Massachusetts Department of Transportation

Construction Standard Details

Highway Division

4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)

GROUND ELEVATION

SAFE FOR 1V:1.5H SLOPE

3"

18"

6" MINIMUM
18" MAXIMUM

1" BEVEL

SEE NOTE #1

BATTER
4%

BACKFILL ELEVATION

GRAVEL BACKFILL

4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)

12" MIN

4.0" MIN

12"

0.5 "H"

"W" 12"

massDOT
Massachusetts Department of Transportation
Highway Division

OCTOBER 2017
EXAMPLE: DRAWING NUMBER - 201.1.0

SECTION NUMBER (1,2,3,4 OR 5)
(100, 200, 300, 400 OR 500 SERIES)
SECTION 1 (100 SERIES)
  HIGHWAY DESIGN AND PAVEMENT DETAILS
SECTION 2 (200 SERIES)
  DRAINAGE
SECTION 3 (300 SERIES)
  CEMENT CONCRETE, MASONRY STANDARDS
SECTION 4 (400 SERIES)
  HIGHWAY GUARD RAIL AND FENCES
SECTION 5 (500 SERIES)
  MISCELLANEOUS

CATEGORY IN SERIES:
  01 FOR CATCH BASINS
  02 FOR MANHOLES
  03 FOR DROP INLETS, ETC.

DRAWING NUMBER IN EACH CATEGORY

AUXILIARY DRAWING NUMBER:
A NUMBER OTHER THAN ZERO WILL APPEAR IN THIS
POSITION WHEN IT IS SUBSEQUENTLY NECESSARY TO INSERT
ONE OR MORE ADDITIONAL DRAWINGS BETWEEN TWO EXISTING
DRAWING NUMBERS IN THE SAME CATEGORY.
SECTION 1
HIGHWAY DESIGN AND PAVEMENT DETAILS

LIMIT OF MUCK EXCAVATION................................................................. E 101.1.0
ROCK CUT SELECTION............................................................................ E 102.1.0
METHOD OF ROUNGING SLOPES- CUT AND FILL SLOPES.................... E 103.1.0
METHOD OF STEPPING SURFACE AND BASE COURSE LAYERS............. E 104.1.0
TRANSVERSE JOINTS AT EXPANSION JOINTS...................................... E 104.1.1
LOCATION OF SAW CUT FOR TRANSVERSE JOINTS
   AT BRIDGE ABUTMENT.......................................................................... E 104.1.2
SCORED CEMENT CONCRETE PAVEMENT AT RAMPS............................... E 105.2.0
SHOULDER SECTION OF SCORED CEMENT CONCRETE PAVEMENT.... E 105.2.1
FREEWAY ENTRANCE RAMP DETAIL - RUMBLE STRIP
   INSTALLATION AT GORE AREAS.......................................................... E 105.3.2
FREEWAY ENTRANCE RAMP DETAIL - PAVEMENT MARKING
   INSTALLATION AT GORE AREAS.......................................................... E 105.3.3
RUMBLE STRIP INSTALLATION DETAILS BICYCLES PROHIBITED.......... E 105.5.0
RUMBLE STRIP INSTALLATION DETAILS BICYCLES PERMITTED............. E 105.7.0
HOT MIX ASPHALT BERM TYPE A.............................................................. E 106.1.0
HOT MIX ASPHALT CURBS...................................................................... E 106.2.0
METHOD OF SETTING VERTICAL CURB................................................... E 106.3.0
METHOD OF SETTING SLOPED EDGING.................................................. E 106.5.0
INTERSECTIONS..................................................................................... E 107.1
WHEELCHAIR RAMPS LESS THAN 12'-4" SIDEWALK......................... E 107.2.0
WHEELCHAIR RAMP ON NARROW SIDEWALK WITH
   DETECTABLE WARNING PANEL....................................................... E 107.2.1
WHEELCHAIR RAMPS GREATER THAN 12'-4" SIDEWALK..................... E 107.3.0
WHEELCHAIR RAMP FOR ONE CONTINUOUS DIRECTION
   OF PEDESTRIAN TRAFFIC.................................................................... E 107.6.0
WHEELCHAIR RAMP WITH 3" CURB REVEAL.............................................. E 107.6.3
“T” INTERSECTION WHEELCHAIR RAMP................................................. E 107.6.4
DETECTABLE WARNING PANEL FOR WHEELCHAIR RAMPS
   AND STANDARD RAMP TERMINOLOGY.............................................. E 107.6.5
WHEELCHAIR RAMP WITH LANDSCAPING STRIP................................. E 107.6.9
SIDEWALK THROUGH DRIVEWAYS WITHOUT CURB RETURNS 6'......... E 107.7.0
SIDEWALK THROUGH DRIVEWAYS WITH CURB
   RETURNS 2' CURB CORNERS.............................................................. E 107.8.0
RESIDENTIAL DRIVEWAYS.................................................................... E 107.8.1
CURB TRANSITION LENGTH FOR WHEELCHAIR RAMPS...................... E 107.9.0
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DRAWING NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION 2</td>
<td></td>
</tr>
<tr>
<td>DRAINAGE</td>
<td></td>
</tr>
<tr>
<td>CONCRETE BLOCK CATCH BASIN</td>
<td>E 201.3.0</td>
</tr>
<tr>
<td>PRECAST CONCRETE CATCH BASIN</td>
<td>E 201.4.0</td>
</tr>
<tr>
<td>PRECAST CONCRETE CATCH BASIN TUB</td>
<td>E 201.5.0</td>
</tr>
<tr>
<td>CATCH BASIN FRAME</td>
<td>E 201.6.0</td>
</tr>
<tr>
<td>HOOK LOCK CASCADE GRATE- FLOW FROM LEFT</td>
<td>E 201.7.0</td>
</tr>
<tr>
<td>HOOK LOCK CASCADE GRATE- FLOW FROM RIGHT</td>
<td>E 201.7.1</td>
</tr>
<tr>
<td>FRAME AND HOOK LOCK CASCADE GRATE- FLOW FROM LEFT- ASSEMBLY DETAILS</td>
<td>E 201.9.0</td>
</tr>
<tr>
<td>FRAME AND HOOK LOCK CASCADE GRATE- FLOW FROM RIGHT- ASSEMBLY DETAILS</td>
<td>E 201.9.1</td>
</tr>
<tr>
<td>HOOK LOCK BAR GRATE</td>
<td>E 201.10.0</td>
</tr>
<tr>
<td>FRAME AND HOOK LOCK BAR GRATE- FRAME ASSEMBLY DETAILS</td>
<td>E 201.10.1</td>
</tr>
<tr>
<td>DROP INLET GRATE</td>
<td>E 201.11.0</td>
</tr>
<tr>
<td>CATCH BASIN HOOD</td>
<td>E 201.12.0</td>
</tr>
<tr>
<td>CONCRETE BLOCK MANHOLE - MANHOLES 9' OR LESS IN DEPTH</td>
<td>E 202.2.0</td>
</tr>
<tr>
<td>CONCRETE BLOCK MANHOLE - MANHOLES OVER 9' IN DEPTH</td>
<td>E 202.3.0</td>
</tr>
<tr>
<td>PRECAST CONCRETE MANHOLES 9' OR LESS IN DEPTH</td>
<td>E 202.4.0</td>
</tr>
<tr>
<td>SPECIAL MANHOLES FOR 36” TO 84” DIAMETER R.C. PIPE</td>
<td>E 202.5.0</td>
</tr>
<tr>
<td>MANHOLE FRAME AND COVER - A FRAME</td>
<td>E 202.6.0</td>
</tr>
<tr>
<td>MANHOLE FRAME AND COVER - B FRAME</td>
<td>E 202.7.0</td>
</tr>
<tr>
<td>MANHOLE COVER DETAILS</td>
<td>E 202.8.0</td>
</tr>
<tr>
<td>CONCRETE COLLARS</td>
<td>E 202.9.0</td>
</tr>
<tr>
<td>DROP INLETS TYPE A - PRECAST CONCRETE TYPE B - CONCRETE BLOCK</td>
<td>E 203.1.0</td>
</tr>
<tr>
<td>DROP INLETS TYPE AF - PRECAST CONCRETE TYPE BF - CONCRETE BLOCK</td>
<td>E 203.2.0</td>
</tr>
<tr>
<td>DROP INLET TYPE C</td>
<td>E 203.3.0</td>
</tr>
<tr>
<td>DROP INLET TYPE CF</td>
<td>E 203.4.0</td>
</tr>
<tr>
<td>DROP INLET TYPE D</td>
<td>E 203.5.0</td>
</tr>
<tr>
<td>DROP INLET TYPE DF</td>
<td>E 203.6.0</td>
</tr>
<tr>
<td>FLUSH DROP INLET THROAT</td>
<td>E 203.7.0</td>
</tr>
<tr>
<td>GUTTER INLET</td>
<td>E 204.2.0</td>
</tr>
<tr>
<td>DRY STONE MASONRY LEACHING BASIN</td>
<td>E 205.1.0</td>
</tr>
<tr>
<td>CONCRETE BLOCK LEACHING BASIN</td>
<td>E 205.2.0</td>
</tr>
<tr>
<td>CORRUGATED STEEL METAL PIPE - TABLE OF MINIMUM WALL THICKNESS</td>
<td>E 206.1.0</td>
</tr>
</tbody>
</table>
**SECTION 2**  
DRAINAGE CONT.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
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</tr>
</thead>
<tbody>
<tr>
<td>CORRUGATED STEEL METAL PIPE ARCH - TABLE OF MINIMUM WALL THICKNESS</td>
<td>E 206.2.0</td>
</tr>
<tr>
<td>CORRUGATED METAL PIPE UNDER FILL SLOPE</td>
<td>E 206.3.0</td>
</tr>
<tr>
<td>CONCRETE AND FIELD STONE MASONRY PIPE ENDS FOR 8&quot; TO 30&quot; PIPE</td>
<td>E 206.4.0</td>
</tr>
<tr>
<td>QUANTITY TABLES FOR CONCRETE AND FIELD STONE MASONRY PIPE ENDS</td>
<td>E 206.4.1</td>
</tr>
<tr>
<td>CONCRETE AND FIELDSTONE MASONRY PIPE ENDS FOR COMBINATION PIPES UP TO 30&quot;</td>
<td>E 206.5.0</td>
</tr>
<tr>
<td>CONCRETE AND FIELDSTONE MASONRY PIPE ENDS FOR 30&quot; TO 84&quot; PIPE CULVERTS</td>
<td>E 206.6.0</td>
</tr>
<tr>
<td>STONE PIPE ENDS FOR PIPES 24&quot; AND LESS IN DIA</td>
<td>E 206.7.0</td>
</tr>
<tr>
<td>REINFORCED CONCRETE PIPE FLARED ENDS</td>
<td>E 206.8.0</td>
</tr>
<tr>
<td>STANDARD METAL END</td>
<td>E 206.9.0</td>
</tr>
<tr>
<td>CONCRETE SPLASH PADS</td>
<td>E 208.1.0</td>
</tr>
<tr>
<td>SUBDRAIN</td>
<td>E 209.1.0</td>
</tr>
<tr>
<td>DITCH CHECK DAMS FOR EROSION CONTROL</td>
<td>E 210.2.0</td>
</tr>
<tr>
<td>HAY BALES AND SILT FENCES FOR EROSION CONTROL</td>
<td>E 210.3.0</td>
</tr>
<tr>
<td>HALF CIRCLE CCM PIPE WATERWAYS</td>
<td>E 211.1.0</td>
</tr>
<tr>
<td>PAVED WATERWAYS AND APRON</td>
<td>E 211.2.0</td>
</tr>
<tr>
<td>PAVED WATERWAYS</td>
<td>E 211.3.0</td>
</tr>
</tbody>
</table>

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**SECTION 3**  
CEMENT CONCRETE & MASONRY STRUCTURES

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
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<tr>
<td>CEMENTED STONE MASONRY WALL</td>
<td>E 302.2.0</td>
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<tr>
<td>SPECIAL SLOPE PAVING UNDER BRIDGES REINFORCED CONCRETE SLAB</td>
<td>E 303.1.0</td>
</tr>
<tr>
<td>SPECIAL SLOPE PAVING UNDER BRIDGES REINFORCED CONCRETE SLAB DETAILS</td>
<td>E 303.1.1</td>
</tr>
<tr>
<td>CEMENT CONCRETE STEPS 1/2</td>
<td>E 304.1.0</td>
</tr>
<tr>
<td>CEMENT CONCRETE STEPS 2/2</td>
<td>E 304.2.0</td>
</tr>
<tr>
<td>TYPICAL CANTILEVER RETAINING WALL SECTION</td>
<td>E 305.1.0</td>
</tr>
<tr>
<td>CANTILEVER RETAINING WALLS DENSE FOUNDATION SOILS, SLOPING BACKFILL</td>
<td>E 305.2.0</td>
</tr>
<tr>
<td>CANTILEVER RETAINING WALLS DENSE FOUNDATION SOILS, LEVEL BACKFILL, SURCHARGE</td>
<td>E 305.3.0</td>
</tr>
</tbody>
</table>
SECTION 3  
CEMENT CONCRETE & MASONRY STRUCTURES CONT.

CANTILEVER RETAINING WALLS LOOSE FOUNDATION SOILS,  
SLOPING BACKFILL.......................................................................................... E 305.4.0
CANTILEVER RETAINING WALLS LOOSE FOUNDATION SOILS,  
LEVEL BACKFILL, SURCHARGE..................................................................... E 305.5.0
CANTILEVER RETAINING WALLS ROCK FOUNDATION,  
SLOPING BACKFILL.......................................................................................... E 305.6.0
CANTILEVER RETAINING WALLS ROCK FOUNDATION,  
LEVEL BACKFILL, SURCHARGE..................................................................... E 305.7.0

SECTION 4  
HIGHWAY GUARD RAIL & FENCES

GENERAL NOTES ........................................................................................... 400.1.0
GUARDRAIL, TL-3 ......................................................................................... 400.1.1
GUARDRAIL, TL-2 ......................................................................................... 400.1.2
W-BEAM & THRIE BEAM PANEL DETAILS .............................................. 400.1.3
POST & OFFSET BLOCK DETAILS .............................................................. 400.1.4
GUARDRAIL MOUNTING HEIGHTS & POST DEPTHS ................................. 400.1.5
GUARDRAIL SECTIONS ............................................................................... 400.1.6
APPROACH GEOMETRY : SINGLE FACED .................................................. 400.2.1
APPROACH GEOMETRY : ADJACENT TO CURB & DOUBLE FACED ......... 400.2.2
LAYOUT TO SINGLE FACED RIGID BARRIER OR BRIDGE RAIL .......... 400.2.3
LAYOUT TO DOUBLE FACED RIGID BARRIER - TRAILING ENDS .......... 400.2.4
TRANSITION TO NCHRP 350 GUARDRAIL ............................................... 400.3.1
TRANSITION TO RIGID BARRIER (SINGLE FACED) ................................. 400.3.2
TRANSITION TO RIGID BARRIER (DOUBLE FACED) .............................. 400.3.3
TRANSITION TO RIGID BARRIER DETAILS ............................................ 400.3.4
TRANSITION TO BRIDGE RAIL (BACK OF SIDEWALK) ......................... 400.3.5
TRANSITION TO BRIDGE RAIL (FACE OF CURB) ................................. 400.3.6
TRANSITION TO BRIDGE RAIL DETAILS .............................................. 400.3.7
TRAILING ANCHORAGE ........................................................................... 400.4.1
TRAILING ANCHORAGE COMPONENT DETAILS .................................... 400.4.2
SPECIAL POST DESIGNS .......................................................................... 400.5.1
F SHAPE CONCRETE BARRIER................................................................... E 402.10.0
F SHAPE CONCRETE BARRIER SYMMETRICAL SECTION  
REINFORCING DETAILS.............................................................................. E 402.11.0
F SHAPE CONCRETE BARRIER ASYMMETRICAL SECTION  
REINFORCING DETAILS.............................................................................. E 402.12.0
SECTION 4
HIGHWAY GUARD RAIL & FENCES CONT.

F SHAPE CONCRETE BARRIER .............................................................. E 402.10.0
F SHAPE CONCRETE BARRIER SYMMETRICAL SECTION
  REINFORCING DETAILS .............................................................. E 402.11.0
F SHAPE CONCRETE BARRIER ASYMMETRICAL SECTION
  REINFORCING DETAILS .............................................................. E 402.12.0
F SHAPE CONCRETE BARRIER DOWEL DETAILS ............................... E 402.13.0
F SHAPE CONCRETE BARRIER WITH CONCRETE SEPARATOR .................. E 402.20.0
  REINFORCING DETAILS .............................................................. E 402.21.0
F SHAPE CONCRETE BARRIER WITH CONCRETE SEPARATOR
  DOWEL DETAILS ........................................................................... E 402.22.0
TEMPORARY CONCRETE BARRIER MASH TL-2  1/3 ............................ E 403.1.0
TEMPORARY CONCRETE BARRIER MASH TL-2  2/3 ............................ E 403.2.0
TEMPORARY CONCRETE BARRIER MASH TL-2  3/3 ............................ E 403.3.0
TEMPORARY CONCRETE BARRIER RETROFITTED
  TO MASH TL-3  1/2 .................................................................... E 403.8.0
TEMPORARY CONCRETE BARRIER RETROFITTED
  TO MASH TL-3  2/2 .................................................................... E 403.9.0
CHAIN LINK FENCE (SPRING TENSION WIRE) ................................... E 404.1.0
CHAIN LINK FENCE (SPRING TENSION WIRE) ................................... E 404.2.0
CHAIN LINK FENCE (PIPE TOP RAIL) ............................................ E 404.4.0
CHAIN LINK FENCE DETAILS OF CABLE ATTACHMENTS
  & POST BASES ........................................................................... E 404.5.0
CHAIN LINK FENCE - SWING GATE ................................................ E 404.6.0
CHAIN LINK FENCE CANTILEVER GATE ......................................... E 404.7.0
CHAIN LINK FENCE MOUNTED ON GUARD RAIL ............................. E 404.8.0
CHAIN LINK FENCE POST DETAILS .............................................. E 404.10.0

SECTION 5
MISCELLANEOUS

WETLANDS PROTECTION ACT SIGN ............................................... E 501.1.0
TREE WELLS ................................................................................. E 502.1.0
SETTING RURAL MAILBOXES ...................................................... E 504.1.0
DEMOUNTABLE REFLECTORIZED STATION MARKER AND
  PROJECT MARKER ....................................................................... E 505.1.0
BOUND LETTERED GRANITE ......................................................... E 506.2.0
LIMIT AND PAYLINE FOR MUCK EXCAVATION WHEN REFERENCE SLOPE INTERSECTS VERTICAL LIMIT OF MUCK EXCAVATION INSIDE OF "B"

VERTICAL LIMIT OF MUCK EXCAVATION

LIMIT AND PAYLINE FOR MUCK EXCAVATION WHEN REFERENCE SLOPE INTERSECTS VERTICAL LIMIT OF MUCK EXCAVATION OUTSIDE OF "B"

VERTICAL LIMIT OF MUCK EXCAVATION

NOTES:

1. "B" - INTERSECTION OF EXISTING GROUND AND SLOPE OF EMBANKMENT
2. THE ABOVE METHOD MAY ALSO BE USED TO DETERMINE THE LIMIT FOR EXCAVATION OF OTHER UNSUITABLE MATERIALS
3. I.T. - INTERSECTION OF TANGENT
**DESIGN**

- W=12' FOR ROCK CUTS OF 20' OR LESS
- W=17' FOR ROCK CUTS 25' OR MORE
- W-VARIES 12' - 17' FOR ROCK CUTS BETWEEN 20' - 25'; DETERMINE PROPORTIONATELY

**NOTES:**

1. ONLY ROCK ACTUALLY REMOVED IS PAYABLE. NO PAYMENT WILL BE MADE BEYOND THE ROCK PAYMENT LINE
METHOD OF ROUNDOING CUT SLOPES

ROUNDING TABLE FOR 1V : 2H SLOPE

<table>
<thead>
<tr>
<th>D FEET</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 &lt;</td>
<td>1&quot;</td>
<td>2&quot;</td>
</tr>
<tr>
<td>&gt;3 TO 20</td>
<td>D/3</td>
<td>2/3 D</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>7&quot;</td>
<td>14&quot;</td>
</tr>
</tbody>
</table>

1V : 3H SLOPE Rounding

1. WHEN "D1" IS 2' OR MORE ROUND AS SHOWN IN TABLE ABOVE.
2. WHEN "D1" IS LESS THAN 2' ROUND FULL LENGTH OF SLOPE.

METHOD OF ROUNDOING FILL SLOPES

* USE SLOPE LENGTHS FOR LIMITED ACCESS OR HIGH SPEED ROADWAYS.

NOTE:
1. THE DIMENSIONS SHOWN FOR ROUNDOING CUT AND FILL SLOPES ARE APPROXIMATE; THEY ARE TO BE USED AS GUIDES.
3 - LAYERED SURFACE AND 2 - LAYERED BASE COURSE

2 - LAYERED SURFACE AND 2 - LAYERED BASE COURSE

2 - LAYERED SURFACE AND 1 - LAYER BASE COURSE

NOTES:
1. ONLY APPLICABLE STEPPING METHODS OF THIS DRAWING ARE TO BE SHOWN IN THE TYPICAL SECTION OF THE CONSTRUCTION PLANS. THIS SHALL BE SHOWN AS A SEPARATE DETAIL AND NOT INCLUDED ON EACH SECTION.
2. STEPPING SHALL NOT BE SHOWN ON THE CROSS SECTION TEMPLATES.
3. ADDITIONAL MATERIAL REQUIRED FOR STEPPING SHALL BE INCLUDED IN ESTIMATED QUANTITIES.
NOTES:

1. WHEN THE TOTAL THICKNESS OF HOT MIX ASPHALT OVER THE EXISTING JOINT EXCEEDS 4-3/8'', A 1/8'' SAWCUT SHALL BE INCLUDED IN THE JOINT AS SHOWN TO A MINIMUM DEPTH OF 2-1/2''.

2. PRIOR TO PLACING THE OVERLAY, ALL JOINTS SHALL BE LOCATED AND REFERENCED.
NOTES:
2. ONLY EXPANSION JOINTS SHALL BE SAW-CUT AND SEALED.
3. ONLY REQUIRED WITH A CONTINUOUS BITUMINOUS CONCRETE SURFACE FROM ROADWAY TO BRIDGE.
NOTES:

1. CONTRACTION JOINTS ARE TO BE SPACED AT A MAXIMUM OF 20' APART.
2. THE JOINTS ARE TO BE SAWS AND LOCATED IN THE DEPRESSIONS OF THE CORRUGATIONS. SEE DETAIL OF CORRUGATIONS.
3. END OF CORRUGATED RIDGES TO BE BEVELED.
4. FOR DESCRIPTION OF MATERIAL AND CONSTRUCTION METHODS SEE STANDARD SPECIFICATIONS AND SPECIAL PROVISIONS.
5. SCORED CEMENT CONCRETE TO BE 5000 psi. SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS.
6. TROUGH FLUSH WITH OR ABOVE ADJACENT PAVEMENT FOR DRAINAGE.
NOTE:
FOR DETAIL OF MILLING AND SPACING OF GROOVES SEE DRAWING E 105.5.0, DETAIL A AND SECTION B-B.
NOTE:
SEE DRAWING E 105 3.2 FOR TRANSITION FROM 6" TO 12" LINES AND OTHER INFORMATION.
NOTES FOR RUMBLE STRIPS:
1. NOT TO BE INSTALLED ON SHOULDERS LESS THAN 2' WIDE.
2. NOT TO BE INSTALLED ON BRIDGE DECKS.
NOTES FOR RUMBLE STRIPS:
1. NOT TO BE INSTALLED ON SHOULDERS LESS THAN 8' WIDE.
2. NOT TO BE INSTALLED ON BRIDGE DECKS.
NOTE:

FOR MODIFIED BERM THE SLOPE REMAINS CONSTANT AT 1 (V) TO 12 (H)

1. THIS DIMENSION VARIES WITH THE THICKNESS OF THE TOP COURSE AND SLOPE OF BINDER
2. SEE E 401.1.1 FOR TYPICAL SECTION AT GUARDRAIL LOCATIONS
3. SEE TYPICAL SECTIONS FOR PROJECT
METHOD OF SETTING
VERTICAL CURB

NOTES:
1. THIS PROCEDURE IS APPLICABLE ONLY IF CURB IS TO BE SET AFTER BASE COURSE IS IN PLACE PRIOR TO BINDER AND TOP PLACEMENT.
2. CUT NEAT LINE 6" FROM CURB LINE AND REMOVE BASE AND GRAVEL. REPLACE WITH CEMENT CONCRETE.
3. ANY DESIGNATED CEMENT CONCRETE THAT IS ACCEPTABLE UNDER SECTION M4 OF THE STANDARD SPECIFICATIONS MAY BE USED. ALL TEST REQUIREMENTS ARE WAIVED. HOT MIX ASPHALT SHALL NOT TO BE USED AS A SUBSTITUTE.
SLOPED EDGING

NOTES:

1. ANY DESIGNATED CEMENT CONCRETE THAT IS ACCEPTABLE TO THE DEPARTMENT UNDER SECTION M4 OF THE STANDARD SPECIFICATIONS; ALL TEST REQUIREMENTS ARE WAIVED. HOT MIX ASPHALT SHALL NOT TO BE USED AS A SUBSTITUTE.

2. THE REVEAL IS TO BE A MAXIMUM OF 4" UNDER ALL CONDITIONS, THE ANGLE IS TO BE A MINIMUM OF 60° FROM VERTICAL UNDER ALL CONDITIONS.
NOTES:
1. LEVEL LANDINGS CAN OVERLAP
2. ISLAND AREAS SUBJECT TO TRAVEL SHOULD BE TREATED AS PLAZAS "NOT MORE THAN 2% SLOPE IN ANY DIRECTION"
3. ALL RAMPS BY REGULATION MUST BE PERPENDICULAR TO THE CURB AT THE GUTTER
4. RAMPS SHOULD BE BOTH AlIGNED TOWARD THE RECEIVING RAMP AND WITHIN THE GENERALLY PREFERRED PEDESTRIAN PHASE OF TRAFFIC
LEGEND

HSL = HIGH SIDE TRANSITION LENGTH  
(SEE E 107.9.0)
W = SIDEWALK WIDTH
W_c = CURB WIDTH
W_r = PERPENDICULAR RAMP LENGTH
CC = CEMENT CONCRETE
* = TOLERANCE FOR CONSTRUCTION ±0.5%

USABLE SIDEWALK WIDTH PER AAB = W-W_c
RAMP LENGTH, W_1 = W-4'-0" Min

W = SIDEWALK WIDTH
4'-0" MIN. W_1 = RAMP LENGTH

SECTION A-A
LEGEND

HSL = HIGH SIDE TRANSITION LENGTH
(SEE E 107.9.0)

W = SIDEWALK WIDTH

W_C = CURB WIDTH

CC = CEMENT CONCRETE

* = TOLERANCE FOR CONSTRUCTION ±0.5%

NOTE:
ROADWAY, GUTTER, AND FIRST 6" OF SIDEWALK TO BE ADJUSTED FOR FIELD CONDITIONS

W = SIDEWALK WIDTH

1.5% *

SECTION A-A

DATE OF ISSUE
OCTOBER 2017

DRgNING NUMBER
E 107.2.1
WHEELCHAIR RAMP FOR ONE CONTINUOUS DIRECTION OF PEDESTRIAN TRAVEL

LIMITS OF WCR CEMENT CONCRETE OR HOT MIX ASPHALT

HSL
HIGH SIDE TRANSITION

ROADWAY DOWNGRADE

LIMITS OF WCR CEMENT CONCRETE OR HOT MIX ASPHALT

LOW SIDE TRANSITION

SIDEWALK

7.5%*
WHEELCHAIR RAMP

3'-0" MIN.

CROSSWALK

RAMP OPENING

1.5% SLOPE FOR DRAINAGE

"LEVEL ENTRANCE"

WHEELCHAIR RAMP

3'-0"

DETECTABLE WARNING PANEL (SEE E 107.6.5)

LIMITS OF BUILDING OR OTHER UNALTERABLE OBJECT

GRANITE CURB

SIDEWALK

7.5%*
WHEELCHAIR RAMP

3'-0"

LIMITS OF BUILDING OR OTHER UNALTERABLE OBJECT

NOTES:

DETECTABLE WARNING PANEL LOCATED NOT LESS THAN 6" OR MORE THAN 24" FROM ROADWAY EDGE (GUTTER LINE). TRUNCATED DOMES TO BE ALIGNED WITH DIRECTION OF TRAVEL.

FOR DETAILS OF TRUNCATED DOMES SEE DRAWING E 107.6.5.

ROADWAY, GUTTER, AND FIRST 6" OF SIDEWALK TO BE ADJUSTED FOR FIELD CONDITIONS.

LEGEND

HSL = HIGH SIDE TRANSITION LENGTH (SEE E 107.9.0)

* = TOLERANCE FOR CONSTRUCTION ±0.5%
LEGEND

- BUILDING OR OTHER UNALTERABLE CONDITION
- TRANSITION LENGTH SHOWN IS MINIMUM. (SEE E 107.9.0)
- ** TOLERANCE FOR CONSTRUCTION ±0.5%

NOTE:
ROADWAY, GUTTER, AND FIRST 6" OF SIDEWALK TO BE ADJUSTED FOR FIELD CONDITIONS

"T" INTERSECTION
WHEELCHAIR RAMP
TYPICAL INSTALLATION

DETAIL OF DETECTABLE WARNING PANEL

SECTION A-A

NOTE:

PANELS MAY BE CONCRETE PRECAST OR CAST IN PLACE OR OTHER SUITABLE MATERIAL PERMANENTLY APPLIED TO THE RAMP. DETECTABLE WARNING SURFACES SHALL CONTRAST VISUALLY WITH ADJACENT WALKING SURFACES EITHER LIGHT-ON-DARK, OR DARK-ON-LIGHT.
LEGEND

HSL = HIGH SIDE TRANSITION LENGTH. SEE E 107.9.0
W = SIDEWALK WIDTH
*= TOLERANCE FOR CONSTRUCTION ±0.5%
CC = CEMENT CONCRETE
HMA = HOT MIX ASPHALT
10 FT SIDEWALK LAYOUT

8 FT SIDEWALK LAYOUT

NOTES:

1. WHEN THE SIDEWALK IS PAVED TO THE CURB LINE, USE SHORT CURB RETURNS AT THE HIGHWAY CURB LINE PC'S, SHOWN IN THESE DESIGNS.

* MUST MAINTAIN PATH OF TRAVEL WITH 1.5% CROSS SLOPE (± 0.5% CONSTRUCTION TOLERANCE)
<table>
<thead>
<tr>
<th>ROADWAY PROFILE GRADE</th>
<th>* HIGH SIDE TRANSITION LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENGLISH UNITS</td>
</tr>
<tr>
<td>%</td>
<td></td>
</tr>
<tr>
<td>=0%</td>
<td>6'-6&quot;</td>
</tr>
<tr>
<td>&gt;0% TO 1%</td>
<td>7'-8&quot;</td>
</tr>
<tr>
<td>&gt;1% TO 2%</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>&gt;2% TO 3%</td>
<td>11'-0&quot;</td>
</tr>
<tr>
<td>&gt;3% TO 4%</td>
<td>14'-0&quot;</td>
</tr>
<tr>
<td>&gt;4% TO 5%</td>
<td>15'-0&quot; Max</td>
</tr>
</tbody>
</table>

**NOTE:**

* BASED ON A DESIGN SLOPE OF 7.5% AND A REVEAL OF 6".
**MINIMUM DEPTH OF SUMP TO BE 2' STANDARD DEPTH 3'

NOTES:
1. WEEPHOLES SHALL BE 4" PIPE OPENING OR EQUIVALENT WITH 1/4 IN. MESH, 23 GAUGE GALVANIZED WIRE SCREEN COVERING. 2 CUBIC FEET OF CRUSHED STONE SHALL BE PLACED AROUND EACH WEEPHOLE.
2. BRICKS MAY BE USED BETWEEN TOP COURSE AND C.B. FRAME FOR GRADE ADJUSTMENT. FRAME SHALL BE SET IN FULL BED OF MORTAR.
3. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
4. DETAILS SHOWN ON DRAWINGS E 201.6.0 - E 201.11.0
5. FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4 IN. FROM FACE OF WALL ALONG CENTERLINE OF PIPE.

**MORTAR NOT REQUIRED IN VERTICAL JOINTS**

**KEYWAYS TO BE FILLED WITH CEMENT MORTAR**

**PLAN OF BASE**

**SECTION C-C**

SOLID SECTION, OR fill hole with bricks and mortar, or fill with 4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) IF CONCRETE IS HAND MIXED, SEE LATEST SPECIFICATIONS.

**SECTION A-A**

BLOCKS TO BE SET IN FULL BED OF CEMENT MORTAR

4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) OR PRECAST CONCRETE SECTIONAL PLATES, SEE ABOVE.

**SECTION B-B**

Cement Mortar
FOR GRATE SEE DRAWING E 201.7.0 - E 201.11.0

FOR FRAME SEE DRAWING E 201.6.0

BRICKS MAY BE USED FOR GRADE ADJUSTMENTS. FRAME TO BE SET IN FULL BED OF MORTAR.

5" MIN

4' ± 1" DIAMETER

MORTAR ALL JOINTS

PROVIDE "V" OPENINGS

OUTSIDE OF PIPE +2" CLEARANCE

*** MIN. 0.12 SQ. IN STEEL PER VERTICAL FOOT, PLACED ACCORDING TO AASHTO DESIGNATION M199

* MINIMUM DEPTH OF SUMP TO BE 2 FT

** WHEN A CURB INLET IS INSTALLED, THE OPENING IS TO BE 24"±1" X 27"±1"

*** REINFORCING STEEL BASED ON A WALL THICKNESS OF 5".

NOTES:

1. DETAILS NOT INDICATED ABOVE ARE TO BE SIMILAR TO THOSE SHOWN ON E 201.3.0

2. FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" FROM FACE OF WALL ALONG CENTERLINE OF PIPE.

3. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHOD, SEE STANDARD SPECIFICATIONS.

4. ALL CONCRETE TO BE AIR ENTRAINED

PRECAST CONCRETE
CATCH BASIN

October 2017

Drawing Number
E 201.4.0
**NOTES:**

1. DETAILS NOT INDICATED ABOVE ARE TO BE SIMILAR TO THOSE SHOWN ON DRAWING E 201.3.0
2. FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" FROM FACE OF WALL ALONG CENTERLINE OF PIPE.
3. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHOD, SEE STANDARD SPECIFICATIONS.
4. ALL CONCRETE TO BE AIR ENTRAINED
MACHINE TOLERANCES:
✓ MACHINED SEATS (4) REQUIRED
FLAT AND IN PLANE WITHIN .010"
TOTAL INDICATOR READING

CLASSIFICATION:
CAST IRON - SEE STANDARD SPECIFICATIONS
WITH NO BLACK ASPHALT COATING ALLOWED

CASTING TOLERANCES:
SHALL CONFORM TO AASHTO
M306

WEIGHTS:
3-FLANGE FRAME 240 LBS. MIN
4-FLANGE FRAME 270 LBS. MIN

AASHTO HS 20 LOAD RATED

NOTE: FOUR FLANGE FRAME SHOWN. MAY
ALSO BE SUPPLIED AS THREE FLANGE FRAME
~ WITH THIS FLANGE REMOVED

NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO BE CAST WITH FRAME AND GRATE

DATE OF ISSUE
OCTOBER 2017

DRAWING NUMBER
E 201.6.0
HOOK LOCK CASCADE GRATE
FLOW FROM LEFT

CLASSIFICATION:
CAST IRON - SEE STANDARD SPECIFICATIONS
WITH NO BLACK ASPHALT COATING ALLOWED

CASTING TOLERANCES:
SHALL CONFORM TO AASHTO M306

Machine tolerances:
Surfaces noted \must be machined flat and
in-plane within .010"
Total Indicator Reading

NOTE: CASCADE GRATE ONLY TO BE
USED ON FACILITIES WHERE BICYCLE
TRAVEL IS LEGALLY ALLOWED.

WEIGHT: 265 LBS. MIN
AASHTO HS 20 PROOF LOAD

NOTE: IDENTIFYING INFORMATION
SHOWN ON FRAMES & GRATES TO BE
CAST WITH FRAME AND GRATE

Tumbler should be set at 1 1/4" below
machined grate seat for installation.

Once grate is set in frame, torque bolt 1/4 turn past snug.
Tumbler should be set at 1 1/4" below machined grate seat for installation.

Once grate is set in frame, torque bolt 1/4 turn past snug.

LOCK TUMBLER ASSEMBLY
(1) REQUIRED—CONSISTS OF:
5/8" x 5" ST. STL. BOLT
5/8" ST. STL. FLAT WASHER
CAST IRON TUMBLER
ST. STL. CAPTURE NUT
STAINLESS STEEL GRADE 304

WARNING:
CAST IRON - SEE STANDARD SPECIFICATIONS
WITH NO BLACK ASPHALT COATING ALLOWED

CASTING TOLERANCES:
SHALL CONFORM TO AASHTO M306

Machine tolerances:
Surfaces noted □ must be machined flat and in-plane within 0.010"
Total Indicator Reading

NOTE: CASCADE GRATE ONLY TO BE USED ON FACILITIES WHERE BICYCLE TRAVEL IS LEGALLY ALLOWED.

NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO BE CAST WITH FRAME AND GRATE
FRAME MAY BE INSTALLED WITH THIS FLANGE REMOVED FOR CURB INLET. FOUR FLANGE IS SHOWN. SEE DWG E 201.6.0 FOR MORE INFORMATION.

NOTE: SEAT SURFACES ON BOTH FRAME AND GRATE ARE MACHINED AND GRATE MUST NOT ROCK IN FRAME WHEN ASSEMBLED.

NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO BE CAST WITH FRAME AND GRATE

LOCK TUMBLER ASSEMBLY (1) REQUIRED—CONSISTS OF:
5/8" x 5" ST. STL. BOLT
5/8" ST. STL. FLAT WASHER
CAST IRON TUMBLER
ST. STL. CAPTURE NUT
STAINLESS STEEL GRADE 304

CLASSIFICATION:
CAST IRON - SEE STANDARD SPECIFICATIONS WITH NO BLACK ASPHALT COATING ALLOWED

Tumbler should be set at 1 1/4" below machined grate seat for installation.

Once grate is set in frame, torque bolt 1/4 turn past snug.

WEIGHTS:
3-FLANGE FRAME 240 LBS. MIN
4-FLANGE FRAME 270 LBS. MIN
B-1 GRATE 265 LBS. MIN

CASTING TOLERANCES:
SHALL CONFORM TO AASHTO M306

MM/DD/YY CL XXX

N.T.S.

SECTION A-A

24 1/4"
23 7/8"
8"
1/2"

15/16"

22"
1 1/16"
24" MIN

AASHTO HS 20 PROOF LOAD

1 1/4"
15/16"
25 3/4

SECTION B-B

FLOW

33" MIN.
FRAME MAY BE INSTALLED WITH THIS FLANGE REMOVED FOR CURB INLET. FOUR FLANGE IS SHOWN. SEE DWG E 201.8.0 FOR MORE INFORMATION.

CLASSIFICATION:
CAST IRON - SEE STANDARD SPECIFICATIONS WITH NO BLACK ASPHALT COATING ALLOWED

AASHTO HS 20 PROOF LOAD N.T.S.

SECTION A-A
24 1/4"
23 7/8"
8"  1 1/8"
1 1/16"
22"
24" MIN

SECTION B-B
1 1/4"
25 3/4"
15/16"

LOCK TUMBLER ASSEMBLY
(1) REQUIRED - CONSISTS OF:
5/8" x 5" ST. STL. BOLT
5/8" ST. STL. FLAT WASHER
CAST IRON TUMBLER
ST. STL. CAPTURE NUT
STAINLESS STEEL GRADE 304

TUMBLER SHOULD BE SET AT 1 1/4" BELOW MACHINED GRATE SEAT FOR INSTALLATION.

ONCE GRATE IS SET IN FRAME, TORQUE BOLT 1/4" TURN PAST SNUG.

WEIGHTS:
3-FLANGE FRAME 240 LBS. MIN
4-FLANGE FRAME 270 LBS. MIN
B-2 GRATE 265 LBS. MIN

CASTING TOLERANCES:
SHALL CONFORM TO AASHTO M306

NOTE: SEAT SURFACES ON BOTH FRAME AND GRATE ARE MACHINED AND GRATE MUST NOT ROCK IN FRAME WHEN ASSEMBLED.

NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO BE CAST WITH FRAME AND GRATE
CASTING TOLERANCES:
SHALL CONFORM TO AASHTO M306

Tumbler should be set at 1 1/4" below machined grate seat for installation.
Once grate is set in frame, torque bolt 1/2 turn past snug.

NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO BE CAST WITH FRAME AND GRATE

LOCK TUMBLER ASSEMBLY
(1) REQUIRED-CONSISTS OF:
5/8" x 5" ST. STL. BOLT
5/8" ST. STL. FLAT WASHER
CAST IRON TUMBLER
ST. STL. CAPTURE NUT
STAINLESS STEEL GRADE 304

AASHTO HS 20 PROOF LOAD

CLASSIFICATION:
CAST IRON - SEE STANDARD SPECIFICATIONS
WITH NO BLACK ASPHALT COATING ALLOWED

Machine tolerances:
Surfaces noted must be machined flat and in-plane within .010"
Total Indicator Reading

NOTE: BAR GRATE NOT TO BE USED ON FACILITIES WHERE BICYCLE TRAVEL IS LEGALLY ALLOWED.
FRAME MAY BE INSTALLED WITH THIS FLANGE REMOVED FOR CURB INLET. FOUR FLANGE IS SHOWN. SEE DWG 201.6.0 R2 FOR MORE INFORMATION.

NOTE: IDENTIFYING INFORMATION SHOWN ON FRAMES & GRATES TO BE CAST WITH FRAME AND GRATE.

SEE DWG # FOR MORE INFORMATION ON GRATE GEOMETRY.

LOCK TUMBLER ASSEMBLY
(1) REQUIRED–CONSISTS OF:
5/8" x 5" ST. STL. BOLT
5/8" ST. STL. FLAT WASHER
CAST IRON TUMBLER
ST. STL. CAPTURE NUT
STAINLESS STEEL GRADE 304

CASTING TOLERANCES:
SHALL CONFORM TO AASHTO M306

CLASSIFICATION:
CAST IRON - SEE STANDARD SPECIFICATIONS WITH NO BLACK ASPHALT COATING ALLOWED

NOTE: SEAT SURFACES ON BOTH FRAME AND GRATE ARE MACHINED AND GRATE MUST NOT ROCK IN FRAME WHEN ASSEMBLED.

Tumbler should be set at 1 1/4" below machined grate seat for installation.

Once grate is set in frame, torque bolt 1/2 turn past snug.

WEIGHTS:
3-FLANGE FRAME 240 LBS. MIN
4-FLANGE FRAME 270 LBS. MIN
A-4 GRATE 205 LBS. MIN

AASHTO HS 20 PROOF LOAD

DATE OF ISSUE OCTOBER 2017
DRAWING NUMBER E 201.10.1
NOTES:
1. MATERIAL - CAST IRON; SEE STANDARD SPECIFICATIONS
2. MINIMUM MASS - 210 LBS.

SECTION A-A

SECTION B-B

DROP INLET GRATE
NOTE:
1. HOODS TO BE GRAY CAST IRON – SEE STANDARD SPECIFICATIONS WITH NO BLACK ASPHALT COATING ALLOWED
BRICKS MAY BE USED BETWEEN FRAME & TOP COURSE FOR GRADE ADJUSTMENT.

8" MIN.

FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" FROM FACE OF WALL ALONG CENTERLINE OF PIPE.

4" DIAMETER MIN.

PIPE VARIES

30" MAX.

VARIABLE DEPTH

BASE TO BE OF
4000 PSI CEMENT CONCRETE
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
OR PRECAST CONCRETE SECTIONAL PLATES, SEE BELOW.

BRICK CHIPS AND MORTAR OR
4000 PSI CEMENT CONCRETE
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
(IF CONCRETE IS HAND MIXED SEE LATEST STANDARDS SPECIFICATIONS.)
ALL CONCRETE TO BE AIR ENTRAINED

INVERT TO BE INVERTED ARCH WITH BRICKS LAIDED ON EDGE AS STRETCHERS.

SECTION A-A

KEYWAYS TO BE FILLED WITH CEMENT MORTAR.
MORTAR NOT REQUIRED IN VERTICAL JOINTS.

PLAN OF BASE

SOLID SECTION; OR FILL HOLE WITH BRICKS AND MORTAR;
OR FILL WITH 4000 PSI CEMENT CONCRETE
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
(IF CONCRETE IS HAND MIXED SEE LATEST STANDARD SPECIFICATIONS)

NOTE:
1. DESIGN SHOWN IS FOR MANHOLE OF 9' OR LESS
AND PIPE DIAMETER OF 30" OR LESS,
2. STANDARD MANHOLE DEPTH TO BE 5.5' OR LESS

CONCRETE BLOCK MANHOLE
MANHOLES 9' OR LESS IN DEPTH
BRICKS MAY BE USED BETWEEN FRAME AND TOP COURSE FOR GRADE ADJUSTMENT. FRAME TO BE SET IN FULL BED OF CEMENT MORTAR.

PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" INSIDE FACE OF WALL ALONG CENTERLINE OF PIPE.

VARIABLE DEPTH 6" WALL TO MAX. DEPTH OF 9'

MORTAR

FLOW

PIVOT

VARYS 30" MAX.

BASE TO BE OF 4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)

OR PRECAST CONCRETE SECTIONAL PLATES. SEE BELOW.

BRICK CHIPS AND MORTAR OR 4000 PSI CEMENT CONCRETE

(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)

(IF CONCRETE IS HAND MIXED SEE LATEST STANDARDS SPECIFICATIONS.)

ALL CONCRETE TO BE AIR ENTRAINED

INVERTED ARCH WITH BRICKS LAID ON EDGE AS STRETCHERS.

KEYWAYS TO BE FILLED WITH CEMENT MORTAR.

MORTAR NOT REQUIRED IN VERTICAL JOINTS.

SECTION A-A

PLAN OF BASE

SOLID SECTION; OR FILL HOLE WITH BRICKS AND MORTAR;
OR FILL WITH 4000 PSI CEMENT CONCRETE

(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)

(IF CONCRETE IS HAND MIXED SEE LATEST STANDARD SPECIFICATIONS)

NOTE:
1. MANHOLE DESIGN IS FOR PIPE DIAMETER OF 30" OR LESS
PRECAST CONCRETE MANHOLES
9' OR LESS IN DEPTH

NOTE:
1. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST STANDARD SPECIFICATIONS.

DATE OF ISSUE
OCTOBER 2017

DRAWING NUMBER
E 202.4.0
STANDARD COVER
FOR COVER DETAILS SEE DRAWING E 202.8.0

TYPE - A FRAME

NOTES:
1. MINIMUM MASS - 265 LBS.
2. MATERIAL - CAST IRON - SEE STANDARD SPECIFICATIONS WITH NO BLACK ASPHALT COATING ALLOWED
MANHOLE FRAME AND COVER - B FRAME

NOTES:
1. MINIMUM FRAME MASS 265 LBS.
2. MATERIAL - CAST IRON - SEE STANDARD SPECIFICATIONS
   WITH NO BLACK ASPHALT COATING ALLOWED

FOR COVER DETAIL, SEE DRAWING E 202.8.0
NOTES:
1. MINIMUM COVER MASS - 200 LBS.
2. MATERIAL - CAST IRON - SEE STANDARD SPECIFICATIONS
   WITH NO BLACK ASPHALT COATING ALLOWED
NOTES:

1. COLLARS TO BE 4000PSI CEMENT CONCRETE MASONRY REGULAR OR H.E.S. AS DIRECTED.  
   (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS).  
   (IF HAND MIXED, SEE LATEST STANDARD SPECIFICATIONS).
2. NO CONCRETE REQUIRED IN CONCRETE PAVEMENT.
1. COLLARS TO BE 4000PSI CEMENT CONCRETE MASONRY REGULAR OR H.E.S. AS DIRECTED.
(SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS).

NOTES:
1. STANDARD PARALLEL BAR GRATES TO BE USED.
   SEE DETAILS ON DRAWINGS E 201.10.0
2. MINIMUM C.I. FRAME MASS - 205 LBS. EACH
3. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION
   METHODS SEE LATEST STANDARD SPECIFICATIONS

**TYPE "A"**
4. 4000 PSI CEMENT CONCRETE (SEE MASSDOT
   SPECIFICATIONS FOR DESIGN REQUIREMENTS).

**TYPE "B"**
5. NOMINAL CONCRETE BLOCK DIMENSIONS
   HEIGHT, 4" TO 6"  
   WIDTH, 8"  
   LENGTH, 8" TO 16"
6. BLOCKS TO BE SET IN FULL BED OF MORTAR
7. THIS DROP INLET IS NOT TO BE USED AT ANY
   LOCATION WHERE IT MAY PRESENT A HAZARD
   TO VEHICLES THAT RUN OFF THE ROAD
   FOR FLUSH TYPE SEE DRAWING E 203.2.0
PLAN

OUTSIDE FACE
AT TOP
AT BASE

INSIDE FACE
AT TOP
AT BASE
SEE NOTE #2

WEEPHOLE

OUTLET PIPE

THROAT

FULL BED OF MORTAR

4" CAST IRON FRAME

TAPER IN 3 OR 4 COURSES

6" MIN.

6'-6" STANDARD DEPTH

WEEPHOLE

OUTLET PIPE

NOTES:
1. MINIMUM CAST IRON FRAME MASS - 205 LBS. SEE DETAIL ON DRAWING E 203.1.0
2. STANDARD PARALLEL BAR GRATE TO BE USED. SEE DETAILS ON DRAWINGS E 201.1.0
3. FOR DESCRIPTION, MATERIALS, AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
4. THIS DROP INLET IS NOT TO BE USED AT ANY LOCATION WHERE IT MAY PRESENT A HAZARD TO VEHICLES THAT RUN OFF THE ROAD FOR FLUSH TYPE SEE DRAWING E 203.4.0
5. SEE DRAWING E 201.3.0 CONCRETE BLOCK CATCH BASIN FOR DETAILS

SECTION A-A

4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) OR PRECAST CONCRETE SECTIONAL PLATES SEE DRAWING E 202.2.0

4'-0" DIA. MIN.

*MIN. DEPTH TO BE 2'

THROAT

1'-10"x1'

6" MIN.

6" MIN.

1'-6" TO 2'-0"

FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" FROM FACE OF WALL ALONG CENTERLINE OF PIPE.
SECTION A-A

4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) OR PRECAST CONCRETE SECTIONAL PLATES SEE DRAWING E 201.3.0

NOTES:
1. MINIMUM CAST IRON FRAME MASS - 205 LBS. SEE DETAIL ON DRAWING E 203.1.0
2. STANDARD PARALLEL BAR GRATE TO BE USED. SEE DETAILS DRAWINGS E 201.11.0
3. FOR DESCRIPTION, MATERIALS, AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
4. TO BE USED IN MEDIAN AND Ditches THAT ARE WITHIN THE RECOVERY AREA.
5. SEE DRAWING E 201.3.0 CONCRETE BLOCK CATCH BASIN FOR DETAILS

DROP INLET TYPE CF

DATE OF ISSUE
OCTOBER 2017
DRAWING NUMBER
E 203.4.0
PARALLEL BAR GRATE SEE DRAWINGS E 201.11.0

FOR FRAME SEE DRAWING E 203.1.0

THROAT

22" ± 1" SQUARE OPENING
8" MIN.

BRICKS MAY BE USED FOR
GRADE ADJUSTMENTS.
FRAME TO BE SET IN
FULL BED OF MORTAR

5" MIN.

SEE DRAWING E 202.4.0
FOR JOINT DETAILS

MORTAR ALL JOINTS

WEEPHOLE
(OPENDING TO BE PRECAST
IN RISER SECTION)

48" ± 1" DIAMETER

1" CLEAR

3'-0" MAX

5" MIN.

OUTSIDE OF
PIPE

MIN. 0.12 SQ. IN. STEEL
PER VERTICAL FOOT,
PLACED ACCORDING TO
AASHTO DESIGNATION M99

SEE DRAWING E 202.4.0 FOR BASE DETAILS

* MINIMUM DEPTH OF SUMP TO BE 2'

NOTES:
1. DETAILS NOT INDICATED ABOVE ARE TO BE SIMILAR TO THOSE SHOWN ON DRAWING E 203.3.0
2. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHOD, SEE LATEST STANDARD SPECIFICATIONS
3. THIS DROP INLET IS NOT TO BE USED AT ANY LOCATION WHERE IT MAY PRESENT A HAZARD TO VEHICLES
    THAT RUN OFF THE ROAD. FOR FLUSH TYPE SEE DRAWING E 203.6.0
PARALLEL BAR GRATE SEE DRAWINGS E 201.11.0
FOR FRAME SEE DRAWING E 201.6.0

BRICKS MAY BE USED FOR
GRADE ADJUSTMENTS.
FRAME TO BE SET IN
FULL BED OF MORTAR,

PRECAST CONCRETE THROAT
SEE DRAWING E 203.7.0

5" MIN

MORTAR ALL JOINTS
PROVIDE "V" OPENINGS

OUTSIDE OF PIPE
+2" CLEARANCE

MIN. 0.12 SQ IN. STEEL
PER VERTICAL FOOT, PLACED
ACCORDING TO AASHTO
DESIGNATION M199

1" CLEAR

3'-0" MAX

SEE DRAWING E 202.4.0 FOR BASE DETAILS

SEE E 202.4.0 FOR JOINT DETAILS
48" ± 1" DIAMETER

THROAT
22" ± 1" SQUARE OPENING

18'-0" TO 24'
TAPERED SECTION

HEIGHT OF RISER SECTIONS
VARY FROM 1' TO 2'

6'-6" (STANDARD DEPTH)

*MINIMUM DEPTH OF SUMP TO BE 2'

NOTES:
1. DETAILS NOT INDICATED ABOVE ARE TO BE SIMILAR TO THOSE SHOWN ON
DRAWINGS E 203.3.0 AND E 203.4.0

2. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHOD, SEE LATEST STANDARD SPECIFICATIONS

3. TO BE USED IN MEDIANS AND DITCHES THAT ARE WITHIN THE RECOVERY AREA

DROP INLET TYPE DF

DATE OF ISSUE
OCTOBER 2017

DRAWING NUMBER
E 203.6.0
PRECAST CONCRETE THROAT
FOR USE IN MEDIANS & DITCHES WITH TYPES
CF AND DF DROP INLETS

PLAN

A

8'

3'-2'

B

8'

1'-10'

16'

3'-2'

8'

A

3'-2'

8'

1'-10'

16'

ISOMETRIC OF PRECAST CONCRETE THROAT OPENING

SECTION A-A

4000 PSI CEMENT CONCRETE
(SEE MASSDOT SPECIFICATIONS
FOR DESIGN REQUIREMENTS)

DROP-INLET TYPE "C"
OR TYPE "D"

PRECAST CONCRETE
THROAT

FULL BED MORTAR

P.W.W.

4" CAST IRON FRAME

SECTION B-B

4000 PSI CEMENT CONCRETE
(SEE MASSDOT SPECIFICATIONS
FOR DESIGN REQUIREMENTS)

DROP-INLET TYPE "C"
OR TYPE "D"

PRECAST CONCRETE
THROAT

2" R

10'

2 CONCRETE PAVED WATERWAY
ON ALL SIDES

NO. 4 BARS (3)

PROPOSED DITCH GRADE
NOTES:
1. WHERE CURB INLET IS NOT USED THE INSIDE HORIZONTAL DIMENSIONS OF GUTTER INLET TO BE 24" x 24" x 1" IN WHICH CASE AND UNLESS OTHERWISE DIRECTED, A STANDARD 4-FLANGE FRAME IS TO BE USED.
2. BRICKS MAY BE USED BETWEEN TOP COURSE AND FRAME FOR GRADE ADJUSTMENT.
3. A CASCADE GRATE IS TO BE USED WHERE BICYCLE TRAVEL IS ALLOWED.
4. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.

OUTLET PIPE
INVERT TO BE CONSTRUCTED OF BRICK AS SHOWN IN DETAILS FOR BRICK GUTTER INLET OR 4000 PSI CEMENT CONCRETE MASONRY (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) (IF HANDMIXED SEE STANDARD SPECIFICATIONS)

4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) OR PRECAST CONCRETE SECTIONAL PLATES
NOTES:

1. USE CASCADE GRATE WHERE BICYCLE TRAVEL IS LEGALLY ALLOWED. SEE DRAWINGS E 201.7.0 - E 201.9.0
2. BRICK WALL TO BE 8" THICK; EVERY FIFTH COURSE TO BE HEADERS; OUTSIDE TO BE FINISHED WITH CEMENT MORTAR COATING.
3. WHEN USING CONCRETE BLOCKS, BLOCKS TO BE SET IN FULL BED OF MORTAR AND TAPERED IN 3 OR 4 COURSES.
4. BACKFILL FOR FULL DEPTH OF BASIN EXCAVATION TO BE GRAVEL.
5. FOR DESCRIPTION, MATERIALS AND METHOD OF CONSTRUCTION SEE STANDARD SPECIFICATIONS.
NOTES:
1. USE CASCADE GRATE WHERE BICYCLE TRAVEL IS LEGALLY ALLOWED. SEE DRAWINGS E 201.7.0 - E 201.9.0.
2. BACKFILL FOR FULL DEPTH OF BASIN EXCAVATION TO BE 1/2" CRUSHED STONE.
3. FOR DESCRIPTION, MATERIALS, AND METHOD OF CONSTRUCTION SEE STANDARD SPECIFICATIONS.
4. FACE OF PIPE FLUSH OR NOT TO PROJECT MORE THAN 4" FROM FACE OF WALL ALONG CENTERLINE OF PIPE.
5. THE LEACHING BASIN SHALL BE CONSTRUCTED OF CEMENT CONCRETE BLOCKS TO CONFORM TO THE REQUIREMENTS OF STANDARD SPECIFICATION SUBSECTION M4.05.1.

HIGH EARLY 4,000 PSI CEMENT CONCRETE COLLAR (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)

PLAN OF BASE

BOTTOM PLATES REQUIRE
10 PIECES PER CIRCLE WITH
1/2" SPACING BETWEEN PLATES.
4" THICK
# Table of Minimum Wall Thickness (FT)

(2 2/3” x 1/2” Corrugation)

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</table>

**Notes:**
1. All pipe below solid line to be shop strutted as per state specifications.
2. Minimum cover is top of pipe to road - 18° grade.
## TABLE OF MINIMUM WALL THICKNESS (IN.)

<table>
<thead>
<tr>
<th>MADE FROM PIPE OF DIA. (IN.)</th>
<th>SPAN (IN.)</th>
<th>RISE (IN.)</th>
<th>HEIGHGT OF COVER ABOVE TOP OF PIPE ARCH (FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MIN. - 3</td>
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<td>15</td>
<td>18</td>
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<tr>
<td>60</td>
<td>72</td>
<td>44</td>
<td>8</td>
</tr>
</tbody>
</table>

### NOTES:
1. MINIMUM COVER IS TOP OF PIPE TO ROAD GRADE - 18”
2. FOR HEAVIER FILLS USE STRUCTURAL PLATE
CCM PIPE WITH CONCRETE END

SLOPE OF FILM

2' MINIMUM COVER

DRAINAGE STRUCTURE

CCM PIPE WITH METAL END

ELBOW COUPLINGS - 2' LONG

INTERMEDIATE COUPLINGS - 2' LONG

METAL ENDS WITH CONNECTOR SECTION
FOR DETAILS SEE DRAWING E 206.9.0

TOE PLATE

2' COUPLING

ELBOW AND COUPLING DETAILS

2' COUPLING BAND

3'

(5) 1/2" DIA X 5" GALVANIZED BOLTS

2"x2"x3/16" GALV ANGLE IRON
RIVETED TO COUPLING BAND

1" (APPROX.)

NOTES:
1. A TOE PLATE IS REQUIRED FOR ALL METAL ENDS.
2. ALL METAL END UNITS AND ELBOWS TO BE SHOP FABRICATED.
CONCRETE CRADLE FOR PIPE CULVERTS

CEMENT CONCRETE 4000 PSI (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) ONLY TO BE USED WHERE SPECIFIED

NOTES:
1. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST STANDARD SPECIFICATIONS.
2. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM.
3. PAYMENTS WILL BE BASED ON THE ACCOMPANYING TABLE.
4. FOR QUANTITY TABLES SEE E 206.4.1
<table>
<thead>
<tr>
<th>PIPE DIAM.</th>
<th>1 1/2 : 1 SLOPE</th>
<th>2 : 1 SLOPE</th>
<th>4&quot; FOR 1 1/2 : 1 SLOPE</th>
<th>6&quot; FOR 2 : 1 SLOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
<td>L</td>
<td>TRENCH EXCAV. LBS.</td>
<td>STEEL LBS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1'-0&quot; DEPTH CU. FT.</td>
<td>CONC. OR F.S.M. C.U. YDS.</td>
</tr>
<tr>
<td>8&quot;</td>
<td>4'-2&quot; 0.77</td>
<td>5'-10&quot; 1.08</td>
<td>21.60 15</td>
<td>2.16 2.63</td>
</tr>
<tr>
<td>10&quot;</td>
<td>4'-10&quot; 1.08</td>
<td>6'-8&quot; 1.28</td>
<td>23.91 20</td>
<td>3.58 4.35</td>
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<tr>
<td>12&quot;</td>
<td>5'-6&quot; 1.34</td>
<td>7'-6&quot; 1.49</td>
<td>26.25 21</td>
<td>3.84 4.61</td>
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<tr>
<td>15&quot;</td>
<td>6'-6&quot; 1.61</td>
<td>8'-6&quot; 1.82</td>
<td>29.75 24</td>
<td>4.10 4.87</td>
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<tr>
<td>18&quot;</td>
<td>7'-6&quot; 1.95</td>
<td>9'-0&quot; 2.18</td>
<td>33.25 30</td>
<td>4.36 5.13</td>
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<tr>
<td>21&quot;</td>
<td>8'-6&quot; 2.16</td>
<td>10'-0&quot; 2.62</td>
<td>37.35 34</td>
<td>4.62 5.39</td>
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<tr>
<td>24&quot;</td>
<td>9'-3&quot; 2.63</td>
<td>12'-0&quot; 2.97</td>
<td>43.75 44</td>
<td>4.88 5.65</td>
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<tr>
<td>30&quot;</td>
<td>10'-6&quot; 3.86</td>
<td>15'-0&quot; 62</td>
<td>59.50 62</td>
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</tbody>
</table>
### Field Stone Masonry Ends

<table>
<thead>
<tr>
<th>Design No.</th>
<th>Diameter (In.)</th>
<th>Lengths</th>
<th>Masonry (Cy)</th>
<th>Steel (Lbs)</th>
<th>Trench Excav. 1'-0&quot; Depth (CF)</th>
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<tbody>
<tr>
<td>1</td>
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<td>3'-9&quot;</td>
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**Note:**

1. For descriptions, materials and construction methods, see standard specifications.
2. All concrete dimensions shown are minimum.
3. Payments will be based on the quantities shown in accompanying table.
STONE PIPE ENDS
FOR PIPES 24" AND LESS IN DIAMETER

MINIMUM RECOVERY AREA *
EDGE OF TRAVELED WAY
SHOULDER

1V: 6H SLOPE *

1V: 4H SLOPE *

1V: 1H SLOPE

* SEE TYPICAL SECTIONS.

NOTES:
1. STONE TREATMENT OF PIPE ENDS SHALL NOT BE USED IN THE VEHICLE RECOVERY AREA.
2. MINIMUM MASS PER STONE = 50 LBS; MAXIMUM MASS PER STONE = 125 LBS.
3. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
### TABLE
[ALL DIMENSIONS ARE inches OR feet]

<table>
<thead>
<tr>
<th>DIAMETER Inch</th>
<th>W</th>
<th>A</th>
<th>B</th>
<th>D</th>
<th>E</th>
<th>P</th>
<th>DIA. +1&quot;</th>
<th>R1</th>
<th>R2</th>
<th>SLOPE</th>
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<tbody>
<tr>
<td>12”</td>
<td>2”</td>
<td>4”</td>
<td>2’-0&quot;</td>
<td>6’-0&quot;</td>
<td>2’-0&quot;</td>
<td>19 5/16&quot;</td>
<td>13&quot;</td>
<td>10 1/8&quot;</td>
<td>9&quot;</td>
<td>1V : 3H</td>
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<tr>
<td>15”</td>
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<td>6”</td>
<td>2’-3&quot;</td>
<td>6’-0&quot;</td>
<td>2’-6&quot;</td>
<td>24 5/16&quot;</td>
<td>16&quot;</td>
<td>12 1/2&quot;</td>
<td>11&quot;</td>
<td>1V : 3H</td>
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<tr>
<td>18”</td>
<td>2 1/2”</td>
<td>9”</td>
<td>2’-3&quot;</td>
<td>6’-0&quot;</td>
<td>3’-0&quot;</td>
<td>29&quot;</td>
<td>19&quot;</td>
<td>15 1/2&quot;</td>
<td>12&quot;</td>
<td>1V : 3H</td>
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<td>2 3/4&quot;</td>
<td>9”</td>
<td>2’-11&quot;</td>
<td>6’-0&quot;</td>
<td>3’-5&quot;</td>
<td>31 5/8&quot;</td>
<td>22&quot;</td>
<td>16 1/8&quot;</td>
<td>13&quot;</td>
<td>1V : 3H</td>
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<td>3’-7 1/2&quot;</td>
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<td>14”</td>
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<td>37”</td>
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<td>5’-3”</td>
<td>8’-0”</td>
<td>6’-6”</td>
<td>53 7/8”</td>
<td>43”</td>
<td>27 1/2&quot;</td>
<td>22”</td>
<td>1V : 3H</td>
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<td>48”</td>
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<td>24’</td>
<td>6’-0”</td>
<td>8’-0”</td>
<td>7’-0”</td>
<td>56 1/2”</td>
<td>49”</td>
<td>28 1/2&quot;</td>
<td>22”</td>
<td>1V : 3H</td>
</tr>
</tbody>
</table>

NOTES:
1. SEE STANDARD SPECIFICATIONS FOR THE TYPE OF PIPE TO BE USED (BELL & SPIGOT OR TONGUE & GROOVE)
2. SEE STANDARD SPECIFICATIONS FOR THE TYPE OF PIPE AND PLACING OF STEEL REINFORCEMENT.
3. THE JOINTS ARE TO BE COMPATIBLE WITH THE MAIN RUN OF PIPE.
ALTERNATE CONNECTIONS

FOR 12" TO 24" ONLY

FOR 30" AND 36" ONLY

NOTES:

1. TOE PLATE TO BE PUNCHED TO MATCH HOLES IN SKIRT LIP, 3/8" GALVANIZED BOLTS TO BE FURNISHED.
2. LENGTH OF TOE PLATE TO BE W+10" FOR 12" TO 30" DIA. PIPE AND W+22" FOR 36" TO 48" DIA.
3. SKIRT SECTION FOR 12" TO 24" DIA. PIPE TO BE MADE IN ONE PIECE. SKIRT SECTION FOR 12" TO 30" DIA. PIPE MAY BE MADE FROM TWO SHEETS JOINED BY MELTING OR BOLTING ON CENTER LINE WITH 3/8" DIA. FASTENERS.
4. CONNECTOR SECTION, TOE PLATE AND SKIRT TO BE OF SAME THICKNESS METAL; EACH TO BE GALVANIZED AND COATED WITH A TAR BASE PAINT.
5. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHOD, SEE LATEST STANDARD SPECIFICATIONS.
SURFACE TREATMENT:

4" PLANTABLE SOIL AND SEED OVER

8" COMPACT GRAVEL OR

4" MINIMUM DEPTH OF PAVEMENT MILLING MULCH PLACE DIRECTLY OVER GEOTEXTILE AND CRUSHED STONE BOX

NOTES:

1. GEOTEXTILE FABRIC AS DESCRIBED IN SECTION M9.50

2. PIPE SHALL BE SET AT BOTTOM OF TRENCH FOR IMPERVIOUS BOTTOM.

3. SUBDRAIN LOCATED APPROXIMATELY AT INTERSECTION OF TANGENTS (SEE DWG. E102.1.0)

4. GRAVEL (AND SPECIAL BORROW WHERE REQUIRED) SHALL INTERSECT CRUSHED STONE FOR SUBDRAIN
SECTION A-A

STAKE (TYP.)

FILTER FABRIC FOR EROSION CONTROL
(STAKE FILTER FABRIC EVERY 1ft)

SECTION X-X

STAKE (TYP.)

HAY Bale FOR EROSION CONTROL

6" X 6" TRENCH LAY FILTER FABRIC IN TRENCH
END UP SLOPE AND BACK FILL

HAY BALES FOR EROSION CONTROL
(2 STAKES PER BALE)
ACCM UNITS TO BE LAPPED IN DIRECTION OF FLOW AND FASTENED WITH TWO GALV. BOLTS 3/8" X 1 1/4"

3" X 2" X 1/4" GALV. ANGLES FASTENED TO METAL FLUME WITH 3/8" GALV. X 1 1/4" BOLTS SPACED 12" C. TO C. OR STITCH WELDED.

UNIT LENGTHS IN MULTIPLES OF 2' UP TO MAX. OF 12'

ANGLES SET BACK 3 CORRUGATIONS FOR LAPPING UNITS

ACCM WATERWAY TO BE FASTENED TO STAKES WITH SPIKES

WOOD STAKES 2" X 6" NOMINAL SIZE

STAKES SPACED 6'-0" MAX. C. TO C.

NOTE:
1. DIAMETER OF HALF CCM PIPE WATERWAY TO BE AS SPECIFIED.
2. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.

GROUND LINE

DIAMETER

2"

2"

3-0"

MIN.

1'-0"

3-0"

1'-0"
SECTION D-D
SEE NOTE NO. 2

CONTRACTION JOINT

EXPANSION JOINT

TRANSITIONAL SECTION FOR STANDARD PAVED WATERWAY

FIELD SODDING

6' 10"-6'± 6'

EXPANSION JOINT

TRANSITIONAL SECTION FOR STANDARD PAVED WATERWAY

FLUSH DROP INLET

INLET APRON

NOTES:
1. CONTRACTION JOINTS ARE TO BE SPACED 30' CENTER TO CENTER FOR CEMENT CONC. SEE DRAWING 211.3.0
2. REINFORCING STEEL TO BE PLACED AS SHOWN ON DRAWING E 211.3.0 - FOR CEMENT CONC.
3. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST STANDARD SPECIFICATIONS.
NOTES:
1. On curved alignment, waterways shall be banked as directed.
2. For descriptions, materials and construction methods, see latest standard specifications.
<table>
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<tr>
<th>H (FT)</th>
<th>W (FT)</th>
<th>D (FT)</th>
<th>CONCRETE MASONRY FOOTING</th>
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COPING TO BE PRECAST CONCRETE OR GRANITE OF UNIFORM DEPTH FOR THE ENTIRE LENGTH. DEPTH OF CONCRETE TO BE 1/12 THE AVERAGE "H" WITHIN THE LIMITS SHOWN. DEPTH OF GRANITE TO BE AS SHOWN ON THE PLANS, 6" OR 9".

FOR CHAIN LINK FENCE ON TOP OF WALL, THE COPING SHALL BE CONCRETE CAST IN-PLACE WITH A MINIMUM DEPTH OF 12", THE LENGTH OF GALVANIZED PIPE SLEEVE FOR FENCE POSTS SHALL BE EQUAL TO THE DEPTH OF COPING.

NOTES:
1. COPING OVERHANG TO BE APPROXIMATELY 3" FOR WALLS 10' OR MORE IN HEIGHT AND APPROXIMATELY 2" FOR WALLS LESS THAN 10' IN HEIGHT. IN A CONTINUOUS WALL OF VARYING HEIGHT THE OVERHANG WILL BE APPROXIMATELY 2" TO 3" FOR THE ENTIRE LENGTH.
2. ALL DIMENSIONS SHOWN ARE MINIMUM.
3. PAYMENT WILL BE BASED ON THE ACCOMPANYING TABLE.
4. TO BE FOUND ON SUITABLE SOIL.
PLAN

6" REINFORCED CONCRETE SLAB
4,000 PSI (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)

TOP OF OUTSIDE FACE OF CONCRETE CURTAIN TOE WALL

SLOPE VARIES

8" CRUSHED STONE (TYPICAL)

6"X6"X1/4" DIA WIRE FABRIC 5.2 lb/SY

CONCRETE CURTAIN TOE WALL

INSTALL SUBDRAIN SEE E 209.1.D

SECTION A-A

* SEE E 303.1.1 FOR SECTION B-B AND CONSTRUCTION AND Expansion JOINTS DETAILS.
NOTES:

1. WIRE FABRIC TO HAVE 12" MINIMUM LAP AT SPLICE AND SHOULD EXTEND WITHIN 3" OF ALL EDGES
2. SLAB SHALL BE GROOVED PARALLEL TO AND NORMAL TO THE CURTAIN TOE WALL AT APPROXIMATELY 6' GRIDS. THE GROOVE DEPTH SHALL BE 1"
3. FOR LIMITS OF SLOPE PAVING SEE BRIDGE MANUAL.
4. CONCRETE SHALL BE 4,000 PSI (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
5. EXTEND GEOTEXTILE FABRIC BENEATH CRUSHED STONE FROM TOP OF CONCRETE CURTAIN TOE WALL TO FACE OF ABUTMENT.
6. SEE E 303.1.0 FOR SLAB PLAN AND SECTION.
PLEASE NOTE: DESIGN B HAS BEEN DISCONTINUED

NOTES:
1. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM EXCEPT RISERS AND TREADS WHICH HAVE 1/4" TOLERANCE.
2. FOR REINFORCING STEEL AND CONCRETE QUANTITIES SEE DRAWING E 304.2.0
For designs "A", "B" and "C" see drawing E 304.1.0

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<th>DESIGN C</th>
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Please note: Design B has been discontinued.

All concrete shall be 4,000 PSI (see MassDOT specifications for design requirements).
### TABLE OF DIMENSIONS AND REINFORCING STEEL

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### Steel (lb/ft)

| 98 | 117 | 152 | 171 | 200 | 233 | 243 | 280 | 292 | 399 | 454 | 470 | 488 | 510 | 524 | 550 | 631 |

### Maximum Soil Bearing Pressure

| Q_max (psf) | 5123 | 5663 | 5452 | 5954 | 7019 | 6759 | 7346 | 7886 | 8482 | 9033 | 8817 | 9355 | 9178 | 8984 | 9103 | 8948 | 8892 |

### Notes:

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

### ASSUMED DESIGN PARAMETERS

**DENSE FOUNDATION SOIL, SLOPING BACKFILL**

1. **BACKFILL LOADING CONDITIONS:**
   - 2H:1V SLOPING BACKFILL
2. **BACKFILL SOIL PROPERTIES:**
   - TYPE: GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES
   - \( \phi = \text{ANGLE OF INTERNAL FRICTION} = 37\degree \)
   - \( \delta = \text{ANGLE OF WALL FRICTION} = 22\degree \)
   - \( \gamma = \text{EFFECTIVE UNIT WEIGHT} = 120 \text{ psf} \)
3. **FOUNDATION SOIL PROPERTIES:**
   - \( c_f = \text{FACTORED BEARING CAPACITY} = 9400 \text{ psf} \)
   - \( F_c = 4000 \text{ psi} \)
   - \( F_y = 50000 \text{ psi} \)
4. **SEISMIC LOADING:**
   - \( A = 0.17q \) (Max.)
   - \( K_h = 0.086 \)
   - \( K_v = 0 \)
5. **REINFORCED CONCRETE:**
   - \( F_y = 50000 \text{ psi} \)

(See MassDOT Specifications for Design Requirements)
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### Quantities of Materials

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| Steel (lb/ft²) | 76 | 86 | 96 | 104 | 118 | 133 | 161 | 182 | 198 | 233 | 240 | 307 | 340 | 360 | 388 | 412 | 438 |

### Maximum Soil Bearing Pressure

| Qmax (psf) | 4071 | 4328 | 4591 | 4860 | 4811 | 5491 | 5752 | 6018 | 5945 | 6208 | 6917 | 6833 | 7090 | 7352 | 7271 | 8079 | 8332 |

### Notes:
1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designers must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

### ASSUMED DESIGN PARAMETERS

**DENSE FOUNDATION SOIL, LEVEL BACKFILL, SURCHARGE**

1. **BACKFILL LOADING CONDITIONS:**
   - LEVEL BACKFILL;
   - 240 psf LIVE LOAD SURCHARGE,

2. **BACKFILL SOIL PROPERTIES:**
   - TYPE: GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES
   - \( \phi = \text{ANGLE OF INTERNAL FRICTION} = 37° \)
   - \( \delta = \text{ANGLE OF WALL FRICTION} = 22° \)
   - \( \gamma = \text{EFFECTIVE UNIT WEIGHT} = 120 \text{ psf} \)

3. **FOUNDATION SOIL PROPERTIES:**
   - \( \sigma_b = \text{FACTORED BEARING CAPACITY} = 9400 \text{ psf} \)
   - FRICITION FACTOR = 0.57

4. **SEISMIC LOADING:**
   - \( A = 0.17g, \text{Max.} \)
   - \( K_h = 0.065 \)
   - \( K_v = 0 \)

5. **REINFORCED CONCRETE:**
   - \( P_c = 4000 \text{ psi} \)
   - \( F_y = 80000 \text{ psi} \)

(See MASSDOT specifications for design requirements)
## Table of Dimensions and Reinforcing Steel

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### Quantities of Materials

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### Steel (lbs/ft)

- 126 @ 158
- 173 @ 189
- 219 @ 309
- 351 @ 379
- 422 @ 440
- 480 @ 500
- 516 @ 557
- 588 @ 625
- 653 @ 664

### Maximum Soil Bearing Pressure

\[ q_{max} = 4918 \text{ psf} \]

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<td>Footing Concrete (yd³/ft)</td>
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### Notes:

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

### Assumed Design Parameters

**Loose Foundation Soil, Sloping Backfill**

1. **Backfill Loading Conditions:**
   - 2H:1V Sloping Backfill

2. **Backfill Soil Properties:**
   - 1. **Type:** Gravel Borrow for Backfilling Structures and Pipes
   - \( \phi = \text{Angle of Internal Friction} = 37^\circ \)
   - \( \delta = \text{Angle of Wall Friction} = 22^\circ \)
   - \( \gamma = \text{Effective Unit Weight} = 120 \text{ pcf} \)

3. **Foundation Soil Properties:**
   - \( q_f = \text{Factored Bearing Capacity} = 6000 \text{ psf} \)
   - Friction Factor \( \phi = 0.50 \)

4. **Seismic Loading:**
   - \( A = 0.17 (\text{Max.}) \)
   - \( K_h = 0.085 \)
   - \( K_v = 0 \)

5. **Reinforced Concrete:**
   - \( F_c = 4000 \text{ psi} \)
   - \( F_y = 60000 \text{ psi} \)

(See MassDOT Specifications for Design Requirements)
## TABLE OF DIMENSIONS AND REINFORCING STEEL

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### Quantities of Materials

| Stere Concrete (yd³/ft) | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.6 | 2.7 |
|-------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Footing Concrete (yd³/ft) | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

### Steel (lb/ft)

| Steel (lb/ft) | 79 | 86 | 101 | 106 | 110 | 114 | 118 | 121 | 121 | 126 | 225 | 267 | 287 | 365 | 343 | 435 | 463 | 492 |

### Maximum Soil Bearing Pressure

\[ Q_{pore} \ (\text{psf}) = 4318 \]

\[ Q_{pore} \ (\text{psf}) = 4614 \]

\[ Q_{pore} \ (\text{psf}) = 5111 \]

\[ Q_{pore} \ (\text{psf}) = 5210 \]

\[ Q_{pore} \ (\text{psf}) = 5133 \]

\[ Q_{pore} \ (\text{psf}) = 5412 \]

\[ Q_{pore} \ (\text{psf}) = 5693 \]

\[ Q_{pore} \ (\text{psf}) = 5616 \]

\[ Q_{pore} \ (\text{psf}) = 5893 \]

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\[ Q_{pore} \ (\text{psf}) = 5440 \]

\[ Q_{pore} \ (\text{psf}) = 5695 \]

\[ Q_{pore} \ (\text{psf}) = 5487 \]

### Notes:

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

### ASSUMED DESIGN PARAMETERS

**LOOSE FOUNDATION SOIL, LEVEL BACKFILL, SURCHARGE**

1. **BACKFILL LOADING CONDITIONS:**
   - LEVEL BACKFILL:
     - 240 psf LIVE LOAD SURCHARGE.

2. **BACKFILL SOIL PROPERTIES:**
   - TYPE: GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES
   - \( \beta = \text{ANGLE OF INTERNAL FRICTION} = 37^\circ \)
   - \( \delta = \text{ANGLE OF WALL FRICTION} = 22^\circ \)
   - \( \gamma = \text{EFFECTIVE UNIT WEIGHT} = 120 \text{ psf} \)

3. **FOUNDATION SOIL PROPERTIES:**
   - \( c = \text{FACTORED BEARING CAPACITY} = 6000 \text{ psf} \)
   - \( F' = \text{REINFORCED CONCRETE} \)
   - \( F' = 4000 \text{ psi} \)
   - \( F' = 60000 \text{ psi} \)
   - \( \theta = \text{ANGLE OF INTERNAL FRICTION} = 37^\circ \)
   - \( \psi = \text{ANGLE OF WALL FRICTION} = 22^\circ \)
   - \( \gamma = \text{EFFECTIVE UNIT WEIGHT} = 120 \text{ psf} \)

4. **SEISMIC LOADING:**
   - \( A = 0.172 \text{ (Max.)} \)
   - \( K_h = 0.085 \)
   - \( K_v = 0 \)

### (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
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| M (ft) | 1.917 | 1.917 | 1.917 | 1.917 | 1.917 | 2.000 | 2.500 | 2.500 | 2.500 | 2.500 | 2.500 | 2.500 | 2.500 | 2.500 | 2.500 | 2.500 | 2.500 |
| N (ft) | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| HOOK (ft) | 1.000 | 1.167 | 1.167 | 1.333 | 1.333 | 1.583 | 1.583 | 1.833 | 1.833 | 1.833 | 1.833 | 1.833 | 2.000 | 2.000 | 2.000 | 2.000 | 2.000 |

**Quantities of Materials**

- **Steel (lb/ft):**
  - Stem Concrete (yd³/ft): 0.3, 0.9, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.2, 2.3, 2.4, 2.5, 2.7
  - Footing Concrete (yd³/ft): 0.6, 0.7, 0.7, 0.7, 0.8, 0.8, 0.9, 1.1, 1.2, 1.3, 1.3, 1.4, 1.7, 1.8, 2.1
  - Maximum Soil Bearing Pressure: 96, 120, 125, 148, 164, 197, 213, 272, 276, 342, 379, 382, 446, 503, 543, 558, 580

**Notes:**
1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

**Assumed Design Parameters**

**Rock Foundation, Sloping Backfill**

1. **Backfill Loading Conditions:**
   - 2H:1V Sloping Backfill
2. **Backfill Soil Properties:**
   - Type: Gravel Borrow for Backfilling Structures and Pipes
   - \( \phi = \text{Angle of Internal Friction} = 37^\circ \)
   - \( \delta = \text{Angle of Wall Friction} = 22^\circ \)
   - \( \gamma = \text{Effective Unit Weight} = 120 \text{ psf} \)
3. **Foundation Soil Properties:**
   - \( q = \text{Factored Bearing Capacity} = 20000 \text{ psf} \)
   - Friction Factor = 0.70
4. **Seismic Loading:**
   - \( A = 0.17 \text{g (Max.)} \)
   - \( K_h = 0.085 \)
5. **Reinforced Concrete:**
   - \( f_c = 4000 \text{ psi} \)
   - \( f_y = 60000 \text{ psi} \)

(See MassDot Specifications for Design Requirements)
<table>
<thead>
<tr>
<th>TABLE OF DIMENSIONS AND REINFORCING STEEL</th>
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<td><strong>P</strong></td>
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<td><strong>HOOK</strong></td>
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| **Steel (lb/ft)** | 76 | 85 | 96 | 104 | 118 | 133 | 176 | 182 | 198 | 233 | 240 | 307 | 340 | 360 | 388 | 412 | 438 |

**Maximum Soil Bearing Pressure**

| **Q_{max} (psf)** | 4071 | 4328 | 4591 | 4860 | 4811 | 5491 | 5672 | 6018 | 5945 | 6208 | 6917 | 6833 | 7090 | 7352 | 7271 | 8079 | 8332 |

**Notes:**

1. All dimensions are in feet, unless specified otherwise.
2. Spacings of reinforcing bars are in inches.
3. Designer must confirm design parameters with Geotechnical Engineer prior to selecting wall for site.

**ASSUMED DESIGN PARAMETERS**

**ROCK FOUNDATION, LEVEL BACKFILL, SURCHARGE**

1. BACKFILL LOADING CONDITIONS:
   - LEVEL BACKFILL:
     - 240 psf LIVE LOAD SURCHARGE.
2. BACKFILL SOIL PROPERTIES:
   TYPE: GRAVEL BORROW FOR BACKFILL STRUCTURES AND PIPES
   - \( \phi = \text{ANGLE OF INTERNAL FRICTION} = 37^\circ \)
   - \( \delta = \text{ANGLE OF WALL FRICTION} = 22^\circ \)
   - \( \gamma = \text{EFFECTIVE UNIT WEIGHT} = 120 \text{ psf} \)
3. FOUNDATION SOIL PROPERTIES:
   \( q_c = \text{FACTORED BEARING CAPACITY} = 20000 \text{ psf} \)
   \( F_c = 4000 \text{ psi} \)
   - \( F_r = 60000 \text{ psi} \)
   - Friction Factor = 0.70
   \( \phi = \text{PERFORMANCE FACTOR FOR SLIDING} = 0.80 \)
4. SEISMIC LOADING:
   - \( A = 0.17g \) (Max.)
   - \( K_n = 0.085 \)
   - \( K_v = 0 \)
NOTES:


2. ALL GUARDRAIL MATERIALS SHALL CONFORM TO M8.07.0 UNLESS OTHERWISE INDICATED.

3. APPROVAL BY THE ENGINEER IS REQUIRED WHERE A DIFFERING GUARDRAIL CONFIGURATION IS REQUIRED FOR CONSTRUCTABILITY BEYOND THE OPTIONS SHOWN IN THESE STANDARDS OR THE PLANS.

4. THE BEGIN OR END STATION LABELS SHOWN IN THESE STANDARDS CORRESPOND TO THE STATION AND OFFSET CALLOUTS SPECIFIED IN THE PLANS.

5. USE 12'-6" NOMINAL LENGTH PANELS UNLESS OTHERWISE INDICATED IN THESE STANDARDS OR THE PLANS.

6. ALL LAP SPLICES SHALL BE MIDSPAN UNLESS OTHERWISE SHOWN.

7. LAP SPLICES SHALL BE CONSTRUCTED WITH THE SPLICE RIDGE ORIENTED DOWNSTREAM OF THE FINAL DIRECTION OF TRAFFIC IN THE NEAREST TRAVEL LANE. REORIENTING LAP SPLICES FOR TEMPORARY TRAFFIC CONTROL IS NOT REQUIRED.

8. STANDARD POSTS SHALL BE STEEL OR TIMBER, UNLESS OTHERWISE INDICATED IN THE PLANS, FABRICATED TO THE DIMENSIONS SHOWN ON 400.1.4. POSTS OF A SINGLE MATERIAL TYPE SHALL BE USED THROUGHOUT AN ENTIRE RUN OF GUARDRAIL; EXCEPTIONS ARE ALLOWED ONLY WHEN SPECIFIC MATERIAL TYPES ARE REQUIRED FOR TRANSITIONS, END TREATMENTS, AND/OR ANCHORAGES.

9. DEEP POST SHALL ONLY BE USED WHERE INDICATED IN THESE STANDARDS OR THE PLANS.

10. OFFSET BLOCKS, WHERE REQUIRED, SHALL BE TIMBER AND FABRICATED TO THE NOMINAL DIMENSIONS SHOWN ON 400.1.4. PLASTIC OR COMPOSITE OFFSET BLOCKS OF THE SAME NOMINAL DIMENSIONS THAT ARE LISTED ON THE QUALIFIED CONSTRUCTION MATERIALS LIST MAY BE SUBSTITUTED. OFFSET BLOCKS OF A SINGLE MATERIAL TYPE SHALL BE USED THROUGHOUT AN ENTIRE RUN OF GUARDRAIL; EXCEPTIONS ARE ALLOWED ONLY WHEN SPECIFIC MATERIAL TYPES ARE REQUIRED FOR TRANSITIONS, END TREATMENTS, AND/OR ANCHORAGES.

11. PAVEMENT MILLING MULCH, WHERE CALLED FOR IN THE STANDARDS, SHALL CONFORM TO SECTION 739.

12. GUARDRAIL DELINEATORS, CONFORMING TO SECTION 601, SHALL BE INSTALLED AT 25' INTERVALS WITHIN 100' OF AN END TREATMENT OR TRAILING ANCHORAGE AND AT 100' INTERVALS IN ALL OTHER AREAS UNLESS OTHERWISE SHOWN IN THE PLANS.

13. MINIMUM OFFSET DISTANCE FROM FACE OF W-BEAM PANEL TO A FIXED (NON-BREAKAWAY) OBJECT SHALL BE 48" FOR TL-2 AND 60" FOR TL-3.
NOTES:

1. CONSTRUCTION TOLERANCE FOR PANEL HEIGHT ± 1/4".
APPROACH TO RIGID BARRIER OR BRIDGE RAIL - PLAN VIEW

MIROR HORIZ. AND/OR VERT. FOR OPPOSITE DIRECTION AND/OR SIDE OF ROAD

APPROACH TO RIGID BARRIER OR BRIDGE RAIL - PLAN VIEW

TAPERED GUARDRAIL FOR MEDIAN

(MIRROR HORIZ. AND VERT. FOR OPPOSITE DIRECTION)

NOTES:
INSTALLATION THE PLAN VIEWS SHOWN ARE SCHEMATIC ONLY. SHOWING example GEOMETRY FOR CONNECTING GUARDRAIL SEGMENTS INCLUDING TAPER LOCATIONS AND DOUBLE FACED GUARDRAIL SUPPORTS AS APPLICABLE. WORK THIS SHEET WITH THE PLAN WHERE STATIONING APPEAR TO THE LEFT, GUARDRAIL SEGMENTS ARE ALIGNED IN THE SAME DIRECTION AS DESCRIBED IN THE PLAN.
Approach to Rigid Barrier - Double Faced Guardrail

Plan View - Median Shoulders Only

(Mirror Horiz. and Vert. for Opposite Direction)
NOTES:
1. MAINTAIN STANDARDS 1" CLEARANCE OF POST ABOE PANEL THROUGHOUT THE ENTIRE LENGTH OF TRANSITION.
2. A MINIMUM OF ONE (1) 12'0" PANEL SHALL BE PLACED BETWEEN THIS TRANSITION AND THE START OF ANY END TREATMENT OR ANCHORAGE.
3. ALL NEW POSTS SHALL BE 7'11" IN LENGTH UNLESS OTHERWISE SPECIFIED BY THE ENGINEER.
4. ALL NEW POSTS AND OFFSET BLOCK MATERIALS SHALL MATCH EXISTING UNLESS OTHERWISE SPECIFIED BY THE ENGINEER.
NOTES:

1. FOR ADDITIONAL DETAILS, SEE AS4362.
2. LAP THE ROUNDED END UNIT OVER THE FACE OF THE VERTICAL PANEL.
3. INSTALL STEEL TUBE FOUNDATIONS BY ONE OF THE FOLLOWING METHODS:
   A: EXCAVATE, INSTALL TUBE, BACKFILL, AND SURFACE CVAPILATE MATERIALS ON
   B: DRIVE THE TUBE USING A DUMMY TIMBER POST TO PREVENT DAMAGE TO THE
      SHORT BREAKAWAY POST.
NOTES:
1. WHEN THE CONSTRUCTION OF GUARDRAIL AT THE REQUIRED POST SPACING REFER TO IN POST 1)
   PLACED WITHIN A CONCRETE OR HMA SURFACE, USE A FRANGIBLE LEAVE-OUT AROUND THE POST BASE
   AS SHOWN IN FIGURE 1. END DETAILS SHOWN IN THE PLAN AND ELEVATION SHOWN HEREIN AS NEEDED.
2. USE THE REQUIRED T-FIT 4" X 4" LEAVE-OUT.
3. ENSURE THE SURROUNDING ARE FILL MATERIAL IS
4. ENSURE THE SURROUNDING ARE FILL MATERIAL IS
   ENSURE THE SURROUNDING ARE FILL MATERIAL IS
**NOTES:**

1. ALL EDGES SHALL BE ROUNDED WITH A 1" RADIUS EXCEPT AS SHOWN
2. FOR DOWEL CONNECTION DETAILS SEE E 402.13.0.
3. FOR REINFORCING SEE E 402.11.0 FOR SYMMETRICAL SHAPE AND E 401.12.0 FOR ASYMMETRICAL SHAPE.
4. ALL CONCRETE IS TO BE FIELD COATED AFTER FINAL INSTALLATION WITH A CONCRETE PENETRANT/SEALER. CAST IN PLACE CONCRETE SHALL CURE NOT LESS THAN 28 DAYS PRIOR TO COATING.
5. LIFT HOLES USED ONLY ON PRECAST BARRIERS 13" AND LESS.

* VARY "A1" RELATIVE TO "H1" WHILE MAINTAINING 55° AND 84° BARRIER ANGLES. A1=4-3/4" MAX., H1=4'-7" MAX.

**F SHAPE CONCRETE BARRIER**

**SYSTEM** | **A** | **H**
---|---|---
NORMAL | 2 1/4" | 2'-8"
TALL | 3 1/4" | 3'-6"
1. CAST IN PLACE NOT TO EXCEED 200' BETWEEN EXPANSION JOINTS.
2. CONSTRUCTION JOINTS REQUIRED AT 40' INTERVALS (1/2" PREMOLDED JOINT FILLER REQUIRED FOR PRECAST BARRIERS).
3. USE MINIMUM COVER OF 1 1/2", UNLESS OTHERWISE INDICATED.
4. MATERIAL IS 4000 PSI CEMENT CONCRETE. (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS)
5. ALL STEEL REINFORCING TO BE GALVANIZED OR EPOXY COATED, AASHTO-M31, GRADE 60.
6. ALL LONGITUDINAL BARS ARE TO BE CONTINUOUS FOR BOTH PRECAST AND CAST IN PLACE BARRIERS.
7. FOR DIMENSIONS SEE E 402.10.0
F SHAPE CONCRETE BARRIER
ASYMETRICAL SECTION
REINFORCING DETAILS

NOTES:

1. CAST IN PLACE NOT TO EXCEED 200’
   BETWEEN EXPANSION JOINTS.
2. CONSTRUCTION JOINTS REQUIRED AT 40’
   INTERVALS (1/2" PREMOLDED JOINT
   FILLER REQUIRED FOR PRECAST BARRIERS).
3. USE MINIMUM COVER OF 1 1/2”.
   UNLESS OTHERWISE INDICATED.
4. MATERIAL IS 4000 PSI CEMENT CONCRETE.
   (SEE MASSDOT SPECIFICATIONS
   FOR DESIGN REQUIREMENTS)
5. ALL STEEL REINFORCING TO BE GALVANIZED
   OR EPOXY COATED, AASHTO-M31, GRADE 60.
6. FOR DIMENSIONS SEE E 402.10.0
NOTES:
1. DOWELS TO BE GALVANIZED, AASHTO-M31, GRADE 60.
2. FOR ADDITIONAL DETAILS SEE E 402.10.0
**SAME DEPTH AS UNDER ROADWAY.**

**BARRIER CAP BUILT USING 4000 PSI CEMENT CONCRETE (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS).**

**NOTES:**
1. ALL LONGITUDINAL BARS TO BE CONTINUOUS FOR BOTH PRECAST BARRIERS AND CAST IN PLACE BARRIERS.
2. USE MINIMUM COVER OF 1 1/2", UNLESS OTHERWISE INDICATED.
3. ALL CONCRETE IS TO BE FIELD COATED AFTER FINAL INSTALLATION WITH A CONCRETE PENETRANT/SEALER. CONCRETE SHALL CURE NOT LESS THAN 28 DAYS PRIOR TO COATING.
4. FOR REINFORCING DETAILS SEE E 402.21.0
5. FOR DOWEL DETAILS SEE E 402.22.0
6. TAR PAPER TO BE PLACED INSIDE LIFT HOLES AND BARRIER JOINTS.
1. ALL LONGITUDINAL BARS ARE TO BE CONTINUOUS FOR BOTH PRECAST BARRIERS AND CAST IN PLACE BARRIERS.
2. USE MINIMUM COVER OF 1 1/2", UNLESS OTHERWISE INDICATED.
3. CAST IN PLACE (CIP) NOT TO EXCEED 200 FT BETWEEN EXPANSION JOINTS.
4. CONTRACTION JOINTS REQUIRED AT 40' INTERVALS (1/2" PREMOULDED JOINT FILLER REQUIRED FOR PRECAST BARRIERS).
5. ALL STEEL REINFORCING TO BE GALVANIZED OR EPOXY COATED, AASHTO-M31, GRADE 60.
6. FOR DIMENSIONS SEE E 401.20.0
PLAN OF CONNECTION

SECTION A–A

REINFORCEMENT DETAIL

CONNECTOR PIN ASSEMBLY
TEST RESULTS
MASH 3-11 ON CONCRETE:
1. INSTALLATION LENGTH: 20 SEGMENTS
2. DYNAMIC DEFLECTION AT BASE: 59.0”
3. PERMANENT DEFLECTION AT BASE: 59.0”
4. WORKING WIDTH: 81.4”

NOTES:
1. SEE MASSDOT DRAWING # E 403.2.0 FOR CONNECTION AND BARRIER DETAILS.
2. FOLLOW MANUFACTURER’S INSTRUCTION FOR INSTALLING SCREW ANCHORS.
PLAN VIEW

ELEVATION VIEW

SECTION B-B

ISOMETRIC VIEW

TEMPORARY CONCRETE BARRIER
RETROFITTED TO MASH TL-3

6" X 4" X ½" ANGLE
ASTM A709 GRADE 50
CHARPY TESTED TO MINIMUM 15 FT/LBS AT 40°
GALVANIZED

ANGLE DETAILS
CHAIN LINK FENCE WITH SPRING TENSION WIRE

LINE POSTS TO BE SPACED 10'-0" C. TO C. MAXIMUM EXCEPT ON CURVES WHERE THEY SHALL BE SPACED AS FOLLOWS:

- CURVES 200' TO 500' RADIUS: 8'-0" C. TO C. MAXIMUM
- CURVES 100' TO 200' RADIUS: 6'-0" C. TO C. MAXIMUM
- CURVES LESS THAN 100' RADIUS: 5'-0" C. TO C. MAXIMUM

LINE POST SPACING

- FASTENING SPRING TENSION WIRE TO LINE POST
- FASTENING FABRIC TO LINE POST EVERY 12" ±
- HOG RINGS EVERY 12" ±
- FABRIC FLUSH WITH TOP OF POST
- FABRIC PLACED PERPENDICULAR TO THE ANCHOR

DETAIL SHOWING LINE POST SET WITH DRIVE ANCHORS

DETAIL OF AN ANCHOR CLAMP

DETAIL SHOWING LINE POST SET IN CONCRETE FOOTING FOR DIMENSIONS SEE 404.5.0
NOTES:

1. FABRIC FOR FENCES 4' OR LESS IN HEIGHT: TOP SELVAGE TO HAVE KNUCKLED FINISH. BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED. FABRIC FOR FENCES 6' OR OVER IN HEIGHT: BOTH TOP AND BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED.

2. GRADE OF FENCE TO BE PARALLEL WITH THE GRADE OF SIDEWALKS, CURBING, GROUND OR TOP OF WALL.

3. INTERMEDIATE POST INTERVALS NOT TO EXCEED 500 FEET.

4. SPACING OF LINE POST ON CURVES, SEE DRAWING E 404.1.0

5. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.

6. SPRING TENSION WIRE TO BE FASTENED TO FABRIC WITH 11 GAUGE HOG RINGS AT 1' INTERVALS.

7. SPRING TENSION WIRE TO BE FASTENED TO LINE POSTS WITH CLIPS.

8. LINE POSTS TO BE DRIVEN EXCEPT WHERE NOTED ABOVE.
NOTES:

1. FABRIC FOR FENCES 4' OR LESS IN HEIGHT. TOP SELVAGE TO HAVE KNUCKLED FINISH. BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED.
2. FABRIC FOR FENCES 5' OR OVER IN HEIGHT. BOTH TOP AND BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED.
3. GRADE OF FENCE TO BE PARALLEL WITH THE GRADE OF SIDEWALKS, CURBING, GROUND OR TOP OF WALL.
4. LINE POSTS TO BE SPACED 10'-0" C. TO C. MAXIMUM EXCEPT ON CURVES WHERE THEY SHALL BE SPACED AS FOLLOWS:
   - CURVES 200' TO 500' RADIUS: 8'-0" C. TO C. MAXIMUM
   - CURVES 100' TO 200' RADIUS: 6'-0" C. TO C. MAXIMUM
   - CURVES LESS THAN 100' RADIUS: 5'-0" C. TO C. MAXIMUM
5. FOR POST BASES AND CABLE ATTACHMENTS, SEE DRAWING E 404-5.0
6. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATIONS.
### Fence Details

**Post Bases**
- **For Corner, End Line and Pull Posts**
- **For Gate Posts**

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<th>Fence Height</th>
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<td>5' or Less</td>
<td>2'-6&quot;</td>
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<tr>
<td>Over 5'</td>
<td>3'-0&quot;</td>
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**For Fastening to Base of Post**

- **7/16" Wire Rope Clips**
- **3/8" Wire Rope Thimble**
- **3/8" Anchor Shackle**
- **5/8" Eye Bolts**

**FOR END PULL POST**

**FOR FASTENING TO BASE OF POST**

*Note:* 
1. For eye bolt installation through pipe sections, use 2 washers on "shoulder side" and 1 washer with lock washer on "nut side" of posts.

**Details of Cable Attachments**
1. Chain link fabric for gates to be the same as required for fence.

2. For gate post base, see drawing 4004.0.
MASS. DEPT. OF ENVIRONMENTAL PROTECTION
FILE NO._____
NOTES:
1. CONSTRUCTED WALL MATERIAL SHALL BE PER SPECIFICATIONS.
2. WALL MATERIAL MAY BE DRY LAYERED BALANCE WALL OR SLOPE PAVING.
3. WALL CONSTRUCTION SHALL NOT COMPROMISE ROOT SYSTEM (BURIED STRUCTURES, SUCH AS MSE OR GEOGRID MAY BE USED FOR FILL BUT NOT CUT CONDITIONS).

SECTION VIEW

PLAN VIEW

TREE WELLS
2" x 6" x 18" LONG SPRUCE

2" x 6" x 30" SPRUCE

LAG SCREWS

LAG SCREWS

NAILS

NAILS

EXTRA HEAVY PIPE FLANGE

WOOD SCREWS

WOOD SCREWS

1 1/2" GALV. IRON PIPE 5'-3" LONG

LEVEL WITH CAR WINDOW

LEVEL WITH CAR WINDOW

MAIL BOXES ON NARROW SIDEWALKS SHOULD BE SET BEHIND CURB AND PARALLEL TO IT WITH LETTER SLOT FACING TRAFFIC.

NOTES:

1. LUMBER TO BE PLANED ON ALL Four SIDES TO FULL 2" x 6" SIZE TO FIT BOTTOM OF MAIL BOXES.
2. TO SET 1 1/2" GALVANIZED PIPE POST, USE DRIVING POINT OF SAME SIZE, THEN TAMPER POST INTO PLACE SO AS TO BE PLUMB BOTH WAYS.
3. ALL FITTINGS (PIPE FLANGES, PIPE, SCREWS, NAILS, ETC.) ARE TO BE GALVANIZED.
4. FOR DESCRIPTIONS, MATERIALS, AND CONSTRUCTIONS METHODS SEE STANDARD SPECIFICATIONS.
5. A 4" X 4" PRESSURE TREATED WOOD POST MAY BE SUBSTITUTED FOR A PIPE POST.
REPLACEMENT OF BOUND BROKEN OR LOST WILL BE INSCRIBED WITH THE YEAR BOUND POINT WAS ESTABLISHED.
BOUNDS LOCATING NEW CORNERS WILL BE INSCRIBED WITH THE YEAR NEW CORNER WAS ESTABLISHED.

ALL LETTERING TO BE
1/2" V SUNK LETTERS

1995
E.G. OPPOSITE FACE WITH "S" FOR CORNER ON MEDFORD-STONEHAM LINE.

P
N.H.
1890

M
MASS
1890

OPPOSITE FACE
HAMMERED

GROUND LINE

OPTIONAL - HAMMERED OR ROUGH SAWED

STATE LINE

CITY OR TOWN CORNER

NOTES:

1. TOP AND 4 SIDES FOR A DISTANCE OF 12" TO BE HAMMERED SMOOTH.

2. IN SPECIFIED LOCATIONS, MONUMENTS MAY BE HAMMERED SMOOTH ON TOP AND 4 SIDES ABOVE GROUND LINE.

3. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS SEE STANDARD SPECIFICATIONS.