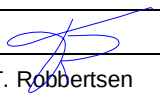
Client: **Eli Lilly**
Project: **Mondrian Leiden**

Calculation storm water sewer system

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Attachments	Revision	Date

Drawings	Revision	Date
LED00-CU-01853200	A	13-05-2026
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LED00-CU-01853202	A	13-05-2026
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LED00-CU-01853204	A	13-05-2026

1 Summary and goal

Eli Lilly is engineering a new pharmaceutical plant at their greenfield location in Leiden. The new plant will contain new buildings, main roads, a parking area, and several secondary pavements. A stormwater sewer system will be designed to discharge the stormwater. This calculation is to define the dimensions of the stormwater sewer system.

2 Starting points

2.1 Rainfall data

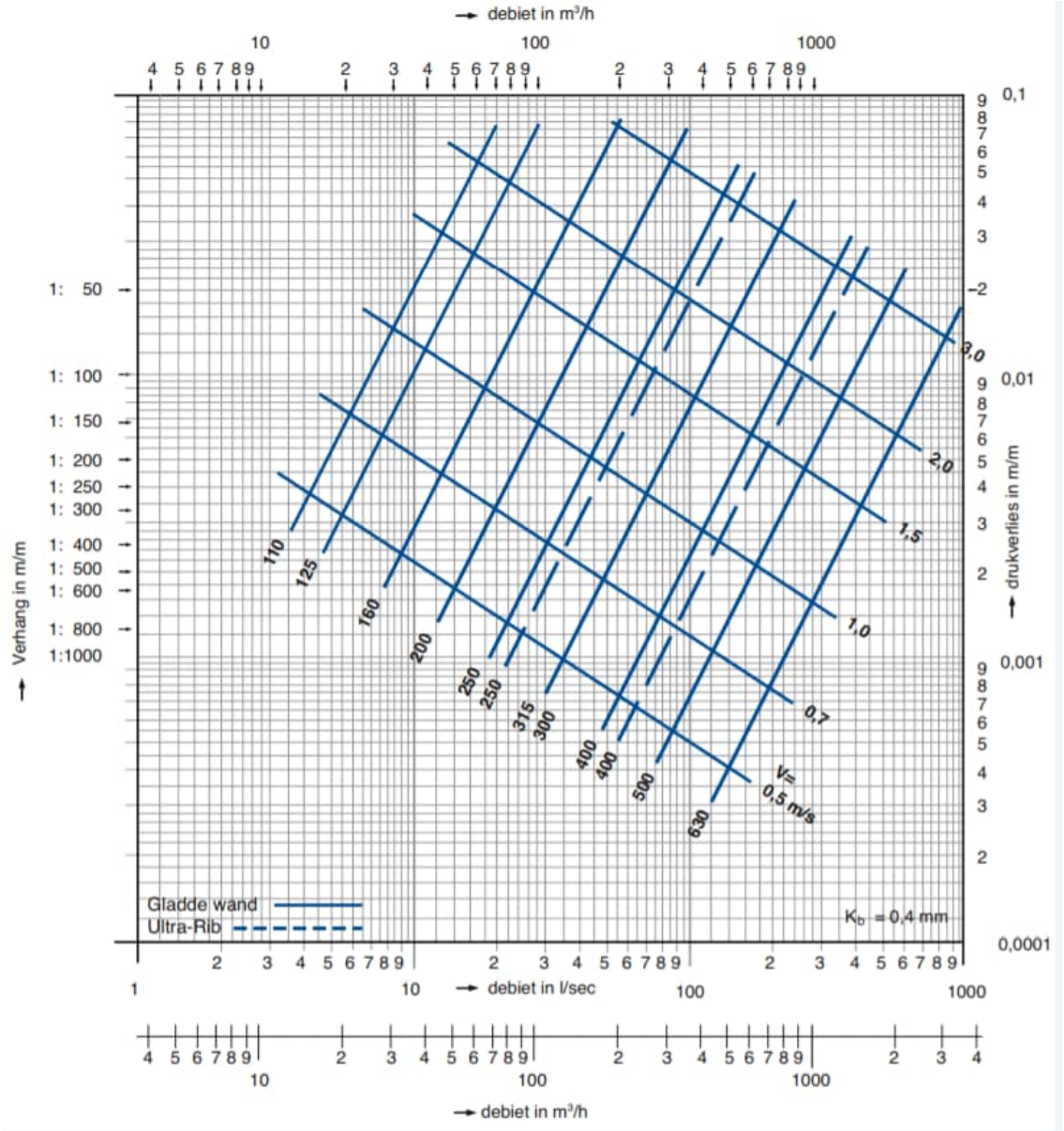
The maximum rainfall per hour of 70mm is divided proportionally to a peak intensity of 195L/sec/ha.
The sewer system will be designed to handle this peak intensity of 195L/sec/ha.

The table below shows multiple rainfall events with a recurrence time in years on the left of the table.
On top of the table the duration of the rainfall event is indicated. The max. rainfall per hour of 70mm will have a recurrence time of *T*=200.

	Neerslagduur										
T [jaar]	10 min	30 min	60 min	2 uur	4 uur	8 uur	12 uur	24 uur	2 dagen	4 dagen	8 dagen
0.5	8.1	10.4	12.6	15.3	18.6	22.2	24.6	30.4	38.6	50.4	68.3
1	10.2	13.5	16.2	19.5	23.4	27.7	30.5	36.8	46.0	59.3	79.4
2	12.2	16.6	20.0	24.0	28.4	33.4	36.5	43.8	54.0	68.6	90.5
5	15.1	21.2	25.8	30.7	35.9	41.7	45.2	54.2	65.5	81.4	105.1
10	17.5	25.3	31.0	36.8	42.8	49.1	52.9	63.0	74.9	91.6	116.1
20	20.3	30.2	37.2	44.2	51.1	58.0	61.9	72.6	85.0	102.1	127.0
25	21.3	32.0	39.5	46.9	54.1	61.2	65.2	75.9	88.5	105.6	130.5
50	24.7	38.2	47.7	56.5	64.8	72.5	76.6	86.9	99.5	116.6	141.5
100	28.7	45.8	57.7	68.4	78.0	86.2	90.2	98.9	111.4	128.1	152.3
200	33.4	55.0	70.0	81.3	88.7	95.0	98.1	112.1	124.2	140.0	163.2
250	35.0	58.4	74.5	86.5	93.9	100.0	102.9	116.7	128.5	143.9	166.7
500	40.8	70.4	90.7	105.0	112.2	117.5	119.6	131.7	142.5	156.4	177.5
1000	47.6	84.9	110.6	127.6	134.4	138.3	139.2	148.2	157.5	169.4	188.3

2.2 Discharge capacity sewer pipes

The table below shows the discharge capacity of PE/PVC sewerpipes.



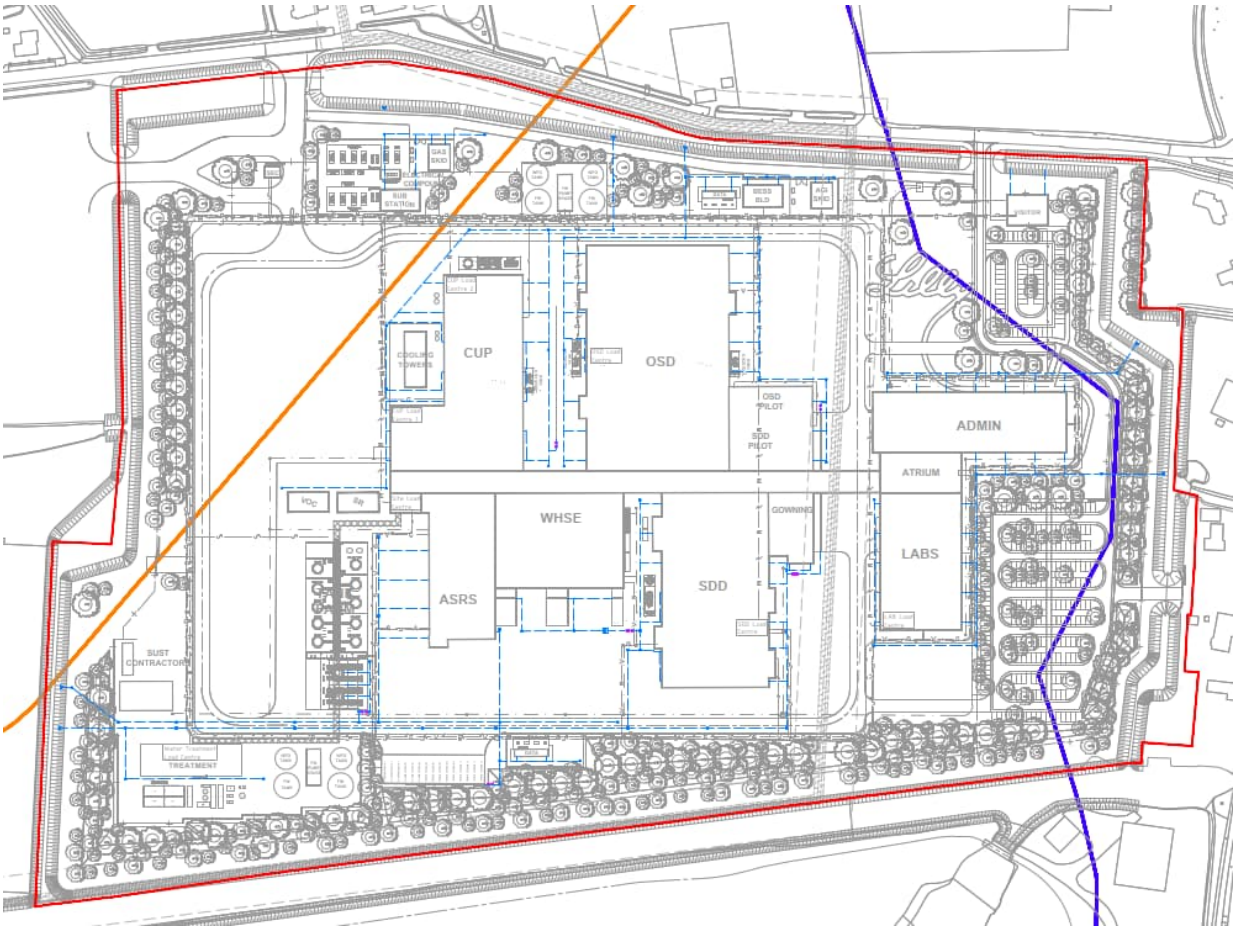
- The new stormwater sewer will be at least Ø200 mm for easy inspection.
- The gradient of the stormwater sewer is at least 1:1000.
- The Average gradient of the stormwater sewer is 1:1000 and 1:500.
- The stormwater sewer is a gravity system, not permanently filled.

2.3 Water level surrounding waterways

The water level of the surrounding waterways is regulated by Hoogheemraadschap Van Rijnland.

- Water level: -0.61m NAP

3 New sewer lines



4 DISCHARGE 004, ADMIN NORTH SIDE,

4.1 Admin North side

- Roof area is 1515m2.
- The main sewer is on the north side of the building and runs to the ditch on the east side of the plot.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 30L/sec.
    - 1515m2 / 10000m2 * 195 = 29,54L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø315mm which is able to discharge the rainwater.
Probably an overflow pipe from infiltration and attenuation solutions in the northern parking area will be connected. Therefore a Ø400mm pipe will be applied.

Velocity = 0,38m/s
V = Q / D
Q = 0,02945m3/sec
D = 0,0779 *(0,25*PI*d^2)*

5 DISCHARGE 005, ADMIN SOUTH SIDE, ATRIUM, LABS

5.1 ADMIN South side, ATRIUM, LABS

- Roof area LABS and ATRIUM is 3724m2.
- Roof area South side ADMIN is 1515m2.
- Total Roof area is 5239m2
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 102L/sec.
    - 5239m2 / 10000m2 * 195 = 102,16L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall start as a pipe Ø315mm and will increase to a pipe Ø500mm which is able to discharge the rainwater.
Probably an overflow pipe from infiltration and attenuation solutions in the northern parking area will be connected. The Ø500mm pipe has enough capacity left to handle this.

Velocity = 0,52m/s
V = Q / D
Q = 0,10187m3/sec
D = 0,1963 *(0,25*PI*d^2)*

6 DISCHARGE 003, OSD, DATA, BESS, AGI SKID

6.1 OSD East side

- Roof area East side OSD is 5960m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 116L/sec.
    - 5239m2 / 10000m2 * 195 = 116,22L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø500mm which is able to discharge the rainwater.

Velocity = 0,52m/s
V = Q / D
Q = 0,10187m3/sec
D = 0,1963 *(0,25*PI*d^2)*

6.2 OSD West side

- Roof area West side OSD is 4140m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 81L/sec.
    - 4140m2 / 10000m2 * 195 = 80,73L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø500mm which is able to discharge the rainwater.

Velocity = 0,41m/s
V = Q / D
Q = 0,08050m3/sec
D = 0,1963 *(0,25*PI*d^2)*

6.3 DATA, BESS, AGI SKID

- Roof area DATA, BESS, AGI SKID is 600m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 12L/sec.
    - 600m2 / 10000m2 * 195 = 11,70L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.

The main sewer shall be a pipe Ø250mm which is able to discharge the rainwater.

Velocity = 0,24m/s
V = Q / D

Q = 0,01167m3/sec
D = 0,049 *(0,25*PI*d^2)*

6.4 Total Outflow OSD, DATA, BESS, AGI SKID

- Total area is 10700m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 209L/sec.
    - 10700m2 / 10000m2 * 195 = 208,65L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø630mm which is able to discharge the rainwater.

Velocity = 0,67m/s
V = Q / D
Q = 0,20806m3/sec
D = 0,3116 *(0,25*PI*d^2)*

7 DISCHARGE 002, CUP, VOC, SR

7.1 CUP East side

- Roof area East side CUP is 1995m2.
- Paving area East side CUP is 3685m2
- Total area East side CUP is 5680m2
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 111L/sec.
    - 5680m2 / 10000m2 * 195 = 110,76L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø500mm which is able to discharge the rainwater.

Velocity = 0,56m/s
V = Q / D
Q = 0,11044m3/sec
D = 0,1963 *(0,25*PI*d^2)*

7.2 CUP West side, VOC, SR

- Roof area West side CUP is 2895m2.
- Roof area VOC, SR is 460m2
- Total area West side CUP is 3355m2
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 66L/sec.
    - 3355m2 / 10000m2 * 195 = 65,42L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.

- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall start as a pipe Ø200mm and will increase to a pipe Ø500mm which is able to discharge the rainwater. For Future expansion the last part of the sewer is increased to a pipe Ø630mm

Velocity = 0,21m/s
V = Q / D
Q = 0,06524m3/sec
D = 0,3116 *(0,25*PI*d^2)*

7.3 Total Outflow CUP, VOC, SR

- Total area is 9035m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 176L/sec.
    - 9035m2 / 10000m2 * 195 = 176,18L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø630mm which is able to discharge the rainwater.

Velocity = 0,56m/s
V = Q / D
Q = 0,17568m3/sec
D = 0,3116 *(0,25*PI*d^2)*

8 DISCHARGE 001, SUB STATION, GAS SKID

8.1 Sub Station, Gas Skid

- Roof area Sub Station, Gas Skid is 370m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 7L/sec.
    - 370m2 / 10000m2 * 195 = 7,215L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø250mm which is able to discharge the rainwater.

Velocity = 0,15m/s
V = Q / D
Q = 0,00719m3/sec
D = 0,0491 *(0,25*PI*d^2)*

9 DISCHARGE 006, SDD, GOWNING, WATER TREATMENT

9.1 SDD East side, Gowning

- Roof area East side SDD is 2685m2.
- Roof area Gowning is 822m2.
- Paving area South side SDD is 1092m2.
- Total area is 4599m2
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 89L/sec.
    - 4599m2 / 10000m2 * 195 = 89,68L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø500mm which is able to discharge the rainwater.

Velocity = 0,46m/s
V = Q / D
Q = 0,08943m3/sec
D = 0,1963 *(0,25*PI*d^2)*

9.2 SDD West side

- Roof area West side SDD is 2685m2.
- Paving area West side SDD is 1675m2.
- Total area is 4360m2
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 85L/sec.
    - 4360m2 / 10000m2 * 195 = 85,02L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø500mm which is able to discharge the rainwater.

Velocity = 0,43m/s
V = Q / D
Q = 0,08478m3/sec
D = 0,1963 *(0,25*PI*d^2)*

9.3 Water Treatment

- Roof and paving area Water Treatment is 2030m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 40L/sec.
    - 1800m2 / 10000m2 * 195 = 35,10L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.

- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø315mm which is able to discharge the rainwater.

Velocity = 0,45m/s
V = Q / D
Q = 0,03500m3/sec
D = 0,0779 *(0,25*PI*d^2)*

9.4 Total Outflow SDD, Gowning, Water Treatment

- Total area is 10759m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 210L/sec.
    - 10759m2 / 10000m2 * 195 = 209,80L/sec.
- A pipe Ø200mm with a gradient of 1:1000 can discharge 10l/sec.
- A pipe Ø250mm with a gradient of 1:1000 can discharge 19l/sec.
- A pipe Ø315mm with a gradient of 1:1000 can discharge 36l/sec.
- A pipe Ø400mm with a gradient of 1:1000 can discharge 65l/sec.
- A pipe Ø500mm with a gradient of 1:1000 can discharge 120l/sec.
- A pipe Ø630mm with a gradient of 1:1000 can discharge 220l/sec.

The main sewer shall be a pipe Ø630mm which is able to discharge the rainwater.

Velocity = 0,67m/s
V = Q / D
Q = 0,20920m3/sec
D = 0,3116 *(0,25*PI*d^2)*

10 DISCHARGE 007, WAREHOUSE, ASRS, TANKER SET DOWN, TRUCK LOADING TANK FARM

10.1 Warehouse, East side ASRS

- Roof area Warehouse is 3170m2.
- Roof area East side ASRS is 1240m2
- Paving area South side of Warehouse is 4430m2.
- Total area is 8840m2
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 172L/sec.
    - 8840m2 / 10000m2 * 195 = 172,38L/sec.
- A pipe Ø200mm with a gradient of 1:500 can discharge 15l/sec.
- A pipe Ø250mm with a gradient of 1:500 can discharge 28l/sec.
- A pipe Ø315mm with a gradient of 1:500 can discharge 50l/sec.
- A pipe Ø400mm with a gradient of 1:500 can discharge 95l/sec.
- A pipe Ø500mm with a gradient of 1:500 can discharge 175l/sec.
- A pipe Ø630mm with a gradient of 1:500 can discharge 325l/sec.

The main sewer shall be a pipe Ø500mm which is able to discharge the rainwater.

Velocity = 0,88m/s
V = Q / D
Q = 0,17189m3/sec
D = 0,1963 *(0,25*PI*d^2)*

10.2 West side ASRS

- Roof area West side ASRS is 1488m2.
- Paving area West side ASRS is 3214m2.
- Total area is 4702m2
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 92L/sec.
    - 4702m2 / 10000m2 * 195 = 91,69L/sec.
- A pipe Ø200mm with a gradient of 1:500 can discharge 15l/sec.
- A pipe Ø250mm with a gradient of 1:500 can discharge 28l/sec.
- A pipe Ø315mm with a gradient of 1:500 can discharge 50l/sec.
- A pipe Ø400mm with a gradient of 1:500 can discharge 95l/sec.
- A pipe Ø500mm with a gradient of 1:500 can discharge 175l/sec.
- A pipe Ø630mm with a gradient of 1:500 can discharge 325l/sec.

The main sewer shall be a pipe Ø400mm which is able to discharge the rainwater.

Velocity = 0,73m/s
V = Q / D
Q = 0,09143m3/sec
D = 0,1256 *(0,25*PI*d^2)*

10.3 Tanker Set Down, DATA

- Paving area Tanker Set Down is 1750m2.
- Paving area Data is 160m2.
- Total area is 1910m2
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 37L/sec.
    - 1910m2 / 10000m2 * 195 = 37,25L/sec.
- A pipe Ø200mm with a gradient of 1:500 can discharge 15l/sec.
- A pipe Ø250mm with a gradient of 1:500 can discharge 28l/sec.
- A pipe Ø315mm with a gradient of 1:500 can discharge 50l/sec.
- A pipe Ø400mm with a gradient of 1:500 can discharge 95l/sec.
- A pipe Ø500mm with a gradient of 1:500 can discharge 175l/sec.
- A pipe Ø630mm with a gradient of 1:500 can discharge 325l/sec.

The main sewer shall be a pipe Ø315mm which is able to discharge the rainwater.

Velocity = 0,48m/s
V = Q / D
Q = 0,03714m3/sec
D = 0,0779 *(0,25*PI*d^2)*

10.4 Truck loading Tank Farm

- Paving area Truck loading is 625m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 12L/sec.
    - 625m2 / 10000m2 * 195 = 12,19L/sec.
- A pipe Ø200mm with a gradient of 1:500 can discharge 15l/sec.
- A pipe Ø250mm with a gradient of 1:500 can discharge 28l/sec.
- A pipe Ø315mm with a gradient of 1:500 can discharge 50l/sec.
- A pipe Ø400mm with a gradient of 1:500 can discharge 95l/sec.
- A pipe Ø500mm with a gradient of 1:500 can discharge 175l/sec.
- A pipe Ø630mm with a gradient of 1:500 can discharge 325l/sec.

The main sewer shall be a pipe Ø200mm which is able to discharge the rainwater.

Velocity = 0,39m/s
V = Q / D
Q = 0,01215m3/sec
D = 0,0314 *(0,25*PI*d^2)*

10.5 Total Outflow Warehouse, ASRS, Tanker Set Down, Truck loading Tank Farm

- Total area is 16077m2.
- A rainfall event with a peak intensity of 195L/sec/ha results in ca. 314L/sec.
    - 16077m2 / 10000m2 * 195 = 313,50L/sec.
- A pipe Ø200mm with a gradient of 1:500 can discharge 15l/sec.
- A pipe Ø250mm with a gradient of 1:500 can discharge 28l/sec.
- A pipe Ø315mm with a gradient of 1:500 can discharge 50l/sec.
- A pipe Ø400mm with a gradient of 1:500 can discharge 95l/sec.
- A pipe Ø500mm with a gradient of 1:500 can discharge 175l/sec.
- A pipe Ø630mm with a gradient of 1:500 can discharge 325l/sec.

The main sewer shall be a pipe Ø630mm which is able to discharge the rainwater.

Velocity = 1,00m/s
V = Q / D
Q = 0,31261m3/sec
D = 0,3116 *(0,25*PI*d^2)*

11 Discharge table

11.1 Discharge to ditch

	Discharge area	**Discharge 195L/sec/ha**	**Discharge 70mm/hour**	**Annual discharge 850mm/year**
4. DISCHAREG 004 ADMIN NORTH SIDE,	1515M2	29,54L/sec	106,05m3	1288m3
5. DISCHAREG 005 ADMIN SOUTH SIDE, LABS, ATRIUM,	5239m2	102,16L/sec	366,73m3	4453m3
6. DISCHAREG 003 OSD, DATA, BESS, AGI SKID	10700m2	208,65L/sec	749,00m3	9095m3
7. DISCHAREG 002 CUP, VOC, SR	9035m2	176,18L/sec	632,45m3	7680m3
8. DISCHAREG 001 SUB STATION, GAS SKID	370m2	7,22L/sec	25,90m3	315m3
9. DISCHARGE 006 SDD, GOWNING, WATER TREATMENT	10759m2	209,80L/sec	753,13m3	9145m3
10. DISCHAREG 007 WAREHOUSE, ASRS, TANKER SET DOWN, TRUCK LOADING TANK FARM	16077m2	313,50L/sec	1125,39m3	13665m3
Totals	**53395m2**	**1047,05L/sec**	**3758,65m3/h**	**45641m3/year**