

# Baviaanspoort Pipeline 1:100 Year Floodline

Report Prepared for

**Department of Public Works**

Report Number 498454/P1



Report Prepared by

The logo for srk consulting, featuring a stylized orange 's' and 'r' followed by the text 'srk consulting' in a grey sans-serif font.

November 2019

# Baviaanspoort Pipeline

## 1:100 Year Floodlines

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## Executive Summary

This floodline report forms part of the application for a Water Use Authorisation for the construction of a pipeline between the Baviaanspoort Correctional Services Pump Station and the Baviaanspoort Municipal Waste Water Treatment Works. The pipeline will run from the Baviaanspoort pump station, which is located on the western bank of the Pienaars River, and will cross the Pienaars River and run on the eastern bank of Pienaars River to the Baviaanspoort WWTW. The location of the project is located approximately 1 km north of Mamelodi Township and about 4.89 km south of Roodeplaat Dam. A need was therefore identified to carry out a 1:100-year floodline study to assess the impact of flooding on the proposed Pipeline.

Results of a floodline study are covered in this report.

## Summary of principal objectives

The principal objective of this project is to carry out a 1:100-year floodline study along the Pienaars River between the Baviaanspoort Correctional Services Pump Station and the Baviaanspoort Municipal Waste Water Treatment Works

## Outline of work programme

The floodlines were determined based on the existing watercourse condition, and survey information supplied by Pherekgong Geo Consulting and City of Tshwane Metropolitan municipality. The catchment hydrology was determined by characterising the hydrological and hydraulic parameters of the catchment within which the future developments may take place. In order to obtain realistic and integrated flood peak data, the CoT municipality was divided into seven major basins. The SWMM (SCS) hydrological model was then compiled for each of the seven basins for potential fully developed land-use as obtained from the CoT Town Planning Department. The peak flow data and other relevant information were entered into the backwater model HECRAS to produce the results on the flooding extent along the river banks in the vicinity of the proposed development site.

## Conclusions

The following is concluded:

- The portion of the pipeline between R513 and Baviaanspoort Correctional Services Pump Station is situated within the 1:100 Year Floodline.
- The 1:100-year water levels range between 1251.9 mamsl at PN7592 and 1230.7 mamsl at chainage PN5385.

## Recommendations

The following is recommended:

- The floodlines be revised should watercourse/control structures be modified in the future.

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## Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by the Department of Public Works. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

# 1 Introduction and Scope of Report

This floodline report forms part of the application for a Water Use Authorisation for the construction of a pipeline between the Baviaanspoort Correctional Services Pump Station and the Baviaanspoort Municipal Waste Water Treatment Works. The pipeline will run from the Baviaanspoort pump station, which is located on the western bank of the Pienaars River, and will cross the Pienaars River and run on the eastern bank of Pienaars River to the Baviaanspoort Waste Water Treatment Works. The location of the project is located approximately 1 km north of Mamelodi Township and about 4.89 km south of Roodeplaat Dam. A need was therefore identified to carry out a 1:100-year floodline study to assess the impact of flooding on the proposed Pipeline.

## 2 Background and Brief

### 2.1 Background of the project

Department of Public works is planning to construct a pipeline between the Baviaanspoort Correctional Services Pump Station and the Baviaanspoort Municipal Waste Water Treatment Works. In terms of the National Water Act, Act 36 of 1998, the 1:100 year floodlines must be indicated on the layout plans of the developments for information purposes.

### 2.2 Program objectives

The project objectives are as follows:

- Identification and delineation of the Pienaars that runs close to the proposed pipeline;
- Delineation of catchment that drain into Pienaars River close to the proposed pipeline;
- Hydrology of the site to indicate the peak flows emanating from the start of the catchments until when it reaches the waste water treatment plant in Baviaanspoort Correctional Services;
- Determination of the detailed 1:50 and 1:100 year floodlines along the Pienaars River in Baviaanspoort Correctional Services; and
- Compile a report and associated floodline drawings showing the extent of flooding along the Pienaars River close to the proposed pipeline.

### 2.3 Purpose of the Report

This report provides the findings of the study and gives necessary information and recommendations on the flood prone areas due to a 1:100 year flood event.

## 3 Legal and Council Requirements

The **1:100-year** floodline is required in terms of the National Water Act, Act 36 of 1998, Chapter 14 Part 3 as given below.

**144.** *For the purposes of ensuring that all persons who might be affected have access to information regarding potential flood hazards, no person may establish a township unless the layout plan shows, in a form acceptable to the local authority concerned, lines indicating the maximum level likely to be reached by flood waters on average once in every 100 years.*

## 4 Description of Study Area

The proposed pipeline will be situated between the Baviaanspoort Correctional Services Pump Station and the Baviaanspoort Municipal Waste Water Treatment Works. The upper portion of the pipeline between the Baviaanspoort Waste Water Treatment Works and the R513 is situated on the eastern side of the Pienaars River whereas the lower portion of the pipeline between R513 and Baviaanspoort Correctional Services Pump Station is situated on the western side of the Pienaars River. The locality of the proposed pipeline is shown in Figure 4-1 below.



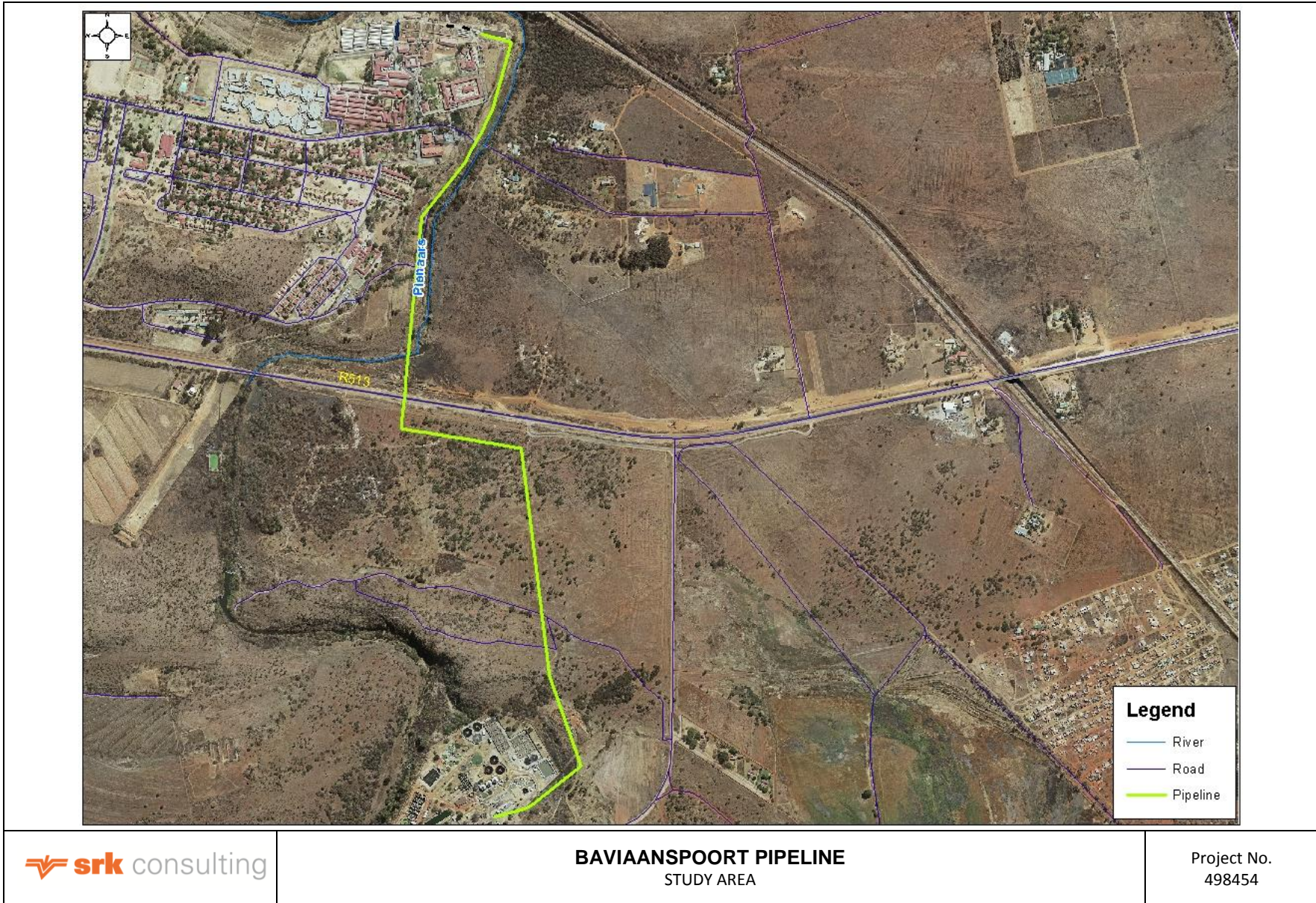
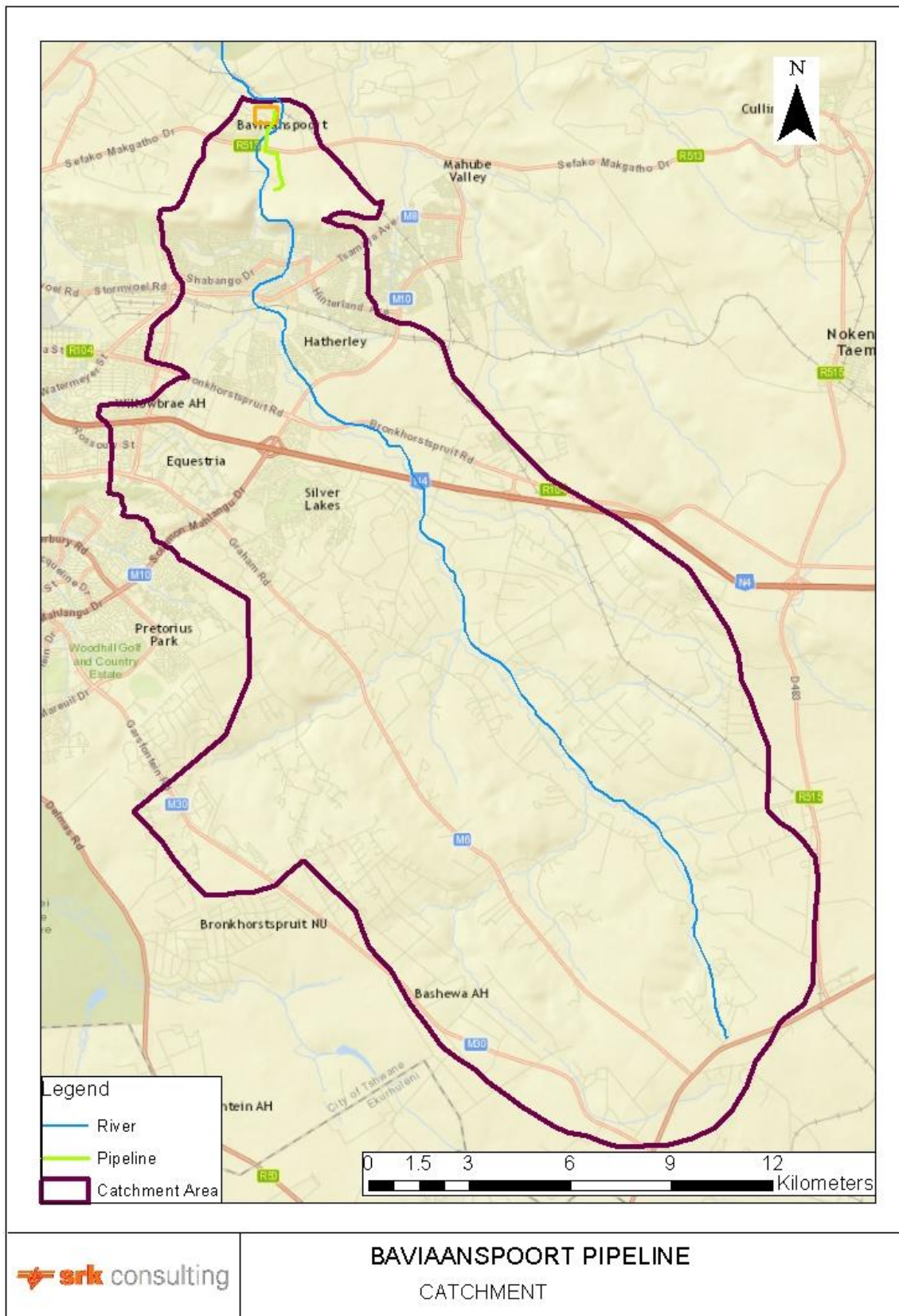


Figure 4-1: Baviaanspoort Pipeline

The floodplains along this watercourse consist mainly of grass, trees and residential properties. The watercourse is well-defined and it starts along the R25 on the western side of Bronkhorstspuit Dam approximately 32km to the south of Baviaanspoort Correctional Services. The catchment that drains towards the study area starts just on the southern side of R25 in Bronkhorstspuit. The major land uses surrounding the project area vary from agriculture, Baviaanspoort Prison north of Zambezi Drive (R513) and scattered human habitation. The catchment area of all the watercourses that drains into the study area is shown in Figure 4-2 below.



Path : G:\proj\498454\_Dept Public Works Sewerage Works\GIS\GISP PROJ\MXD\Bau Baviaanspoort\Baviaanspoort\_catchment.mxd

Figure 4-2: Baviaanspoort Pipeline (Catchment Area).

## 5 Topographical Details

The general topography was determined using 1:50 000 topographical map. In order to improve the accuracy of the aerial survey an additional terrestrial survey was carried out along the proposed development area. The survey was supplied by Pherekong Geo Consulting. This survey gave cross sectional data of the floodplains while the 1m contours from CoT gave cross sectional data of the watercourse.

### 5.1 Site Visit

A site visit of the study area was conducted to determine the catchment characteristics from the on-site observations and to obtain details of the typical land cover. From the observations made during the site visit as well as using the available topographical information and the satellite images on Google Earth, the catchment was divided into sub catchments based on the existing and proposed land use.

### 5.2 River Vegetation and Manning’s n-value

Manning’s n-value is a coefficient which is a measure of the roughness of the river. This roughness is determined by the irregularity of the stream, presence of boulders, density and type of vegetation, degree of erosion of the river banks, etc. This section includes a selection of photographs illustrating the condition of the river beds and flood plains. Mannings “n” values within the watercourse and along the floodplains are shown in pictures in Figure 5-1 below.

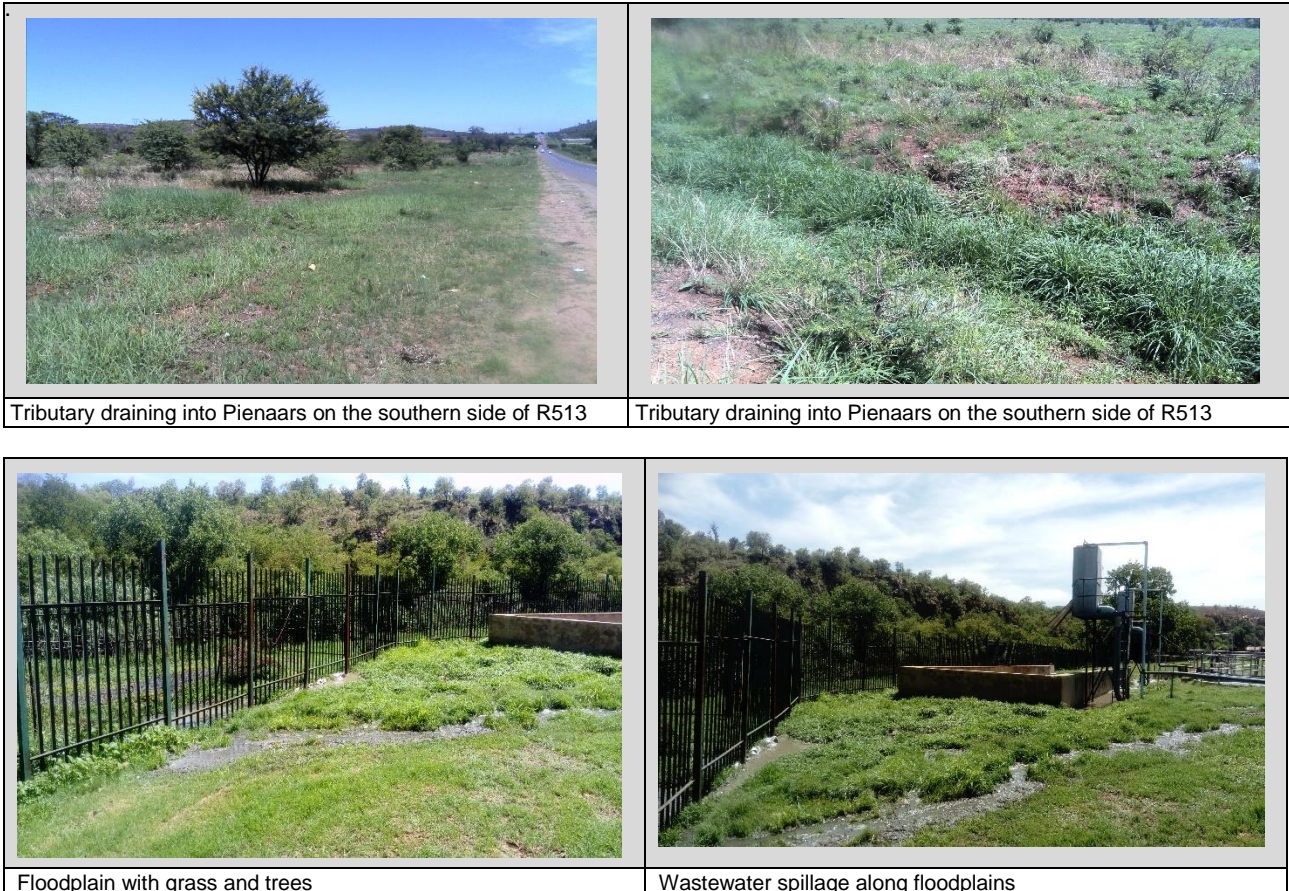




Figure 5-1: Photos taken during site visit showing the existing conditions of rivers and floodplains.

## 6 Rainfall Data

### 6.1 Storm Rainfall depths

Rainfall for the model was based on IDF (intensity-duration-frequency) curves derived for the CoT area. The estimated design rainfall depths were determined for durations ranging from 15 minutes to 24 hours and for return periods ranging from 1:2 to 1:200 years for the CoT Municipality's area of jurisdiction. The adopted 24-hour design rainfall depths for selected return periods are shown in Table 6-1 below.

Table 6-1: Adopted storm rainfall depths (mm)

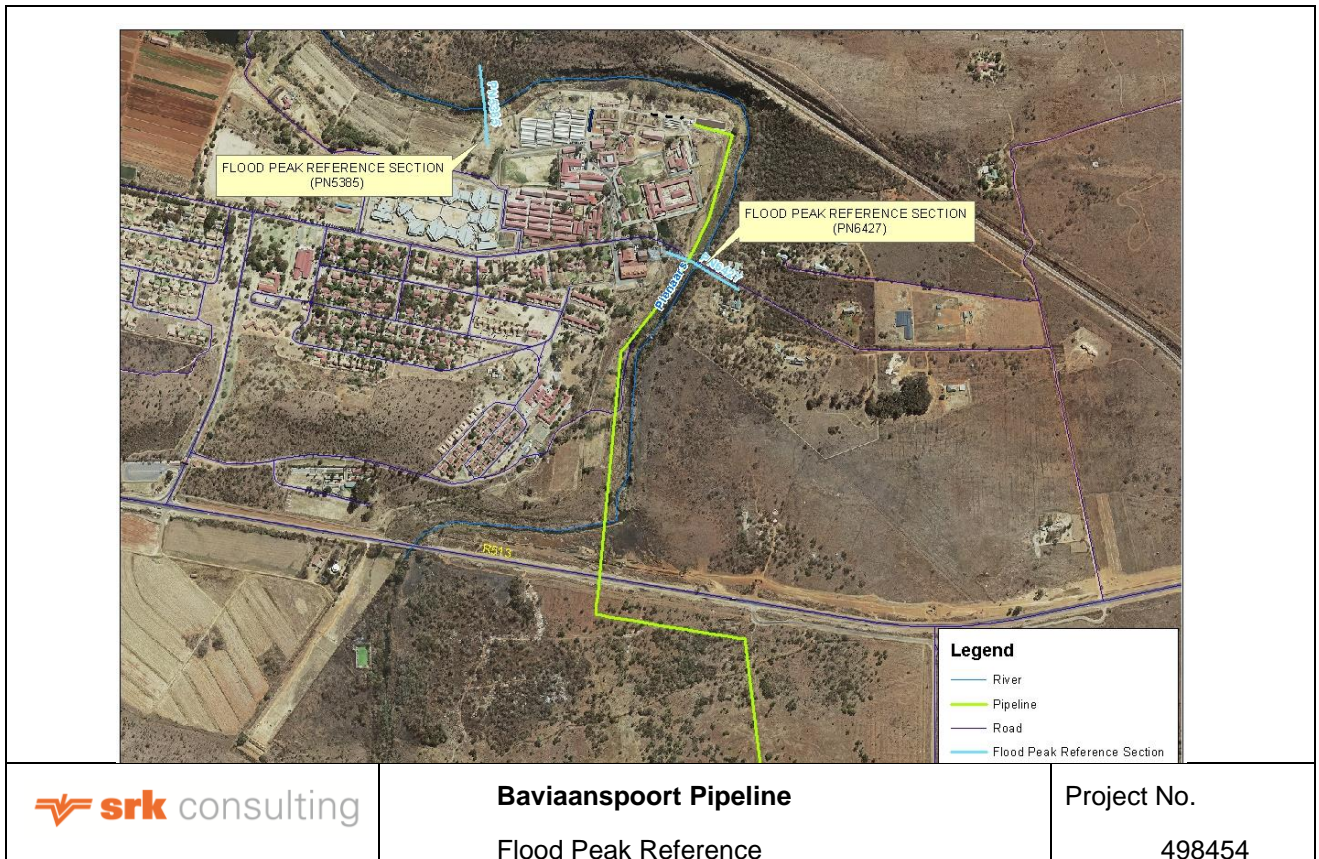
Duration	Return Period Rainfall (mm)						
	1:2 Year	1:5 Year	1:10 Year	1:20 Year	1:50 Year	1:100 Year	1:200 Year
24hours	67.3	93	112.4	133	163.1	188.4	216.2

## 7 Flood Hydrology

The catchment area was delineated using the 1:50 000 topographical map together with the 1m contours from CoT. The hydrological and hydraulic parameters of all the catchments contributing

towards the proposed site of development were calculated. The catchment hydrology was determined by characterising the hydrological and hydraulic parameters of the catchment within which the future developments may take place. In order to obtain realistic and integrated flood peak data, the City of Tshwane (CoT) municipality was divided into seven major basins. The SWMM (SCS) hydrological model was then compiled for each of the seven basins for potential fully developed land-use as obtained from the CoT Town Planning Department to determine the peak flow rates. The peak flow rates were then entered into the HECRAS model to determine relevant flood levels and associated floodlines.

The cross section where the peaks were calculated is shown in Figure 7-1 below.



**Figure 7-1: Flood Peak Reference Sections**

The SWMM calculated flood peaks together with the catchment area are summarised in Table 7-1 below

**Table 7-1: Summary of flood peaks (Future Development Conditions)**

River Segment & Chainage	Catchment Area (km <sup>2</sup> )	Peak Flow Rate (m <sup>3</sup> /s)	
		1:50	1:100
PN6427	355.4	887	1026
PN5385	357.7	892	1032

## 8 HECRAS Model Compilation

The 1m contour survey was supplied by the client and it was converted into a Digital Terrain Model (DTM) which was then entered into the HECRAS (Version 5.0.1) model. This program employs detailed channel morphology as well as site-specific hydrological data combined to perform one-

dimensional hydraulic calculations for a river network. The HECRAS model employs standard backwater techniques to compute the high-water level for various steady flow conditions, taking into account structures and controls across the watercourse. The model requires certain boundary river flow conditions as a calculation starting point.

The HECRAS model main parameters are summarised in Table 8-1 below.

**Table 8-1: HECRAS Model Main Parameters**

Parameter	Average Value/Selection	Reason
Manning 'n'	0.045 -0.060(main flow channel)	Defined watercourse with thick vegetation
	0.050(floodplains)	Moderate to thick vegetation
Boundary conditions	Normal flow depth	Control structures present
Flow regime	Mixed flow	Slope and cross section changes requiring super and sub-critical flow regimes
R513 Bridge	2 Openings 15 m W and 6m High	Backwater effect of the Bridge

The HECRAS model cross-sections were named in accordance with the defined River Referencing System (RRS) for CoT. The HECRAS model was then used in conjunction with the GIS program, Arc Map (With 3-D analyst and spatial analyst extensions). GIS was also used to create cross sections and other geometrical data for use in HECRAS and was used to export water surface data from HECRAS into a GIS data base. Further details of the HECRAS model parameter files are given in **Appendix A**.

## 9 Findings of the Floodline Study

The 1:100-year floodlines were determined based on the HECRAS model and peak flow rates as given in Table 7-1 above.

Details of the HECRAS model output data are given in Appendix A.

The certified floodlines are shown on drawing 498454/B1. From the floodline study, the following was observed:

- The portion of the pipeline between R513 and Baviaanspoort Correctional Services Pump Station is situated within the 1:100 Year Floodline.
- The 1:100-year water levels range between 1251.9 mamsl at PN7592 and 1230.7 mamsl at chainage PN5385.

## 10 Recommendations

The following is recommended:

- The floodlines be revised should watercourse/control structures be modified in the future.

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Peter Shepherd

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.



# Appendices

## **Appendix A: Hecras Outputs**

## **Appendix B: Drawings**

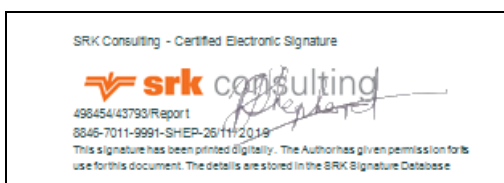
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