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TECHNICAL MANUAL

WASTE SYSTEMS

Waste systems in compliance with UNI EN 12056

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WASTE SYSTEMS IN COMPLIANCE WITH UNI EN 12056

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4.1 Introduction

The standard that regulates the sizing of gravity waste systems inside buildings is the European Standard UNI EN 12056 composed of five parts. This standard is applied to systems for discharge of waste water operating by gravity inside buildings for residential, industrial, commercial, institutional and industrial use. The standard describes the main systems but does not deal with them in detail due to the complexity and vast nature of the system configurations in existence today. Part 2 of the standard, that will be dealt with in this chapter, establishes the principles to follow for project design and calculation. The standard classifies the systems into four types, divided by the type of ventilation used. The type suggested by Valsir and adopted in most European countries is the “Single discharge stack system with partly filled waste branches”, defined by the standard as the type I system; in this case the sanitary fixtures are connected to drainage branches sized with a filling degree equal to 0.5 (50%).

The sizing process of a waste system can be divided up into the following phrases:
- Calculation of the flow rates in relation to the drainage units of the sanitary fixtures connected.
- Determination of the diameters of branches that connect the sanitary fixtures to the waste stacks.
- Determination of the diameters of the waste stacks.
- Determination of the diameters of the waste collectors.
- Determination of ventilation section diameters.

In the following paragraphs the waste flows will be based on the nominal diameters of the pipework; the European Standard UNI EN 12056 establishes a correlation between the nominal diameters and the minimum internal diameters, this enables us to define a corresponding table for the various product lines manufactured by Valsir:

Table 4.1 Correspondence between nominal diameters and external diameters of the waste pipe for different product lines.

DN	$d_{i,\,min}$	OD [mm]				
		Polyethylene	Polypropylene	Triplus®	Silere®	Blackfire®
30	26	32	32			32
40	34	40	40	40		40
50	44	50	50	50	58	50
56	49	56				
60	56	63				
70	68	75	75	75	78	75
80	75					
90	79	90	90	90	90	90
100	96	110	110	110	110	110
125	113	125	125	125	135	125
150	146	160	160	160	160	160
200	184	200		200		
225	207					
250	230	250		250		
300	290	315				

4.2 Calculation of flow rates

The sizing of a waste system is bases on the total flow rates Q_{tot} that circulate in the various sections deriving from the sanitary fixtures; the continuous flow fixtures (for example the waste water of cooling systems) and any waste waster pumps.

$$Q_{tot} = Q_{ww} + Q_c + Q_p \qquad [4.1]$$

where:

Q_{ww} is the flow rate of the waste waters caused by sanitary fixtures [l/s],
Q_c is the continuous flow rate [l/s],
Q_p the pumping flow rate [l/s].

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If the system does not have continuous flow rates or waste water pumps, then the total flow rate for each section of the waste system is given exclusively by the flow rate of the sanitary fixtures and therefore the previous equation becomes:

$$Q_{tot} = Q_{ww} \qquad [4.2]$$

The waste flow of the waste waters Q_{ww} in a section of the system is not the algebraic sum of the flows of all of the sanitary fixtures that lead into that section, but it is obtained by means of a simple formula that takes account of the factor of contemporary use of the fixtures.
In a building it is reasonable to assume that not all of the sanitary fixtures will be discharged contemporarily, therefore, the flows that are flushed into the waste system are less than the algebraic sum of the flows of the single fixtures. The levels of simultaneous use obviously depend on the type of building: a household has a usage frequency of the sanitary fixtures that is lower than that of hospitals or restaurants.

The formula for calculating the flow rate of the waste waters in relation to the type of building is the following:

$$Q_{WW} = K \cdot \sqrt{\sum DU} \qquad [4.3]$$

where:

K is the factor of contemporary use (or frequency factor) defined in the table that follows.
$\sum DU$ is the sum of the drainage units of the sanitary fixtures that flow in that section of the system.

The drainage unit DU (Drainage Unit) is the average flow rate of a sanitary fixture expressed in litres per second [l/s]. It is important to remember that the value Q_{ww} must correspond, minimum, to the flow rate of the sanitary fixtures with the biggest drainage unit.

Table 4.2 Coefficient of contemporary use as a function of use and type of building.

Use	Building type	Coefficient K
Intermittent	Homes and offices	0.5
Frequent	Hospitals, schools, restaurants, hotels	0.7
Very frequent	Public bathrooms and showers	1.0
Special	Laboratories	1.2

With the following diagram or table it is possible to identify the flow rate of the waste waters as a function of the coefficient of contemporary use and the sum of the drainage units of the sanitary fixtures that flow in the section of the system.

Figure 4.1 Flow rate of waste waters in relation to the coefficient of contemporary use and the sum of the drainage units.

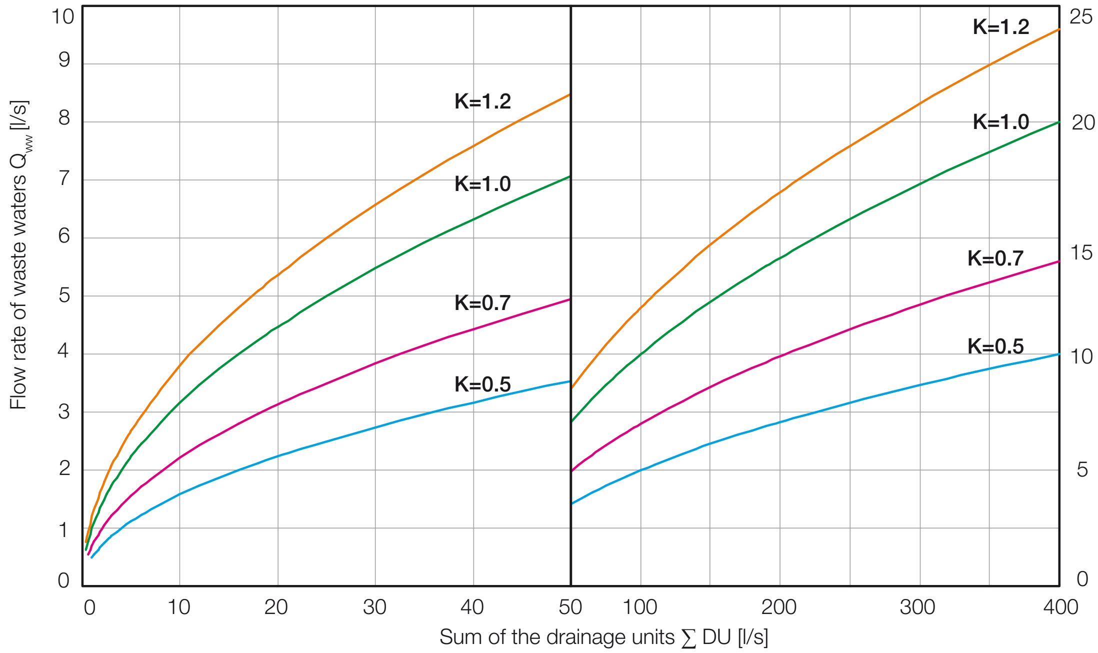


Table 4.3 Flow rate of waste waters in relation to the coefficient of contemporary use and the sum of the drainage units.

∑ DU [l/s]	Q_{ww} [l/s]				∑ DU [l/s]	Q_{ww} [l/s]			
	K = 0.5	K = 0.7	K = 1	K = 1.2		K = 0.5	K = 0.7	K = 1	K = 1.2
1.0	0.5	0.7	1.0	1.2	65	4.0	5.6	8.1	9.7
1.2	0.5	0.8	1.1	1.3	70	4.2	5.9	8.4	10.0
1.4	0.6	0.8	1.2	1.4	75	4.3	6.1	8.7	10.4
1.6	0.6	0.9	1.3	1.5	80	4.5	6.3	8.9	10.7
1.8	0.7	0.9	1.3	1.6	85	4.6	6.5	9.2	11.1
2.0	0.7	1.0	1.4	1.7	90	4.7	6.6	9.5	11.4
2.5	0.8	1.1	1.6	1.9	95	4.9	6.8	9.7	11.7
3.0	0.9	1.2	1.7	2.1	100	5.0	7.0	10.0	12.0
3.5	0.9	1.3	1.9	2.2	110	5.2	7.3	10.5	12.6
4.0	1.0	1.4	2.0	2.4	120	5.5	7.7	11.0	13.1
4.5	1.1	1.5	2.1	2.5	130	5.7	8.0	11.4	13.7
5.0	1.1	1.6	2.2	2.7	140	5.9	8.3	11.8	14.2
6.0	1.2	1.7	2.4	2.9	150	6.1	8.6	12.2	14.7
8.0	1.4	2.0	2.8	3.4	160	6.3	8.9	12.6	15.2
10	1.6	2.2	3.2	3.8	170	6.5	9.1	13.0	15.6
12	1.7	2.4	3.5	4.2	180	6.7	9.4	13.4	16.1
14	1.9	2.6	3.7	4.5	190	6.9	9.6	13.8	16.5
16	2.0	2.8	4.0	4.8	200	7.1	9.9	14.1	17.0
18	2.1	3.0	4.2	5.1	220	7.4	10.4	14.8	17.8
20	2.2	3.1	4.5	5.4	240	7.7	10.8	15.5	18.6
25	2.5	3.5	5.0	6.0	260	8.1	11.3	16.1	19.3
30	2.7	3.8	5.5	6.6	280	8.4	11.7	16.7	20.1
35	3.0	4.1	5.9	7.1	300	8.7	12.1	17.3	20.8
40	3.2	4.4	6.3	7.6	320	8.9	12.5	17.9	21.5
45	3.4	4.7	6.7	8.0	340	9.2	12.9	18.4	22.1
50	3.5	4.9	7.1	8.5	360	9.5	13.3	19.0	22.8
55	3.7	5.2	7.4	8.9	380	9.7	13.6	19.5	23.4
60	3.9	5.4	7.7	9.3	400	10.0	14.0	20.0	24.0

The Standard proposes the values for the drainage units DU for various types of sanitary fixtures for domestic use; these values must be considered if there is no information on hand regarding the products that will actually be installed.

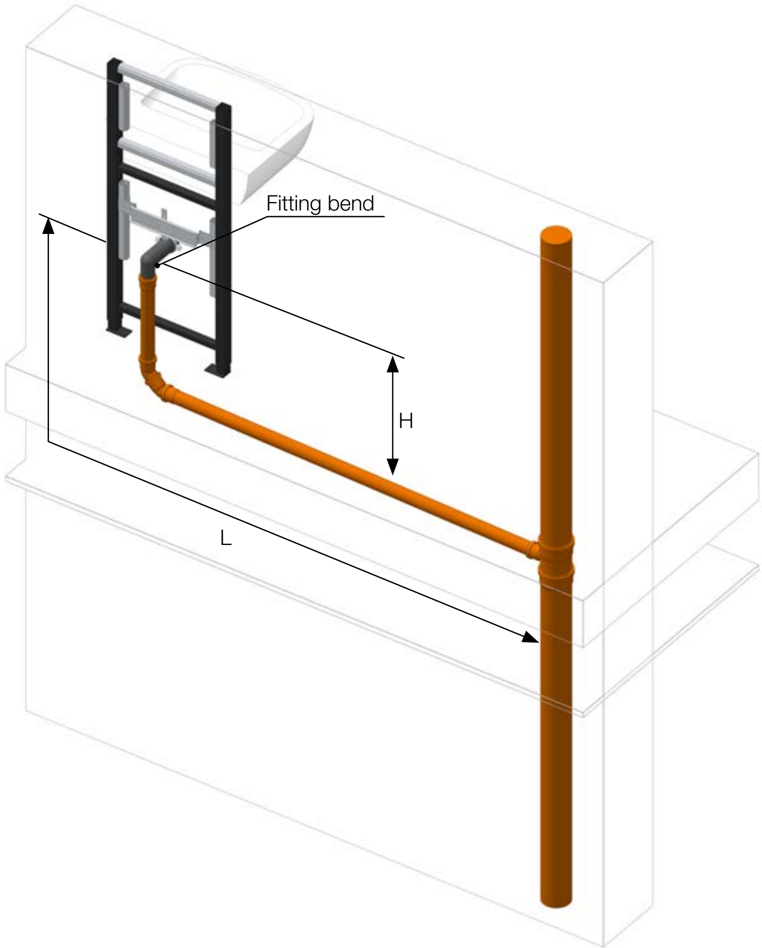
Table 4.4 Typical flow rates for various types of sanitary fixtures (domestic).

Sanitary fixture	DU [l/s]
Washbasin	0.5
Bidet	0.5
Shower without plug	0.6
Shower with plug	0.8
Urinal with cistern	0.8
Urinal with flush valve	0.5
Wall urinal	0.2
Bathtub	0.8
Kitchen sink	0.8
Dishwasher (domestic)	0.8
Washing machine, max. load 6 kg	0.8
Washing machine, max. load 12 kg	1.5
WC with 6 l cistern	2.0
WC with 7.5 l cistern	2.0
WC with 9 l cistern	2.5
Floor drain DN 50	0.8
Floor drain DN 70	1.5
Floor drain DN 100	2.0

4.3 Sizing of waste branches

The sizing of the waste branches depends on whether there is a ventilation system for the branch itself. The Standard establishes not just the nominal diameters in relation to the waste flow but also the restrictions on the geometry of the branches.

Figure 4.2 Branch and characteristic dimensions.



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4.3.1 Sizing of branches without vent

The restrictions on the geometry and characteristics of the branches indicated in Figure 4.2 are specified in the following table.

Table 4.5 Geometrical restrictions on branch without vent.

Characteristic	Restriction
Branch length (between the trap attachment and the waste stack)	L ≤ 4 m
Difference in height (between the trap attachment and the horizontal section)	H ≤ 1 m
Minimum gradient of the horizontal section	1%
Maximum number of 90° bends (excluding the trap bend attachment)	3

The maximum flow rates allowed in relation to the nominal diameters are indicated in the following table.

Table 4.6 Maximum flow rates and nominal diameters of the branches without vents.

Branch DN	Maximum flow rate Q_{max} [l/s]	Typical sanitary fixture
40	0.50	Washbasin, bidet, urinal without cistern
50	0.80	Shower, bathtub, sink, dishwasher, washing machine max. load 6 kg
60	1.00	
70	1.50	Washing machine max. load 12 kg
80	2.00	
90*	2.25	WC with cistern up to 7.5 l
100	2.50	WC with 9 l cistern

* In the presence of a WC the minimum diameter allowed is DN 90 as long as there are no more than two WCs on the same branch and the total change in direction is no greater than 90°, if this is not the case then diameter DN 100 should be used.

4.3.2 Sizing of ventilated branches

In the case of ventilated branches the geometrical restrictions and the characteristics specified in Figure 4.2 are reduced to the values indicated in the table.

Table 4.7 Geometrical restrictions on ventilated branches.

Characteristic	Restriction
Branch length (between the trap attachment and the waste stack)	$L \leq 10$ m
Difference in height (between the trap attachment and the horizontal section)	$H \leq 3$ m
Minimum gradient of the horizontal section	0.5%
Maximum number of 90° bends (excluding the trap bend attachment)	No restriction

The following table indicates the maximum flow rate allowed in relation to the nominal diameters and the minimum diameters required for the vent pipe of the branch.

Table 4.8 Maximum flows and nominal diameters of the branches and vent pipes.

Branch DN	Max flow rate Q_{max} [l/s]	Vent DN	Typical sanitary fixture
50	0.75	40	Washbasin, bidet, urinal without cistern
60	1.50	40	Shower, bathtub, sink, dishwasher, washing machine
70	2.25	50	
80	3.00	50	
90*	3.40	60	WC
100	3.75	60	

* In the presence of a WC the minimum diameter allowed is DN 90 as long as there are no more than two WCs on the same branch and the total change in direction is no greater than 90°, if this is not the case then diameter DN 100 should be used.

4.3.3 Sizing of the membrane air admittance valve for ventilated drainage branches

If it is necessary to ventilate a drainage branch through a membrane air admittance valve, geometric and flow rate limits mentioned in the previous paragraph remain valid. In addition, it is necessary to check that the minimum air flow rate required to ventilate the branch is met by the air admittance valve.

This condition is checked as follows:

$$Q_a \leq Q_{a,max} \quad [4.4]$$

where:

Q_a is the air flow rate that generates in the horizontal branch [l/s],

$Q_{a,max}$ is the maximum air flow rate that can be managed by the aerator with membrane [l/s] (see Table 4.9).

Table 4.9 Characteristics of membrane air admittance valve.

Valve model	Air flow rate $Q_{a,max}$ [l/s]	Connection with diameters [mm]
63	6.1	32-40-50-63
110	23.2	70-75-90-100-110

The formula that allows to calculate the air flow rate in a horizontal branch is the following:

$$Q_a = Q_{tot} \cdot C_a \quad [4.5]$$

where:

Q_{tot} is the total drainage flow rate [l/s] (see chapter 4.2),

C_a ratio between generated air flow rate and defined drainage flow rate defined by standard UNI EN 12056 (see Table 4.10).

Table 4.10 Ratio between air flow rate and drainage flow rate.

Pipe section type	Coefficient C_a
Horizontal branch (System I and IV)	1
Horizontal branch (System II and III)	2

Considering System I, the most used of the systems defined by standard EN 12056, the coefficient C_a is equal to 1.

4.4 Sizing of the waste stack

The diameter of the waste stack is chosen as a function of the type of vent adopted: primary, parallel or secondary.

4.4.1 Sizing of stacks with primary ventilation

Sizing is affected by the flow rate to be discharged and by the type of fitting used to connect the waste branch to the stack.

Table 4.11 Flow rates of the waste stack with primary ventilation.

Waste stack and relief vent* DN	Max. flow rate Q_{max} [l/s]			
	Square branch	Angle branch	Sweep branch	Ball branch
60	0.5	0.7	-	-
70	1.5	2.0	-	-
80	2.0	2.6	-	-
90	2.7	3.5	3.5	-
100**	4.0	5.2	5.2	5.2
125	5.8	7.6	-	7.6
150	9.5	12.4	-	12.4
200	16.0	21.0	-	-

* Waste stack relief vent is the extension of the waste stack above the highest branch attachment. The extension must have the same diameter as the waste stack.
** Minimum dimension allowed if waste water from at least one WC flows through the branch.

4.4.2 Sizing of stacks with parallel or secondary ventilation

Sizing is affected by the flow rate to be discharged and the type of fitting used to connect the branch to the stack.

Table 4.12 Flow rate of the waste stack with parallel or secondary ventilation.

Waste stack DN	Vent stack DN	Max. flow rate Q_{max} [l/s]			
		Square branch	Angle branch	Sweep branch	Ball branch
60	50	0.7	0.9	-	-
70	50	2.0	2.6	-	-
80	50	2.6	3.4	-	-
90	50	3.5	4.6	4.6	-
100*	50	5.6	7.3	7.3	7.3
125	70	7.6	10.0	-	10.0
150	80	12.4	18.3	-	18.3
200	100	21.0	27.3	-	-

* Minimum dimension allowed if waste water from at least one WC flows through the branch.

To improve the ventilation performances of the waste system, Valsir suggests to use the increased diameters shown in Table 4.13, instead of those indicated in Table 4.12 and contained in standard EN 12056.

Table 4.13 Diameters (increased) of the vent stacks.

Waste stack DN	Vent stack DN
60	50
70	56
80	60
90	60
100	70
125	80
150	100
200	150

4.4.3 Sizing of membrane air admittance valve for waste stacks

If it is necessary to ventilate a waste stack through a membrane air admittance valve, the check described in chapter 4.3.3 must be performed using a C_a coefficient of 8.

4.4.4 Sizing of stacks with ventilation branches

The sizing of waste systems with ventilation branches is more or less the same as the calculations adopted for traditional waste systems as described in the European Standard UNI EN 12056. For all the details on the sizing process please refer to the chapter dedicated to sizing contained in this manual.

4.5 Sizing of waste collectors

The waste collectors are dimensioned in relation to the flow to be discharged, the gradient of the conduit and the filling degree to be achieved. The formula that can be applied for the calculation are quite a lot, in the diagrams and in the following tables the Chézy-Bazin formula was used with a roughness coefficient of about 0.16 $m^{1/2}$ (corresponding to an equivalent roughness of 1 mm as suggested by the European Standard UNI EN 12056)*.

For the choice of diameter it is possible to use:
a) the tables created with specific filling degrees,
b) the diagram of the flow rates together with the corrective factors of flow and velocity for the different filling degrees.

To use the tables and the diagram take a look at the examples at the end of this chapter.

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Table 4.14 Velocity and flow of the waste pipes in relation to the gradient and for a filling degree h/ID=0.5 (50%).

i [cm/m]	DN = 80		DN = 90		DN = 100		DN = 125		DN = 150		DN = 200		DN = 225		DN = 250		DN = 300	
	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]
0.5	0.4	0.8	0.4	1.0	0.5	1.7	0.5	2.6	0.6	5.3	0.7	9.9	0.8	13.6	0.9	18.2	1.0	33.9
1.0	0.5	1.2	0.6	1.4	0.7	2.4	0.7	3.7	0.9	7.5	1.1	14.0	1.1	19.3	1.2	25.7	1.5	48.0
1.5	0.7	1.5	0.7	1.7	0.8	2.9	0.9	4.5	1.1	9.1	1.3	17.2	1.4	23.6	1.5	31.4	1.8	58.8
2.0	0.8	1.7	0.8	1.9	0.9	3.3	1.0	5.2	1.3	10.6	1.5	19.8	1.6	27.3	1.7	36.3	2.1	67.8
2.5	0.9	1.9	0.9	2.2	1.0	3.7	1.2	5.9	1.4	11.8	1.7	22.2	1.8	30.5	2.0	40.6	2.3	75.8
3.0	0.9	2.1	1.0	2.4	1.1	4.1	1.3	6.4	1.5	12.9	1.8	24.3	2.0	33.4	2.1	44.5	2.5	83.1
3.5	1.0	2.2	1.1	2.6	1.2	4.4	1.4	6.9	1.7	14.0	2.0	26.2	2.1	36.1	2.3	48.0	2.7	89.7
4.0	1.1	2.4	1.1	2.8	1.3	4.7	1.5	7.4	1.8	14.9	2.1	28.0	2.3	38.6	2.5	51.3	2.9	95.9
4.5	1.1	2.5	1.2	2.9	1.4	5.0	1.6	7.8	1.9	15.8	2.2	29.7	2.4	40.9	2.6	54.5	3.1	101.8
5.0	1.2	2.7	1.3	3.1	1.5	5.3	1.6	8.3	2.0	16.7	2.4	31.4	2.6	43.2	2.8	57.4	3.2	107.3

Table 4.15 Velocity and flow of the waste pipes in relation to the gradient and for a filling degree h/ID=0.6 (60%).

i [cm/m]	DN = 80		DN = 90		DN = 100		DN = 125		DN = 150		DN = 200		DN = 225		DN = 250		DN = 300	
	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]
0.5	0.4	1.1	0.4	1.3	0.5	2.3	0.6	3.5	0.7	7.1	0.8	13.4	0.9	18.4	0.9	24.5	1.1	45.7
1.0	0.6	1.6	0.6	1.9	0.7	3.2	0.8	5.0	1.0	10.1	1.1	18.9	1.2	26.0	1.3	34.6	1.6	64.6
1.5	0.7	2.0	0.7	2.3	0.9	3.9	1.0	6.1	1.2	12.4	1.4	23.2	1.5	31.9	1.6	42.4	1.9	79.1
2.0	0.8	2.3	0.9	2.6	1.0	4.5	1.1	7.1	1.4	14.3	1.6	26.8	1.7	36.8	1.9	49.0	2.2	91.3
2.5	0.9	2.6	1.0	3.0	1.1	5.1	1.3	7.9	1.5	16.0	1.8	29.9	2.0	41.2	2.1	54.7	2.5	102.1
3.0	1.0	2.8	1.1	3.2	1.2	5.5	1.4	8.7	1.7	17.5	2.0	32.8	2.1	45.1	2.3	60.0	2.7	111.9
3.5	1.1	3.0	1.1	3.5	1.3	6.0	1.5	9.4	1.8	18.9	2.1	35.4	2.3	48.7	2.5	64.8	2.9	120.8
4.0	1.2	3.2	1.2	3.7	1.4	6.4	1.6	10.0	1.9	20.2	2.3	37.9	2.5	52.1	2.7	69.2	3.1	129.2
4.5	1.2	3.4	1.3	4.0	1.5	6.8	1.7	10.6	2.0	21.4	2.4	40.2	2.6	55.3	2.8	73.4	3.3	137.0
5.0	1.3	3.6	1.4	4.2	1.6	7.2	1.8	11.2	2.2	22.6	2.5	42.3	2.8	58.2	3.0	77.4	3.5	144.4

* Further details on the formula adopted are found in the appendix.

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Table 4.16 Velocity and flow of the waste pipes in relation to the gradient and for a filling degree h/ID=0.7 (70%).

i [cm/m]	DN = 80		DN = 90		DN = 100		DN = 125		DN = 150		DN = 200		DN = 225		DN = 250		DN = 300	
	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]
0.5	0.4	1.4	0.5	1.7	0.5	2.8	0.6	4.4	0.7	8.9	0.8	16.7	0.9	23.0	1.0	30.6	1.2	57.0
1.0	0.6	2.0	0.6	2.3	0.7	4.0	0.8	6.3	1.0	12.6	1.2	23.7	1.3	32.5	1.4	43.2	1.6	80.6
1.5	0.8	2.5	0.8	2.9	0.9	4.9	1.0	7.7	1.2	15.5	1.5	29.0	1.6	39.8	1.7	52.9	2.0	98.7
2.0	0.9	2.9	0.9	3.3	1.0	5.7	1.2	8.9	1.4	17.9	1.7	33.5	1.8	46.0	2.0	61.1	2.3	113.9
2.5	1.0	3.2	1.0	3.7	1.2	6.3	1.3	9.9	1.6	20.0	1.9	37.4	2.0	51.4	2.2	68.3	2.6	127.4
3.0	1.1	3.5	1.1	4.1	1.3	7.0	1.4	10.9	1.7	21.9	2.1	41.0	2.2	56.3	2.4	74.9	2.8	139.6
3.5	1.2	3.8	1.2	4.4	1.4	7.5	1.6	11.7	1.9	23.6	2.2	44.3	2.4	60.9	2.6	80.9	3.1	150.7
4.0	1.2	4.1	1.3	4.7	1.5	8.0	1.7	12.6	2.0	25.3	2.4	47.3	2.6	65.1	2.8	86.4	3.3	161.1
4.5	1.3	4.3	1.4	5.0	1.6	8.5	1.8	13.3	2.1	26.8	2.5	50.2	2.7	69.0	3.0	91.7	3.5	170.9
5.0	1.4	4.5	1.4	5.2	1.7	9.0	1.9	14.0	2.3	28.2	2.7	52.9	2.9	72.7	3.1	96.6	3.6	180.2

Table 4.17 Velocity and flow of the waste pipes in relation to the gradient and for a filling degree h/ID=0.8 (80%).

i [cm/m]	DN = 80		DN = 90		DN = 100		DN = 125		DN = 150		DN = 200		DN = 225		DN = 250		DN = 300	
	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]
0.5	0.4	1.7	0.5	1.9	0.5	3.3	0.6	5.2	0.7	10.4	0.9	19.6	0.9	26.9	1.0	35.7	1.2	66.5
1.0	0.6	2.4	0.7	2.7	0.8	4.7	0.9	7.3	1.0	14.8	1.2	27.7	1.3	38.0	1.4	50.5	1.7	94.1
1.5	0.8	2.9	0.8	3.4	0.9	5.8	1.0	9.0	1.3	18.1	1.5	33.9	1.6	46.6	1.7	61.8	2.0	115.2
2.0	0.9	3.4	0.9	3.9	1.1	6.6	1.2	10.4	1.5	20.9	1.7	39.1	1.9	53.8	2.0	71.4	2.3	133.1
2.5	1.0	3.8	1.0	4.3	1.2	7.4	1.3	11.6	1.6	23.3	1.9	43.7	2.1	60.1	2.2	79.8	2.6	148.8
3.0	1.1	4.1	1.1	4.8	1.3	8.1	1.5	12.7	1.8	25.6	2.1	47.9	2.3	65.8	2.5	87.5	2.9	163
3.5	1.2	4.5	1.2	5.1	1.4	8.8	1.6	13.7	1.9	27.6	2.3	51.7	2.5	71.1	2.7	94.5	3.1	176
4.0	1.3	4.8	1.3	5.5	1.5	9.4	1.7	14.7	2.1	29.5	2.4	55.3	2.6	76.0	2.8	101	3.3	188.2
4.5	1.3	5.0	1.4	5.8	1.6	10.0	1.8	15.6	2.2	31.3	2.6	58.7	2.8	80.6	3.0	107.1	3.5	199.6
5.0	1.4	5.3	1.5	6.1	1.7	10.5	1.9	16.4	2.3	33.0	2.7	61.8	2.9	85.0	3.2	112.9	3.7	210.4

Table 4.18 Velocity and flow of the waste pipes in relation to the gradient and for a filling degree h/ID=0,9 (90%).

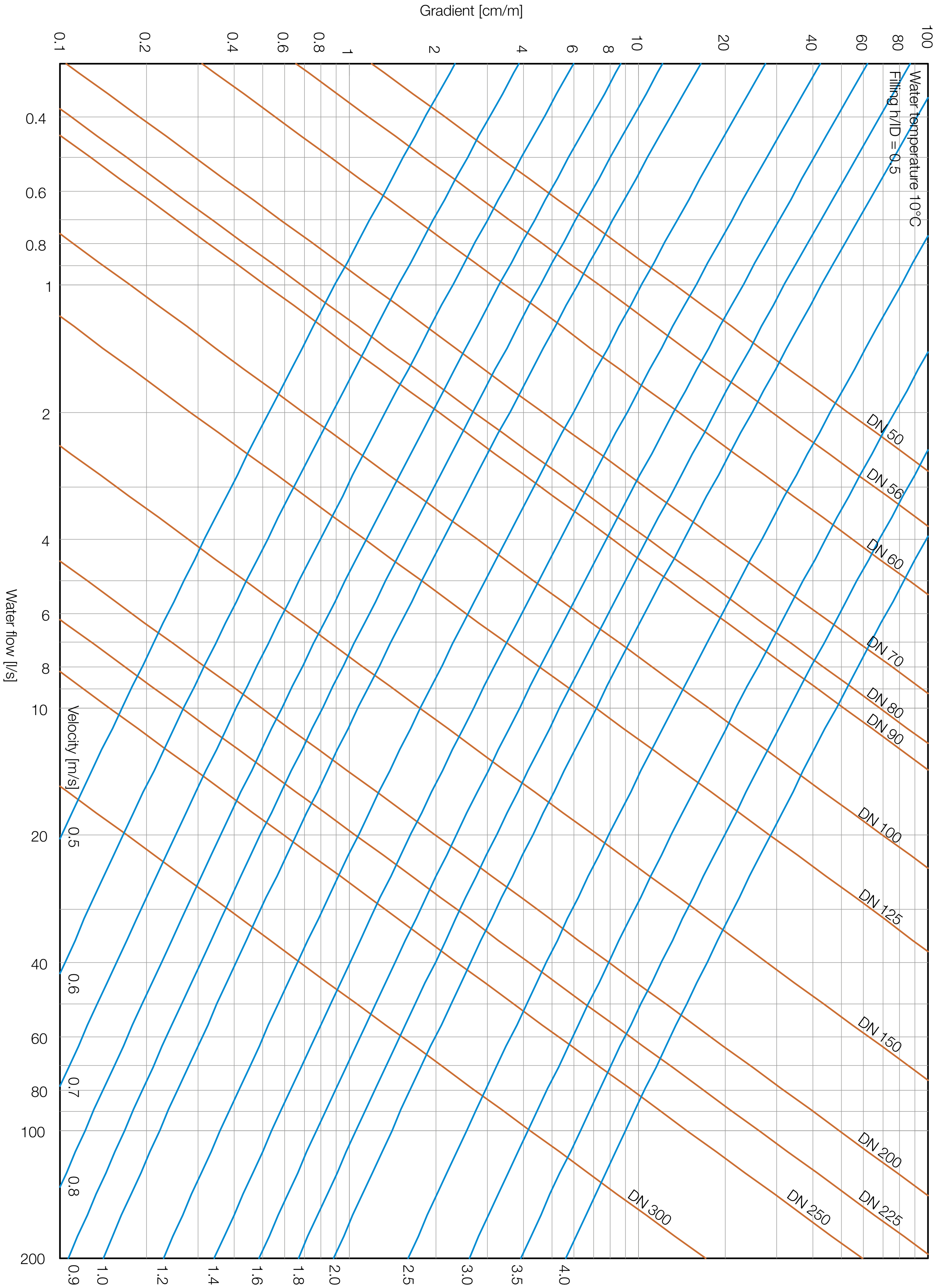
i [cm/m]	DN = 80		DN = 90		DN = 100		DN = 125		DN = 150		DN = 200		DN = 225		DN = 250		DN = 300	
	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]
0.5	0.4	1.8	0.5	2.1	0.5	3.6	0.6	5.7	0.7	11.4	0.8	21.3	0.9	29.3	1.0	38.9	1.2	72.5
1.0	0.6	2.6	0.6	3.0	0.7	5.1	0.8	8.0	1.0	16.1	1.2	30.1	1.3	41.4	1.4	55.0	1.6	102.6
1.5	0.8	3.2	0.8	3.7	0.9	6.3	1.0	9.8	1.2	19.7	1.5	36.9	1.6	50.7	1.7	67.4	2.0	125.6
2.0	0.9	3.7	0.9	4.2	1.1	7.2	1.2	11.3	1.4	22.7	1.7	42.6	1.8	58.6	2.0	77.8	2.3	145.1
2.5	1.0	4.1	1.0	4.7	1.2	8.1	1.3	12.6	1.6	25.4	1.9	47.6	2.1	65.5	2.2	87.0	2.6	162.2
3.0	1.1	4.5	1.1	5.2	1.3	8.9	1.5	13.8	1.8	27.9	2.1	52.2	2.2	71.7	2.4	95.3	2.8	177.7
3.5	1.2	4.8	1.2	5.6	1.4	9.6	1.6	15.0	1.9	30.1	2.2	56.4	2.4	77.5	2.6	103.0	3.1	191.9
4.0	1.2	5.2	1.3	6.0	1.5	10.2	1.7	16.0	2.0	32.2	2.4	60.3	2.6	82.8	2.8	110.1	3.3	205.2
4.5	1.3	5.5	1.4	6.3	1.6	10.8	1.8	17.0	2.1	34.1	2.5	63.9	2.8	87.9	3.0	116.7	3.5	217.6
5.0	1.4	5.8	1.4	6.7	1.7	11.4	1.9	17.9	2.3	36.0	2.7	67.4	2.9	92.6	3.1	123.1	3.7	229.4

The diagram in Figure 4.3 refers to a filling degree h/ID equal to 50%. To achieve different degrees of filling, it is possible to amend the values shown in the diagram with the corrective factors k shown in Table 4.19.
K_Q is the corrective factor of flow rate, while K_V is the corrective factor of speed.

Table 4.19 Corrective multiplying factors of flow and velocity for the values in Figure 4.3.

h/ID	K_Q	K_v
1.0	2.00	1.00
0.9	2.07	1.09
0.8	1.89	1.10
0.7	1.63	1.09
0.6	1.32	1.05
0.5	1.00	1.00
0.4	0.69	0.93
0.3	0.42	0.83
0.2	0.20	0.69
0.1	0.05	0.50

Figure 4.3 Diagram of flows and velocity as a function of gradient for filling degree h/ID=0,5 (50%).



4.6 Sizing of offsets or ventilation collectors

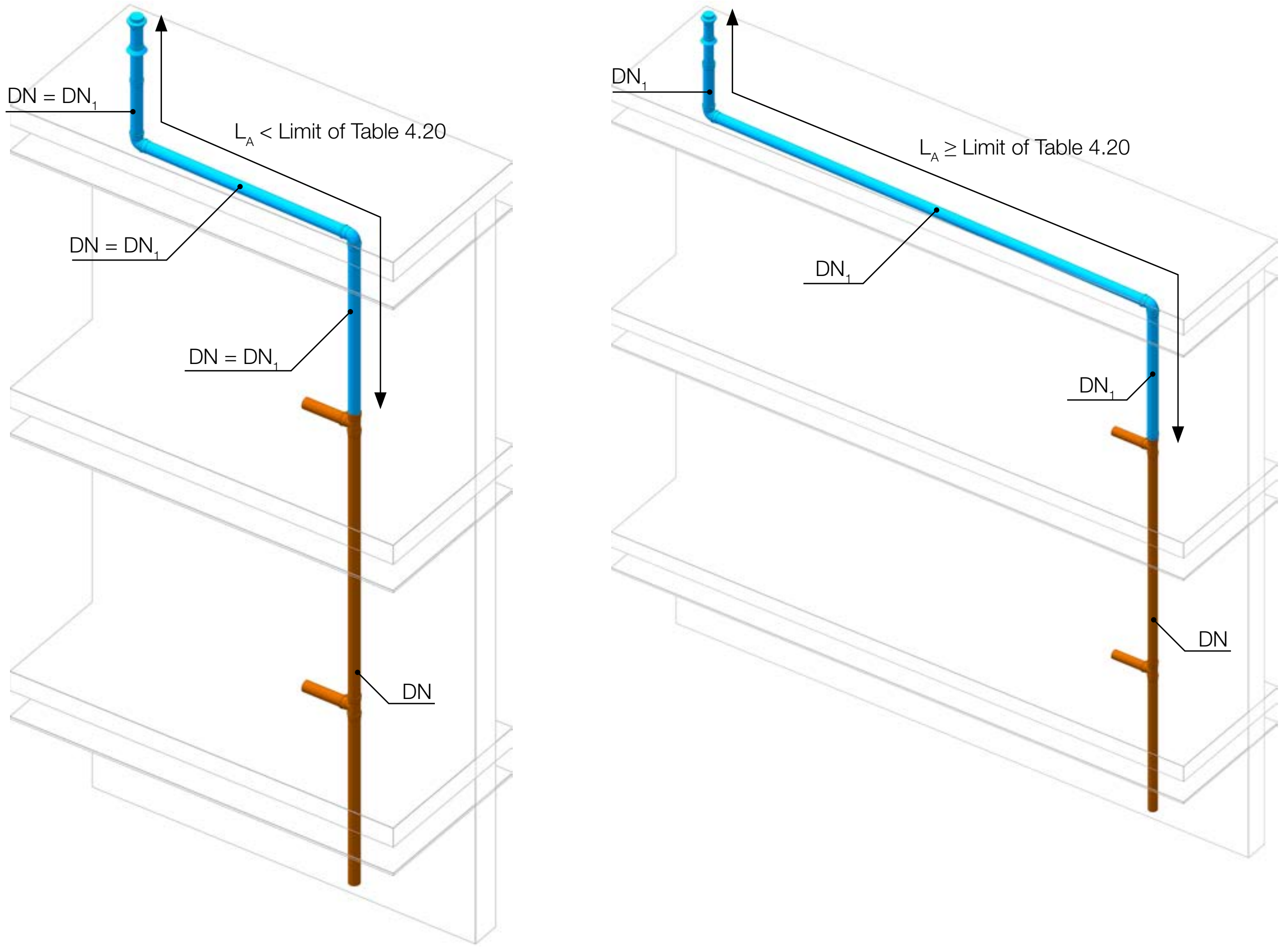
Standard EN 12056 does not provide indications on how to behave if it is necessary to deviate the ventilation stack laterally with respect to the waste stack. However, this system solution can be implemented by following the rules below:

- The waste stack must always end up at the roof level without diameter reductions.
- Consider section L_A between the last connection in the stack and the emission point (see Figure 4.4) and check the length of this section according to Table 4.20.

Table 4.20 Increase of ventilation stack diameter in case of offset.

Waste stack diameter DN (OD) [mm]	Movement L_A [m]	Diameter of ventilation section and roof ventilation cowl DN_1 (OD_1) [mm]
60 (63)	< 6	60 (63)
	≥ 6	70 (75)
70 (75)	< 8	70 (75)
	≥ 8	90 (90)
90 (90)	< 9	90 (90)
	≥ 9	100 (110)
100 (110)	< 11	100 (110)
	≥ 11	125 (125)
125 (125)	< 13	125 (125)
	≥ 13	150 (160)
150 (160)	< 16	150 (160)
	≥ 16	200 (200)
200 (200)	< 20	200 (200)
	≥ 20	250 (250)

Figure 4.4 Ventilation stacks offset.



If it is necessary to connect several stacks to a single ventilation collector, comply with the rules below:

- Ventilation sections must be dimensioned according to the total waste flow rate at stack foot managed by them using Table 4.21.
- The pipes that make up the ventilation collector cannot be subject to diameter reductions in the direction from the stacks towards the roof.

Table 4.21 Maximum flow rate for sizing of a ventilation collector sections.

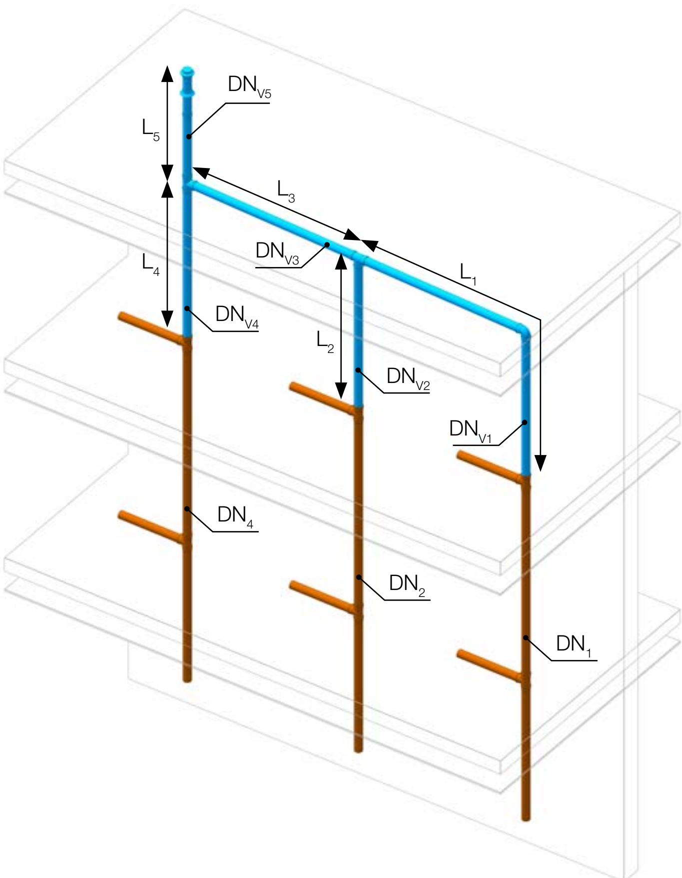
Ventilation section diameter DN	Maximum flow rate ∑DU
60	2
70	16
90	49
100	126
125	231
150	615
200	1764
250	4029
300	10184

• After sizing the ventilation sections according to their flow rate, use Table 4.22 to check whether it is necessary to increase the pipe diameter based on the length of every single section.

Table 4.22 Increase of pipe diameter in case of ventilation collector.

Sizing diameter DN (OD) Table 4.21 [mm]	Section length [m]	Diameter DN_v (OD_v) to use [mm]
60 (63)	< 6	60 (63)
	≥ 6	70 (75)
70 (75)	< 8	70 (75)
	≥ 8	90 (90)
90 (90)	< 9	90 (90)
	≥ 9	100 (110)
100 (110)	< 11	100 (110)
	≥ 11	125 (125)
125 (125)	< 13	125 (125)
	≥ 13	150 (160)
150 (160)	< 16	150 (160)
	≥ 16	200 (200)
200 (200)	< 20	200 (200)
	≥ 20	250 (250)
250 (250)	< 25	250 (250)
	≥ 25	300 (315)
300 (315)	< 32	300 (315)

Figure 4.5 Ventilation collector.



4.7 Examples of sizing

Example 1. System with primary ventilation

For the waste system shown in Figure 4.6 consider that it is necessary to dimension waste stacks and collector. The residential building consists of 12 flats on 3 floors and the basement is equipped with a laundry room. The waste system consists of 2 stacks with primary ventilation to which branches are connected through square branch fittings. The waste collector has a slope of 1% and must be dimensioned using a filling degree of 50%.

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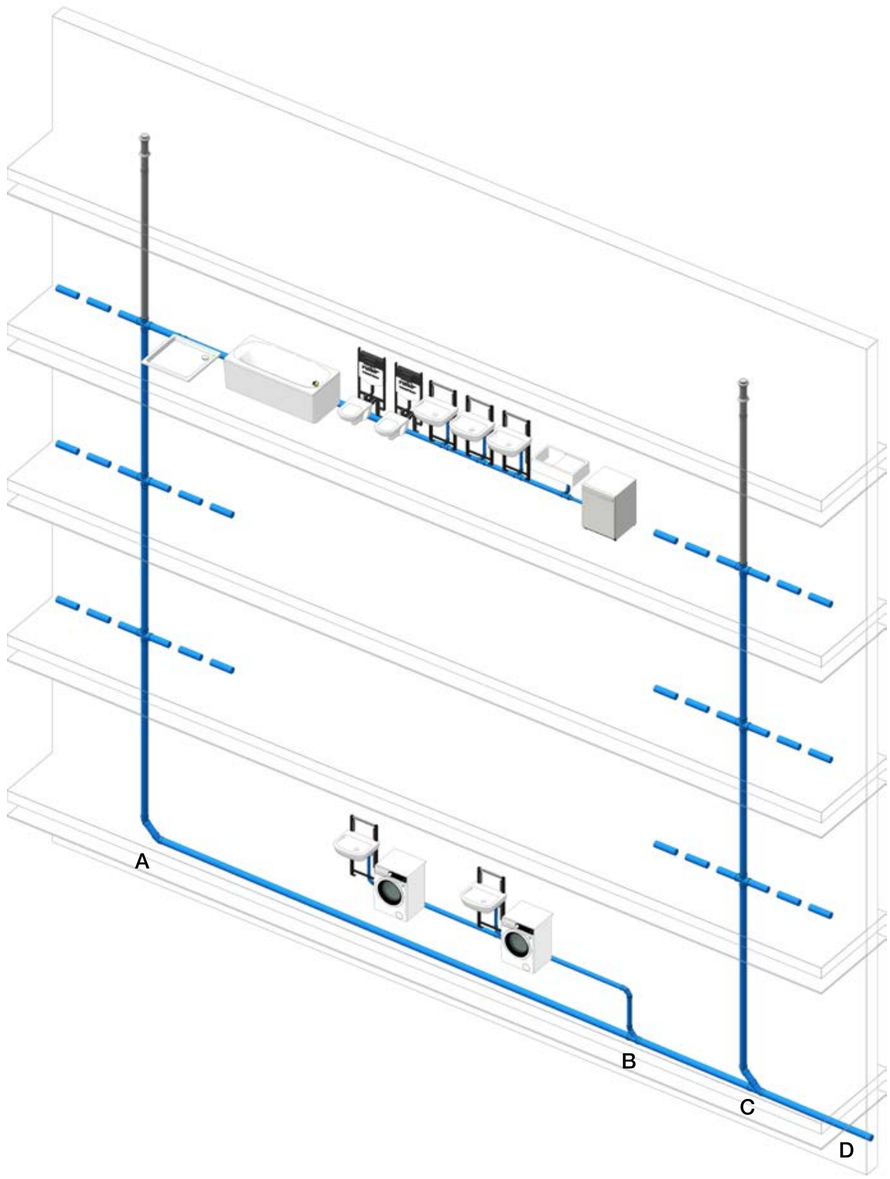
Figure 4.6 Waste system layout.



Each apartment has the following fixtures:

- WCs with 6 litre cisterns.
- 1 shower.
- 1 bathtub.
- 3 washbasins.
- 1 sink.
- 1 dishwasher.

The washroom is equipped with:

- 2 washing machines 6 kg.
- 2 sinks.

Calculation of flow rates

By using the Table 4.4 it is possible to calculate the total flow rate coming from each apartment and from the washroom.

Table 4.23 Bathroom.

Sanitary fixture	Quantity	DU [l/s]	∑ DU [l/s]
WC with 6 litre cistern	2	2.0	4.0
Shower	1	0.6	0.6
Bathtub	1	0.8	0.8
Washbasin	3	0.5	1.5
Sink	1	0.8	0.8
Dishwasher	1	0.8	0.8
Total			8.5

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Table 4.24 Washroom.

Sanitary fixture	Quantity	DU [l/s]	∑ DU [l/s]
6 kg washing machine	2	0.8	1.6
Sink	2	0.5	1.0
Total			2.6

It is not possible to dimension the waste branches in that there is no drawing available with the horizontal distribution of the fixtures, we proceed, therefore, with the calculation of the waste stacks.

Sizing of the waste stacks

In theory, each section of the stack can be dimensioned in relation to the flow that is conveyed from all the apartments in question and therefore, the upper part of the stack, in which the flows are discharged from two apartments, could have a smaller diameter than the lower part of the stack, into which the flows of 6 apartments are discharged.
In reality, the European Standard UNI EN 12056 requires that the relief vent stack (extension of the waste stack with the end terminating in the open air) has the same diameter as the waste stack. As each waste stack represents, due to the lower branches, a relief vent stack, it is necessary to dimension the diameter for the maximum flow and, therefore, for the 6 apartments.

The total flow is:

$$\sum DU = 6 \cdot 8.5 = 51.0 \text{ l/s} \qquad [4.6]$$

and, therefore, the project flow, given by the equation [4.3], is

$$Q_{ww} = K \cdot \sqrt{\sum DU} = 0.5 \cdot \sqrt{51.0} = 3.6 \text{ l/s} \qquad [4.7]$$

considering that the building is residential and the contemporary use degree is K=0.5.

From the Table 4.11 we find that the diameter of the two stacks (equipped with square branch) must be DN 100, this is the diameter that, in fact, ensures a flow rate no smaller than 3.6 l/s. DN 100 is also the minimum diameter allowed when waste water is being drained from WCs.

Sizing of the waste collectors

Before sizing the waste collector, it is necessary to first calculate the flow rates discharged in the various sections:

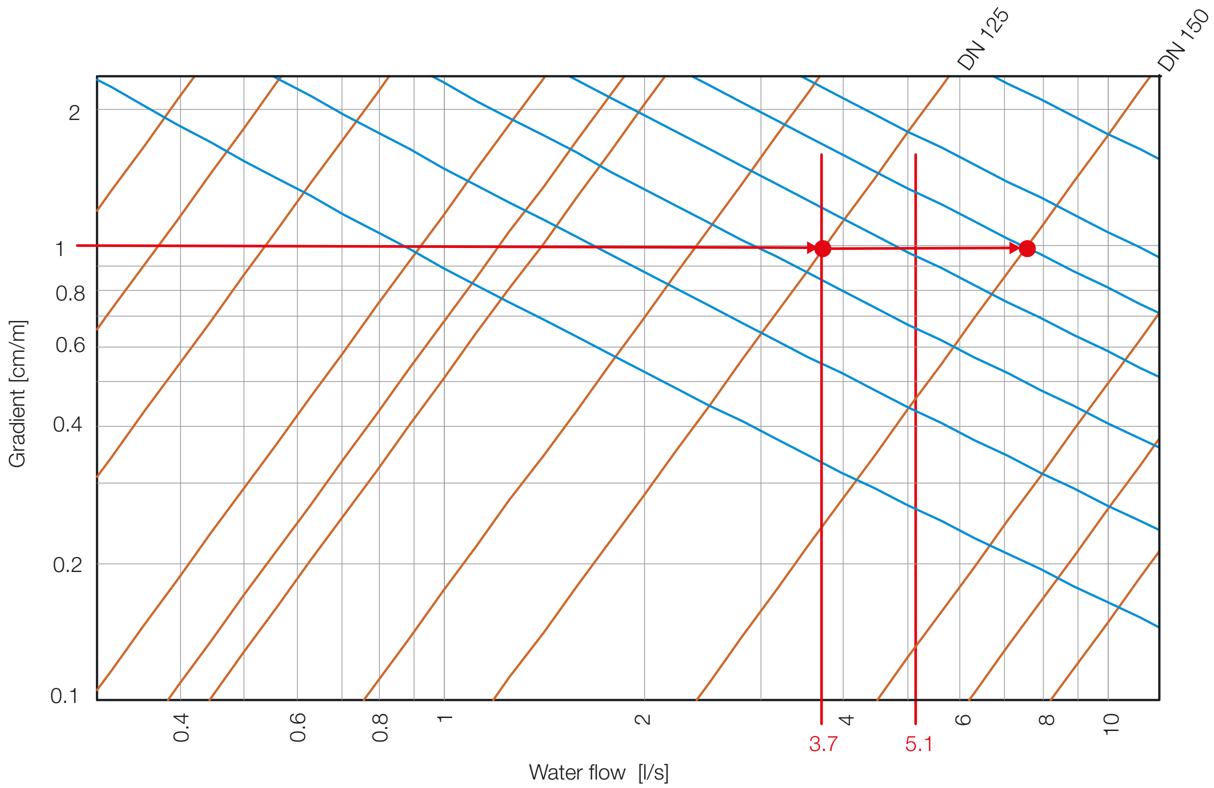
Table 4.25 Distribution of flow in the waste collector.

Section	Users served	∑ DU [l/s]	Q_{ww} [l/s]
AB	6 apartments	51.0	$0.5 \cdot \sqrt{51.0} = 3.6$
BC	6 apartments + washroom	51.0 + 2.6	$0.5 \cdot \sqrt{53.6} = 3.7$
CD	12 apartments + washroom	51.0 + 2.6 + 51.0	$0.5 \cdot \sqrt{104.6} = 5.1$

The choice of diameter of the various sections can be made by following the tables. For a specific case, for a filling degree of 50% use Table 4.14 from which the minimum diameter must be identified, for the gradient of 1%, that ensures a flow no smaller than the one calculated. For the sections AB and BC diameter DN 125 is necessary, that ensures required flows of 3.6 and 3.7 l/s, whereas for the section CD a diameter of DN 150 is necessary, that ensures a flow rate of 7.5 l/s > 5.1 l/s.

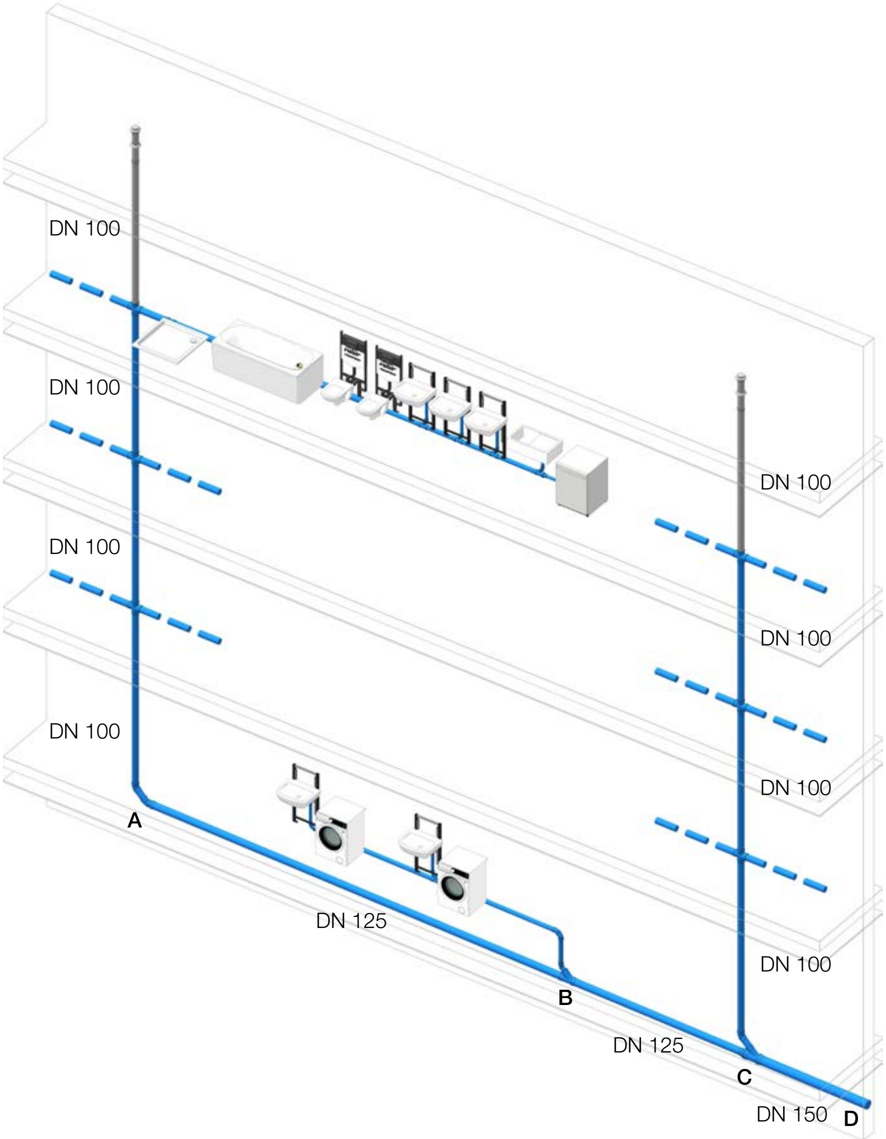
The same result can be obtained by means of Figure 4.3 as indicated.

Figure 4.7 Choice of diameters of waste stacks.



The final layout of the system is shown in the following figure.

Figure 4.8 Dimensions of waste system.



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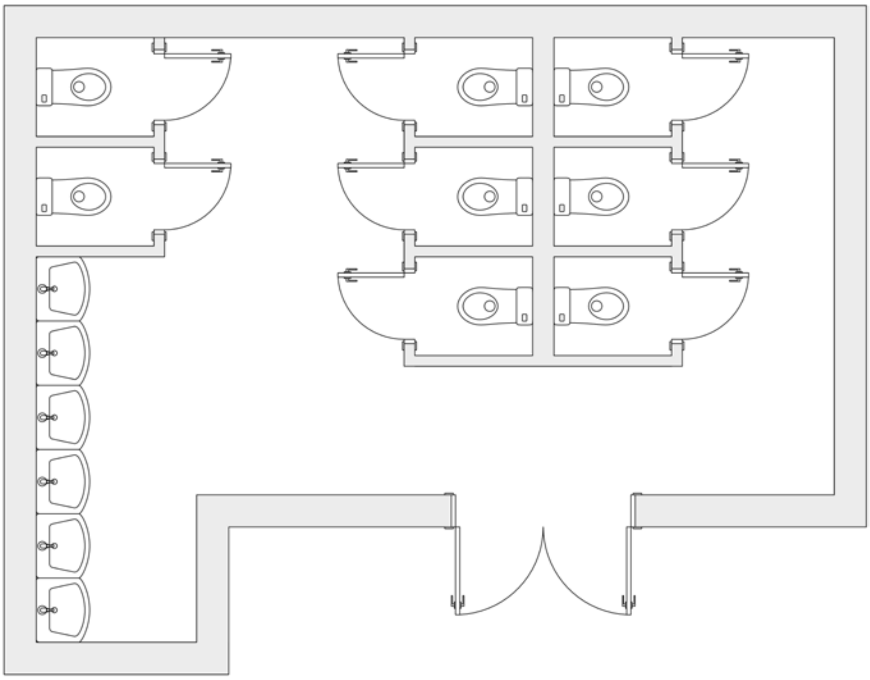
Example 2. Drainage branches
It is necessary to dimension the drainage branch (frequent use K=0.7) for connection of sanitary fixtures shown in Figure 4.9 i.e. 8 WCs (with 6 l cistern) and 6 sinks.

Figure 4.9 Arrangement of the sanitary fixtures.



In order to calculate the diameters of the branches it is necessary to define the flows deriving from each sanitary fixture through Table 4.4.
Given the sanitary fixture layout, 2 different drainage branches are connected tothe stack. With regard to the waste branch for the 6 central WCs, since the total length is lower than 4 m, Table 4.6 is used for its sizing. For the series of WCs, which in sequence are united inside the branch, the diameters are indicated in the table. Keeping in mind that the project flow can be no less that the sanitary fixture with the greatest drainage unit, a branch with one diameter DN 100 is obtained.

Table 4.26 Series of WCs.

N.	Sanitary fixture	DU [l/s]	∑ DU [l/s]	Q_{ww} [l/s]		Branch DN
1	WC (6 litre cistern)	2.0	2.0	2.0		100
2	WC (6 litre cistern)	2.0	4.0	$0.7 \cdot \sqrt{4.0} = 1.40$	assumed flow 2.0*	100
3	WC (6 litre cistern)	2.0	6.0	$0.7 \cdot \sqrt{6.0} = 1.71$	assumed flow 2.0*	100
4	WC (6 litre cistern)	2.0	8.0	$0.7 \cdot \sqrt{8.0} = 1.98$	assumed flow 2.0*	100
5	WC (6 litre cistern)	2.0	10.0	$0.7 \cdot \sqrt{10.0} = 2.21$		100
6	WC (6 litre cistern)	2.0	12.0	$0.7 \cdot \sqrt{12.0} = 2.42$		100

* Remember that, if the project flow is smaller that the flow of one of the sanitary fixtures served, then the latter value is used as the project flow rate. In the specific case, the project flow of 1.98 l/s is less than the drainage units of the WC (with cistern capacity of 6 l) and, therefore, the value must be equal to the flow of the WC itself, that is 2.0 l/s.

For the set of sinks and the 2 WCs, diameters are shown in the table below.
Since the total length of drainage branch is greater than 4 m, the branch must be ventilated; for its sizing, refer to Table 4.8.

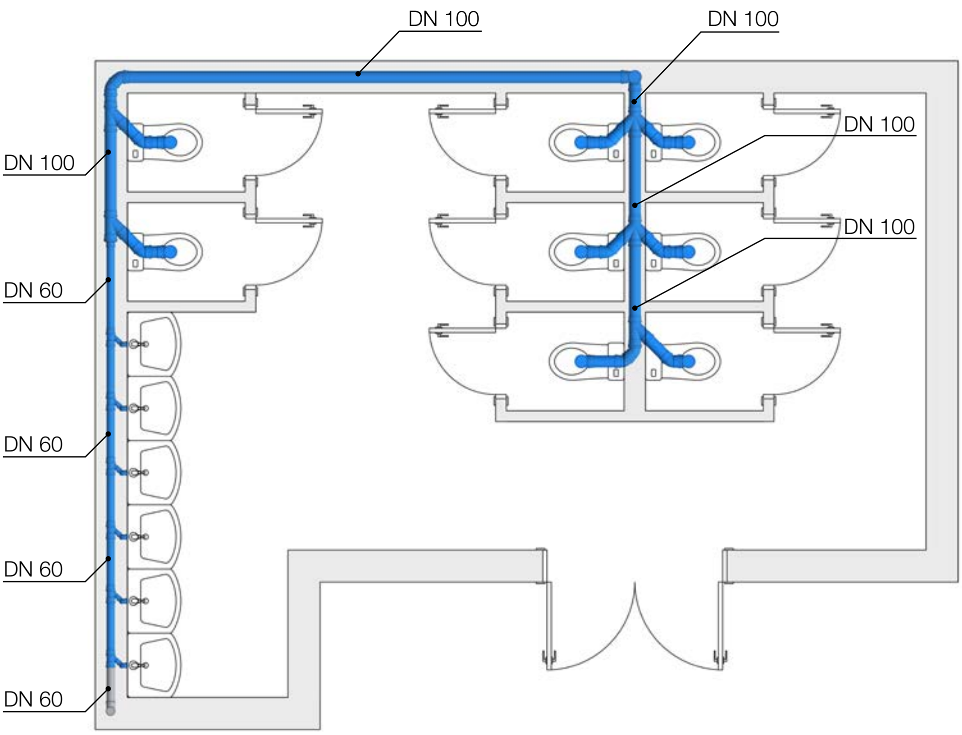
Table 4.27 Series of washbasins.

N.	Sanitary fixture	DU [l/s]	∑ DU [l/s]	Q_{ww} [l/s]		Branch DN	Ventilation DN
1	Washbasin	0.5	0.5	0.5		50	40
2	Washbasin	0.5	1.0	$0.7 \cdot \sqrt{1.0} = 0.7$		50	40
3	Washbasin	0.5	1.5	$0.7 \cdot \sqrt{1.5} = 0.86$		60	40
4	Washbasin	0.5	2.0	$0.7 \cdot \sqrt{2.0} = 0.99$		60	40
5	Washbasin	0.5	2.5	$0.7 \cdot \sqrt{2.5} = 1.11$		60	40
6	Washbasin	0.5	3.0	$0.7 \cdot \sqrt{3.0} = 1.21$		60	40
7	WC (6 litre cistern)	2.0	5.0	$0.7 \cdot \sqrt{5.0} = 1.56$	assumed flow 2.0*	100**	60
8	WC (6 litre cistern)	2.0	7.0	$0.7 \cdot \sqrt{7.0} = 1.85$	assumed flow 2.0*	100**	60

* Please note that if the design flow rate is lower than the flow rate of one of the sanitary fixtures, the latter must be used as design flow rate. In this specific case, the design flow rate of 1.85 l/s is lower than the WC waste units (with cistern capacity of 6 l) and therefore must be assumed to be equal to the WC flow rate, i.e. 2.0 l/s.
** In case of WCs, the minimum diameter permitted is DN 90, provided that there are no more than two WCs on the same branch and the total change of direction does not exceed 90°, otherwise DN 100 must be used.

Since the waste pipe of the various sanitary fixtures in the unit is also used as ventilation pipe for the other sanitary fixtures, the diameter required to ventilate the section with greatest flow rate must be used as minimum diameter of the branch; this applies if the calculations show that some drainage sections have a diameter smaller than the diameter required to ventilate other ventilation sections.
In the example above, the minimum diameter of the ventilated branch will be DN 60, which corresponds to the diameter of the pipe required to ventilate a DN 100 branch.

Figure 4.10 Definition of the diameters of the branches.



Example 3. System with direct parallel ventilation
It is necessary to dimension the waste system of a residential building with 5 equal floors defined in the layout in Figure 4.11. The figure shows the technical compartments (red blocks) available for waste stack installation. The waste collector is located in the basement (garage) floor with a slope of 1.5% and must be dimensioned with a filling degree of 50%. The waste system is made with direct parallel ventilation for the stacks of bathrooms and primary ventilation for the stacks of kitchens. Connection of the branches (not ventilated) is carried out with square branch fitting.

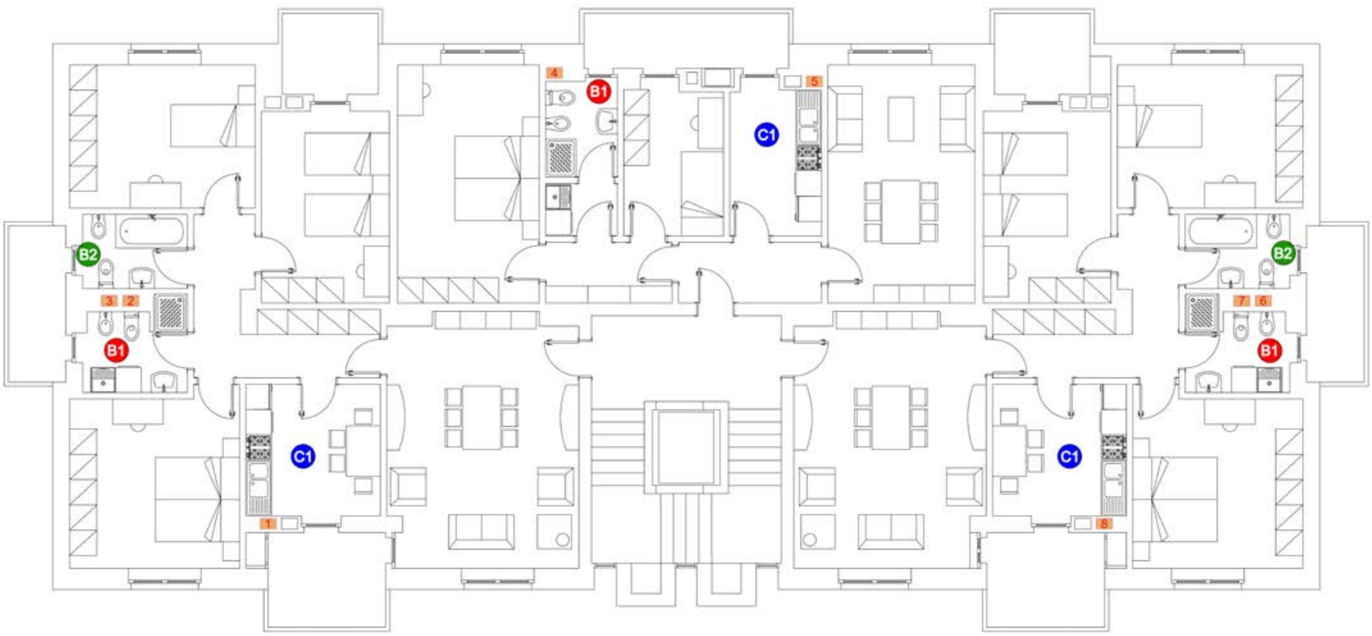
In the figure the technical areas are numbered and the rooms have been classified in relation to the type of sanitary fixtures installed:

Bathroom - type B1
- 1 WC with 9 litre flushing cistern.
- 1 bidet.
- 1 shower.
- 1 washbasin.
- 1 sink.
- 1 washing machine 6 kg.

Bathroom - type B2
- 1 WC with 9 litre flushing cistern.
- 1 bidet.
- 1 washbasin.
- 1 bathtub.

Kitchen - type C1
- 1 sink.
- 1 dishwasher.

Figure 4.11 Representative plan of building floors.



Calculation of flow rates

With the use of Table 4.4 it is possible to calculate the total flow coming from each sanitary fixture and for the three room types identified in the project.

Table 4.28 Bathroom - type B1.

Sanitary fixture	Quantity	DU [l/s]	∑ DU [l/s]
WC with 9 litre flushing cistern	1	2.5	2.5
Bidet	1	0.5	0.5
Shower	1	0.6	0.6
Washbasin	1	0.5	0.5
Sink	1	0.8	0.8
Washing machine 6 kg	1	0.8	0.8
Total			5.7

Table 4.29 Bathroom - type B2.

Sanitary fixture	Quantity	DU [l/s]	∑ DU [l/s]
WC with 9 litre flushing cistern	1	2.5	2.5
Bidet	1	0.5	0.5
Washbasin	1	0.5	0.5
Bathtub	1	0.8	0.8
Total			4.3

Table 4.30 Kitchen - type C1.

Sanitary fixture	Quantity	DU [l/s]	∑ DU [l/s]
Washbasin	1	0.8	0.8
Dishwasher	1	0.8	0.8
Total			1.6

Sizing of the waste branches

The choice of the waste branch diameters is made through Table 4.6 by simply comparing the flows of the sanitary fixtures with the maximum flow allowed for each diameter.

Table 4.31 Choice of diameters of the branches.

Sanitary fixture	DU [l/s]	Branch DN
WC with 9 litre cistern	2.5	100
Shower	0.6	50
Sink	0.8	50
Bathtub	0.8	50
Washing machine 6 kg	0.8	50
Dishwasher	0.8	50
Bidet	0.5	40
Washbasin	0.5	40

After choosing the diameters it is possible to trace the routes on the drawing, paying attention that the restrictions imposed are observed Table 4.5 and, where possible, connecting the pipes to branches with angles below 90°.

Figure 4.12 Branches of room types B1 and B2.

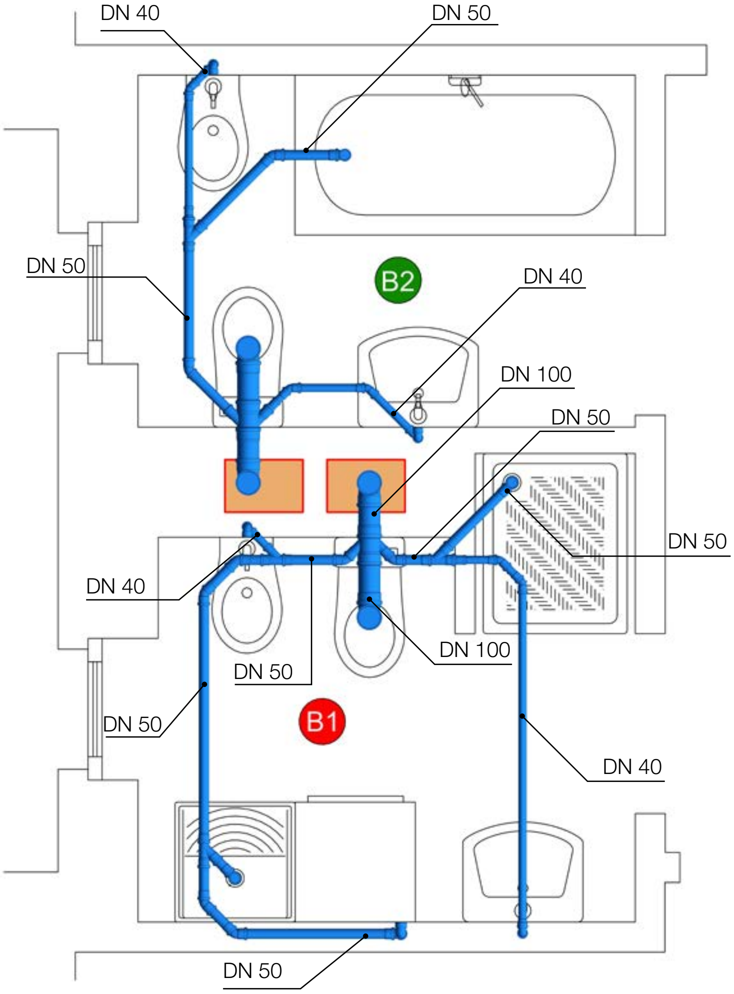
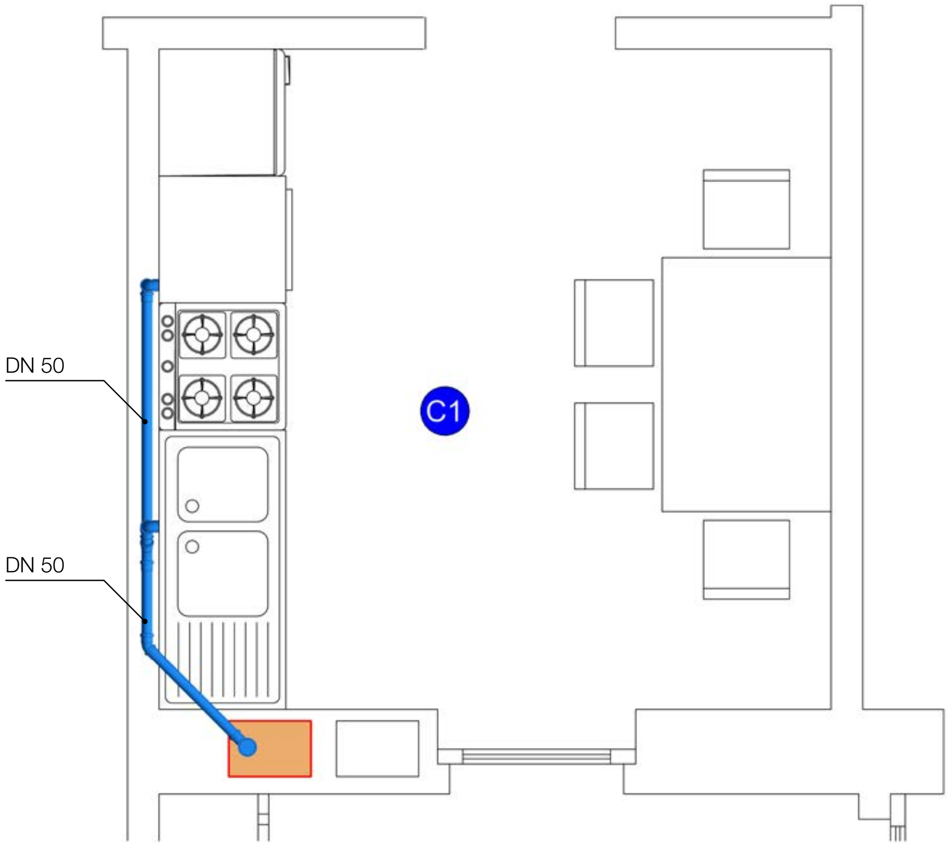


Figure 4.13 Branches of room type C1.



Sizing of waste stacks

With the use of the drawing we find that there are 8 waste stacks numbered with the same numbering as the technical areas and there are three types; the stacks for the black waste waters (bathrooms) which we will identify with the abbreviation T1 and T2 in relation to the type of bathroom served and those that transport the grey waste waters (kitchens) that we will label T3.

Table 4.32 Identification of the types of stacks.

Stack type	Room served	Stacks
T1	Bathroom type B1	2; 4; 7
T2	Bathroom type B2	3; 6
T3	Kitchen type C3	1; 5; 8

4

For each stack the maximum waste flows must be calculated by summing the flows of the rooms served.

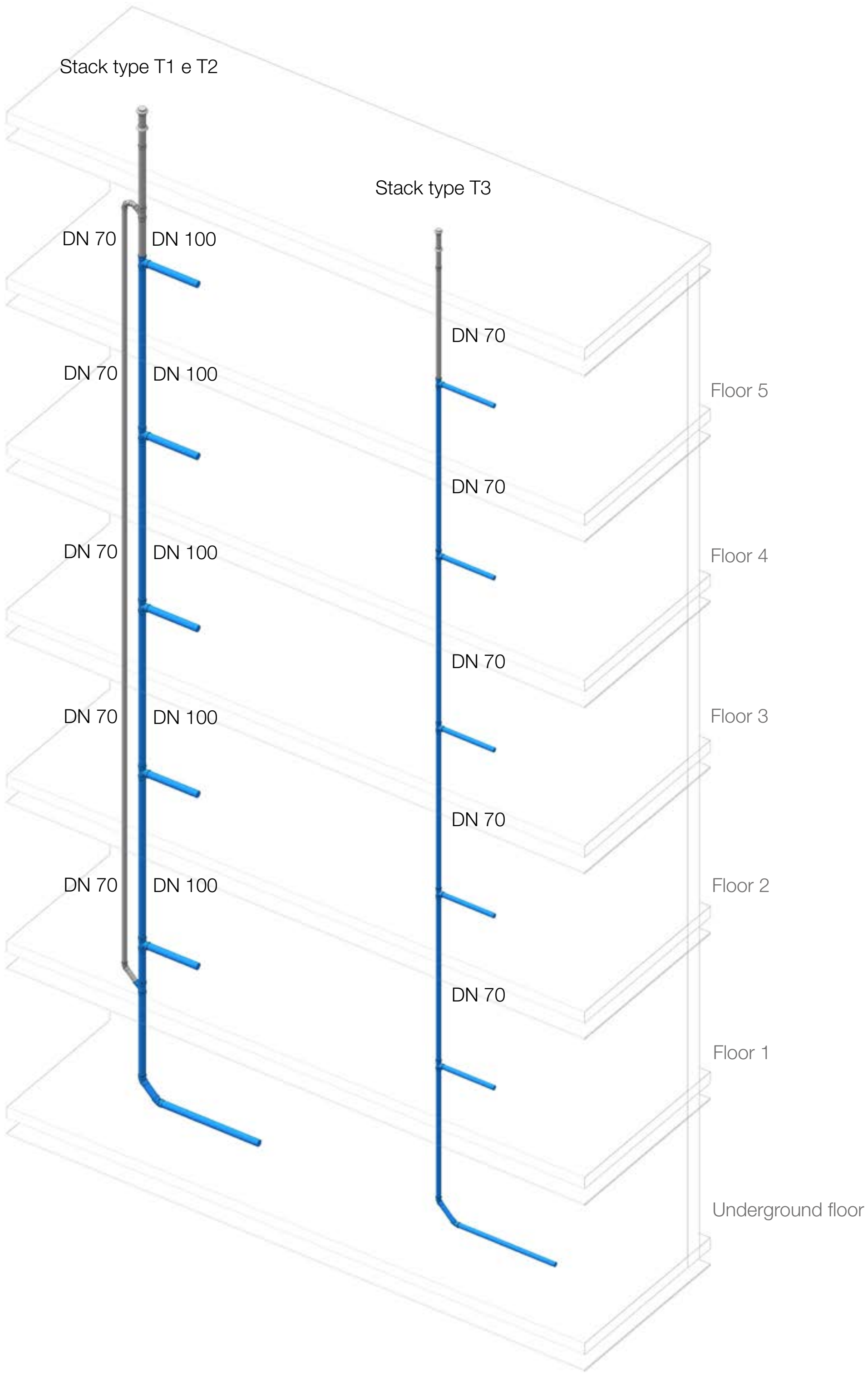
Table 4.33 Waste flows of the stacks.

Stack type	∑ DU [l/s]	Q_{ww} [l/s]
T1	$\sum DU = 5 \cdot 5.7 = 28.5$	$0.5 \cdot \sqrt{28.5} = 2.7$
T2	$\sum DU = 5 \cdot 4.3 = 21.5$	$0.5 \cdot \sqrt{21.5} = 2.3$ assumed flow 2.5*
T3	$\sum DU = 5 \cdot 1.6 = 8$	$0.5 \cdot \sqrt{8} = 1.4$

* Remember that, if the project flow is smaller that the flow of one of the sanitary fixtures served, then the latter value is used as the project flow rate. In the specific case, the project flow of 2.3 l/s is less than the drainage units of the WC (with cistern capacity of 9 l) and, therefore, the value must be equal to the flow of the WC itself, that is 2.5 l/s.

From Table 4.12 From Table 4.10 we find that the stack types T1 and T2 must be made with pipe diameters DN 100 in that, despite the project flow rates being relatively low, there are WCs connected to them and the standard requires a minimum diameter of DN 100. The diameter for the direct parallel vent stack is, on the other hand, DN 70 (see Table 4.13).
From Table 4.11 shows that stacks T3 must be made with pipe DN 70.

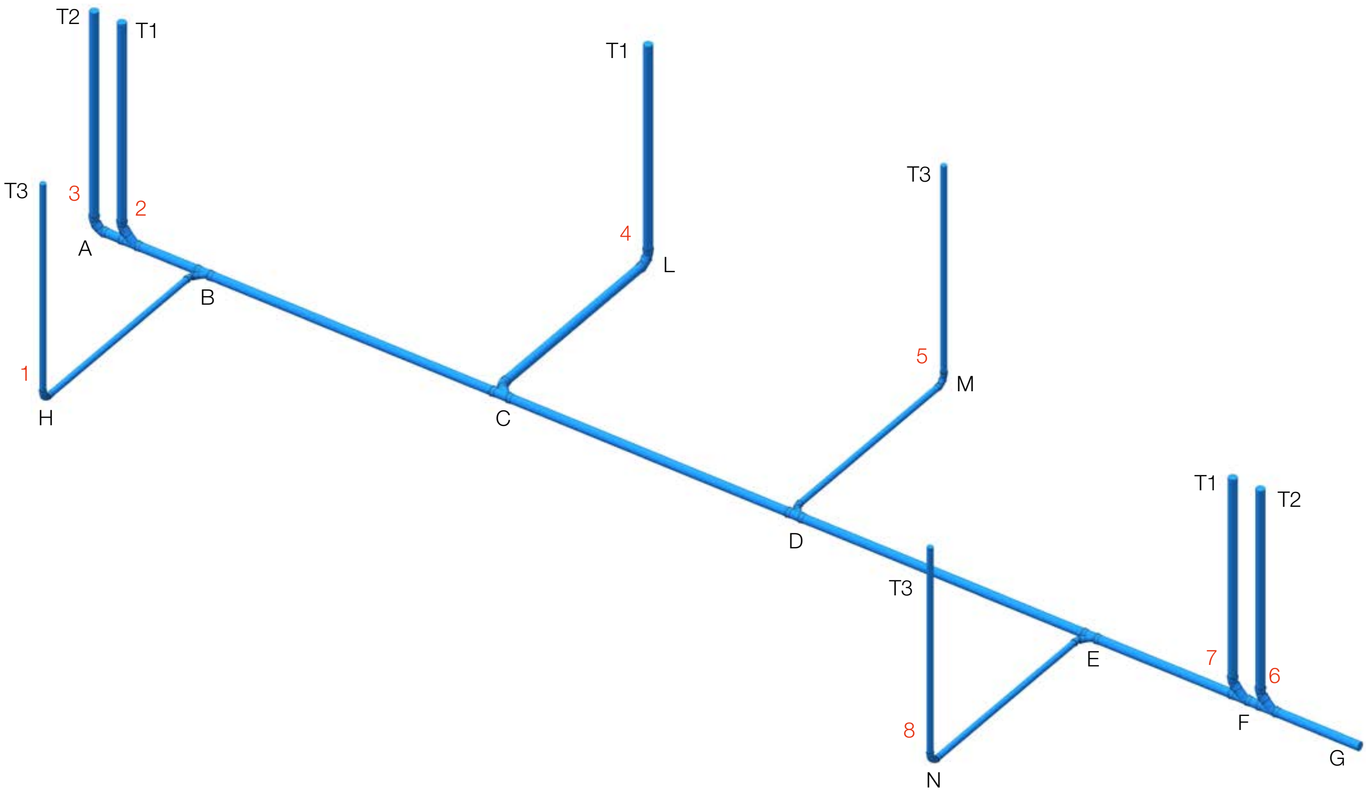
Figure 4.14 Sizing of waste stacks.



Sizing of the waste collectors

Once the configuration of the waste collector has been defined on the plan, we proceed with the calculation of the diameters of the various sections. The layout of the waste collector and the identification of the various sections is shown in Figure 4.15.

Figure 4.15 Configuration of the waste collector.



The waste flow deriving for the stacks is calculated for the single sections.

Table 4.34 Distribution of the flows in the waste collector.

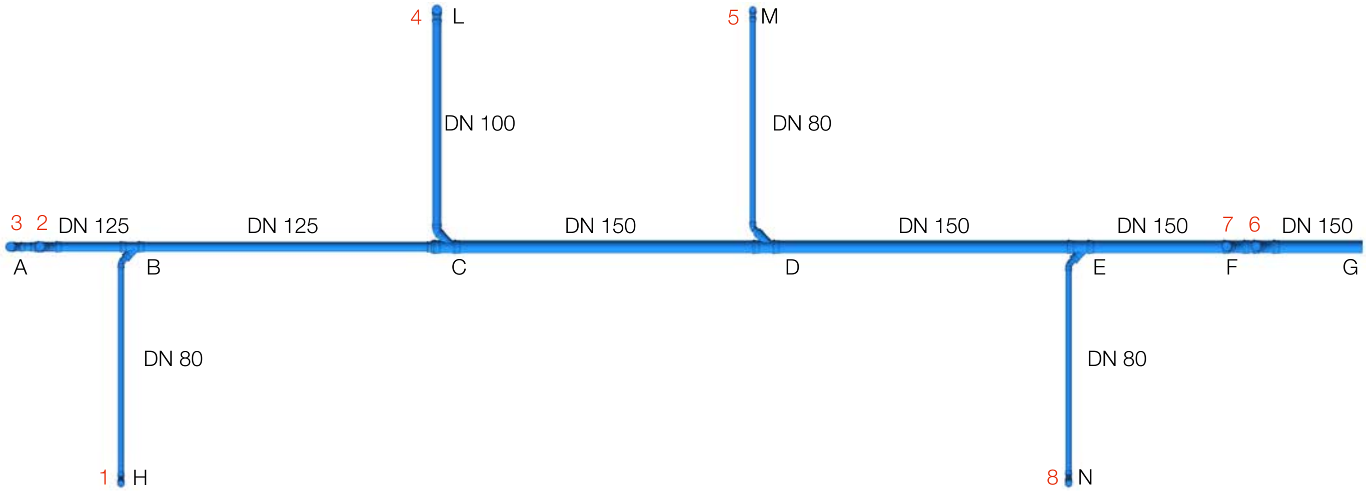
Section	Stacks served	∑ DU [l/s]	Q_{ww} [l/s]
AB	T1 + T2	50.0	$0.5 \cdot \sqrt{50.0} = 3.5$
HB	T3	8	$0.5 \cdot \sqrt{8} = 1.4$
BC	T1 + T2 + T3	58	$0.5 \cdot \sqrt{58} = 3.8$
LC	T1	28.5	$0.5 \cdot \sqrt{28.5} = 2.7$
CD	T1 + T2 + T3 + T1	86.5	$0.5 \cdot \sqrt{86.5} = 4.6$
MD	T3	8	$0.5 \cdot \sqrt{8} = 1.4$
DE	T1 + T2 + T3 + T1 + T3	94.5	$0.5 \cdot \sqrt{94.5} = 4.9$
NE	T3	8	$0.5 \cdot \sqrt{8} = 1.4$
EF	T1 + T2 + T3 + T1 + T3 + T3	102.5	$0.5 \cdot \sqrt{102.5} = 5.1$
FG	T1 + T2 + T3 + T1 + T3 + T3 + T1 +T2	152.5	$0.5 \cdot \sqrt{152.5} = 6.2$

Comparing the flows with those indicated in Table 4.14 for a gradient of 1.5% the diameters necessary for each section are determined as indicated in Table 4.35 and in Figure 4.16.

Table 4.35 Dimensions of the sections of the waste collector.

Section	Diameter DN
AB	125
HB	80
BC	125
LC	100
CD	150
MD	80
DE	150
NE	80
EF	150
FG	150

Figure 4.16 Dimensions of the waste collector.



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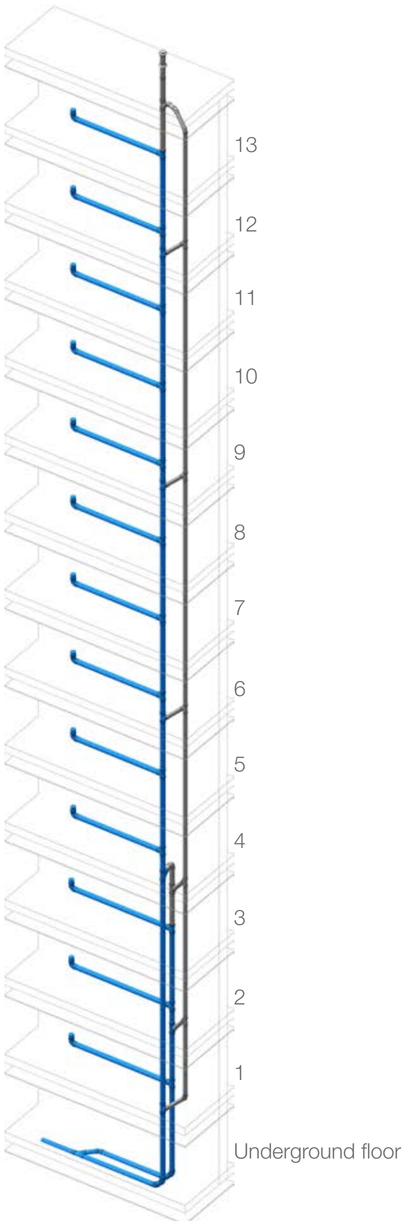
Example 4. System with direct parallel ventilation and stack division
We need to configure and dimension the waste stack, with direct parallel ventilation, of a residential building, composed of 13 equally designed floors. Each floor drains a total of 10 l/s (WCs included) into the stack through a square branch. The waste collector is laid in the pavement of the underground floor.

Configuration of the waste stack

In the table shown in the section dedicated to the project design of waste systems, and, in particular, in the chapter concerning the configuration of stacks with parallel and secondary ventilation, we obtain the following information:

- The stack must be divided.
- The top 10 floors are connected to the main stack.
- The last 3 floors are connected to the secondary stack.
- Further division of the secondary stack is not necessary.
- The intermediate connecting sections between the waste stack and the ventilation stack can be made every 2-3 floors.

Figure 4.17 Configuration of the waste stack.



Sizing of the waste stack

The secondary stack must have the same diameter as the main stack to ensure a good ventilation (vent loop), therefore, the choice of the diameter is based on the flows drained into the main stack.

The flow in the main stack is:

$$\sum DU = 10 \cdot 10 = 100 \text{ l/s} \quad [4.8]$$

since there are 10 floors draining into it. The project flow, given by the equation [4.3], is then:

$$Q_{ww} = K \cdot \sqrt{\sum DU} = 0.5 \cdot \sqrt{100} = 5 \text{ l/s} \quad [4.9]$$

4

considering that the building is residential with a degree of contemporary use of K=0.5.
From Table 4.12 we find that the diameter of the main stack and of the secondary stack is DN 100.
This diameter ensures a flow of at least 5.6 l/s and it is therefore the minimum diameter that can be applied in the presence of WCs.

Sizing of the vent stack

Since the ventilation is the same for both stacks, primary and secondary, its diameter depends on the total flow that would be created if there were only one waste stack.
Since we presume that all 13 floors are drained into it, the total flow is:

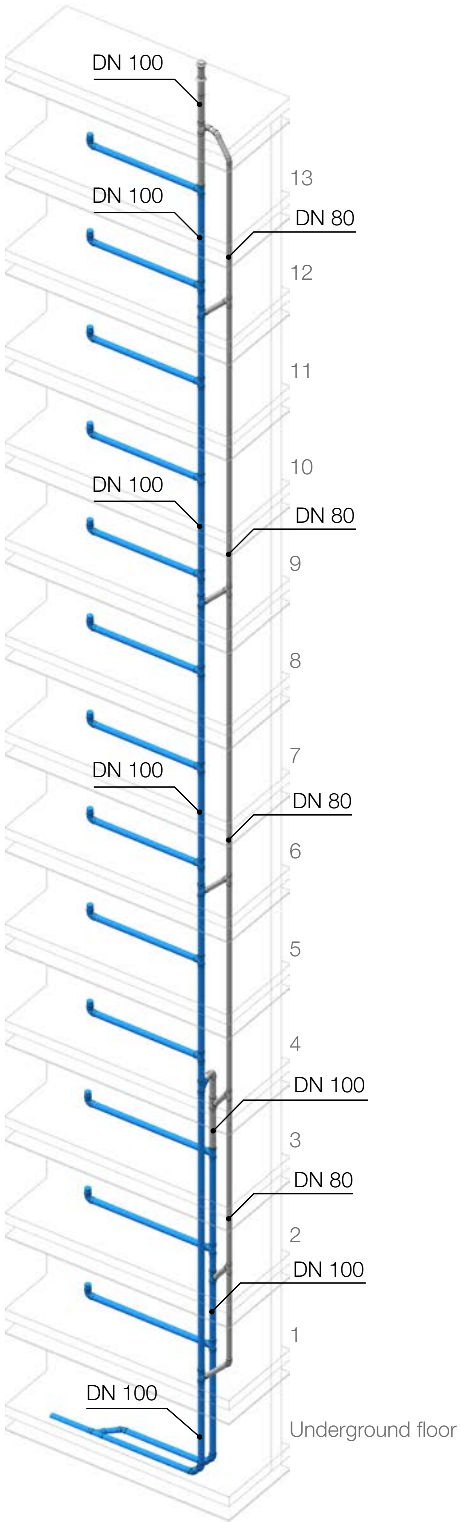
$$\sum DU = 13 \cdot 10 = 130 \text{ l/s} \quad [4.10]$$

the project flow is:

$$Q_{ww} = K \cdot \sqrt{\sum DU} = 0.5 \cdot \sqrt{130} = 5.7 \text{ l/s} \quad [4.11]$$

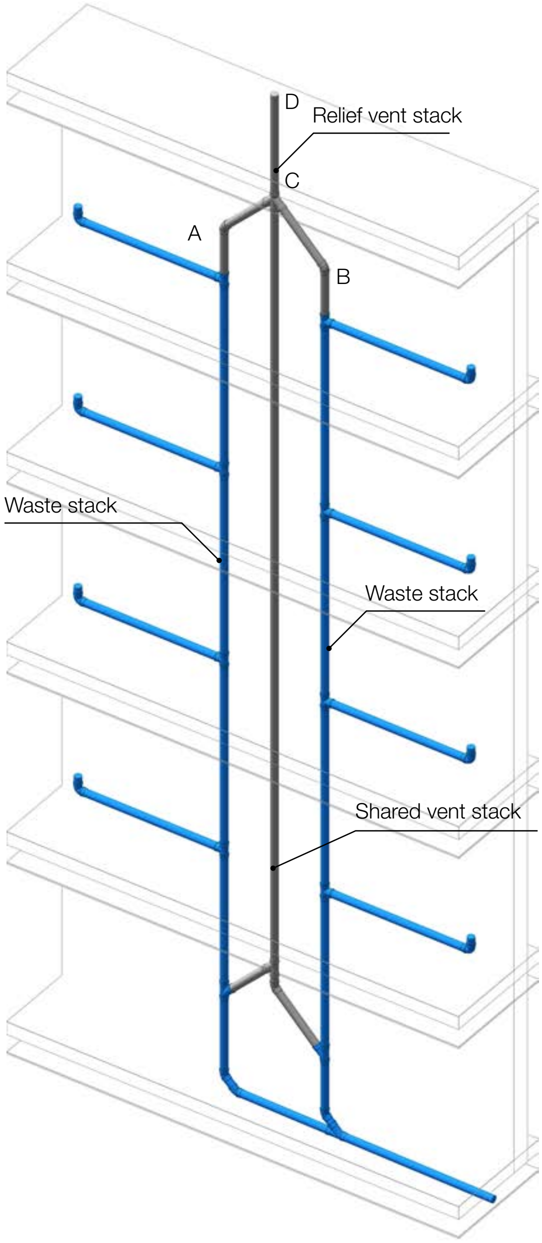
In this case, Table 4.12 shows that diameter DN 125 ensures a flow rate of 5.7 l/s and requires a ventilation stack DN 80 (see Table 4.13). The system dimensions are shown in the diagram in the figure below.

Figure 4.18 Dimensions of the waste system.



Example 5. System with direct parallel ventilation divided between two waste stacks
Imagine a residential building characterised by two waste stacks (with square branch) having in common one direct parallel vent stack. The sum of the drainage units ∑DU of the stacks is 117 l/s and 196 l/s respectively. Calculate the diameters of the two waste stacks, of the vent stack and of the relief vent stack.

Figure 4.19 System layout.



Sizing of the waste stack

The project flow of the two waste stacks is given by:

$$Q_{WW,1} = K \cdot \sqrt{\sum DU} = 0.5 \cdot \sqrt{117} = 5.41 \text{ l/s} \quad [4.12]$$

$$Q_{WW,2} = K \cdot \sqrt{\sum DU} = 0.5 \cdot \sqrt{196} = 7.00 \text{ l/s} \quad [4.13]$$

considering that the building is residential with a degree of contemporary use of K=0.5.
Table 4.12 shows that the diameter of stacks is DN 100 and DN 125, respectively.

Sizing of the vent stack

Since the ventilation is shared by both stacks, its diameter depends on the total flow that would result if there were just one single stack.
The hypothetical total flow transported in one single stack is:

$$\sum DU = 117 + 196 = 313 \text{ l/s} \quad [4.14]$$

and the project flow is:

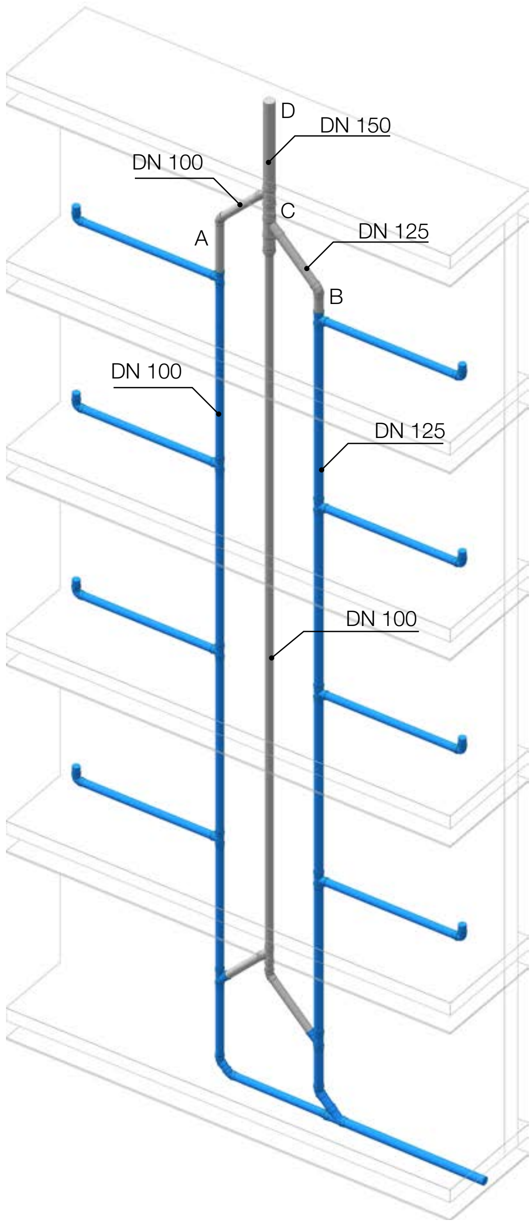
$$Q_{ww} = K \cdot \sqrt{\sum DU} = 0.5 \cdot \sqrt{313} = 8.85 \text{ l/s} \quad [4.15]$$

4

Table 4.12 shows that the waste stack should have diameter DN 150 and require a parallel ventilation stack DN 100 (see Table 4.13).
For sizing of sections AC, BC, and CD, use Table 4.21. Since for section AC $\sum DU = 117$ l/s,
the diameter to use is DN 100. For section BC $\sum DU = 196$ l/s, therefore the diameter required is DN 125.
Section CD has $\sum DU = 313$ l/s and therefore requires DN 150.

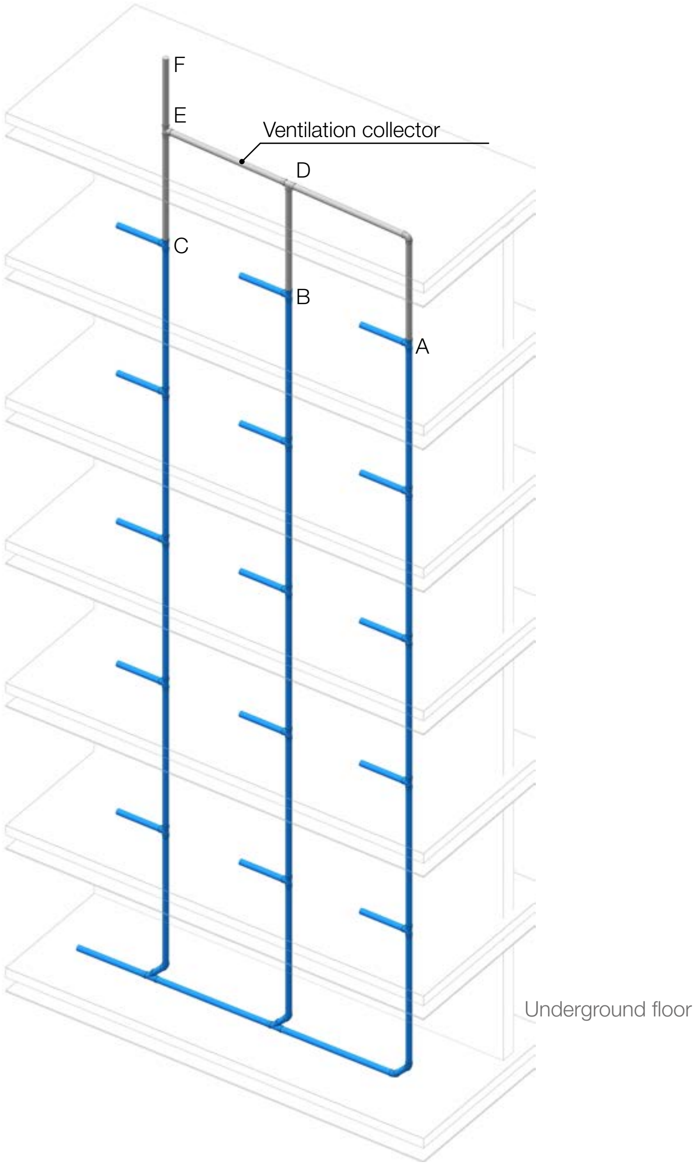
The check is then carried out in accordance with Table 4.22; in this case, the various sections maintain the diameter dimensions shown above

Figure 4.20 Dimensions of the waste system.



Example 6. Primary ventilation system with ventilation collector
Consider a residential building with 3 waste stacks featuring primary ventilation but connected to each other before the exit through the roof by means of a ventilation collector. Drainage flow rate in each stack is 30 l/s. Dimensions of the various ventilation sections are as follows: AD = 8 m, BD = 3 m, CE = 3 m, DE = 5 m and EF = 1 m. Stacks and ventilation collector must be dimensioned.

Figure 4.21 System layout.



Sizing of the waste stack

The flow in each stack is:

$$\sum DU = 30.0 \text{ l/s} \quad [4.16]$$

and the project flow is:

$$Q_{ww} = K \cdot \sqrt{\sum DU} = 0.5 \cdot \sqrt{30.0} = 2.74 \text{ l/s} \quad [4.17]$$

considering that the building is of residential type with a simultaneously degree K=0.5.
Table 4.11 shows that the diameter to be used for the three waste stacks is DN 100.

Sizing of the vent collector
For ventilation collector sizing, the rules described in chapter 4.6 apply.
First, sizing of the various sections in made based on ∑DU according to Table 4.21; the results are shown below.

Table 4.36 Determination of ventilation collector diameters based on ∑DU.

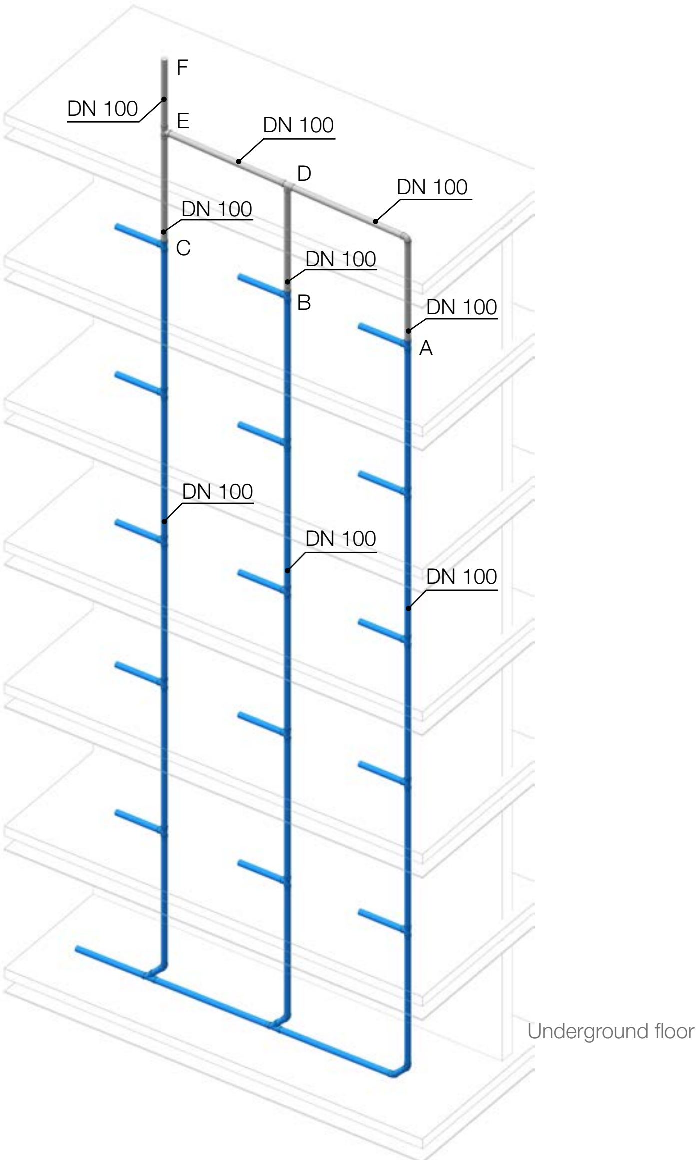
Section	Users served	∑ DU [l/s]	Collector diameter DN
AD	1 stack	30	100
BD	1 stack	30	100
CE	1 stack	30	100
DE	2 stacks	60	100
EF	3 stacks	90	100

Then, the lengths of the various ventilation sections are checked according to Table 4.22 to define whether it is necessary to increase the pipe dimension; the results are shown below.

Table 4.37 Determination of ventilation collector diameters based on the length of the various sections.

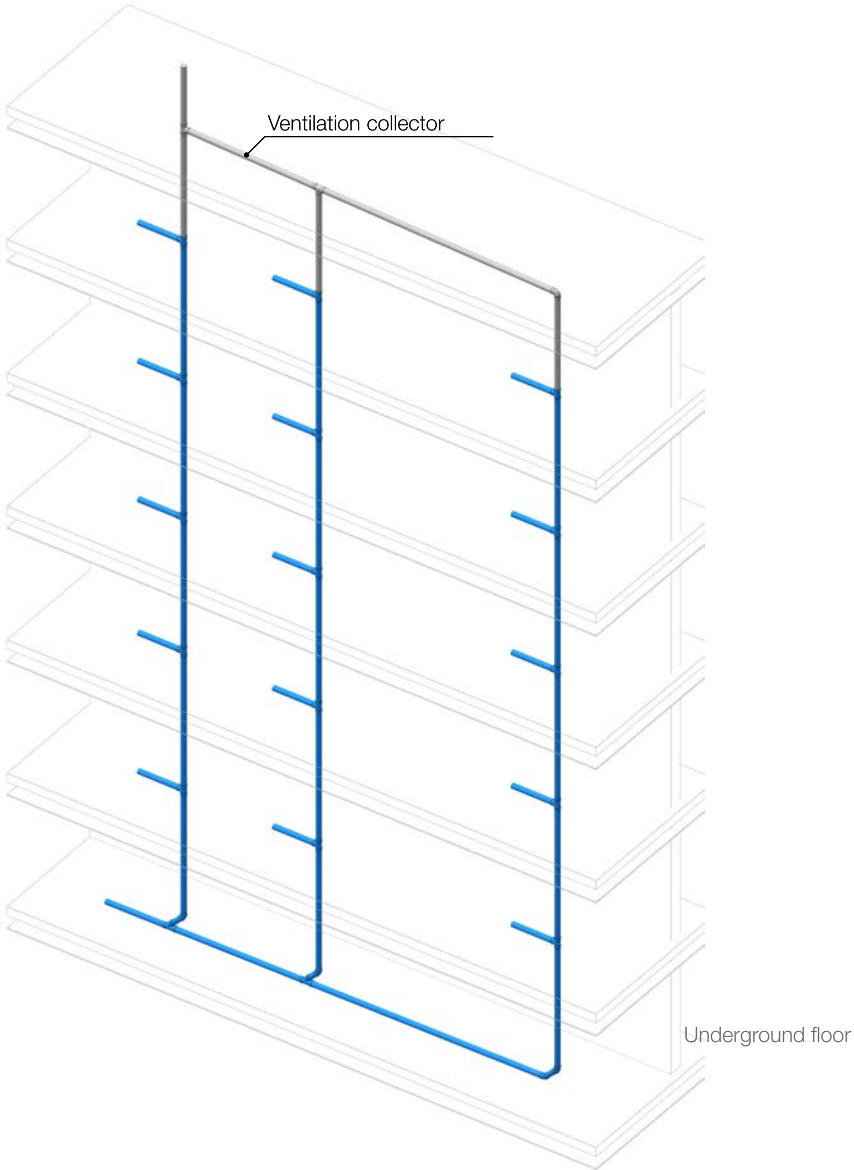
Section	Length [m]	Verify	Collector diameter DN
AD	8	8 < 11 m	100
BD	3	3 < 11 m	100
CE	3	3 < 11 m	100
DE	5	5 < 11 m	100
EF	1	1 < 11 m	100

Figure 4.22 Dimensions of the waste system.



Example 7. Primary ventilation system with ventilation collector
The system of example 6 is dimensioned, considering section AD with length of 12 metres.

Figure 4.23 System diagram.



Waste stack sizing

Stack sizing is the same as example 6.

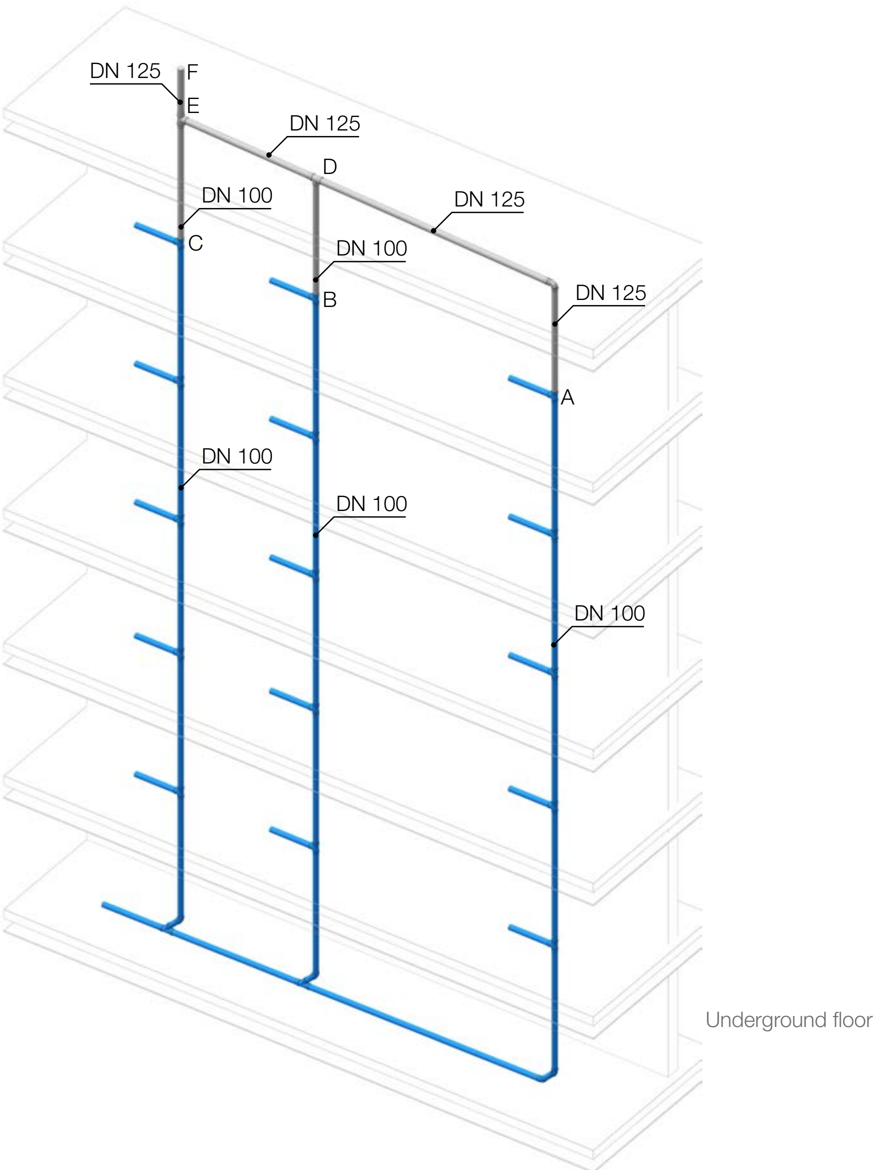
Ventilation collector sizing

Sizing of the various sections based on ∑DU does not change compared to example 6.
Check of lengths according to Table 4.22, also considering that the collector diameter cannot be reduced in the emission point direction, gives the following results.

Table 4.38 Determination of ventilation collector diameters.

Section	Length [m]	Verify	Collector diameter DN
AD	12	12 > 11 m	125
BD	3	3 < 11 m	100
CE	3	3 < 11 m	100
DE	5	Already increased in the previous section. No check required.	125
EF	1	Already increased in the previous section. No check required.	125

Figure 4.24 Waste system dimensions.



WASTE SYSTEMS

SUPPLY SYSTEMS

GAS SYSTEMS

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TRAPS

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VALSIR S.p.A. - Società a Socio Unico
Località Merlaro, 2
25078 Vestone (BS) - Italy
Tel. +39 0365 877.011
Fax +39 0365 81.268
e-mail: valsir@valsir.it

www.valsir.it

Soggetta all'attività di direzione e coordinamento ex art. 2497 bis C.C.
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