## Sample Calculation

**Pipe T1:**

*Determination of wastewater flow:*

| Category | Facilities | Water Supply (klpd) |
|---|---|---|
| **Residential** | Building Type – Villa | 19.8 |
| | Building Type – A | 27 |
| | Building Type – B | 33.5 |
| | Building Type – C | 56.8 |
| | Building Type – D | 66.1 |
| **Industrial** | N/A | 0 |
| **Institutional** | Central Mosque | 48.6 |
| | School | 66.3 |
| **Commercial** | Community Center | 5.4 |
| | Residential Estate Office | 2.8 |
| | Water Pump Station | 0.1 |
| | Central Park & Sports Field | 5 |

Total water supply on:

- Residential facilities: $19.8 + 27 + 33.5 + 56.8 + 66.1 = 203.2$ klpd
- Industrial facilities: $0$ klpd
- Institutional facilities: $48.6 + 66.3 = 114.9$ klpd
- Commercial facilities: $5.4 + 2.8 + 0.1 + 5 = 13.3$ klpd

Wastewater flows from:

- Residential facilities: $203.2 \times 0.8 = 162.56\ klpd$
  $= 162.56/86400$ cumec
  $= 0.001881$ cumec
- Industrial facilities: $0 \times 0.9 = 0$ klpd $= 0$ cumec
- Institutional facilities: $114.9 \times 0.8 = 91.92$ klpd $= 0.001064$ cumec
- Commercial facilities: $13.3 \times 0.8 = 10.64$ klpd $= 0.000123$ cumec

Peak factor for residential flow: $2.228 \times 0.001881^{-0.07333} \leq 3.34$
$= 3.53 \leq 3.34 = 3.34$

Peak flows:

- Residential facilities: $162.56 \times 3.34 = 542.95$ klpd
- Industrial facilities: $0 \times 2.1 = 0$ klpd
- Institutional facilities: $91.92 \times 4 = 367.68$ klpd
- Commercial facilities: $10.64 \times 1.8 = 19.15$ klpd

Total peak wastewater flow: $542.95 + 0 + 367.68 + 19.15 = 929.78$ klpd

*Determination of infiltration flow:*

- Subzone: 1.1
- Area: 7.7 ha
- Infiltration allowance: $26.593 \times 7.7^{-0.300} \leq 8.75$
  $= 14.42 \leq 8.75 = 8.75$
- Infiltration flow: $8.75 \times 7.7 = 67.38$ klpd

*Determination of cumulative flows:*

- Feeder flow: 0 klpd [first node]
- Entering wastewater flow: 929.78 klpd
- Entering infiltration flow: 67.38 klpd
- Total entering flow: $929.78 + 67.38 = 997.16$ klpd
- Cumulative flow: $997.16 + 0 = 997.16\ klpd = 0.0115\ cumec$

*Determination of pipe diameter:*

- Flow: 0.0115 cumec
- Assumed slope, S: 0.0033
- Calculated diameter: $0.0115 = \frac{1}{0.013}\frac{\pi D_{calc}^2}{4}\left(\frac{D_{calc}}{4}\right)^{2/3}\sqrt{0.0033}$
  $\Longrightarrow D_{calc} = 0.166$ m
- Actual diameter: 0.200 m
- Corrected slope: 0.0033
- Discharge, $Q_{full}$: $\frac{1}{0.013}\frac{\pi \times 0.2^2}{4}\left(\frac{0.2}{4}\right)^{2/3}\sqrt{0.0033} = 0.0189$ cumec
- Velocity, $V_{full}$: $\frac{1}{0.013}\left(\frac{0.2}{4}\right)^{2/3}\sqrt{0.0033} = 0.5997$ m/s
- $Q/Q_{full}$: $0.0115/0.0189 = 0.6122$
- $V/V_{full}$: 1.06
- $d/D$: 0.57
- Velocity, $v$: $1.06 \times 0.5997 = 0.64$ m/s [$0.64 \geq 0.60 \therefore$ OK]

*Pipe profile:*

- Length: $128.0$ m
- Slope: $0.0033$
- Diameter: $200$ mm
- Fall in sewer: $128.0 \times 0.0033 = 0.422$ m
- Invert drop: $0$ mm [no feeder pipe to compare]
- Ground elevation (upper): $28$ m
- Ground elevation (lower): $28.3$ m [direction towards ground elevation]
- Invert elevation (upper): $28 - 2 - 0.05 - 0.2 = 25.75$ m
- Invert elevation (lower): $25.75 - 0.422 = 25.33$ m
- Cover (upper): $28 - (25.75 + 0.2 + 0.05) = 2.00$ m
- Cover (lower): $28.3 - (25.33 + 0.2 + 0.05) = 2.72$ m

## Determination of Wastewater Flow

| Pipe | From | To | Category | Facilities | Water Supply (klpd) | Wastewater Flow (klpd) | Wastewater Flow ($m^3/s$) | Peak Factor | Peak Flow (klpd) | Total Peak Flow (klpd) |
|---|---|---|---|---|---|---|---|---|---|---|
| **T1** | 1 | 2 | Residential | Building Type - A<br>Building Type - Villa<br>Building Type - B<br>Building Type - C<br>Building Type - D | 203.20 | 162.56 | 0.001881 | 3.34 | 542.95 | 929.78 |
| | | | Institutional | Central Mosque<br>School | 114.90 | 91.92 | 0.001064 | 4.00 | 367.68 | |
| | | | Commercial | Community Center<br>Residential Estate Office<br>Water Pump Station<br>Central Park & Sports Field | 13.30 | 10.64 | 0.000123 | 1.80 | 19.15 | |

| Pipe | From | To | Category | Facilities | Water Supply (klpd) | Wastewater Flow (klpd) | Wastewater Flow ($m^3/s$) | Peak Factor | Peak Flow (klpd) | Total Peak Flow (klpd) |
|---|---|---|---|---|---|---|---|---|---|---|
| **T2** | 2 | 3 | Commercial | Insurance Corporate Office<br>Dairy Retail Outlet & Café<br>Shopping Complex<br>Autoshop & Truck Servicing Center<br>Daycare Center<br>Hardware Store<br>Veterinary Medicine<br>Pharmacy<br>Salon<br>Laundry<br>Bank<br>Telecom Center<br>Postal Services<br>Gym<br>Water Pump Station<br>Food Court<br>Supermarket | 49.80 | 39.84 | 0.000461 | 1.80 | 71.71 | 71.71 |
| **T3** | 3 | 4 | Institutional | Exhibition Center<br>Training Academy | 25.30 | 20.24 | 0.000234 | 4.00 | 80.96 | 176.00 |

| Pipe | From | To | Category | Facilities | Water Supply (klpd) | Wastewater Flow (klpd) | Wastewater Flow ($m^3/s$) | Peak Factor | Peak Flow (klpd) | Total Peak Flow (klpd) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Commercial | Security Checkpoint<br>Inspection Bay<br>CMS<br>Logistics & Customs Office<br>Veterinary Office<br>Parking Lot<br>Corporate HQ<br>IT Center<br>Park Op. Center<br>R&D Facility<br>QA Office<br>Fire Station<br>Health Clinic<br>Water Pump Station<br>Power Plant | 66.00 | 52.80 | 0.000611 | 1.80 | 95.04 | |
| **T4** | 4 | 5 | Industrial | Truck Staging Yard<br>Shipping Docks<br>Cold Storage Warehouse<br>Chilling & Filtration Block<br>Milking Center Utilities<br>Water Pump Station<br>Raw Milk Silos | 1.50 | 1.35 | 0.000016 | 2.10 | 2.84 | 2.98 |

| Pipe | From | To | Category | Facilities | Water Supply (klpd) | Wastewater Flow (klpd) | Wastewater Flow ($m^3/s$) | Peak Factor | Peak Flow (klpd) | Total Peak Flow (klpd) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Commercial | Water Pump Station | 0.10 | 0.08 | 0.000001 | 1.80 | 0.14 | |
| **T5** | 5 | 6 | Industrial | Milking Rotary<br>Processing Core<br>Cow Barn B<br>Packaging Station<br>Bottle Inventory<br>Cow Barn A | 7.00 | 6.30 | 0.000073 | 2.10 | 13.23 | 13.37 |
| | | | Commercial | Water Pump Station | 0.10 | 0.08 | 0.000001 | 1.80 | 0.14 | |
| **B1** | 7 | 6 | Industrial | Effluent Treatment Plant | 0.20 | 0.18 | 0.000002 | 2.10 | 0.38 | 1.67 |
| | | | Commercial | Water Pump Station<br>Water Pump Station<br>Solid Waste Dump<br>Sewage Treatment Plant | 0.90 | 0.72 | 0.000008 | 1.80 | 1.30 | |

## Determination of Infiltration Flow

| Pipe | From | To | Subzone | Area (ha) | Infiltration Allowance ($m^3$/ha-d) | Infiltration ($m^3$/d) |
|---|---|---|---|---|---|---|
| **T1** | 1 | 2 | 1.1 | 7.7 | 8.75 | 67.375 |
| **T2** | 2 | 3 | 1.2 | 5.5 | 8.75 | 48.125 |
| **T3** | 3 | 4 | 1.3 | 5.3 | 8.75 | 46.375 |
| **T4** | 4 | 5 | 2.1 | 1.5 | 8.75 | 13.125 |
| **T5** | 5 | 6 | 2.2 | 7.4 | 8.75 | 64.75 |
| **B1** | 7 | 6 | 2.3 | 6.5 | 8.75 | 56.875 |

## Determination of Cumulative Flow

| Pipe | Feeder | Feeder Flow (klpd) | Entering Wastewater Flow (klpd) | Entering Infiltration Flow (klpd) | Total Entering Flow (klpd) | Cumulative Flow (klpd) | Cumulative Flow (cumec) |
|---|---|---|---|---|---|---|---|
| **T1** | None | 0.00 | 929.78 | 67.38 | 997.16 | 997.16 | 0.0115 |
| **T2** | T1 | 997.16 | 71.71 | 48.13 | 119.84 | 1116.99 | 0.0129 |
| **T3** | T2 | 1116.99 | 176.00 | 46.38 | 222.38 | 1339.37 | 0.0155 |
| **T4** | T3 | 1339.37 | 2.98 | 13.13 | 16.10 | 1355.47 | 0.0157 |
| **T5** | T4 | 1355.47 | 13.37 | 64.75 | 78.12 | 1433.60 | 0.0166 |
| **B1** | None | 0.00 | 1.67 | 56.88 | 58.55 | 58.55 | 0.0007 |

Note: Cumulative wastewater flow from the adjacent East subzone of the STP is very low as calculated above. Thus, installation of dedicated trunk sewer is not deemed practical (to ensure self-cleansing velocity). Instead, a branch sewer (*B1*) conveys the wastewater directly into STP's entrance node.

## Determination of Pipe Diameter

| Pipe | Flow (cumec) | Assumed S | $D_{calc}$ (m) | $D_{actual}$ (m) | Corrected S | $Q_{full}$ (cumec) | $V_{full}$ (m/s) | $Q/Q_{full}$ | $V/V_{full}$ | d/D | $V_{actual}$ (m/s) | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **T1** | 0.0115 | 0.0033 | 0.166 | 0.200 | 0.0033 | 0.0189 | 0.5997 | 0.6122 | 1.0600 | 0.5700 | 0.64 | OK |
| **T2** | 0.0129 | 0.0033 | 0.174 | 0.200 | 0.0033 | 0.0189 | 0.5997 | 0.6858 | 1.0800 | 0.6100 | 0.65 | OK |
| **T3** | 0.0155 | 0.0033 | 0.186 | 0.200 | 0.0033 | 0.0189 | 0.5997 | 0.8223 | 1.1200 | 0.7000 | 0.67 | OK |
| **T4** | 0.0157 | 0.0033 | 0.187 | 0.200 | 0.0033 | 0.0189 | 0.5997 | 0.8322 | 1.1300 | 0.7100 | 0.68 | OK |
| **T5** | 0.0166 | 0.0033 | 0.191 | 0.200 | 0.0033 | 0.0189 | 0.5997 | 0.8802 | 1.1350 | 0.7400 | 0.68 | OK |

## Trunk Sewer Profile

| Pipe | Length (ft) | Length (m) | Slope (m/m) | Diamter (mm) | Fall in Sewer (m) | Invert Drop (m) | Ground Elevation: Upper (m) | Ground Elevation: Lower (m) | Sewer Invert Elevation: Upper (m) | Sewer Invert Elevation: Lower (m) | Cover Above Pipe: Upper (m) | Cover Above Pipe: Lower (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **T1** | 420 | 128.0 | 0.0033 | 200 | 0.422 | 0 | 28 | 28.3 | 25.75 | 25.33 | 2.00 | 2.72 |
| **T2** | 336 | 102.4 | 0.0033 | 200 | 0.338 | 0 | 28.3 | 28.5 | 25.33 | 24.99 | 2.72 | 3.26 |
| **T3** | 1034 | 315.2 | 0.0033 | 200 | 1.040 | 0 | 28.5 | 27.5 | 24.99 | 23.95 | 3.26 | 3.30 |
| **T4** | 680 | 207.3 | 0.0033 | 200 | 0.684 | 0 | 27.5 | 26.9 | 23.95 | 23.27 | 3.30 | 3.38 |
| **T5** | 230 | 70.1 | 0.0033 | 200 | 0.231 | 0 | 26.9 | 26.4 | 23.27 | 23.03 | 3.38 | 3.12 |

## Manhole Placement

| Manhole ID | Location | Distance from Upper End of Pipe (m) | Diameter (m) |
|---|---|---|---|
| **MH-1** | 1 | 0.0 | 1.5 |
| **MH-1A** | 1–2 | 64.0 | 1.5 |
| **MH-2** | 2 | 64.0 | 1.5 |
| **MH-3** | 3 | 102.4 | 1.5 |
| **MH-3A** | 3–4 | 19.5 | 1.5 |
| **MH-3B** | 3–4 | 70.1 | 1.5 |
| **MH-3C** | 3–4 | 70.1 | 1.5 |
| **MH-3D** | 3–4 | 77.7 | 1.5 |
| **MH-4** | 4 | 77.7 | 1.5 |
| **MH-4A** | 4–5 | 103.6 | 1.5 |
| **MH-5** | 5 | 103.6 | 1.5 |
| **MH-6** | 6 | 70.1 | 1.5 |