment: Telephone Survey Sample Design Methodology

Integrated Energy Systems Productivity & Building Science Program

A project of the State of California PIER Program

Element: Element 7 - Exterior Lighting Baseline Assessment
Deliverable: 7.3.1
Deliverable Date: 8-15-01

PIER
Public Interest Energy Research
CALIFORNIA ENERGY COMMISSION

New Buildings Institute, Inc.

Introduction

During the months of May and June of 2001 RLW conducted telephone surveys with 1,000 business in the state of California. The intention of the 1,000 telephone surveys was to gather information on the amount of and types of outdoor lighting associated with each commercial and industrial sampled address. The surveys included both existing and new construction, but did not address roadway lighting or billboard lighting. The need for completing the 1,000 surveys was driven by the requirement to have a sample frame from which RLW could select a sample of 300 buildings for the statewide assessment task. The 1,000 surveys also serve as the mechanism for extrapolating the findings from the statewide assessment back to the population of commercial/industrial buildings in California.

The target population is the outdoor lighting associated with all existing nonresidential buildings in California. The population includes both commercial and industrial buildings, as well as large apartment complexes. In order to focus the study on existing construction, we developed a stratified sampling plan using measures of commercial activity by zip code, and a database of existing businesses by zip code.

The remainder of this document summarizes the sample design used to select the 1,005 buildings that participated in the telephone survey portion of the study.

Task 7.3.1 Sample Design

Methodology

The first step in conducting the initial market characterization was to define the study target population. The following list describes the various options that were considered in defining the target population:

- Exterior Building Lighting vs. Roadway Lighting and Billboard Lighting,
- Title 24 Building Standards vs. Title 20 Appliance Standards,
- New Buildings vs. Existing Buildings, and
- Constructed in Last Five Years vs. Last 1-2 years or last 10 years.

During the development of the workplan we considered two options for determining the study target population and the methodology that would be used to study each. Both options called for studying exterior building lighting and omitting roadway and billboard lighting. The first option, Option A, was an approach that would include only new construction in the study design, using F.W. Dodge new construction data as the population frame. The second option, Option B, was directed at establishing a baseline that could be used to assist in evaluating the impacts of revising Title 20 appliance standards, and to a lesser degree, assist in reviewing possible Title 24 building codes aimed at commercial outdoor lighting. Because this study is intended to be a baseline study of existing outdoor lighting, Option B was selected for this study.

Target Population

The target population studied is the outdoor lighting associated with all existing nonresidential buildings in California. The population includes both commercial and industrial buildings, as well as multi-tenant apartment buildings.

The unit of data collection and analysis will be the outdoor lighting associated with each self-standing building. As explained in the next section, the initial contact was a business, identified through the Pro CD database. In the telephone survey with the business, we identified the building in which the business was located as the unit of data collection. If the building is in a multi-building complex, we sought to identify the outdoor parking and other space associated with the selected building. If the parking and other space is common to several buildings, we allocated a suitable proportion of the total space to the selected building.

Sample Design

We used the 1997 Zip Code Business Patterns CD-ROM from the U.S. Census Bureau[1] to determine the amount of business activity in each zip code in California. The Zip Code business patterns CD provides the number of employees, first quarter payroll, annual payroll, total number of establishments, and number of establishments in nine employment size classes for every zip code. It also provides business data summarized for nine employment size classes by SIC Code and zip code.

[1] The most recent version of the Zip Code Business Patterns CD-ROM available is the 1997 version.

In order to create a measure of the amount of business activity in each zip code in California, two quantities, the total number of employees and the average number of employees per business[2], were examined for each zip code. First, the average number of employees per businesses in each zip code was classified into one of the following categories: extra low, low, medium, high, or extra high. Next, the total number of employees per business in each zip code was classified into one of five categories: extra low, low, medium, high, or extra high. These classifications were designed so that the amount of employment in each cross-classification was roughly equal. In other words, the amount of employment for zip codes with extra low average number of employees and extra low total number of employees is roughly the same as the amount of employment for zip codes with extra high average number of employees per businesses and extra high number of employees.

Table 1 shows the number of zip codes in each cross-classification. The table also shows the cut-points used to classify the zip codes by the average number of employees per business. The cut-points for classifying the zip codes by total employment are not shown because they depend on the 'average number of employees' classification. The greatest number of zip codes belong to the extra low average, extra low total cross-classification, while the extra high average, extra high total cross-classification has the least. Though the numbers vary greatly between the two cross-classifications, the amount of employment is roughly equal in each.

A sample of 2 zip codes was randomly selected for each cell in the matrix shown in Table 1, yielding a total of 50 sampled zip codes. We planned on surveying 20 buildings in each sampled zip code, or 40 in each cross-classification.

	Total Employment				
Average # Employees per Business	Extra Low	Low	Medium	High	Extra High
Extra Low (0.33 - 11.2997)	1,234	119	71	47	31
Low (11.3 - 14.151)	183	49	35	26	18
Medium (14.152 - 17.890)	143	35	27	20	14
High (17.890 - 25.743)	160	27	18	13	8
Extra High (25.748 - 3750)	236	24	14	9	7

Table 1: Number of Zip Codes by Employment Categories

Once we had selected a sample of approximately 50 zip codes, we used the Select Phone CD-ROM published by InfoUSA.com to identify and enumerate each business in the selected zip codes. The Select Phone CD allows the user to "query" the CD's database for all records meeting certain criteria. For example, the user can retrieve all businesses in a certain zip code or city. The Select Phone CD also provides the SIC Code for each business listed. Finally, a sample of businesses was randomly selected from each zip code.

Some zip codes, particularly those in more remote areas, contained less than 20 buildings, making it impossible to complete 20 surveys in the zip code. When this occurred, we supplemented the missing surveys with additional surveys from the other sampled zip code belonging to the same cross-classification. We selected an additional zip code from the same cross-classification when

[2] The average number of employees per business was calculated as the number of employees divided by the number of businesses.

the two zip codes combined contained fewer than 40 buildings. Ultimately, we telephone surveyed 1,005 buildings in 52 zip codes. Table 2 presents the list of sampled zip codes along with the corresponding city name. The completed 1,005 surveys of buildings now becomes the sample frame from which the 300 sites will be selected for the statewide assessment task.

Zip Code	City	# Surveys Completed
90024	LOS ANGELES, CA	20
90035	LOS ANGELES, CA	20
90067	LOS ANGELES, CA	20
90210	BEVERLY HILLS, CA	20
90248	GARDENA, CA	20
90403	SANTA MONICA, CA	20
90703	CERRITOS, CA	20
91106	PASADENA, CA	20
91210	GLENDALE, CA	2
91304	CANOGA PARK, CA	20
91504	BURBANK, CA	20
91731	EL MONTE, CA	21
91746	LA PUENTE, CA	20
91789	WALNUT, CA	20
91910	CHULA VISTA, CA	20
92024	ENCINITAS, CA	20
92121	SAN DIEGO, CA	19
92274	THERMAL, CA	13
92337	FONTANA, CA	39
92590	TEMECULA, CA	20
92618	IRVINE, CA	20
92705	SANTA ANA, CA	21
92804	ANAHEIM, CA	21
92831	FULLERTON, CA	20
93030	OXNARD, CA	20
93612	CLOVIS, CA	20
93721	FRESNO, CA	20
93740	FRESNO, CA	8
94025	MENLO PARK, CA	21
94111	SAN FRANCISCO, CA	20
94115	SAN FRANCISCO, CA	20
94303	PALO ALTO, CA	20
94305	STANFORD, CA	20
94518	CONCORD, CA	20
94523	PLEASANT HILL, CA	20
94545	HAYWARD, CA	20
94550	LIVERMORE, CA	20
94560	NEWARK, CA	20
94576	DEER PARK, CA	10
94926	COTATI, CA	1
94947	NOVATO, CA	33
95035	MILPITAS, CA	20
95054	SANTA CLARA, CA	20
95060	SANTA CRUZ, CA	20
95374	STEVINSON, CA	7
95433	EL VERANO, CA	7
95490	WILLITS, CA	20
95670	RANCHO CORDOVA, CA	20
95814	SACRAMENTO, CA	20
95955	MAXWELL, CA	26
96096	WHITMORE, CA	8
96146	OLYMPIC VALLEY, CA	21

Table 2: Sampled Zip Codes

Customer:_____ RLWID #_____

Address:_____City: _____

Phone:_____ Interviewer: _____

Fill in the following at time of survey:

Date _____ Time _____

Respondent _____

Screening Questions

Hello, my name is _____ and I am calling from RLW Analytics. We are carrying out a study on behalf of the California Energy Commission to assess the amount of energy currently used by outdoor lighting in California.

1) Can we have five minutes to ask you a few questions about the outdoor lighting at your building?
   1) Yes **(record respondent's name and time of interview at top of page)**
   2) No, this is not a good time **(get time to call back)**

      Time to call back_____
   3) No, I am not the right person to talk to but that person is here

      (Repeat introduction to new respondent, record respondent's name and time of interview at top of page)
   4) No, I am not the right person to talk to but that person is not here

      (record respondent's name and get time to call back)

      Name: _____

      Time to call back: _____
2) Is your business a home-based business, or is it located in a commercial/industrial building?
   1) Home-based **(Thank and terminate)**
   2) Commercial/Industrial building **(Continue)**
   3) Don't know **(Thank and terminate)**
3) According to our information your building is located at **(address listed on cover sheet)** - Is that correct?
   1) Yes
   2) No **(thank and terminate)**

4) Are there other addresses associated with your building?
   1) Yes **(Record other addresses)**

      Other address numbers: _____

      _____

      _____

      _____

      _____
   2) No
   3) Don't know **(Thank and terminate)**

SURVEY QUESTIONS:

5) What are the primary business functions of this building?

Total must add to 100%

ONE OF THE FOLLOWING MUST BE DOMINATE %

	Building Type	Percentage Usage
01	Commercial & Industrial Storage	
02	Grocery Store	
03	General Commercial & Industrial Work	
04	Medical/Clinical	
05	Office	
06	Other (Specify):	
07	Religious Worship, Auditorium, Convention	
08	Restaurant	
09	Retail and Wholesale Store	
10	School	
11	Theater	
12	Unknown	
13	Hotels/Motels	
14	Fire/Police/Jails	
15	Community Center	
16	Gymnasium	
17	Libraries	

6) Approximately how many employees work in the building?
   1) Fewer than 25
   2) 26 – 50
   3) 51 – 100
   4) 101 – 250

5) 251 – 500
6) 501 or Greater

7) Does your building have an outdoor parking lot?
   1) Yes
   2) No → **(Go To Q9)**

8) Approximately how many parking spaces does your outdoor parking lot contain?
   1) 25 or Fewer
   2) 26 – 50
   3) 51 – 100
   4) 101 – 250
   5) 251 or Greater

9) Is outdoor lighting an important part of the building's business?
   1) Yes
   2) No → **(Go to Q11)**
   3) Don't Know → **(Go to Q11)**

10) How is it important? **(Record Exact Response Verbatim, Probe for Specifics)**

_____

_____

_____

11) Is outdoor lighting used to attract customers or light showrooms?
   1) Yes
   2) No

12) Does your building serve customers at night?
   1) Yes
   2) No → **(Go to Q14)**

13) During what times does your building serve customers at night?

_____PM/AM TO _____ PM/AM

14) Does your building have a night shift?

1) Yes
2) No → **(Go to Q17)**

15) Approximately how many employees work on the night shift?

1) Fewer than 25
2) 26 – 50
3) 51 – 100
4) 101 or Greater

16) What are the hours of the building's night shift?

_____PM/AM TO _____ PM/AM

17) What are your building's operating hours?

_____PM/AM TO _____ PM/AM

18) Does your building have signs that are lit up at night?

1) Yes
2) No **(Go to Q21)**

19) How many signs that are lit up at night does your building have?

1) One
2) Two
3) Three – Five
4) Six or More

20) What are the approximate size(s) of these signs?

Sign 1: _____ Ft BY _____ Ft
Sign 2: _____ Ft BY _____ Ft
Sign 3: _____ Ft BY _____ Ft
Sign 4: _____ Ft BY _____ Ft
Sign 5: _____ Ft BY _____ Ft
Sign 6: _____ Ft BY _____ Ft

21) Are there lights meant to provide safety attached to the outside of the building or integrated into landscaping or walkways?

1) Yes

2) No
3) Don't know

22) Are there lights meant to light up the building that are attached to the outside of the building?

1) Yes
2) No
3) Don't know

23) A future component of this research study involves collecting outdoor lighting data on-site at a set of randomly selected buildings throughout the state of California. This information will be used to better understand outdoor lighting usage in California. The on-site survey usually begins with a meeting between our engineer/surveyor and your facility manager. What is the name, title and phone number of the most appropriate person to contact to secure permission in the event your building is randomly selected?

Name: _____

Title: _____

(If Property management) Company Name: _____

Phone Number: _____

Those are all my questions. Thank you very much for your cooperation on this study.

Initial Market Characterization: Survey Tracking Report

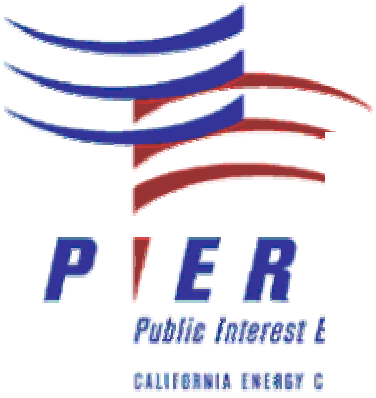
Integrated Energy Systems Productivity & Building Science Program

A project of the State of California PIER Program

Element*:* Element 7 - Exterior Lighting Baseline Assessment

Deliverable: 7.3.4 Final

Deliverable Date: 7-5-01



New Buildings Institute, Inc.

Introduction

This document is the survey tracking report for task 3 (Initial Market Characterization) of the Outdoor Lighting Baseline Assessment (Element 7) conducted for the California Energy Commission as a part of the Integrated Energy Systems, Productivity, & Building Science Program. The Initial Market Characterization consisted of completing just over 1,000 telephone surveys with owners and property managers of buildings located in California. The surveys will be used to assess the current types of outdoor lighting applications and develop a proxy for the amount of each type present at each site.

Background

The general goal of the outdoor lighting baseline assessment is to understand the amount of energy currently used by outdoor lighting in California and evaluate the environmental impacts. Task three of the baseline assessment was to characterize the market place. For this task of the study RLW conducted just over 1,000 telephone surveys of buildings throughout California to assess the types of outdoor lighting applications in use and to develop a proxy for the amount of each type present at each site. The purpose of this survey is to estimate the "expected" amount of outdoor lighting present at each site in order to guide site selection for the Statewide Assessment task. We asked respondents several questions regarding outdoor lighting at their building in order to begin to understand how California's commercial/industrial business sectors use outdoor lighting. With this in mind, a survey instrument was developed that used proper diction and content to determine the extent and function of outdoor lighting present at the building.

Sample Design and Data Collection

Sample Design

The 1997 Zip Code Business Patterns CD-ROM from the U.S. Census Bureau[1] was used to determine the amount of business activity in each zip code in California. The Zip Code business patterns CD provides the number of employees, first quarter payroll, annual payroll, total number of establishments, and number of establishments in nine employment size classes for every zip code. It also provides business data summarized for nine employment size classes by SIC Code and zip code.

In order to create a measure of the amount of business activity in each zip code in California, two quantities, the total number of employees and the average number of employees per business[2], were examined. First, the average number of employees per businesses was classified into one of the following categories: extra low, low, medium, high, or extra high. Next, the total number of

[1] The most recent version of the Zip Code Business Patterns CD-ROM available is the 1997 version.

[2] The average number of employees per business was calculated as the number of employees divided by the number of businesses.

employees was classified into one of five categories: extra low, low, medium, high, or extra high. These classifications were designed so that the total employment in each cross-classification was roughly equal. In other words, the total employment for zip codes with extra low average number of employees per business and extra low number of employees is roughly the same as the total employment for zip codes with extra high average number of employees per businesses and extra high number of employees.

Table 1 shows the number of zip codes in each cross-classification. The greatest number of zip codes belong to the extra low average, extra low total cross-classification, while the extra high average, extra high total cross-classification has the least. A sample of 2 zip codes was randomly selected for each cell in the matrix shown in Table 1.

Average # Employees per Business	**Total Employment**				
	Extra Low	Low	Medium	High	Extra High
Extra Low	1,234	119	71	47	31
Low	183	49	35	26	18
Medium	143	35	27	20	14
High	160	27	18	13	8
Extra High	236	24	14	9	7

Table 1: Number of Zip Codes by Employment Categories

Once we had selected a sample of approximately 50 zip codes, we used the Select Phone CD-Rom published by InfoUSA.com to identify and enumerate each business in the selected zip codes. The Select Phone CD allows the user to "query" the CD's database for all records meeting certain criteria. For example, the user can retrieve all businesses in a certain zip code or city. The Select Phone CD also provides the SIC Code for each business listed. Finally, a sample of businesses was randomly selected from each zip code.

Data Collection

Using the survey instrument that was developed for the Market Characterization Task, we asked respondents to respond to questions addressing the following information about their building:

- Confirm site address and obtain name of respondent,
- Confirm building type, age, and type of location (urban, suburban, or rural)
- Estimate number of employees at building
- Outdoor parking and quantity of spaces
- Importance of outdoor lighting to business function
- Hours of operation
- Functional use of outdoor lighting (i.e., signage, walkway, parking, etc.), and
- Name of a contact person for a future site visit.

Data Analysis

The survey responses for each site will be analyzed to develop a proxy for the amount of outdoor lighting present at the site, which will be used to design a stratified sample of approximately 300 buildings from the 1,000 respondents for

the statewide assessment. Model Based Statistical Sampling (MBSS) methods will be used to efficiently design the sample[3].

The 1,000 telephone surveys will be analyzed to determine which building types tend to require which types of outdoor lighting as well as which building types tend to require the most outdoor lighting. Additionally, we will examine the telephone survey data for trends by the age of the building, location of the building (i.e. urban, suburban, and rural), number of employees, and the presence and size of a night shift at the building.

Survey Tracking Report

A total of 1,003 telephone surveys were completed with owners and property managers of buildings located in California. Our original sample design called for surveying a total of 20 buildings in each of the 50 sampled zip codes. However, we later learned that some of the sampled zip codes had fewer than 20 buildings located within the zip code. For these zip codes, we completed as many surveys as was possible and supplemented the number of completed surveys with additional surveys from a zip code belonging to the same cell of Table 1. For example, if one of the sampled zip codes with an extra low average number of employees per business and extra low total number of employees contained fewer than 20 buildings, additional surveys were completed in the other sampled zip code with an extra low average number of employees per business and extra low total number of employees. Table 2 shows the number of telephone surveys completed by zip code.

[3] The methodology behind MBSS methods is presented in the sample design section of Task 7.3, Initial Market Characterization, in the project workplan.

Zip Code	# Surveys Completed
90024	20
90035	20
90067	20
90210	20
90248	20
90403	20
90703	20
91106	20
91210	2
91304	20
91504	20
91731	20
91746	20
91789	20
91910	20
92024	20
92121	20
92274	12
92337	39
92590	20
92618	20
92705	21
92804	21
92831	20
93030	20
93612	20
93721	20
93740	8
94025	21
94111	20
94115	20
94303	20
94305	20
94518	20
94523	20
94545	20
94550	20
94560	20
94576	10
94926	1
94947	32
95035	20
95054	20
95060	20
95374	7
95433	7
95490	20
95670	20
95814	20
95955	26
96051	26
96096	8
96115	1
96146	21
Statewide	1003

Table 2: Telephone Survey Sample by Zip Code

EXTERIOR LIGHTING BASELINE ASSESSMENT
TASK 7.3.4: SUMMARY OF SURVEY RESPONSES

Introduction

During the months of May and June of 2001 RLW conducted telephone surveys with 1,000 business in the state of California. The intention of the 1,000 telephone surveys was to gather information on the amount of and types of outdoor lighting associated with each commercial and industrial sampled address. The surveys included both existing and new construction, but did not address roadway lighting or billboard lighting. The need for completing the 1,000 surveys was driven by the requirement to have a sample frame from which RLW could select a sample of 300 buildings for the statewide assessment task. The 1,000 surveys also serve as the mechanism for extrapolating the findings from the statewide assessment back to the population of commercial/industrial buildings in California.

The target population is the outdoor lighting associated with all existing nonresidential buildings in California. The population includes both commercial and industrial buildings, as well as large apartment complexes. In order to focus the study on existing construction, we developed a stratified sampling plan using measures of commercial activity by zip code, and a database of existing businesses by zip code. In addition, during the implementation of the phone surveys we changed the telephone survey protocols. Originally it was expected that the receptionist answering the phone would be able to answer all of the survey questions. However, we quickly learned that in many cases we were required to speak to the property manager in order to collect the survey information. As a result, we asked our telephone surveyors to contact the property manager when the initial contact was unable to provide the desired information. This step added a substantial layer to this task that was not originally anticipated, resulting in the task taking longer to complete than originally planned.

However, contacting the property manager has turned out to be of benefit to the study. As part of the Statewide Assessment task, a sample of 300 buildings will be selected from the 1,000 telephone surveys completed for the Market Characterization task. As usual, permissions will be needed in order to gain on-site access to the sampled sites. Our contact with the property manager has allowed us to gauge the customer's level of willingness to participate in an on-site survey, in essence making the recruiting task much easier when the time comes to begin the Statewide Assessment.

The rest of this document summarizes the survey responses collected from the 1,000 businesses that participated in the study survey.

Telephone Survey Results

All initial contacts for the building were asked if they owned or leased the building for the address we provided them with. Seldom were the initial contacts the actual owners or property managers of the facility. To insure the questions about the building were answered correctly, surveyors ensured the survey respondents were the building owner, property manager or someone that could effectively speak on their behalf. Table 1 summarizes building ownership; the individuals answering the survey questions own 48% of the buildings surveyed, while 52% of the surveys were completed with property managers.

	% of Respondents
Own	48.0%
Lease	51.6%
Don't Know	0.4%

Table 1: Building Ownership Status

All telephone survey respondents were asked how many businesses are located in their building. Table 2 summarizes the responses given. Fifty-eight percent of the respondents indicate their building contains multiple businesses, while 42% claim only one business is located in their building.

	% of Buildings
Yes	57.7%
No	42.3%

Table 2: Incidence of Multiple Business in Building

Approximately fifty percent of buildings surveyed were approximately 21 – 50 years of age. Buildings fifty years and older tended to be special cases such as those surveyed within the Stanford University zip code. Table 3 shown below summarizes approximate ages of the building's surveyed.

	%of Buildings
1-5 YR	2.2%
6-10 YR	5.8%
11-20 YR	26.3%
21-50 YR	52.6%
50 + YR	13.1%

Table 3: Approximate Age of Buildings

Respondents were asked about the primary use and function of their building. Table 4 is a summary of the various types of business that operate in the buildings. Office spaces consume

30% of the sample, while another 18% of buildings function primarily as retail spaces. Nearly 16% of the buildings surveyed are operating as General Commercial/Industrial Work.

	% of Buildings
Multi-Family Residential	4.1%
Medical Offices	5.3%
Office	30.4%
Retail	17.8%
Warehouse	7.9%
Church	2.4%
Hospital	0.8%
School	3.6%
Restaurant	4.4%
Lodging	2.2%
Gas Station / Mini-mart	0.8%
C&I Work	15.8%
Recreational Facility	1.3%
Fire Station	0.3%
Community Center	0.9%
Grocery Store	1.2%
Library / Museum	0.9%

Table 4: Building's Primary Function

All respondents were asked approximately how many employees worked in the building. Table 5 displays the results. Nearly half of the buildings in the study have fewer than twenty-five employees.

	% of Buildings
Fewer than 25 Employees	47.8%
26 - 50 Employees	20.5%
51 - 100 Employees	12.1%
101 - 250 Employees	8.8%
251 - 500 Employees	4.5%
501 or More Employees	6.2%

Table 5: Number of Employees per Building

Eighty-five percent of buildings have an outdoor parking lot, as shown in Table 6. Buildings that didn't have outdoor parking lots were often found in urban cities such as downtown San Francisco and Los Angeles. In these cases most contained underground parking garages furnished by their building owner or by their city.

	% of Buildings
Yes	85.0%
No	15.0%

Table 6: Outdoor Parking Lots

Of the 85% of building found to have outdoor parking lots, approximately 81% are illuminated. Table 7 shows additionally that 19 percent of outdoor parking lots are not illuminated. In many cases, these responses are from small rural areas where populations are sparse and the parking lots are not necessarily illuminated nor paved.

	% of Outdoor Parking Lots
Yes	80.8%
No	19.2%

Table 7: Illuminated Outdoor Parking Lots

Of the 69% of buildings containing illuminated parking lots, the following table illustrates an approximate number of parking spaces furnished for each building[1]. As seen in Table 8, 30% of illuminated outdoor parking lots have 25 or fewer parking spaces, while approximately another 30% of buildings are associated with a parking lot containing 100 parking spaces or more.

	% of Illuminated Outdoor Parking Lots
25 or less	29.7%
26-50	21.4%
51-100	20.3%
101-250	14.6%
251 or +	14.0%

Table 8: Number of Parking Spaces per Lot
Among Buildings with Illuminated Outdoor Parking Lots

Table 9confirms that the majority of participants believe outdoor lighting is an important part of the building's business, with about 60% in agreement. Many respondents who claimed outdoor lighting wasn't important often didn't operate their businesses after dark or used sidewalk lighting provided by their local government.

	% of Respondents
Yes	60.4%
No	39.6%

Table 9: Importance of Outdoor Lighting

All respondents who stated that outdoor lighting was an important part of their building's business were asked to describe how it is important. Table 10 illustrates that the primary reason for the importance of outdoor lighting are concerns with either safety and or security, with 97% of respondents mentioning these items. Less than five percent spontaneously stated that outdoor

[1] Eighty-five percent of buildings have outdoor parking lots. Nearly 81% of outdoor parking lots are illuminated. Therefore, the percentage of buildings with outdoor parking lots that are illuminated is 0.85*0.808 = 0.6868.

lighting was important for attracting customers, even though nearly 20% of the buildings surveyed function primarily as retail establishments.

	% of Buildings
Safety	27.1%
Security	40.0%
Safety & Security	30.2%
Attract Customers	3.6%
Aesthetics	1.0%
Identify Building	1.7%
Other	1.5%

Table 10: Purposes for Outdoor Lighting

Table 11 illustrates that 88 % of respondents claim their exterior lighting is not used to attract customers, while 12% acknowledge they are using it for that purpose.

	% of Respondents
Yes	12.0%
No	88.0%

Table 11: Attracting Customers with Exterior Lighting

Table 12 shows the percentage of respondents who acknowledge their building uses exterior lighting to attract customers by building type. Restaurants / bars and retail buildings are significantly more likely to use exterior lighting for the purpose of attracting customers than are other types of buildings[2], while General Commercial and Industrial Work buildings and warehouses are the least likely to utilize exterior lighting to this end.

	% of Respondents
General C&I Work	3.2%
Medical Office	9.4%
Office	8.6%
Restaurant / Bar	47.7%
Retail	20.5%
Warehouse	2.6%
Other	14.2%

Table 12: Attracting Customers with Exterior Lighting by Building Type

Table 13: illustrates the percentage of buildings which serve the public or customers at night. Only about 40% of the respondents are open to the public or customers at night. The various purposes for extended hours of operation often include cleaning and security crews, residents

[2] All statistical significance tests are conducted at the 0.05 level of significance.

living on site that require 24-hour access, restaurants and bars, or commercial and industrial businesses with split shifts.

	% of Buildings
Yes	38.5%
No	61.5%

Table 13: Buildings Open at Night

Table 14 illustrates the hours of closure for business that serve the public or customers at night. Hours of operation are categorized for businesses that serve the public or customers occasionally at night, and those that do so regularly. For example, 19% of the buildings serving the public or customers at night are open until 10 PM, while 25% are open to the public 24 hours a day, all week.

	% of Buildings Serving Customers At Night	
	Occasionally	All Week
Until 8 PM	1.5%	12.1%
Until 9 PM	1.3%	18.8%
Until 10 PM	3.6%	19.3%
Until 11 PM	-	6.4%
Until 12 AM	0.3%	4.9%
Until 1 AM or After	-	5.9%
All Night	0.3%	25.0%

Table 14: Buildings Serving Customers at Night

Table 15 summarizes the responses given when participants were asked if their building operations included a nightshift. Of the sample, 34% said yes while 66% said no. The majority of nightshifts were not swing shifts, instead they were cleaning and security crews that arrived for a few hours after closure.

	% of Buildings
Yes	34.0%
No	66.0%

Table 15: Buildings with Night Shifts

As shown in Table 16, 85% of respondents whose building had a night shift claim there are fewer than 25 employees working on a night shift. Night shift employees were often security and/or cleaning crews.

	% of Respondents
Fewer than 25	85.1%
26-50	6.7%
51-100	4.4%
101 or Greater	3.8%

Table 16: Number of Night Shift Employees

As Table 17 shows, thirty-nine percent of the respondents claim their building has one or more illuminated signs, while 61% said they did not have an illuminated sign. In a few cases, respondents reported having an illuminated sign but had removed the lamp to save money and conserve electricity.

	% of Buildings
Yes	39.5%
No	60.5%

Table 17: Buildings with Illuminated Signs

All respondents who stated their building had an illuminated sign were asked how many of these signs were at the building. Table 18 shows that 48% of the buildings surveyed have only one-illuminated sign, 22% have two signs, 19% have three to five signs, and 10% have six or more signs. Chain restaurants, mini-mart gas stations and hotels commonly claimed to have at least one or more illuminated signs.

	% of Buildings
One	47.6%
Two	22.2%
Three-Five	19.6%
Six or more	10.6%

Table 18 Number of Illuminated Signs per Building

All respondents who reported having one or more illuminated sign were asked to indicate, for each sign (up to a maximum of 6 illuminated signs), if, in their opinion, it is small, medium or large. Table 19 shows that among those who claim to have six or more signs, 80.9% are considered medium in size.

	% of Respondents					
	Sign 1	Sign 2	Sign 3	Sign 4	Sign 5	Sign 6
Small	34.8%	34.8%	35.8%	38.8%	39.3%	19.0%
Medium	37.8%	41.1%	50.8%	51.3%	52.5%	80.9%
Large	27.5%	24.2%	13.3%	10.0%	8.2%	0.1%

Table 19 Sizes of Illuminated Signs

All respondents were asked if they had the types of lighting shown in Table 20. Seventy percent of the survey respondents have entrance lighting, the most common type exterior of lighting. Sixty-seven percent have area lighting, which also included parking lot lighting. Approximately 3.2% of respondents reported having exterior lighting in all categories.

	% of Buildings
Landscape Lighting	19.0%
Entrance Lighting	70.4%
Walkway Lighting	41.4%
Area Lighting	67.4%
Building Mounted Lighting	66.6%
Building Highlight Lighting	10.6%

Table 20 Exterior Lighting Functions

Table 21 presents the percentage of buildings that have landscape lighting present at the facility by building type. Buildings that are used for general commercial and industrial work, warehousing, or medical offices are significantly less likely to have landscape lighting, and there is an indication multi-family residential buildings and office buildings are the most likely.

	% of Buildings
General C&I Work	8.3%
Medical Office	11.3%
Multi-Family Residential	31.7%
Office	24.0%
Restaurant / Bar	20.5%
Retail	18.2%
School	22.2%
Warehouse	9.1%
Other	26.4%

Table 21: Buildings with Landscape Lighting

Table 22 presents the percentage of buildings that have entrance lighting present by building type. Buildings that are used for general commercial and industrial work, warehousing, or retail are significantly less likely to have entrance lighting, while multi-family residential buildings are significantly more likely.

	% of Buildings
Church	82.6%
General C&I Work	55.1%
Lodging	81.8%
Medical Office	79.2%
Multi-Family Residential	95.1%
Office	78.7%
Restaurant / Bar	72.7%
Retail	60.8%
School	80.6%
Warehouse	50.6%
Other	80.3%

Table 22: Buildings with Entrance Lighting

Table 23 presents the percentage of buildings that have walkway lighting present by building type. Buildings that are used for general commercial and industrial work or warehousing are significantly less likely than other buildings to have walkway lighting.

	% of Buildings
Church	39.1%
General C&I Work	23.1%
Lodging	59.1%
Medical Office	52.8%
Multi-Family Residential	58.5%
Office	45.2%
Recreational Facility	53.8%
Restaurant / Bar	47.7%
Retail	40.3%
School	55.6%
Warehouse	23.4%
Other	56.3%

Table 23: Buildings with Walkway Lighting

Table 24 presents the percentage of buildings that have area lighting present by building type. There were no statistically significant differences among the various building types, although there is an indication that medical offices and "other" buildings are more likely to have area lighting.[3]

	% of Buildings
Church	60.9%
General C&I Work	62.8%
Lodging	68.2%
Medical Office	75.5%
Multi-Family Residential	58.5%
Office	67.6%
Restaurant / Bar	65.9%
Retail	68.2%
School	66.7%
Warehouse	67.5%
Other	78.7%

Table 24: Buildings with Area Lighting

Table 25 presents the percentage of buildings that have building mounted lighting present by building type. There were no statistically significant differences among the various building

[3] In Table 24, the "Other" building type is comprised of community centers, fire stations, gas stations, grocery stores, hospitals, libraries and museums, and recreational facilities.

types, although there is an indication that multi-family residential facilities, schools, and "other" buildings are more likely to have building mounted lighting.[4]

	% of Buildings
Church	65.2%
General C&I Work	65.4%
Lodging	63.6%
Medical Office	62.3%
Multi-Family Residential	80.5%
Office	64.1%
Restaurant / Bar	68.2%
Retail	61.1%
School	83.3%
Warehouse	68.8%
Other	78.7%

Table 25: Buildings with Building Mounted Lighting

Table 26 presents the percentage of buildings that have building mounted lighting present by building type. There were no statistically significant differences among the various building types.

	% of Buildings
General C&I Work	5.8%
Medical Office	7.5%
Office	10.5%
Retail	10.2%
Warehouse	9.1%
Other	15.4%

Table 26: Buildings with Building Highlight Lighting

[4] In Table 25, the "Other" building type is comprised of community centers, fire stations, gas stations, grocery stores, hospitals, libraries and museums, and recreational facilities.

Survey Trip Report for Final Forty Pilot On-site Visits

Integrated Energy Systems Productivity & Building Science Program

A project of the State of California PIER Program

Element: Element 7 - Exterior Lighting Baseline Assessment
Deliverable: 7.4.4, Produced by Clanton and Associates
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PIER
Public Interest Energy Research
CALIFORNIA ENERGY COMMISSION

New Buildings Institute, Inc.

Survey Trip Report for Final Forty Pilot On-site Visits

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Introduction

As a methodology for developing an outdoor lighting survey instrument and an on-site survey procedure, fifty commercial/industrial sites in California were surveyed as part of the PIER Outdoor Lighting Baseline Assessment (Element 7). Under contract to RLW Analytics, Inc., Clanton and Associates, and their subcontractor Mike Neil Engineering, conducted all fifty of the pilot site surveys. This work was conducted as part of Task 4, the Critical Analysis.

Clanton and Associates delivered a site survey trip report after the first ten pilot sites were completed. A Technical Advisory Group (TAG) meeting was held shortly after the first trip in order to synthesize the data that had been collected, assess the completeness of the data, and prepare for the remaining 40 sites that would be surveyed in subsequent rounds of field trips. This report summarizes Clanton and Associates experiences, progressions, and findings while conducting the final 40 pilot site surveys.

Overview

From June 3-7, a second set of trial site surveys were performed at various locations around Sacramento. Eighteen different sites were completed during this trip in order to expedite the deliverable process. From August 5-8, a third set of trial site surveys were performed at various locations around San Diego. The third set included twelve (12) sites. The fourth survey trip was September 10-12, and was scheduled to include ten (10) sites in the Los Angeles area. Due to the terrorist attacks on September 11, one of the facilities (a federal building which houses FBI offices) was unavailable for the survey. With such short notice, there was no possibility to select another site to survey, so the number of sites in the fourth survey trip was reduced to nine (9), for a total of 49 completed pilot site surveys.

The sites surveyed in both the third and fourth trips will be included in the data for the Baseline Assessment. This is possible because the survey instrument and procedures have been refined to the point that all the relevant data is being collected. The only modifications that will be made for the final revision of the survey instrument will be minor workflow and ergonomic adjustments that will make the data collection process more efficient.

General Survey Notes

Contacting Site Representatives
The sites were selected through a random phone survey of selected ZIP code regions of Sacramento. Of the properties in the phone interviews, those willing to permit a site survey were collected and called back to set up a time that was satisfactory to the on-site contact. The surveys were scheduled at a rate of three per day. Each site must be visited during the day and then again after dark.

Daytime Survey
The surveys were scheduled so that there was a specific appointment time for the surveyors to be on site. The day before the site visit, a call was made to the site contact to confirm the visit and brief the site contact on the survey procedure.

Nighttime Survey
The nighttime surveys were completed in full darkness in the same order the sites were surveyed during the day, typically beginning at around 8:45 PM. At all sites, the site contact was not present for the nighttime survey portion, although some of the sites were still in operation (primarily the fast food vendors). In cases where the site was still operational, a survey team member would enter the establishment and introduce the survey team to the business manager and inquire whether they were expecting the survey team that evening. In some cases the night managers were not informed, however by providing them with the name of the daytime contact person and a description of the survey, they became comfortable with our presence.

The nighttime measurements and subjective questionnaire are performed as efficiently as possible, however, at least three conditions that we encountered will slow down the process of taking light measurements considerably. First, the nighttime use of parking spaces by vehicles resulted in the greatest amount of time lost. Measurement grids laid out during the day were often times occupied at night by vehicles, forcing the site survey team to redo the measurement grids at night. To combat this problem, the survey team changed the protocols to facilitate night grid layouts rather than during the day. This resulted in less loss of time during subsequent site surveys.

The second situation that resulted in a loss of time was the presence of a nighttime security officer. With security guards, the survey team must explain the intent of the survey and discuss lighting issues with them. Since the survey team is intruding on the security guard’s area of responsibility, the survey team must ensure that the security guards have been informed, and that the guard is satisfied and comfortable with the presence of the surveyors.

The third condition is vehicular traffic at businesses that operate into evening hours or 24 hours. In all cases, the measurements were delayed until the conditions were clear to proceed. When there is heavy vehicle traffic, the

measurements must be taken during gaps in the traffic flow to avoid interfering with the operation of the facility.

Trip #2: Survey 18 Sites

The second trip was originally intended to have twenty site surveys, however, only eighteen sites were surveyed due to scheduling difficulties. The remaining two sites were included in the third survey trip. Despite scheduling the meetings, two site contacts were not available, and the surveys were performed without meeting the site contact in person.

The sites included:

1. A gas station on a corner lot, with moderate use.
   This is a typical gas station in this area, with moderate nighttime use, and a small snack shop in the building.

2. A small fast-food store with drive-through on a small lot.
   This facility turns off all exterior lights at midnight, but leaves some nightlights on inside the store. Busy at night.

3. A single story retail building with three small businesses.
   The maintenance on this facility was not current, some lamp burnouts.

4. A large church and adjoining school facility.
   This site had been modified over the years, so there was a great variety of equipment ranging from original equipment installed in the 1960's to equipment installed in the late 1990's.

5. A single story commercial office facility with several buildings
   This site was not clearly defined, as there were several similar buildings in the area, and the property lines were not made 'apparent' by roads or sidewalks. The selection of the site area was 'best reasonable guess'.

6. A large multi-building motel facility.
   This facility was under renovation, however, a portion of the site was still unaffected. The readings and lamp information was taken in that area.

7. A gas station and minimart on a corner lot.
   This site is atypical of the gas stations in the area; the site has a very large lighted parking area that was used lightly. The main gas pump area is heavily used day and night.

8. An automobile dealership.
   This facility had disconnected some of the retail lights for energy conservation. The facility has a security guard and a significant amount of

time was spent making him comfortable with our presence, even after he had been notified we would be visiting the site that evening.

9. A fast-food restaurant with drive-through.
   This facility has heavy nighttime drive-up use, and high light levels overall. This site emphasized the need of the second person to be on the look out for incoming traffic from the blind side of the surveyor taking the measurements.

10. A sit-down restaurant with 24-hour operation.
    This building was in the corner of a shopping mall, and had no obvious property boundaries. Located in a high crime area. This site highlights the need for a two person 'survey team' for safety reasons.

11. A large retail store with concrete tilt-up walls and no windows.
    The facilities' systems are controlled by the corporate headquarters, at another location, through the internet/modem. All the parking lot lights turn off about an hour after store closing. The parking lot is completely empty after hours.

12. A small two-story office building with multiple tenants.
    This facility had little equipment for parking, and what little there was, was mostly inoperative. This is a low budget office space, in a run down section of town.

13. A corner gas station on a busy intersection.
    This site has a very large gas canopy that covers approximately 15% of the site. The store manager/owner has taken an active role in reducing the energy use of the facility by operating only one-half of the canopy lights at night. After 23:00, the facility operates through the pumps only. Light level readings taken with one-half of the lights on.

14. A fast food restaurant with drive-through.
    This facility is right next to Site #2, and contributes a significant amount to the light levels at Site #2. Floodlights are used as parking lot fixtures. A great deal of light trespassing was observed at this site.

15. A large commercial building in the more urban center of Sacramento (with a parking garage)
    This property has little or no 'site' other than the sidewalks along the street, the building entries, and the top level of the parking garage. The parking garage is located under a highway overpass, so this site is mostly contained, with little 'open to air'. Measurements were taken in the parking lot top deck.

16. A strip mall with several buildings.
This facility was irregularly shaped, with curving roads on three sides, which made site measurements difficult. The parking lighting was done with 'decorative' style lanterns, which are a major source of glare and light trespass for the neighboring residential area.

17. A large indoor shopping mall.
This facility is fairly old, so there had been some renovation work performed to various portions of the building. There were a number of different fixtures on the site, and of varying condition. This was also one of the few HPS parking lots surveyed on a retail site.

18. A high school with multiple buildings.
This school is on a large site comprised of multiple buildings connected by covered walkways. The parking lot lighting was accomplished with pole mounted refractor luminaires (and floodlights that were inoperative), the walkway lighting was a mix of incandescent luminaires in original construction and fluorescent and metal halide luminaires in renovated areas. The walkways in the areas outside of the gated areas were turned off.

Notes from Trip #2

Lamp Type and Wattage Accuracy
This issue remains the most difficult detail to resolve at this point. For the third set of site surveys, a 'lookup sheet' will be used that has scale drawings of the most typical HID light sources. With this sheet, a surveyor will be able to 'size up' the lamp with the sheet to make a more accurate assessment of the lamp wattage.

The wattage of incandescent sources is not completely dependent on the size of the lamp, so this approach is not applicable for incandescent lamps. Since these lamps are generally at lower mounting heights, the lamps are easier to see and read the wattage code.

However, if the lamp is completely obscured, the task of determining lamp wattage is much more difficult. The surveyor may have to make a reasonable guess of the wattage based on the size of the equipment and a reasonable wattage based on the application.

An interview with the maintenance personnel on site, and a look through the lamps in the maintenance supply closet will help eliminate most lamp wattage questions.

On-Site Interview With Site Contact
After trip #2, it became apparent that enough information was not being collected regarding the operation of the lighting system and other aspects of the site. While the phone interviews were collecting important information, the majority of site operational information was left for the site surveyors to collect.

The Survey Instrument was then modified with a series of questions that addressed operational information needed for modeling energy use. This has changed the interaction with the site contact from a simple exchange of salutations and a brief explanation of the purpose of the survey to a full 'interview' that requires the site contact to provide a large amount of information on the operation of the facility.

The amount of time that this interview takes is highly dependant on the personality of the site contact and time demands placed upon them. In some cases, the site contact would call the head of maintenance, which is generally the best person to answer most of the questions.

This interview takes time, and one surveyor will spend a significant portion of the daytime survey time allotment performing the interview. Meanwhile, the other surveyor is on the site, recording the luminaire data and taking measurements. At most sites, the survey seemed to take approximately one-quarter of the total man-hours required for the daytime work.

The majority of site contacts do not have full information on the site and lighting equipment to completely answer all the questions. Even at well-organized sites with a full time maintenance staff, some information will not be available. The most common question that could not be answered was to provide the square footage (or acreage) of the site.

Another aspect of the site contact interview that must be considered is the accuracy of the answers provided by the contact. We noted that few of the contacts (including the facility managers and maintenance crew) were able to provide both accurate and precise information on the lamps used at the facility. In some cases the lamp technology was incorrectly reported (e.g., mixing up metal halide and high-pressure sodium), and in all cases, the specific lamp wattage was not known unless spare lamps were available in a supply closet for review.

Survey Toolkit Modifications
For the first survey trip, a tripod was used as a support device for the vertical illuminance readings. However, this proved difficult to level and slow to manipulate for readings at each point. The tripod was replaced with a monopod, which is faster to use, however care must be taken to ensure the meter head is vertical.

Large Site Survey Procedures
Very large sites and multiple building sites necessitate several procedural changes to accommodate the survey within a reasonable time allotment. Provided below are several comments and procedures that are recommended to speed up the survey, and still maintain the accuracy desired.

The surveyors must take a walking tour of the site (or slow driving tour for very large sites) to establish an appreciation for the variety of buildings and lighting equipment on the site. This is important, because the survey intent at the large sites is to do a representative sampling of the site, and extrapolate this up to the entire site. Once the site has been viewed, the surveyors must make a judgment about what to survey to make a truly representative sampling.

We recommend that the site lighting be treated separately from the building lighting. It is possible to do a small percentage sampling of a parking lot that represents the entire site, and still maintain the desired accuracy. The building sampling, however, may require a significant percentage of the total to be a fair representation. Unless there is little or no deviation in building lighting through the entire site, the minimum amount of buildings sampled should be approximately 25%.

Sampling this amount of the total area will permit the surveyors to select portions of the buildings that seem to be a fair representation of the entire site. The percentage of the site surveyed, by functional use area, must be documented so that the extrapolation can take place when the data is analyzed.

It is not important that *every* luminaire type on the property is catalogued, just that the data collected be a representation of the equipment used so that a reasonably accurate energy profile is generated. A typical large site to survey is a large regional mall. There is the potential, through several building phases, and the large variety of individual store facades, that there are more than a hundred different luminaire types on the exterior of the various buildings at the site. However, the sampling approach can reduce this data collection to a much more manageable number, as long at the sampled areas are fair representations of the site as a whole.

Trip #3: Survey 12 Sites

General Survey Notes
The sites were selected and organized in the same procedure as those for the previous survey trip. The sites were renumbered, however, to correspond to the site number that was assigned during the phone surveys.

The site contacts for the three sites scheduled for Sunday, August 5, were not at their facilities, so times were scheduled to interview the site contact over the

phone later in the week. This proved to be difficult to do, as the contacts were unavailable at the scheduled times. Several follow-up calls were required before the interviews were completed.

The sites included:

1. #1382 An office building/shopping center with two buildings.
   This facility was located on a heavily sloped site, with some retaining walls and a driveway up to the facility on each side. It was surveyed on Sunday, when the majority of the offices were closed. The lighting system was not fully functional, with one complete building not operational after dark, and most of the parking lot lights not operational. The equipment was counted, assuming the system was operational. However, the lighting measurements were not possible due to the lack of light.

2. #1325 A medical office park with five buildings.
   This facility was also located on a heavily sloped site, with 1:3 sloped banks at the back and the front of the lot. There is a driveway up to the facility on each side of the front of the property. This facility had been retrofitted within the last few years with new lighting for the parking lot, however it appears somewhat misdirected; the replacement floodlights are halogen, and it appears that the older fixtures were a wallpak design, which was probably HPS. So, it is possible the energy use went up, while the light levels went down.

3. #323 A light manufacturing facility with several tenants.
   This property was on a flat site, and has little landscaping, except a green strip at the very front of the building. The rest of the property is paved for parking. The parking lot is lit primarily by wallpaks on the building façade.

4. #1444 A large medical office building.
   This property is located near a hospital, and was one of several properties in the area that served as support buildings to the hospital complex. The building has five floors. Half of the exterior soffit lights at the entry and perimeter were not operating. The maintenance manager told us that he keeps only half operating because of the energy problems California is experiencing.

5. #1601 An older medical office facility with four buildings.
   This facility shows how difficult some properties will be to survey, even though they are small. The site contact was unable to provide building square footage or site acreage. There are only four buildings, but the outlines were very complex. The lighting was fairly easy to count, but getting an accurate measure of building SF was time consuming. The daytime site measurements took 3.5 man-hours to complete, without including travel time.

6. #308 A large regional mall.
This facility was very large, and took many hours to collect the data, for several reasons: both the site and the amount and types of equipment on the property is very large. We used percentage sampling for this property, because of the complexity and size. Even with this approach, the site took 9 man-hours for the daytime data collection, not including travel time. The nighttime measurements were completed in about the same amount of time as a regular site. This was the only site in the survey set where the facility manager had plans readily available, and also knew information on square footage and acreage. His estimate for site acreage was accurate within .5 acres (55 acres vs. 44.5 acres calculated).

7. #327 A large office park.
This facility was the first site in the set to use LPS lamps in the parking lot. Most interesting about this facility is that at best, the parking lot could be described as 'dim' or 'dark', but the energy use in the lot is no lower than that of comparable office park lots that used HPS or metal halide lamps.

8. #337 A small light manufacturing facility.
This facility has two tenants, and the back of the building is taken up by a shipping/receiving area that is used more for palette storage than for trailer parking. This facility also has LPS lights in the parking area, but the luminaires use two lamps, so the light levels are higher here than the above site.

9. #1507 A large office building with medical and general offices.
This was a fairly new facility in an apparently high-rent district. The parking lot lighting for this property was not operational at all, even though the facility manager told us that the lights operated from dusk to dawn. He did say that the lighting has been scaled back because of the energy bills, and is actively doing T12 to T8 retrofits in the parking garage. We returned to the same site the next evening, and the same condition existed. The daytime site data had all ready been collected for the site, and the energy consumption for the site will be accurate, when the lights are operational.

This does raise another unanticipated benefit of the nighttime site visits. The ability to actually see the system in operation permits the survey to be more 'accurate'. In this case, the question arises whether the facility should be modeled as it actually operates at the time of the survey, or as it would ideally operate with a properly functioning system.

10. #329 A medium office/lt. manufacturing facility.
This property is typical of many of the facilities in the area, with wallpaks on the building to light the parking lot; light trespass and glare are significant.

11. #1179 A medium strip mall shopping center with three buildings.
This property was in the renovation process, so the parking lot layout is likely to be different, although the same lamps are in the old and new fixtures. This property is maintained by a maintenance company, which raises some questions regarding the interest of these companies to reduce light levels and energy consumption. More about this issue in the "Further Issues" section below.

12. #338 A small fitness/racquetball club center.
This facility shares the parking lot with the adjacent property, and the lights are shared as well. This highlights the need to accommodate the selective counting of fixtures based on geometry. Apparently, both properties are owned by the same company, so 'sharing' the parking lot and lighting is not an issue, and is a more efficient way to use the space. We made a decision to assign one half of the parking lot and lighting to the surveyed site. This facility also has a large highway-readable billboard on the top of the building.

Notes from Trip #3

Scheduling Site Visits
For reasons of efficiency, site surveys were scheduled to begin on Sunday and continue through Wednesday. This proved to be difficult, because the site contacts were not at the sites on Sunday, and the effort it took to get a phone interview later in the week was time consuming. If the site is a fast food facility or other seven-day-a-week facility, a visit can be scheduled for a weekend day, however, other sites should be scheduled midweek.

One scheduling conflict possibility is that the contact is not always available due to last minute issues, or is simply unable or unwilling to accommodate the surveyor at the scheduled time. These situations will occur, and the surveyors must try their best to accommodate the contact's scheduling. If, however, the contact is unwilling to provide the time necessary for the interview, the site may have to be abandoned.

It is also important that the type and size of the facility be known while the scheduling is being set. If a large mall is set as the last site of the day, it will not delay the arrival of the survey to the other sites that day. This information is also good to provide to the survey team, so that they know what the facility should look like while driving an unfamiliar street. When scheduling the appointments questions should be asked regarding the square footing of the building and site, to best accommodate the timeframe allotted for the surveyor to complete their task.

Further information that is very useful to the survey team is the crossroad intersection that the site is located nearest. While the street address is useful when locating the site on the street, it is not always useful when looking at the street on a map, especially when the surveyors are not familiar with the area. However, providing a crossroad intersection will almost always place the site precisely on the map, and make it much easier to plan the travel schedule for the day's surveys.

Survey Toolkit Modifications
One modification to the survey toolkit has been made before the fourth trip. The light meter required for the surveys is the Minolta T-1 meter, with the remote head cable attachment. For the previous surveys, that meter was used for the horizontal and vertical illuminance readings, while another meter was used (with additional attachments) for the light trespass and glare ratio readings.

Since the survey teams will have only one meter, attachments were made for the T-1 meter to permit it to do the light trespass and glare ratio readings in addition to the illuminance readings. This eliminates the need for two separate meters, and provides a more accurate reading for light trespass and glare ratio.

Trip #4: Survey 10 Sites

The sites were selected and organized in the same procedure as those for the previous survey trips.

The sites included:

1. #40 A large office building with a multi-story parking garage.
   This building has no site to speak of, except for the sidewalk at the front and a small dumpster and loading area at the rear. The light levels were taken on the top level of the parking garage.

2. #1900 A corner lot shopping center with food and a convenience store.
   This facility has two buildings, and constant traffic, which made the nighttime readings more difficult.

3. #48 A high-rise commercial office building.
   This facility has an interesting combination of light sources. The facility manager told us that the architect insisted that the exterior soffit and entry lights all be incandescent, they are mounted at approximately 35' above grade. He indicated that maintenance is very difficult because of the mounting height, and retrofit options have been discussed, but the architect is adamantly opposed to any changes.

4. #1213 A small bank facility with ATM.

An example of the poor application of the ATM lighting guidelines, this bank had an ATM added, and a large wallpak was installed on the front facade to meet the lighting guidelines.

5. #24 A high-rise condominium building.
There is not much of a 'site' at this facility, but what there is has incandescent landscape lighting and steplights. At least one valet is on duty at all times.

6. #1558 A small office building that was once a two-story motel.
This facility has two very large billboards on the top of the structure. The typical lamping of billboards needs to be investigated to ensure an accurate accounting of electrical demand and energy use.

7. #1483 A federal office building.
As discussed, this survey was scheduled for September 11. The FBI occupies a large portion of the building, and our contact with the GSA confirmed that no civilians were permitted on the site while the events were unfolding. Site cancelled for now.

8. #1487 A large office building with a bank on the first floor.
This facility is another example of the ATM lighting guidelines. An ATM was added to the bank, and three large 400-watt floodlights were placed over the ATM pointed towards the small parking lot intended for bank customers. The light trespass and glare from this arrangement is extreme.

9. #52 A high-rise commercial office building.
This building was an early 70's building that has been kept in very good condition. There was a lighting retrofit performed on the exterior of the site within the last few years, although the parking garage was not retrofitted. Light levels were taken under the new pedestrian lights and also on the top deck of the garage, which uses mercury vapor lamps.

10. #57 Another high-rise commercial office building.
This building is a good example for how significantly a small amount of brightness or glare can drastically reduce visibility. There are many custom light bollards on the site that are unshielded. Although the lamp wattage was not excessively high, the ability to see 'past' the fixtures is very limited. When the bollards are blocked from view the visibility of the entire site is much greater. This site also has a very complicated layout and many different fixture types, so the daytime survey took 3.5 man-hours without travel.

Further Issues

Lamp and facility maintenance companies
In the third survey trip, an external electrical maintenance contractor maintains site #1179, a shopping center. This has posed some questions about the potential success of energy saving programs. These maintenance companies make their money in one primary way; they charge for lamp replacement and other service calls.

There are a number of effective changes that will save energy at a facility. The use of controls to turn off lights after hours, reducing the lamp wattage in certain fixtures, and reducing the number of fixtures in operation will all have a significant impact on the energy use of a facility.

However, the profit of an external maintenance contractor is directly proportional to the hours of operation and the number of lamps in operation. When a recommendation to reduce either of these items is made, the maintenance contractor will likely be against these measures due to the financial impact this will have for them.

Further Modifications to the Survey Instrument

The Survey Instrument is in close to final form, with only a few minor layout modifications to enhance the efficiency of the form while in the field. It was noted that the forms should be split into the site contact 'interview' section, and the site 'information' section, since the two surveyors will be apart and using both sections at the same time.

Also, although it is easier to use the forms when they are stapled together (they do not get out of order, and the sheets are not prone to blow in the wind), having the forms stapled when the data analysis is performed may be a problem. The forms get somewhat tattered due to the need to constantly be checking and crosschecking the data, so automatic photocopying of the sheets may cause problems.

We recommend that the surveys not be stapled together, but they may be secured with binder clips to avoid potential wind scattering problems. As previously discussed, the two sections should be separate, so that the surveyors can work on two different tasks at the same time.

Review of Survey Instrument Question List

The following chart provides feedback on the Survey Instrument questions in the order they appear. Comments provided will help prepare the surveyors for the responses and any assistance they may need to provide to the contact to get suitable answers.

Questions Directed toward the Site Contact

Question	Level of Difficulty (1-10, 10 hardest)	Comments
Q1	7	Some had responses, most “I don’t know”. Fairly easy for surveyor to measure building and multiply by # of floors.
Q2	10	Few had responses. Easier for surveyor to measure site.
Q3	2	
Q5	5	Some contacts had to count the number of tenants off a list, others knew the number.
Q6	4	
Q7, Q8	7	Some knew the lamps, or were able to show us the supply closet.
Q10, Q13, Q16, Q19, Q22	4	Most seemed to know the control technology, although some provided inaccurate responses. Some would hesitate on response, so the surveyor would go through and explain each technology so they knew how to respond.
Q11, Q14, Q16, Q20, Q23	7	The facility maintenance contacts all seemed to know this question, but the other contacts generally did not. The surveyor may need to help them figure out the hours of operation for a time clock, since the facility maintenance personnel generally set it as a reaction to site conditions and time of year.
Q24	2	
Q25	1	Most answered “no”, however, it is possible they were trying to limit perceived liability.
Q26	1	

Questions Directed toward the Surveyor

Question	Level of Difficulty (1-10, 10 hardest)	Comments
Q4	3	
Q9, Q12, Q15, Q18, Q21	4	At times, a judgment call must be made regarding whether to include a Functional use area (FUA) in the survey if it is small or has no lighting equipment. Sometimes, a FUA was used, and then no lighting was assigned to that FUA. In this case, the FUA has no lighting equipment, and can be dropped from the survey data.
Q27	1	
Q28	3	
Q26	1	
Luminaire Schedule	10	Time consuming and difficult to get complete data. Lamp wattages most difficult. Quantities fairly easy to obtain.
Signage Schedule	8	Fewer signs, less options than the luminaire schedule. The signs require making an estimate for size, since most are unreachable for actual measurement. Also, most light sources are concealed for the signs, so obtaining an accurate lamping account is difficult.
Sub. Ext. Ltg. Survey	5	It is important that the surveyor be consistent with responses, to establish a reasonable baseline to the responses.
Q29	1	
Q30	3	
Q31	3	
Q32	3	
Glare Ratio	6	Asks for a more precise impression of glare conditions than Q32.
Light Tress.	4	
Site Sketch	6	Time consuming, but not too difficult. Useful to collect luminaire quantities for complete count.
Parking Lot Measurements	3	Time consuming, but easy to accomplish.
Sidewalk Measurements	3	

Surveyor Training:
California's Statewide Outdoor Lighting Baseline Study

Trainers:
Matt Brost, RLW Analytics, Inc.
Michael Mutmansky, Clanton Engineering Inc.

January 14th, 2002

Day 1 Agenda

- Day 1
  - Introductions (8:00 - 8:30 AM)
  - Study Objectives (8:30 - 9:00 AM)
  - Outdoor Lighting Technical Discussion (9:00 – 10:00 AM)
  - Break 10:00 – 10:15 AM
  - The daytime on-site survey (10:15 AM – 12:00 PM)
  - Lunch Break 12:00 – 1:00 PM
  - Field Practice of Daytime Survey 1:00 – 3:00 PM
  - Break 3:00 – 3:30 PM
  - The Nighttime on-site survey 3:30 – 5:00
  - Dinner Break 5:00 – 6:00 PM
  - Field Practice of Nighttime Survey 6:00 – 9:00 PM

Day 2 Agenda

- Day 2
  - Review of Previous Day (9:00 – 10:00 AM)
  - Recruiter/Surveyor Communication Protocols (10-10:45 AM)
  - Break 15 Minutes
  - Survey Procedures (11:00 AM – 12:00 PM)
  - Lunch Break 12:00 – 1:00 PM
  - Large Site Methodology
  - Large Site Daytime Survey 1:00 – 4:00 PM
  - Dinner Break 4:00 – 5:00 PM
  - Large Site Nighttime Survey 5:00 – 8:00 PM

Introductions

- Team Members
  - California Energy Commission - Public Interest Energy Research Sponsor
  - New Buildings Institute (NBI) - PIER Prime Contractor
  - RLW Analytics, Element 7, Prime Contractor
    - **Clanton Engineering - RLW Sub-contractor**
    - **Robert Penny Enterprises - RLW DVBE Sub-contractor**
- Key Staff
  - RLW Analytics
    - **Roger Wright, Ph.D - Program Director**
    - **Matt Brost, Project Manager**
  - Clanton and Associates
    - **Michael Mutmansky, Field Engineer**
  - Robert Penny Enterprises
    - **Nancy Woods, Project Manager**
- Surveyors
  - Introductions, past experience

Study Objectives

- **Problem Statement:** Greater understanding and more data are needed to balance non-residential outdoor lighting with requirements for task visibility, security, safety, aesthetics, light pollution and light trespass mitigation, retail appeal and energy consumption in current building design practice.
- **Technical and Economic Performance Objectives:** The goal of this element is to understand the amount of energy currently used by outdoor lighting in California and evaluate the environmental impacts. This project will fill in the knowledge gaps, recommend good design practices, highlight poor outdoor lighting practices, and estimate the energy savings potential from improving current practices statewide.

Study Objectives (Cont.)

- **Projected Outcome:** This will be the first major study of nighttime lighting in California. It will address the problems of light trespass, unnecessary outdoor lighting, alternative methods of lighting control, and the impacts of night lighting on sky darkness. The objective of this study is to provide a baseline of outdoor lighting energy usage and key environmental factors that can be used to measure the impact of any code revisions.

General Study Design

- Telephone survey of 1000 commercial and industrial business on outdoor lighting
- 50 Pilot on-site surveys
  - used to develop methodology for 300 sites
  - conducted statewide by Clanton and Associates
    - **Michael Mutmansky present for each of the 50**
- 300 Statewide Outdoor Lighting Surveys
  - Subset of 1,000 customers surveyed by phone
  - Using methods established by Clanton Engineering
- Analysis

Task 7.6 Statewide Assessment

- 300 On-site Surveys in CA
  - 200 Robert Penny
  - 100 RLW
- Daytime and nighttime on-site surveys
  - Survey Teams
    - **regional/zip code**
  - 6 hours to complete
    - **two people**
    - **travel time**
  - Survey Instrument
    - **paper and pencil**

Task 7.6 Statewide Assessment

- Data Collection
  - Interview with site contact
  - Inventories
  - measurements
  - subjective assessments
  - user surveys
  - pictures
- Final responsibility
  - 100% completed surveys, pictures and subjective surveys

Technical Terms and Issues

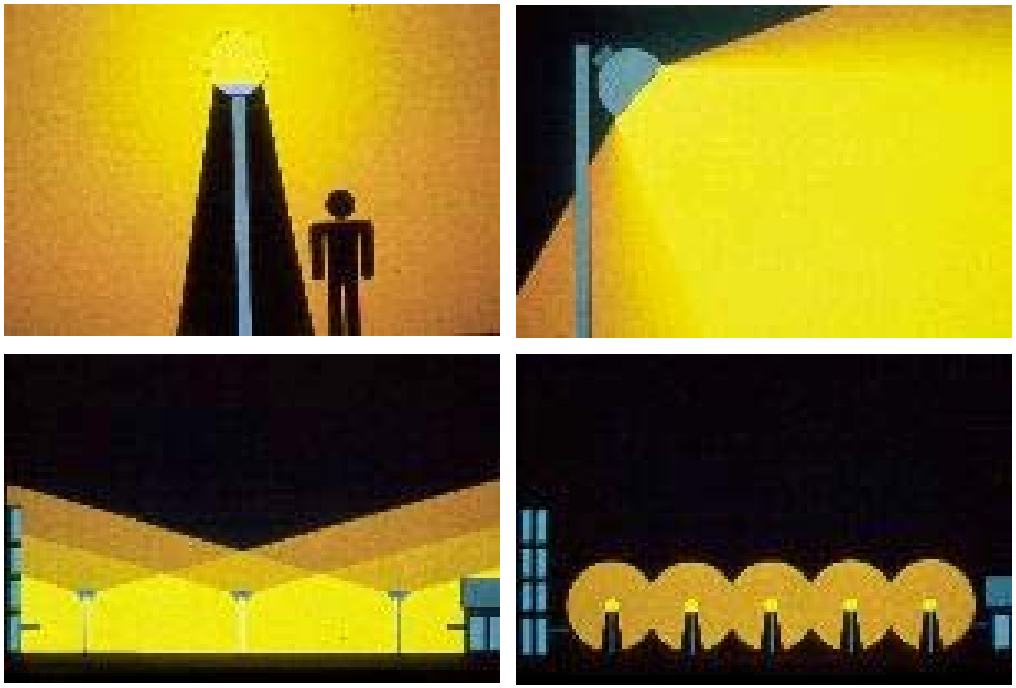
- What is outdoor lighting used for?
- Environmental/Design issues
- General terms
- Technologies
  - Lamps
  - Fixtures
  - Controls

Uses of Outdoor Lighting

- Crime mitigation
  - Safety, security, crime prevention
- Retail Appeal
  - Aesthetics
- Landscaping
- Parking
- Walkways
- Sporting Events

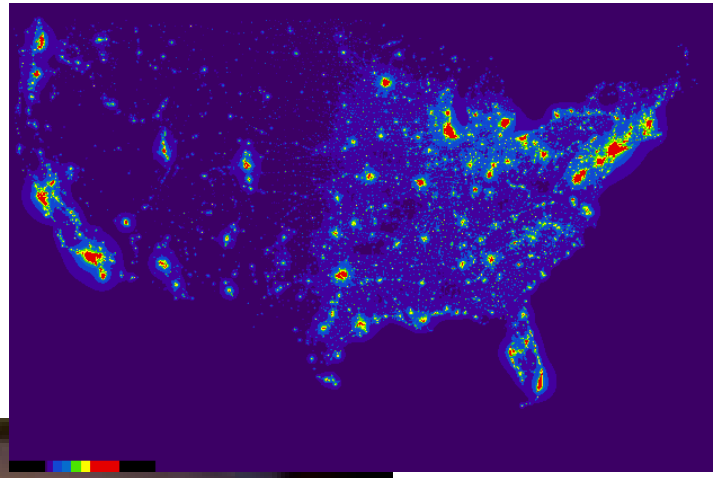
Environmental/Design Issues

- Excessive Illumination
- Unshielded or misaligned fixtures
  - Light Pollution
  - Light Trespass
  - Glare



Environmental/Design Issues

- **Light Pollution** - Any adverse effect of manmade light
  - Causes
    - **Poorly designed**
      - Excessive lighting
      - Poorly directed light
      - Poor fixture selection
  - Problems
    - **wasted $/money**
    - **"Sky glow"**

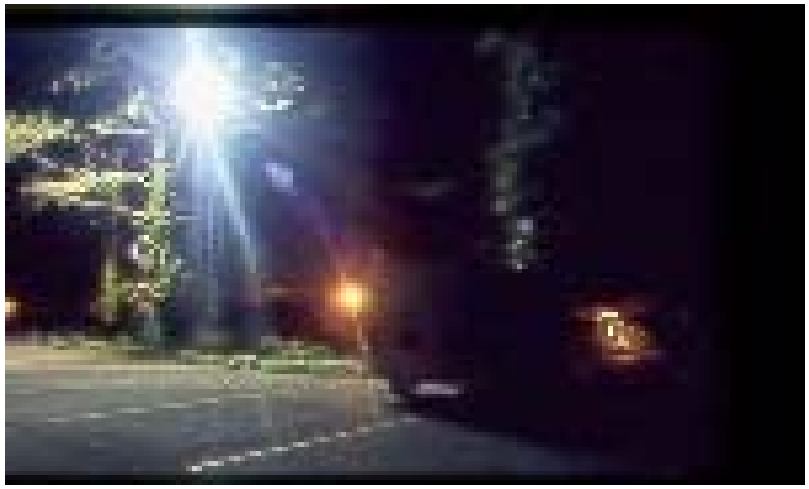


Environmental/Design Issues

- **Light Trespass** - Light falling where it is not needed/wanted
  - Causes
    - **Poor design**
      - Unshielded, misdirected, or misaligned fixtures
      - Excessive Light
  - Problems
    - **wasted $/energy**
    - **law suits**

Environmental/Design Issues

- **Glare** - Intense and blinding light, never helps visibility.
  - Causes
    - **Unshielded, misdirected, or misaligned fixtures**
    - **Excessive Light**
  - Problems
    - **Visual impairment**
    - **wasted $/energy**



General Terms

- See glossary of basic terms. Included in training manual.

Ballasts

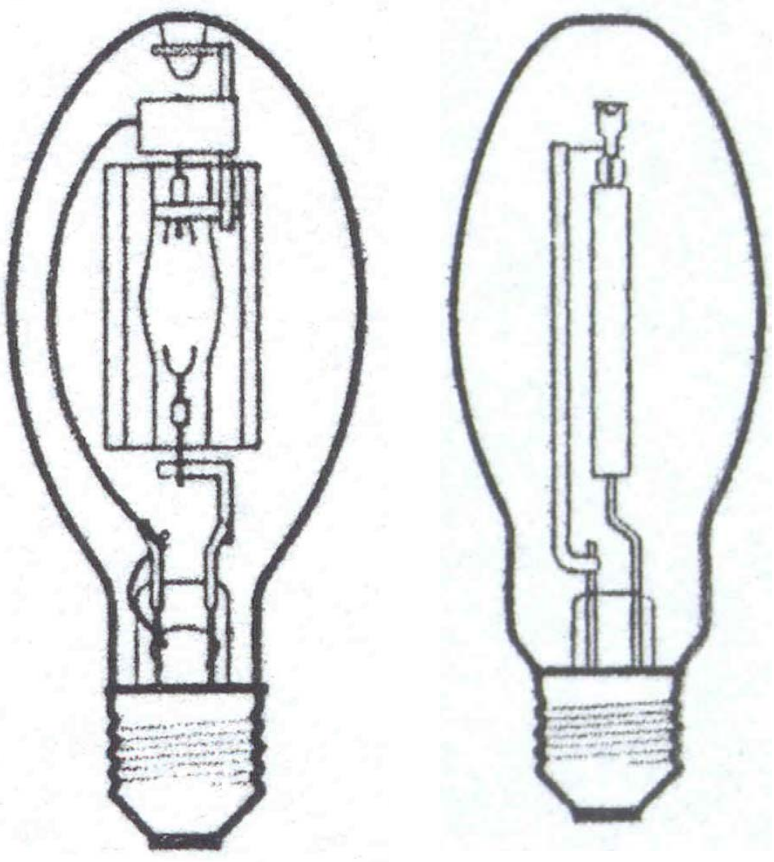
- Fluorescent Tube
  - Electronic
    - **T-8**
  - Magnetic
    - **T-12**
  - Test Method
    - **Motorola Flicker Checker**
      - Solid gray = electronic
      - “rainbow” = magnetic

Determining Lamp Type and Wattage

- This is the MOST DIFFICULT aspect of site surveys.
- Most errors will occur here.
- Information is critical for accurate energy analysis!
- What do we do???

Using lamp shape to determine lamp type

- Each lamp type has a distinctive set of physical characteristics.
- If the lamp is visible, this is generally the easiest method to determine lamp type.
- This only works during the daytime!



Lamps - Incandescent

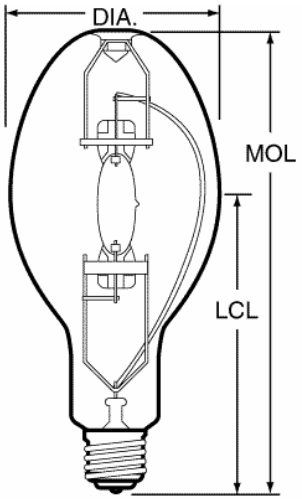
- Standard
- Halogen
- PAR

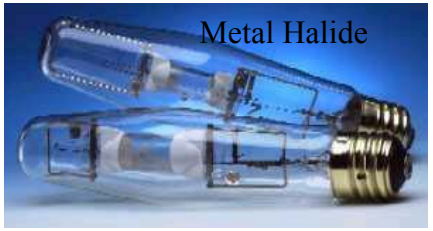
Lamps - Fluorescent

- Tube
  - Width
    - **T-12, 1” Diameter**
    - **T-8, 3/4” Diameter**
  - Lengths
    - **2’, 4’, 8’, U-tube**
- Compact Fluorescent
  - Many types
  - Do not perform well in cold

Lamps - High Intensity Discharge

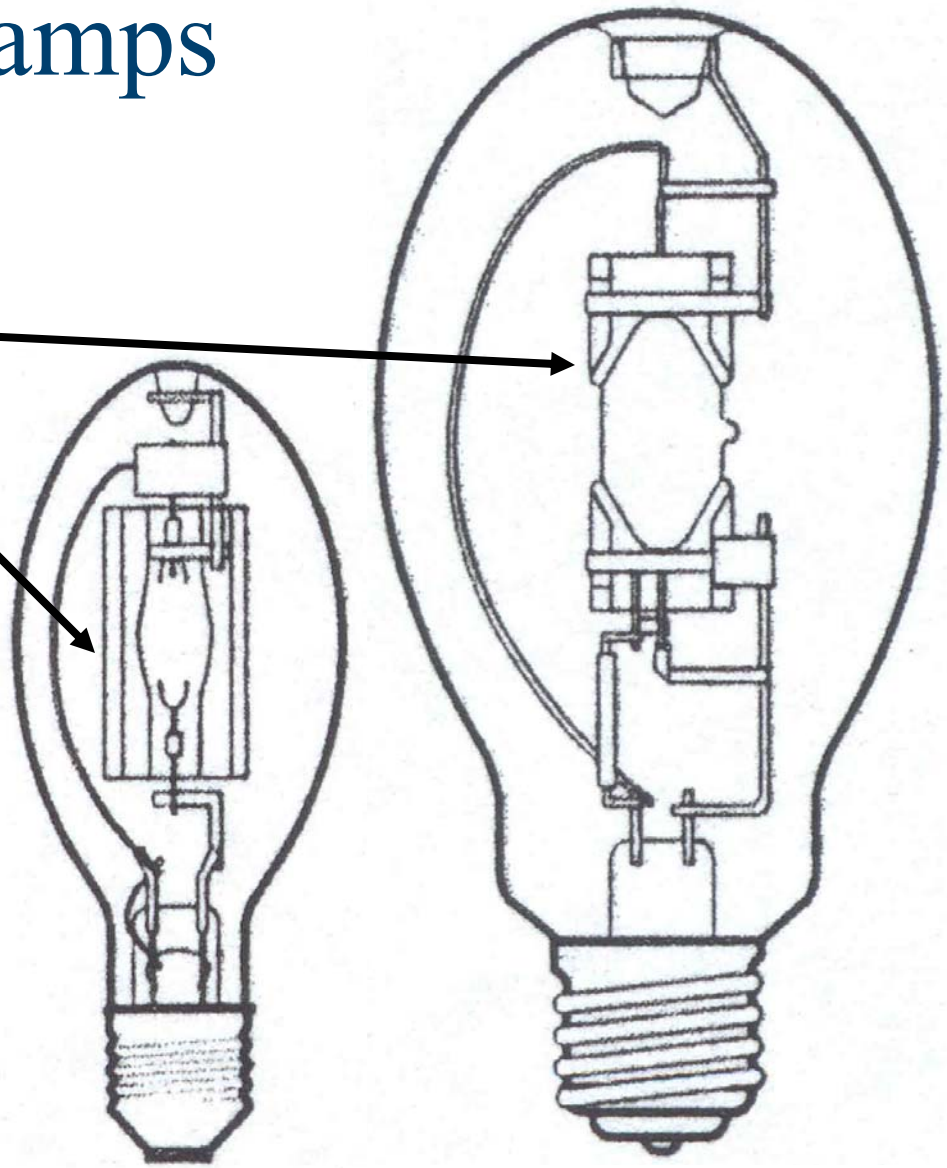
- Metal Halide
- Mercury Vapor
- Sodium
  - Low Pressure
  - High Pressure



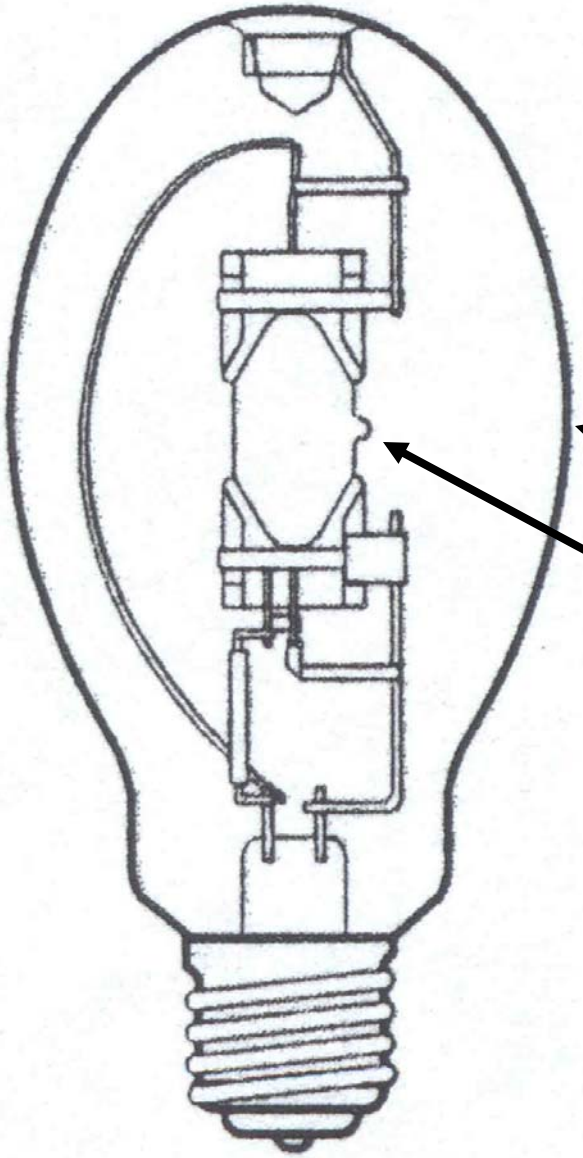


Metal Halide Lamps (MH)

- Short, clear, bulbous arc tube
- Some have inner glass shield
- Some have frosted outer bulb
- ANSI color --- White



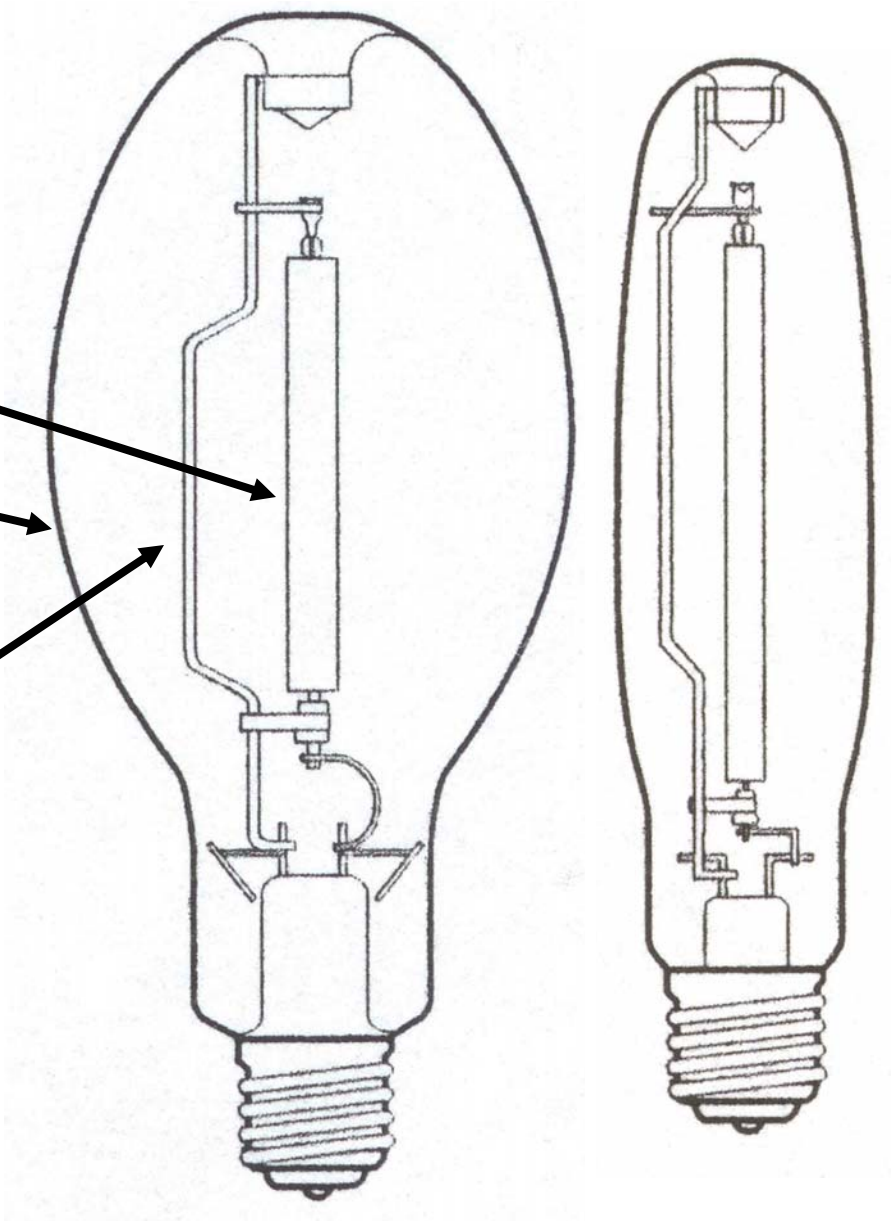
Mercury Vapor Lamps (MV)



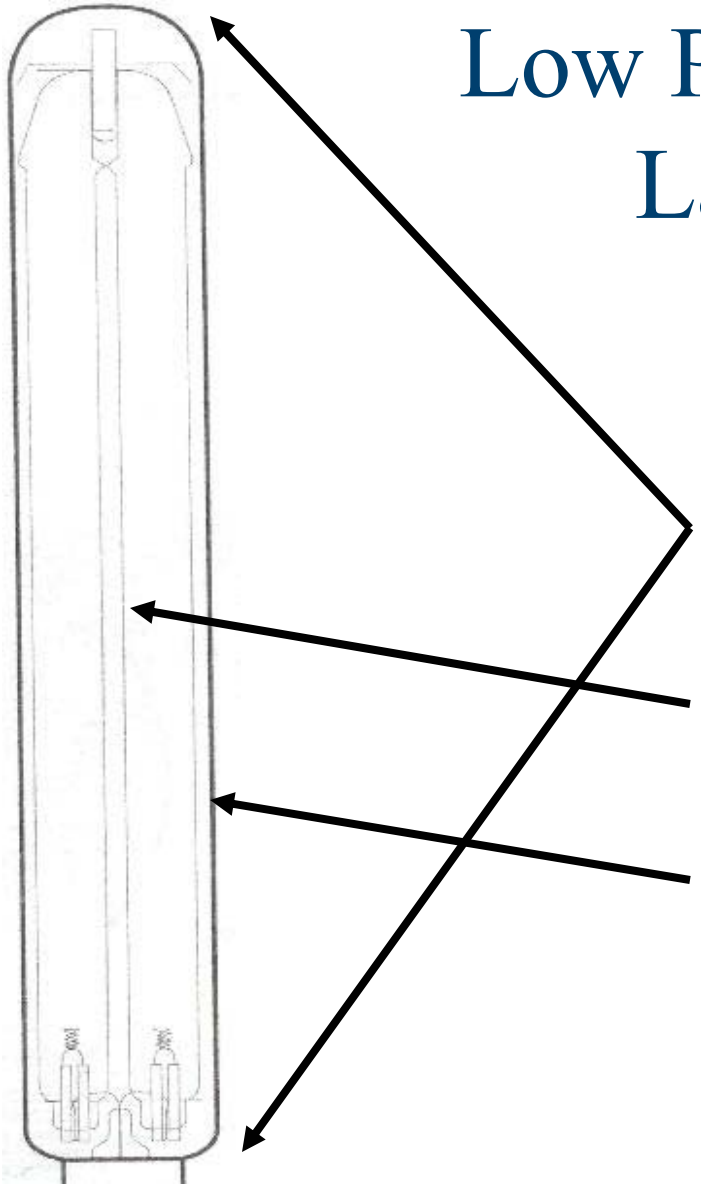
- Very similar to MH lamps
- Some have frosted outer bulb
- NEVER has inner glass shield
- ANSI color --- Blue

High Pressure Sodium Lamps (HPS)

- Skinny arc tube, frosted
- Outer bulb NEVER coated
- NEVER has inner glass shield
- ANSI color--Yellow



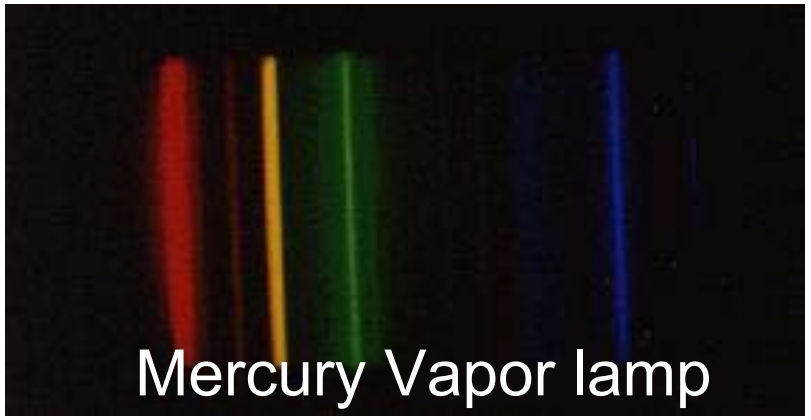
Low Pressure Sodium Lamps (LPS)

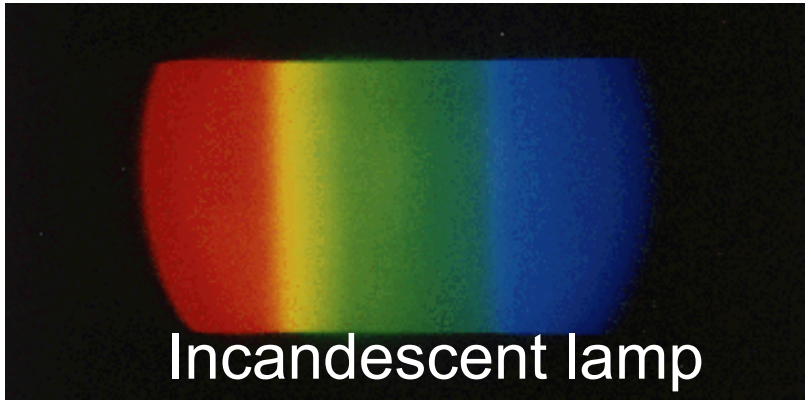


- Most distinctive lamp shape
- Very long lamp (up to 2 feet!)
- Long, bent, clear arc tube
- NEVER frosted bulb
- ANSI color---Orange

Using Spectrum to Identify Lamp Type

- Each lamp type produces it's own distinct spectral distribution.
- This can be thought of as a 'fingerprint'
- Rainbow of light will provide a good reference for lights that may be difficult to determine.
- Most lamps will be easy to identify by shape, color.
- This only works during the night!

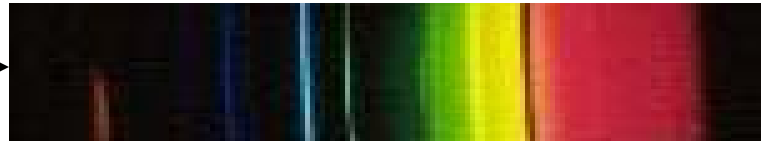




Using Spectrum to Identify Lamp Type (Cont.)

- Low Pressure Sodium (LPS)
  ---VERY yellow/orange

- High Pressure Sodium (HPS)
  ---SOMEWHAT yellow/orange



- Mercury Vapor (MV)
  ---SOMEWHAT green

- Metal Halide (MH)
  ---SOMEWHAT blue/white

- Fluorescent (FL)
  ---WHITE

- Incandescent (IN)
  ---WHITE, sometimes warm WHITE

Fixtures: Area Lighting

- ‘Shoebox’
- ‘Hockeypuck’
- ‘Cobrahead’
- ‘Barnyard’ light






Fixtures: Landscape/Walkway

- Bollard
- Steplight

- Accent

Fixtures: Flood Lighting

- Floodlight
- Quartz ‘worklight’

Fixtures: Building Mounted

- ‘Wallpack’
- ‘Globe’ or ‘Jelly Jar’
- Downlight
- Wall Sconce

Controls

- Time Clock
  - Interview
    - **Where?**
    - **controls what?**
- Photocells
  - How to Identify?
    - **Visual**
    - **Interview**
- Motion Detection
  - built in photocell
    - **motion on/off**

Break

- Take a 15-minute break

Daily Survey Procedure Overview

Daytime Sequence

- Morning Preparation
- Travel to site
- Site Contact Interview
- Site Survey
- Site photos
- Travel to next site
- More Sites…
- Review surveys for completeness
- Prepare for night

Nighttime Sequence

1. Return to site
2. Nighttime Subjective Survey
3. Light level readings
4. Glare Ratio readings
5. Light Trespass readings
6. Site photos if possible
7. Final site survey check
8. More Sites…
9. Check for all equipment accounted

Daily Morning Preparation

- Fill out the site survey sheet headers for all the day's surveys.
- Review maps to be clear where sites are located.
- Check batteries, pens, weather forecast, etc.
- Check vehicle to ensure the necessary survey equipment is available.

Daytime Equipment

- Measuring wheel
- Digital Camera
- Safety Vests
- Notebook/clipboard
- Two-way radios
- Reference Material
- Contact List for sites
- Hat/rain gear

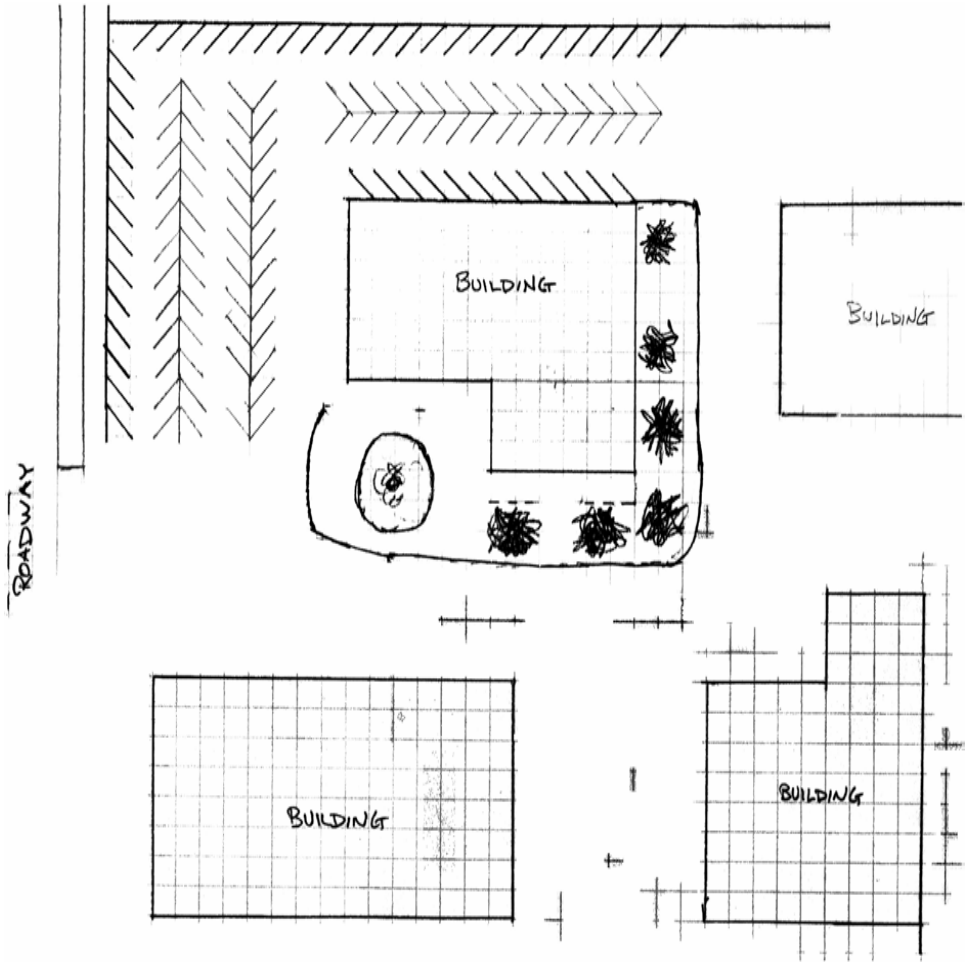
The Daytime Survey

- Survey Instrument
  - Defining the Site
  - Interviewing the site contact
  - Gathering daytime data
    - **Luminaires**
    - **Signs**

Identifying the Survey Area

- We are after the building address
  - The outdoor area (or part of) serving the address you have been been dispatched to
- Some sites will be difficult!
  - Campuses
  - Multi-building addresses

Determining Site and Survey Area



- Walk the site to become familiar with boundaries and equipment, establish FUA
- Property line located at street, middle of alleys
- Include sidewalks!
- Make judgment on questionable site boundaries
  - Look for changes in landscaping, paving, maintenance, etc.
  - Center between buildings if small spacing between

The Interview

- Q1. What is the overall building floor area?
  - Total square footage of building(s) at site address
- Q2. What is the overall site area?
  - Square footage best, could be acreage,
  - make note if different from square footage
- Q3. How many floors
- Q4. Building type
- Q5. How many businesses/tenants occupy this building?
  - At that specific address/building

The Interview (Cont.)

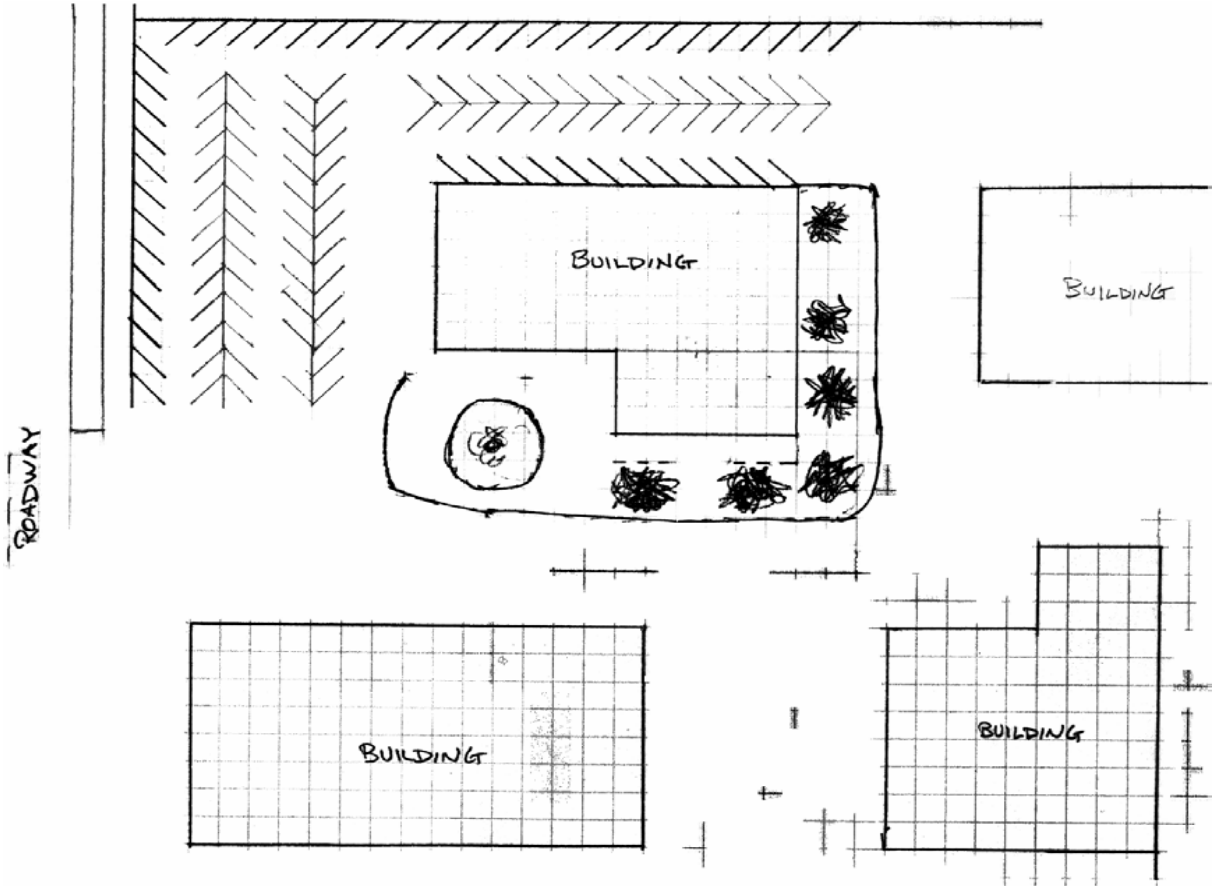
- Q6. Tenants have own electric meter?
- Q7. Are you familiar with the lamp wattage and types used at this facility?
  - Establishes knowledge (or lack of)
  - Good (not best) way to obtain hard to get wattage data
  - If not familiar, may be able to tell you who is
  - Try to get access to lamp storage closet. Probably only have one if they do their own maintenance.

The Interview (Cont.)

- Defining Usage of Outdoor Lighting
  - Q8, Q11, Q14, Q17, Q20. - Functional Use Area
    - **See footer of survey**
      - 1. Parking
      - 2. Pedestrian & Walkway
      - 3. Landscape
      - 4. Retail
      - 5. Internal Roadway
      - 6. Storage
      - 7. ATM
      - 8. Recreation
      - 9. No Use
      - 10. Façade & Aesthetic
    - **Use these predominantly!**
    - **Add other types only if very different**
    - **As many per site as needed, survey includes 5, add if needed.**

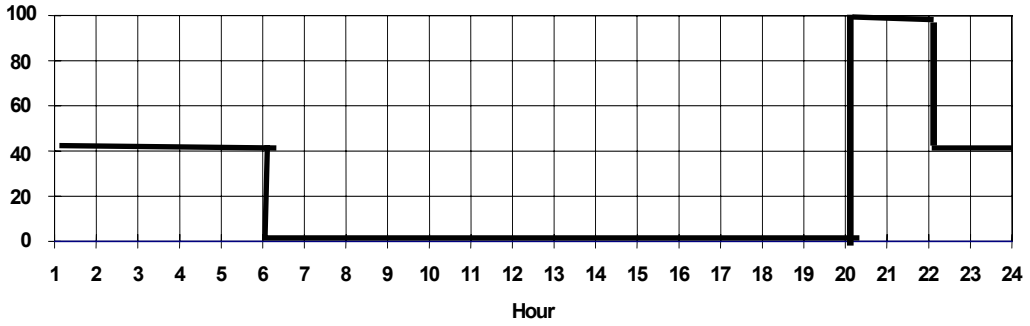
Functional Use Area

- Parking
- Landscape
- Building
- Walkway



The Interview (Cont.)

- Q9, Q12, Q15, Q18, Q21. - Lighting Controls
  - **Control Scheme**
    - Time clock, photocell or both
- Q10, Q13, Q16, Q19, Q22. - Scheduling
  - **Critical info to establish time of use**
  - **24-hour day type matrix**
  - **For each area under different control**
  - **Otherwise same as FUA 1**
  - **Hour ending**
  - **Example**
    - 9PM-6AM
    - Vary % ON



Daytime Site Survey

- Weather Conditions
- Site Conditions
- Functional Use Area SF calculation
- Luminaire Schedule
- Signage Schedule
- Site Sketch

Luminaire Schedule Data

Luminaire Information

FUA	Symbol	Notes	Type	Qty	Lamp Type	Lamp Wattage	Luminaire Height	Lens Cond.	Suitability
								G / F / P	G / F / P
								G / F / P	G / F / P

- Assign each luminaire type a *Symbol*
- Jot a *Note* to yourself about what the fixture is, or where it is located
- Select a *Type* from the Luminaire Catalogue
- Determine *Lamp Type* and *Lamp Wattage*
- Determine the *Luminaire Height*
- Make judgment about *Lens Condition* and *Suitability* for application
- Determine *FUA* for luminaires
- Determine *Quantity* of luminaires once site is complete

Notes About Luminaire Schedule

FUA	Symbol	Notes	Type	Qty	Lamp Type	Lamp Wattage	Luminaire Height	Lens Cond.	Suitability
1	0--0	Pkg Lot	A	12	MH	250	25’	(G) / F / P	(G) / F / P
2	0--0	Sidewalks	A	4	MH	250	25’	(G) / F / P	(G) / F / P

- The same luminaire may be in different FUA. If this is the case, the luminaire must be recorded twice on the Luminaire Schedule, so that it may be recorded in each FUA.
- The same luminaire *Type* classification may occur for several different luminaires on a site. Count them as separate line items, because they may have different lamping, etc.
- If the lamp is obscured, then the lamp information may be difficult to obtain. The info may have to be left blank until the night visit to determine *Lamp Type*, etc.

Signage Schedule

Signage Information

Symbol	Type	# of Faces	Qty	Lamp Type	Lamp Wattage / Linear Feet	Size	Notes	Suitability
								G / F / P
								G / F / P

Signage Classification List			
1. Cabinet	2. Front Lighted	3. Multi-bulb Flasher	4. Direct View Neon
5. Concealed Neon	6. LED	7. Gas Pump	8.
9.	10.	11.	12.

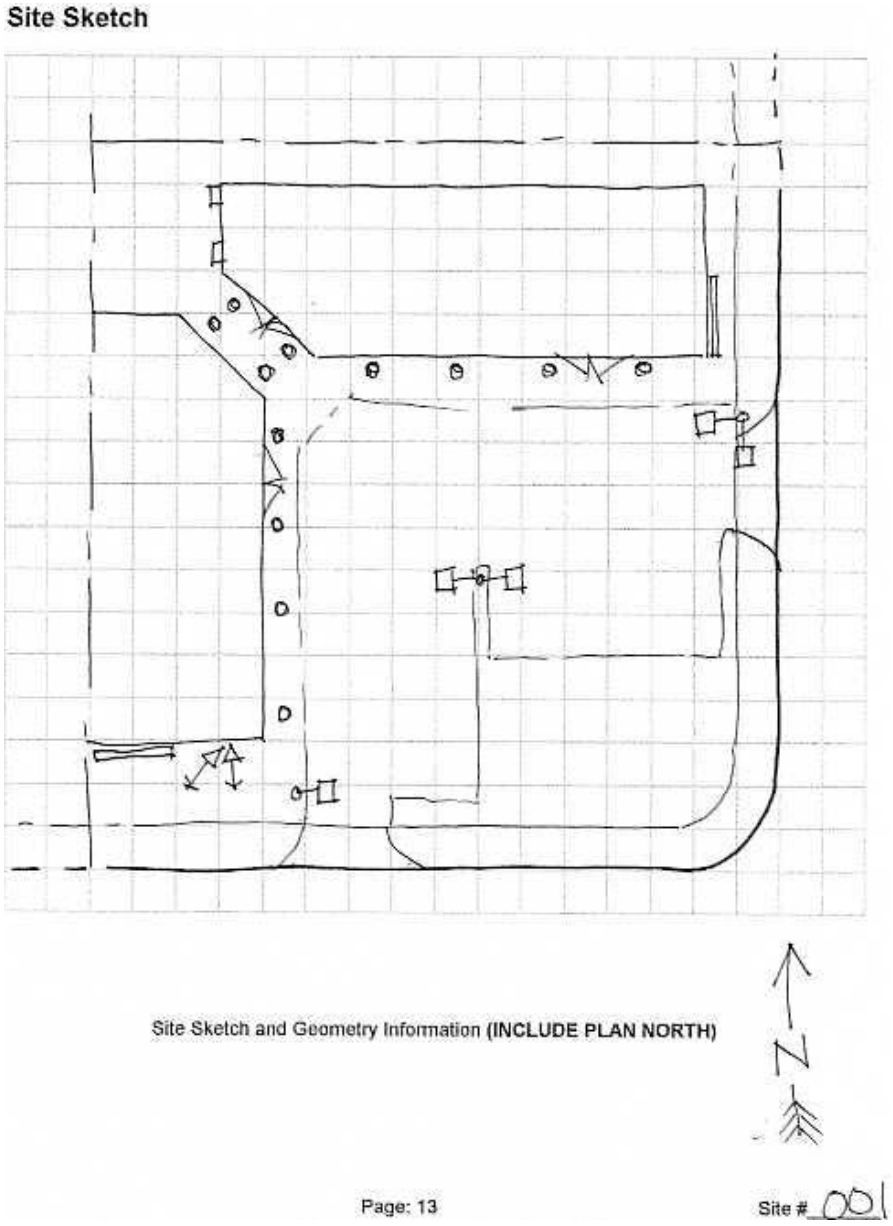
- Assign each group of signs a *Type* from the Signage Classification List
- Determine *# of Faces* for sign group
- Determine *Lamp Type* if possible
- Determine *Lamp Wattage* or *Linear Feet* for Neon
- Measure (if possible) or estimate *Size*
- Add *Notes* about sign
- Determine the *Suitability* of sign for application

Notes About Signage Schedule

- Group signs based on all the categories. If there are many of a similar sign style, but the sizes are different, then create a new line.
- For neon tubing that defines building architecture, estimate the *Linear Feet* of neon tube. For bent neon signs that make letters, etc. estimate the *Size* of the overall sign.
- Front lighted signs should be considered Signage, even if the luminaire used is the same as another luminaire on the site. The important aspect is the use of the energy, and the energy should be counted as signage energy, even though the luminaire may be just like one used in the landscaping or for façade lighting.

Site Sketch

- Use Consistent labels
- Use plan to count #'s of fixture types for luminaire schedule
- INCLUDE NORTH ARROW!
- Make reasonable effort to produce an accurate, proportional drawing



Daytime Survey Wrap-up

- Check that data is entered in all locations
- Formulate a plan for nighttime lighting measurements
- Take photo of survey coversheet
- Take general site photos
- Take photos of all luminaires
- Take photos of sign types
- Verify that all equipment is back in vehicle for transport to next site

Daytime Training Practice

- After lunch
  - Daytime data collection
- Teams of two
  - Who will you most likely be working with?
- You will need:
  - Clipboard
  - pencil
  - Coat (rain?)
  - Survey Binder

Lunch Break

- 1 Hour Lunch
- Meet back at RLW Parking Lot
- Lunch Spots
  - Burgers
  - Sandwiches
  - Chinese
- Don’t be late!!

Nighttime Data Collection Overview

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Nighttime Sequence

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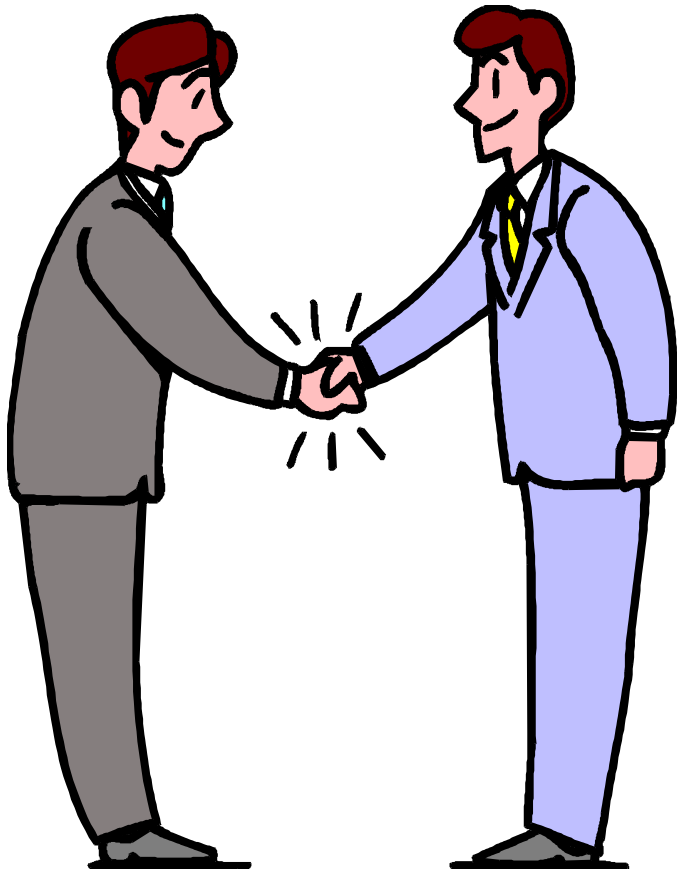
Night Equipment

- Illuminance Meter
  - Monopod
  - Head Attachments
- Spectroscope
- Flicker Checker
- Subjective Survey Sheets
- Survey Sheets

Returning to the Site

- Reintroduce yourselves
  - Have handy
    - **Day contact name handy**
    - **Letter from CEC/RLW**
      - see training material
  - Provide estimate of time on-site (about 30min.)
  - Describe reason for survey only if necessary, time is of the essence!!



Nighttime Subjective Survey

- Each surveyor must fill one out for each site!
- Fill out before beginning any other night work
- Quick, first impression answers
- #12 - Compare to mental picture of similar places from you have been in past.

Nighttime Subjective Lighting Evaluation

Site ID #	

Surveyor _____

OR

On-site user ❑

All of the statements below (except question 1) refer to the lighting of the area around you, at night.

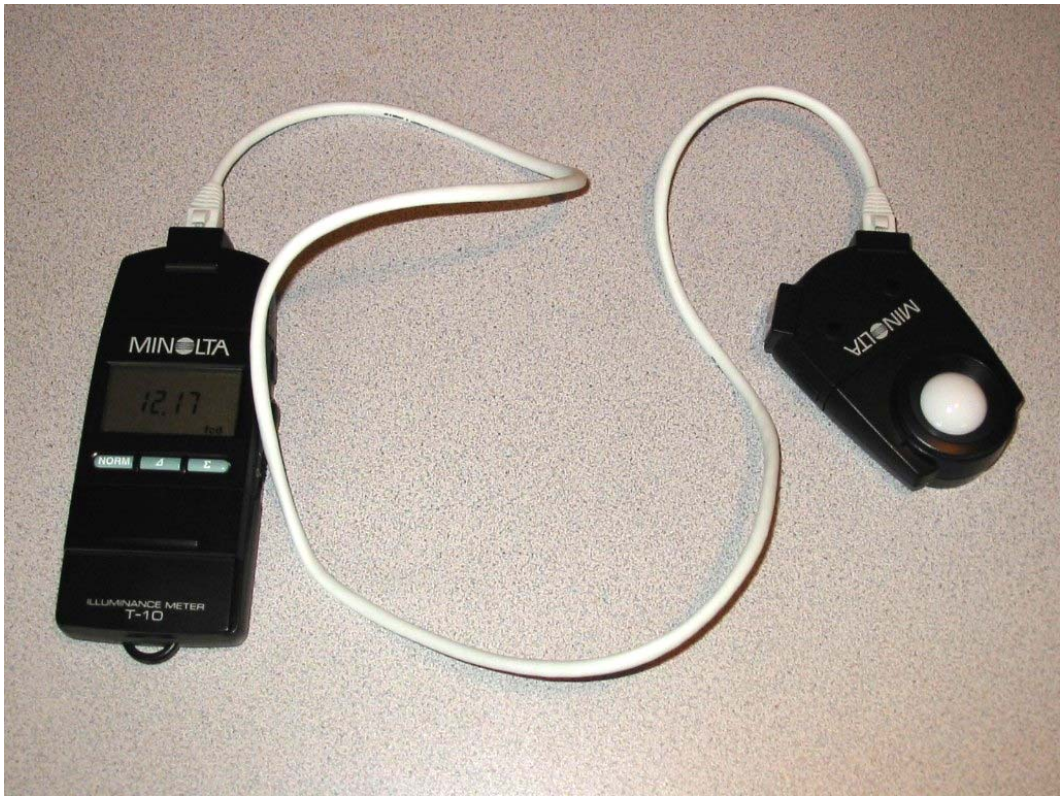
1.	It would be safe to walk here, alone, **during the day**.	Yes	No
2.	It would be safe to walk here, alone, at night.	Yes	No
3.	The lighting is comfortable.	Yes	No
4.	This is a good example of security lighting.	Yes	No
5.	The lighting is too bright.	Yes	No
6.	The lighting is too dark.	Yes	No
7.	The lighting is uneven (patchy).	Yes	No
8.	The lighting is glaring.	Yes	No
9.	The lighting is too limited in area.	Yes	No
10.	The lighting is poorly matched to the site.	Yes	No
11.	I cannot tell the colors of things.	Yes	No

12. How does the lighting here compare with the lighting of similar areas at night?

Worse About the same Better

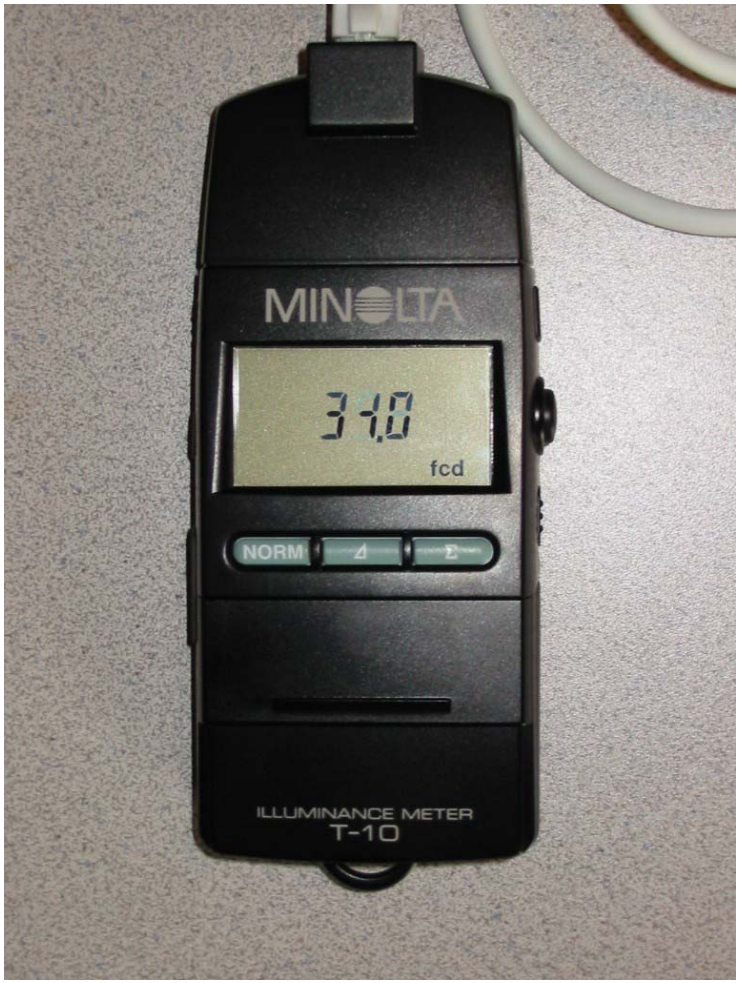
Light Level Measurements

- Parking lot grid
- Pedestrian corridor grid
- Security lighting grid (normally just like parking lot grid)
- Use chalk to mark points on pavement, other marker for landscape areas (tennis balls?)



Using the Light Meter

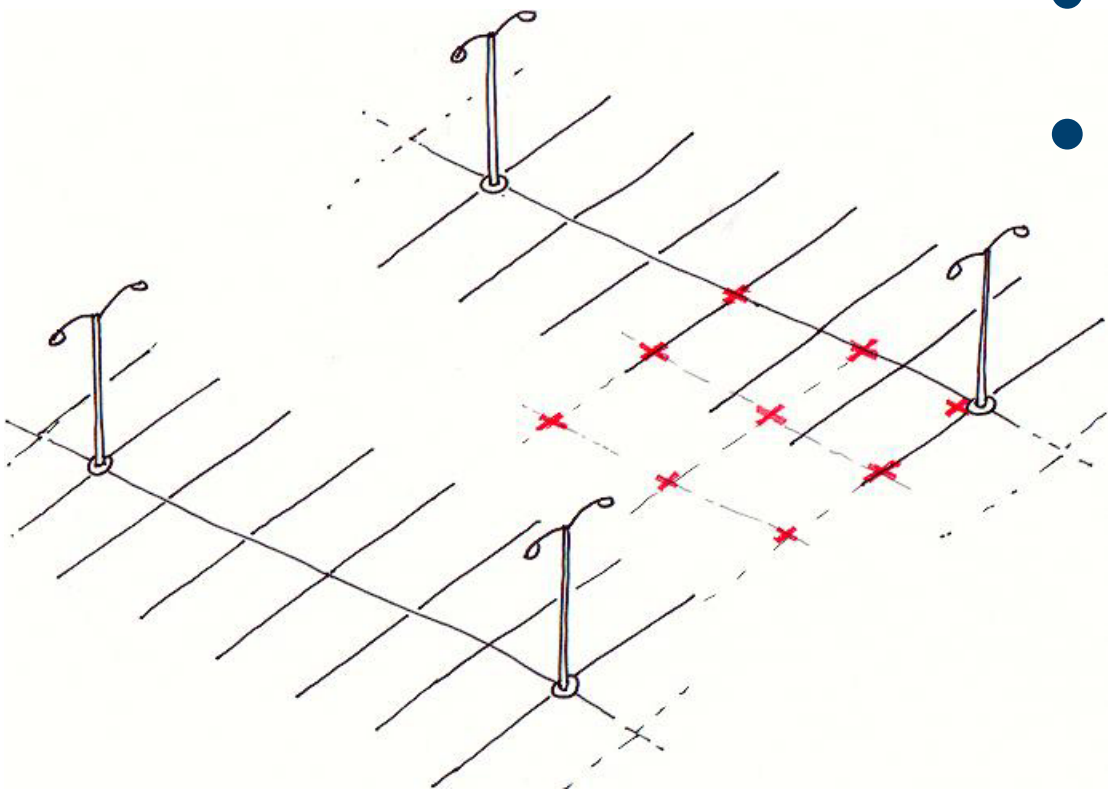
- Keep the cap on the receptor when turning the meter ‘on’ until the ‘cal’ changes to ‘0.000’.
- The meter must show ‘fc’ in the bottom right of the display at all times.
- Keep receptor head detached using the data cable for all measurements.
- Readings should be made in ‘slow’ response mode (on left side of unit).
- Button on right can be pushed to hold reading. Be careful to ensure it is not accidentally locked.



Meter reading methods

- Two different light level readings for the sites:
  - Horizontal, where the meter head is placed ON THE GROUND.
  - VERTICAL, where the meter is placed on a monopod, with the receptor located 5'-0" ABOVE GRADE.

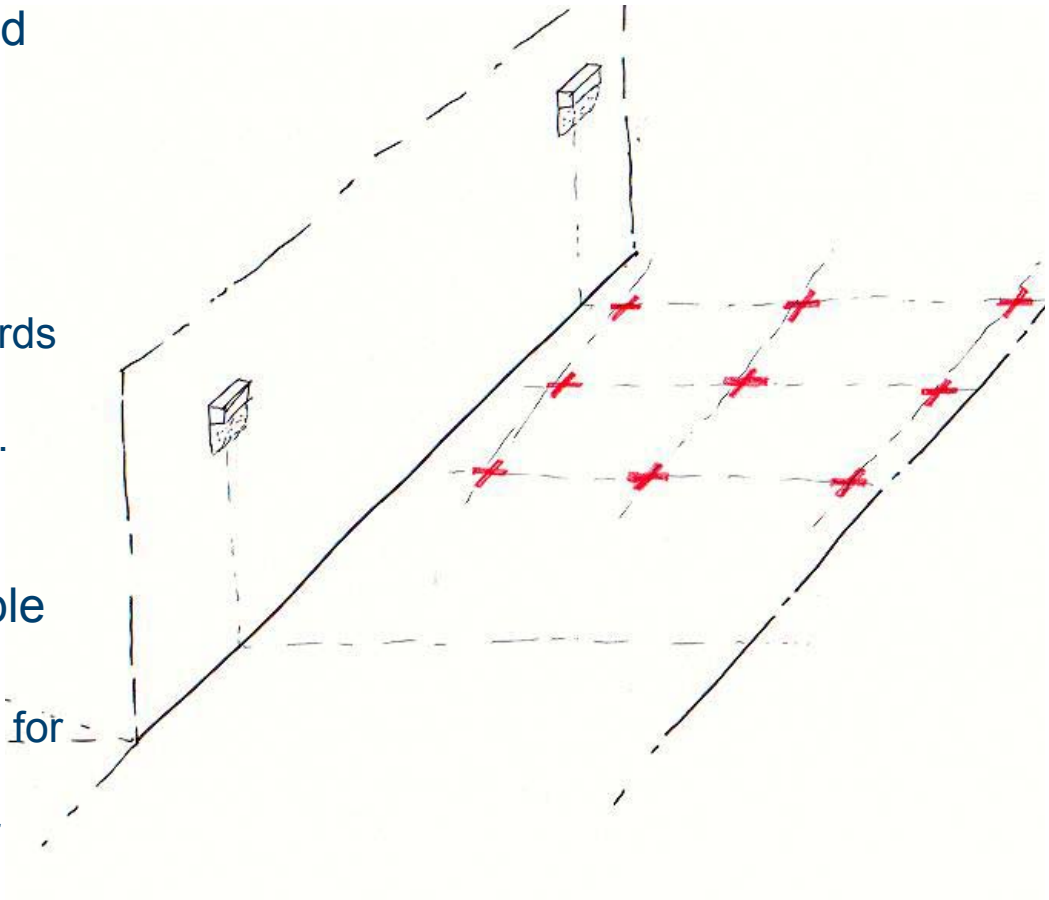
Parking Lot Lighting Grid Layout

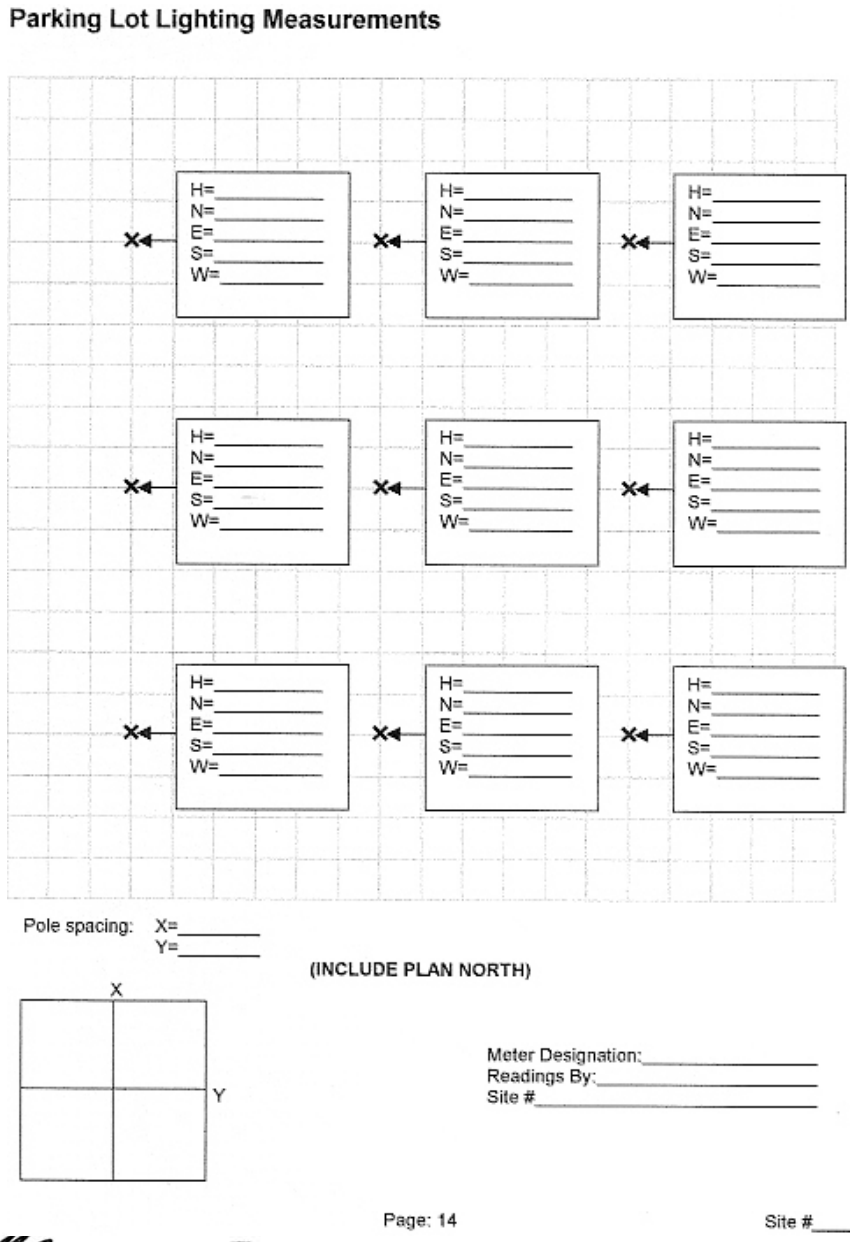


- 9 data collection points for grid
- Grid needs to cover ¼ of the parking lot area.
  - Measure between poles and divide by 4.
  - Measure from pole base the calculated dimension and make a mark. Continue one more time in same direction.
  - Repeat procedure in other direction towards other pole.

Security Lighting Grid Layout

- 9 data collection points for grid
- Grid needs to cover ½ of the light spacing.
  - Measure between lights and divide by 4.
  - Measure from first light towards the second the calculated dimension and make a mark. Continue one more time in same direction.
- Grid needs to cover reasonable area away from lighting
  - Go at least the spacing used for other direction
  - Go to edge of property line if reasonable



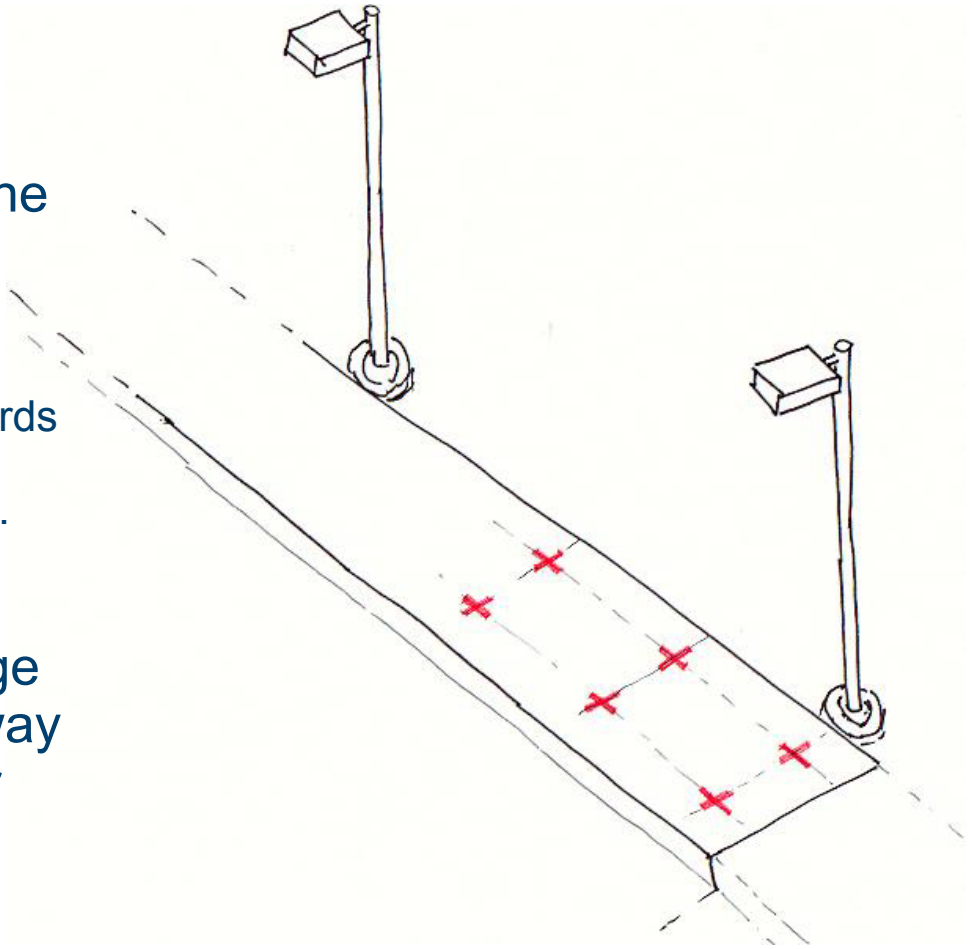


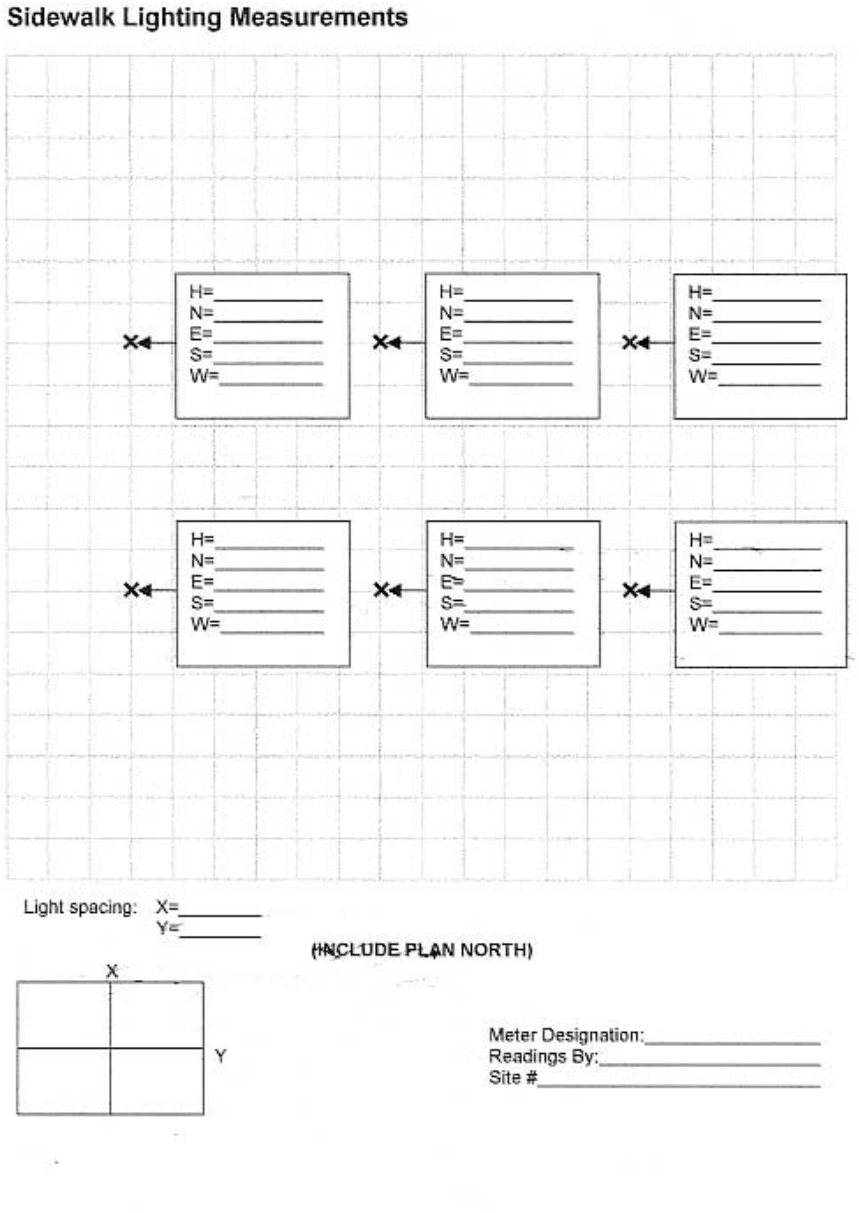
Parking Lot or Security Grid Data Entry

- Five readings at each location
  - 1 horizontal
  - 4 vertical, related to compass headings
- Show Plan North. Relate Plan North to Site Plan North if possible.
- Show spacing, luminaire locations, luminaire types, buildings, trees, etc. on plan

Sidewalk Lighting Grid Layout

- 6 data collection points
- Grid needs to cover ½ of the light spacing
  - Measure between lights and divide by 4.
  - Measure from first light towards the second the calculated dimension and make a mark. Continue one more time in same direction.
- Grid points are ¼ from edge of sidewalk and ¾ of the way across (or 1’ from edge for narrow walks)





Sidewalk Grid Data Entry

- Five readings at each location
  - 1 horizontal
  - 4 vertical, related to compass headings
- Show Plan North. Relate Plan North to Site Plan North if possible.
- Show spacing, luminaire locations, luminaire types, buildings, trees, etc. on plan

Glare Ratio Input

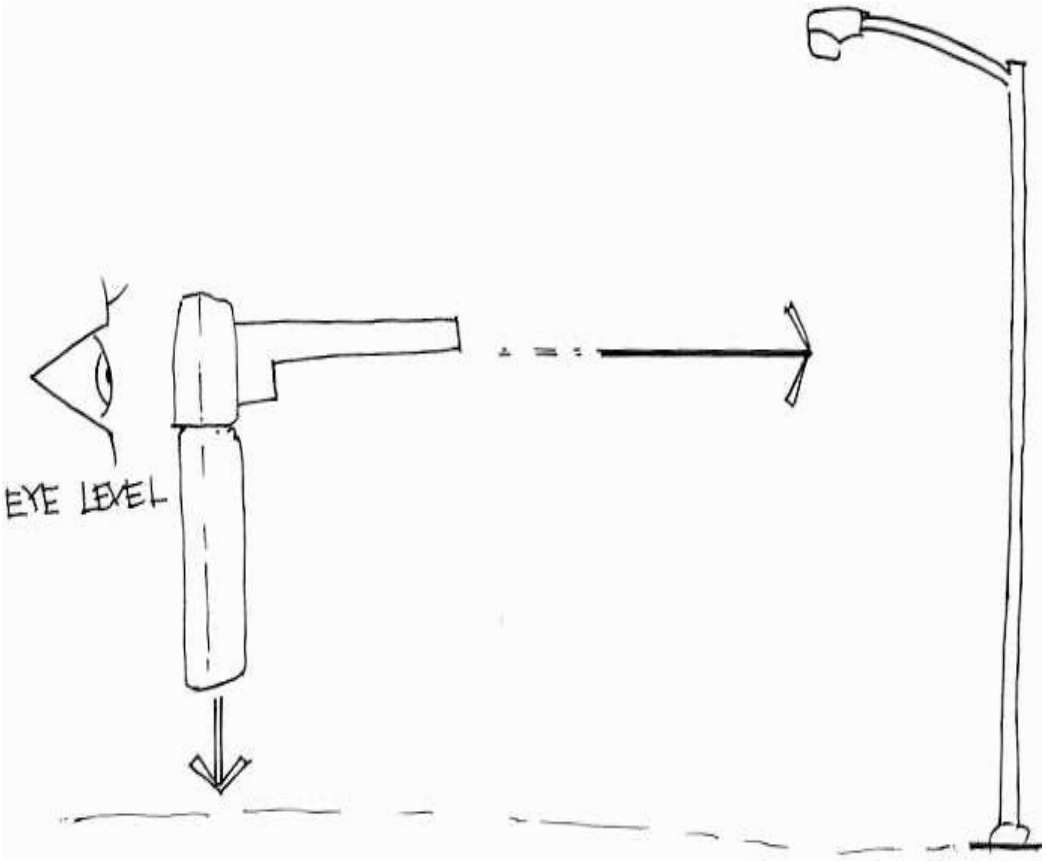
Glare Ratio:

	Reading UP	Reading DOWN	Subjective Impression (1 is best, 5 is worst)	Measurement taken from	Offending Fixture
1			1 • 2 • 3 • 4 • 5		
2			1 • 2 • 3 • 4 • 5		
3			1 • 2 • 3 • 4 • 5		

Glare Ratio Measurement Location List			
1. Parking area	2. Building entry	3. Property edge	4. Site entry / exit
5. Pedestrian conflict	6.	7	8.
9.	10.	11.	12.

Glare Ratio Procedure

- Move around site until you find a spot with the 'worst' perceived glare
- Set the meter at eye level, with the long 'glare hood' on the receptor, hood up.
- Aim meter toward worst glare direction, BUT KEEP METER AND 'GLARE HOOD' HORIZONTAL
- Take reading and enter in the 'Reading DOWN' box
- Rotate 'glare hood' down and take another reading without moving meter
- Enter in 'Reading UP' box
- Fill in rest of info



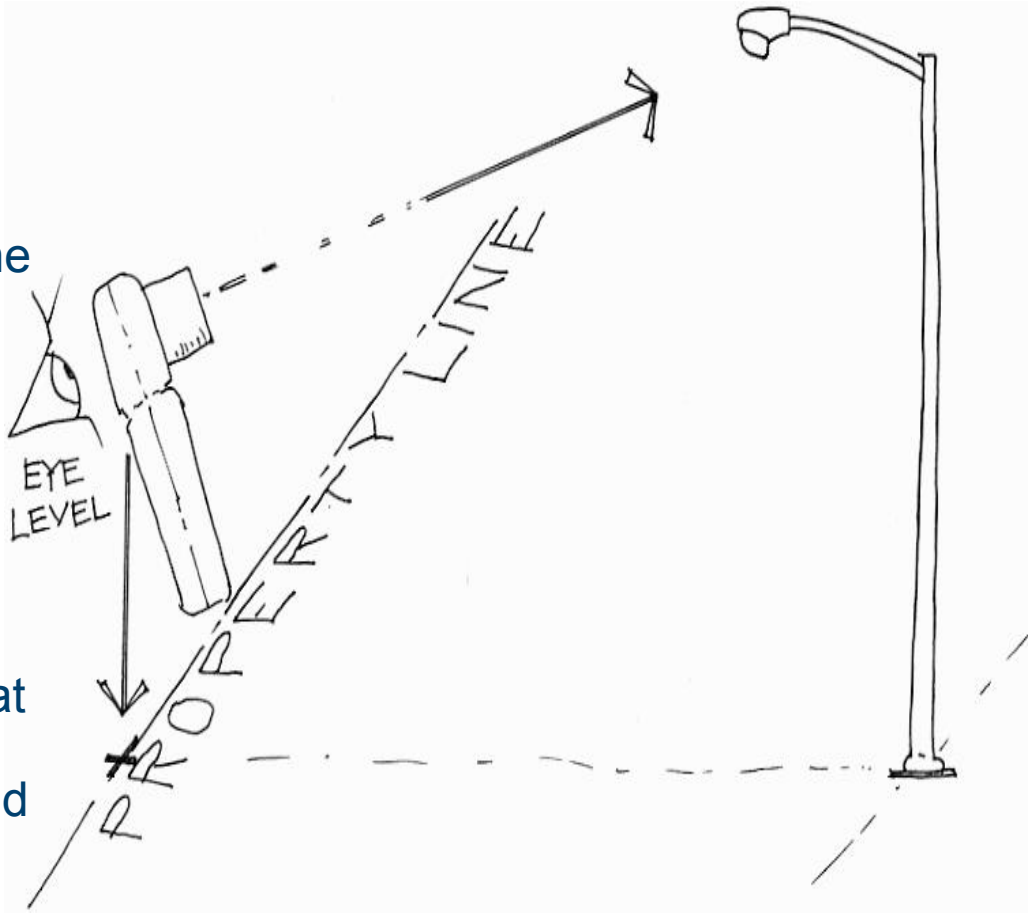
Light Trespass Input

Light Trespass:

	Reading	Subjective Impression (1 is best, 5 is worst)	Offending Fixture/s
1		1 • 2 • 3 • 4 • 5	
2		1 • 2 • 3 • 4 • 5	
3		1 • 2 • 3 • 4 • 5	

Light Trespass Procedure

- Move around site property lines until you fine the ‘worst’ spot for light leaving the property
- Set meter at eye level, with the short ‘blinder’ hood on the receptor
- Aim the meter DIRECTLY towards the lights that are causing the trespass. Meter may be tilted.
- Begin taking readings and record the highest reading that is read at that point, while moving the meter head around a bit
- Fill in rest of info



Dinner

- Dinner Break
- Meet at RLW Parking Lot, at 6:00 PM
- Nearby Locations:
  - Pizza
  - Thai
  - Burgers
  - Chinese

Day Two Training

- Day 1 review and questions
- Recruiting and Fielding Protocols
  - Transmittal of Scheduled sites
  - Review of Site Survey Form
- Large Site Methodology
  - Sampling
- Large Site Practice

Day 1 Questions and Review

- Questions/Comments

Communication Protocols

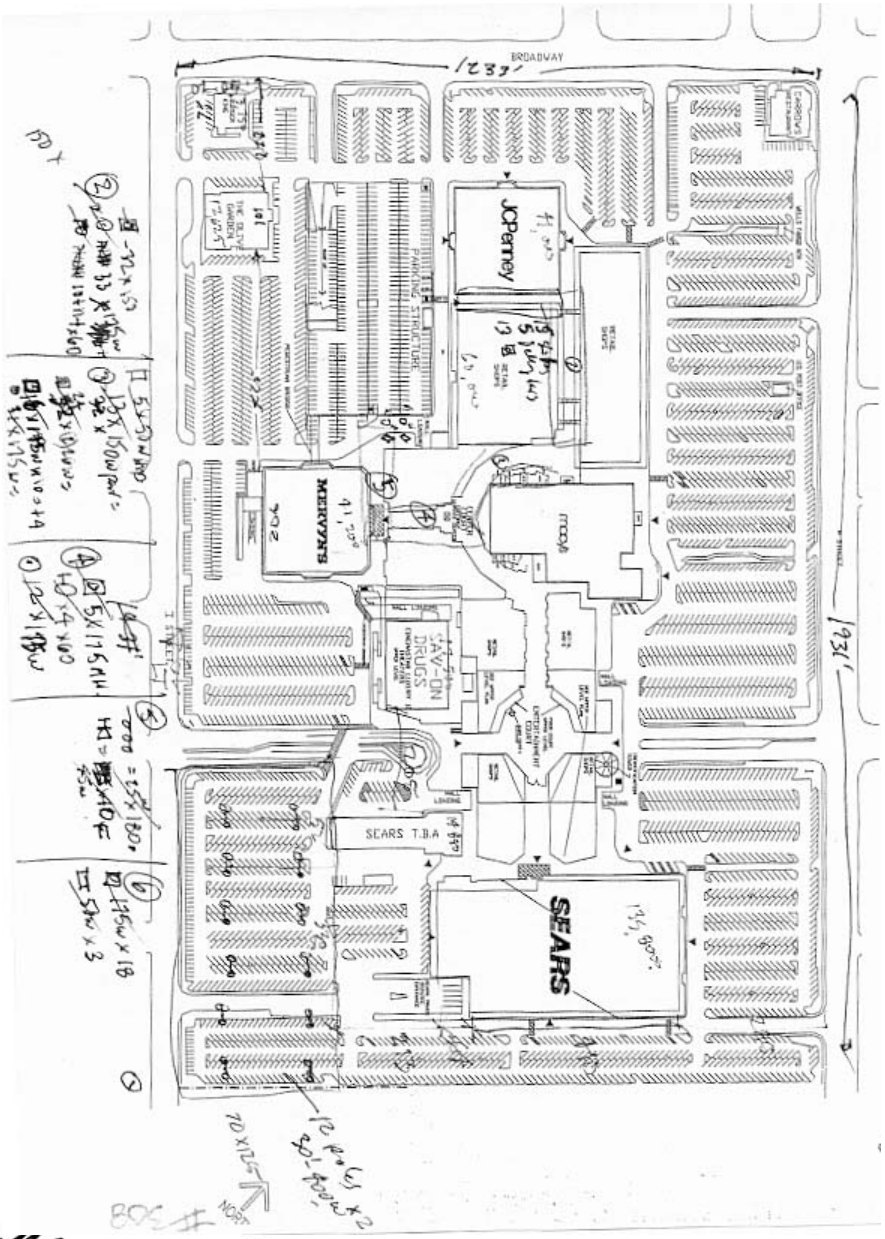
- Recruiter and Surveyors must communicate!
  - See sample on-site appointment sheet
    - **review and comment**
  - Contact information
    - **phone numbers**
    - **email addresses**
    - **fax machines**

Large Site Methodology

- Sampling areas for large sites
- Completing the Survey
- Reading Building Plans

Sampling Large Sites

- Sampling is used when it is not possible to survey entire site
  - Malls, campuses, large factories, industrial parks
- The sampling must be a representative selection of the facility
- Sampling allows a statistical extrapolation of survey data for accurate estimate of entire site energy use.
- Try to get site plans to assist!!!!!



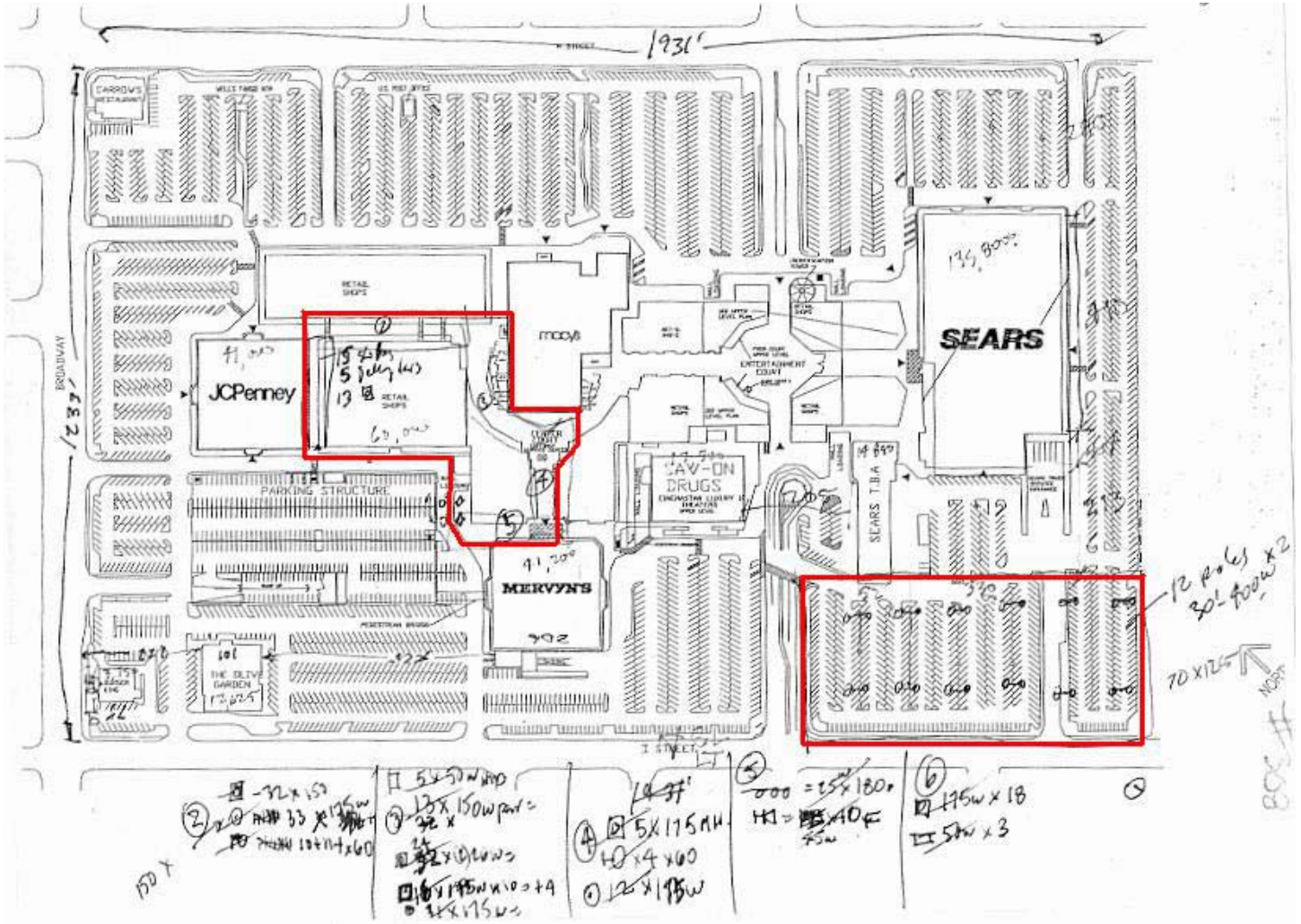
How to sample a large site

- Become familiar with site first. Drive (or better; walk) the site and get a feeling for the lighting equipment that is on the site.
- Look for a repeating pattern to the buildings, light fixtures to help establish a sampling unit
- Make a decision about a sampling area --- should be about 25% of site if possible.

Large Site Sampling - Example

- Large regional mall in Chula Vista area
- Approximate site size – 55 acres (2,380,000 square feet)
- Approximate site dimensions – 1250'x1950'
- Number of anchor stores – 4
- Total number of retailers at this site – 100+
- Very complicated site – lots of different lighting equipment, signage types, and building types happing
- Renovation in 1994 results in additional lighting equipment and site complexity
- Multiple floors in some areas make sampling more difficult

Large Site Sampling - Example



Large Site Sampling - Example

Site # 309

Luminaire Information

FUA	Symbol	Type	Qty	Lamp Type	Lamp Wattage	Luminaire Height	Photo #	Condition	Suitability
1	O	CC	33+31+12 31+12	MH	175w	16'	1	G/F/P	G/F/P
1	O	G	24	MH	400w	30'	—	G/F/P	G/F/P
2	O	O	5+3	HPS	50w		9	G/F/P	G/F/P
2	O	T	2+4	INC	60w	30'	7	G/F/P	G/F/P
2	O	X	20+15 18	MH	175w	25'	2	G/F/P	G/F/P
2	O	EE	180	INC	25w	25'	6	G/F/P	G/F/P
2	O	U	40	FLN	PAR 45w	20'	8	G/F/P	G/F/P
1	O	XX					3	G/F/P	G/F/P
2	O	W	24	CFL	(2) 26w	10'	4	G/F/P	G/F/P
2	O	K	13	INC	PAR 150 ?	15'	5	G/F/P	G/F/P

Page: 9

Site # 308

Signage Information

Symbol	Type	# of Faces	Qty	Lamp Type	Lamp Wattage / Linear Feet	Size	Photo #	Suitability
	5	1	1	6 Neon	20LF x 3FT.		10,11	G/F/P
	4	1	11	Neon	1.5x 2' 22 LF		12,	G/F/P
	5	1	1111		30 LF.		13	G/F/P
	5	1	11		20 LF.		14	G/F/P
	4	1	1111		50 LF		15	G/F/P
	1	1	111	PL	8x2 FT.		16	G/F/P
								G/F/P
								G/F/P
								G/F/P
								G/F/P
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								G/F/P
								G/F/P
								G/F/P

Signage Classification List

1. Cabinet	2. Front Lighted	3. Multi-bulb Flasher	4. Direct View Neon
5. Concealed Neon	6. LED	7. Gas Pump	8.
9.	10.	11.	12.

Page: 10

Large Site Methods Cont.

- Survey Instrument, Page 8
  - Functional Use Table
  - % of total area is critical when sampling

Functional Use Information

Functional Use Area	Square Feet	% of Total Area	Grid Yes / No
From Q8.			
From Q11.			
From Q14.			
From Q17.			
From Q20.			

TOTAL *SITE* SQUARE FEET		**100%**
BUILDING FOOTPRINT		

TOTAL SQUARE FEET	

Contact Information

- RLW Analytics
  - 1-800-472-6716
  - Technical Questions
    - **Matt Brost x13**
    - **Eric Swan x17**
    - **Sam Pierce**
    - **Jeff Staller x14**
  - Recruiting Questions
    - **Pam Phimister x21**
    - **Amber Watkins x10**
  - RLW Cell Phones
    - **707-529-0150**
    - **707-529-0160**

- E-mail Addresses
  - Matt Brost
    - **mattb@rlw.com**
  - Eric Swan
    - **eswan@rlw.com**
  - Pam Phimister
    - **pam@rlw.com**
  - Amber Watkins
    - **amber@rlw.com**

Statewide Assessment:
On-Site Survey Instrument

Integrated Energy Systems Productivity & Building Science Program

A project of the State of California PIER Program

Element: Element 7 - Outdoor Lighting Baseline Assessment
Deliverable: 7.6.2 Final
Deliverable Date: 12-05-01

PIER
Public Interest Energy Research
CALIFORNIA ENERGY COMMISSION

New Buildings Institute, Inc.

Outdoor Lighting On-site Survey Instrument

General Information

Site ID #	

Surveyor Name: Building Name:

Date: Primary Contact: Phone:

Building Address:

City Zip

Daytime	Start Time:	Finish Time:	Travel Time:
Nighttime	Start Time:	Finish Time:	Travel Time:

Interview Questions

The following interview questions will be used to help us identify unobservable aspects of your building. These aspects include exterior lighting schedules and unobservable equipment types, such as lamps. Answers to these questions will be coupled with data collected from our walk-through survey to produce a complete assessment of the exterior lighting at your building.

Building Overview

Q1. What is the overall building floor area? _____ SF

Q1A What is the building footprint? _____SF

Q2. What is the overall site area? _____SF

Q3. How many floors? _____

Q4. Circle the appropriate building type description:

1	Small office	11	Hotel
2	Large office	12	Small school
3	Small retail	13	Large school
4	Multi-story large retail	14	Community college
5	Single story large retail	15	Large university
6	Grocery	16	Assembly
7	Quick service restaurant	17	Hospital
8	Full-service restaurant	18	Lt. Manufacturing
9	Conditioned warehouse	19	Bio/Tech Manufacturing
10	Uncond. warehouse	29	Apartments and Condominiums

Functional Use Area Selection List			
1. Parking	2. Pedestrian & Walkway	3. Landscape	4. Outdoor Retail Sales (car lot)
5. Internal Roadway	6. Storage	7. ATM	8. Recreation
9. No Use	10. Façade & Aesthetic	11. Security	12. Point of Sales (fast food)
13. Entry (if different*)	14. Gas Station Canopy	15.	(*if lit differently from walkways)

Building Areas

Q5. How many individual tenants (businesses) occupy this building? _____

Q6. Do the majority of tenants have their own electric meter? Y N

Ask the respondent of they have building plans available, this will provide site acreage, building area and possibly an outdoor lighting power plan with schedule of fixtures.

Exterior Lighting Lamp Types

Q7. Are you familiar with the lamp types and lamp wattage that are used at this facility? Y N

If yes, ask respondent to provide a description of lamp wattage and type for all surveyed fixtures (list below).

If no, ask respondent who would know (i.e., maintenance contractor, facility person) or ask if there is a location where spare lamps are stored.

Name:_____ Phone:_____

Ask to talk with person who would know (i.e., maintenance contractor, facility person) after the initial interview is completed.

Ask to be shown the lamp storage room after the initial interview is completed.

Functional Use Area Selection List			
1. Parking	2. Pedestrian & Walkway	3. Landscape	4. Outdoor Retail Sales (car lot)
5. Internal Roadway	6. Storage	7. ATM	8. Recreation
9. No Use	10. Façade & Aesthetic	11. Security	12. Point of Sales (fast food)
13. Entry (if different*)	14. Gas Station Canopy	15.	(*if lit differently from walkways)

Exterior Lighting Schedules and Controls

Q8. **Functional Use Area A :_____(** SEE FOOTER FOR AREA SELECTION LIST)

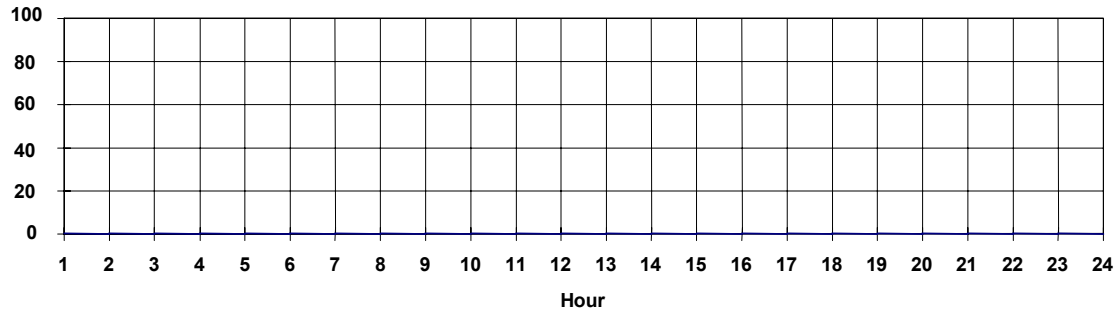
Q9. How are the exterior lights controlled?

❑ Manual ❑ Time Clock ❑ Photocell ❑ Both ❑ DK

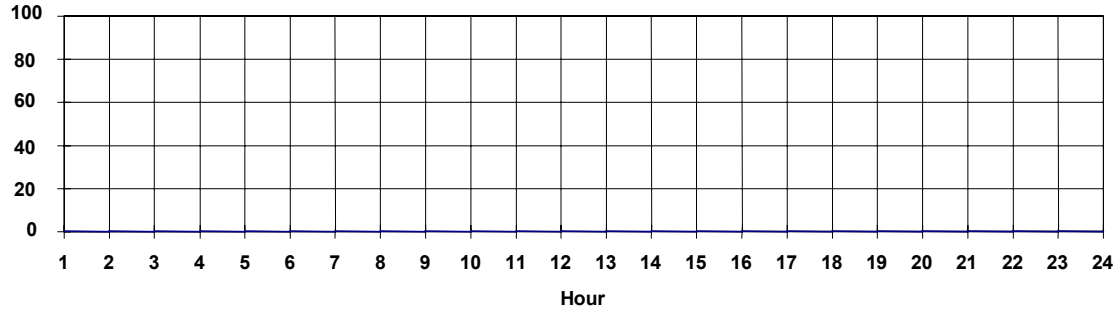
Q10. If the exterior lights are controlled manually or with a time clock, draw a line that describes the schedule.

If respondent doesn't know, ask if you can be given access to the time clock to ascertain time-of-use.

Weekdays (Summer = Blue/Winter = Red)



Weekends/Holidays *(Summer = Blue/Winter = Red)*



Q11. **Functional Use Area B:_____(** SEE FOOTER FOR AREA SELECTION LIST**)**

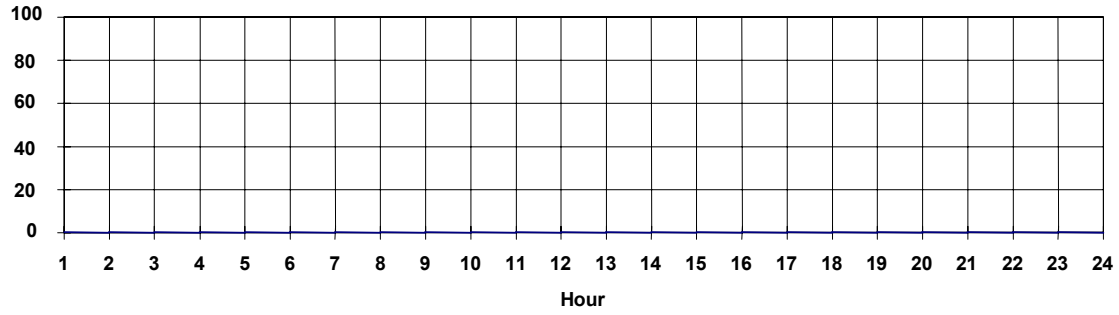
Q12. How are the exterior lights controlled?

❑ Manual ❑ Time Clock ❑ Photocell ❑ Both ❑ DK

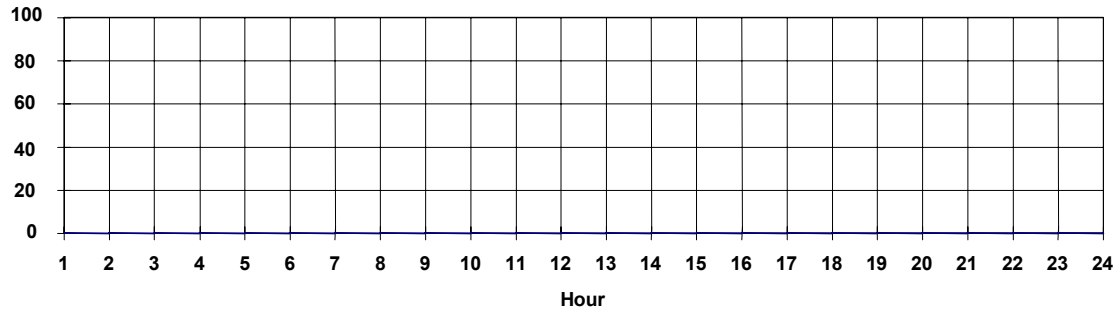
Q13. If the exterior lights are controlled manually or with a time clock, draw a line that describes the schedule.

Functional Use Area Selection List			
1. Parking	2. Pedestrian & Walkway	3. Landscape	4. Outdoor Retail Sales (car lot)
5. Internal Roadway	6. Storage	7. ATM	8. Recreation
9. No Use	10. Façade & Aesthetic	11. Security	12. Point of Sales (fast food)
13. Entry (if different*)	14. Gas Station Canopy	15.	(*if lit differently from walkways)

Weekdays (Summer = Blue/Winter = Red)



Weekends/Holidays *(Summer = Blue/Winter = Red)*



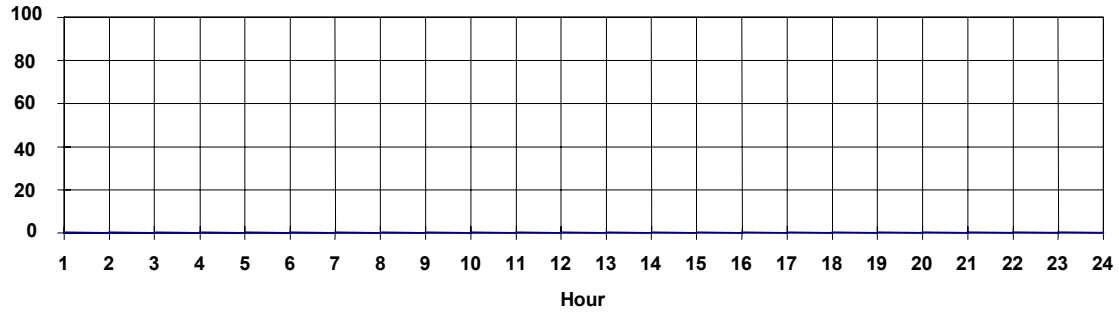
Q14. **Functional Use Area C:_____(** SEE FOOTER FOR AREA SELECTION LIST**)**

Q15. How are the exterior lights controlled?

❑ Manual ❑ Time Clock ❑ Photocell ❑ Both ❑ DK

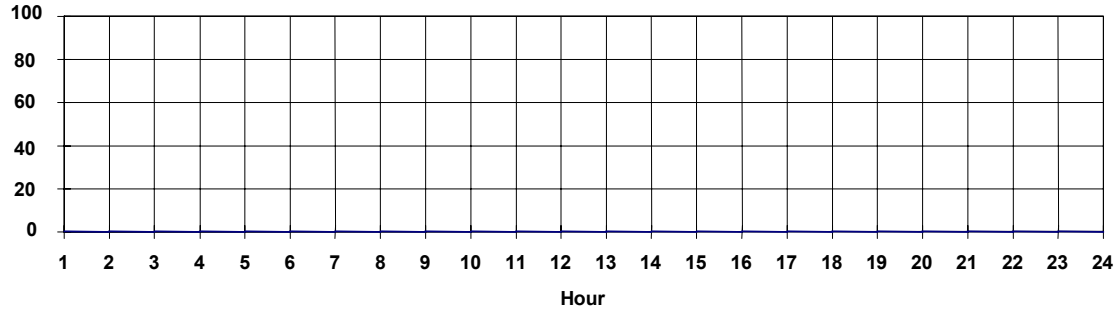
Q16. If the exterior lights are controlled manually or with a time clock, draw a line that describes the schedule.

Weekdays (Summer = Blue/Winter = Red)



Functional Use Area Selection List			
1. Parking	2. Pedestrian & Walkway	3. Landscape	4. Outdoor Retail Sales (car lot)
5. Internal Roadway	6. Storage	7. ATM	8. Recreation
9. No Use	10. Façade & Aesthetic	11. Security	12. Point of Sales (fast food)
13. Entry (if different*)	14. Gas Station Canopy	15.	(*if lit differently from walkways)

Weekends/Holidays (Summer = Blue/Winter = Red)



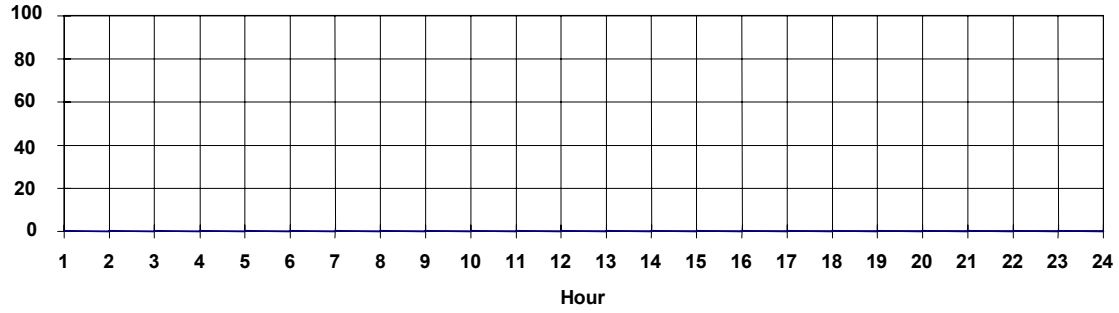
Q17. **Functional Use Area D:_____(** SEE FOOTER FOR AREA SELECTION LIST**)**

Q18. How are the exterior lights controlled?

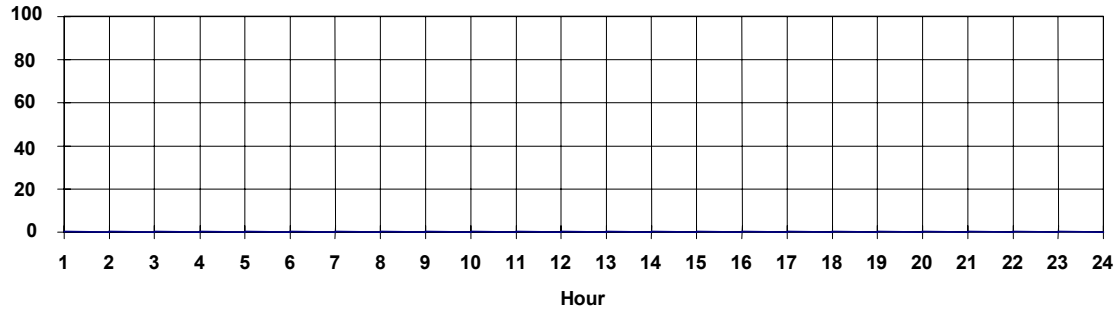
❑ Manual ❑ Time Clock ❑ Photocell ❑ Both ❑ DK

Q19. If the exterior lights are controlled manually or with a time clock, draw a line that describes the schedule.

Weekdays (Summer = Blue/Winter = Red)



Weekends/Holidays *(Summer = Blue/Winter = Red)*



Functional Use Area Selection List			
1. Parking	2. Pedestrian & Walkway	3. Landscape	4. Outdoor Retail Sales (car lot)
5. Internal Roadway	6. Storage	7. ATM	8. Recreation
9. No Use	10. Façade & Aesthetic	11. Security	12. Point of Sales (fast food)
13. Entry (if different*)	14. Gas Station Canopy	15.	(*if lit differently from walkways)

Site #_____

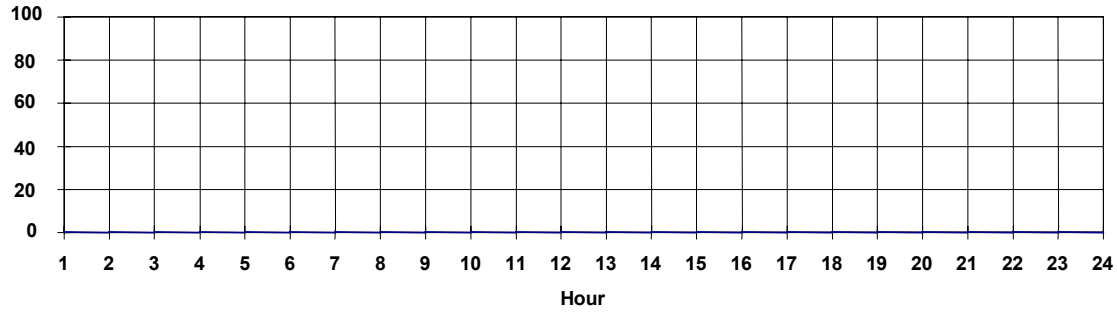
Q20. **Functional Use Area E:_____(SEE FOOTER FOR AREA SELECTION LIST)**

Q21. How are the exterior lights controlled?

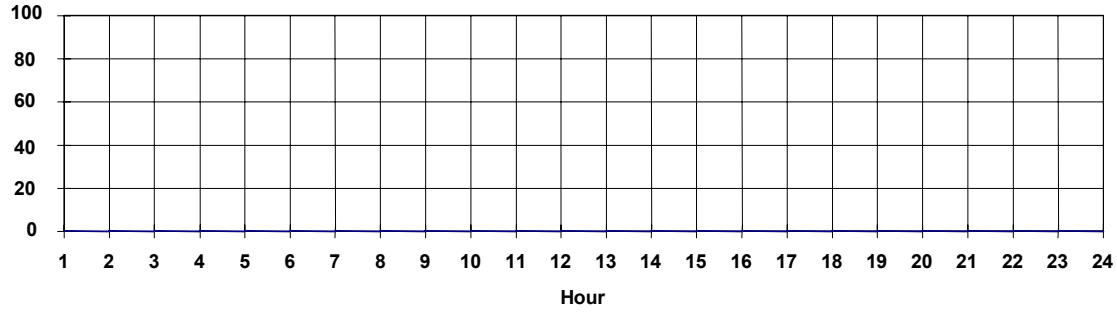
❑ Manual ❑ Time Clock ❑ Photocell ❑ Both ❑ DK

Q22. If the exterior lights are controlled manually or with a time clock, draw a line that describes the schedule.

Weekdays (Summer = Blue/Winter = Red)



Weekends/Holidays *(Summer = Blue/Winter = Red)*



Exterior Lighting Misc.

Q23. Are there any lights that are not turned on at night, except for special occasions (for example: loading dock lights)? Y N DK

If Yes, please provide information on the lights that are not used.

Q24. Are you familiar with Governor Gray Davis's recent legislation that restricts outdoor lighting use during non-business hours? Y N (***If no, skip next question)***

Q25. Have you changed the schedule of operation for any of your outdoor lights in response to the Governor's legislation? Y N DK (If "DK", find out who would know:_____)
If yes, indicate on the schedule matrices in green pen what the old schedule was.

Functional Use Area Selection List			
1. Parking	2. Pedestrian & Walkway	3. Landscape	4. Outdoor Retail Sales (car lot)
5. Internal Roadway	6. Storage	7. ATM	8. Recreation
9. No Use	10. Façade & Aesthetic	11. Security	12. Point of Sales (fast food)
13. Entry (if different*)	14. Gas Station Canopy	15.	(*if lit differently from walkways)

Daytime Site Data Collection

Q26. Daytime weather conditions:

- ❑ Clear
- ❑ raining
- ❑ icy
- ❑ snowing
- ❑ foggy
- ❑ overcast/cloudy

Q27. Site conditions:

- ❑ flat
- ❑ hilly
- ❑ sloped
- ❑ clear

Q28. Surrounding conditions:

	Residential	Commercial	Roadway	Open	Other/Description
North					
South					
East					
West					

Check as each task is completed:

- ❑ Layout / determine calculation grid for parking / security lighting
- ❑ Layout / determine calculation grid for pedestrian paths
- ❑ Determine most likely locations for light trespass / glare ratio readings

Functional Use Area Summary Information

Area Description Lighted or Unlighted?	FUA Area (square ft) (wall sq-ft if façade Ltng)	% of total FUA Area (if sampled)	% Covered by Canopy
FUA A:			
FUA B:			
FUA C:			
FUA D:			
FUA E:			

Functional Use Area Selection List			
1. Parking	2. Pedestrian & Walkway	3. Landscape	4. Outdoor Retail Sales (car lot)
5. Internal Roadway	6. Storage	7. ATM	8. Recreation
9. No Use	10. Façade & Aesthetic	11. Security	12. Point of Sales (fast food)
13. Entry (if different*)	14. Gas Station Canopy	15.	(*if lit differently from walkways)

Luminaire Information

FUA (letter)	Ballast Type (FL)	Notes	Fixture Type	FixtureQty	Lamp Type	Lamp Wattage	Luminaire Height	Distance from Luminaire (see below)	Ft Cndle Reading (see below)	Suitability/Lens Cond
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P
										G / F / P G / F / P

Note: record Qty of fixtures not poles: 4 poles with 2 fixtures each ---Qty=8

Wattage Determination (optional method)

If the wattage of lights are not available, the meter can be used. Follow these steps and record each in the space provided above.

Step 1: Determine post or fixture height. (record in “Luminaire Height / Distance”)

Step 2: Measure from pole or wall to brightest point illuminated by fixture.
(record in “Luminaire Height / Distance” column)

Step 3: Point meter with snoot attached directly at fixture and take reading.
(record in “Ft Cndle Reading” column)

Signage Information

Qty of Signsl	Fixture Type	# of Faces	Fixture Qty per sign	Lamp Type	Lamp Wattage / Linear Feet	Size	Notes	Suitability
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P
								G / F / P

Signage Classification List			
1. Cabinet	2. Front Lighted	3. Multi-bulb Flasher	4. Direct View Neon
5. Concealed Neon	6. LED	7. Gas Pump	8.
9.	10.	11.	12.

Nighttime Data Collection

Site Conditions

Q29. Nighttime weather conditions:

- ❑ Clear
- ❑ raining
- ❑ icy
- ❑ snowing
- ❑ foggy
- ❑ overcast/cloudy

Walk around and become familiar with the nighttime conditions of the site. Complete the Nighttime Subjective Lighting Evaluation Forms (One for each surveyor and one for available users of the site)

- ❑ Forms Completed

Answer Questions Q29. through Q31. from the edge of property line.

Q30. Describe the environmental conditions of the neighborhood:

- ❑ Area with intrinsically dark landscape
  (Residential areas with little or no streetlighting. Zone E1)
- ❑ Area of low ambient brightness
  (Outer urban and rural area, residential areas. Zone E2)
- ❑ Area of medium ambient brightness
  (Urban residential areas, lighted to higher traffic level. Zone E3)
- ❑ Area of high ambient brightness
  (Urban area with both residential and commercial use, high traffic volume. Zone E4)

Q31. The lighting at this site is:

- ❑ Inadequate
- ❑ Adequate
- ❑ More than needed

Q32. The lighting at this site is?

- ❑ Not Glary
- ❑ Somewhat Glary
- ❑ Very Glary

Glare Ratio:

	Reading UP	Reading DOWN	Subjective Impression (1 is best, 5 is worst)	Measurement taken from	Offending Fixture
1			1 • 2 • 3 • 4 • 5		
2			1 • 2 • 3 • 4 • 5		
3			1 • 2 • 3 • 4 • 5		

Glare Ratio Measurement Location List			
1. Parking area	2. Building entry	3. Property edge	4. Site entry / exit
5. Pedestrian conflict	6.	7.	8.
9.	10.	11.	12.

Light Trespass:

	Reading	Subjective Impression (1 is best, 5 is worst)	Offending Fixture/s
1		1 • 2 • 3 • 4 • 5	
2		1 • 2 • 3 • 4 • 5	
3		1 • 2 • 3 • 4 • 5	

Site Sketch

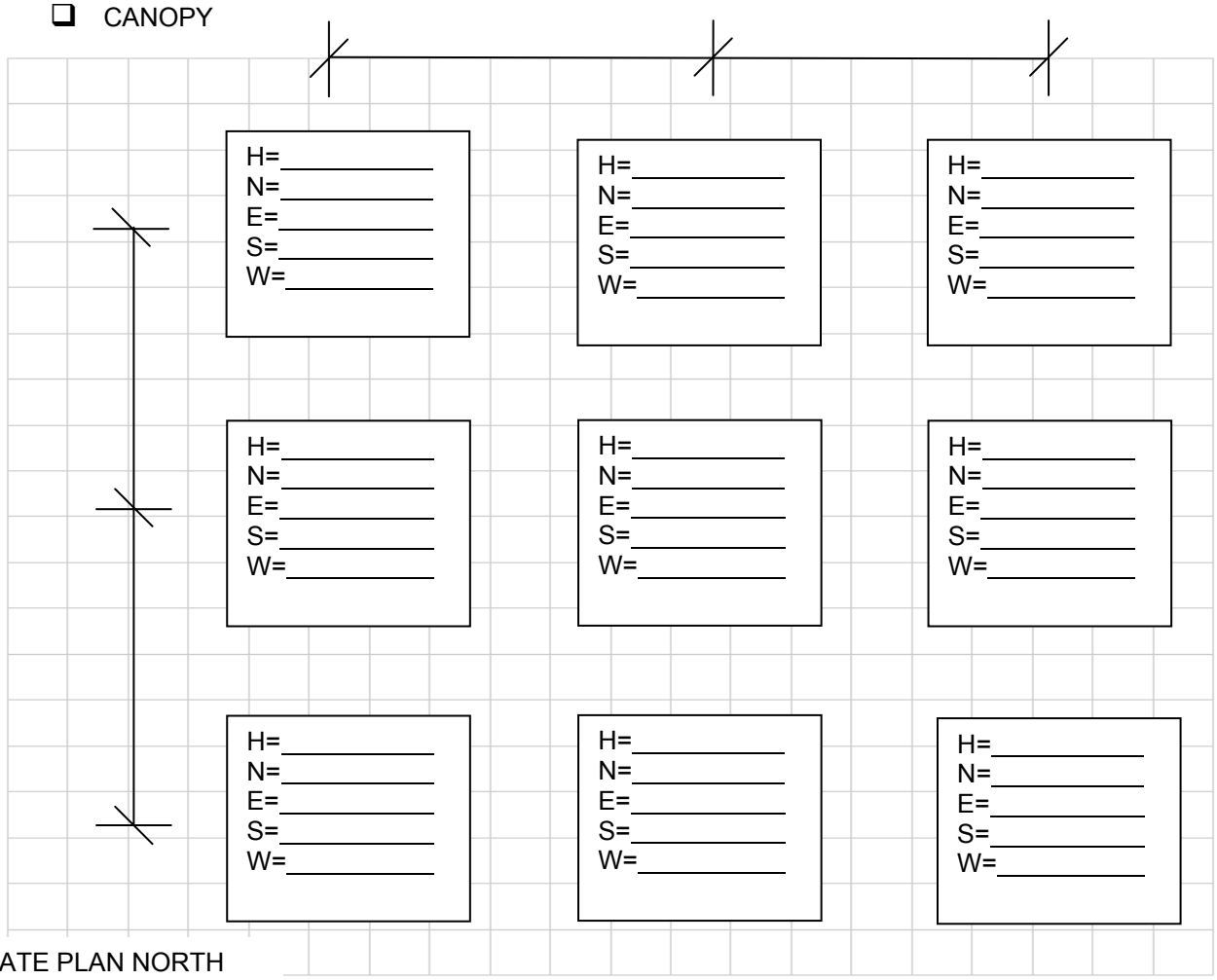
****INDICATE GLARE AND TRESPASS READING LOCATION**

Site Sketch and Geometry Information **(INCLUDE PLAN NORTH)**

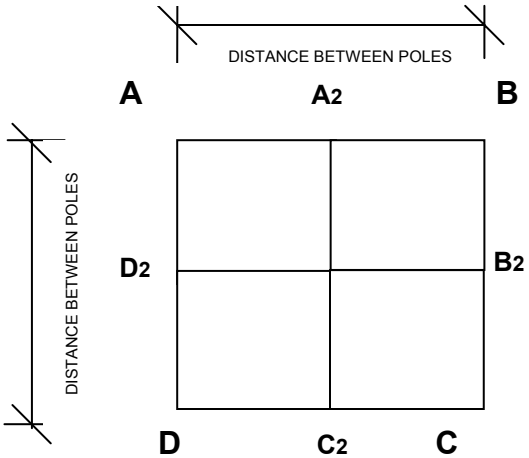
Lighting Measurements

- ❑ PARKING LOT
- ❑ SECURITY
- ❑ CANOPY

_____Other



INDICATE PLAN NORTH



_____FIXTURE LOCATION

_____FIXTURE TYPE

_____LAMP TYPE

_____LAMP WATTAGE

ADDITIONAL TYPES:

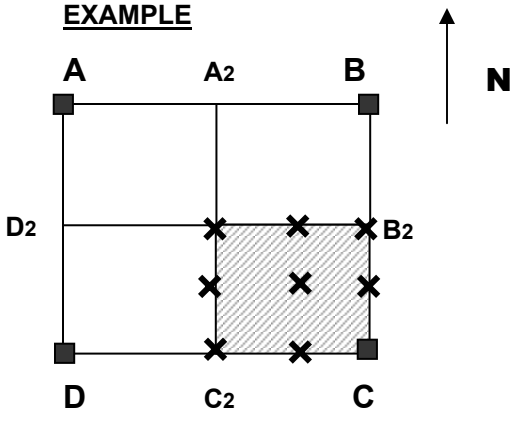
_____FIXTURE LOCATIONS

_____FIXTURE TYPE

_____LAMP TYPE

_____ LAMP WATTAGE

EXAMPLE

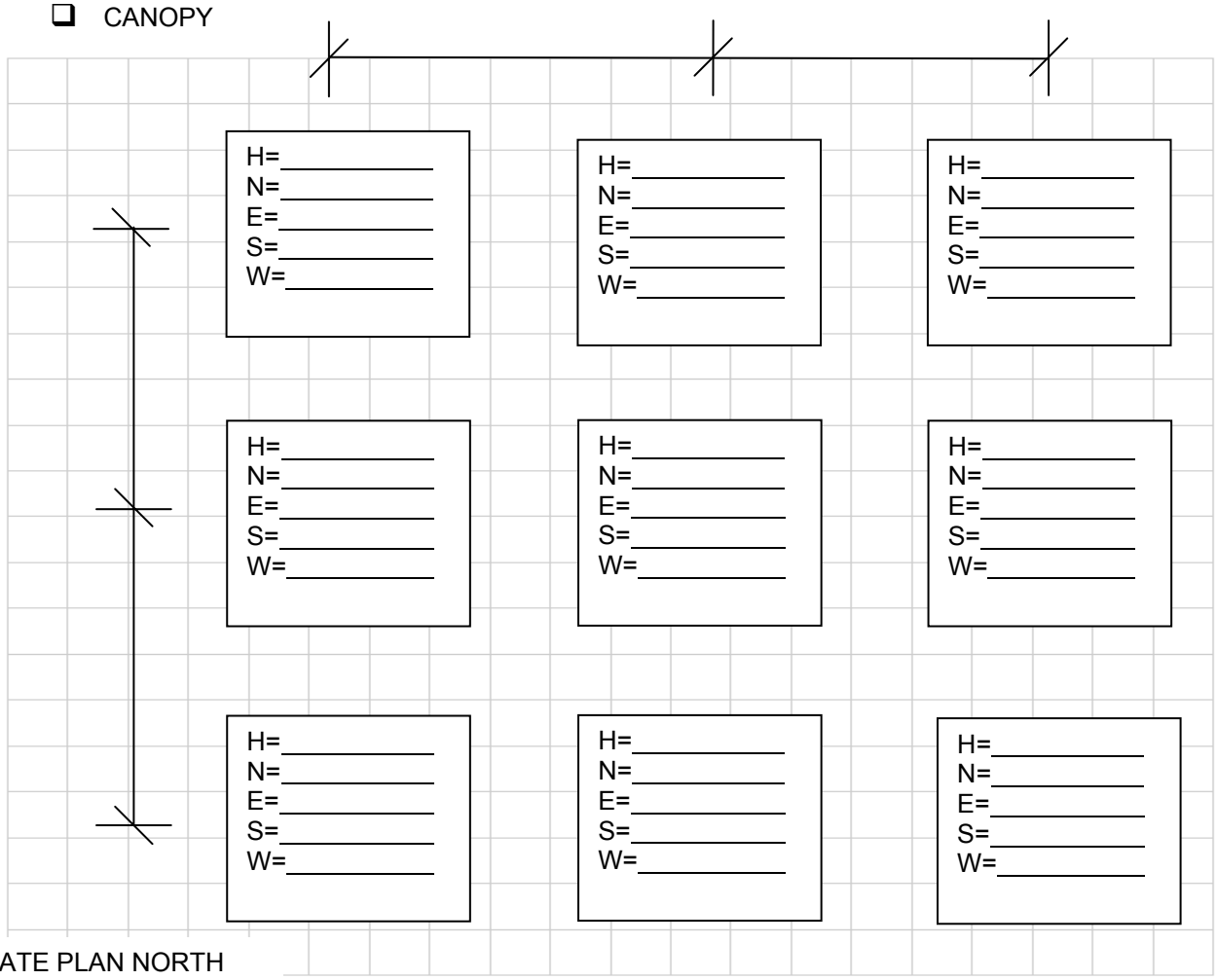


Site #_____

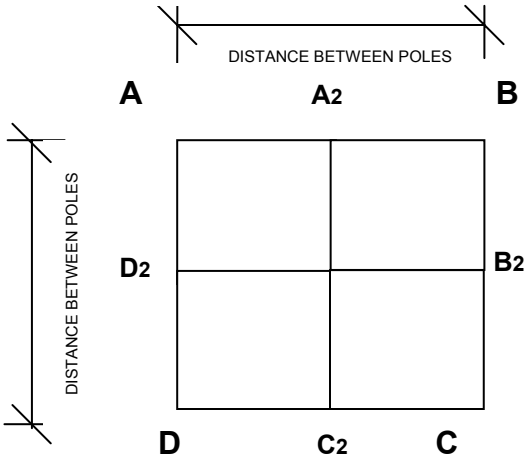
Lighting Measurements

- ❑ PARKING LOT
- ❑ SECURITY
- ❑ CANOPY

_____Other



INDICATE PLAN NORTH



_____FIXTURE LOCATION

_____FIXTURE TYPE

_____LAMP TYPE

_____LAMP WATTAGE

ADDITIONAL TYPES:

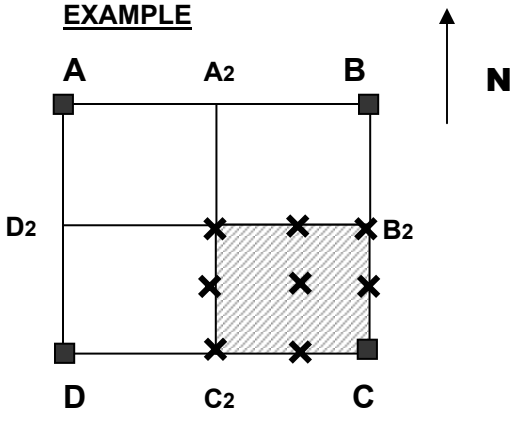
_____FIXTURE LOCATIONS

_____FIXTURE TYPE

_____LAMP TYPE

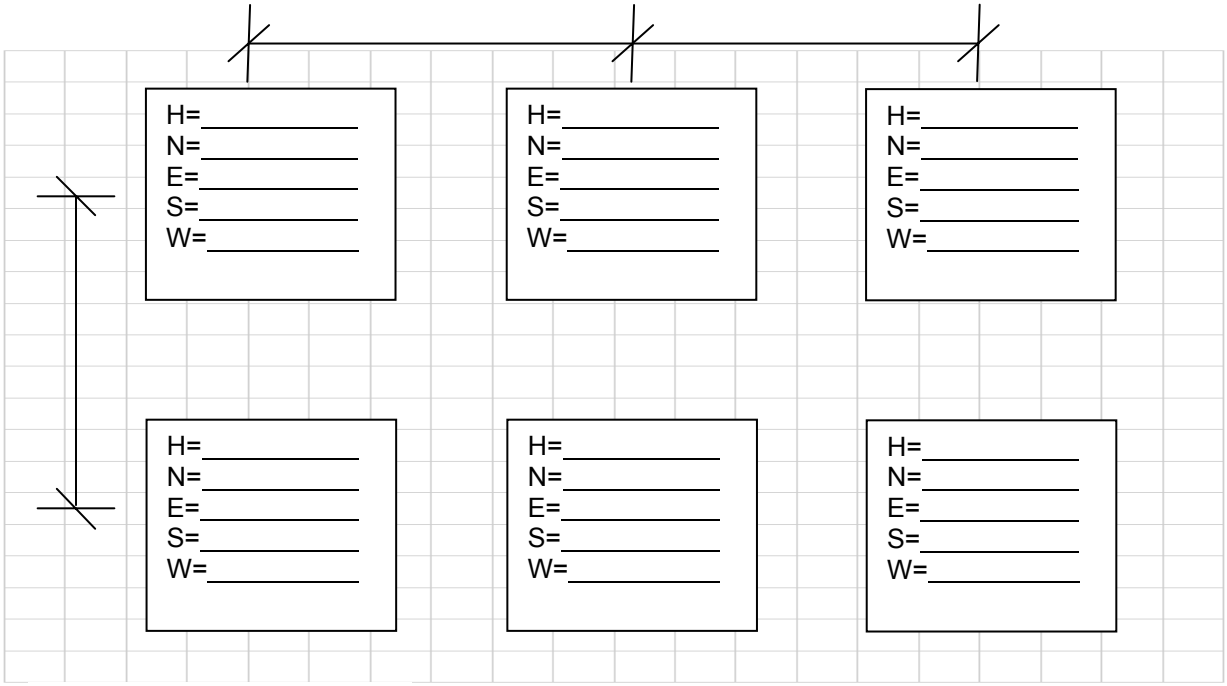
_____ LAMP WATTAGE

EXAMPLE



Site #_____

Sidewalk Lighting Measurements



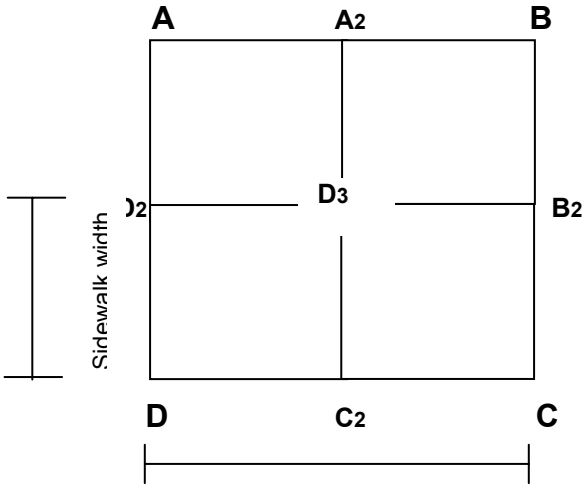
INDICATE PLAN NORTH

_____ Fixture Location

_____ Fixture Type

_____ Lamp Type

_____ Lamp Wattage



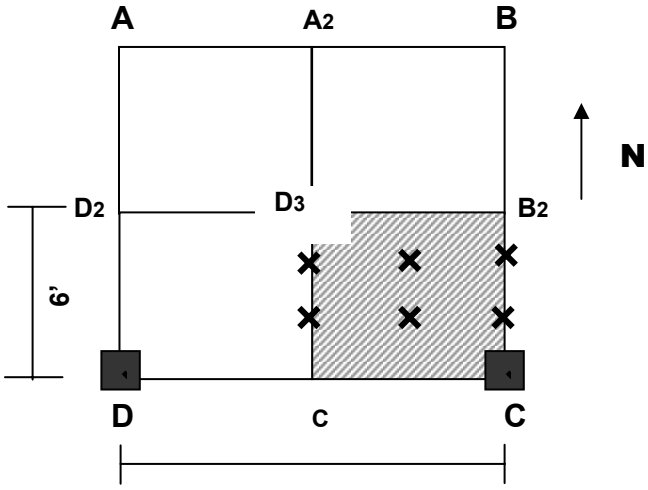
DISTANCE BETWEEN LIGHTS

Example: C, D Fixture Location

0 Fixture Type

MH Lamp Type

175 Lamp Wattage



12'

Site #_____