# APPENDIX A

## Metric Practice

# THIS PAGE LEFT BLANK INTENTIONALLY

# METRIC PRACTICE

## GENERAL

This Appendix was originally included in the Metric PPM and was used as guidelines for the development of Metric plans. This was a useful tool especially for the English to Metric conversion of design information. This Appendix has now been included in the English PPM as a tool for use in cases where the designer may need to obtain information from Metric plans. This may provide the designer some insight as to how those Metric plans were developed.

## SUMMARY OF RULES

1. Convert values related to surveys, right of way and other geometric alignment using the U. S. Survey Foot taken to a minimum of 8 decimal places:

$$1 \text{ foot} = \frac{12 \text{ inches/foot}}{39.37 \text{ inches/meter}} = 0.304\ 800\ 61 \text{ meters}$$

   For other direct mathematical conversions use the SI definition:

$$1 \text{ foot} = 0.3048 \text{ meters}$$

2. Display direct mathematical (soft) converted values to the nearest 0.001 m or 1 mm.

3. Do not use commas to separate digits if a number has more than 4 digits. For numbers with more than 4 digits either right or left of the decimal, leave a space when practical. (Where the displayed number must be used in a mathematical operation on a computer the space may not be recognized properly and should not be used).

   Example: 10 000 or 0.609 35 or 13 471.359

4. To the extent practical, use the following rules for dimensioning roadway plans:

   a. For dimensions in meters, display values to at least one decimal place.

   b. For dimensions in millimeters, display values as whole numbers with no decimal place.

c. Do not use the centimeter.

d. Using the above rules, do not show the unit symbols "m" and "mm" unless needed for clarification. Show even dimensions in meters with a decimal and following zero digit, e.g. 300.0 to avoid confusion with 300 mm.

5. If a dimensioned item has a numerical quantity that is part of a group of numbers in a different range, select the unit that most adequately covers the range without unduly large or small numbers. For example, if 300 mm is part of a group of numbers shown in meters, show it as 0.3 m.

6. Show long dimensions, including all horizontal and vertical geometry, wall lengths, bridge span lengths and box or three sided culvert lengths, spans and heights in meters.

7. In general, show cross section dimensions of structural members in millimeters. This will normally include most drainage structures (except box culverts), drainage pipe, and special drainage structure details. (Note: The actual size of drainage pipe and standard drainage structure boxes will remain the same. However, label these items in nominal size based on 1" = 25 mm. Example: Label 24" pipe as 600 mm pipe; Label a 4' diameter structure as a 1200 mm structure.)

8. Show pavement thickness descriptions in millimeters.

9. Use 0.1 m for both base extension on rural sections (formerly 3") and for stabilization extension on curbed sections (formerly 6").

10. On typical sections, show type of curb, "E" or "F", not the dimension.

11. As a general rule, display metric dimensions to one more decimal place than the corresponding dimension in English units:

a. Typical Section Elements, including lane widths and shoulder widths - in meters, generally to 1 decimal place.

b. Horizontal control points on plans, including survey centerline, baseline, intersections and alignment - in meters to 3 decimal places. The normal station interval for centerlines and baselines is 100 meters. (1+00.000 = 100 m)

c. Vertical alignment control points, (PVC, PVI, PVT) and profile grade elevations - in meters to 3 decimal places.

d. Profile Grade - in percent to 4 decimal places.

e. Proposed flow lines - in meters to 2 decimal places.

f. Manhole tops and grate elevations - in meters to 2 decimal places.

g. Ditch elevations - in meters to 2 decimal places.

h. Box Culvert or Three-sided Spans and Heights - in meters to 1 decimal for new construction; in meters to 2 decimal places for extensions of existing box culverts originally constructed to English dimensions.

12. Where practical, round short radius curves (<150.0 m), including curb returns and control radii, to the nearest meter. Round longer radius curves to the nearest 5 meters. (See attached tables.)

13. Display alignment bearings and delta angles in curve data in degrees, minutes and seconds, rounded to the nearest second.

14. Omit "degree of curvature" from curve data. It has no definition in the metric system. Instead, use the radius definition. Equations:

$$\text{Tangent } T = R \tan\left(\frac{\Delta}{2}\right)$$

$$\text{Length } T = R \ (\Delta \text{ in Radians})$$

$$\text{Long Chord } LC = 2 \ R \sin\left(\frac{\Delta}{2}\right)$$

15. On resurfacing projects, hard convert typical section dimensions (lane widths, shoulder widths, etc.) where existing conditions permit. Exception: Use direct mathematical (soft) conversion (Rule Number 2) for existing pavement widths in curbed sections, existing right of way widths, and existing median widths.

16. Continue to post sign messages for speed limits and distances in English units. Note: The posted speed for curb and gutter sections with design speed of 80 km/h (corresponds to 50 mph), should not exceed 45 mph.

17. A "hard" metric project is defined as one where metric standard index drawings and metric specifications are used, and the design complies with adopted metric criteria.

18. Beginning with metric projects express slope ratios in vertical to horizontal (V:H) format. For example, show roadside slopes as 1:6, 1:4, rather than past convention as 6:1 or 4:1.

19. As a general guideline for new construction and reconstruction, show cross sections in 20 meter intervals for urban projects and 50 meter intervals for rural projects. Project specific factors may dictate greater or lesser intervals.

20. When project limits are identified by kilometer point location on the Key Sheet, show the equivalent milepost using direct mathematical conversion.

(example: kp 1.609 = MP 1.000)

21. Label existing and proposed utilities in metric. Use the FDOT ***Basis of Estimates Manual*** utility pay item list of metric sizes as a guide.

**PLAN SCALES**

| ENGLISH SCALE | METRIC SCALE |
|---|---|
| 1" = 2' | 1: 25 |
| 1" = 5' | 1: 50 |
| 1" = 10' | 1: 100 |
| 1" = 20' | 1: 200 |
| 1" = 40' | 1: 400 or 1: 500 |
| 1" = 50' | 1: 500 |
| 1" = 100' | 1: 1000 |
| 1" = 200' | 1: 2000 |
| 1" = 400' | 1: 5000 |

Plan sheet size will remain the same. The viewing area of a plan sheet will be 800 mm long on "D" size sheets and 400 mm on "B" size sheets. Allowing for open space at each side, this provides a coverage of 140 m at 1:400 scale, 350 m at 1:1000 and 700 m at 1:2000 on "B" size sheets.

**Plan/ Profiles**:

| | Sheet Size | Horizontal | Vertical |
|---|---|---|---|
| Rural - | D | 1:1000 | 1:50 or 1:100 |
| | B | 1:2000 | 1:100 or 1:200 |
| Urban - | D | 1:200 | 1:50 |
| | B | 1:400 or 1:500 | 1:50 or 1:100 |

Show centerline major tick marks at each station. Show centerline minor tick marks at 20 meter intervals when using 1:200 and 1:400 scale, and at 25 meter intervals when using 1:500 scale.

**Cross Sections**:

| | Sheet Size | Horizontal | Vertical |
|---|---|---|---|
| Normal | D | 1:50 | 1:25 |
| | B | 1:100 | 1:50 |
| Wide Sections | D | 1:100 | 1:25 or 1:50 |
| | B | 1:200 | 1:50 or 1:100 |
| Narrow Sections | D | 1:25 | 1:25 |
| | B | 1:50 | 1:50 |

As a guideline, the normal interval for cross sections is 20 meters for urban projects and 50 meters for rural projects.

# COMPARISON OF ENGLISH AND METRIC VALUES

## LANE WIDTHS

| CURRENT | SOFT | HARD |
|---|---|---|
| 8 ft | 2.438 m | 2.4 m |
| 9 ft | 2.743 m | 2.7 m |
| 10 ft | 3.048 m | 3.0 m |
| 11 ft | 3.353 m | 3.3. m |
| 12 ft | 3.658 m | 3.6 m |
| 14 ft | 4.267 m | 4.2 m |
| 15 ft | 4.572 m | 4.5 m |

## BIKE LANE WIDTHS

| | | |
|---|---|---|
| 4 ft | 1.219 m | 1.2 m |
| 5 ft | 1.524 m | 1.5 m |

## SIDEWALK AND UTILITY STRIP WIDTHS

| CURRENT | SOFT | HARD |
|---|---|---|
| 2 ft | 0.610 m | 0.6 m |
| 3 ft | 0.914 m | 0.9 m |
| 4 ft | 1.219 m | 1.2 m |
| 5 ft | 1.524 m | 1.5 m |
| 6 ft | 1.829 m | 1.8 m |
| 7 ft | 2.134 m | 2.1 m |
| 8 ft | 2.438 m | 2.4 m |
| 9 ft | 2.743 m | 2.7 m |
| 10 ft | 3.048 m | 3.0 m |

## CURB AND GUTTER WIDTHS

| TYPE | CURRENT | SOFT | HARD |
|---|---|---|---|
| E | 2.25 ft | 686 mm | 675 mm |
| F | 2.00 ft | 610 mm | 600 mm |
| Shoulder Gutter | 3.50 | 1067 mm | 1050 mm |

## SHOULDER WIDTHS

| CURRENT | SOFT | HARD |
|---|---|---|
| 2 ft | 0.610 m | 0.6 m |
| 4 ft | 1.219 m | 1.2 m |
| 5 ft | 1.524 m | 1.5 m |
| 6 ft | 1.829 m | 1.8 m |
| 8 ft | 2.438 m | 2.4 m |
| 10 ft | 3.048 m | 3.0 m |
| 12 ft | 3.658 m | 3.6 m |

# COMPARISON OF ENGLISH AND METRIC VALUES

## TRAFFIC SEPARATOR WIDTHS

| CURRENT | SOFT | HARD |
|---|---|---|
| 4 ft | 1.219 m | 1.2 m |
| 6 ft | 1.829 m | 1.8 m |
| 8.5 ft | 2.591 m | 2.6 m |

## MEDIAN WIDTHS

| CURRENT | SOFT | HARD |
|---|---|---|
| 15.5 ft | 4.724 m | 5.0 m |
| 17.5 ft | 5.334 m | N/A |
| 19.5 ft | 5.944 m | 6.0 m |
| 22 ft | 6.706 m | 6.6 m |
| 26 ft | 7.925 m | 7.8 m |
| 30 ft | 9.144 m | 9.0 m |
| 40 ft | 12.192 m | 12.0 m |
| 50 ft | 15.240 m | 15.0 m |
| 60 ft | 18.288 m | 18.0 m |
| 64 ft | 19.507 m | 19.2 m |
| 88 ft | 26.822 m | 26.4 m |

## DITCH WIDTHS

| CURRENT | SOFT | HARD |
|---|---|---|
| 3 ft | 0.914 m | 0.9 m |
| 3.5 ft | 1.067 m | 1.0 m |
| 4 ft | 1.219 m | 1.2 m |
| 5 ft | 1.524 m | 1.5 m |

## DESIGN SPEED

| CURRENT | METRIC | |
|---|---|---|
| 20 | 30 | |
| 25 | 40 | |
| 30 | 50 | |
| 35 | 60 | low speed |
| 40 | 60 | |
| 45 | 70 | ⇑ |
| 50 | | ⇓ |
| 55 | 80 | |
| 60 | 90 | |
| 65 | 100 | high speed |
| 70 | 110 | |
| | 110 | |

# METRIC CONVERSIONS

## RETURN RADII
## CONTROL RADII
## SHORT RADIUS CURVE RADII

| TURNING SPEED mph | RADIUS (feet) | SOFT (meters) | HARD (meters) | TURNING SPEED km/h | RADIUS (meters) | |
|---|---|---|---|---|---|---|
| | 15 | 4.572 | 5.0 | | | |
| | 20 | 6.096 | 6.0 | | | |
| 10 | 25 | 7.620 | 8.0 | 15 | 7.0 | |
| | 30 | 9.144 | 9.0 | 20 | 10.0 | |
| | 35 | 10.668 | 11.0 | | | |
| | 40 | 12.192 | 12.0 | | | |
| | 45 | 13.716 | 14.0 | | | |
| 15 | 50 | 15.240 | 15.0 | | | |
| | 60 | 18.288 | 18.0 | | | |
| | 75 | 22.860 | 23.0 | | | |
| 20 | 90 | 27.432 | 27.0 | 30 | 25.0 | |
| | 100 | 30.480 | 30.0 | | | |
| 25 | 150 | 45.720 | 46.0 | 40 | 50.0 | |
| 30 | 230 | 70.104 | 70.0 | 50 | 80.0 | |
| 35 | 310 | 94.488 | 94.0 | 60 | 115.0 | Small |
| 40 | 430 | 131.064 | 131.0 | 60 | 115.0 | Radii ⇑ |
| | 550 | 167.640 | 170.0 | | | ⇓ |
| | 690 | 210.312 | 210.0 | | | Large |
| | 840 | 256.032 | 255.0 | | | Radii |
| | 1040 | 316.992 | 315.0 | | | |

Note: Selection of appropriate radii should also consider design vehicle.

Conversions on this sheet and the next are accomplished as follows:

1. Radius in feet x (12 ÷ 39.37) = radius in meters (soft)

2. Values for metric turning speeds based on proposed AASHTO metric criteria.

# COMPARISON OF ENGLISH AND METRIC VALUES

| DEGREE OF CURVE TO RADIUS VALUES | | | |
|---|---|---|---|
| **DEGREE** | **RADIUS** | **RADIUS-Soft (meters)** | **RADIUS-Hard (meters)** |
| 0°-15' | 22918.31 | 6985.515 | 6985.0 |
| 0°-30' | 11459.16 | 3492.758 | 3495.0 |
| 0°-45' | 7639.44 | 2328.505 | 2330.0 |
| 1°-00' | 5729.58 | 1746.379 | 1745.0 |
| 1°-15' | 4583.66 | 1397.103 | 1395.0 |
| 1°-30' | 3819.72 | 1164.253 | 1165.0 |
| 1°-45' | 3274.04 | 997.931 | 1000.0 |
| 2°-00' | 2864.79 | 873.189 | 875.0 |
| 2°-15' | 2546.48 | 776.168 | 775.0 |
| 2°-30' | 2291.83 | 698.552 | 700.0 |
| 2°-45' | 2083.48 | 635.047 | 635.0 |
| 3°-00' | 1909.86 | 582.126 | 580.0 |
| 3°-15' | 1762.95 | 537.347 | 535.0 |
| 3°-30' | 1637.02 | 498.965 | 500.0 |
| 3°-45' | 1527.89 | 465.701 | 465.0 |
| 4°-00' | 1432.39 | 436.595 | 435.0 |
| 4°-15' | 1348.14 | 410.913 | 410.0 |
| 4°-30' | 1273.24 | 388.084 | 390.0 |
| 4°-45' | 1206.23 | 367.659 | 370.0 |
| 5°-00' | 1145.92 | 349.276 | 350.0 |
| 5°-30' | 1041.74 | 317.523 | 320.0 |
| 6°-00' | 954.93 | 291.063 | 290.0 |
| 7°-00' | 818.51 | 249.483 | 250.0 |
| 8°-00' | 716.20 | 218.297 | 220.0 |
| 9°-00' | 636.62 | 194.042 | 195.0 |
| 10°-00' | 572.96 | 174.638 | 175.0 |

**Note:** Degree of Curvature is not used in the Metric System.

# GENERAL METRIC INFORMATION

**SI PREFIXES**

M mega $10^{6} = 1\ 000\ 000$
k kilo $10^{3} = 1\ 000$
m milli $10^{-3} = 0.001$

| Base SI Units | | | Related Units | | | |
|---|---|---|---|---|---|---|
| **Quantity** | **Unit** | **Symbol** | **Unit** | **Symbol** | **Relation** | |
| length | meter | m | millimeter | mm | =0.001 m | ($10^{-3}$ m) |
| | | | kilometer | km | =1000 m | ($10^{3}$ m) |
| mass | kilogram | kg | gram | g | =0.001kg | ($10^{-3}$ kg) |
| | | | megagram | Mg | =1000 kg | ($10^{3}$ kg) |
| | | | metric ton | t | =1000 kg | ($10^{3}$ kg) |
| time | second | s | hour | h | =3600 s | |

## DERIVED SI UNITS WITH SPECIAL NAMES

| Quantity | Unit | Symbol | Formula |
|---|---|---|---|
| force | newton | N | $kg \cdot m/s^2$ |
| pressure | pascal | Pa | $N/m^2$ |
| moment | newton meter | N·m | N·m |
| Temperature | degree Celsius | °C | --- |

# GENERAL METRIC INFORMATION

| Common Derived Units of SI | | | Related Units | | | |
|---|---|---|---|---|---|---|
| **Quantity** | **Unit** | **Symbol** | **Unit** | **Symbol** | **Relation** | |
| acceleration | meter/second $^2$ | $m/s^2$ | | | | |
| area | square meter | $m^2$ | sq. millimeter | $m\ m^2$ | $=0.000\ 001\ m^2$ | $(10^{-6}\ m^2)$ |
| | | | hectare | ha | $=10\ 000\ m^2$ | $(10^4\ m^2)$ |
| | | | sq. Kilometer | $k\ m^2$ | $=1\ 000\ 000\ m^2$ | $(10^6\ m^2)$ |
| density, mass | kilogram/cubic | $kg/m^3$ | | | | |
| velocity | meter/second | m/s | kilometer/hour | km/h | =0.2778 m/s | |
| volume | cubic meter | $m^3$ | liter | L | $=0.001\ m^3$ | $(10^{-3}\ m^3)$ |
| | | | milliliter | mL | $-0.000\ 001\ m^2$ | $(10^{-6}\ m^3)$ |

# GENERAL METRIC INFORMATION

## SOFT CONVERSION FACTORS

| CLASS | MULTIPLY | BY | | TO GET |
|---|---|---|---|---|
| LENGTH | inches | 25.400 000 | | mm |
| | inches | 0.025 400 | | m |
| | feet | 0.304 800 | ** | m |
| | yards | 0.914 400 | | m |
| | miles | 1609.344 000 | | m |
| | miles | 1.609 344 | | km |
| AREA | sq inches | 645.160 000 | | $mm^2$ |
| | sq feet | 0.092 903 | | $m^2$ |
| | sq yard | 0.836 127 | | $m^2$ |
| | acres | 4046.873 000 | | $m^2$ |
| | sq miles | 2.589 988 | | $km^2$ |
| VOLUME | board feet | 0.002 360 | | $m^3$ |
| | cubic feet | 0.028 317 | | $m^3$ |
| | cubic yard | 0.764 555 | | $m^3$ |
| | gallon (fluid) | 3.785 412 | | L |
| | ounce (fluid) | 29.573 530 | | ML |
| | bushels | 0.035 239 | | $m^3$ |
| MASS | ounce | 0.028 350 | | kg |
| | pound | 0.453 592 | | kg |
| | ton | 907.184 700 | | kg |
| | lb/ft | 1.488 164 | | kg/m |
| | $lb/ft^2$ | 4.882 425 | | $kg/m^2$ |
| | $lb/ft^3$ | 16.018 460 | | $kg/m^3$ |
| | $ounces/ft^2$ | 0.305 152 | | $kg/m^2$ |
| FORCE | pound (force) | 4.448 222 | | N |
| | lb/ft | 14.593 900 | | N/m |
| | $lb/ft^2$ | 47.880 260 | | $N/m^2$ |
| | $lb/ft^3$ | 157.087 5 | | $n/m^3$ |
| STRESS | psi | 6894.757 000 | | Pa |
| | $kips/in^2$ | 6.894 757 | | $N/mm^2$ |
| VELOCITY | fps | 0.304 800 | | m/s |
| | mph | 0.447 040 | | m/s |
| | mph | 1.609 344 | | km/h |
| TEMPERATURE | (°F-32) / 1.8 = °C | | | |
| ANGLES | (no change) | deg, min, sec | | |

** For conversion from U.S. Geodetic Survey, the U.S. survey foot equals 0.304 800 610 m