Illumination Design for Transportation Applications

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2007 – derived from November 2006 DM chapter 840
Definitions

- **Illumination (Illuminance)** - the intensity of light per unit of area. (Roadway Lighting Design Guide - October 2005 - page 63) (RP-8-00 page 27)

- **Luminance** - luminous intensity, expressed in candles per unit projected area for the luminous surface. Roadway luminance is the light from a luminaire, projected onto a point on the roadway, then back to the observer, opposite the direction of travel. (Roadway Lighting Design Guide - October 2005 - page 64) (RP-8-00 page 57)

- **Veiling Luminance** - The stray light produced within the eye by the light source that alters the apparent brightness of an object within the visual field and the background against which it is viewed. (Roadway Lighting Design Guide - October 2005 - page 66) (RP-8-00 page 58)
(There is only an observer in the Luminance and Veiling Luminance calculations.)
**Red** → Path of Luminance from the luminaire to the observer's eye.

**Green** → Observer's line of sight looking at the Luminance point value to be calculated on the pavement surface.
Veiling Luminance

**Red** → Path of Veiling Luminance (Disability Glare) from the luminaire to the observers eye.

**Green** → Observers line of sight looking at the Veiling Luminance point value \( (L_v) \) to be calculated on the pavement surface.
Definitions - continued

- **Lamp lumens** - The total output from a lamp, measured in lumens. (A lumen being a unit of luminous flux.)

- **Luminous Flux** - the time rate of flow of light radiation.

- **Foot-candle** - The illumination of a surface one square foot in area on which is uniformly distributed a flux of one lumen. A foot-candle equals one lumen per square foot.
Definitions - continued

• **Minimum light level** - The minimum light intensity of illumination at any single point within the design area measured just prior to relamping the system. (DM-Nov 2006-page 840-2 @ page 840-41, figure 840-25, Note 1)

• **Minimum average light level** - The average of all light intensities within the design area measured just prior to relamping the system. (DM-Nov 2006-page 840-2 & page 840-41, figure 840-25, Note 6)

• **Uniformity Ratio** - The ratio of the minimum average light level on the design area to the minimum light level of the same area. (DM-Nov 2006-page 840-2 & page 840-41, figure 840-25, Note 1)
Definitions - continued

- **Dirt Factor** - the amount of environmental contamination deposited on the reflector, refractor or luminaire bulb. Expressed as percentage of light transmission loss at end of life / relamping time compared to new installation. \((DF) = 0.85\) (RP-8-00 page 27)

- **Lamp Lumen Depreciation Factor** - the factor used in illumination calculations to relate initial rated output to the anticipated output at replacement time. \((LLDF) = 0.73\) (GE Catalog Dec. 1995 - section 9050 page 2)

- **Light Loss Factor** (Maintenance factor) Percentage of light degeneration through the life of the lamp. 
  \((DF) 0.85 \times (LLDF) 0.73 = 0.62LLF\)
Dirt Factor

Figure A5. Luminaire Dirt Depreciation (LDD) factors.

SELECT THE APPROPRIATE CURVE IN ACCORDANCE WITH THE TYPE OF AMBIENT AS DESCRIBED BY THE FOLLOWING EXAMPLES:

VERY CLEAN—No nearby smoke or dust generating activities and a low ambient contaminant level. Light traffic. Generally limited to residential or rural areas. The ambient particulate level is no more than 150 micrograms per cubic meter.

CLEAN—No nearby smoke or dust generating activities. Moderate to heavy traffic. The ambient particulate level is no more than 300 micrograms per cubic meter.

MODERATE—Moderate smoke or dust generating activities nearby. The ambient particulate level is no more than 600 micrograms per cubic meter.

DIRTY—Smoke or dust plumes generated by nearby activities may occasionally envelope the luminaires.

VERY DIRTY—As above but the luminaires are commonly enveloped by smoke or dust plumes.
## HIGH PRESSURE SODIUM LAMP DATA

<table>
<thead>
<tr>
<th>ORDERING ABBREVIATION</th>
<th>ANSI CODE</th>
<th>FINISH</th>
<th>LIGHT CENTER LENGTH INCHES</th>
<th>INITIAL LUMENS</th>
<th>LAMP LUMEN DEPRECIATION</th>
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</thead>
<tbody>
<tr>
<td><strong>35-WATT-LIFE AT 10 HOURS/START = 16,000 HOURS</strong></td>
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<tr>
<td>LU35/med</td>
<td>S76-HA-35</td>
<td>Clear</td>
<td>3-13/32</td>
<td>2,525</td>
<td>0.90</td>
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<td>LU35/D/med</td>
<td>S76-HB-35</td>
<td>Diffuse</td>
<td>3-13/32</td>
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<tr>
<td>LU50/Med</td>
<td>S68-XX-50</td>
<td>Clear</td>
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<td>LU1000</td>
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<td>140,000</td>
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</tr>
</tbody>
</table>
Definitions - continued

• Type III Medium Cutoff Fixture - Type I, II, III & IV are designations for asymmetrical (noncircular) distribution patterns. A “Type III” projects light further across the street (transverse) than a “Type II” and less far across the street than a “Type IV”.

• “Medium” is the distance up and down the highway (longitudinal) a luminaire directs light. This is in the range of >2.0xMH(mounting height) & < 4.0xMH (approx.).

• “Cutoff” - tells how much light a luminaire directs above 80 & 90 degrees vertical. A cutoff fixture directs almost no light (2% - 3%) above 90 degrees.
Required (Basic) Illumination

- The design matrices identify the design levels for illumination on all preservation and improvement jobs. (see Chapter 325 - Design Manual) (DM 840.05 – November 2006)

- The design matrices are shown in figures 325-3 through 325-7. Follow Design Manual guidance for all projects except as noted in the design matrices and elsewhere as applicable. (DM 325.03 – December 2003)

- A minimum of two light standards of standard pole height are required at all design areas, with the exception of ramp terminals and the entrance/exit points of minor parking lots. (addition to Nov. 2006 DM chapter 840).
Freeway Off Ramps and On Ramps (1)

Single-Lane Off-Connection
(The Design Area May Be Shifted up to 100 Feet From the Beginning of the Wide Line)

Two-Lane Off-Connection
(The Design Area Can Be Shifted up to 100 Feet From the Beginning of the Wide Line)
How to place Luminance & Veiling Luminance Grids

Single-Lane Off-Connection
(The Design Area May Be Shifted up to 100 Feet From the Beginning of the Wide Line)

Two-Lane Off-Connection
(The Design Area Can Be Shifted up to 100 Feet From the Beginning of the Wide Line)
Freeway Off Ramps and On Ramps (1)

Single-Lane On-Connection
(The Design Area May Be Shifted up to 100 Feet From the 10-Foot-Wide Ramp Point)

Two-Lane On-Connection
(The Design Area May Be Shifted up to 100 Feet From the 22-Foot-Wide Ramp Point)
How to place Luminance & Veiling Luminance Grids

Single-Lane On-Connection
(The Design Area May Be Shifted up to 100 Feet From the 10-Foot-Wide Ramp Point)

Two-Lane On-Connection
(The Design Area May Be Shifted up to 100 Feet From the 22-Foot-Wide Ramp Point)
Freeway Off Ramps and On Ramps (1)

Auxiliary Lane at On-Connection
(The Design Area May Be Shifted up to 100 Feet From the 10-Foot-Wide Ramp Point)

Exit-Only Lane
The Design Area May Be Shifted up to 100 Feet From the End of Lane and the Beginning of Wide Line
How to place Luminance & Veiling Luminance Grids

Auxiliary Lane at On-Connection
(The Design Area May Be Shifted up to 100 Feet From the 10-Foot-Wide Ramp Point)

Exit-Only Lane
The Design Area May Be Shifted up to 100 Feet From the End of Lane and the Beginning of Wide Line
Freeway Ramp Terminals (2)

Design Area (Typ.)

On-Ramp

Off-Ramp

See Figure 840-2 for Additional Details

Off-Ramp

On-Ramp

Two-Lane Crossroad

Required Illumination for a Typical Diamond Interchange (Shown for Single-Lane Ramp Connection and a Two-Lane Crossroad Without Channelization)
Freeway Ramp Terminals (2)

This area was intended to be included in the design area. Include this area in your designs.

This area was not intended to be included in the design area.
How to place Luminance & Veiling Luminance Grids

Ramp must be tangent for 272 feet or do not calculate veiling luminance

Grid 1

Grid 2

Grid 3
Intersections With Left Turn Channelization (3)

Intersection With Left-Turn Lane Channelization

RI(3) DM 840-5 & DM figure 840-3b, page 840-19
How to place Luminance & Veiling Luminance Grids

Grid 4

Grid 3

Grid 1

Grid 2

Marked Crosswalk

Design Area

Approach Design Area (Typ.)

Beginning of Full Left-Turn Roadway Width (Typ.)

Painted Channelization (Typ.)

Intersection With Left-Turn Lane Channelization
Intersections With Left Turn Channelization (3)

Two-Way Left-Turn Lane

50 ft. Approx.

Beginning of Storage Lane

Approach Design Area

Alternate for Transitions to Two-Way Left-Turn Lanes

Approach Design Area

Alternate for Long Storage Lanes
How to place Luminance & Veiling Luminance Grids

Alternate for Transitions to Two-Way Left-Turn Lanes

Alternate for Long Storage Lanes

RI(3) DM 840-2 & DM figure 840-3
Intersections With Left Turn Channelization (3)

Alternate for Raised Channelization

RI (3) DM page 840-5 & DM figure 840-3b, page 840-19
How to place Luminance & Veiling Luminance Grids

Alternate for Raised Channelization

RI(3) DM 840-2 & DM figure 840-3
How to place Luminance & Veiling Luminance Grids

Grid 1

Grid 2

Grid 3

Grid 4

Marked or Unmarked Crosswalk (Typ.)

Approach Design Area

Beginning of Full Left-Turn Roadway Width (Typ.)

Design Area
Intersections without channelization AI(5)

Marked or Unmarked Crosswalk

Radius Return Point (Typ.)

Two-Lane (Major) roadway

Stop Line

Two-Lane (Minor) Roadway

AI (5) DM 840-8 & Figure 840-23
How to place Luminance & Veiling Luminance Grids

Marked or Unmarked Crosswalk

Intersection design area

Two-Lane (Major) roadway

Approach roadway must be tangent for 272 feet or do not calculate veiling luminance

Grid 1

Grid 2

Grid 3

Two-Lane (Minor) Roadway

Radius Return Point (Typ.)

Stop Line
Intersections With Traffic Signals (4)

- Four-Way Intersection (Without Left-Turn Channelization)
- Major Tee Intersection (Without Left-Turn Channelization)
How to place Luminance & Veiling Luminance Grids

Grid 1

Grid 2

Grid 3

Grid 4

Marked or Unmarked Crosswalk

Design Area

Multilane (Major) Roadway

Two-Lane (Minor) Roadway

Major Tee Intersection
(Without Left-Turn Channelization)

Four-Way Intersection
(Without Left-Turn Channelization)
Note: Luminaires are shown in specific locations, and should be installed on the side of road as detailed here.
How to place Luminance & Veiling Luminance Grids

Grid 1

Grid 2

Design Area

Railroad Track

Light Standard (Typ.)

Railroad Signal or Gate (Typ.)

50 ft. Min.
Transit Flyer Stop (6)

RI(6) DM 840-3 & figure DM 840-6
How to place Luminance & Veiling Luminance Grids
Major Parking Lot (7)
How to place Luminance & Veiling Luminance Grids

Grid 1

Grid 2

Grid 3

Grid 4

Grid 5

Grid 6
Minor Parking Lot (8)
None required
Truck Weigh Sites (9)
How to place Luminance & Veiling Luminance Grids

Grid 1 (diverge point from mainline)

Grid 2

Grid 3

Grid 4

Grid 5

Grid 6 (merge point at mainline)
Design area encompasses midblock crossing with raised median pedestrian refuge, and the crossing is not within the limits of a continuously illuminated roadway.
How to place Luminance & Veiling Luminance Grids

$X = \text{Distance From Nose of Divider to Crosswalk (1st Case) or 40 ft. Min. (2nd Case)}$

Design Area (Typ.)

40 ft. Min. (Typ.)

50 ft. Min. (Typ.)

Stop Line (Typ.)

Sidewalk

Planting Strip

Two-Way Left-Turn Lane

Raised Median Section

Location of Future Pedestrian Signal (Typ.)

Grid 1

Grid 2

Two-Way Left-Turn Lane

Raised Median Section

Location of Future Pedestrian Signal (Typ.)

Grid 1

Grid 2
Long Tunnel (11)

Design Area

Tunnel

210 ft.

16.5 ft. or 22.5 ft.

RI(11) DM 840-3, Figure 840-11
How to place Luminance & Veiling Luminance Grids

Grid 1

Grid 2

Design Area

Tunnel

210 ft.

16.5 ft. or 22.5 ft.
Lane Reduction (12)

Main Line Lane Reduction
(The Design Area Can Be Shifted up to 100 Feet From the End of Lane and the Beginning of Wide Line)

Same as exit only lane – slide 17
How to place Luminance & Veiling Luminance Grids

Main Line Lane Reduction
(The Design Area Can Be Shifted up to 100 Feet From the End of Lane and the Beginning of Wide Line)

Lane Reduction

Lane Reductions
*Figure 840-12*
Intersection with Right Turn channelization (13)

See slide 53 & 54 for what the intention was for the design area of a right turn lane.
How to place Luminance & Veiling Luminance Grids

See slide 53 & 54 for what the intention was for the design area of a right turn lane.
Intersection with Right Turn channelization (13)

Intersection With Right-Turn Lane Channelization

Figure 840-13

RI(13) DM 840-6, replacement for Figure 840-13
How to place Luminance & Veiling Luminance Grids

Grid 1

Grid 2

Intersection With Right-Turn Lane Channelization

Figure 840-13

RI(13) DM 840-6, replacement for Figure 840-13

54
Same direction traffic split around an obstruction (14)

For speeds 45 mph or more: \( L = WS \)
For speeds less than 45 mph: \( L = WS/60 \)

\( L = \) Taper length in feet
\( W = \) Width of offset in feet
\( S = \) Posted speed

For temporary Work Zone Plan applications a site-specific Traffic Control Plan is required. Refer to Chapters 710 and 720 for traffic barrier and attenuator information, Chapter 810 for Work Zone Information, and Chapter 820 for signing information.
How to place Luminance & Veiling Luminance Grids

Grid 1
Splitter Island (Typ.)
Design Area (Typ.)

Grid 2

For speeds 45 mph or more: \[ L = \frac{WS}{60} \]
For speeds less than 45 mph: \[ L = WS \]

\( L \) = Taper length in feet  
\( W \) = Width of offset in feet  
\( S \) = Posted speed

For temporary Work Zone Plan applications a site-specific Traffic Control Plan is required. Refer to Chapters 710 and 720 for traffic barrier and attenuator information, Chapter 810 for Work Zone information, and Chapter 820 for signing information.
Add Lane channelization (15)
How to place Luminance & Veiling Luminance Grids

Design Area

Direction of travel

Grid 1

Taper

100 ft. Min. 100 ft. min.

Full Roadway Width
Notes:

1. Exclude truck apron from lighting calculation.
2. Exclude the portion inside the 2 feet offset areas of the raised channelization islands from lighting calculation.
3. All channelization 2 feet wide or less in Design Area to be included in lighting calculation.
How to place Luminance & Veiling Luminance Grids

Notes:
1. Exclude truck apron from lighting calculation.
2. Exclude the portion inside the 2 feet offset areas of the raised channelization islands from lighting calculation.
3. All channelization 2 feet wide or less in Design Area to be included in lighting calculation.
Bridge Inspection Lighting (17)
Blank Page
Freeway On-Ramps with ramp Meter Signals (18)
How to place Luminance & Veiling Luminance Grids

Approach roadway must be tangent for 272 feet or do not calculate veiling luminance

Direction of travel

Grid 1

RI(18) 840-6 figure 840-18
Freeway to Freeway Ramp connections - (19)

- Provide the necessary light standards to illuminate freeway-to-freeway ramps.
Ramp must be tangent for 272 feet or do not calculate veiling luminance.

How to place Luminance & Veiling Luminance Grids
HOT (High Occupancy Toll) Lane enter/exit zones - (20)

Double Wide Lane Line or Barrier Line

Enter/Exit Zone
Distance Varies (Typ. 1500')

200 ft.

250 ft.

Extend Design Area 50 ft. Beyond End of Barrier or Striping

Design Area (Typ.)

HOT Lane

Double Wide Lane Line or Barrier Line

HOT Lane
How to place Luminance & Veiling Luminance Grids

Grid 1

Double Wide Lane Line or Barrier Line

HOT Lane

Design Area (Typ.)

Grid 2

HOT Lane

Double Wide Lane Line or Barrier Line

Enter/Exit Zone

Distance Varies (Typ. 1500')

200 ft.

250 ft.

Extend Design Area 50 ft. Beyond End of Barrier or Striping

Direction of travel

Direction of travel

RI 20 page 840-7, figure 840-20
Chain up / Chain off Parking Areas - (21)
How to place Luminance & Veiling Luminance Grids

Design Area

Full Width Chain-Up Parking Area

Grid 1

RI 21 page 840-7, figure 840-21
How to place Luminance & Veiling Luminance Grids

There is not a roadway section within this example where there is a tangent section of roadway greater than 272 feet in length before the design area. No veiling luminance calculations required.
Overhead Sign Illumination - (23)

- Provide sign lighting on overhead signs as discussed in Design Manual Chapter 820.
- When DM Chapter 820 is updated the overhead sign lighting section will move to DM Chapter 840.
Additional Illumination

• Diminished Level of Service
  – Mobility condition where the peak level of service is “D” or lower

• Nighttime Collision Frequency
  – Condition when the number of nighttime accidents equal or exceed the number of daytime accidents
  – An Engineering study is needed to show that installing illumination will result in a reduction of nighttime accidents

• High nighttime pedestrian accident locations
  • AI 840-7
Highways AI (1) (a)

- On the mainline of full limited access highways, consider full illumination if a diminished level of service exists and any two of the following conditions exist:
  
  - There are three or more successive interchanges with an average spacing of 1 ½ miles or less.
  
  - The roadway segment is in an urban area.
  
  - The nighttime accident frequency condition exists.
  
  - A cost benefit analysis between the required and full (continuous) illumination.

  - AI 840-8
Highways With Full Access Control (1)(a)
• Mainline of highways without Full Access Control (b)
• Consider full (continuous) illumination if the segment of highway is in a commercial area, and either
  – A diminished level of service exists.
  – Or, the nighttime accident frequency exists
• And an engineering study indicates that nighttime driving conditions will be improved.
Ramps - AI (2)

• At ramps, consider additional illumination if a diminished level of service exists for the ramps and any of the following conditions are present:
  • Complex ramp alignment & grade. ("complex ramp alignment & grade" is: The exit advisory speed is 35 mph or lower than the posted mainline speed, or there is a 6% or greater change in grade from exiting mainline grade to the ramp grade)
  • Routine queues of five or more vehicles per lane at ramp terminal.
  • The nighttime accident frequency condition exists.
  • The criteria for continuous mainline illumination has been satisfied.
The gore point of the exit ramp is past this sign.
The gore point of the exit ramp is past this sign. The ramp traffic begins here.
Highway to Highway Ramp connections - AI (3)

- Provide the necessary light standards to illuminate highway-to-highway ramps.
Ramp must be tangent for 272 feet or do not calculate veiling luminance

Grid 1

Design Area

Match to On-Connection Design Area

Match to Off-Connection Design Area
Crossroads - AI (4)

- At crossroads, consider additional illumination when:
  - A diminished level of service exists, and
  - the nighttime accident frequency condition exists.
  - Also, consider additional illumination if the crossroad is in a tunnel, under crossing or lid.
Intersections w/o Channelization AI (5)

- Consider illumination of an intersection without channelization if:
  - The intersection is located in an urban area.
  - The nighttime intersection accident frequency condition exists.
  - Traffic volumes and movements would be improved with the installation of left turn channelization.
Intersections Without Channelization (5)
(and without a traffic signal)
Short Tunnels, Underpasses, or Lids AI (6)

- Consider illumination if:
  - portal conditions result in a brightness in the tunnel, underpass or lid that is less than the measured daytime brightness of the approach roadway divided by 15 and,
  - The length to vertical clearance ratio is 10:1 or greater.

- Note: IESNA RP-22-05 (Recommended Practice for Tunnel Lighting) recommends daytime illumination of underpasses greater than 80 feet in length. This significant change was not implemented in the 2006 rewrite of DM chapter 840. The entire concept of illuminating short tunnels, underpasses, or lids is under review.
Given:
1) Widen three lane roadway to four lane roadway.
2) Gap between new traffic barrier on structures is 4 feet.
3) Bridge design height = 17.0 feet.
4) Undercrossing roadway is City street with 500 plus pedestrians each day.
Work Zones and Detours  AI (7)

- Consider temporary illumination of the highway through work zones and detours when changes to the highway alignment or grade remain in place during nighttime hours, and when the following conditions may be present:
  - Nonstandard features such as narrow lanes, shoulders, or shy distance to barriers or structures are present.
  - When the temporary alignment includes abrupt changes in highway direction or lane shift with substandard lane shift tapers.
  - When other unusual highway features such as abrupt lane edge drop-offs, sudden changes in pavement conditions, or temporary excavation or trenching covers are present.
  - When there is an anticipation of heavy construction truck traffic, possibly requiring flaggers, entering and exiting the highway during nighttime hours.
Transit Stops AI (8)

- The responsibility for lighting at transit stops is shared with the transit agency. Negotiating a memorandum of understanding with the transit agency is preferred over spot negotiations. If the agency is unable or unwilling to participate in the funding or maintenance of the illumination, a single light standard positioned to illuminate both the transit pullout area and the loading area can be considered.

- Transit stops with shelters are indicative of higher passenger usage. Consider illumination of transit stops with shelters. This lighting consists of one luminaire positioned to illuminate both the transit pullout area and the loading area.

- Additional illumination to further illuminate the loading area at transit stops with significant, nighttime activity may be considered, if the transit agency will provide the funding for construction and maintenance.
Transit Stop AI(8)

AI(8) DM 840-6
Bridges AI (9)

Railroad Xing Without Gates or Signals AI (10)

• Bridges:
  – Justification for illuminating bridges is the same as that for highways, with or without full limited access control, as applicable.

• Railroad Crossings Without Gates or Signals:
  – Consider illuminating these facilities when:
    – Collision history indicates motorists experience difficulty seeing trains.
    – There is a substantial amount of nighttime activity.
    – The crossing is blocked for long periods of time due to low train speeds.
    – The crossing is blocked for long periods at night.
Blank Page
Walkways and Bicycle Trails

- Consider illuminating the walkway if it is a connection between two highway facilities.
- Consider illuminating existing walkways or bicycle trails if security problems have been reported.
- Consider illuminating of new construction walkways or bicycle trails if security problems are anticipated.
Walkways and Bicycle Trails - AI(11)

- Roadway Diverge/Merge Design Area
- Truck Parking Design Area
- Walkways
- Trail
- Passanger Vehicle Parking Design Area
- Pedestrian Walkway Design Area
What’s new in illumination design
(or not so new)

• Getting the base map from the Design Office.

• You should have only one base map file you get from the location office. The contents of this file is spelled out in the “Traffic PS&E Preparation CADD Base plan requirements” Current Practices. Everything listed on this sheet is critical and should be shown in the base map.

• Supervisors – send a copy of this CADD requirements sheet to the location office when you are scoping the job.

• Designer - Send a copy of this CADD requirements sheet to the location office when you are first assigned the job.

• Having only one base map insures this process works easily throughout the design stages.
YOUR REGION
Traffic PS&E Preparation
CADD BASE PLAN REQUIREMENTS

The base plan needs to contain the following if they apply specifically to this project.
• North Arrow, Township and Range
• Existing and Proposed Alignment
• Existing and Proposed Right of Way, Limited Access and Easements
• Existing and Proposed Channelization
• Existing and Proposed Striping (crosswalks, stop bars)
• Existing and Proposed Utilities (overhead/underground)
• Existing and Proposed Drainage, including wetlands, ecology embankments, etc.
• Existing Illumination System 1
• Existing Traffic Signal System 2
• Existing ITS System
• Existing Signing
• Existing and Proposed bridge structures, walls, drainage vaults, etc. (all structures)
All of the items listed above must be contained in one CADD file.

NOTE: THE BASE PLAN CADD FILE SHALL BE PER THE PLANS PREPARATION MANUAL.

In order for us to have a complete understanding of the project, we also need copies of the following:
• Approved Channelization Plan
• Traffic Analysis
• Project Summary (Prospectus)
• Project File (Design Report)
• Signal Permit
• Roadway Sections

Engineering back up data to support all illumination design shall be submitted along with the PS&E for each project.

1 Light standards, conduit runs, junction boxes, electrical service cabinet with service agreement number. Depending on the nature of the work it may be necessary to survey any or all of these items. Signal Maintenance will assist in locating these elements in the field on request. Once surveyed it is imperative that the information is accurately included in the base plan. (Electrical Maintenance Supervisor – Name Here – Ph. #) (ITS Maintenance Supervisor – Name Here – Ph. #).
2 Same as Footnote 1 with the addition of signal poles and signal controller cabinet. Signal poles, controllers, electrical service, junction boxes and all other above ground improvements at traffic signal intersections must be shown accurately, this will require a survey.
Note: Base plans have been prepared incorrectly by using As-Buils as the only source of information on existing features, this approach has cost many preliminary engineering dollars and has also had a negative impact on project scheduling. We assume the data you provide to be correct and verify it only if something appears to be grossly wrong.

Please direct questions to:
Name Here, Traffic Signal Design Team Supervisor Ph. #
Name Here, Your ITS Supervisor Ph. #

Name Here, A second Signal Design Team Supervisor here Ph. #
Name Here, Signing Team Supervisor here Ph. #

10/3/2005
• Placement of Light Standards.
  – Luminaires should be placed as far back from the traveled way as is practical, generally 16’ from the fog stripe. Luminaires should not be placed; in ditches, in ecology embankments, on steep cut slopes, above buried utilities, below overhead utilities, or within 10’ (measured circumferentially) of power wires - including the neutral (depending on the voltage of the line the distance may be greater than 10 feet).
  – Watch your wetlands!
Example 1

R/W line

**LUMINAIRE SCHEDULE**

<table>
<thead>
<tr>
<th>LUMINAIRE NUMBER</th>
<th>CIRCUIT</th>
<th>LOCATION STATION</th>
<th>OFFSET</th>
<th>TYPE-DISTRIBUTION-WATTAGE</th>
<th>MAST ARM</th>
<th>HI</th>
<th>BASE TYPE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>ST 16+618.74</td>
<td>14.06m RT</td>
<td>III-MED CUTOFF-400 HPS</td>
<td>4.88m</td>
<td>15.2m</td>
<td>SLIP</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>ST 16+650.22</td>
<td>11.01m LT</td>
<td>III-MED CUTOFF-400 HPS</td>
<td>4.88m</td>
<td>15.2m</td>
<td>SLIP</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>ST 16+681.56</td>
<td>10.54m RT</td>
<td>III-MED CUTOFF-400 HPS</td>
<td>4.88m</td>
<td>15.2m</td>
<td>SLIP</td>
<td></td>
</tr>
</tbody>
</table>
Example 1
Example 1
Example 2
Example 2
Example 3

Is the signpost plumb or is the luminaire plumb?
Example 3
Example 3
Example 4
I met with [ ] and we probed and took measurements of several foundation where the ecology embankment has been installed behind the foundation.

These are on the off ramp from SR [ ] to 244 Ave. SE. The measurements are taken from top of foundation to the depth that we could push the bar down into the material. We probed the sides also and they stayed fairly consistent at 8 inches of unstable material on the surface.

Pole base number Depth of unstable material at **2-ft. 4-inches** back of foundation and **1-foot back** of foundation

<table>
<thead>
<tr>
<th>#</th>
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<th></th>
</tr>
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<tbody>
<tr>
<td>12</td>
<td>4'5&quot;</td>
<td>2'</td>
</tr>
<tr>
<td>11</td>
<td>2'</td>
<td>1'</td>
</tr>
<tr>
<td>10</td>
<td>3'1&quot;</td>
<td>3'8&quot;</td>
</tr>
<tr>
<td>9</td>
<td>3'6&quot;</td>
<td>3'</td>
</tr>
<tr>
<td>8</td>
<td>3'</td>
<td>3'</td>
</tr>
</tbody>
</table>

The last pole we checked was on SE 200 Street at SE 257 St. This is [ ] pole base number K 31.

# K 31 20-inches back: 3'4" of unstable material and at 36-inches back: 3' of unstable material.

I have attached 2 pictures of the foundation number 12 with the bar pushed into the ground at 2 foot 4 inches back of the foundation and a straight edge laying across the top of the foundation. The red mark on the bar is at 4-foot. This is how we took the measurements listed above.
This person is standing on the grated inlet that was constructed (by change order) to drain the water away from the hole this traffic signal pole was built into.
The guardrail was also constructed (by change order) to keep vehicles away from the hole this traffic signal pole was built into.
Example 9
Example 10

Luminaire #37

R/W line

<table>
<thead>
<tr>
<th>POLE NO.</th>
<th>DIST. TYPE</th>
<th>STATION LOCATION</th>
<th>OFFSET</th>
<th>LUMINAIRE TYPE</th>
<th>MAST ARM</th>
<th>HT</th>
<th>POLE BASE TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>III</td>
<td>36-EB STA 70+65.00</td>
<td>30.00' LT</td>
<td>400 HPS</td>
<td>14'</td>
<td>40'</td>
<td>BREAKAWAY</td>
<td>PROVIDE MULTIVOLTAGE BALLAST</td>
</tr>
<tr>
<td>35</td>
<td>III</td>
<td>36-EB STA 73+04.00</td>
<td>40.00' LT</td>
<td>400 HPS</td>
<td>14'</td>
<td>40'</td>
<td>BREAKAWAY</td>
<td>PROVIDE MULTIVOLTAGE BALLAST</td>
</tr>
<tr>
<td>36</td>
<td>III</td>
<td>36-EB STA 75+30.00</td>
<td>65.00' LT</td>
<td>400 HPS</td>
<td>14'</td>
<td>40'</td>
<td>BREAKAWAY</td>
<td>MULTIVOLTAGE BALLAST</td>
</tr>
<tr>
<td>37</td>
<td>III</td>
<td>36-EB STA 78+10.00</td>
<td>60.00' LT</td>
<td>400 HPS</td>
<td>14'</td>
<td>40'</td>
<td>BREAKAWAY</td>
<td>MULTIVOLTAGE BALLAST</td>
</tr>
<tr>
<td>45</td>
<td>III</td>
<td>WB STA 328+32.00</td>
<td>43.00' RT</td>
<td>400 HPS</td>
<td>16'</td>
<td>40'</td>
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<tr>
<td>44</td>
<td>III</td>
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<td>60.00' RT</td>
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<td>16'</td>
<td>40'</td>
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<td>PROVIDE MULTIVOLT BALL &amp; INDIVIDUAL PHOTOCCELL</td>
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**Example 10**

**SHOULDER SLOPE TABLE**

<table>
<thead>
<tr>
<th>LINE</th>
<th>SIDE</th>
<th>LIMITS</th>
<th>SHOULDER SECTION</th>
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</thead>
<tbody>
<tr>
<td>36-EB</td>
<td>RT</td>
<td>STA 74+26.59 to STA 76+08.74</td>
<td>RAMP TRANSITION SECTION 4</td>
</tr>
<tr>
<td>36-EB</td>
<td>RT</td>
<td>STA 76+08.74 to STA 77+15.00</td>
<td>TYPE 1 DITCH TYPICAL SECTION</td>
</tr>
<tr>
<td>36-EB</td>
<td>RT</td>
<td>STA 77+15.00 to STA 78+60.00</td>
<td>FILL TYPICAL SECTION 1</td>
</tr>
<tr>
<td>36-EB</td>
<td>RT</td>
<td>STA 78+60.00 to STA 81+00.00</td>
<td>FILL TYPICAL SECTION 1 AND TYPE 2 DITCH TYPICAL SECTION</td>
</tr>
<tr>
<td>36-EB</td>
<td>RT</td>
<td>STA 81+00.00 to STA 81+90.85</td>
<td>FILL TYPICAL SECTION 1</td>
</tr>
<tr>
<td>36-EB</td>
<td>RT</td>
<td>STA 81+90.85 to STA 82+64.00</td>
<td>BARRIER CURB SECTION 2</td>
</tr>
<tr>
<td>36-EB</td>
<td>RT</td>
<td>STA 82+64.00 to STA 84+04.00</td>
<td>BARRIER CURB SECTION 1</td>
</tr>
<tr>
<td>36-EB</td>
<td>RT</td>
<td>STA 84+04.00 to STA 85+91.00</td>
<td>BARRIER CURB SECTION 2</td>
</tr>
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<td>36-EB</td>
<td>RT</td>
<td>STA 85+91.00 to STA 86+60.00</td>
<td>BARRIER CURB SECTION 3</td>
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<tr>
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<td>RT</td>
<td>STA 86+60.00 to STA 87+03.00</td>
<td>BARRIER CURB SECTION 1</td>
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<td>36-EB</td>
<td>RT</td>
<td>STA 87+03.00 to STA 87+16.97</td>
<td>BARRIER CURB SECTION 1</td>
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<tr>
<td>36-EB</td>
<td>LT</td>
<td>STA 74+26.59 to STA 76+33.52</td>
<td>TURF REINFORCEMENT MATTING SLOPE</td>
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<td>STA 76+33.52 to STA 77+55.00</td>
<td>SPECIAL CUT SECTION 1</td>
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<td>36-EB</td>
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<td>BARRIER CURB SECTION 1</td>
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<tr>
<td>36-EB</td>
<td>LT</td>
<td>STA 82+45.00 to STA 84+15.00</td>
<td>FILL TYPICAL SECTION 1</td>
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<td>36-EB</td>
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<td>SPECIAL CUT SECTION 2</td>
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<tr>
<td>36-EB</td>
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<td>BARRIER CURB SECTION 1</td>
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<tr>
<td>EB-36</td>
<td>RT</td>
<td>STA 52+30.00 to STA 56+73.39</td>
<td>SPECIAL TYPICAL SECTION</td>
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<td>EB-36</td>
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<td>STA 50+27.04 to STA 51+77.00</td>
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<td>RT</td>
<td>STA 51+77.00 to STA 52+00.00</td>
<td>TRANSITION TO BERM SECTION 1</td>
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<tr>
<td>EB-36</td>
<td>LT</td>
<td>STA 52+00.00 to STA 53+83.00</td>
<td>BERM SECTION 1</td>
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<td>BERM SECTION 2</td>
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<td>BERM SECTION 1</td>
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## Part 1: Request (from TNC construction, subcontractors or quality control)

<table>
<thead>
<tr>
<th>1. Originator:</th>
<th>JJ Jacoby</th>
<th>Company:</th>
<th>TNC</th>
<th>Ph #: 853-9715</th>
</tr>
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<tbody>
<tr>
<td>2. Project Area:</td>
<td>☑ Gig Harbor</td>
<td>☐ NB Substructure</td>
<td>☐ NB Superstructure</td>
<td>☐ Existing Bridge</td>
</tr>
<tr>
<td>3. Reference Drawing(s) or Specification(s):</td>
<td>Rev No:</td>
<td>Title of Document</td>
<td></td>
<td></td>
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<tr>
<td>GIL-005</td>
<td>3</td>
<td>Gig Harbor Mainline Illumination Plan EB Sta 320+00 to EB Sta 335+00</td>
<td></td>
<td></td>
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</tbody>
</table>

| 4. Reason for the request and potential solution: (include potential cost or schedule impact) |
| The luminaire pole #37 is located at the top of a cut slope at 18' behind the fog line. The slope of the cut is approximately 1-1/2 to 1. The luminaire pole base is 3'-0'' diameter by 4'-1/2'', deep per the standard plans. This would leave the leading edge of the pole with only 2-1/2'' below grade. This does not appear to be an optimal depth for the pole base. |
| We suggest that the pole depth be increased to 6'-1/2'', to compensate for the placement in the slope. |
| We also suggest that the pole center be relocated 2' closer to the fog line so that the luminaire avoids interferences with existing utilities at the top of the slope. |

| 5. Requested Response Date: | 9/March/2005 | Date Sent: | 7/March/2005 |
| 6. Send to TNC: | E-Mail: | pcwheato@bechtel.com | Fax: | 253-858-1816 |

## Part 2: TNC Review / Response (by TNC Construction)

| 7. TNC Response: |

## Part 3: Design Response

| 9. Design Responder: | Guillermo Sanchez | Company: | PTG/HNTB | Ph#: 425.450.2543 |
| 10. Design Response or Comments: |
| As coordinated with Joe Jacoby on 3/09/05. |
| Per the design the cut slope should have been a 2:1 slope at the location where the pole is to be installed. It is acceptable to install the luminaire pole 2 ft closer to the edge stripe. It is acceptable to increase the luminaire pole foundation depth to 6½'. |
| DCN GIL-005-03-01 will be issued concurrently with this response to revise the pole location and depth of foundation. |

| 11. Design Reviewer Approval: | Ray Wright | Date: | 3/09/05 |
| 12. Design Supervisor Approval: | Ben Whisler | Date: | 2/1/05 |
CONSTRUCTION NOTES:

3. CONSTRUCT FOUNDATION AND INSTALL LUMINAIRE STANDARD PER LUMINAIRE SCHEDULE.

26. INSTALL CONDUIT INTO EXISTING JUNCTION BOX. SPLICE NEW CIRCUIT WIRES TO EXISTING CIRCUIT "A" ILLUMINATION CONDUCTORS.

47. EXTEND FOUNDATION DEPTH 4FT. VERIFY ADDITIONAL DEPTH WITH THE ENGINEER.
Example 11

**ROADWAY SECTION DR-1**

DR3' 1+613.00 TO DR3' 1+820.00

* See slope table for A&B values
** See Sheet PD3 for butt joint planing detail

<table>
<thead>
<tr>
<th>STATION TO STATION</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR3 1+627.34 TO DR3 1+640.00</td>
<td>1:2</td>
<td>1:2</td>
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<tr>
<td>DR3 1+640.00 TO DR3 1+720.00</td>
<td>1:1.8</td>
<td>1:2</td>
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<tr>
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<td>1:1.8</td>
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<tr>
<td>DR3 1+750.00 TO DR3 1+760.00</td>
<td></td>
<td>1:4</td>
</tr>
<tr>
<td>DR3 1+760.00 TO DR3 1+820.00</td>
<td></td>
<td>1:6</td>
</tr>
</tbody>
</table>
What’s new in illumination design (or not so new) - continued

- Cross-sections
- At every location you are installing a luminaire you need to check the roadway sections for the slope in that area. You need this information to input the mounting height of the luminaire in AGI and to know how big to make the foundation.
What’s new in illumination design (or not so new) - continued

• Reviewing luminaire locations
  – After initial luminaire locations are identified the designer needs to check to make the location will work with other design features. The designer should review the approved channelization plan, existing and proposed utility plans, existing and proposed drainage plans, existing and proposed ITS plans, existing and proposed signing plans, last minute changes / addendums and all those other items that caught you in the past. (let us know what they are and we will add them here)
Reference Materials

- Roadway Lighting - RP-8-00 IESNA (Illuminating Engineering Society of North America) 2000 (update to RP-8, 1983)
- Recommended Practice for Tunnel Lighting IESNA RP-22-05 (updates Recommended Practice for Tunnel Lighting – IESNA. 1996)
- Tunnel Lighting Design Procedures – FHWA. 1985
- International Commission on Illumination (CIE). 1992
- WSDOT Traffic Manual. 1993
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Any questions?