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| 18th Fl, Tower C, Cyber Green Building DLF Cyber City, DLF Phase - III Gurgaon, Haryana - 122 002, India / Tel. +911... | East West Rail Phase 2 Section 2A2-12 |  |
| Date 23/01/2020 File 133735_2A-EWR-OXD-XX-M3-DR-000041.MDX | Designed by Steven Genever Checked by Ben Wilding | |
| XP Solutions | Network 2018.1 | |

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for 2A2-12

Pipe Sizes EWRP2 Manhole Sizes EWRP2 Ld

FSR Rainfall Model - England and Wales

| | | | | | |
|--------------------------------------|--------|-------------------------------|-------|---------------------------------------|-------|
| Return Period (years) | 5 | Foul Sewage (l/s/ha) | 0.000 | Maximum Backdrop Height (m) | 1.500 |
| M5-60 (mm) | 20.000 | Volumetric Runoff Coeff. | 0.750 | Min Design Depth for Optimisation (m) | 0.800 |
| Ratio R | 0.412 | PIMP (%) | 100 | Min Vel for Auto Design only (m/s) | 0.76 |
| Maximum Rainfall (mm/hr) | 100 | Add Flow / Climate Change (%) | 0 | Min Slope for Optimisation (1:X) | 500 |
| Maximum Time of Concentration (mins) | 30 | Minimum Backdrop Height (m) | 0.200 | | |

Designed with Level Soffits


Network Design Table for 2A2-12

« - Indicates pipe capacity < flow











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|-----------|---------------|-------------|--------------|---------------|-------------|-------------|----------|------------|------------|----------------|-------------|-------------|
| PN | Length | Fall | Slope | I.Area | T.E. | Base | n | HYD | DIA | Section | Type | Auto |
| (m) | (m) | (1:X) | (ha) | (mins) | Flow | (l/s) | SECT | (mm) | | | | Design |

Network Results Table

| | | | | | | | | | | |
|-----------|-------------|-------------|--------------|-----------------|---------------|-------------|-----------------|------------|------------|-------------|
| PN | Rain | T.C. | US/IL | Σ I.Area | Σ Base | Foul | Add Flow | Vel | Cap | Flow |
| (mm/hr) | (mins) | (m) | (ha) | Flow (l/s) | (l/s) | (l/s) | (l/s) | (m/s) | (l/s) | (l/s) |


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Network Design Table for 2A2-12

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | n | HYD SECT | DIA (mm) | Section Type | Auto Design |
|--------------|---------------|-------------|----------------|----------------|----------------|--------------------|-------|-------------|-------------|--------------|---|
| 2A2_12-1.000 | 40.139 | 0.512 | 78.4 | 0.437 | 5.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.001 | 50.156 | 0.278 | 180.4 | 0.441 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.002 | 50.185 | 0.455 | 110.3 | 0.443 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.003 | 50.179 | 0.308 | 162.9 | 0.444 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.004 | 50.182 | 0.468 | 107.2 | 0.444 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.005 | 50.045 | 0.300 | 166.8 | 0.444 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.006 | 39.832 | 0.530 | 75.2 | 0.437 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.007 | 1.014 | 0.020 | 50.7 | 0.000 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.008 | 1.586 | 0.020 | 79.3 | 0.000 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |
| 2A2_12-1.009 | 2.239 | 0.030 | 74.6 | 0.000 | 0.00 | 0.0 | 0.035 | 1 \ \ / | 1000 | 1:1 Ditch |  |

Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|--------------|-----------------|----------------|--------------|------------------|----------------------|---------------|-------------------|--------------|--------------|---------------|
| 2A2_12-1.000 | 87.93 | 5.58 | 74.921 | 0.437 | 0.0 | 0.0 | 0.0 | 1.14 | 446.0 | 104.1 |
| 2A2_12-1.001 | 80.87 | 6.69 | 74.409 | 0.878 | 0.0 | 0.0 | 0.0 | 0.75 | 294.0 | 192.3 |
| 2A2_12-1.002 | 76.19 | 7.56 | 74.131 | 1.321 | 0.0 | 0.0 | 0.0 | 0.96 | 376.0 | 272.6 |
| 2A2_12-1.003 | 71.27 | 8.62 | 73.676 | 1.765 | 0.0 | 0.0 | 0.0 | 0.79 | 309.4« | 340.7 |
| 2A2_12-1.004 | 67.78 | 9.47 | 73.368 | 2.209 | 0.0 | 0.0 | 0.0 | 0.98 | 381.4« | 405.5 |
| 2A2_12-1.005 | 63.94 | 10.53 | 72.900 | 2.653 | 0.0 | 0.0 | 0.0 | 0.78 | 305.8« | 459.4 |
| 2A2_12-1.006 | 62.09 | 11.10 | 72.600 | 3.090 | 0.0 | 0.0 | 0.0 | 1.17 | 455.5« | 519.6 |
| 2A2_12-1.007 | 62.05 | 11.12 | 72.070 | 3.090 | 0.0 | 0.0 | 0.0 | 1.42 | 554.6 | 519.6 |
| 2A2_12-1.008 | 61.98 | 11.14 | 72.050 | 3.090 | 0.0 | 0.0 | 0.0 | 1.14 | 443.5« | 519.6 |
| 2A2_12-1.009 | 61.88 | 11.17 | 72.030 | 3.090 | 0.0 | 0.0 | 0.0 | 1.17 | 457.1« | 519.6 |

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| XP Solutions | Network 2018.1 | |

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 2A2-12

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0


Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.412 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status OFF


Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 100
Climate Change (%) 40

| PN | US/MH Name | Event | US/CL (m) | Water Surcharged | | | Flooded | | Pipe | Status |
|--------------|---------------|---------------------------------|--------------|------------------|--------------|-----------------------------|----------------|-------------------|---------------|--------|
| | | | | Level (m) | Depth (m) | Volume (m ³) | Flow / Cap. | Overflow (l/s) | Flow (l/s) | |
| 2A2_12-1.000 | 2A2_12-1 | 15 minute 100 year Winter I+40% | 75.450 | 75.149 | -0.301 | 0.000 | 0.22 | 268.5 | OK | |
| 2A2_12-1.001 | 2A2_12-2 | 15 minute 100 year Winter I+40% | 75.100 | 74.843 | -0.257 | 0.000 | 0.41 | 543.2 | FLOOD RISK* | |
| 2A2_12-1.002 | 2A2_12-3 | 15 minute 100 year Winter I+40% | 74.750 | 74.593 | -0.157 | 0.000 | 0.56 | 783.7 | FLOOD RISK* | |

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 2A2-12

| PN | US/MH Name | Event | US/CL (m) | Water | Surcharged | Flooded | Flow / Cap. | Overflow | Pipe | Status |
|--------------|---------------|---------------------------------|--------------|--------------|--------------|-----------------------------|----------------|---------------|---------------|-------------|
| | | | | Level (m) | Depth (m) | Volume (m ³) | | Flow (1/s) | Flow (1/s) | |
| 2A2_12-1.003 | 2A2_12-4 | 15 minute 100 year Winter I+40% | 74.300 | 74.264 | -0.036 | 0.000 | 0.86 | | 1004.5 | FLOOD RISK* |
| 2A2_12-1.004 | 2A2_12-5 | 15 minute 100 year Winter I+40% | 73.900 | 73.938 | 0.038 | 38.146 | 0.95 | | 1011.5 | FLOOD |
| 2A2_12-1.005 | 2A2_12-6 | 15 minute 100 year Winter I+40% | 73.550 | 73.538 | -0.012 | 0.000 | 0.94 | | 1166.4 | FLOOD RISK* |
| 2A2_12-1.006 | 2A2_12-7 | 15 minute 100 year Winter I+40% | 73.200 | 73.158 | -0.042 | 0.000 | 0.86 | | 1362.7 | FLOOD RISK* |
| 2A2_12-1.007 | 2A2_12-8 | 15 minute 100 year Winter I+40% | 72.800 | 72.614 | -0.186 | 0.000 | 0.52 | | 1344.9 | FLOOD RISK* |
| 2A2_12-1.008 | 2A2_12-9 | 15 minute 100 year Winter I+40% | 72.800 | 72.610 | -0.190 | 0.000 | 0.57 | | 1351.0 | FLOOD RISK* |
| 2A2_12-1.009 | 2A2_12-10 | 15 minute 100 year Winter I+40% | 72.800 | 72.581 | -0.219 | 0.000 | 0.53 | | 1355.2 | FLOOD RISK* |

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for 2A2-13


Pipe Sizes EWRP2 Manhole Sizes EWRP2 Ld

FSR Rainfall Model - England and Wales

| | | | | | |
|--------------------------------------|--------|-------------------------------|-------|---------------------------------------|-------|
| Return Period (years) | 5 | Foul Sewage (l/s/ha) | 0.000 | Maximum Backdrop Height (m) | 1.500 |
| M5-60 (mm) | 20.000 | Volumetric Runoff Coeff. | 0.750 | Min Design Depth for Optimisation (m) | 0.800 |
| Ratio R | 0.412 | PIMP (%) | 100 | Min Vel for Auto Design only (m/s) | 0.76 |
| Maximum Rainfall (mm/hr) | 100 | Add Flow / Climate Change (%) | 0 | Min Slope for Optimisation (1:X) | 500 |
| Maximum Time of Concentration (mins) | 30 | Minimum Backdrop Height (m) | 0.200 | | |


Designed with Level Soffits

Network Design Table for 2A2-13







| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | n | HYD SECT | DIA (mm) | Section | Type | Auto Design |
|--------------|------------|----------|-------------|-------------|-------------|-----------------|-------|----------|----------|---------|-------|---|
| 2A2_13-1.000 | 29.900 | 0.485 | 61.6 | 0.025 | 5.00 | 0.0 | 0.035 | 1 _ / | 500 | 1:1 | Ditch |  |

Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | E I.Area (ha) | E Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|--------------|--------------|-------------|-----------|---------------|-------------------|------------|----------------|-----------|-----------|------------|
| 2A2_13-1.000 | 89.02 | 5.43 | 74.548 | 0.025 | 0.0 | 0.0 | 0.0 | 1.15 | 276.3 | 5.9 |


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Network Design Table for 2A2-13

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | n | HYD SECT | DIA (mm) | Section Type | Auto Design |
|--------------|---------------|-------------|----------------|----------------|----------------|--------------------|-------|-------------|-------------|--------------|---|
| 2A2_13-1.001 | 49.828 | 0.294 | 169.5 | 0.036 | 0.00 | 0.0 | 0.035 | 1 _/\ | 500 | 1:1 Ditch |  |
| 2A2_13-1.002 | 49.828 | 0.140 | 355.9 | 0.034 | 0.00 | 0.0 | 0.035 | 1 _/\ | 500 | 1:1 Ditch |  |
| 2A2_13-1.003 | 49.851 | 0.406 | 122.8 | 0.036 | 0.00 | 0.0 | 0.035 | 1 _/\ | 500 | 1:1 Ditch |  |
| 2A2_13-1.004 | 49.814 | 0.321 | 155.2 | 0.037 | 0.00 | 0.0 | 0.035 | 1 _/\ | 500 | 1:1 Ditch |  |
| 2A2_13-1.005 | 49.951 | 0.503 | 99.3 | 0.036 | 0.00 | 0.0 | 0.035 | 1 _/\ | 500 | 1:1 Ditch |  |
| 2A2_13-1.006 | 34.001 | 0.513 | 66.3 | 0.028 | 0.00 | 0.0 | 0.035 | 1 _/\ | 500 | 1:1 Ditch |  |

Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|--------------|-----------------|----------------|--------------|------------------|----------------------|---------------|-------------------|--------------|--------------|---------------|
| 2A2_13-1.001 | 81.25 | 6.63 | 74.063 | 0.061 | 0.0 | 0.0 | 0.0 | 0.69 | 166.7 | 13.4 |
| 2A2_13-1.002 | 72.39 | 8.36 | 73.769 | 0.095 | 0.0 | 0.0 | 0.0 | 0.48 | 115.0 | 18.6 |
| 2A2_13-1.003 | 68.13 | 9.38 | 73.629 | 0.131 | 0.0 | 0.0 | 0.0 | 0.82 | 195.8 | 24.1 |
| 2A2_13-1.004 | 63.98 | 10.52 | 73.223 | 0.167 | 0.0 | 0.0 | 0.0 | 0.73 | 174.2 | 29.0 |
| 2A2_13-1.005 | 61.04 | 11.44 | 72.902 | 0.204 | 0.0 | 0.0 | 0.0 | 0.91 | 217.7 | 33.6 |
| 2A2_13-1.006 | 59.54 | 11.95 | 72.399 | 0.232 | 0.0 | 0.0 | 0.0 | 1.11 | 266.5 | 37.4 |

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 2A2-13

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0


Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.412 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 100
Climate Change (%) 40

| PN | US/MH Name | Event | US/CL (m) | Water Surcharged | | | Flooded | | Pipe | Status |
|--------------|---------------|---------------------------------|--------------|------------------|--------------|-----------------------------|----------------|-------------------|---------------|--------|
| | | | | Level (m) | Depth (m) | Volume (m ³) | Flow / Cap. | Overflow (l/s) | Flow (l/s) | |
| 2A2_13-1.000 | 2A2_13-1 | 15 minute 100 year Winter I+40% | 75.048 | 74.605 | -0.443 | 0.000 | 0.02 | 15.2 | OK | |
| 2A2_13-1.001 | 2A2_13-2 | 15 minute 100 year Winter I+40% | 74.563 | 74.198 | -0.365 | 0.000 | 0.08 | 37.7 | OK | |
| 2A2_13-1.002 | 2A2_13-3 | 15 minute 100 year Winter I+40% | 74.269 | 73.974 | -0.295 | 0.000 | 0.18 | 54.3 | FLOOD RISK* | |

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for 2A2-13

| PN | US/MH Name | Event | US/CL (m) | Water | Surcharged | Flooded | Flow / Cap. | Overflow | Pipe | Status |
|--------------|---------------|---------------------------------|--------------|--------------|--------------|-----------------------------|----------------|---------------|---------------|-------------|
| | | | | Level (m) | Depth (m) | Volume (m ³) | | Flow (1/s) | Flow (1/s) | |
| 2A2_13-1.003 | 2A2_13-4 | 15 minute 100 year Winter I+40% | 74.129 | 73.799 | -0.330 | 0.000 | 0.13 | | 68.1 | OK |
| 2A2_13-1.004 | 2A2_13-5 | 15 minute 100 year Winter I+40% | 73.723 | 73.423 | -0.300 | 0.000 | 0.17 | | 80.7 | FLOOD RISK* |
| 2A2_13-1.005 | 2A2_13-6 | 15 minute 100 year Winter I+40% | 73.402 | 73.091 | -0.311 | 0.000 | 0.16 | | 92.3 | OK |
| 2A2_13-1.006 | 2A2_13-7 | 15 minute 100 year Winter I+40% | 72.899 | 72.576 | -0.323 | 0.000 | 0.14 | | 101.4 | OK |