

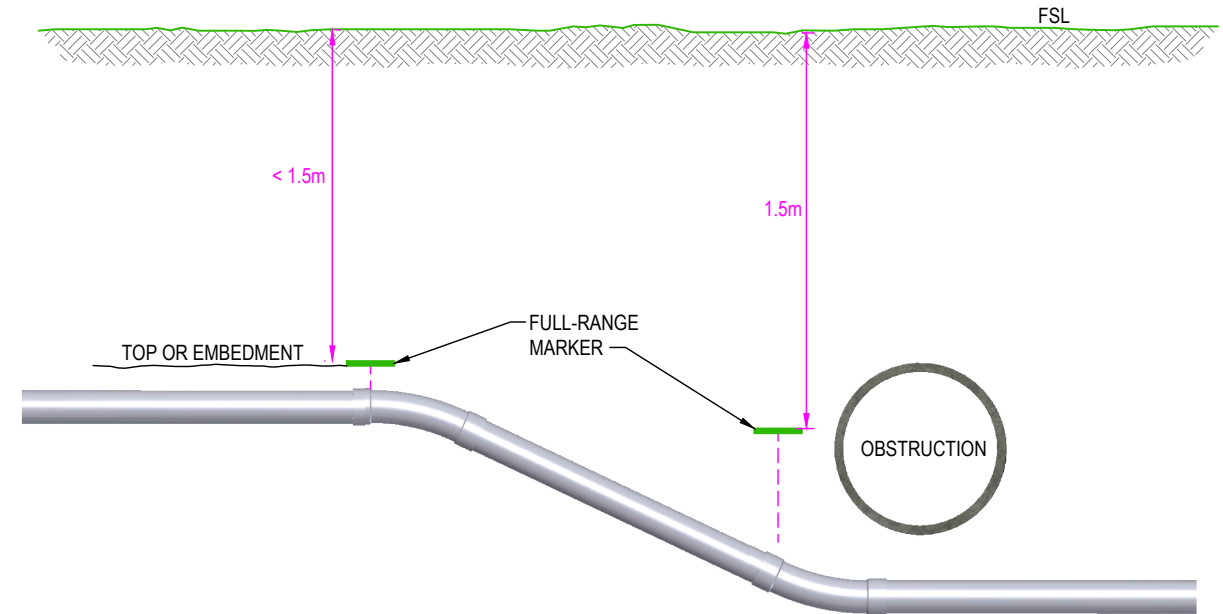
# BENDS

**TABLE 104-C: BEND REQUIREMENTS AND LIMITATIONS (Reticulation and Branch Sewers)**

PIPE TYPE	BEND TYPE TO BE USED	MAX NUMBER OF BENDS ALLOWED	MAX ANGLE OF A HORIZONTAL BEND	MAX ANGLE OF A VERTICAL BEND	MAX CUMULATIVE ANGLE IN SEWER LINE <sup>5</sup>
DN100 PVC DWV SPUR BRANCHES	PLAIN BENDS ONLY AVAILABLE	3	45°	45°	135°
DN150 & DN225 PVC	>1000 RADIUS	3 <sup>3</sup>	90°	22.5° <sup>7</sup>	135°
DN300 & DN375 PVC	LONG RADIUS BENDS CURRENTLY NOT AVAILABLE- BENDS NOT ALLOWED				
PP (DN150 or DN225)	GRP SEGMENTED BEND (MIN R = 2.5 x Ø)	3 <sup>3</sup>	90°	22.5° <sup>7</sup>	90°
PP (≥DN300)	GRP SEGMENTED BEND (MIN R = 2.5 x Ø)	1 <sup>3</sup>	45°	NOT ALLOWED <sup>3</sup>	45°
GRP REFER TABLE 104-D	GRP SEGMENTED BEND (MIN R = 2.5 x Ø)	1 <sup>3</sup>	45°	NOT ALLOWED <sup>3</sup>	45°
PE (PN8, SDR21, ≤DN280)	COLD BENT PIPE (MIN R = 35 x Ø)	3 CURVES <sup>3</sup>	90°	22.5° <sup>7</sup>	135°
PE (PN8, SDR21, ≥DN315)	COLD BENT PIPE (MIN R = 35 x Ø)	1 CURVE <sup>3</sup>	45°	NOT ALLOWED <sup>3</sup>	45°

**NOTES Regarding Table 104-C:**

- Bend radius is to the centre line of the bend.
  - Where long radius PVC DWV bends are cut, they will require an end adaptor to convert the curved spigot end to something straight that can be joined. This adaptor may have either a straight socket or straight spigot end connection. Long radius PVC DWV bends when used whole will not require these adaptors as they are formed with straight sockets and/or spigots at both ends.
  - Four vertical bends / curves of up to 22.5° are allowed in a sewer line when a siphon or water seal is to be constructed.
  - Bends oriented to achieve both a horizontal and vertical angular deflection are acceptable in ≤DN225 pipe provided maximum angular requirements are met.
  - The maximum cumulative angle in sewer line is the addition of all bends between one end of the sewer line and the other.
- eg: if there was one 30° horizontal and two 45° vertical bends in a PVC DN225 line, the total cumulative bend would be 120° which would be permitted. Any 45° deflection at the termination of a sewer line (ie: an OB) shall also be included in this calculation.
- The X, Y and Z co-ordinates of all intersections of straight pipes, bends and maintenance structures shall be "picked up" and recorded in the As Constructed information.
  - Vertical bends are restricted to 22.5° as the maximum incline that some maintenance equipment can climb is about 25°. Where a sewer line can be maintained from both upstream and downstream via a maintenance structure, this 22.5° bend restriction may be increased on approval of the Water Agency.
  - Indicate on the design plans the deflection angle of all bends which are **not** long radius PVC DWV bends.



**FIGURE 104-H: MARKER PLACEMENT ABOVE BENDS (ELEVATION)**

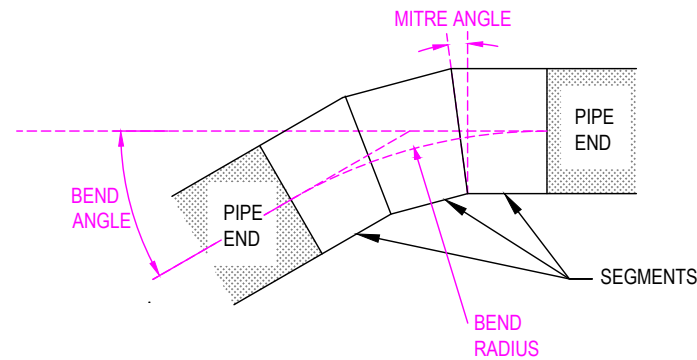
**NOTES Regarding Sewer Markers:**

- Markers are required above all bends which are not connected directly to maintenance structures.
- Markers shall be installed directly above the upstream end of the bend.
- If multiple bends are joined to make one larger bend, this shall be considered to be one bend. Only one marker would be required in this case.
- Markers shall be green and specific to marking wastewater infrastructure.
- Markers shall be full depth and capable of marking to at least 2.4m depth.
- Markers need not be programmable.
- Ensure that markers are installed flat.
- Locate markers at the shallower of:
  - Top of embedment, or
  - 1.5m deep.

**TABLE 104-D: GRP BEND REQUIREMENTS**

BEND ANGLE	11.25°	15°	22.5°	30°	45°	60°*	90°*
MITRE ANGLE	5.63°	7.5°	11.25°	7.5°	11.25°	10°	9°
NO. SEGMENTS	2	2	2	3	3	4	6

\* 60° and 90° GRP bends require approval from the Water Agency.



**FIGURE 104-G: EXAMPLE GRP BEND**

**Construction and As Constructed Information for Compound or Multiple Connected Bends:**

- The designer may specify only the chainage and invert of the ends of straight or curved pipe. Use bends to bridge between these stipulated pipe ends, ensuring:
- Compliance to Table 104-C,
  - That the minimum possible number of bends are used,
  - That bridging pipework meets minimum grade requirements,
  - That minimum clearances from other services are maintained,
  - That Type B cement stabilised (although cement can be added and mixed on site) embedment is used, and
  - Where fixed angle bends are used (ie: GRP bends) and the pipe ends cannot be exactly met, use minor deflections in the straight pipe as per Tables 104-E, F & G to obtain minor additional deflection.
  - "Pick up" the location of all ends of pipe which are greater than 2m in length.

## CURVED SEWERS (BENDING OF PIPE &/OR DEFLECTION AT PIPE JOINTS)

**TABLE 104-E: PVC / PP PIPELINE MIN RADIUS OF CURVATURE**

DN	150	225	300	375	450	525	600
PVC MIN R (m)	24	38	172	172	NA	NA	NA
PP MIN R (m)	172						

**NOTES Regarding Curves Requirements:**

- Curvature is only permitted in the horizontal plane.
- Changes to jointing type shall be noted in the As Constructed record.
- Should a different pipe material be required to provide a smaller radius curve (ie: GRP), the entire sewer line from maintenance structure to maintenance structure shall be changed to that pipe material.
- Marker discs are required at the beginning and end of all curves as per Figure 104-F.

**TABLE 104-F: PE PIPELINE MIN RADIUS OF CURVATURE**

DN	180	280	315	355	400	500	560
PE MIN R (m)	6.3	9.8	11	12.4	14	17.5	19.6

**TABLE 104-G: GRP PIPELINE MIN RADIUS OF CURVATURE**

DN RANGE	TYPICAL MAX JOINT ANGLE <sup>6</sup>	MIN CURVE R (m)		
		3 m PIPE	6 m PIPE	12 m PIPE
DN300 to DN450	3.0°	57	115	230
DN525 to DN900	2.0°	86	172	344
DN1000 to 1800	1.0°	172	344	688

**NOTES Regarding Radius of Curvature:**

- Minimum Radius is as follows:
- Curved DN150 and DN225 PVC DWV sewers shall be SCJ in 3m or 6m lengths. Curvature shall be achieved by bending the pipe, ensuring that the pipe is bent by hand around curved objects (not around stakes or pegs). Min R(m) = 150 x Pipe Ø (DN (m)) (as per AS/NZS 2032 section 5.3.11).
  - Curved ≥DN300 PVC DWV sewers shall be RRJ in 3m lengths. It is assumed that larger DWV pipe cannot be bent by hand and that there is no safe way to curve the pipe with machine assistance. It is therefore assumed that all deflection must occur at the rubber ring joints.
- PVC DWV joints are not specifically deigned to provide deflection, but must successfully pass a 2° deflection test. Until further research can be undertaken, it is assumed a 1° deflection is safe and can be applied to DWV RRJs (refer note 7 for method of calculation).
- PE (PN8, SDR21)- Min R(m) = 35 x Pipe Ø (DN in m)
  - PP & GRP pipe shall not be bent.
  - PP has a maximum 1° deflection at each joint.
  - GRP joint deflections as per Table 104-G.
  - GRP RRJ deflections depend on the manufacturer.
  - GRP, PP and ≥DN300 PVC DWV radius calculation as follows:  

$$\text{Min Radius (m)} = \frac{L (m)}{2 \times \tan (\theta / 2)}$$
 Where L= pipe length and θ= joint deflection.

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE				DESIGNED: R. JAGGER DATE: 1 JULY 2015	
				DRAWN: R. JAGGER DATE: 1 JULY 2015	
				CHECKED: NAME DATE APPROVED: NAME DATE	
				<input checked="" type="checkbox"/> CWW D. MOORE 01/09/15 <input checked="" type="checkbox"/> CWW R. CARRUTHERS 01/09/15 <input checked="" type="checkbox"/> SEW C. PAXMAN 01/09/15 <input checked="" type="checkbox"/> SEW D. O'DONOVAN 01/09/15 <input checked="" type="checkbox"/> YVW K. DAWSON 01/09/15 <input checked="" type="checkbox"/> YVW J. TOMASI 01/09/15	
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MELBOURNE RETAIL WATER AGENCIES

MRWA SEWERAGE STANDARDS

BENDS AND CURVED SEWERS

NOT TO SCALE

MRWA-S-104B

Planning	Design	Construction
	✓✓	✓✓