



Montana Department of Transportation

PO Box 201001
Helena, MT 59620-1001

VISION ZERO

zero deaths
zero serious injuries

Memorandum

To: Distribution

From: David Hedstrom, PE - Hydraulic Engineer *DJH*

Date: September 22, 2017

Subject: Updated Culvert Bedding and Hydraulic Standards

To simplify the construction process and improve the finished product, the Hydraulics Section is proposing revisions to culvert bedding specifications for culvert sizes 54-inches and larger and culvert cutoff walls.

As a result, the quantities changed for both the bedding material per foot of pipe and the cubic yards of concrete for the cutoff walls. The Detailed Drawings have been updated to reflect the proposed changes including the recalculated quantities.

Following is a summary of changes that were made to the Detailed Drawings:

552-00: CONCRETE CUTOFF WALLS FOR CULVERTS

- Removed riprap pattern and callout in Note 3.
- Added "T" dimension and defined as culvert shell thickness for concrete or corrugation depth for metal
- Changed cutoff wall depth from 3'-0" min. to dimension "d" and defined dimension "d" as 3'-0" min. or 1'-0" below bottom of foundation material if specified.
- Defined "X" dimension for metal culverts.
- Defined cutoff wall depth measurement to be at the outside diameter of the culvert for both concrete and metal.

552-04, 552-06, 552-08: CONCRETE, RIPRAP AND BEDDING MATERIAL QUANTITIES FOR SINGLE AND DOUBLE CULVERT INSTALLATIONS

- Changed "BEDDING" to "GRANULAR BEDDING" in title.
- Concrete Edge Protection
 - Removed 1.5:1, 2.5:1, 3:1 columns.
 - Updated quantities for proposed changes to 552-00.
- Cutoff Wall
 - Added columns for H=3', H=4', and H=5'.
 - Updated quantities for proposed changes to 552-00.
- Riprap - Updated quantities for proposed changes to 552-00.
- Changed Bedding Material column title to Granular Bedding. Updated quantities for proposed changes to 603-19.

603-19: BEDDING FOR CULVERTS 54" [1350 mm] EQUIVALENT AND LARGER

- Changed "BEDDING" to "GRANULAR BEDDING" in title.
- Changed bedding material to granular bedding.
- Changed bedding thickness below the bottom of the pipe from 2'-0" to 1'-0".
- Extended the granular bedding to the back of the cutoff wall.
- Added special backfill limits (when specified).

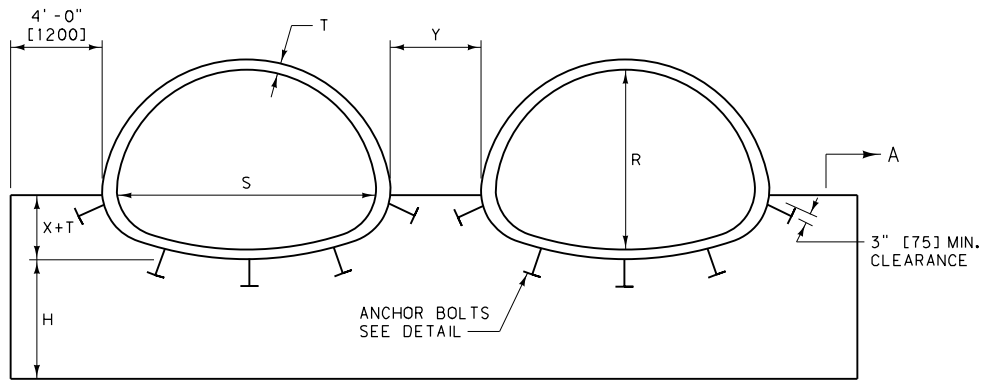
These revisions will be effective the first letting of 2018 in conjunction with release of the Detailed Drawing Revisions. Copies of the revised Detail Drawings are attached.

If there are any questions, please contact Dave Hedstrom in the Hydraulics Section.

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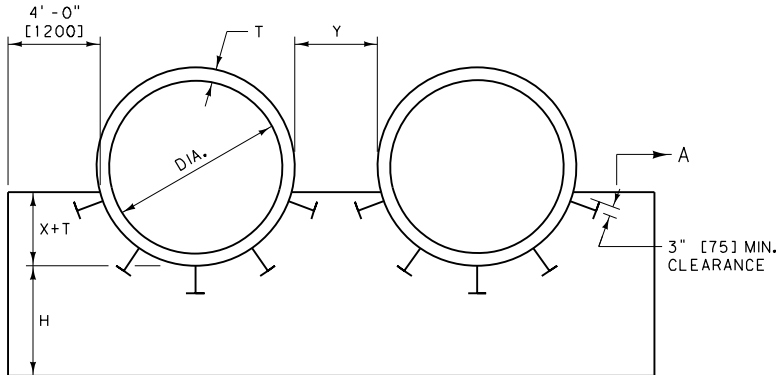
MULTIPLE ARCH CULVERTS

(METAL CULVERTS SHOWN)

- X: VARIABLE, FOR METAL CULV. SEE DTL. DWG. 603-32 (CIRCULAR) OR 603-34 (ARCH), AND FOR CONCRETE CULV. WITH FETS SEE DTL. DWG. 603-08 (ROUND) OR 603-10 (ARCH), AND FOR CONCRETE CULV. WITH SQUARE ENDS, THE "X" DIMENSIONS IS D/4 OR R/3
- Y: FOR METAL CULV. AND CULV. WITHOUT FETS: Y = 4'-0" [1200] (OUTSIDE WALL TO OUTSIDE WALL)
- H: 3'-0" [900] MIN. OR 1'-0" [300] BELOW BOTTOM OF FOUNDATION MATERIAL IF SPECIFIED.
- T: CULVERT WALL THICKNESS FOR CONCRETE OR CORRUGATION DEPTH FOR METAL.
- S: INSIDE PIPE SPAN

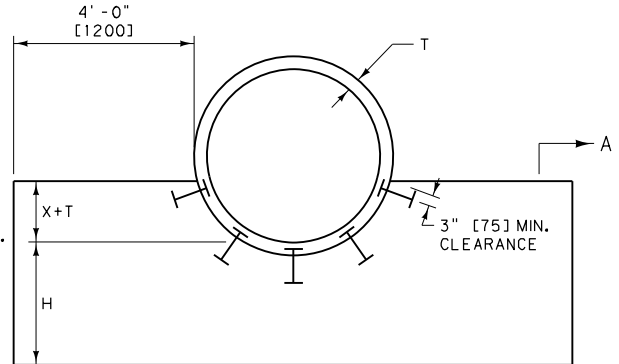
FOR CONCRETE CULV. WITH FETS: USE Y AS REQUIRED FOR PARALLEL PIPE INSTALLATION, PER DTL. DWG. NO. 613-08

NOTE: Y MAY BE INCREASED ON LARGE DIAMETER PIPES (UP TO A MAX. OF 8'-0" [2400]) TO AID IN INSTALLATION AND BACKFILL. THE QUANTITIES SHOWN IN 552-04, 06 & 08 WERE FIGURED USING Y = 4'-0" [1200]. ADJUST QUANTITIES AS NEEDED WHEN Y IS OTHER THAN 4'-0" [1200].



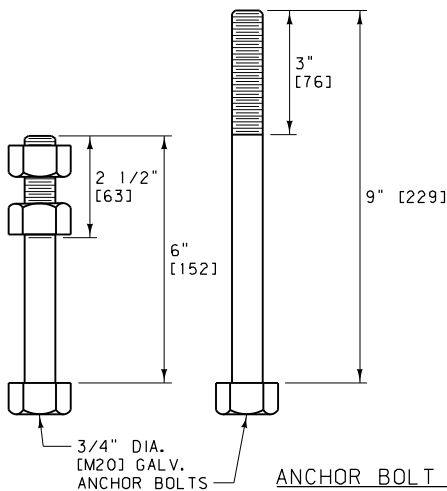
MULTIPLE ROUND CULVERTS

(METAL CULVERTS SHOWN)



SINGLE ROUND CULVERT

(CONCRETE CULVERT SHOWN)



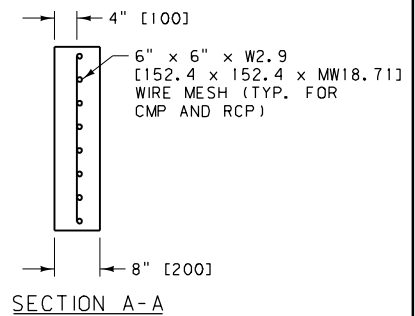
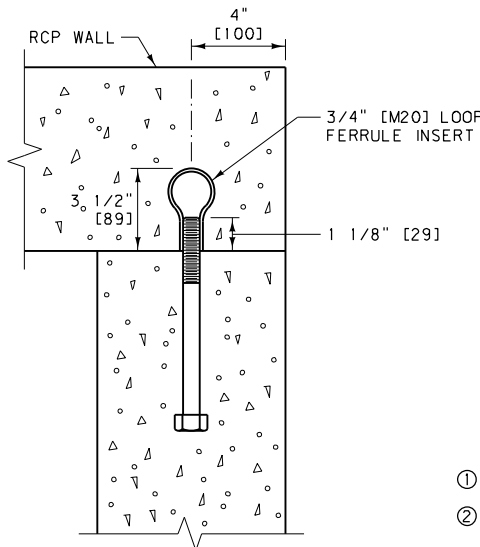
ANCHOR BOLT DETAILS

6" [152] LONG FOR METAL PIPE
9" [229] LONG FOR CONCRETE PIPE

ANCHOR BOLT SPACING:
MIN. OF FIVE 3/4" DIA. [M20] GALV. ANCHOR BOLTS IN WALL. USE MAX. SPACING OF 1.5' [455].

REINFORCING STEEL:
USE REBAR DOWELS MEETING THE REQUIREMENTS OF AASHTO M 31 GRADE 60 (GRADE 420).

EPOXY RESIN BONDING ADHESIVE:
MEET THE REQUIREMENTS OF AASHTO M 235 TYPE 4.



SECTION A-A

NOTES:

- ① USE CLASS GENERAL CONCRETE OR EQUAL.
- ② SEE DTL. DWG. NO. 603-18 AND 603-19 FOR BEDDING UNDER CULVERTS.

UNITS SHOWN IN BRACKETS [] ARE METRIC AND ARE IN MILLIMETERS (mm) UNLESS OTHER UNITS ARE SHOWN.

DETAILED DRAWING	
REFERENCE STANDARD SPEC. SECTION 552, 603, 613	DWG. NO. 552-00
CONCRETE CUTOFF WALLS FOR CULVERTS	
EFFECTIVE:	
MDTA MONTANA DEPARTMENT OF TRANSPORTATION	

CULVERT INSTALLATION QUANTITIES													
DIAMETER OR SPAN x RISE	CUBIC YARDS OF CLASS GENERAL CONCRETE (EACH END)								CUBIC YARDS OF RIPRAP (EACH END) ① (DTL. DWG. NO. 613-14)		CUBIC YARDS GRANULAR BEDDING MATERIAL PER FOOT OF PIPE (DTL. DWG. NO. 603-19) ②		
	CUTOFF WALL (DTL. DWG. NO. 552-00)						CONCRETE EDGE PROTECTION (DTL. DWG. NO. 613-08)						
	H=3ft		H=4ft		H=5ft		2:1		2:1				
	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.	
RCP (SQ. END)													
54"	1.4	2.3	1.7	2.9	2.0	3.4	2.7	4.0	11.3	18.2	0.7	1.4	
60"	1.5	2.5	1.8	3.1	2.2	3.7	3.0	4.4	12.2	19.7	0.8	1.5	
66"	1.6	2.6	1.9	3.3	2.3	3.9	3.2	4.8	13.1	21.3	0.8	1.7	
72"	1.7	2.8	2.0	3.5	2.4	4.1	3.5	5.2	14.0	22.8	0.9	1.8	
78"	1.8	3.0	2.1	3.7	2.5	4.4	3.8	5.6	14.9	24.3	1.0	2.0	
84"	1.9	3.2	2.3	3.9	2.7	4.6	4.0	6.0	15.8	25.9	1.1	2.1	
90"	2.0	3.4	2.4	4.1	2.8	4.8	4.3	6.4	16.8	27.5	1.2	2.3	
96"	2.1	3.6	2.5	4.3	2.9	5.1	4.6	6.9	17.7	29.1	1.2	2.5	
RCPA (SQ. END)													
65.00" x 40.00"	1.4	2.4	1.8	3.0	2.1	3.6	2.3	3.5	10.1	16.6	0.7	1.4	
73.00" x 45.00"	1.5	2.6	1.9	3.2	2.3	3.8	2.5	3.8	11.0	18.1	0.7	1.5	
88.00" x 54.00"	1.7	2.9	2.1	3.6	2.5	4.3	3.0	4.6	12.6	20.9	0.9	1.8	
102.00" x 62.00"	1.9	3.2	2.3	4.0	2.8	4.8	3.4	5.2	14.1	23.7	1.0	2.0	
115.00" x 72.00"	2.1	3.5	2.5	4.4	3.0	5.2	3.8	5.9	15.7	26.4	1.1	2.2	
122.00" x 77.25"	2.2	3.7	2.6	4.6	3.1	5.5	4.1	6.4	16.6	28.1	1.2	2.4	
138.00" x 87.13"	2.4	4.1	2.9	5.0	3.4	6.0	4.6	7.3	18.6	31.6	1.3	2.7	
154.00" x 95.88"	2.6	4.5	3.1	5.5	3.7	6.5	5.2	8.2	20.7	35.3	1.5	3.0	
168.75" x 106.50"	2.7	4.7	3.3	5.8	3.9	6.9	5.6	8.9	22.2	38.0	1.6	3.2	

CULVERT INSTALLATION QUANTITIES													
DIAMETER OR SPAN x RISE (mm)	CUBIC METERS OF CLASS GENERAL CONCRETE (EACH END)								CUBIC METERS OF RIPRAP (EACH END) ① (DTL. DWG. NO. 613-14)		CUBIC METERS GRANULAR BEDDING MATERIAL PER FOOT OF PIPE (DTL. DWG. NO. 603-19) ②		
	CUTOFF WALL (DTL. DWG. NO. 552-00)						CONCRETE EDGE PROTECTION (DTL. DWG. NO. 613-08)						
	H=915 mm		H=1220 mm		H=1525 mm		2:1		2:1				
	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.	
RCP (SQ. END)													
1350	1.1	1.8	1.3	2.2	1.5	2.6	2.1	3.1	8.6	13.9	1.8	3.5	
1500	1.1	1.9	1.4	2.4	1.7	2.8	2.3	3.4	9.3	15.1	2.0	3.8	
1650	1.2	2.0	1.5	2.5	1.8	3.0	2.4	3.7	10.0	16.3	2.0	4.3	
1800	1.3	2.1	1.5	2.7	1.8	3.1	2.7	4.0	10.7	17.4	2.3	4.5	
1950	1.4	2.3	1.6	2.8	1.9	3.4	2.9	4.3	11.4	18.6	2.5	5.0	
2100	1.5	2.4	1.8	3.0	2.1	3.5	3.1	4.6	12.1	19.8	2.8	5.3	
2250	1.5	2.6	1.8	3.1	2.1	3.7	3.3	4.9	12.8	21.0	3.0	5.8	
2400	1.6	2.8	1.9	3.3	2.2	3.9	3.5	5.3	13.5	22.2	3.0	6.3	
RCPA (SQ. END)													
1650 x 1015	1.1	1.8	1.4	2.3	1.6	2.8	1.8	2.7	7.7	12.7	1.8	3.5	
1895 x 1145	1.1	2.0	1.5	2.4	1.8	2.9	1.9	2.9	8.4	13.8	1.8	3.8	
2235 x 1370	1.3	2.2	1.6	2.8	1.9	3.3	2.3	3.5	9.6	16.0	2.3	4.5	
2590 x 1575	1.5	2.4	1.8	3.1	2.1	3.7	2.6	4.0	10.8	18.1	2.5	5.0	
2920 x 1830	1.6	2.7	1.9	3.4	2.3	4.0	2.9	4.5	12.0	20.2	2.8	5.5	
3100 x 1960	1.7	2.8	2.0	3.5	2.4	4.2	3.1	4.9	12.7	21.5	3.0	6.0	
3505 x 2215	1.8	3.1	2.2	3.8	2.6	4.6	3.5	5.6	14.2	24.2	3.3	6.8	
3910 x 2460	2.0	3.4	2.4	4.2	2.8	5.0	4.0	6.3	15.8	27.0	3.8	7.5	
4285 x 2705	2.1	3.6	2.5	4.4	3.0	5.3	4.3	6.8	17.0	29.1	4.0	8.0	


DIAMETER OR SPAN x RISE	CUBIC YARDS OF CLASS GENERAL CONCRETE (EACH END)								CUBIC YARDS OF RIPRAP (EACH END) ① (DTL. DWG. NO. 613-14)		CUBIC YARDS GRANULAR BEDDING MATERIAL PER FOOT OF PIPE (DTL. DWG. NO. 603-19) ②		SLOPE ③
	CUTOFF WALL (DTL. DWG. NO. 552-00)						CONCRETE EDGE PROTECTION (DTL. DWG. NO. 613-08)						
	H=3ft		H=4ft		H=5ft		2:1		2:1				
	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.			
RCP (FETS)													
54"	1.8	3.0	2.2	3.7	2.6	4.4	3.0	4.7	10.1	17.0	0.7	1.4	2.0:1
60"	2.0	3.3	2.4	4.0	2.8	4.8	2.6	4.2	10.6	18.0	0.8	1.5	1.9:1
66"	1.9	3.2	2.3	3.9	2.7	4.7	2.9	4.6	12.0	20.3	0.8	1.7	1.7:1
72"	2.0	3.4	2.5	4.2	2.9	5.0	3.1	4.9	13.0	22.1	0.9	1.8	1.9:1
78"	2.1	3.5	2.5	4.3	3.0	5.2	3.4	5.5	14.2	24.2	1.0	2.0	1.8:1
84"	2.1	3.6	2.6	4.4	3.1	5.3	3.5	5.6	14.0	23.9	1.1	2.1	1.5:1
90"	2.5	4.2	3.0	5.2	3.5	6.2	3.9	6.4	15.8	27.5	1.2	2.3	1.5:1
RCPA (FETS)													
65.00" x 40.00"	1.7	2.9	2.1	3.6	2.6	4.4	2.8	4.5	14.4	24.5	0.7	1.4	3.0:1
73.00" x 45.00"	1.9	3.2	2.3	3.9	2.7	4.7	2.8	4.5	14.7	25.2	0.7	1.5	3.0:1
88.00" x 54.00"	2.1	3.5	2.6	4.4	3.0	5.2	2.8	4.5	12.7	21.9	0.9	1.8	2.0:1
102.00" x 62.00"	2.1	3.7	2.6	4.6	3.2	5.6	3.7	6.0	15.5	26.9	1.0	2.0	2.0:1

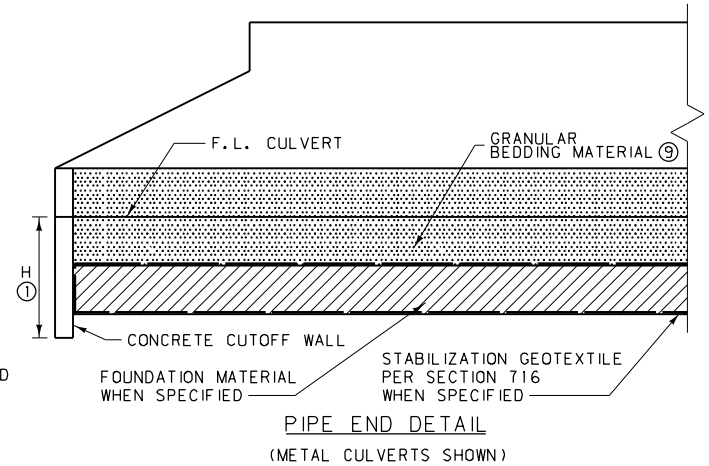
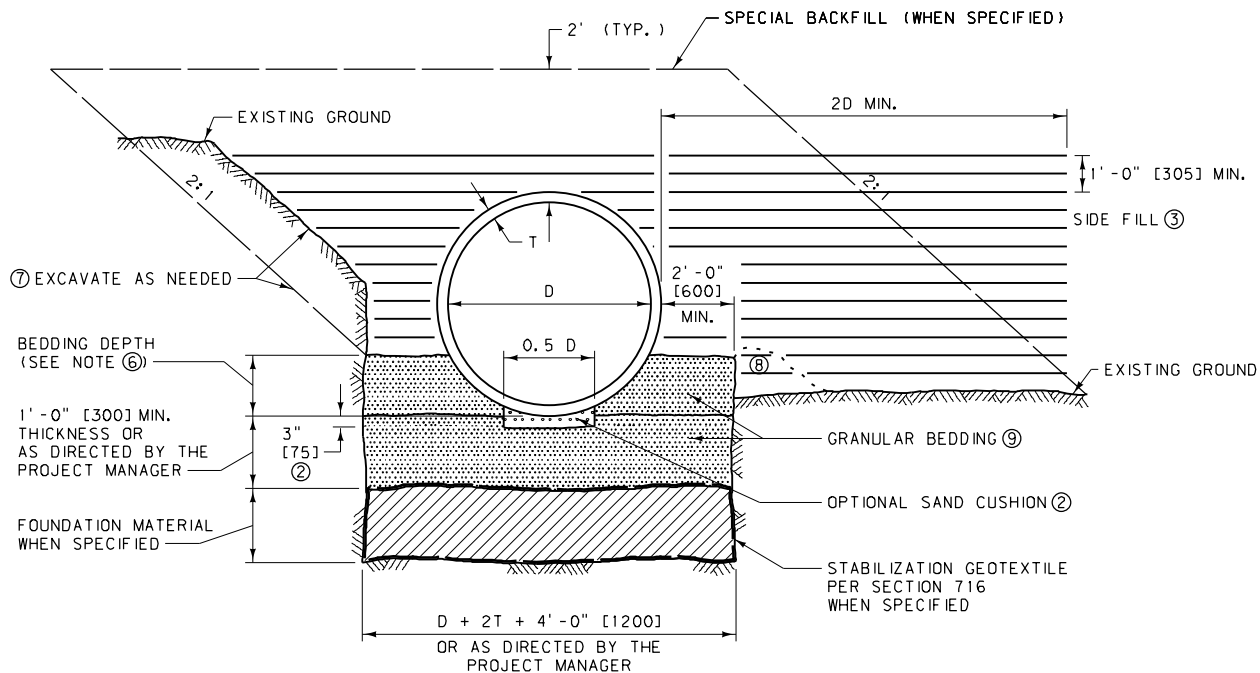
DIAMETER OR SPAN x RISE (mm)	CUBIC METERS OF CLASS GENERAL CONCRETE (EACH END)								CUBIC METERS OF RIPRAP (EACH END) ① (DTL. DWG. NO. 613-14)		CUBIC METERS GRANULAR BEDDING MATERIAL PER FOOT OF PIPE (DTL. DWG. NO. 603-19) ②		SLOPE ③
	CUTOFF WALL (DTL. DWG. NO. 552-00)						CONCRETE EDGE PROTECTION (DTL. DWG. NO. 613-08)						
	H=915 mm		H=1220 mm		H=1525 mm		2:1		2:1				
	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.	SING.	DBL.			
RCP (FETS)													
1350	1.4	2.3	1.7	2.8	2.0	3.4	2.3	3.6	7.7	13.0	1.8	3.5	2.0:1
1500	1.5	2.5	1.8	3.1	2.1	3.7	2.0	3.2	8.1	13.8	2.0	3.8	1.9:1
1650	1.5	2.4	1.8	3.0	2.1	3.6	2.2	3.5	9.2	15.5	2.0	4.3	1.7:1
1800	1.5	2.6	1.9	3.2	2.2	3.8	2.4	3.7	9.9	16.9	2.3	4.5	1.9:1
1950	1.6	2.7	1.9	3.3	2.3	4.0	2.6	4.2	10.9	18.5	2.5	5.0	1.8:1
2100	1.6	2.8	2.0	3.4	2.4	4.1	2.7	4.3	10.7	18.3	2.8	5.3	1.5:1
2250	1.9	3.2	2.3	4.0	2.7	4.7	3.0	4.9	12.1	21.0	3.0	5.8	1.5:1
RCPA (FETS)													
1650 x 1015	1.3	2.2	1.6	2.8	2.0	3.4	2.1	3.4	11.0	18.7	1.8	3.5	3.0:1
1895 x 1145	1.5	2.4	1.8	3.0	2.1	3.6	2.1	3.4	11.2	19.3	1.8	3.8	3.0:1
2235 x 1370	1.6	2.7	2.0	3.4	2.3	4.0	2.1	3.4	9.7	16.7	2.3	4.5	2.0:1
2590 x 1575	1.6	2.8	2.0	3.5	2.4	4.3	2.8	4.6	11.9	20.6	2.5	5.0	2.0:1

NOTES:

- ① CULVERT RIPRAP IS USED ONLY IN SPECIAL CIRCUMSTANCE. QUANTITIES ARE BASED ON A THICKNESS OF 2 FT. [600] AND ARE PROPORTIONED WHEN A DIFFERENT THICKNESS IS SPECIFIED.
- ② GRANULAR BEDDING QUANTITIES FOR CONCRETE PIPES ARE BASED ON BEDDING DETAILS SHOWN ON DTL. DWG. NO. 603-19 WITH A WIDTH EQUAL TO (DIAMETER OR SPAN) + 4 FT. [1200] + (2 TIMES CONCRETE SHELL THICKNESS) AND A DEPTH EQUAL TO 1 FT. [300] + (D/4 OR R/3) + (CONCRETE SHELL THICKNESS). TO COMPUTE THE TOTAL BEDDING QUANTITY MULTIPLY BY (LENGTH OF PIPE MINUS 1.3 FT. [0.40 m]). EXTEND GRANULAR BEDDING TO BACK OF CUTOFF WALL.
- ③ FETS, CONCRETE EDGE PROTECTION, AND RIPRAP SLOPE
- ④ SEE DTL. DWG. NO 603-08 AND 603-10 FOR "X" DIMENSIONS FOR RCP AND RCPA WITH FETS. THE "X" DIMENSION FOR RCP AND RCPA WITH SQUARE ENDS IS D/4 OR R/3.

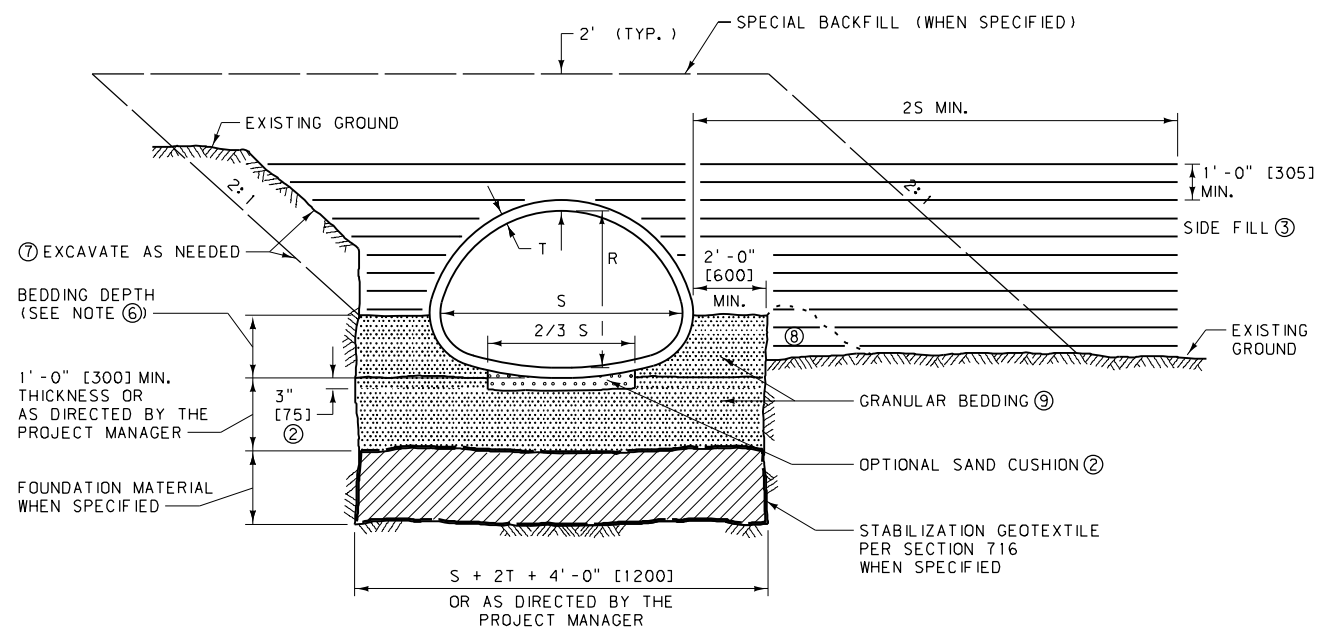
UNITS SHOWN IN BRACKETS [] ARE METRIC AND ARE IN MILLIMETERS (mm) UNLESS OTHER UNITS ARE SHOWN.

DETAILED DRAWING	
REFERENCE DWG. NO.	552-04
STANDARD SPEC.	SECTION 552, 603, 613
CONCRETE, RIPRAP AND GRANULAR BEDDING MATERIAL QUANTITIES FOR SING. AND DBL. CULVERT INSTALLATION	
EFFECTIVE:	
	



NOTES:

- ① 3'-0" [900] MIN. OR 1'-0" [300] BELOW BOTTOM OF FOUNDATION MATERIAL IF SPECIFIED.
- ② THE CONTRACTOR HAS THE OPTION OF USING A SAND CUSHION AS APPROVED BY THE PROJECT MANAGER TO FACILITATE CULVERT INSTALLATION. IF A SAND CUSHION IS USED, THAT MATERIAL WILL BE MEASURED AND PAID FOR AS GRANULAR BEDDING.
- ③ COMPACT AND PLACE SIDE FILL PER SECTION 603 AND 203.
- ④ FURNISH GRANULAR BEDDING AND FOUNDATION MATERIAL PER SECTION 701.
- ⑤ DIMENSIONS D, S, AND R ARE THE INSIDE PIPE DIAMETER, SPAN, AND RISE. DIMENSION T IS THE CULVERT SHELL THICKNESS FOR CONCRETE OR CORRUGATION DEPTH FOR METAL.
- ⑥ THE BEDDING DEPTH FOR CONCRETE PIPE IS $D/4 + T$ OR $R/3 + T$. THE BEDDING DEPTH FOR METAL PIPE IS "X" + T. SEE DTL. DWG. NO. 603-32 AND 603-34 FOR "X" DIMENSIONS OF METAL PIPES. AFTER LAYING CULVERT, COMPACT GRANULAR BEDDING AT HAUNCHES AND SIDES.
- ⑦ EXCAVATE A SUFFICIENT AMOUNT TO PROVIDE A SAFE WORKING ENVIRONMENT AND TO ALLOW ACHIEVEMENT OF ALL CULVERT INSTALLATION AND COMPACTION REQUIREMENTS. SLOPE, BENCH OR PROVIDE SHORING FOR ALL EXCAVATIONS IN ACCORDANCE WITH THE U.S. DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION.
- ⑧ BUILD BERM WITH FILL MATERIAL AS NEEDED TO CONTAIN THE GRANULAR BEDDING MATERIAL TO THE PROPER DEPTH.
- ⑨ COMPACT GRANULAR BEDDING BY PROOF ROLLING WITH A VIBRATORY COMPACTOR IN 12 INCH LIFTS OR BY USING A METHOD APPROVED BY THE PROJECT MANAGER.



DETAILED DRAWING	
REFERENCE STANDARD SPEC. SECTION 203, 207, 603	DWG. NO. 603-19
GRANULAR BEDDING FOR CULVERTS 54" [1350 mm] EQUIVALENT & LARGER	
EFFECTIVE:	
MDT MONTANA DEPARTMENT OF TRANSPORTATION	

UNITS SHOWN IN BRACKETS [] ARE METRIC AND ARE IN MILLIMETERS (mm) UNLESS OTHER UNITS ARE SHOWN.