

Project	Vista Hermosa housing development — Storm drainage, reach C-3	Date	16 Oct 2026
Element	Concrete-lined drainage channel	Author	Eng. Ana Pérez

1 · Purpose and scope

Using the Manning equation under uniform-flow conditions, this report determines the normal flow depth of the concrete-lined drainage channel of the project Vista Hermosa housing development — Storm drainage, reach C-3, a trapezoidal section evaluated for a design discharge of 2.50 m³/s. The discharge comes from the hydrological study of the project, the slope from its longitudinal profile, the bottom width and side slope from the existing geometry, and the roughness coefficient from Chow (1959), table 5-6. The values are listed in the input-data section.

2 · Input data

Parameter	Symbol	Value	Unit	Source
Design discharge	Q	2.50	m ³ /s	Hydrological study of the project
Longitudinal slope	S	0.0020	m/m	Longitudinal profile of the project
Manning roughness coefficient	n	0.015	—	Concrete, normal finish — Chow (1959), table 5-6
Bottom width	b	1.20	m	Existing geometry
Side slope (H:V)	z	1.0	—	Existing geometry

3 · Assumptions and acceptance criteria

- Steady uniform flow: the calculated flow depth is the normal flow depth y_n .
- Prismatic channel of constant section, with the lining or channel surface in good condition (n constant along the reach).
- Practical criteria adopted: velocity between 0.60 and 3.00 m/s (minimum to prevent sedimentation, maximum to limit lining wear or channel erosion); Froude number ≤ 0.85 , to keep the flow away from the critical regime; freeboard $\geq \max(0.30 \text{ m}; y/3)$, with the total height rounded up to a multiple of 0.05 m.
- The freeboard is the vertical distance between the water surface and the top of the channel; it absorbs waves, surface undulations and the uncertainties of the calculation.
- Acceleration due to gravity $g = 9.81 \text{ m/s}^2$.

4 · Methodology

Manning equation (SI) and geometric relationships of the trapezoidal section:

$$Q = \frac{1}{n} A R_h^{2/3} S^{1/2}$$

$$A = (b + zy)y \quad P = b + 2y\sqrt{1 + z^2} \quad R_h = \frac{A}{P}$$

$$V = \frac{Q}{A} \quad Fr = \frac{V}{\sqrt{gAT}} \quad T = b + 2zy$$

5 · Calculations

Substituting the inputs into the Manning equation and solving iteratively for the normal flow depth (bisection method, relative tolerance 10^{-13}):

$$2.50 = \frac{1}{0.015} [(1.20 + y) y] \left[\frac{(1.20 + y) y}{1.20 + 2y\sqrt{1 + 1^2}} \right]^{2/3} (0.0020)^{1/2} \rightarrow y_n = 0.746 \text{ m}$$

With $y_n = 0.746 \text{ m}$: $A = (1.20 + 0.746) \cdot 0.746 = \mathbf{1.452 \text{ m}^2}$; $P = 1.20 + 2 \cdot 0.746 \sqrt{1 + 1^2} = \mathbf{3.311 \text{ m}}$;
 $R_h = A/P = \mathbf{0.439 \text{ m}}$; $V = Q/A = \mathbf{1.72 \text{ m/s}}$; $T = 1.20 + 2 \cdot 1 \cdot 0.746 = \mathbf{2.69 \text{ m}}$; $Fr = 1.72/\sqrt{9.81 \cdot 0.539} = \mathbf{0.75}$.

6 · Results

Quantity	Value	Quantity	Value
Normal flow depth, y_n	0.746 m	Mean velocity, V	1.72 m/s
Wetted area, A	1.452 m²	Froude number, Fr	0.75 (subcritical)
Hydraulic radius, R_h	0.439 m	Adopted freeboard	0.30 m
Top width, T	2.69 m	Recommended total height, H	1.05 m

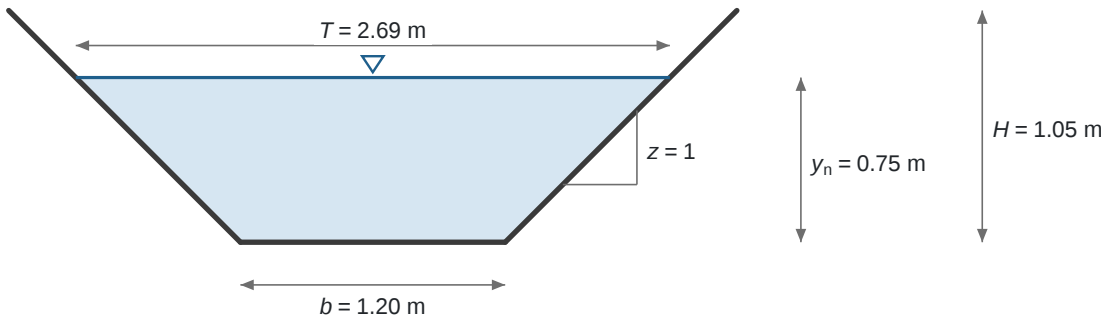
7 · Design checks

Criterion	Limit	Calculated value	Result
Minimum velocity (sedimentation)	$\geq 0.60 \text{ m/s}$	1.72 m/s	✓ SATISFIED
Maximum velocity (lining wear, erosion)	$\leq 3.00 \text{ m/s}$	1.72 m/s	✓ SATISFIED
Flow regime away from critical	$Fr \leq 0.85$	0.75	✓ SATISFIED

At the design discharge, the channel flows at a normal depth of 0.746 m with a mean velocity of 1.72 m/s. This velocity lies above the minimum velocity of 0.60 m/s, so the deposition of sediment along the reach is not expected under uniform flow. It also remains below the maximum velocity of 3.00 m/s, which limits wear of the concrete lining and the risk of erosion.

The Froude number of 0.75 places the flow in the subcritical regime, in which surface disturbances can propagate upstream and the water surface is governed by downstream conditions. The criterion requires subcritical flow with a margin from the critical state, and the obtained value stays 0.10 below the adopted limit. That margin keeps the flow clear of the surface instability associated with near-critical conditions.

8 · Cross-section sketch



9 · Conclusion

For the design discharge, the trapezoidal section develops a normal flow depth of 0.746 m. A freeboard of 0.30 m above this depth gives a recommended total height of 1.05 m. All the adopted design criteria are satisfied. The section of the concrete-lined drainage channel is therefore hydraulically adequate for the design discharge under the adopted assumptions. These results correspond to uniform-flow conditions in a prismatic reach, with representative roughness and no external controls.

10 · References

- Chow, V. T. (1959). *Open-Channel Hydraulics*. McGraw-Hill. — Roughness coefficients (table 5-6) and uniform flow theory.
- French, R. H. (1985). *Open-Channel Hydraulics*. McGraw-Hill. — Permissible velocity criteria.

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