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OSHOEK SITE CLEARANCE

SERVICES DESIGN REPORT

DRAFT REPORT
REVISION 01

SEPTEMBER 2023

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DOCUMENT CONTROL

TITLE:	Services Design Report		
ELECTRONIC FILE LOCATION:	P17080_REPORTS_18 SERVICES DESIGN REPORT_REV 01.docx		
REPORT STATUS:	Draft		
REVISION NUMBER:	01		
CLIENT:	256 Madiba Street Pretoria Central Pretoria 0001		
CONSULTANT:	Delta Built Environment Consultants (Pty) Ltd P.O. Box 35703 Menlo Park 0102		
DATE:	September 2023		
REFERENCE NUMBER:	P17080 / 5320		
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DISTRIBUTION LIST:	**COMPANY**	**NAME & SURNAME**	
	Department of Public Works	Gudani Magau	

RECORD OF REVISIONS

REV. NO.	**STATUS**	**DESCRIPTION OF REVISION**	**REV. DATE**
00	Draft	Issued for comments	30/10/2018
01	Draft	Revised quantities and cost estimations for 2022	26/09/2022

EXECUTIVE SUMMARY

Delta Built Environment Consultants (Delta BEC) was appointed by the National Department of Public Works (DPW) to render civil infrastructure professional services for Oshoek Port of Entry. The Services Design report was determined through the client's requirements for future developments. In the previous report, which was the Status Quo report, the state of the following services was determined:

Potable Water Reticulation

The water reticulation network currently caters for the area sufficiently, although there is no municipal connection for the area. The area is fully dependent on the borehole system, which has sufficient yield for the current demand.

Sewer Reticulation

The sewer reticulation network is in a good working condition with no notable concerns raised or picked up during site investigations. The sewer network does not experience blockages as no manhole has been found overflowing on site. The wastewater treatment works (WWTW) do not show any signs of being overloaded in terms of organic loading and overspill during peak hours. A new perimeter fence will need to be erected around the maturation ponds and reed beds.

Stormwater

The stormwater on the site is managed through a series of channels and an underground pipe network that discharges into the open grassland on the northern end of the study area. The stormwater network requires urgent maintenance especially on the discharge outlet and earth channels.

Roads, Parking and Pavement

The road network is in a fair condition with minor concerns. A section of the entrance has edge breaks on the left-hand side towards the entrance of the border post. The parking is in a good condition although sections of it still require remarking.

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1 INTRODUCTION

1.1 BACKGROUND

The Department of Public Works (DPW) has requested assistance in conducting a feasibility study for the establishment of the Oshoek Border Post. The proposed border post is envisaged to prevent entrance of unrestricted vehicles. It is proposed that the border post enables agreements between South Africa and Swaziland to provide an enabling legal basis of the two governments. The Oshoek Border Post will be a place to integrate risk and information management, improve cooperation and reduce illegal border crossing and related logistics costs.

The core objective of the border post is to combine the two countries for national border control processing into one and to consolidate border control functions in a shared space for exiting one country and entering another. The first deliverable is the Status quo report, and the second deliverable is the services design report, which will encompass the following aspects:

- Water distribution network
- Sewer reticulation network
- Stormwater reticulation network
- Roads, pavements and parking within the proposed development site.

1.2 PURPOSE OF REPORT

This report aims to provide a detailed summary of existing services as well as recommendations with regard to the provision of services.

The objective of this report is to present Delta BEC's methodology and assessment of the capacity of the existing civil services as well as the required capacity to accommodate the development of the Oshoek Border Post.

1.3 STRUCTURE OF REPORT

The report comprises the following sections:

- Section 2: Description of the Site
- Section 3: Status Quo
- Section 4: Services Design
- Section 5: Conclusion
- Section 6 Recommendations
- Appendices.

2 DESCRIPTION OF THE SITE

2.1 LOCALITY

Oshoek port of entry is situated in the Mpumalanga Province. The study area is located on Oshoek No. 212-IT. It lies within the jurisdiction of the Gert Sibande District Municipality, in particular within the Chief Albert Local Municipality. The property is partially developed with most of the area currently utilised. The study area is 39.5 ha in size.

The Oshoek Border Post is located at 26°12'46.15"S and 30°59'18.10"E. The border post links South Africa and Swaziland.

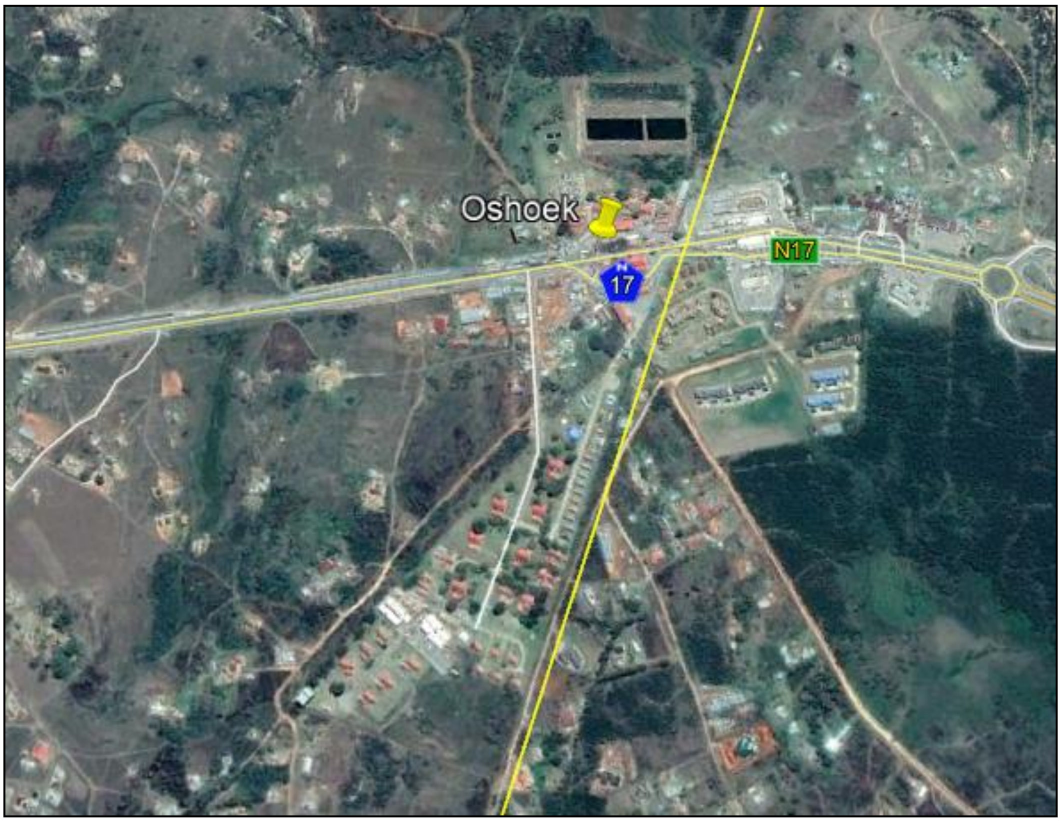


Figure 2-1: Oshoek port of entry site location

3 STATUS QUO

The objective of this section is to provide the methodology followed in compiling the services report findings.

3.1 INTRODUCTION

In order to formulate the report and to make appropriate recommendations, Delta BEC studied the *Department of Public Works Civil Engineering Manual* (DPW Manual) and supplemented it with *The Neighbourhood Planning and Design Guide* (the Redbook, 2018), in order to establish requirements and applicable standards. The criteria identified is summarised below.

This section will describe the following items in detail:

- Potable water reticulation
- Firewater reticulation
- Sewer reticulation
- Wastewater treatment works
- Stormwater reticulation
- Roads, pavement and parking.

3.1.1 WATER SUPPLY

3.1.1.1 Status Quo

The study area has two elevated tanks (Figure 3-1) that receive water from two boreholes (Figure 3-2). Based on the test results that were provided by Virtual Consulting Engineers, the safe abstraction of the boreholes is as follows:

- Borehole 1 (site office) can deliver 1.5 litres/sec at 12 hours with 64 800 litres/day
- Borehole 2 (next to fence) can deliver 0.5 litres/sec at 24 hours with 43 200 litres/day.

The first elevated tank has a capacity of 441.25 m^3 and the second tank has a capacity of 245.14 m^3 that supplies the potable water reticulation. There is a disinfectant dosing room (sodium hypochlorite) located below the two elevated tanks for dosing borehole water before discharging into the elevated storage tanks.

Figure 3-1: Two elevated potable water tanks, a firewater tank and a fire pump station

Figure 3-2: A borehole

The current daily water demand was calculated to be 21.88 m^3, while the future daily demand for potable water was calculated to be 94.35 m^3. The calculation sheet can be found in **Appendix B.**

The existence of a firewater network was confirmed on site with fire hydrants, a firewater storage tank and fire hose reels (Figure 3-3).

Figure 3-3: Firewater hydrant and hose reel

An existing firewater layout was received from Virtual Consulting Engineers. The firewater reservoir receives water from the two boreholes located on site. The layout indicates two on-ground reservoirs; one with a 65.371 m^3 capacity and a second one with a 50.85 m^3 capacity. The reservoir with a 50.85 m^3 capacity does not seem to be connected to any network connecting to it; there also is no supporting pump.

Further investigations are required to determine the purpose of the construction of the storage tank.

The existing water storage capacity is not sufficient for the fire risk category for future usage. The fire risk category of the Border Post is Moderate. This was evaluated through the usage of the buildings, and the possible heights of future buildings. The combined firewater capacity stands at 116.21 m^3. The capacity needed for firewater stands at 1440 m^3. However, it is important to note that the potable water tank may have been oversized to supplement for future firewater by the previous designer.

The calculations for the water and firewater demand can be found in **Appendix B.**

3.1.1.2 Methodology

The methodology for the design of the water supply is as follows:

- The Status Quo of Water Reticulation
- Establish design criteria applicable to the water reticulation network
- Establish connection points with the existing pipelines, which are determined during the Status Quo Phase, and determine possible pipe routes for the proposed site
- Calculate water demand and peak flows
- Determine optimum pipe sizes and pipe pressure classes
- Determine valve, fire hydrant and erf connection positions
- Calculate water meter sizes
- Compile layout plans, pipe schedules and water reticulation details.

3.1.2 SEWER DEMAND

3.1.2.1 Status Quo

Oshoek border post utilises the conventional gravity sewer system. Based on site investigations and a topographical survey, the following is deduced from the internal reticulation:

- A network of sewer pipelines
- Non-overflowing manholes (Figure 3-4)
- The network drains to a Wastewater Treatment Works (WWTW) in the north-eastern boundary of the study area.

The sewer reticulation network is in a good working condition, with no overflowing manholes, and all are seemingly in order. There were no as-built drawings found from all possible sources but through sewer outfall calculation, it could be determined that the pipe sizes of the network are 110mm minimum diameter and 160mm maximum diameter. **Appendix A** shows the possible sewer outfall network.

Figure 3-4: Non-overflowing sewer manhole

3.1.2.2 Methodology

The methodology for the design of the sewer reticulation network is as follows:

- The Status Quo of the Sewer Reticulation
- Establish design criteria applicable to the sewer reticulation network
- Establish connection points at the existing pipelines (manholes), determined during the Status Quo Phase, and determine possible pipe routes for the proposed site
- Calculate sewage demand and peak flows
- Conduct a hydraulic analysis of the proposed system to determine optimum pipe sizes
- Compile layout plans, long sections and sewer reticulation details.

3.1.3 STORMWATER DRAINAGE

3.1.3.1 Status Quo

Oshoek Border Post has a number of stormwater side channels and pipe networks around the site that direct excess stormwater during heavy rain to a nearby stream. Sections of the stormwater network are no longer functional and require urgent maintenance. These sections are completely filled with silt. In other sections, the grid inlet is completely blocked, thus reducing the capacity of the system.

Silt build up on an open earth channel suggests that the channel is not self-cleansing and therefore the channel will need to be redesigned to the adequate slope. Earth channels need to be cleaned regularly.

The images indicate the state of the stormwater network.

Figure 3-5: Earth channel overgrown with grass

Figure 3-6: Blocked grid inlet

Figure 3-7: Grouted stone pitching with silt deposition

Figure 3-8: Kerbs forming a channel along the segmented block paving

3.1.3.2 Methodology

The methodology for the design of the stormwater network is as follows:

- The status quo of the stormwater outfall
- Establish design criteria applicable to the stormwater reticulation network
- Propose a layout of the stormwater system
- Establish catchment areas
- Conduct hydrological calculations to estimate stormwater run-off
- Conduct hydraulic calculations of stormwater infrastructure.
- Compile layout plans, long sections and stormwater reticulation details.

3.1.4 Roads, Pavements and Parking

The Oshoek Border Post has a ring network of block paved roads and asphalt paving. The parking lots are also paved with paving blocks.

The road network is in a fair condition with just minor concerns. Certain sections of the road network are not maintained with grass growing over the paving blocks.

Figure 3-9: Parking bays

Figure 3-10: Internal roads still in a good condition

Figure 3-11: Segmented paving block that is overgrown with grass

Figure 3-12: Asphalt internal road still in a good condition

4 SERVICES DESIGN

4.1 GENERAL

The design of the services is discussed under the following headings:

- Water Supply
- Sewer Outfall
- Stormwater Drainage
- Road Network.

4.2 PROPOSED FUTURE LAYOUT

The master plan layout which was used for the determination of the future services requirements and design is shown below in Figure 4-1. The map legend is shown in Figure 4-2. The layout can also be seen in **Appendix A**.

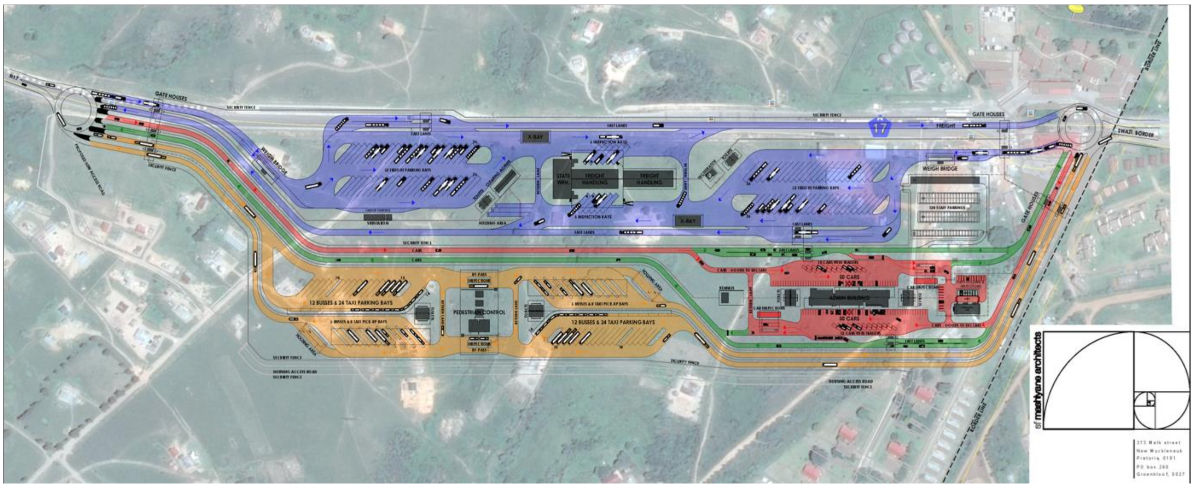


Figure 4-1: Oshoek Border Post master plan layout

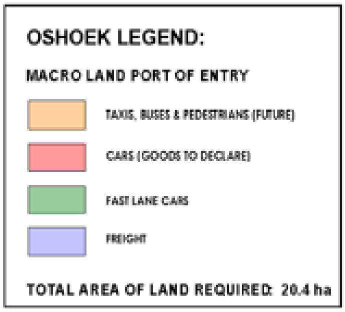


Figure 4-2: Master plan legend

4.3 WATER SUPPLY

The bulk water demand for the proposed master plan is calculated to be 94.4 kl/day. A reservoir of 200 m³ is required to provide 48 hour storage. The current capacity of the reservoirs is sufficient to supply the planned future expansion of the Oshoek Border Post.

The on-site boreholes with a joint capacity of 108 kl/day have sufficient yield to cater for the increased demand.

A calculation sheet of the water and sewer demand is shown in **Appendix B**.

The following table shows the summary of the water demand according to future developments:

Table 4-1: Water demand summary

DESCRIPTION	TOTAL SIZE m^2	DESIGN FLOW $l/100m^2/d$	DAILY USAGE IN kl/day	PEAK FLOW l/s
FREIGHT				
X ray and Vehicle Control Points	726	50	0.4	0.014
Freight Inspection Building	2372	400	9.5	0.351
Admin Building	1022	400	4.1	0.151
State Warehouse	732	300	2.2	0.081
Toilets	140	400	0.6	0.020
Gatehouse	33		0.9	0.033
FAST LANE CARS				
N/A				
CARS (GOODS TO DECLARE)				
SAPS Kennels	454	400	1.8	0.067
Car Inspections (arrivals)	121	400	0.5	0.017
Car Inspections (departures)	121	400	0.5	0.017
Toilets	280	400	1.1	0.041
Admin Building	1706	400	6.8	0.252
Support Admin Buildings	1137	400	4.5	0.168
SAPS holding and inspections	333	400	1.3	0.049
Gatehouse	22		0.6	0.022
Main Security & Patrol Control Room	22		0.6	0.022
TAXIS, BUSES & PEDESTRIANS (FUTURE)				
Pedestrian Control Building	2400	400	0.8	0.029
Toilets	200	400	0.8	0.029
RESIDENTIAL				
Residential buildings	3400.55	450	51.75	1.916
Residential mobile	501.05	400	4.4	0.162
Operational mobile homes	135	400	1.2	0.044
TOTAL				
TOTAL DAILY USAGE			94.4	4.4

4.3.1 Design Criteria

The design criteria applied in the design of the upgraded pipeline system are summarised in Table 4-2.

Table 4-2: Water design criteria

DESIGN PARAMETER	VALUE
Average Annual Daily Demand (AADD) for Manufacturing Centres	0.4 kl/100 m2/day or 70 l/person/day
AADD for Offices	0.5 kl/100 m2/day
Pipe type	HDPE Class 12
Minimum pipe diameter	80 mm
Maximum pipe diameter	200mm
Fire flow at any one hydrant under the condition of domestic peak flows	15l/s
Daily peak factor	2.5
Instantaneous peak factor	4.0
Minimum residual head (fire plus domestic peak flow)	25 m
Maximum linear flow velocity under conditions of fire fighting	3.0 m/s
Boundary roughness (K-Value)	0.1 mm
Flow formula	D'Arcy Weisbach
Fire hydrants	80 mm diameter
Fire hydrant spacing	120m (category B)

4.3.2 Pipe Routing

4.3.2.1 Route Selection

Delta BEC was informed that the design of the water reticulation network was done according to the design guidelines set out in the DPW Manual and the Redbook. These standards will continue to apply on the design of the water reticulation system.

4.3.2.2 Fire Hydrants

The existence of a firewater network was confirmed on site with fire hydrants, a firewater storage tank and fire hose reels. The area currently has two firewater storage reservoirs with a total capacity of 116.221 m^3. The firewater reservoir receives water from the two boreholes located on site.

The existing fire storage reservoir will not be sufficient to cater to the future firewater demand. The yield of the boreholes can accommodate the increased demand but an additional 1323.779 m³ of storage is required. Additional storage tanks have to be installed to meet the required capacity. The following table shows the firewater demand for the site.

Table 4-3: Firewater demand table

FIREWATER DEMAND	
Fire Risk Category	Moderate risk
Minimum Design Flow (l/min)	6000
Hydrant flow rate (l/min)	1500
Number of Hydrants	4
Fire Demand	6000
Fire Demand (l/hour)	360000
Fire Demand (l/day)	1440000
Operational Hours	4
Fire Storage (kl)	1440

Fire hydrants will be installed according to the DPW Manual and the Redbook.

4.3.2.3 Peak Flows

Potable peak water flows are determined and then added to the fire flow in order to determine optimum pipe sizes. Average potable water consumption was calculated for each facility by utilising figures published in the Red Book standards. A Summary of the peak flow calculation is presented in Table 4-1.

The detailed peak flow calculation is presented in **Appendix B**.

4.4 SEWER OUTFALL

Oshoek Border Post utilises the conventional gravity sewer system, which drains to a wastewater treatment works located in the north-eastern boundary of the study area.

The current daily sewage outflow for the Oshoek Border Post is estimated to be in the order of 18.784kl/day. The sewer reticulation network is in a good working condition, with no overflowing manholes and everything is seemingly in order.

The bulk sewage outflow for the proposed master plan is calculated to be 51.615kl/day. This is an increase of 33 kl/day.

The following table shows the Sewer Outfall Demand according to future developments that will be made:

Table 4-4: Sewer demand table

DESCRIPTION	TOTAL SIZE m^2	DAILY OUTFLOW l/d	AVERAGE DAILY OUTFLOW l/s	PEAK FLOW l/s
FREIGHT				
X ray and Vehicle Control Points	726	290.4	0.003	0.013
Freight Inspection Building	2372	7590.4	0.088	0.351
Admin Building	1022	3270.4	0.038	0.151
State Warehouse	732	1756.8	0.020	0.081
Toilets	140	448	0.005	0.021
Gatehouse	33	720	0.008	0.033
FAST LANE CARS				
N/A				
CARS (GOODS TO DECLARE)				
SAPS Kennels	454	1452.8	0.017	0.067
Car Inspections (arrivals)	121	387.2	0.004	0.018
Car Inspections (departures)	121	387.2	0.004	0.018
Toilets	280	896	0.010	0.041
Admin Building	1706	5459.2	0.063	0.253
Support Admin Buildings	1137	3638.4	0.042	0.168
SAPS holding and inspections	333	1065.6	0.012	0.049
Gatehouse	22	480	0.006	0.022
Main Security & Patrol Control Room	22	480	0.006	0.022
TAXIS, BUSES & PEDESTRIANS (FUTURE)				
Pedestrian Control Building	2400	640	0.007	0.030
Toilets	200	640	0.007	0.030
RESIDENTIAL				
Residential buildings	41400	450	0.479	1.917
Residential mobile	3520	400	0.041	0.163
Operational mobile homes	960	400	0.011	0.044
TOTAL				
TOTAL DAILY USAGE		75.48 kl	0.874	3.494

4.4.1 Sewer Design Criteria

The design criteria listed in Table 4-5 was used in the design of the current sewer reticulation network.

Table 4-5: Sewer design criteria

DESIGN PARAMETER	VALUE
Average Annual Daily Demand (AADD) for Manufacturing Centres	0.3 kl/100m^2/day
AADD for Offices	0.4 kl/unit/day

DESIGN PARAMETER	VALUE
Peak Factor	2.5
Stormwater infiltration	15%
Capacity of sewer	80% full
Minimum pipe diameter	110 mm
Sewer pipe type	uPVC pipes Class 34
Maximum manhole intervals	110 m
Minimum velocity	0.75 m/s at full flow
Manning friction coefficient	0.012
Minimum depth of cover	1.5 m in street reserve

4.4.2 PIPE ROUTING

4.4.2.1 Route Selection

The internal sewer drainage network was designed as a gravity system. The sewer design was done according to the DPW Manual and the Red Book. The Border Post site currently has an existing sewer network. The general area has pipes that range from 110 mm to 160 mm in diameter. Pipe diameters will be sized to cater for the demand of the proposed land uses for the proposed development. The sewer network will be extended to areas that the proposed development covers. These pipelines connect to the existing bulk sewer pipeline.

4.4.2.2 Peak Flows

Peak sewer flows have been determined in order to determine optimum pipe sizes, as recommended by the DPW Manual and the Redbook. The peak flows are derived from the water demand calculations, as it is a rule of thumb to take 80% of the peak water demand flows to calculate sewer outfall flows. A summary of the peak flows is presented in Table 4-4. For the detailed peak flow calculation, please refer to **Appendix B**.

4.5 STORMWATER DRAINAGE

4.5.1 STATUS QUO

The status quo study assessed the existing hydrological and hydraulic conditions for the immediate stormwater network serving the study area. The assessment criteria are based on a risk rating indicating areas ranging from low to high risk, in terms of the existing system capacity.

The study area receives approximately 925 mm of rainfall per year. The following table depicts the rainfall data gathered.

Table 4-6: Rainfall depths (mm) for different recurrence intervals and storm durations for the Oshoek Border post

STORM DURATION	RECURRENCE INTERVAL (YEAR) AND RAINFALL DEPTH (MM)					
	1:2	**1:5**	**1:10**	**1:20**	**1:50**	**1:100**
5 minutes	9.2	12.7	15.5	18.4	22.7	26.3
10 minutes	13.1	18.2	22.1	26.3	32.4	37.5
15 minutes	16.1	22.4	27.2	32.3	39.9	46.2
30 minutes	20.8	28.9	35.1	41.7	51.4	59.6
45 minutes	24.1	33.5	40.7	48.4	59.6	69.1
1 hour	26.8	37.2	45.2	53.7	66.2	76.8
1.5 hours	31.1	43.2	52.4	62.3	76.8	89.1
2 hours	34.5	48.0	58.2	69.2	85.3	99.0

Furthermore, there are no flow attenuation facilities on site or water improvement components available.

4.5.2 DESIGN STANDARDS

Table 4-7 lists the design standards used in the stormwater reticulation design.

Table 4-7: Stormwater design criteria

DESIGN PARAMETER	VALUE
Design method	Rational Method for smaller catchment areas
Stormwater details	SANRAL Guidelines for Human Settlement Planning, DPW Manual and the Redbook
Minimum time of concentration and run-off coefficient	According to The South African National Roads Agency Limited Design Manual
Minimum pipe size	450 mm diameter
Maximum pipe size	750 mm
Minimum pipe gradient	0.7%
Minimum flow velocity	0.9 m/s
Maximum flow velocity	1.5 m/s
Average yearly rainfall	925 mm
Flood return period	1:20 years for minor rainfall events and 1:50 years for major rainfall events
Pipe Joining	Soffit to soffit
Manning's friction factor	n = 0.012
Minimum pipe cover	1.2 m in road crossings and reserves (where less than 0.9 m cover are available, the crossing will be backfilled with 1:8 soilcrete mixture).

4.5.3 PIPE ROUTING

The stormwater system consists of numerous kerb inlets, grid inlets, earth channels, open channels and underground stormwater pipes. This network consists of underground pipes, which discharge water into the nearby streams.

4.5.4 HYDROLOGY

This section presents hydrological design calculations for the proposed stormwater system. This portion of the report consists of the following sections:

- Stormwater system
- Rainfall
- Hydrological calculation methodology
- Hydraulic calculations.

4.5.4.1 Stormwater System

The stormwater system consists of combined surface, road and pipe systems. Stormwater will flow from the respective catchment areas into the nearest downstream kerb inlet, entering the stormwater pipe network and discharging into the open stream.

The open stream is in the northern part of the general area. The stormwater run-off will be collected from internal roads, through kerb inlets and from parking spaces, through grid inlets. All pipes will be sized according to a storm recurrence interval of 1 in 20 years for minor systems and 1 in 50 years for major systems.

4.5.4.2 Rainfall

In order to determine surface water run-off, probabilistic relationships between the average daily rainfall, the rainfall intensity, duration and return period are required. These relationships were estimated by using a regional scale invariance approach, developed by Smithers and Schulze (2003). The project is located at latitude 26º12’S and longitude 30º59’E with an altitude of 1463 m above mean average sea level (m.a.s.l). The mean annual precipitation (MAP) is estimated at 925 mm per annum.

With the Rainfall Data that is retrieved, it was possible to calculate the run-off for all the available return year periods for both Pre-Development and Post-Development purposes. Table 4-10 shows run-off data for return year periods of 1 in 20 years and 1 in 50 years.

Table 4-8: Summary of Pre-Development and Post-Development run-off for return year periods of 1:20 and 1:50

	PRE-DEVELOPMENT		POST-DEVELOPMENT	
Catchment	**Return Year Period / Runoff (Q m^3/s)**		**Return Year Period / Runoff (Q m^3/s)**	
	20	**50**	**20**	**50**

	PRE-DEVELOPMENT		POST-DEVELOPMENT	
Area 1	5.05	6.44	14.79	18.3

4.5.4.3 Hydrological Calculation Methodology

For purposes of this study, the Rational Method was selected to determine estimated run-off for the specific site. The Rational Method is used throughout the world and in South Africa and it is known to give a fair indication of the flood peak design values for small catchments. For the purpose of this report, one future developed catchment has been identified for the Oshoek Border Post and has been determined as an appropriate size for the positioning of the various kerb inlets. Low points on the road alignment also play a big role in the positioning of the stormwater kerb inlets.

4.5.4.4 Hydraulic Calculations

4.5.4.4.1 General

The pipe sizes are relatively unknown in this study area. The pipelines have thus been sized based on the run-off estimations obtained from the Rational Method.

4.5.4.4.2 Pipe Class calculation

The concrete pipe classes were selected using the *DPW Manual,* supplemented with the *Red Book*. A Class B bedding was selected for all of the pipe diameters. The pipe class is presented in Table 4-9.

Table 4-9: Pipe class

PIPE DIAMETER (MM)	COVER DEPTH (MM)	PIPE CLASS
450	>600	50D & 100D on Road Crossings
525	>600	50D & 100D on Road Crossings

4.6 ROAD NETWORK STATUS QUO

The condition of the roads is good. The N17 Freeway, which is a three-lane divided carriageway and is classified as a Class 1 Freeway.

The condition of the internal roads is fair but refurbishment is needed, with no vegetation growing on the road or on the available sidewalks.

4.7 WAYLEAVE APPLICATIONS

There will be no need for wayleave applications to be made as the facility has its own internal reticulation systems that work efficiently.

5 CONCLUSION

This report provided Delta BEC's Services Design assessment of the Oshoek Border Post. Data was gathered during site investigations. There were a few concerns raised during the infrastructure inspection, which is summarised below:

5.1 WATER RETICULATION

The following are the conclusions reached in the services design for the water reticulation:

- The current demand was calculated to be 21.88 m^3, while the future daily demand for potable water was calculated to be 94.4 m^3
- The existing water storage capacity is not sufficient for the fire risk category for future usage
- The combined firewater capacity stands at 116.21 m^3. The capacity needed for firewater stands at 1440 m^3.

5.2 SEWER RETICULATION

The following are the conclusions reached in the services design for the sewer outfall:

- The Border Post site currently has an existing sewer network. The general area has pipes that range from 110 mm to 160 mm in diameter
- The bulk sewage outflow for the proposed master plan is calculated to be 75.5kl/day. This is an increase of 56.7 kl/day
- The current daily sewage outflow for the Oshoek Border Post is estimated to be in the order of 18.78kl/day. The sewer reticulation network is in a good working condition, with no overflowing manholes and everything is seemingly in order.

5.3 STORMWATER

The following are the conclusions reached in the services design for the stormwater outfall:

- The study area receives approximately 925 mm of rainfall per year
- The stormwater system consists of numerous kerb inlets, grid inlets, earth channels, open channels and underground stormwater pipes. This network consists of underground pipes, which discharge water into the nearby streams
- All pipes will be sized according to a storm recurrence interval of 1 in 20 years for minor systems and 1 in 50 years for major systems.

5.4 ROADS

The following are the conclusions reached in the services design for the Road Networks:

- The condition of the roads is good. The N17 Freeway, which is a three-lane divided carriageway and is classified as a Class 1 Freeway
- The condition of the internal roads is fair but refurbishment is needed, with no vegetation growing on the road or on the available sidewalks.

6 RECOMMENDATIONS

The following are the recommendations from Delta BEC. The recommendations were made with careful consideration of what the area needs and within certain parameters that cannot be changed.

6.1 WATER RETICULATION

It is recommended that a feasibility study be done again after the final master plan, as there could be water demand changes to the area due to the ongoing drought. The preceding master plan may include a higher degree of detail and more accurate calculations can be done to size pipes. This will allow Delta BEC to save funds for the client.

6.2 FIRE RETICULATION

It is recommended that no compromise be made to the water reserves for fire fighting in case of emergencies. If the drought continues, other sources of water are to be found. Delta BEC recommends that the client look into Rainwater Harvesting as an option.

6.3 SEWER RETICULATION

The WWTP may need to be upgraded to house additional sewer from the development. However, it is recommended that the upcoming development use the option with the least sewer flow as their reference for the Master Plan.

6.4 STORMWATER

The study area has no attenuation facilities and water quality components within it. Delta BEC recommends that this infrastructure be upgraded to be able to accommodate the 1 in 20 and 1 in 50-year storm events. This will prevent localised flooding in the area.

There are no flow attenuation facilities on site or water improvement components available.

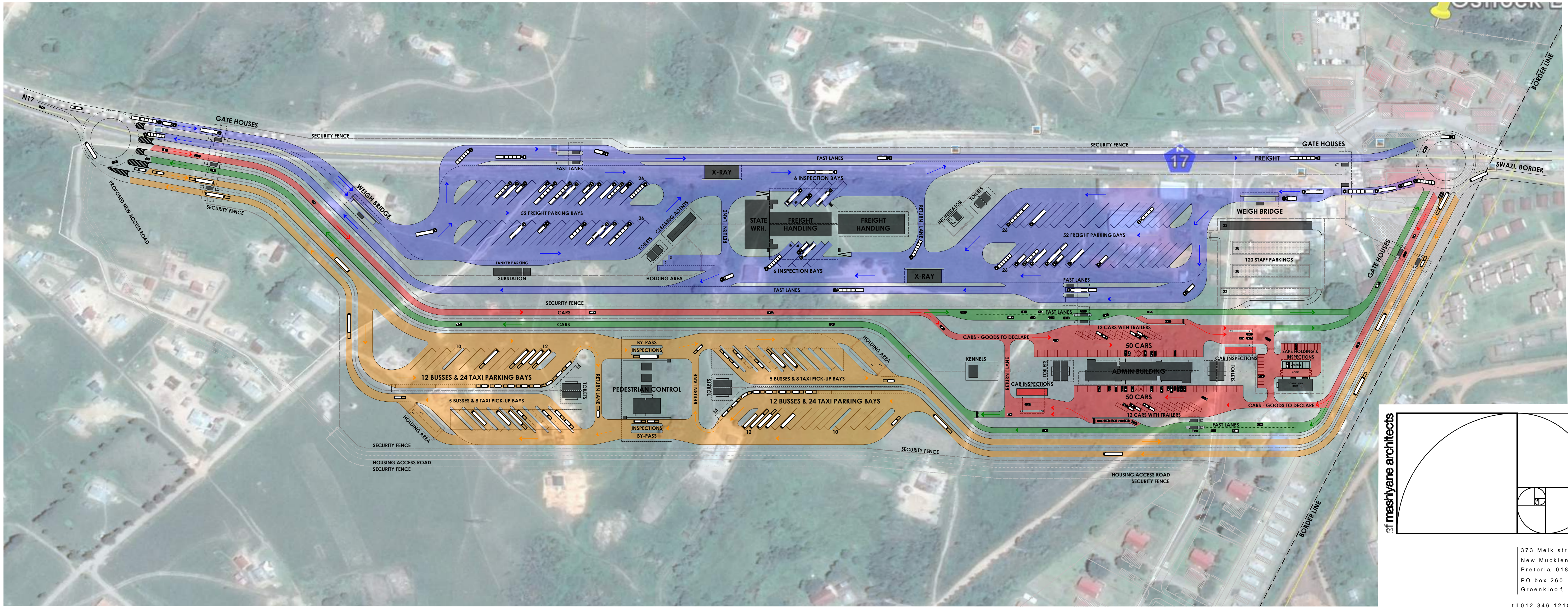
Since Delta BEC has already recommended Rainwater Harvesting as an option. The attenuation facilities may aid in making this option feasible.

6.5 ROADS

The roads are well maintained and there is no vegetation on the roadway or the available walkway. The roads do not have any potholes or any form of deformation on them.

APPENDIX A: DRAWINGS

revisions
no/date/description:



OSHOEK LEGEND:

MACRO LAND PORT OF ENTRY

- TAXIS, BUSES & PEDESTRIANS (FUTURE)
- CARS (GOODS TO DECLARE)
- FAST LANE CARS
- FREIGHT

TOTAL AREA OF LAND REQUIRED: 20.4 ha

OVERALL SITE PLAN
NTS

sf mashiyane architects

373 Melk street
New Muckleneuk
Pretoria, 0181
PO box 260
Groenkloof, 0027

t | 012 346 1218/9
f | 012 346 2706
e | sfarch@sfarch.com
w | www.sfarch.com

discipline

ARCHITECTURE

description

PROPOSED OSHOEK BORDER POST MASTER PLAN

drawing title

OSHOEK BORDER POST MASTER PLAN SITE LAYOUT

job. no.	1602	designed	JJ
scale	N.T.S	drawn	JJ
date	01-07-2016	checked	RJS

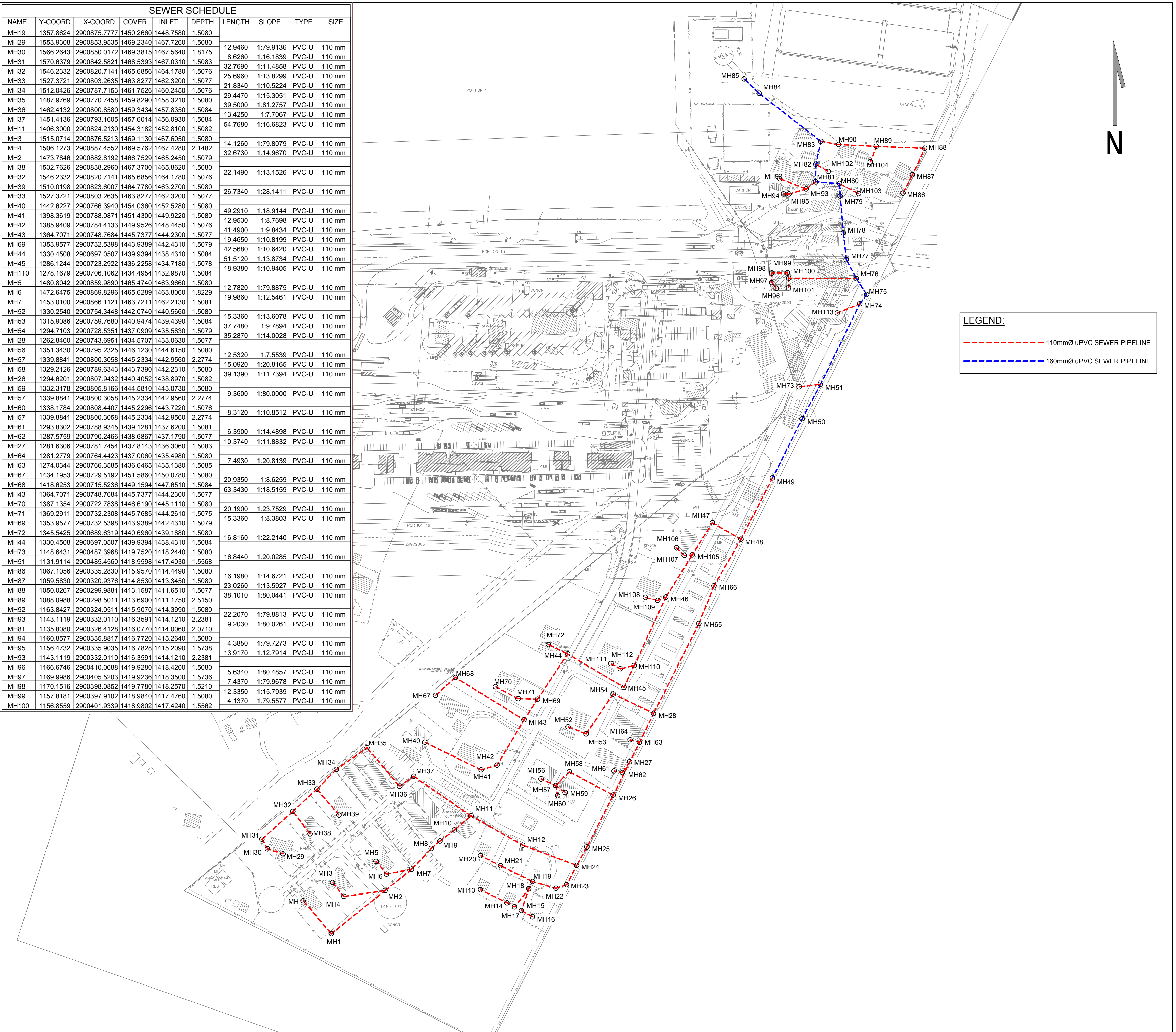
1602-AR-4.1 -

SEWER SCHEDULE

NAME	Y-COORD	X-COORD	COVER	INLET	DEPTH	LENGTH	SLOPE	TYPE	SIZE
MH	1538.0765	2900890.8667	1472.3740	1470.8660	1.5080	34.0030	1:80.0070	PVC-U	110 mm
MH1	1516.0335	2900916.7584	1472.5067	1470.4410	2.0657	54.1930	1:10.4298	PVC-U	110 mm
MH2	1473.7846	2900882.8192	1466.7529	1465.2450	1.5079	26.6590	1:8.7925	PVC-U	110 mm
MH7	1453.0100	2900866.1121	1463.7211	1462.2130	1.5081	22.4300	1:11.5857	PVC-U	110 mm
MH8	1437.6149	2900849.7986	1461.7853	1460.2770	1.5083	8.9880	1:2.9851	PVC-U	110 mm
MH9	1430.7265	2900844.0254	1458.7737	1457.2660	1.5077	14.3390	1:13.4260	PVC-U	110 mm
MH10	1419.3989	2900835.2345	1457.7060	1456.1980	1.5080	17.1190	1:5.0528	PVC-U	110 mm
MH11	1406.3000	2900824.2130	1454.3182	1452.8100	1.5082	46.6340	1:11.2182	PVC-U	110 mm
MH12	1365.7348	2900847.2181	1450.1613	1448.6530	1.5083	45.2970	1:11.5113	PVC-U	110 mm
MH24	1323.3109	2900863.0943	1446.2258	1444.7180	1.5078	16.5100	1:9.7692	PVC-U	110 mm
MH25	1315.3729	2900848.6177	1444.5363	1443.0280	1.5083	45.6630	1:11.0537	PVC-U	110 mm
MH26	1294.6201	2900807.9432	1440.4052	1438.8970	1.5082	29.2410	1:11.2856	PVC-U	110 mm
MH27	1281.6306	2900781.7454	1437.8143	1436.3060	1.5083	17.1590	1:14.6909	PVC-U	110 mm
MH63	1274.0344	2900766.3585	1436.6465	1435.1380	1.5085	25.2750	1:12.1807	PVC-U	110 mm
MH28	1262.8460	2900743.6951	1434.5707	1433.0630	1.5077	79.0680	1:12.8128	PVC-U	110 mm
MH65	1227.2804	2900673.0779	1428.3996	1426.8920	1.5076	31.7390	1:15.5889	PVC-U	110 mm
MH66	1215.5154	2900643.5998	1426.3640	1424.8560	1.5080	42.3540	1:14.2943	PVC-U	110 mm
MH48	1194.2789	2900606.9545	1423.4011	1421.8930	1.5081	54.0080	1:20.0326	PVC-U	110 mm
MH49	1169.5680	2900558.9324	1420.7536	1419.1970	1.5566	52.1250	1:35.7265	PVC-U	160 mm
MH50	1146.2568	2900512.3099	1419.2954	1417.7380	1.5574	30.4460	1:90.8836	PVC-U	160 mm
MH51	1131.9114	2900485.4560	1418.9598	1417.4030	1.5568	70.4690	1:158.0023	PVC-U	160 mm
MH74	1100.9709	2900422.1427	1418.5138	1416.9570	1.5568	9.0060	1:80.4107	PVC-U	160 mm
MH75	1095.5258	2900414.9700	1418.4019	1416.8450	1.5569	15.1150	1:177.8236	PVC-U	160 mm
MH76	1103.7481	2900402.2865	1418.5263	1416.7600	1.7663	16.7280	1:170.6939	PVC-U	160 mm
MH77	1111.5769	2900387.5038	1418.2193	1416.6620	1.5573	21.2080	1:88.3667	PVC-U	160 mm
MH78	1113.8949	2900366.4230	1417.9790	1416.4220	1.5570	28.9770	1:24.4945	PVC-U	160 mm
MH79	1116.4316	2900337.5573	1416.7960	1415.2390	1.5570	9.7160	1:11.7627	PVC-U	160 mm
MH80	1116.8033	2900327.8479	1415.9701	1414.4130	1.5571	19.0590	1:46.8280	PVC-U	160 mm
MH81	1135.8080	2900326.4128	1416.0770	1414.0060	2.0710	13.8330	1:24.8795	PVC-U	160 mm
MH82	1135.4567	2900312.5840	1415.0070	1413.4500	1.5570	18.4300	1:6.5308	PVC-U	160 mm
MH83	1131.5861	2900294.5648	1413.5820	1410.6280	2.9540	61.4670	1:31.1068	PVC-U	160 mm
MH84	1180.1330	2900256.8644	1410.2095	1408.6520	1.5575	16.1550	1:13.3955	PVC-U	160 mm
MH85	1191.7367	2900245.6243	1409.0028	1407.4460	1.5568				
MH101	1156.9652	2900409.6752	1419.4171	1417.9090	1.5081	7.7420	1:15.9629	PVC-U	110 mm
MH100	1156.8559	2900401.9339	1418.9802	1417.4240	1.5562	53.1090	1:79.9834	PVC-U	110 mm
MH76	1103.7481	2900402.2865	1418.5263	1416.7600	1.7663				
MH102	1125.9127	2900318.2233	1415.5200	1414.0120	1.5080	11.0850	1:19.7242	PVC-U	110 mm
MH82	1135.4567	2900312.5840	1415.0070	1413.4500	1.5570				
MH103	1101.8142	2900335.7176	1416.3880	1414.8800	1.5080	16.9290	1:36.2505	PVC-U	110 mm
MH80	1116.8033	2900327.8479	1415.9701	1414.4130	1.5571				
MH104	1092.7171	2900310.7881	1414.7320	1413.2240	1.5080	13.1260	1:6.4061	PVC-U	110 mm
MH89	1088.0988	2900298.5011	1413.6900	1411.1750	2.5150	29.5610	1:79.8946	PVC-U	110 mm
MH90	1117.6247	2900297.0660	1413.9340	1410.8050	3.1290	14.1830	1:80.1299	PVC-U	110 mm
MH83	1131.5861	2900294.5648	1413.5820	1410.6280	2.9540				
MH106	1244.9074	2900613.6379	1428.2020	1426.6940	1.5080	8.5350	1:30.0528	PVC-U	110 mm
MH107	1238.8718	2900619.6735	1427.9177	1426.4100	1.5077	6.3200	1:8.4154	PVC-U	110 mm
MH105	1232.5638	2900619.2858	1427.1673	1425.6590	1.5083	29.6160	1:14.6252	PVC-U	110 mm
MH47	1216.8466	2900594.1836	1425.1420	1423.6340	1.5080	25.9310	1:14.8943	PVC-U	110 mm
MH48	1194.2789	2900606.9545	1423.4011	1421.8930	1.5081				
MH108	1269.3995	2900652.7379	1431.8120	1430.3040	1.5080	9.8870	1:15.2342	PVC-U	110 mm
MH109	1259.7776	2900655.0122	1431.1631	1429.6550	1.5081	6.9490	1:7.5780	PVC-U	110 mm
MH46	1253.3224	2900652.4400	1430.2459	1428.7380	1.5079	39.1160	1:12.7041	PVC-U	110 mm
MH105	1232.5638	2900619.2858	1427.1673	1425.6590	1.5083				
MH111	1296.4721	2900704.6088	1436.2150	1434.7070	1.5080	8.4200	1:20.8933	PVC-U	110 mm
MH112	1289.1244	2900708.7200	1435.8124	1434.3040	1.5084	11.2640	1:8.5528	PVC-U	110 mm
MH110	1278.1679	2900706.1062	1434.4954	1432.9870	1.5084	59.1390	1:13.9183	PVC-U	110 mm
MH46	1253.3224	2900652.4400	1430.2459	1428.7380	1.5079				
MH113	1118.6197	2900429.3782	1418.9520	1417.4440	1.5080	19.0740	1:39.1663	PVC-U	110 mm
MH74	1100.9709	2900422.1427	1418.5138	1416.9570	1.5568				
MH13	1398.9742	2900882.1632	1456.8250	1455.3170	1.5080	23.3150	1:8.4261	PVC-U	110 mm
MH14	1378.0684	2900892.4849	1454.0580	1452.5500	1.5080	6.8090	1:23.0814	PVC-U	110 mm
MH15	1372.0766	2900895.7213	1453.7628	1452.2550	1.5078	18.0750	1:6.4669	PVC-U	110 mm
MH18	1360.9676	2900881.4634	1450.9682	1449.4600	1.5082	6.4780	1:9.2279	PVC-U	110 mm
MH19	1357.8624	2900875.7777	1450.2660	1448.7580	1.5080	19.0440	1:12.2234	PVC-U	110 mm
MH22	1339.5807	2900881.1135	1448.7084	1447.2000	1.5084	8.6870	1:8.9372	PVC-U	110 mm
MH23	1331.3584	2900878.3144	1447.7362	1446.2280	1.5082	17.2160	1:11.4013	PVC-U	110 mm
MH24	1323.3109	2900863.0943	1446.2258	1444.7180	1.5078				
MH16	1358.0811	2900903.4189	1451.8590	1450.3510	1.5080	9.9830	1:79.8640	PVC-U	110 mm
MH17	1366.8282	2900898.6079	1452.8250	1450.2260	2.5990	18.1190	1:23.6540	PVC-U	110 mm
MH18	1360.9676	2900881.4634	1450.9682	1449.4600	1.5082				
MH20	1398.8867	2900855.3968	1455.4440	1453.9360	1.5080	17.6820	1:9.1522	PVC-U	110 mm
MH21	1383.1418	2900863.4442	1453.5120	1452.0040	1.5080				

SEWER SCHEDULE

NAME	Y-COORD	X-COORD	COVER	INLET	DEPTH	LENGTH	SLOPE	TYPE	SIZE
MH19	1357.8624	2900875.7777	1450.2660	1448.7580	1.5080				
MH29	1553.9308	2900853.9535	1469.2340	1467.7260	1.5080	12.9460	1:79.9136	PVC-U	110 mm
MH30	1566.2643	2900850.0172	1469.3815	1467.5640	1.8175	8.6260	1:16.1839	PVC-U	110 mm
MH31	1570.6379	2900842.5821	1468.5393	1467.0310	1.5083	32.7690	1:11.4858	PVC-U	110 mm
MH32	1546.2332	2900820.7141	1465.6856	1464.1780	1.5076	25.6960	1:13.8299	PVC-U	110 mm
MH33	1527.3721	2900803.2635	1463.8277	1462.3200	1.5077	21.8340	1:10.5224	PVC-U	110 mm
MH34	1512.0426	2900787.7153	1461.7526	1460.2450	1.5076	29.4470	1:15.3051	PVC-U	110 mm
MH35	1487.9769	2900770.7458	1459.8290	1458.3210	1.5080	39.5000	1:81.2757	PVC-U	110 mm
MH36	1462.4132	2900800.8580	1459.3434	1457.8350	1.5084	13.4250	1:7.7067	PVC-U	110 mm
MH37	1451.4136	2900793.1605	1457.6014	1456.0930	1.5084	54.7680	1:16.6823	PVC-U	110 mm
MH11	1406.3000	2900824.2130	1454.3182	1452.8100	1.5082				
MH3	1515.0714	2900876.5213	1469.1130	1467.6050	1.5080	14.1260	1:79.8079	PVC-U	110 mm
MH4	1506.1273	2900887.4552	1469.5762	1467.4280	2.1482	32.6730	1:14.9670	PVC-U	110 mm
MH2	1473.7846	2900882.8192	1466.7529	1465.2450	1.5079				
MH38	1532.7626	2900838.2960	1467.3700	1465.8620	1.5080	22.1490	1:13.1526	PVC-U	110 mm
MH32	1546.2332	2900820.7141	1465.6856	1464.1780	1.5076				
MH39	1510.0198	2900823.6007	1464.7780	1463.2700	1.5080	26.7340	1:28.1411	PVC-U	110 mm
MH33	1527.3721	2900803.2635	1463.8277	1462.3200	1.5077				
MH40	1442.6227	2900766.3940	1454.0360	1452.5280	1.5080	49.2910	1:18.9144	PVC-U	110 mm
MH41	1398.3619	2900788.0871	1451.4300	1449.9220	1.5080	12.9530	1:8.7698	PVC-U	110 mm
MH42	1385.9409	2900784.4133	1449.9526	1448.4450	1.5076	41.4900	1:9.8434	PVC-U	110 mm
MH43	1364.7071	2900748.7684	1445.7377	1444.2300	1.5077	19.4650	1:10.8199	PVC-U	110 mm
MH69	1353.9577	2900732.5398	1443.9389	1442.4310	1.5079	42.5680	1:10.6420	PVC-U	110 mm
MH44	1330.4508	2900697.0507	1439.9394	1438.4310	1.5084	51.5120	1:13.8734	PVC-U	110 mm
MH45	1286.1244	2900723.2922	1436.2258	1434.7180	1.5078	18.9380	1:10.9405	PVC-U	110 mm
MH110	1278.1679	2900706.1062	1434.4954	1432.9870	1.5084				
MH5	1480.8042	2900859.9890	1465.4740	1463.9660	1.5080	12.7820	1:79.8875	PVC-U	110 mm
MH6	1472.6475	2900869.8296	1465.6289	1463.8060	1.8229	19.9860	1:12.5461	PVC-U	110 mm
MH7	1453.0100	2900866.1121	1463.7211	1462.2130	1.5081				
MH52	1330.2540	2900754.3448	1442.0740	1440.5660	1.5080	15.3360	1:13.6078	PVC-U	110 mm
MH53	1315.9086	2900759.7680	1440.9474	1439.4390	1.5084	37.7480	1:9.7894	PVC-U	110 mm
MH54	1294.7103	2900728.5351	1437.0909	1435.5830	1.5079	35.2870	1:14.0028	PVC-U	110 mm
MH28	1262.8460	2900743.6951	1434.5707	1433.0630	1.5077				
MH56	1351.3430	2900795.2325	1446.1230	1444.6150	1.5080	12.5320	1:7.5539	PVC-U	110 mm
MH57	1339.8841	2900800.3058	1445.2334	1442.9560	2.2774	15.0920	1:20.8165	PVC-U	110 mm
MH58	1329.2126	2900789.6343	1443.7390	1442.2310	1.5080	39.1390	1:11.7394	PVC-U	110 mm
MH26	1294.6201	2900807.9432	1440.4052	1438.8970	1.5082				
MH59	1332.3178	2900805.8166	1444.5810	1443.0730	1.5080	9.3600	1:80.0000	PVC-U	110 mm
MH57	1339.8841	2900800.3058	1445.2334	1442.9560	2.2774				
MH60	1338.1784	2900808.4407	1445.2296	1443.7220	1.5076	8.3120	1:10.8512	PVC-U	110 mm
MH57	1339.8841	2900800.3058	1445.2334	1442.9560	2.2774				
MH61	1293.8302	2900788.9345	1439.1281	1437.6200	1.5081	6.3900	1:14.4898	PVC-U	110 mm
MH62	1287.5759	2900790.2466	1438.6867	1437.1790	1.5077	10.3740	1:11.8832	PVC-U	110 mm
MH27	1281.6306	2900781.7454	1437.8143	1436.3060	1.5083				
MH64	1281.2779	2900764.4423	1437.0060	1435.4980	1.5080	7.4930	1:20.8139	PVC-U	110 mm
MH63	1274.0344	2900766.3585	1436.6465	1435.1380	1.5085				
MH67	1434.1953	2900729.5192	1451.5860	1450.0780	1.5080	20.9350	1:8.6259	PVC-U	110 mm
MH68	1418.6253	2900715.5236	1449.1594	1447.6510	1.5084	63.3430	1:18.5159	PVC-U	110 mm
MH43	1364.7071	2900748.7684	1445.7377	1444.2300	1.5077				
MH70	1387.1354	2900722.7838	1446.6190	1445.1110	1.5080	20.1900	1:23.7529	PVC-U	110 mm
MH71	1369.2911	2900732.2308	1445.7685	1444.2610	1.5075	15.3360	1:8.3803	PVC-U	110 mm
MH69	1353.9577	2900732.5398	1443.9389	1442.4310	1.5079				
MH72	1345.5425	2900689.6319	1440.6960	1439.1880	1.5080	16.8160	1:22.2140	PVC-U	110 mm
MH44	1330.4508	2900697.0507	1439.9394	1438.4310	1.5084				
MH73	1148.6431	2900487.3968	1419.7520	1418.2440	1.5080	16.8440	1:20.0285	PVC-U	110 mm
MH51	1131.9114	2900485.4560	1418.9598	1417.4030	1.5568				
MH86	1067.1056	2900335.2830	1415.9570	1414.4490	1.5080	16.1980	1:14.6721	PVC-U	110 mm
MH87	1059.5830	2900320.9376	1414.8530	1413.3450	1.5080	23.0260	1:13.5927	PVC-U	110 mm
MH88	1050.0267	2900299.9881	1413.1587	1411.6510	1.5077	38.1010	1:80.0441	PVC-U	110 mm
MH89	1088.0988	2900298.5011	1413.6900	1411.1750	2.5150				
MH92	1163.8427	2900324.0511	1415.9070	1414.3990	1.5080	22.2070	1:79.8813	PVC-U	110 mm
MH93	1143.1119	2900332.0110	1416.3591	1414.1210	2.2381	9.2030	1:80.0261	PVC-U	110 mm
MH81	1135.8080	2900326.4128	1416.0770	1414.0060	2.0710				
MH94	1160.8577	2900335.8817	1416.7720	1415.2640	1.5080	4.3850	1:79.7273	PVC-U	110 mm
MH95	1156.4732	2900335.9035	1416.7828	1415.2090	1.5738	13.9170	1:12.7914	PVC-U	110 mm
MH93	1143.1119	2900332.0110	1416.3591	1414.1210	2.2381				
MH96	1166.6746	2900410.0688	1419.9280	1418.4200	1.5080	5.6340	1:80.4857	PVC-U	110 mm
MH97	1169.9986	2900405.5203	1419.9236	1418.3500	1.5736	7.4370	1:79.9678	PVC-U	110 mm
MH98	1170.1516	2900398.0852	1419.7780	1418.2570	1.5210	12.3350	1:15.7939	PVC-U	110 mm
MH99	1157.8181	2900397.9102	1418.9840	1417.4760	1.5080	4.1370	1:79.5577	PVC-U	110 mm
MH100	1156.8559	2900401.9339	1418.9802	1417.4240	1.5562				



OSHOEK SITE SEWER LAYOUT

SCALE 1:1500

APPENDIX B: CALCULATIONS

Water and Sewer Demand Calculations

POTABLE WATER											SEWER				
Description	**Number of Units**	**Size m^2**	**Total size m^2**	**Design Flow $l/100m^2/d$**	**Daily usage in l/day**	**Daily usage in kl/day**	**Daily demand (l/s)**	**Daily Peak Factor**	**Peak flow l/s**	**2 Day Storage in kl**	**Daily Outflow l/day**	**Generated l/s**	**Daily Peak factor**	**Peak Flow l/s**	**REFERENCE**
FREIGHT															
X ray and Vehicle Control Points	1	726	726	50	363.0	0.4	0.004201	4	0.016806	0.726	290.4	0.003	4	0.013	Assumed
Freight Inspection Building	1	2372	2372	400	9488.0	9.5	0.109815	4	0.439259	18.976	7590.4	0.088	4	0.351	DPW
Admin Building	1	1022	1022	400	4088.0	4.1	0.047315	4	0.189259	8.176	3270.4	0.038	4	0.151	DPW
State Warehouse	1	732	732	300	2196.0	2.2	0.025417	4	0.101667	4.392	1756.8	0.020	4	0.081	DPW
Toilets	2	70	140	400	560.0	0.6	0.006481	4	0.025926	1.12	448	0.005	4	0.021	DPW
Gatehouse	3	11	33		900.0	0.9	0.010417	4	0.041667	1.8	720	0.008	4	0.033	Red Book
FAST LANE CARS															
N/A															
CARS (GOODS TO DECLARE)															
SAPS Kennels	2	227	454	400	1816.0	1.8	0.021019	4	0.084074	3.632	1452.8	0.017	4	0.067	Assumed
Car Inspections (arrivals)	1	121	121	400	484.0	0.5	0.005602	4	0.022407	0.968	387.2	0.004	4	0.018	DPW
Car Inspections (departures)	1	121	121	400	484.0	0.5	0.005602	4	0.022407	0.968	387.2	0.004	4	0.018	DPW
Toilets	4	70	280	400	1120.0	1.1	0.012963	4	0.051852	2.24	896	0.010	4	0.041	DPW
Admin Building	1	1706	1706	400	6824.0	6.8	0.078981	4	0.315926	13.648	5459.2	0.063	4	0.253	DPW
Support Admin Buildings	1	1137	1137	400	4548.0	4.5	0.052639	4	0.210556	9.096	3638.4	0.042	4	0.168	DPW
SAPS holding and inspections	1	333	333	400	1332.0	1.3	0.015417	4	0.061667	2.664	1065.6	0.012	4	0.049	DPW
Gatehouse	2	11	22		600.0	0.6	0.006944	4	0.027778	1.2	480	0.006	4	0.022	Red Book
Main Security & Patrol Control Ro	2	11	22		600.0	0.6	0.006944	4	0.027778	1.2	480	0.006	4	0.022	Red Book
TAXIS, BUSES & PEDESTRIANS (FUTURE)															
Pedestrian Control Building	2	1200	2400	400	800	0.8	0.009259	4	0.037037	1.6	640	0.007	4	0.030	DPW
Toilets	2	100	200	400	800	0.8	0.009259	4	0.037037	1.6	640	0.007	4	0.030	DPW
RESIDENTIAL															
Residential buildings	115	29.57	3400.55	450	51750	51.75	0.598958	4	2.395833	103.5	41400	0.479	4	1.917	DPW
Residential mobile	11	45.55	501.05	400	4400	4.4	0.050926	4	0.203704	8.8	3520	0.041	4	0.163	DPW
Operational mobile homes	3	45	135	400	1200	1.2	0.013889	4	0.055556	2.4	960	0.011	4	0.044	DPW
TOTAL			**15857.6**			**94.35**	**1.09**		**4.4**	**188.7**	**75482.4**	**0.874**		**3.495**	

Fire Water Demand			
Fire Risk Category	Moderate		
Minimum Design Flow	6000	l/min	100
Hydrant flow rate	1500	l/min	25
Number of Hydrants	4		
Fire Demand	6000	l/min	
Operational Hours	4	h	
Fire Storage	1440000	l	
	1.44	Ml	