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Hydrological Assessment for the Proposed Newcastle Greenwich Landfill Site

Report

Version – 1

13 April 2018

Envitech Solutions

GCS Project Number: 17-0212

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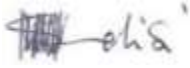
Author	Daniel Fundisi		13 April 2018
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LIST OF ACRONYMS

Acronym	Description
CMA	Catchment Management Agency
COC	Chain of Custody
DEM	Digital Elevation Model
DWS	Department of Water and Sanitation
GCS	GCS Water and Environment (Pty) Ltd
LCD	Leachate Collection Dam
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MIPI	Midgley and Pitman.
NEM:WA	National Environmental Management: Waste Act (Act No. 59 of 2008)
NWA	South African National Water Act, 1998 (Act No. 36 of 1998)
PCD	Pollution Control Dam
PCSWMM	Personal Computer Storm Water Management Model.
PFD	Process Flow Diagram
RM2	Rational Method Alternative 2
RM3	Rational Method Alternative 3
RQIS	Resource Quality Information Service
SDF	Standard Design Flood.
SWMP	Storm Water Management Plan
WR2012	Water Resources Study of South Africa, 2012
WMA	Water Management Area
WSA	Water Source Area

LIST OF DEFINITIONS

Term	Definition
Catchment	A catchment defines an area from which water will naturally drain to a defined point.
CMA	Catchment Management Agencies were created in terms of the National Water Act to manage water resources within defined major catchments.
Flood	A flood results from heavy or continuous rainfall that does not infiltrate into soils, but runs off and collects to form extreme high flow rates in rivers or streams that may not be contained within river banks.
Hydraulic Conductivity	A measure of how easily water can pass through soil or rock with high values indicating permeable material and low values indicating less permeable material.
Hydrology	Hydrology describes a field of study that analyses natural cycles of water as it passes through the environment. Aspects analysed include rainfall, evaporation, transpiration and runoff. Hydrology also refers to the results of analysis of certain aspects of hydrological cycles, such as river flow, or likely peak floods.
Infiltration	The movement of water from the land surface into the soil.
Percentiles	A statistical term indicating the value below which a given percentage of observations in a group of observations fall. For example, the 10th percentile is the value (or score) below which 10% of the observations may be found.
Perennial	Having continuous flow in parts or the whole stream/river all year round during years of normal rainfall.
Runoff	Surface runoff is defined as the water that finds its way into a surface stream channel without infiltration into the soil and may include overland flow, interflow and base flow.
Seepage	The slow movement of water through small cracks, pores, etcetera, of a material into or out of a body of surface or subsurface water. Also the loss of water by infiltration into the soil from drainage channel, ditches, watercourse, reservoir, storage facilities, or other body of water, or from a field.
Suction head	Pressure of water held in soil pores which influences water infiltration into the soil.
Sump	A hollow at the lowest point of a stormwater system into which water drains in order to be pumped out.
Watercourse	Watercourse refers to a river or spring, a natural channel in which water flows regularly or intermittently, a wetland, lake or dam into which, or from which water flows, and any collection of water.
WR2012	The WR2012 model and database describes the water resources of South Africa, Lesotho and Swaziland. It is the culmination of a number of water resource appraisals that have been carried out over the past four decades (WRC, 2015).
Water Source Area	Areas that supply downstream water users with a varying amount of water

EXECUTIVE SUMMARY

Envitech Solutions appointed GCS Water and Environment (Pty) Ltd. (GCS) to conduct a surface water study for the proposed Greenwich Land Fill Site located in Newcastle within the KwaZulu-Natal Province of South Africa. The site is situated in the Thukela Water Management Area 7 (WMA 7) and in quaternary catchments V31J and V31K.

This study was undertaken to contribute to specialist study requirements for an Environmental Impact Assessment (EIA) with respect to surface water in terms of the National Environmental Management Act (NEMA), Act 107 of 1998, National Environmental Management: Waste Act, 1998 (Act No. 59 of 2008) (NEM: WA) and the National Water Act, (Act No. 36 of 1998) (NWA). The objective of this study would be to enable a better understanding in terms of the potential impacts on the hydrological environment and to inform surface water management requirements for the Greenwich site.

Climate and Hydrology

- The Newcastle Greenwich site has an MAP of 835 mm, MAE of 1 475 mm and MAR of 42.2 mm.
- Average monthly maximum temperatures are generally in the range 19.5 to 27.6°C, while average monthly minimum temperatures are in the range of 2.2 to 15°C (SA Explorer, 2018).
- The greater Newcastle Greenwich region is drained by the perennial Ncandu River and its unnamed non-perennial tributaries.
- Five hydrological sub-catchments (SC1 to SC5) were delineated at the Newcastle Greenwich site which contributes flows to the Ncandu tributaries.
- The SDF peak flows for delineated Ncandu tributaries' sub-catchments (SC1 to SC5) which were used in HEC-RAS are: 36.4 m^3/s, 25.4 m^3/s, 23.2 m^3/s, 13.8 m^3/s and 37.7 m^3/s for the 1:50-year event, respectively and 45.8 m^3/s, 32 m^3/s, 29.2 m^3/s, 17.3 m^3/s and 47.4 m^3/s for the 1:100-year event, respectively.

Flood Lines

- Flood lines analysis shows Landfill Cells 4 to 7, the Pollution Control Dam (PCD) or Leachate Collection Dam (LCD), the Wheel Wash/ Workshop area at the proposed Newcastle Greenwich Landfill site fall within the development exclusion zone.
- Only Landfill Cells 1 to 3 are indicated to be outside the development exclusion zone.

Storm Water Management Plan

- Six storm water sub-catchments were delineated at the proposed Newcastle Greenwich Landfill site.
- The PCD or LCD storage as modelled for the 1:50-year storm event was determined to be 5 565 m^3.
- The optional temporary sump storage volume at the Workshop/Wheel Wash Area was determined to be 643 m^3.

Water Quality Analysis & Monitoring

- Two water quality monitoring localities were determined, one upstream and one downstream of the landfill site.
- Based on the historical data, accessed from the RQIS, the portion of the Ncandu River in proximity to the proposed landfill site indicates satisfactory water quality. When comparing the upstream (V3H7) and downstream (V3R2) monitoring localities V3R2 does indicate a slight increase in most analysed parameters. Despite the increase the parameter concentrations are still low.
- A monthly water quality monitoring programme was determined to include 7 monitoring locations.

Water Balance

- A total annual potable water requirement of 19 800 m^3 was calculated for the Newcastle Greenwich Landfill site. This water is expected to come from groundwater boreholes on site.
- The water balance indicates that 17 870 m^3 on average, of dirty water should pass through the PCD or Leachate Collection Dam during the wettest 6 months.

- The average 6 driest months PCD dirty water volume of 5 591 m^3 was determined.
- Monthly and daily average PCD dirty water volumes of 1 955 m^3 and 64 m^3, respectively were determined at the Greenwich Landfill site.

Impact Assessment

A surface water impact assessment was undertaken and the following potential surface water impacts or risks were identified for the construction, operation and decommissioning phases of the proposed Newcastle Greenwich Landfill development:

- Sedimentation/Siltation of the nearby Ncandu River and its tributaries will likely occur from the disturbance of soils during land preparation (Construction phase) and removal of infrastructure (decommissioning phase).
- Reduction of runoff at downstream reaches by approximately 0.5 % of Mean Annual Runoff (MAR) is expected to result from the landfill site development.
- Destruction of aquatic and riparian habitats will occur resulting in reduced biodiversity.
- Increased probability of flooding will occur as a result of the construction of infrastructure on site.
- Pollution of groundwater and the nearby Ncandu River and its tributaries will likely result from dirty landfill stormflow and leachate seepage.

Recommendations

It is recommended that:

- Application for GN 704 exemption should be submitted together with the authorisation application since the impact resulting from infrastructure development within the exclusion zone is deemed insignificant (0.5 % impact on MAR). The disturbed tributaries are non-perennial hence their runoff yield is not significant.
- The proposed PCD or Leachate Collection Dam (LCD) must have a 200 mm HDPE lining in order to minimise pollution of groundwater resources.
- The dirty water must be channelled by HDPE or concrete-lined drains to the PCD or LCD to prevent pollution of groundwater resources.
- To improve accuracy for determining flow rates, it is recommended that a calibrated flow meter be installed on the leachate inlet pipe to the PCD or LCD.

- A water level gauge be installed in the PCD.
- Surplus water should be re-used for dust suppression (if required) on the site if it meets DWS standard limits.
- The site water balance be updated if flow rates and more information become available.
- A monthly water quality monitoring programme should be implemented to include the 7 determined monitoring locations.
- Land preparation must be restricted to the landfill footprint area to minimise the size of the affected area.
- Silt traps should be installed to trap sediments from clean stormflow before discharging it into natural watercourses, especially during the construction phase.
- Quick clean-ups be undertaken when spills occur in line with the landfill site's waste management plan. Oil recovered from vehicles or machinery on site should be collected, stored and disposed of by accredited vendors for recycling.
- Impervious areas be confined to the development footprint.
- Possible treatment of dirty water from the PCD and then discharge clean treated water into the natural environment to recoup a fraction of the runoff lost.

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 107 OF 1998 (NEMA): APPENDIX 6

REQUIREMENT	STATUS
1. A specialist report prepared in terms of these Regulations must contain—	
(a) details of—	
(i) the specialist who prepared the report; and	Refer to section 2
(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Refer to Appendix 4
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Refer to Appendix 5
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Refer to section 3
(cA) an indication of the quality and age of base data used for the specialist report;	Refer to section 7
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Refer to section 11
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Refer to section 4.1
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Refer to section 4
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Refer to section 13
(g) an identification of any areas to be avoided, including buffers;	Refer to section 8
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Refer to section 8
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	N/A
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Refer to sections 8 & 13
(k) any mitigation measures for inclusion in the EMPr;	Refer to section 12

REQUIREMENT	STATUS
(l) any conditions for inclusion in the environmental authorisation;	Refer to Section 16
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Refer to Section 11
(n) a reasoned opinion—	Refer to Section 16
(i) whether the proposed activity, activities or portions thereof should be authorised;	Refer to Section 16
(iA) regarding the acceptability of the proposed activity or activities; and	Refer to Section 16
(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Refer to Section 16
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(q) any other information requested by the competent authority.	N/A
2. Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	-N/A

CONTENTS PAGE

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF TABLES

1 INTRODUCTION

Envitech Solutions appointed GCS Water and Environment (Pty) Ltd (GCS) to conduct a surface water study for the proposed Greenwich Land Fill Site located in Newcastle within the KwaZulu-Natal Province of South Africa. The site is situated in the Thukela Water Management Area 7 (WMA 7) and in quaternary catchments V31J and V31K.

This study was undertaken to contribute to specialist study requirements for an Environmental Impact Assessment (EIA) with respect to surface water in terms of the National Environmental Management Act (NEMA), Act 107 of 1998, National Environmental Management: Waste Act, 1998 (Act No. 59 of 2008) (NEM: WA) and the National Water Act, (Act No. 36 of 1998) (NWA). The objective of this study would be to enable a better understanding in terms of the potential impacts on the hydrological environment and to inform surface water management requirements for the Greenwich site.

2 DETAILS OF THE SPECIALISTS

Details of the specialists who prepared the report are presented in Table 1.1. The declaration of independence of the main author is attached as Appendix 4 while the CV's of all the specialists including reviewers are attached as Appendix 5.

Table 1.1: Details of Specialists

Person	Qualification & Registration	Years' experience
Alkie Marais	MSc (Pr.Sci.Nat)	20
Jacques Harris	BSc (Pr.Sci.Nat.)	23
Robert Verger	MSc (Pr.Sci.Nat.)	8.5
Daniel Fundisi	MSc (Pr.Sci.Nat.)	6.5

3 SCOPE OF WORK

In order to achieve the study objectives the Scope of Work (SoW) was defined as follows:

1. Site Visit:
    - A site visit was conducted on the 29th of January 2018.
2. Baseline Hydrology:
    - Catchment delineation for the relevant, greater area; and
    - Hydro-meteorological analysis including rainfall and evaporation; and
    - Determination of Mean Annual Runoff (MAR).
3. Flood Lines Modelling:
    - Peak flows calculations.
    - Setting-up and running of the HEC-RAS hydraulic modelling software,
    - Analysis of modelling results, and
    - Delineation of exclusion zones based on the 1:50- and 1:100-year flood lines and a 100 m buffer zone.
4. Stormwater Management Plan (e.g. culverts, diversion canals, berms and cut-off trenches:
    - Delineation of site sub-catchment;
    - Clean and dirty water catchment separation; and
    - Conceptual sizing of stormwater infrastructure.
5. Baseline Water Quality Analysis:
    - Analysis of water chemistry results; and
    - Determination of baseline water quality.
6. Water Balance:
    - A Visio-based water process flow diagram was generated based on information supplied by the Client; and
    - Average annual, monthly and daily water balances were compiled as per the Department of Water and Sanitation (DWS) requirements and format.
7. Impact assessment:

- Identification of potential receptors downstream of the site using Water Authorisation Registration Management System (WARMS) data; and
- A description of all surface water impacts and proposed mitigation measures, using the client's or GCS standard EIA Risk and Mitigation methodology.

8. Reporting:
   - A project close-out report detailing the results of all of the activities listed above will be compiled; and
   - Recommendations will be made for additional work and data requirements, if needed.

4 METHODOLOGY

4.1 Site Visit and Field Work

The site visit was undertaken on the 29th of January 2018 to ground-truth findings of preliminary satellite (Google Earth) desktop assessment. The site visit dates were appropriate to enable physical investigation of rainfall and runoff dynamics including land cover distribution, since this was during the rainy season. The site visit enabled GCS specialists to verify desktop assessment findings with respect to river networks, general land cover and terrain characteristics as well as to physically pick other details not observable through satellite imagery due to resolution limitations.

The catchment characterisation was conducted in order to establish baseline conditions and to assist in identifying elements that could potentially influence flood lines modelling and stormwater management measures on site.

4.2 Hydrological Assessment

Climate data obtained from the database of the WR2012 study (WRC, 2015) were analysed to determine the Mean Annual Precipitation (MAP), Mean Annual Evaporation (MAE) and the Mean Annual Runoff (MAR). Tenth (E10) to ninetieth exceedance percentiles (E90) of the MAP, MAE and MAR monthly distributions were calculated for the Newcastle Greenwich Landfill project site. These statistics were used to evaluate general trends of the aforementioned climate elements.

4.3 Flood Lines

Four methods were used to calculate peak flows for the Newcastle Greenwich study site as input into the flood line assessment. These are the Rational Method Alternative 3 (RM3), Rational Method Alternative 2 (RM2), Standard Design Flood (SDF) and the Midgley and Pitman (MIPI) methods. A brief description of each of the methods can be seen in the following box:

Rational Method

The rational method was developed in the mid-19th century and is one of the most widely used methods for the calculation of peak flows for small catchments (< 15 km^2). The formula indicates that Q = CIA/3.6, where I is the rainfall intensity, A is the upstream runoff area and C is the runoff coefficient. Q is the peak flow. There are 3 alternatives to the Rational Method which differ on the methodology used to calculate rainfall intensities. The first alternative (RM1) uses the depth-duration frequency relationships approach, the second uses the modified Hershfield equation while the third alternative uses the Design Rainfall software for South Africa (SANRAL, 2013).

Standard Design Flood Method

The Standard Design Flood (SDF) method was developed specifically to address the uncertainty in flood prediction under South African conditions (Alexander, 2002). The runoff coefficient (C) is replaced by a calibrated value based on the subdivision of the country into 26 regions or Water Management Areas (WMAs). The design methodology is slightly different and looks at the probability of a peak flood event occurring at any one of a series of similarly sized catchments in a wider region, while other methods focus on point probabilities (SANRAL, 2013).

Empirical Method: Midgley & Pitman

Empirical methods such as the Midgley and Pitman (MIPI) are based on correlation between peak flows and some catchment characteristics. Regional parameters are then mapped out for South Africa. These methods are mostly suitable for medium to large catchments (SANRAL, 2013).

Flood lines for tributaries of the Ncandu River were analysed for the 1:50-year and 1:100-year flood events to evaluate the risks associated with potential flooding. A summary of the methodology used in the hydraulic modelling process is presented in Figure 4.1.

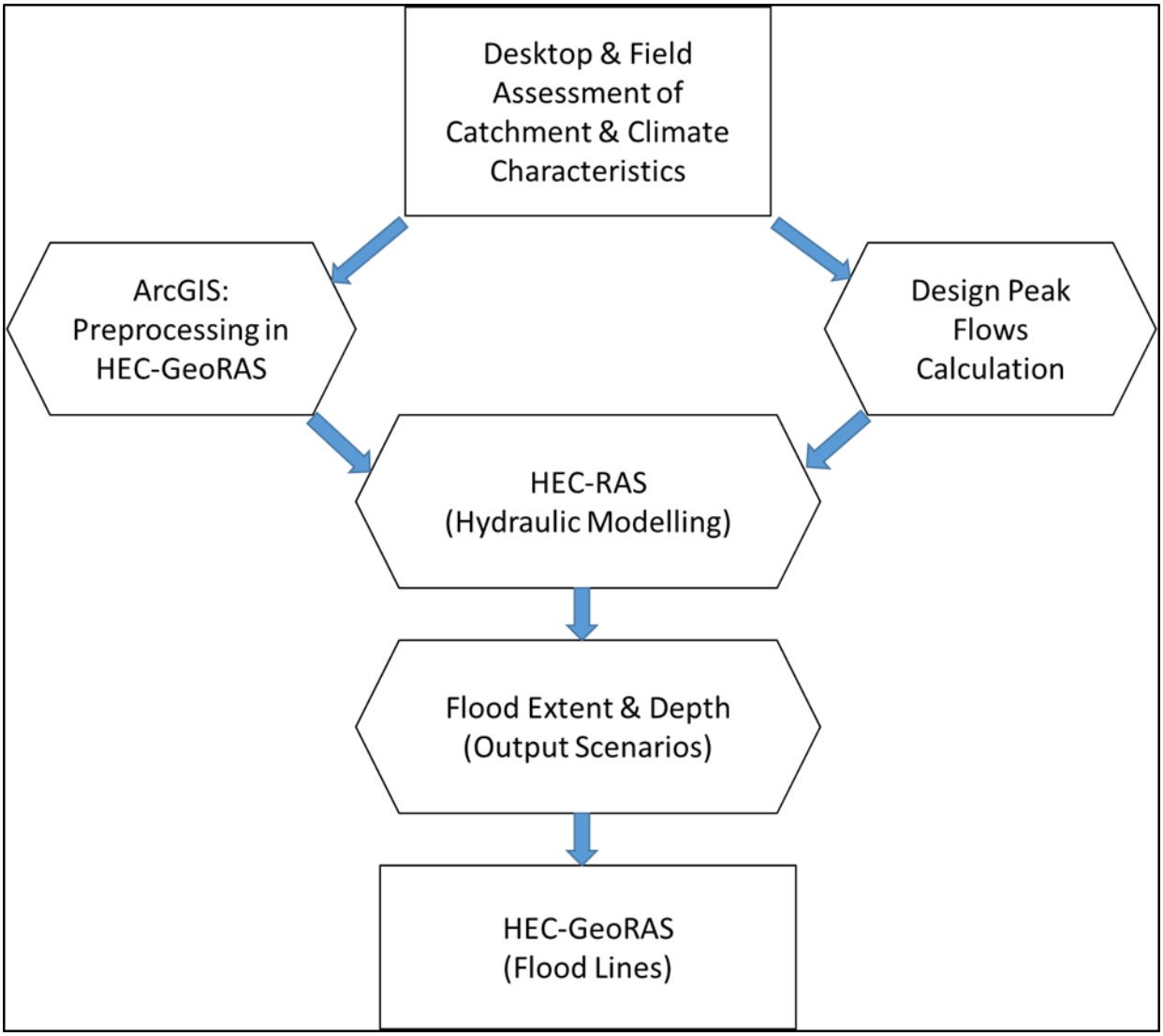


Figure 4.1: Summary of the hydraulic modelling process

The approach adopted in the study can be summarised as follows:

- The site was visited to assess the site specific hydrological conditions of the streams, which will influence the flood line determination;
- The catchment areas were determined;
- Available 0.5 m contour data provided by the client of the study area were used as input to delineate channel geometry for the river sections;
- A flood peak analysis was undertaken to determine the 1:50-year and 1:100-year flood peaks for the rivers;
- The flood peaks were used as inputs to the HEC-RAS backwater programme to determine the surface water elevations for the 1:50-year and 1:100-year floods; and

- The flood lines were plotted on the available infrastructure, using ESRI ArcGIS software for Geographic Information Systems (GIS) work and mapping.

The river sections were modelled using the HEC-RAS software (US Army Corps of Engineers, 1995) after creating cross-sections at various intervals using the HEC-GeoRAS 'add-in' within ArcGIS. HEC-GeoRAS enables the preparation of geometric features such as cross-sections and bank stations in ArcGIS (ESRI, 2012) in a format suitable for import into the HEC-RAS hydraulic model.

The HEC-RAS model simulates total energy of water by applying basic principles of mass, continuity and momentum as well as roughness factors between all cross sections (US Army Corps of Engineers, 1995). A height is calculated at each cross-section, which represents the level to which water will rise at that section, given the potential peak flows. This was calculated for the 1:50-year and 1:100-year flows on all river sections.

Analyses are performed by modelling flows at the sub-catchment outlet of particular stream or channel sections first, moving upstream. Manning's Roughness Coefficients (n) for the channels were set at 0.035, and those for river banks were determined to be 0.04 representing natural channels with light brush and reeds on the banks (Chow, 1959). These coefficients were selected based on the Cowan Theory (Cowan, 1956) according to the following equation:

$$\boldsymbol{n = (nb + n1 + n2 + n3 + n4)m}$$

Where n_b is a base value of n for a straight, uniform, smooth natural channel:

n_1 is a correction factor for the effect of surface irregularities;

n_2 is a value depicting channel cross sectional area variations in shape and size;

n_3 is a value for flow obstructions in the channel;

n_4 is a value for vegetation and flow conditions, and

m is a correction factor for the meandering of the channel.

Physiographic characteristics of assessed channels were used to estimate roughness adjustment factors, as described in the aforementioned equation (Cowan, 1956).

4.4 Conceptual Storm Water Management Plan (SWMP)

The conceptual SWMP was undertaken with adherence to the guidelines for Human Settlement Planning and Design as stipulated by the Council for Scientific and Industrial Research (CSIR, 2005). Clean and dirty water catchments were delineated based on the functions of proposed infrastructure on site. Stormwater drains and berms were determined and sized in the Personal Computer Storm Water Management Model (PCSWMM). PCSWMM is a dynamic rainfall-runoff simulation model used for single event or long-term simulation of runoff quantity (James, Rossman and James, 2010). The PCSWMM programme derived site elevation details from a Digital Elevation Model (DEM) generated using 0.5 m contours for the site.

The storage capacity of an outfall/storage structure was determined as a function of the simulated stormflow, incident rainfall and outfall depth for an optimised model to ensure zero flooding or surcharge. The drains were sized not to spill, on average, when a 1:50-year flood event occurs. The model uses the catchment area, average slope, catchment permeability and the design rainfall depth to simulate storm flows which are channelled to containment structures or discharged through low-point outlets. The influence of paved areas such as rooftops, roads and concrete slabs was incorporated in PCSWMM by specifying the proportionate percentages of impervious areas within the demarcated sub-catchments. In this case impervious areas were a small proportion confined to access roads, the administration offices, the parking area, workshop area and the transfer area.

4.5 Baseline Surface Water Quality

Water quality data from the Resource Quality Information Service (RQIS) (DWS, 2018) of the Department of Water and Sanitation were used. The website offers a water quality data exploration tool where historical chemical water quality data can be accessed. Water quality data for two (2) points along the Ncandu River were obtained from the RQIS dataset, as mentioned (DWS, 2018). One point (V3H7) is located upstream, while the other point (V3R2) is downstream of the proposed landfill site.

The chemistry data were illustrated graphically by means of relevant hydrochemical plots and this enabled the determination of the baseline water quality for the chosen localities. This information will be useful for future water quality monitoring to determine any pollution that might result from activities at the proposed Greenwich Landfill site development.

4.6 Water Balance

The Water Balance is based on a water Process Flow Diagram (PFD) that was developed in conjunction with the client. The PFD describes a concept water balance indicating, sources of water and the movement of water within the site, abstraction, water storage and discharges.

The static water balance compilation utilised results of the hydrological assessment to provide hydrological inputs such as rainfall, runoff and evaporation into modelling calculations. The water uses and consumption volumes used in the water balance were either calculated or provided by the client. Where information gaps were identified, assumptions were made.

The Water Balance was conducted in accordance with the DWS Best Practice Guidelines (BPG) G2: Water and Salt Balances (DWA, 2006).

4.7 Impact Assessment

The following methodology was used to rank identified impacts at the Greenwich Landfill site. Clearly defined ranking scales were used to assess all identified impacts. Each identified impact was rated according to the expected magnitude, duration, scale and probability of the impact.

The assessment of the identified impact was conducted in terms of scale (spatial scale), magnitude (severity) and duration (temporal scale). Impact consequence was then determined as follows:

Consequence = Severity + Spatial Scale + Duration *(Equation 1)*

The Risk of the activity was then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

Likelihood = Frequency of activity + frequency of impact + legal issues + detection

(Equation 2)

The risk was then based on the consequence and likelihood as follows:

Risk = Consequence x likelihood *(Equation 3)*

In order to assess each of these factors for each impact, the ranking scales in Table 4.1 – Table 4.7 were used.

Table 4.1: Severity.

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful / within a regulated sensitive area	5

Table 4.2: Spatial Scale

Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5km)	3
Regional / neighbouring areas (5km to 50km)	4
National	5

Spatial scale addresses the question: How big is the area that the aspect is impacting on?

Table 4.3: Duration.

One day to one month (immediate)	1
One month to one year (Short term)	2
One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity (permanent)	5

Duration addresses the question: How long does the impact last?

Table 4.4: Frequency of the activity

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Frequency addresses the question: How often is the specific activity carried out?

Table 4.5: Frequency of the incident/impact

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Frequency of impact addresses the question: How often does the activity impact on the environment?

Table 4.6: Legal Issues

No legislation	1
Fully covered by legislation	5

Legal issues address the question: How is the activity governed by legislation?

Table 4.7: Detection

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Detection addresses the question: How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property?

Environmental effects were rated as either of high, moderate or low significance on the basis provided in Table 4.8.

Table 4.8: Impact Ratings.

RATING	CLASS
1 – 55	(L) Low Risk
56 – 169	M) Moderate Risk
170 – 600	(H) High Risk

5 STUDY SITE

The Newcastle Greenwich Landfill site is located approximately 15 km to the south of the Newcastle Town off the N11 National Road in KwaZulu-Natal, South Africa.

The topography of the area slopes in a north westerly direction towards the non-perennial Ncandu River according to observations on site as well as the 0.5 m topographical data obtained from the client. As mentioned, the site is situated in the Thukela Water Management Area 7 (WMA 7) and in quaternary catchments V31J and V31K. The study site locality can be seen in Figure 5.1.

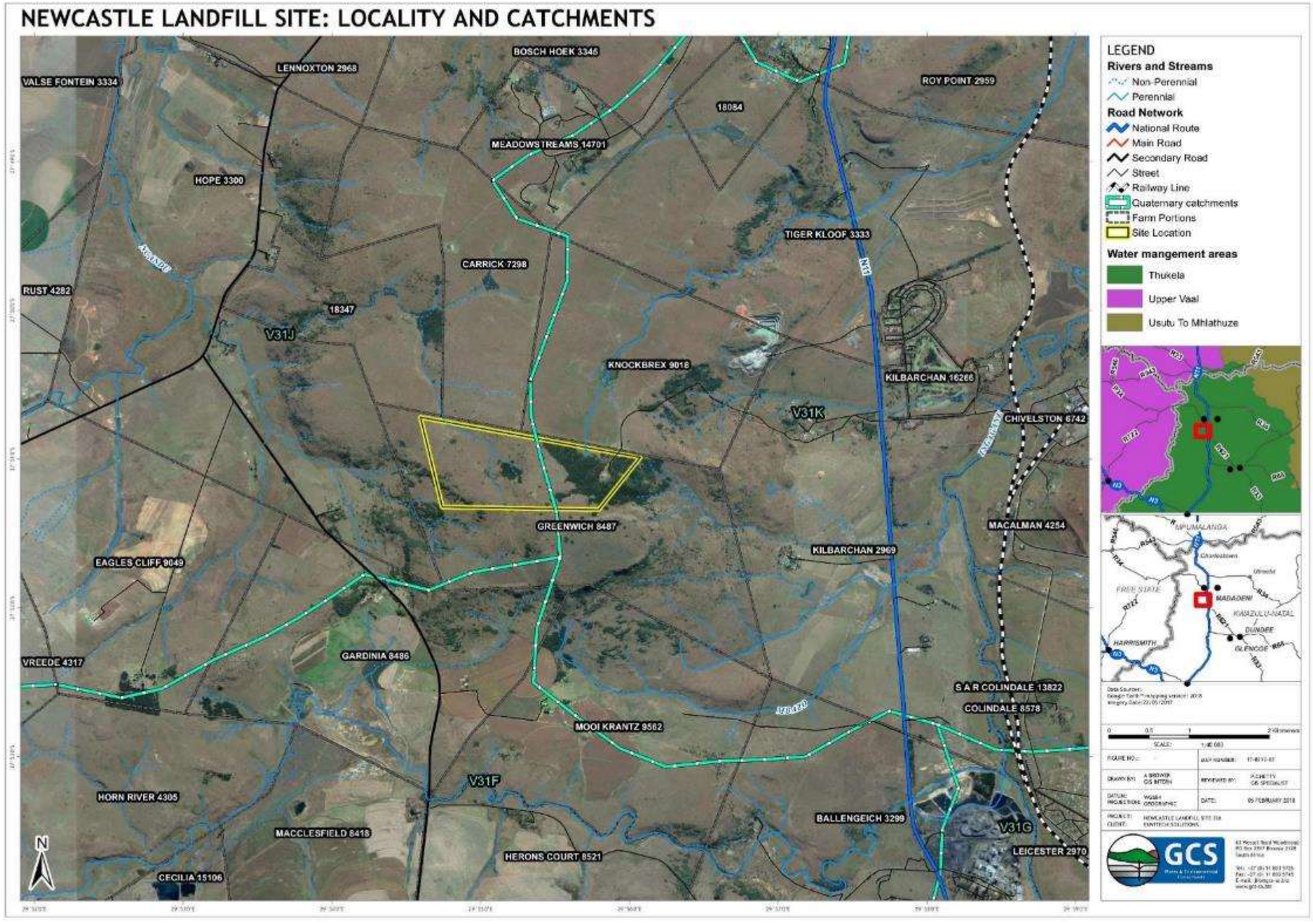


Figure 5.1: Locality of the proposed Greenwich Landfill site

The general outlook of the proposed Greenwich Landfill site and the proximal watercourses can be seen in Photograph 5.1 to Photograph 5.7. The site is predominantly Greenfield and is covered by short grasses interspaced with brush and isolated trees. The regional vegetation in the project area is the Northern KwaZulu-Natal Moist Grassland Vegetation unit.

The general terrain is undulating and rocky on the southern parts of the site and the scattered rocks gradually disappear downslope to hillslope valley bottoms as depicted in Photograph 5.1 and Photograph 5.2. Some of the mid-slopes and valley bottoms are plains covered in grass and sparse brush and the soils are typical of seasonal wetland soils. The intermittent watercourses in close proximity to the Greenwich Landfill site are presented in Photograph 5.3 to Photograph 5.7.

Photograph 5.1: Rocky southern part of the Greenwich Landfill site

Photograph 5.2: South-north transitional view of the Greenwich Landfill site

Photograph 5.3: Part of Ncandu tributary 1 in the north-west direction from landfill site

Photograph 5.4: Part of Ncandu tributary 2 in the eastern direction towards landfill site

Photograph 5.5: Ncandu tributary 3 general outlook north-west form site

Photograph 5.6: Ncandu tributary 4 general outlook across the northern fringe

Photograph 5.7: Ncandu tributary 5 general outlook northwards from landfill site

6 LEGISLATION AND POLICY FRAMEWORK

6.1 Catchment Management Strategies

Catchment Management Agencies (CMAs) are tasked with coordinating the water demands, interests and responsibilities of all relevant government departments, institutions and water users within a specific CMA (DWA, 2012). This is to ensure that on a regional scale, water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner for the benefit of all persons. The main instrument that guides and governs the activities of a CMA is the Catchment Management Strategy which, while conforming to relevant legislation and national strategies, provides detailed arrangements for the protection, use, development, conservation, management and control of the region's water resources. The proposed Newcastle Greenwich Landfill site falls within the Thukela Water Management Area 7 (WMA 7) and in quaternary catchments V31J and V31K.

6.2 The National Water Act, No. 36 of 1998

The National Water Act (NWA), Act 36 of 1998 is the principal legal instrument relating to water resource management in South Africa. As guardian and trustee of the nation’s water resources, the Government (specifically the DWS) must ensure that water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner for the benefit of all persons and in accordance with its constitutional mandate. The act addresses specific issues such as protection of water resources from pollution by developmental activities including mining, urban development which is linked to waste disposal by landfills.

6.3 GN 704 Guideline Document

The DWS General Notice 704 provide robust regulations for the implementation of the NWA by stipulating specific requirements in respect of the use of water for mining and related activities aimed at the protection of water resources. The 1:100 year flood-line restriction is the internationally accepted norm for the placement of anything that may be in danger of failing or have a potential safety hazard (DWAF, 2000). Regulation Number 4 states that no person in control of a mine or related activity may locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked (DWAF, 2000).

6.4 Environmental Management Act, No. 107 of 1998

The National Environmental Management Act (NEMA), Act No. 107 of 1998, is the key overarching environmental legislation in South Africa. The objective of the Act is to provide for co-operative, environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state; and to provide for matters connected therewith. The NEMA works in conjunction with the National Environmental Management: Waste Act (NEM: WA), Act No. 59 of 2008 which specifically deals with the proposer management of wastes to prevent pollution of the environment including water resources. Any development must be socially, environmentally and economically sustainable.

6.5 National Environmental Management: Waste Act, No. 59 of 2008

The purpose of the National Environmental Management: Waste Act, (NEM:WA) No. 59 of 2008 is to regulate waste management in order to protect human/animal health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development. It is also to provide for institutional arrangements and planning matters, national norms and standards for regulating the management of waste by all spheres of government. The NEM:WA calls for the provision of specific waste management measures, licensing and control of waste management activities.

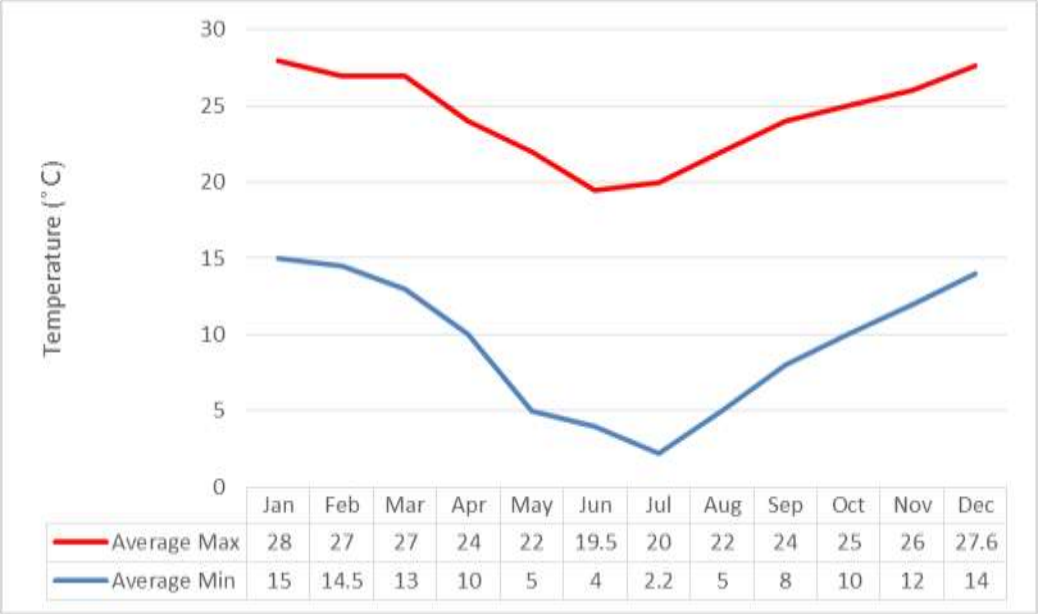
7 HYDROLOGICAL ASSESSMENT

This section presents the climate and hydrology for the Newcastle Greenwich region.

7.1 Climate

The Koppen Geiger classification indicates that the study site falls under the Temperate or C-climate category, characterised by cold dry winters and warm summers denoted as Cwb (Peel et al., 2007).

Typical monthly average maximum and minimum temperatures for the study site are indicated in Figure 7.1. Average maximum temperatures are generally in the range 19.5 to 27.6°C, while average minimum temperatures are in the range of 2.2 to 15°C (SA Explorer, 2018).

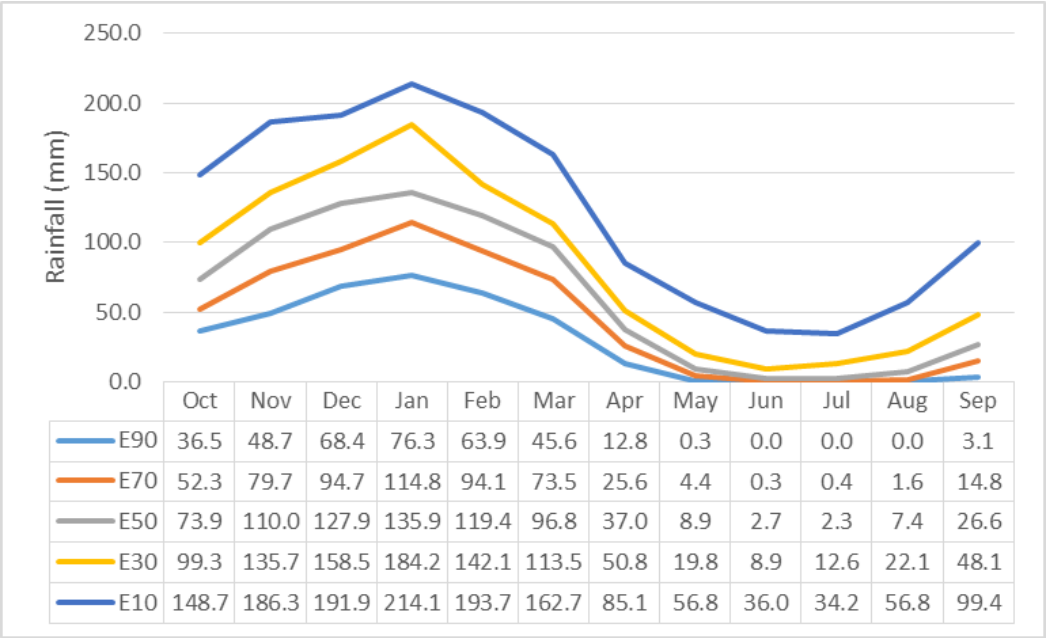


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Max	28	27	27	24	22	19.5	20	22	24	25	26	27.6
Average Min	15	14.5	13	10	5	4	2.2	5	8	10	12	14

Figure 7.1: Temperature distribution for the Newcastle Greenwich Landfill site

7.2 Rainfall

The Mean Annual precipitation (MAP) for the site is 835 mm whose distribution is indicated in Figure 7.2 (WRC, 2015). The maximum rainfall depth likely to be exceeded in 10% of years equals 214.1 mm falling approximately during the month of January. The median rainfall depth for the wettest month of January is indicated to be 135.9 mm.

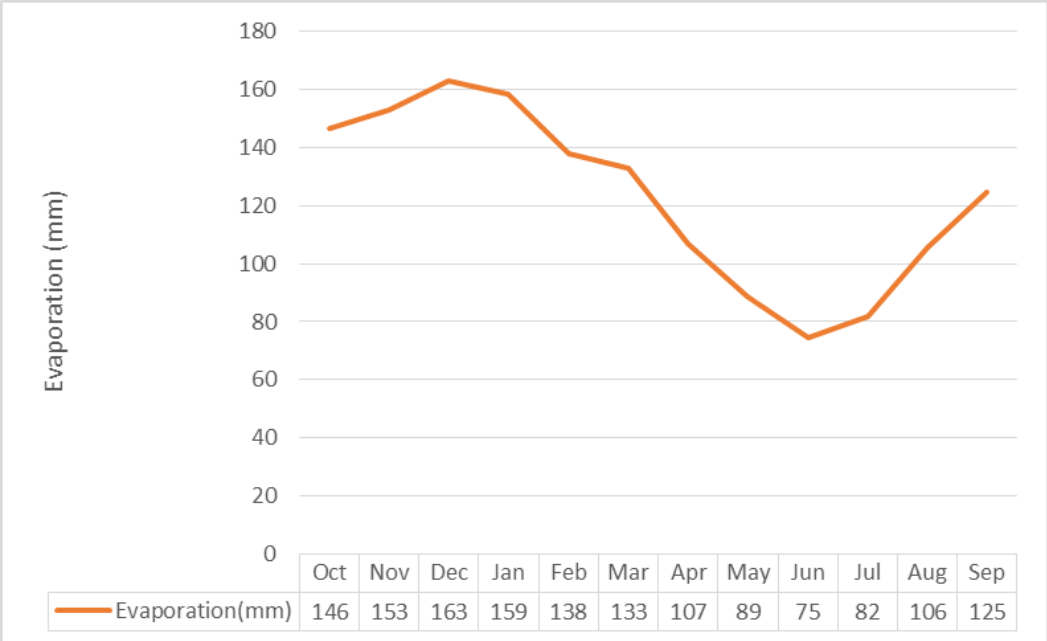


	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
E90	36.5	48.7	68.4	76.3	63.9	45.6	12.8	0.3	0.0	0.0	0.0	3.1
E70	52.3	79.7	94.7	114.8	94.1	73.5	25.6	4.4	0.3	0.4	1.6	14.8
E50	73.9	110.0	127.9	135.9	119.4	96.8	37.0	8.9	2.7	2.3	7.4	26.6
E30	99.3	135.7	158.5	184.2	142.1	113.5	50.8	19.8	8.9	12.6	22.1	48.1
E10	148.7	186.3	191.9	214.1	193.7	162.7	85.1	56.8	36.0	34.2	56.8	99.4

Figure 7.2: Rainfall distribution for the Newcastle Greenwich Landfill site

7.3 Evaporation

The Mean Annual Evaporation (MAE) for quaternaries V31J and V31K is 1 475 mm which is almost 2 times higher than the MAP of 835 mm (WRC, 2015). This MAE is only an indication of maximum potential evaporation and not actual evaporation for the region. The average of the potential monthly evaporation trend for the site can be seen in Figure 7.3.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation(mm)	146	153	163	159	138	133	107	89	75	82	106	125

Figure 7.3: Monthly evaporation trend for the Newcastle Greenwich Landfill site

7.4 Drainage and Catchments

The greater region in which the Newcastle Greenwich project site is located is drained by the Ncandu River which is a secondary perennial channel, being fed by non-perennial tertiary streams. Five sub-catchments were delineated at the Greenwich site and these can be seen in Figure 7.4. The hydraulic characteristics of the delineated sub-catchments are presented in Table 7.1. Catchment characterisation was undertaken in order to evaluate catchment parameters which included the catchment area, hydraulic length, distance to catchment centroid and channel slopes. These parameters were useful in calculating associated peak flows for the sub-catchments.

Table 7.1: Characteristics of the delineated catchments

Catchments	Area	Hydraulic Length (L)	Distance to Catchment Centroid (Lc)	Slope
	km^2	km	km	(m/m)
SC1	1.69	2.41	1.06	0.101
SC2	0.83	1.214	0.582	0.136
SC3	1.16	2.33	1.26	0.069
SC4	0.54	1.061	0.535	0.041
SC5	1.64	1.72	0.93	0.068

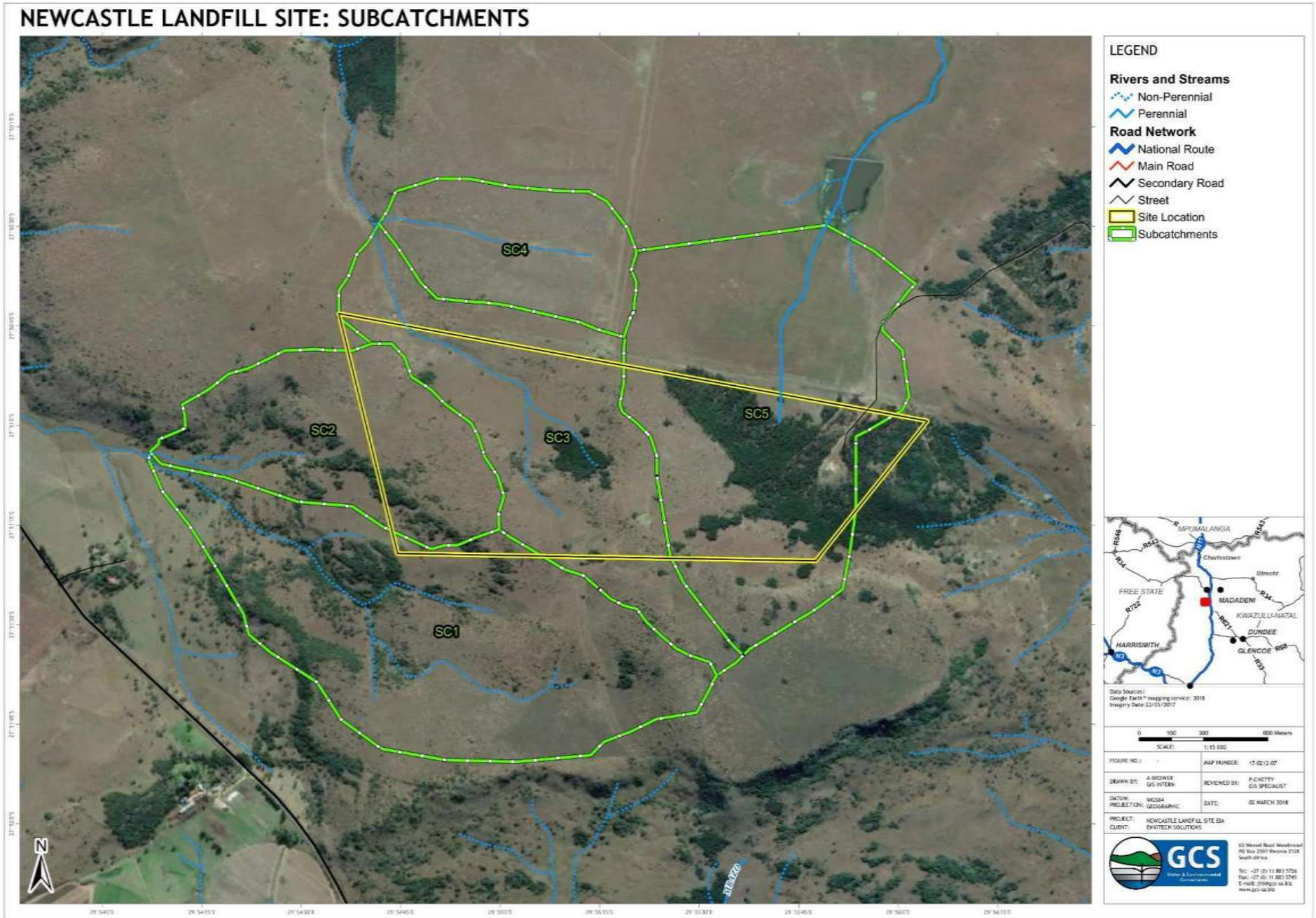
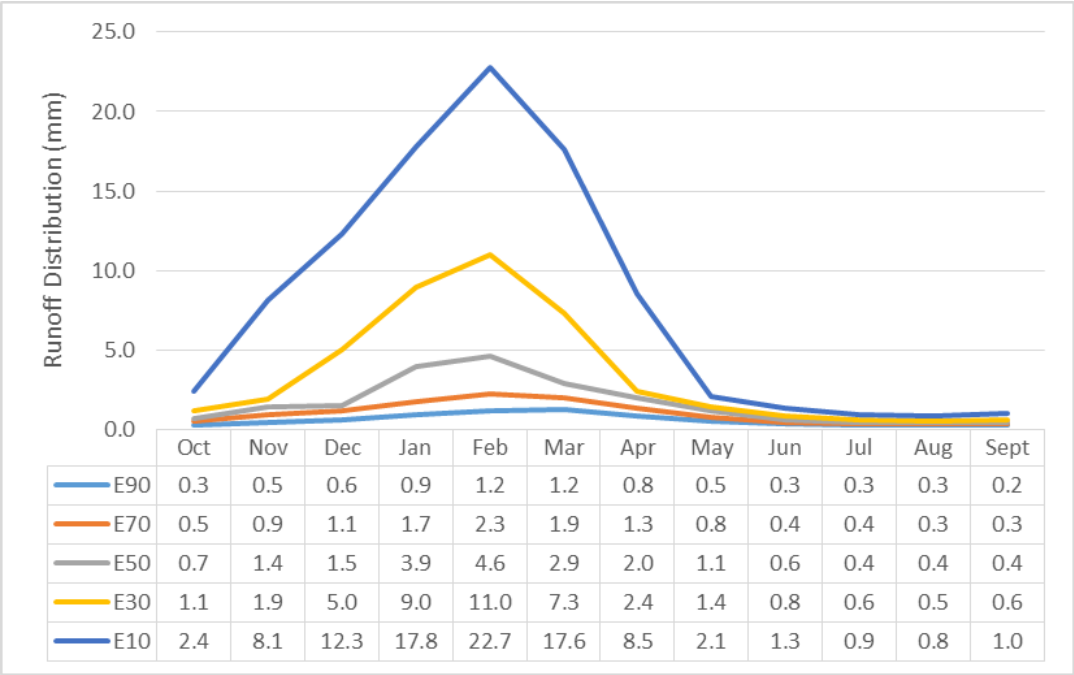


Figure 7.4: Delineated sub-catchments at the Newcastle Greenwich Landfill site

7.5 Runoff Processes

The combined Mean Annual Runoff (MAR) of quaternaries V31J and V31K where the project site is located is 42.2 mm which accounts for approximately 5% of MAP. The distribution of this MAR is indicated in Figure 7.5.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
E90	0.3	0.5	0.6	0.9	1.2	1.2	0.8	0.5	0.3	0.3	0.3	0.2
E70	0.5	0.9	1.1	1.7	2.3	1.9	1.3	0.8	0.4	0.4	0.3	0.3
E50	0.7	1.4	1.5	3.9	4.6	2.9	2.0	1.1	0.6	0.4	0.4	0.4
E30	1.1	1.9	5.0	9.0	11.0	7.3	2.4	1.4	0.8	0.6	0.5	0.6
E10	2.4	8.1	12.3	17.8	22.7	17.6	8.5	2.1	1.3	0.9	0.8	1.0

Figure 7.5: Runoff distribution for quaternaries V31J and V31K

7.6 Design Rainfall Depths

The design rainfall depths for the proposed Newcastle Greenwich Landfill site were calculated using the Design Rainfall software for South Africa (Smithers and Schulze, 2000). The design rainfall depths for the 1:2-year to 1:200-year return periods can be seen in Table 7.2. These rainfall depths were used as input in calculating flood peak flows for the project site using the RM3 method as well as for stormwater modelling in PCSWMM.

Table 7.2: Design rainfall depths for the proposed Greenwich Landfill site

Return Period							
Duration	**2year**	**5year**	**10year**	**20year**	**50year**	**100year**	**200year**
5 m	12.9	17	19.8	22.7	26.5	29.6	32.7
10 m	17	22.4	26.1	29.9	34.9	38.9	43.1
15 m	20	26.3	30.7	35.1	41.1	45.8	50.6
30 m	25.4	33.4	39	44.6	52.2	58.2	64.3
45 m	29.2	38.5	44.9	51.3	60.1	66.9	74
1 h	32.3	42.5	49.6	56.7	66.3	73.9	81.8
1.5 h	37.1	48.9	57.1	65.2	76.3	85.1	94.1
2 h	41	54	63	72.1	84.3	94	103.9
4 h	48	63.2	73.8	84.3	98.7	110	121.6
6 h	52.6	69.3	80.8	92.4	108.2	120.5	133.3
8 h	56.1	73.9	86.3	98.7	115.4	128.7	142.3
10 h	59	77.8	90.8	103.8	121.4	135.3	149.7
12 h	61.5	81	94.6	108.2	126.6	141	156
16 h	65.7	86.5	101	115.5	135.1	150.5	166.5
20 h	69.1	91	106.2	121.4	142.1	158.4	175.1
24 h	72	94.8	110.7	126.6	148.1	165	182.5

7.7 Peak Flows

The flood peak flows for the delineated sub-catchments (See Table 7.3) were calculated using the RM3, RM2, SDF and the MIPI methods. Generally all 4 methods indicated peak flows of the same order of magnitude which implies these peaks are realistic for the study site. The SDF peak flows were selected for use in HEC-RAS because they were more conservative than for the remaining 3 methods to ensure infrastructure safety from flood inundation and associated risks. The calculated peak flows are presented in Table 7.3.

Table 7.3: Peak flows for sub-catchments at the proposed Greenwich Landfill site

Catchment	Method							
	RM3		RM2		SDF		MIPI	
	1:50yr	1:100yr	1:50yr	1:100yr	1:50yr	1:100yr	1:50yr	1:100yr
	(m^3/s)							
SC1	20.2	27.1	20.3	28.2	36.4	45.8	30.0	37.9
SC2	28.2	37.8	28.9	40.1	25.4	32.0	22.6	28.6
SC3	12.3	16.5	18.8	26.1	23.2	29.2	20.8	26.3
SC4	12.9	17.3	11.4	15.8	13.8	17.3	14.9	18.8
SC5	25.6	34.4	29.8	41.3	37.7	47.4	30.9	39.0

8 FLOOD LINES

Flood lines were calculated for 5 non-perennial tributaries of the Ncandu River for flood events of the 1:50-yr and 1:100-year return periods. The calculated flood lines and the exclusion zone can be seen in Figure 8.1 and Figure 8.2. The exclusion zone represents an area where no development should take place and is marked by the furthest of either the 1:100-year flood line or the 100 m buffer from a watercourse. The exclusion zone is demarcated in order to ensure protection of infrastructure from flood hazards as well as to protect the water resources in the area.

The proposed leachate collection or Pollution Control Dam (PCD) and Landfill Cells 4 to 7 fall within the exclusion zone at the Newcastle Greenwich Landfill site. Only Landfill Cells 1 to 3 are outside the development exclusion zone (See Figure 8.2).

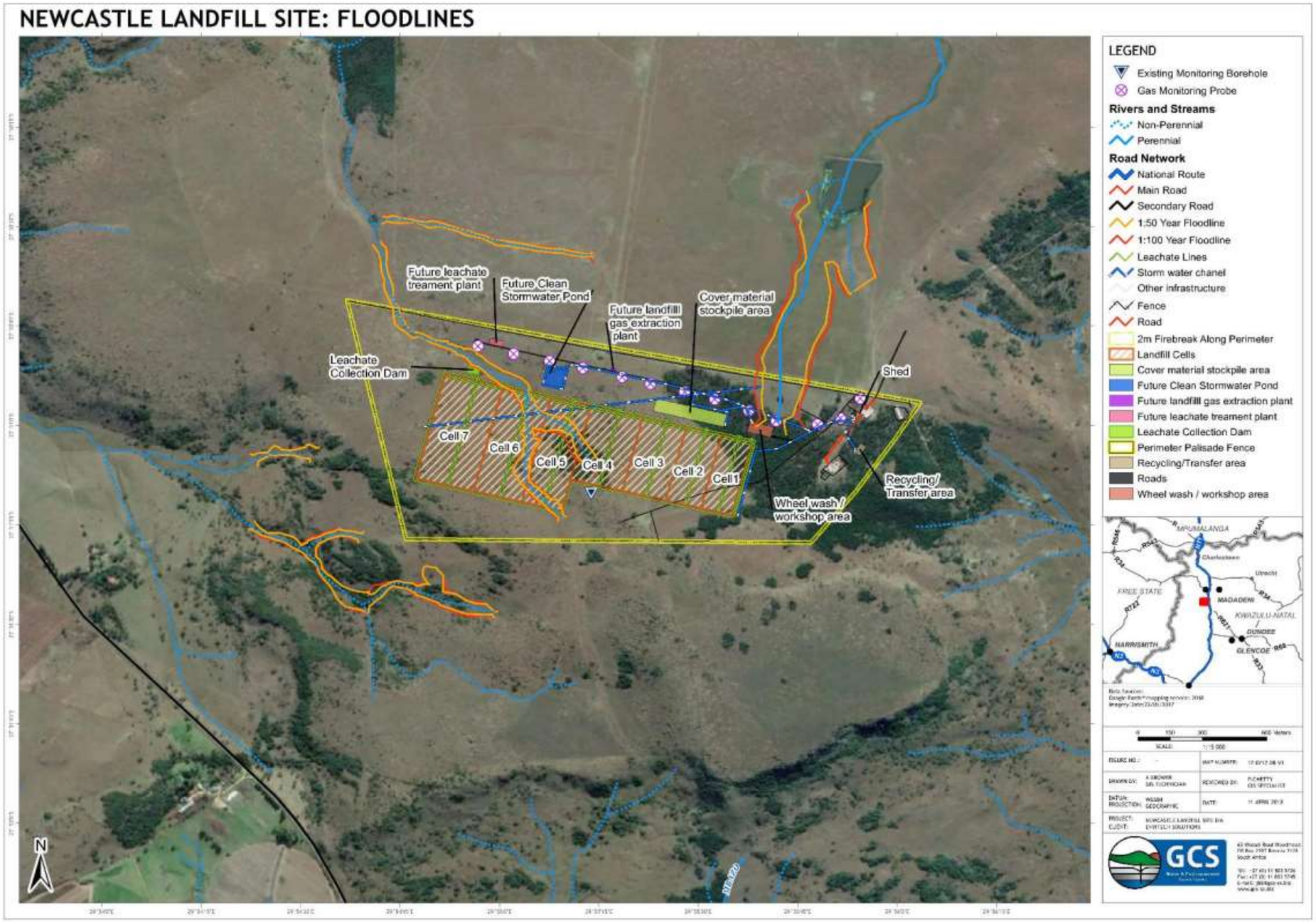


Figure 8.1: 1:50-year and 1:100-year flood lines for the Newcastle Greenwich Landfill site

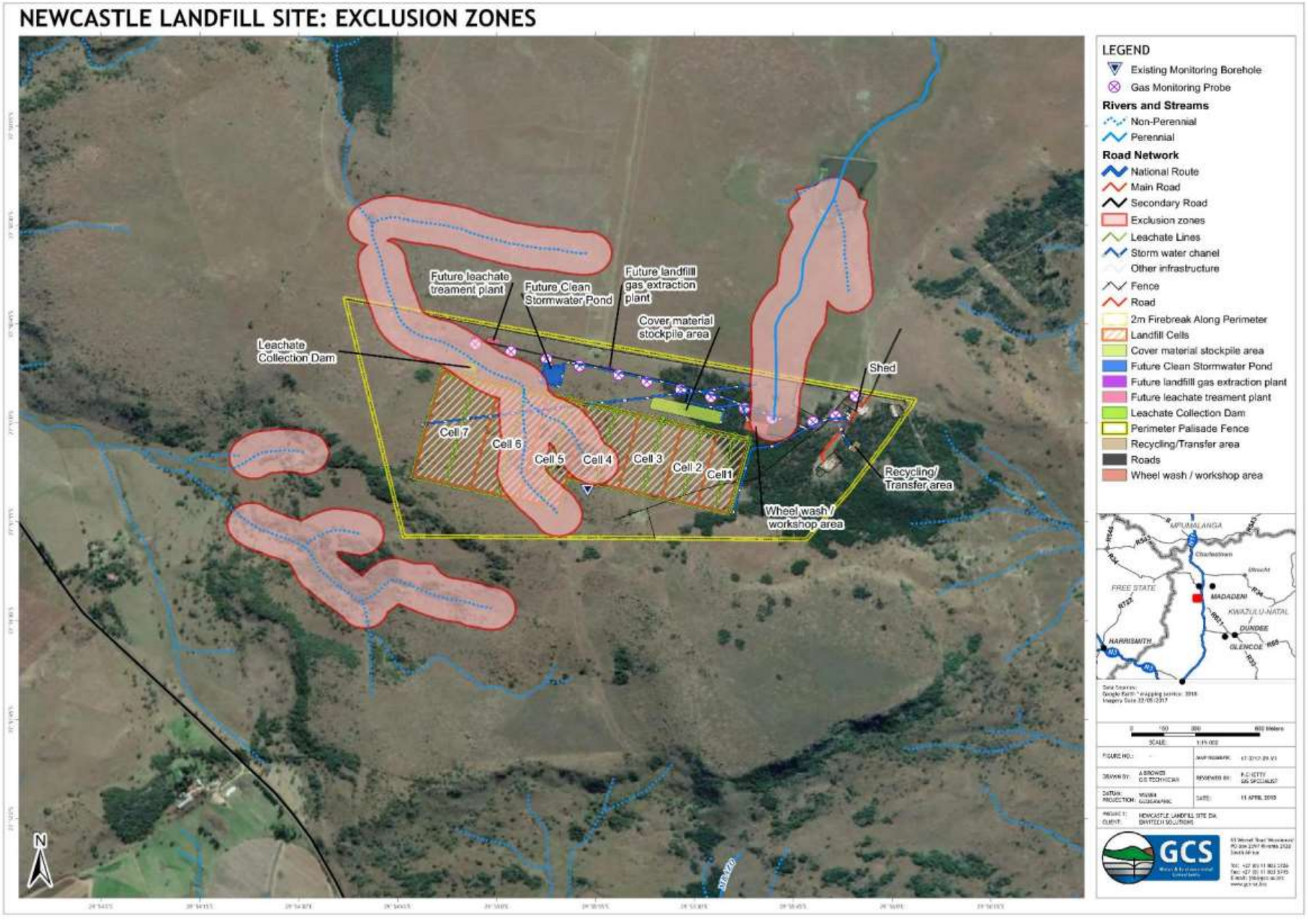


Figure 8.2: Exclusion zone at the proposed Newcastle Greenwich Landfill site

9 CONCEPTUAL STORM WATER MANAGEMENT PLAN

A conceptual SWMP was developed for the Newcastle Greenwich Landfill site to manage stormflow from clean and dirty water sub-catchments on site and this is presented in Figure 9.1.

9.1 Classification of Storm Water Sub-Catchments

Three dirty water catchments were determined to comprise the proposed landfill cells area, workshop/wheel wash area and the overburden dump site, while the rest of the site was determined to be clean (See Figure 9.1). The overburden dump is dirty since exposure of subsurface material to rain and oxygen in the atmosphere results in the occurrence of redox reactions with subsequent precipitation of toxic chemicals. The workshop/wheel wash area is also dirty since this is where oils and grease from washed vehicles together with dirty refuse remnants are deposited during the washing process. All these dirty substances need to be managed so that they don't end up in clean water catchments and proximal watercourses.

9.2 Storm Water Runoff

Manning's 'n' coefficient used in the model for the impervious and pervious areas were 0.013 (concrete float finish) and 0.03 (brush and grass vegetation), respectively (McCuen, 1996). The soils of the Greenwich area are generally clay-loam. These soils are characterised by moderate infiltration rates where the terrain is gentle to flat and moderate to high runoff where slopes are generally steep. The PCSWMM requires these criteria to incorporate infiltration into the analysis using the Green-Ampt infiltration method. The clay-loam group resulted in an average capillary suction head of 218.5 mm, a saturated hydraulic conductivity of 3 mm/hr and an initial deficit of 0.143 being used in the stormwater modelling. Modelled peak flows and runoff volumes for storm water sub-catchments are summarised in Table 9.1 for the 1:50-year recurrence interval flood event. The 1:50-year design rainfall was calculated at a 1'x1' latitude and longitude grid consisting of 24 points surrounding the Newcastle Greenwich Landfill site (Smithers and Schulze, 2000). The 1:50-year design rainfall depth is then disaggregated in PCSWMM into 5-minute rainfall intensities over a 24-hour period.

Table 9.1: Peak flows and runoff volumes for stormwater sub-catchments

Sub-catchment	Classification	X-Coordinate	Y-Coordinate	Area (ha)	Precipitation (mm)	Infiltration (mm)	Runoff Depth (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)	Runoff Coefficient
S1	Clean	29,92173	-27,850312	120,0	148,1	111,82	51,6	30,9	10,56	0,3
S2_1	Dirty	29,917689	-27,851382	32,6	148,1	64,46	9,5	3,1	0,43	0,1
S2_2	Dirty	29,922321	-27,850638	26,4	148,1	64,46	9,5	2,5	0,35	0,1
S3_1	Dirty	29,927479	-27,850057	0,3	148,1	0	134,0	0,4	0,17	0,9
S3_2	Dirty	29,927762	-27,850271	0,2	148,1	0	133,1	0,3	0,14	0,9
S4	Dirty	29,92466	-27,849463	1,8	148,1	64,46	10,6	0,2	0,02	0,1

Figure 9.1: Storm water management plan for the Newcastle Greenwich Landfill site

9.3 Stormwater Drainage

A network of stormwater drains/conduits were defined to channel stormwater from inlet outlet points. All stormwater infrastructure was conceptually sized to prevent flooding resulting from the 1:50-year design rainfall event. All dirty stormwater drains were defined to have a trapezoidal cross section with side slopes of 1V:1H, while clean water diversion channel have slopes of 1V:2H as indicated in Table 9.2. Clean water channels were conceptually designed to be grassed earth channels since these convey clean water which does not contaminate groundwater resources. Stormflow velocities within the clean water earth channels (C7 and C8) slightly exceed 3 m/s implying potential erosion risks (Table 9.2). These stormwater drains should be protected against erosion through use of riprap and/or allowing brush and grass vegetation to grow within them.

Dirty water channels should have a 200 mm High Density Polyethylene (HDPE) lining (n = 0.011) in order to prevent pollution of groundwater aquifers through seepage and to allow fast stormflow to containment structures. Adjoining perimeter berms should be constructed on the periphery of the landfill cells and around the Wash Bay area (See Figure 9.1). A perimeter berm should be constructed around the cover material stockpile area to prevent erosion of the cover material and possible redox precipitates to nearby watercourses as indicated in Figure 9.1. The stormwater infrastructure should allow for a minimum freeboard of 500 mm. The conceptual design of a typical stormwater drain adjoined to a berm is indicated in Figure 9.2.

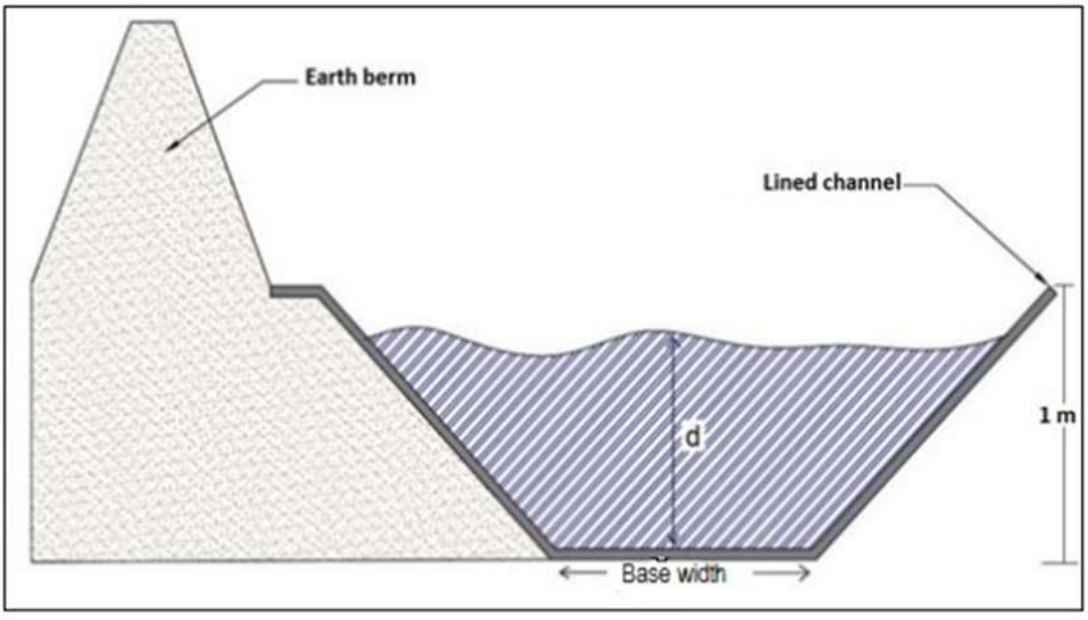


Figure 9.2: Conceptual design of storm water drain with an adjoining berm

Table 9.2: Stormwater drains at the proposed Newcastle Greenwich Landfill site

Drain/Conduit	Classification	Length (m)	Cross-Section	Max Depth (m)	Bottom Width (m)	Left Slope (m/m)	Right Slope (m/m)	Slope (m/m)	Max. |Flow| (m^3/s)	Max. |Velocity| (m/s)	Max. Unit Flow ($m^3/s/ha$)
C1	Dirty	1774	TRAPEZOIDAL	1	1	1	1	0,030	0,31	3,20	0,01
C2	Dirty	1888	TRAPEZOIDAL	1	1	1	1	0,028	0,24	2,72	0,01
C3	Dirty	34	TRAPEZOIDAL	1	1	1	1	0,051	0,47	2,92	0,01
C4	Dirty	168	TRAPEZOIDAL	1	1	1	1	0,025	0,17	2,00	0,65
C5	Dirty	124	TRAPEZOIDAL	1	1	1	1	0,041	0,14	1,92	0,64
C6	Dirty	2	TRAPEZOIDAL	1	1	1	1	0,072	0,30	3,52	0,63
C7	Clean	762	TRAPEZOIDAL	1	2	2	2	0,046	3,91	3,26	0,08
C8	Clean	2061	TRAPEZOIDAL	1	2	2	2	0,034	4,59	3,07	0,06

9.4 Dirty water containment facilities

Dirty stormwater from the Greenwich Landfill should be contained in a PCD (See Figure 9.1 and Table 9.3). Dirty water from the Workshop/Wheel Wash Bay area should temporarily be contained in a sump and be allowed to evaporate or should be pumped directly to the PCD. The storage volumes of the PCD and the sump were modelled to be 5 565 m^3 and 643 m^3, respectively as indicated in Table 9.3. All the contaminated water in the PCD should be managed by either evaporation or by treatment before being discharged into the natural environment. This dirty water should not be discharged into proximal natural watercourses unless it is treated to acceptable quality.

Table 9.3: Contaminated water storage structures

Structure	Location		Classification	Storage Volume
	X-Coordinate	Y-Coordinate		(m^3)
PCD (OF1)	29.914444	-27.847402	Dirty	5 565
Sump (Optional) (OF2)	29.928171	-27.850046	Dirty	643

10 BASELINE SURFACE WATER QUALITY

Localities of monitoring points and the results of the water quality analysis are presented in this section.

10.1 Water Quality Monitoring Points

Two (2) water quality monitoring localities, namely V3H7 and V3R2, were used. Both monitoring localities are situated within the Ncandu River, upstream (V3H7) and downstream of the proposed Greenwich Landfill site. The location of these monitoring points is indicated in Figure 10.1.

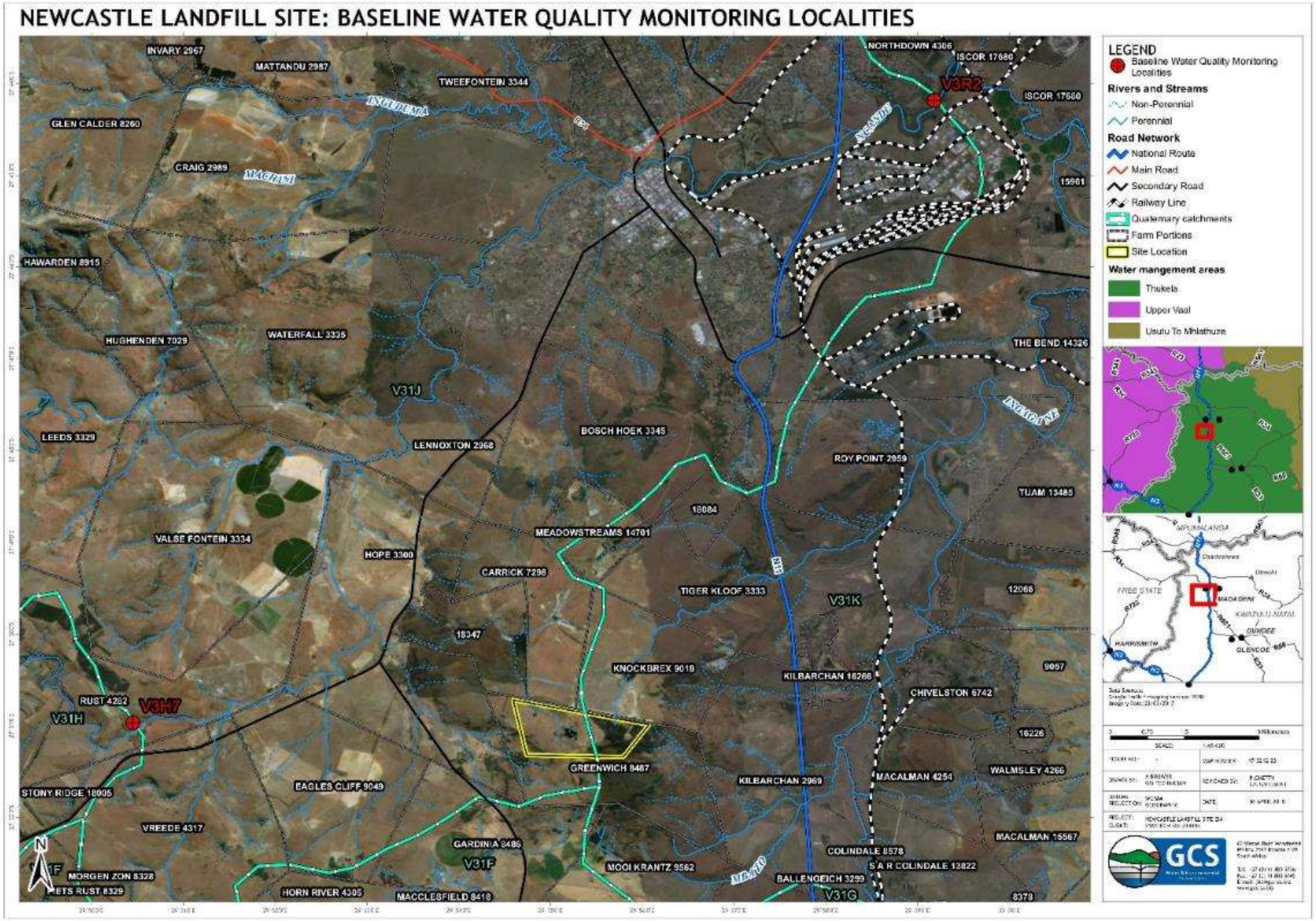


Figure 10.1: Baseline water quality monitoring localities.

10.2 Ncandu River water quality

Chemical water quality data for monitoring locality V3H7 is attached in Appendices 2. Monitoring locality V3H7 indicates satisfactory water quality with neutral pH (average 7.25 pH units) and low electrical conductivity (average 8.58 mS/m). Low sulphate and low nitrate and nitrite as N concentrations are also consistently present throughout the monitoring period (1966 to 2017). The time series of the pH, EC, sulphate and nitrate and nitrite as N trends are illustrated in Figure 10.2, Figure 10.3 and Figure 10.4.

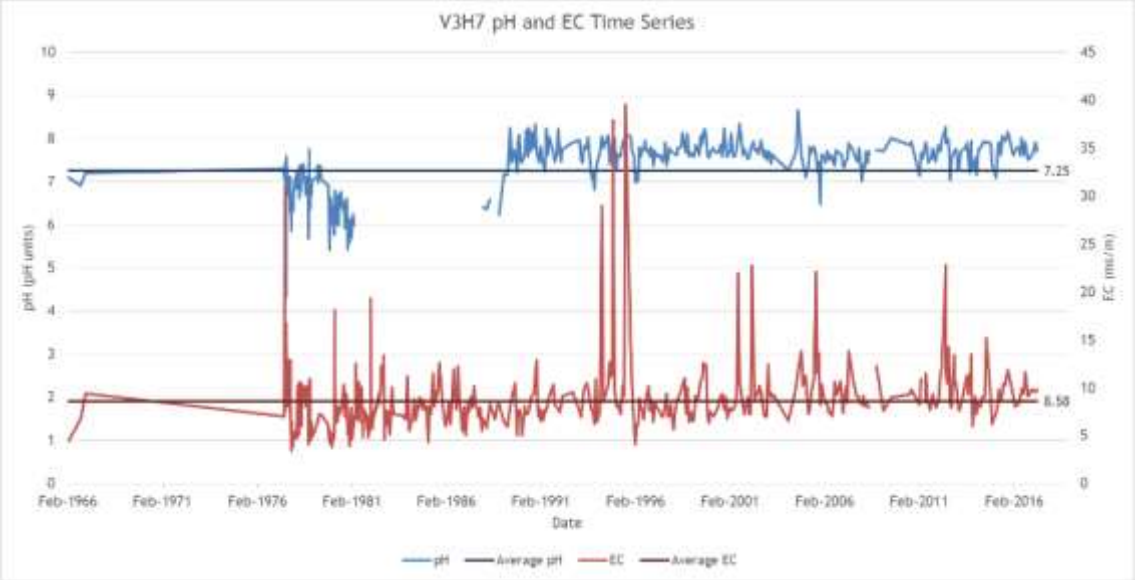


Figure 10.2: Time series of pH and EC

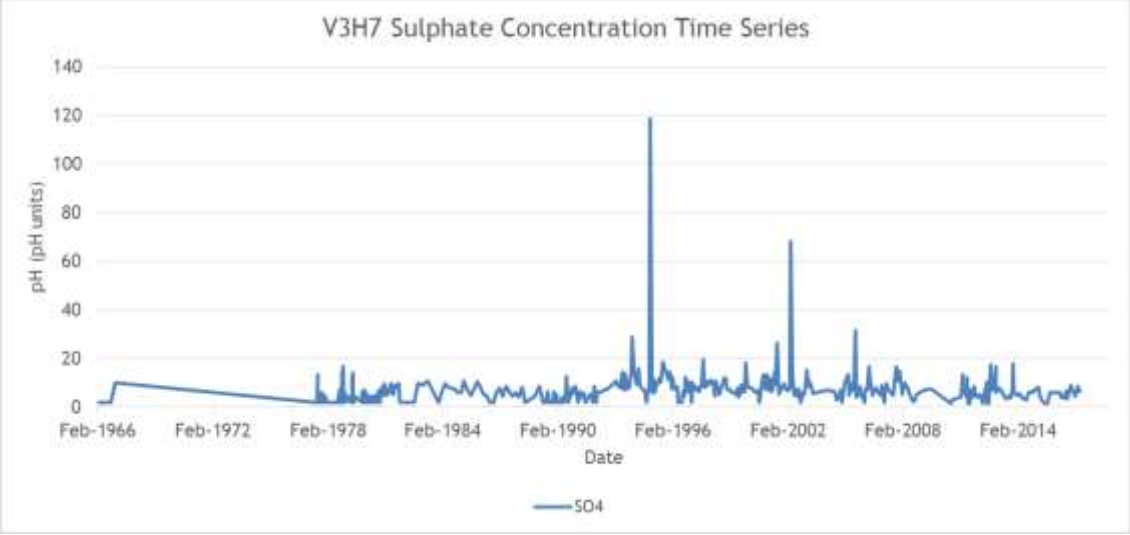


Figure 10.3: Time series of sulphate concentration

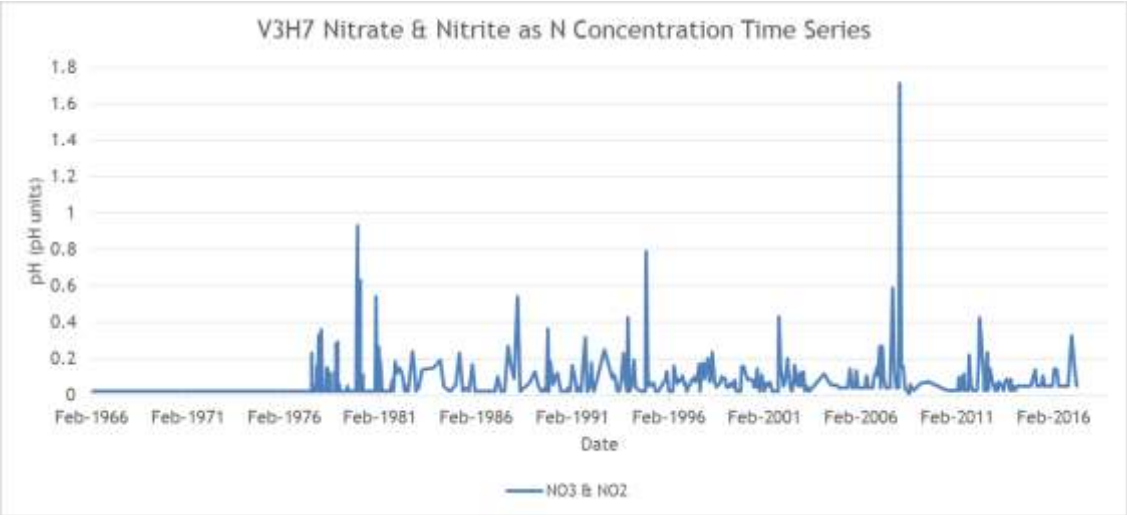


Figure 10.4: Time series of nitrate and nitrite as N concentration

Chemical water quality data for monitoring locality V3R2 is attached in Appendix 3. Monitoring locality V3R2 indicates satisfactory water quality with neutral pH (average 7.54 pH units) and low electrical conductivity (average 20.97 mS/m). Low sulphate and low nitrate and nitrite as N concentrations are also present throughout the monitoring period (1980 to 2017).

When comparing the upstream (V3H7) and downstream (V3R2) monitoring localities V3R2 does indicate a slight increase in most analysed parameters. Despite the increase the sulphate, nitrates N and nitrite as N concentrations are still low. The time series of the pH, EC, sulphate and nitrate and nitrite as N trends are illustrated in Figure 10.5, Figure 10.6 and Figure 10.7.

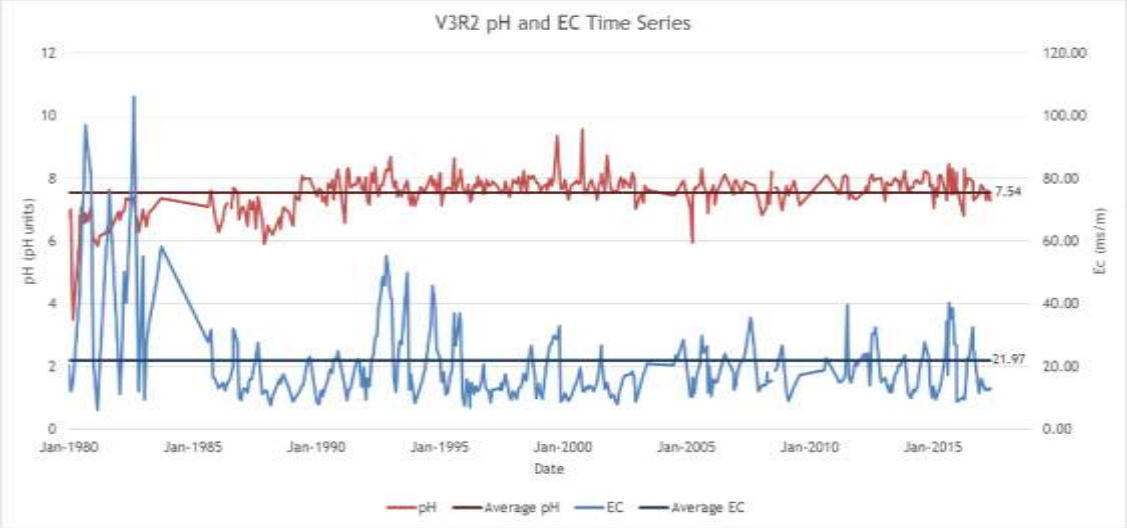


Figure 10.5: Time series of pH and EC

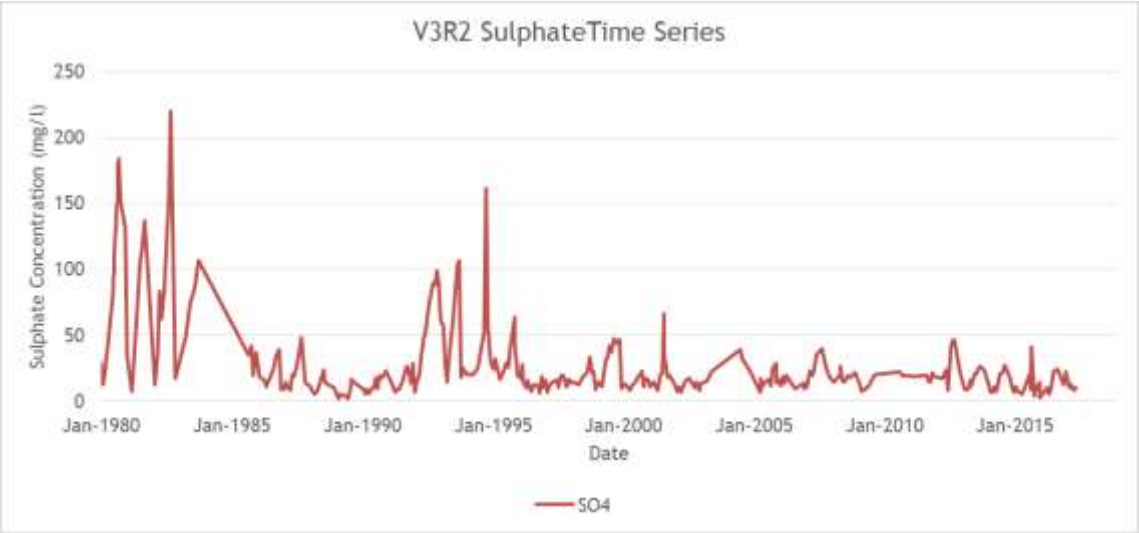


Figure 10.6: Time series of sulphate concentration

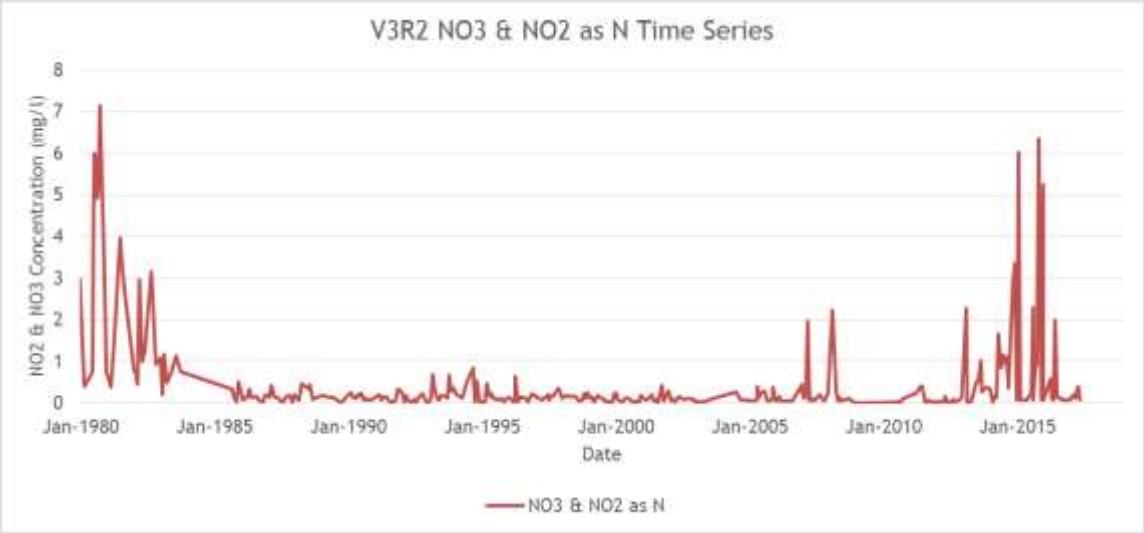


Figure 10.7: Time series of nitrate and nitrite as N concentration

11 WATER QUALITY MONITORING PROGRAMME

A surface water monitoring programme is recommended at the proposed Newcastle Greenwich Landfill site in terms of the Best Practice Guidelines G3: Water Monitoring Systems (DWAF, 2006). The monitoring programme will assist with overall water management at the site, including but not limited to:

- Preventing pollution and thereby protecting the receiving water environment;
- Developing an understanding of the current water quality on site and monitoring how it changes over time; and
- Assessing performance of pollution prevention measures, i.e. compliance with license conditions.

The monitoring programme should be amended according to on-site operations including any future permit requirements.

11.1 Proposed Monitoring Locations

It is recommended that any water containment facilities on site be monitored for water quality and quantity on a monthly basis. The water quality results should meet applicable standards or ensure that water released into the environment, either intentionally or unintentionally, is of appropriate quality and that associated risks are well understood. Points on the Ncandu River and its tributaries (See Figure 11.1 and Table 11.1) and water within the PCD should be monitored on a monthly basis.

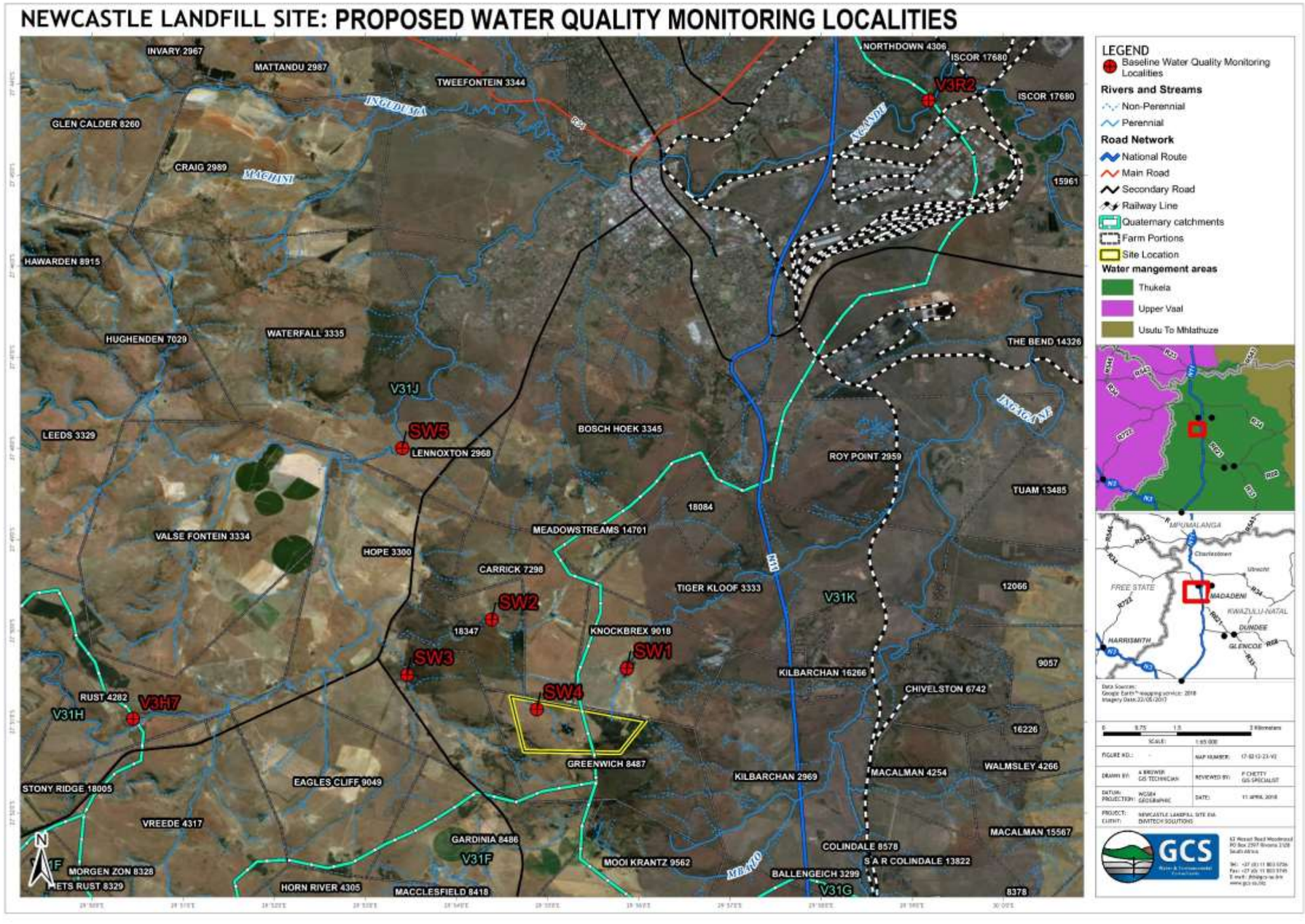


Figure 11.1: Proposed water quality monitoring localities

Table 11.1: Proposed monitoring programme

SAMPLE POINT	COORDINATES		MONITORING FREQUENCY
	Latitude	Longitude	
SW1	-27.840197°	29.931174°	Monthly water samples
SW2	-27.831302°	29.906490°	
SW3	-27.841388°	29.890989°	
SW4 (PCD)	-27.847863°	29.915124°	
SW5	-27.799958°	29.890094°	
V3H7	-27.850399°	29.841783°	
V3R2	-27.739791°	29.983201°	

11.2 Applicable Parameters and Standards

The water samples should be analysed for the parameters listed in Table 11.2 on a monthly basis, and on a bi-annual basis all samples should additionally be submitted for a full ICP-MS metal scan, as specified in Table 11.3. This list of parameters should be amended annually to ensure all priority parameters are analysed monthly and lower-priority parameters are only analysed on a bi-annual basis.

Table 11.2: List of parameters for monthly analysis

PARAMETERS	
pH at 22°C	Chloride, Cl
Conductivity mS/m	Sulphate, SO_4
Total Dissolved Solids (TDS)	Nitrate, NO_3
Calcium, Ca	Fluoride, F
Magnesium, Mg (mg/l)	Aluminium, Al
Sodium, Na	Manganese, Mn
Potassium, K	Iron, Fe
Total Alkalinity as $CaCO_3$	Zinc, Zn
Bicarbonate, HCO_3	

Table 11.3: List of parameters for bi-annual analysis

PARAMETERS	
Antimony as Sb	Nickel as Ni
Arsenic as As	Selenium as Se
Barium as Ba	Silicon as Si
Beryllium as Be	Silver as Ag
Bismuth as Bi	Strontium as Sr
Cadmium as Cd	Tin as Sn
Cobalt as Co	Titanium as Ti
Lithium as Li	Vanadium as V
Mercury as Hg	Zirconium as Zr
Molybdenum as Mo	

11.3 Sampling Methodology

The sampling procedure should be in accordance with the following publications:

- SABS ISO 5667 – 1:1980 Guidance on the design of sampling programs;
- SABS ISO 5667 – 2:1991 Guidance on sampling techniques; and
- SABS ISO 5667 – 3:1994 Guidance on the preservation and handling of samples.

Samples should be submitted to a South African National Accreditation System (SANAS) accredited laboratory for analysis.

Field observations including the following should be recorded on field data sheets:

- Coordinates of each surface water sampling point;
- *In-situ* Electrical Conductivity (EC), pH, Temperature and redox potential (Eh) are measured and recorded for each sampling point;
- Documenting general characteristics of the water samples such as colour, turbidity and smell;
- Any potential sources of contamination at the sampling points; and

- Annual photographs of each sampling point.

It is further recommended that a Chain of Custody (CoC) be filled in at the time of sampling recording the following information:

- Date and time of sampling;
- Coordinates of each sample point (at first sampling event only);
- *In-situ* measurements for each sampling point, namely pH, EC, TDS and temperature.
- General characteristics of the water samples such as colour, turbidity (murky/clear) and smell, as well as visual observations of the sample site.

The CoC form is completed when the samples are transported and transferred to the laboratory for analysis.

Care should be taken to ensure that the samples taken are sufficiently large enough, at least one (1) litre (l), as to allow the laboratory to run duplicate analyses if required. Samples should be kept cool when stored and transported. Samples for metal analysis should be filtered through a 0.45 micrometre (µm) pore size membrane in the field and preserved with nitric acid (HNO_3).

11.4 Data Storage and Processing

It is essential that all data relating to the monitoring programme be maintained in a reliable and secure database. This database should be updated as monthly data becomes available in order to identify any immediate problems and to identify any trends that are of concern.

11.5 Monitoring Reports

The following reports should be prepared by relevant bodies:

- Monthly reports; and
- Bi-annual/annual reports.

The following should be included in the reports in terms of data interpretation and trend analysis:

- Summary of the analytical results, including a comparison with relevant DWS standards;
- Map of the monitoring points showing their level of compliance;
- Brief discussion of any problem areas;
- Time series graphs showing fluctuations or trends in constituents of concern over time; and
- Recommendations and mitigations measures where applicable.

12 WATER BALANCE

This section describes average water balances (annual average, average 6 wettest months, average 6 driest months, average monthly and average daily) for the Newcastle Greenwich Landfill site.

12.1 Process Flow Diagram

To set up the average water balance model based on the findings of the site visit, a PFD was drafted to provide insight into all water-linked flows within the proposed infrastructure. The final PFD as confirmed by the client is presented in Figure 12.1.

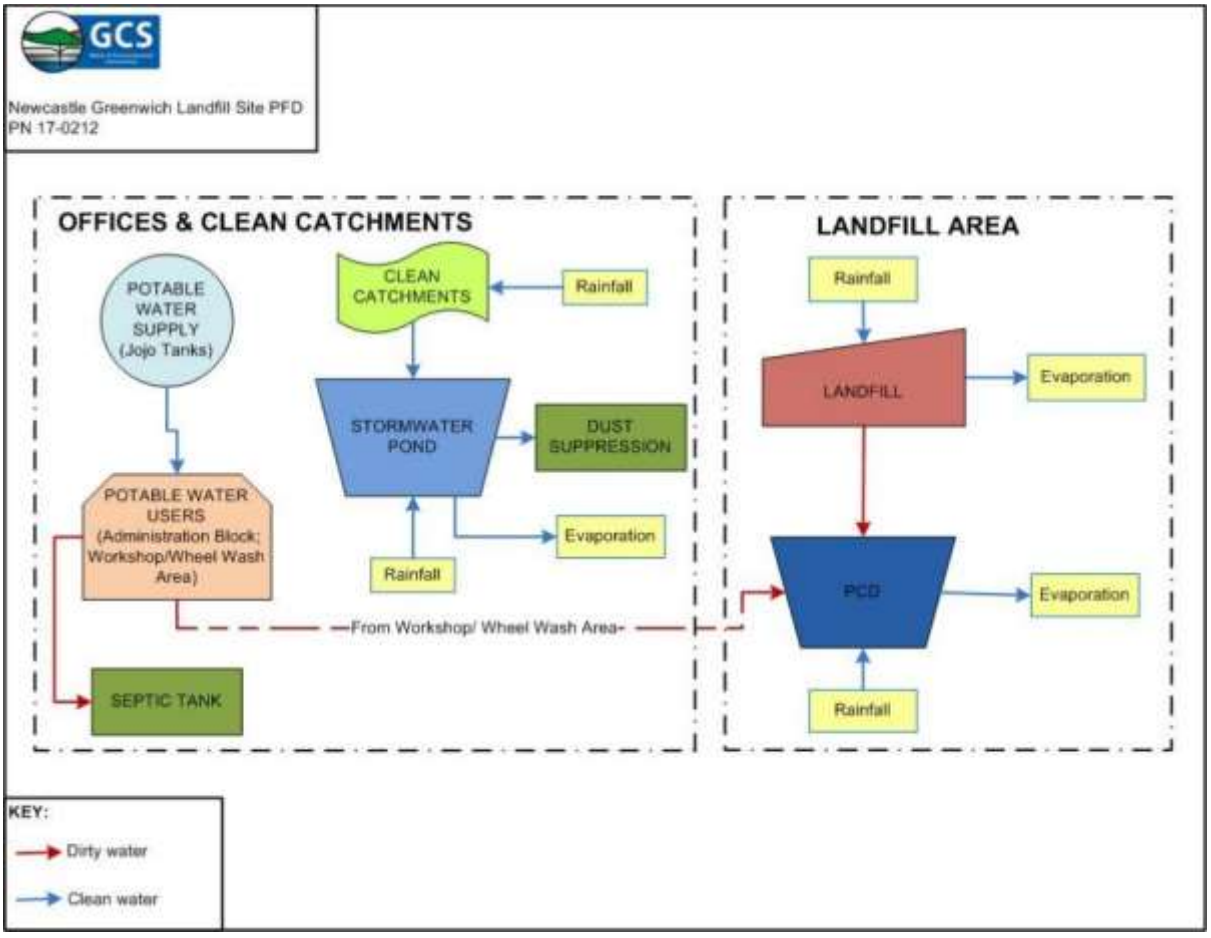


Figure 12.1: Process Flow Diagram for the Newcastle Greenwich Landfill site

12.2 Operational Philosophy and Volumes

The following operational philosophy assumptions were made to develop the PFD and water balances:

- Potable water supplied by the Newcastle Municipality will be stored in Jojo Tanks on site.
- The available on-site surface water include rainfall and stormflow over the landfill area; rainfall and stormflow channelled and contained in the Clean Stormwater Pond.
- The PCD will play a combined role of containing dirty stormflow and collecting landfill leachate as the Leachate Collection Dam (LCD).
- Dirty water in the PCD will be disposed of entirely by evaporation or will be treated and discharged into the natural environment after meeting recommended DWS discharge standard limits.
- Sewage from potable water users on site will be contained in a septic tank which is occasionally emptied by a licensed honey sucker.
- It was assumed that 15 m^3/day of potable water will be used on site, based on an estimate of 100 persons each consuming 150 l/day. The estimated figures were provided by the client;
- This Newcastle region's annual average precipitation depth for the wettest six months for the area is approximately 600 – 830 mm/annum (based on 10 years of time series data for Cedara obtained from Agrimet and the South African Weather Bureau (Geomeasure, 2016).
- The evaporation of the wettest six months, as measured using the A-Pan averages (based on 10 years of data) and incorporating an evaporation factor of 0.7, is approximately 490 mm /annum 930 mm / annum (Geomeasure, 2016).
- Seepage losses from the PCD were assumed to be zero since this structure will be having a 200 mm HDPE lining.
- The modelled maximum storage capacity of the PCD is 5 565 m^3. This figure was used in the water balance after adaptation to selected time scales (annual, wettest 6 months average, driest 6 months average, monthly average and daily average).

12.3 Calculated Water Balances

The calculated water balances for the Newcastle Greenwich Landfill site are presented in Table 12.1 to Table 12.5. These water balances provide an overview of all water uses at the Newcastle Greenwich Landfill site at the aforementioned selected time scales.

The annual water balance indicates that the total amount of potable water required for all operations at the site is equivalent to 19 800 m^3/annum (Table 12.1). This water will cater for administrative offices and workshop consumption as well as use at the wheel wash area.

The average of the wettest 6 months indicates a storage volume of 17 870 m^3 which accounts for direct rainfall on the PCD and stormflow from the landfill (See Table 12.2). This volume of dirty water will be allowed to evaporate. This water can be treated and be discharged into the natural environment, if it meets the DWS discharge standard limits. The average of the 6 driest months indicates a PCD dirty water volume of 5 591 m^3 which means that during this dry period, dirty water can be managed entirely by evaporation from the PCD.

Manageable PCD storage volumes of 1 955 m^3 and 64 m^3 were determined for the monthly and daily averages, respectively, at the Greenwich Landfill site.

Table 12.1: Annual average water balance for the Greenwich Landfill site

Average Annual Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/ annum)**	**Water Circuit/stream**	**Quantity (m^3/annum)**	
Landfill					
	From: Rainfall	76 489	To: Evaporation	53 542	
			To: Stormflow to PCD	21 340	
			To: Landfill leachate to PCD	1 606	
	Total	**76 489**		**76 489**	-
PCD					
	From: Direct Rainfall	515			
	From: Landfill site stormflow	21 340	To: Evaporation	23 462	
	From: Landfill seepage	1 606			
	Total	**23 462**		**23 462**	-
STORMWATER POND					
	From: Direct Rainfall on Pond	**1 089**			
	From: Clean Catchment Runoff	**2 408**	To: Evaporation	**3 496**	
	Total	**3 496**		**3 496**	-
POTABLE WATER USERS (Administration Offices; Workshop/Wheel Wash Area)			To: PCD from Workshop/Wheel Wash Area	1 286	
	From: Jojo Tanks	19 800	To: Septic Tank	13 114	
			To: Consumption	5 400	
	Total	**19 800**		**19 800**	-
Total Water Balance		**123 246**		**123 246**	-

Table 12.2: Average wettest 6 months' water balance for the Greenwich Landfill site

Average Wettest 6 Months Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/ 6 mon)**	**Water Circuit/stream**	**Quantity (m^3/6 mon)**	
Landfill					
	From: Rainfall	58 260	To: Evaporation	40 782	
			To: Stormflow to PCD	16 254	
			To: Landfill leachate to PCD	1 223	
	Total	**58 260**		**58 260**	-
PCD					
	From: Direct Rainfall	392			
	From: Landfill site stormflow	16 254	To: Evaporation	17 870	
	From: Landfill seepage	1 223			
	Total	**17 870**		**17 870**	-
STORMWATER POND					
	From: Direct Rainfall on Pond	829			
	From: Clean Catchment Runoff	1 447	To: Evaporation	2 277	
	Total	**2 277**		**2 277**	-
POTABLE WATER USERS (Administration Offices; Workshop/Wheel Wash Area)			To: PCD from Workshop/Wheel Wash Area	643	
	From: Jojo Tanks	9 900	To: Septic Tank	6 557	
			To: Consumption	2 700	
	Total	**9 900**		**9 900**	-
Total Water Balance		**88 306**		**88 306**	-

Table 12.3: Average driest 6 months' water balance for the Greenwich Landfill site

Average Driest 6 Months Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/ 6 mon)**	**Water Circuit/stream**	**Quantity (m^3/6 mon)**	
Landfill					
	From: Rainfall	18 229	To: Evaporation	12 760	
			To: Stormflow to PCD	5 086	
			To: Landfill leachate to PCD	383	
	Total	**18 229**		**18 229**	-
PCD					
	From: Direct Rainfall	123			
	From: Landfill site stormflow	5 086	To: Evaporation	5 591	
	From: Landfill leachate	383			
	Total	**5 591**		**5 591**	-
STORMWATER POND					
	From: Direct Rainfall on Pond	259			
	From: Clean Catchment Runoff	960	To: Evaporation	1 220	
	Total	**1 220**		**1 220**	-
POTABLE WATER USERS (Administration Offices; Workshop/Wheel Wash Area)			To: PCD from Workshop/Wheel Wash Area	643	
	From: Jojo Tanks	9 900	To: Septic Tank	6 557	
			To: Consumption	2 700	
	Total	**9 900**		**9 900**	-
Total Water Balance		**34 940**		**34 940**	-

Table 12.4: Average monthly water balance for the Greenwich Landfill site

Average Monthly Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/ month)**	**Water Circuit/stream**	**Quantity (m^3/month)**	
Landfill					
	From: Rainfall	6 374	To: Evaporation	4 462	
			To: Stormflow to PCD	1 778	
			To: Landfill leachate to PCD	134	
	Total	**6 374**		**6 374**	-
PCD					
	From: Direct Rainfall	43			
	From: Landfill site stormflow	1 778	To: Evaporation	1 955	
	From: Landfill seepage	134			
	Total	**1 955**		**1 955**	-
STORMWATER POND					
	From: Direct Rainfall on Pond	**91**			
	From: Clean Catchment Runoff	**201**	To: Evaporation	**291**	
	Total	**291**		**291**	-
POTABLE WATER USERS (Administration Offices; Workshop/Wheel Wash Area)			To: PCD from Workshop/Wheel Wash Area	107	
	From: Jojo Tanks	1 650	To: Septic Tank	1 093	
			To: Consumption	450	
	Total	**1 650**		**1 650**	-
Total Water Balance		**10 271**		**10 271**	-

Table 12.5: Average daily water balance for the Greenwich Landfill site

Average Daily Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/day)**	**Water Circuit/stream**	**Quantity (m^3/day)**	
Landfill					
	From: Rainfall	209.4	To: Evaporation	146.6	
			To: Stormflow to PCD	58.4	
			To: Landfill leachate to PCD	4.4	
	Total	**209.4**		**209.4**	-
PCD					
	From: Direct Rainfall	1.4			
	From: Landfill site stormflow	58.4	To: Evaporation	64.2	
	From: Landfill seepage	4.4		-	
	Total	**64.2**		**64.2**	-
STORMWATER POND					
	From: Direct Rainfall on Pond	**3.0**			
	From: Clean Catchment Runoff	**6.6**	To: Evaporation	**9.6**	
		9.6		**9.6**	
POTABLE WATER USERS (Administration Offices; Workshop/Wheel Wash Area)			To: PCD from Workshop/Wheel Wash Area	3.5	
	From: Jojo Tanks	54.2	To: Septic Tank	35.9	
			To: Consumption	14.8	
	Total	**54.2**		**54.2**	-
Total Water Balance		**337.4**		**337.4**	-

13 IMPACT ASSESSMENT

The impacts on surface water resources were assessed for the construction, operation and decommissioning phases of the Greenwich Landfill project cycle. A description of the nature of potential impacts and downstream receptors of the identified impacts are presented in this section.

13.1 Impact Identification and Mitigation

13.1.1 Construction Phase

Impact 1:

- Sedimentation/siltation of nearby watercourses.

Activity:

- Removal of vegetation and land preparation disturbs the soil's structure rendering it susceptible to water erosion.

Mitigation measures:

- Land preparation must be restricted to the landfill footprint area to minimise the size of the affected area.
- Silt traps should be installed to trap sediments from clean stormflow before discharging it into natural watercourses.

Impact 2:

- Pollution of surface water resources.

Activity:

- Movement of heavy machinery and vehicles may spill and leak oils, grease and other chemicals which are potential pollutants to nearby water resources.

Mitigation measures:

- Conducting quick clean-ups when spills occur in line with the landfill site's waste management plan. Oil recovered from vehicles or machinery on site should be collected, stored and disposed of by accredited vendors for recycling.

Impact 3:

- (a) Reduction of runoff at downstream reaches by approximately 0.5 % of MAR.
- (b) Disruption of aquatic and riparian biodiversity.

Activity:

- Vegetation removal and land preparation will destroy headwater segments of the non-perennial Ncandu tributaries which start in this area.

Mitigation measures:

- (a) Treating dirty water from the PCD and then discharge clean treated water into the natural environment to recoup a fraction of the water lost.
- (b) No mitigation measures available for this impact.

13.1.2 Operation Phase

Impact 4:

- Increased probability of flooding.

Activity:

- Construction of infrastructure on site.

Mitigation measures:

- Minimise impervious areas to development footprint and adhere to the storm water management plan.

Impact 5:

- Pollution of nearby watercourses.

Activity:

- Dirty landfill stormflow and leachate seepage.

Mitigation measures:

- Channel dirty storm water and leachate to a pollution control dam as per the storm water management plan (See Section 9).

13.1.3 Decommissioning Phase

Impact 6:

- Sedimentation/Siltation of nearby watercourses

Activity:

- Removal of landfill site infrastructure increases soil erodibility potential

Mitigation measures:

- Installing silt traps to capture sediment before it gets to watercourses.
- Restrict clearance and disturbance to footprint area.

Impact 7:

- Pollution of nearby watercourses.

Activity:

- Spillage and leakage of oils, grease and other chemicals.

Mitigation measures:

- Conduct quick clean-ups after spills.
- Oil recovered from vehicles and machinery should be collected, stored and disposed of by accredited vendors for recycling.

13.2 Cumulative Impacts from the whole project life cycle

- Apart from the permanent impacts associated with the destruction of a local water source area, and the disruption of aquatic and riparian ecosystems, there are no significant cumulative impacts on water resources which will result from the landfill project if all the aforementioned mitigation measures are implemented.

The impact significance before and after mitigation measures have been implemented are summarised and presented in Table 13.1.

Table 13.1: Summary of surface water impact assessment for the Newcastle Greenwich Landfill site

Impact description					Significance before mitigation		Significance after mitigation		Mitigation measures	Action plan	Responsible person
No.	Phases	Activity	Aspect	Impact							
1	Construction	Removal of vegetation and land preparation	Disturbance of the soil	Sedimentation/Siltation of nearby watercourses	60.0	M	52.2	L	1. Installing silt traps to capture sediment before it reaches watercourses; 2. Restrict clearance to footprint area.	Refer to management plan	Site manager and ECO
2	Construction	Heavy machinery and vehicle movement	Spillage and leakage of oils, grease and other chemicals	Pollution of nearby watercourses	61.5	M	12.7	L	1. Conduct quick clean-ups after spills; 2. Oil recovered from vehicles and machinery should be collected, stored and disposed of by accredited vendors for recycling.	Refer to management plan	Site manager and ECO
3	Construction	Removal of vegetation and land preparation	Permanent destruction of stream headwater sections	Reduction of runoff at downstream reaches by approximately 0.5 % of MAR.	180.0	H	167.2	M	1. Treating dirty water from the PCD and then discharge clean treated water into the natural environment to recoup a fraction of the water lost.	Refer to storm water management plan	Site manager and ECO
4	Construction	Removal of vegetation and land preparation	Destruction of aquatic and riparian habitats	Reduced bio-diversity	176.0	H	187.2	H	1. This impact cannot be mitigated.	Refer to management plan	Site Manager and ECO
5	Operation	Infrastructure construction	Increase of paved surfaces	Increased probability of flooding	56.0	M	50.4	L	1. Minimise impervious areas & adhere to the storm water management plan.	Refer to management plan	Site Manager and ECO
6	Operation	Dirty landfill stormflow and leachate seepage	Dissolution of pollutants by incident rainfall and stormflow	Pollution of nearby watercourses	147.2	M	52.2	L	1. Channel dirty storm water and leachate to a pollution control dam.	Refer to storm water management plan	Site Manager and ECO
7	Decommissioning	Infrastructure removal	Disturbance of the soil	Siltation of watercourses due to deposition of eroded soils	60.0	M	52.2	L	1. Installing silt traps to capture sediment before it reaches watercourses; 2. Restrict clearance to footprint area.	Refer to management plan	Site Manager and ECO
8	Decommissioning	Heavy machinery and vehicle movement	Spillage and leakage of oils, grease and other chemicals	Pollution of nearby watercourses	57.3	M	50.4	L	1. Conduct quick clean-ups after spills; 2. Oil recovered from vehicles and machinery should be collected, stored and disposed of by accredited vendors for recycling.	Refer to management plan	Site manager and ECO

13.3 Downstream Water Users or Receptors

A total of eight potential receptors downstream of the Greenwich Landfill site were identified using the WARMS database and these are presented in Table 13.2. The water users are a combination of individuals and companies who rely on the Ncandu River and its tributaries for water supply. The water uses include irrigation and livestock watering.

The Newcastle Greenwich Landfill development will negatively impact on these water users by reducing the downstream runoff, and the subsequent volume of water they can abstract from the Ncandu River. The impact on the runoff was estimated to be 0.5% of MAR which culminates to a depth of 0.21 mm. This runoff loss is deemed to be small and will not result considerable loss of productivity to downstream water users.

Table 13.2: Potential receptors downstream of the proposed Greenwich Landfill site

Date of Registration	Registration & Water Use Number	Property	Water Source	Telephone	Address of Water User	User Group	Latitude	Longitude
07/06/2002	21073071/1	Hope	Ncandu River	034-3511720	PO BOX 2320, Newcastle, 2940	Individual	-27.8333	29.8833
29/06/2002	21078824/1	Hope	Ncandu River	034-3125339	PO BOX 91, Newcastle, 2940	Individual	-27.8167	29.8833
29/11/2000	21002950/1	Valse Fontein	Ncandu River	034-3154932	PO BOX 1589, Newcastle, 2940	Individual	-27.8056	29.87778
05/07/2002	21083827/1	Valse Fontein	Ncandu River	034-3511720	PO BOX 2320, Newcastle, 2940	Individual	-27.8000	29.85000
07/11/2002	21127166/1	Valse Fontein	Ncandu River Tributary	034-3511865	PO BOX 1789, Newcastle, 2940	Individual	-27.8318	29.85133
28/06/2002	21077932/1	Waterfall	Ncandu River	034-3154901	PO BOX 1282, Newcastle, 2940	Individual	-27.7667	29.8500
10/07/2002	21084078/1	Waterfall	Ncandu River Tributary	034-3186560	PO BOX 1901, Newcastle, 2940	Company	-27.7764	29.86592
30/07/2002	21102922/1	Waterfall	Ncandu River	034-3186560	PO BOX 1901, Newcastle, 2940	Company	-27.7822	29.8869

14 CONCLUSIONS

This section describes the main conclusions derived from this study based on the hydrological assessment discussion in the preceding sections.

- The Newcastle Greenwich site has an MAP of 835 mm, MAE of 1 475 mm and MAR of 42.2 mm.
- Average monthly maximum temperatures are generally in the range 19.5 to 27.6°C, while average monthly minimum temperatures are in the range of 2.2 to 15°C (SA Explorer, 2018).
- The greater Newcastle Greenwich region is drained by the perennial Ncandu River and its unnamed non-perennial tributaries.
- Five hydrological sub-catchments were delineated at the Newcastle Greenwich site which contributes flows to the Ncandu tributaries.
- The SDF peak flows for the 5 Ncandu tributaries which were used as input in HEC-RAS were 36.4 m^3/s, 25.4 m^3/s, 23.2 m^3/s, 13.8 m^3/s and 37.7 m^3/s for the 1:50-year event and 45.8 m^3/s, 32 m^3/s, 29.2 m^3/s, 17.3 m^3/s and 47.4 m^3/s for the 1:100-year event.
- Flood lines analysis shows that Landfill Cells 4 to 7, the PCD, the Wheel Wash/ Workshop area at the proposed Newcastle Greenwich Landfill site fall within the development exclusion zone.
- Landfill Cells 1 to 3 are indicated to be outside the exclusion zone.
- Six stormwater sub-catchments were delineated at the proposed Newcastle Greenwich Landfill site.
- The PCD or Leachate Collection Dam storage volume was modelled to be 5 565 m^3 for the 1:50-year storm event.
- The optional temporary sump storage volume at the Workshop/Wheel Wash Area was determined to be 643 m^3.
- Based on the historical data, accessed from the RQIS, the portion of the Ncandu River in proximity to the proposed landfill site indicates satisfactory water quality. When comparing the upstream (V3H7) and downstream (V3R2) monitoring localities V3R2 does indicate a slight increase in most analysed parameters. Despite the increase the parameter concentrations are still low.
- A monthly water quality monitoring programme was determined to include 7 monitoring locations.
- A total annual potable water requirement of 19 800 m^3 was calculated for the Newcastle Greenwich Landfill site. This water is expected to come from groundwater boreholes on site.

- The water balance indicates that 17 870 m^3 on average, of dirty water should pass through the PCD or Leachate Collection Dam during the wettest 6 months.
- The average 6 driest months PCD dirty water volume of 5 591 m^3 was determined.
- Monthly and daily average PCD dirty water volumes of 1 955 m^3 and 64 m^3, respectively were determined at the Greenwich Landfill site.
- Sedimentation/Siltation of the nearby Ncandu River and its tributaries will likely occur from the disturbance of soils during land preparation (Construction phase) and removal of infrastructure (decommissioning phase).
- Reduction of runoff at downstream reaches by approximately 0.5 % of MAR is expected to result from the landfill site development.
- Destruction of aquatic and riparian habitats will occur resulting in reduced biodiversity.
- Increased probability of flooding will likely occur as a result of the construction of infrastructure on site.
- Pollution of groundwater and the nearby Ncandu River and its tributaries will likely result from dirty landfill stormflow and leachate seepage.

15 RECOMMENDATIONS

The following measures are recommended based on findings of the hydrological assessment study:

- Application for GN 704 exemption should be submitted together with the authorisation application since the impact resulting from infrastructure development within the exclusion zone is deemed insignificant (0.5 % impact on MAR, equivalent to a runoff depth of 0.21 mm). The disturbed tributaries are non-perennial hence their runoff yield is not significant.
- The proposed PCD or LCD must have a 200 mm thick HDPE lining in order to minimise pollution of groundwater resources.
- The dirty water must be channelled by HDPE-lined drains to prevent pollution of groundwater resources.
- To improve accuracy in determining flow rates, it is recommended to install a calibrated flow meter on the leachate outlet to the PCD or LCD.
- It is also recommended to install a water level gauge in the PCD/LCD.
- Surplus water should be re-used for dust suppression (if required) on the site if it meets DWS standard limits.
- If flow rates and more information become available, it is recommended to update the site water balance accordingly.
- The baseline surface water quality analysis should be the basis for future water quality monitoring at the proposed Newcastle Greenwich landfill site.
- A surface water monitoring programme which includes 7 determined localities should be adhered to. This will enable the detection of any pollution that might result from activities at the Newcastle Greenwich Landfill site which has the potential of impacting on downstream water users.
- Land preparation must be restricted to the landfill footprint area to minimise the size of the affected area.
- The preparation of the land and removal of vegetation will disturb a relatively very small area. The streams to be disturbed are non-perennial hence the runoff loss impact is deemed insignificant (0.5 % of MAR).
- Possible treatment of dirty water from the PCD and then discharge clean treated water into the natural environment to recoup a fraction of the water lost.

- Silt traps should be installed to trap sediments from clean stormflow before discharging it into natural watercourses, especially during the construction phase.
- Quick clean-ups be undertaken when spills occur in line with the landfill site's waste management plan. Oil recovered from vehicles or machinery on site should be collected, stored and disposed of by accredited vendors for recycling.
- Impervious areas must be confined to the development footprint.

16 REASONED OPINION AND CONDITIONS

- Given the hydrological impacts as described in this report, the landfill project can only be viable if only the first 3 Landfill Cells (Cell 1, Cell 2 and Cell 3) are implemented. These cells are outside the development exclusion zone, therefore, are not expected to negatively impact available water resources in the area, provided all recommended mitigation measures are adhered to;
- Should the client need to go ahead with a full implementation of all 7 Landfill Cells, the application should include a GN 704 exemption for Landfill Cells 4 to 7.
- Potable water supply should be externally sourced and stored in 3 by 20 m^3 Jojo tanks.

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18 APPENDICES

APPENDIX 1: CALCULATION OF PEAK FLOWS

RATIONAL METHOD 3							
Description of catchment	SC1						
River detail	Ncandu Tributary 1						
Calculated by	Daniel Fundisi			Date	07/02/2018		
Physical characteristics							
Size of catchment (A)	1.69	km^2		Rainfall region	V3B		
Longest watercourse (L)	2.41	km		**Area distribution factors**			
Average slope (S_{av})	0.10082	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		1.00	0	0	
Mean annual rainfall(MAR)	835	mm					
Rural				**URBAN**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C2**
Wetlands and pans (<3%)	2.00	0.03	0.06	**Lawns**			
Flat areas (3 - 10%)	65.00	0.08	5.20	Sandy,flat<2%	5	0.08	0.4
Hilly (10 - 30%)	30.00	0.16	4.80	Sandy,steep>7%	15	0.16	2.4
Steep Areas (>30%)	3.00	0.26	0.78	Heavy s,flat<2%	5	0.15	0.75
Total	100.00	0.53	10.84	Heavy s,steep>7%	2	0.3	0.6
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very permeable	0	0.04	0.00	Houses	18	0.5	9
Permeable	30	0.08	2.40	Flats	5	0.6	3
Semi-permeable	80	0.16	12.80	Industry			
Impermeable	20	0.26	5.20	Light industry	15	0.6	9
Total	130	0.54	20.40	Heavy industry	5	0.7	3.5
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush & plantation	0	0.04	0.00	City centre	5	0.8	4
Light bush & farm-lands	65	0.11	7.15	Suburban	15	0.65	9.75
Grasslands	20	0.21	4.20	Streets	10	0.75	7.5
No vegatation	15	0.28	4.20	Max flood		1	
Total	100	0.64	15.55	Total (C2)	100		49.9
Time of concentration (TC)							
Overland flow	Defined watercourse						
$T_C = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$			Use Defined watercourse			
1.014 hours	0.316 hours						
Run-off coefficient							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Run-off coefficient, C_1					0.468	0.468	
Adjusted for dolomitic areas, C_{1D}					0.468	0.468	
Adj factor for initial saturation, F_t					0.83	1	
Adjusted run - off coefficient, C_{1T}					0.388	0.468	
Combined run - off coefficient, C_T					0.388	0.468	
Rainfall							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Point rainfall (mm), P_T					34.90	38.90	
Point Intensity (mm/h), P_{it}					110.59	123.27	
Area reduction factor (%),ARF_T					1.000	1.000	
Average intensity (mm/hour),I_T					110.595	123.270	
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Peak flow (m3/s)					20.2	27.1	

RATIONAL METHOD 3

Description of catchment		SC2					
River detail		Ncandu Tributary 2					
Calculated by		Daniel Fundisi			Date	07/02/2018	
Physical characteristics							
Size of catchment (A)	0.83	km^2		Rainfall region		V3B	
Longest watercourse (L)	1.21	km		**Area distribution factors**			
Average slope (S_{av})	0.13619	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		1.00	0	0	
Mean annual rainfall(MAR)	835	mm					
Rural				**URBAN**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C2**
Wetlands and pans (<3%)	2.00	0.03	0.06	**Lawns**			
Flat areas (3 - 10%)	65.00	0.08	5.20	Sandy,flat<2%	5	0.08	0.4
Hilly (10 - 30%)	30.00	0.16	4.80	Sandy,steep>7%	15	0.16	2.4
Steep Areas (>30%)	3.00	0.26	0.78	Heavy s,flat<2%	5	0.15	0.75
Total	100.00	0.53	10.84	Heavy s,steep>7%	2	0.3	0.6
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very permeable	0	0.04	0.00	Houses	18	0.5	9
Permeable	30	0.08	2.40	Flats	5	0.6	3
Semi-permeable	80	0.16	12.80	Industry			
Impermeable	20	0.26	5.20	Light industry	15	0.6	9
Total	130	0.54	20.40	Heavy industry	5	0.7	3.5
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush & plantation	0	0.04	0.00	City centre	5	0.8	4
Light bush & farm-lands	65	0.11	7.15	Suburban	15	0.65	9.75
Grasslands	20	0.21	4.20	Streets	10	0.75	7.5
No vegatation	15	0.28	4.20	Max flood		1	
Total	100	0.64	15.55	Total (C2)	100		49.9
Time of concentration (TC)							
Overland flow		Defined watercourse					
$T_C = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$		$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$		Use Defined watercourse			
0.687	hours	0.166	hours				
Run-off coefficient							
Return Period (years)		**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Run-off coefficient, C_1						0.468	0.468	
Adjusted for dolomitic areas, C_{1D}						0.468	0.468	
Adj factor for initial saturation, F_t						0.83	1	
Adjusted run - off coefficient, C_{1T}						0.388	0.468	
Combined run - off coefficient, C_T						0.388	0.468	
Rainfall								
Return Period (years)		**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Point rainfall (mm), P_T						52.20	58.20	
Point Intensity (mm/h), P_{it}						314.59	350.76	
Area reduction factor (%),ARF_T						1.000	1.000	
Average intensity (mm/hour),I_T						314.595	350.755	
Return Period (years)		**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Peak flow (m3/s)						28.2	37.8	

RATIONAL METHOD 3

Description of catchment	SC3						
River detail	Ncandu Tributary 3						
Calculated by	Daniel Fundisi			Date	07/02/2018		
Physical characteristics							
Size of catchment (A)	1.16	km^2		Rainfall region	V3B		
Longest watercourse (L)	2.331	km		**Area distribution factors**			
Average slope (S_{av})	0.06921	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		1.00	0	0	
Mean annual rainfall(MAR)	835	mm					
Rural				**URBAN**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C2**
Wetlands and pans (<3%)	2.00	0.03	0.06	**Lawns**			
Flat areas (3 - 10%)	65.00	0.08	5.20	Sandy,flat<2%	5	0.08	0.4
Hilly (10 - 30%)	30.00	0.16	4.80	Sandy,steep>7%	15	0.16	2.4
Steep Areas (>30%)	3.00	0.26	0.78	Heavy s,flat<2%	5	0.15	0.75
Total	100.00	0.53	10.84	Heavy s,steep>7%	2	0.3	0.6
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very permeable	0	0.04	0.00	Houses	18	0.5	9
Permeable	30	0.08	2.40	Flats	5	0.6	3
Semi-permeable	80	0.16	12.80	Industry			
Impermeable	20	0.26	5.20	Light industry	15	0.6	9
Total	130	0.54	20.40	Heavy industry	5	0.7	3.5
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush & plantation	0	0.04	0.00	City centre	5	0.8	4
Light bush & farm-lands	65	0.11	7.15	Suburban	15	0.65	9.75
Grasslands	20	0.21	4.20	Streets	10	0.75	7.5
No vegatation	15	0.28	4.20	Max flood		1	
Total	100	0.64	15.55	Total (C2)	100		49.9
Time of concentration (TC)							
Overland flow	Defined watercourse						
$T_C = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$			Use Defined watercourse			
1.091 hours	0.356 hours						
Run-off coefficient							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Run-off coefficient, C_1					0.468	0.468	
Adjusted for dolomitic areas, C_{1D}					0.468	0.468	
Adj factor for initial saturation, F_t					0.83	1	
Adjusted run - off coefficient, C_{1T}					0.388	0.468	
Combined run - off coefficient, C_T					0.388	0.468	
Rainfall							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Point rainfall (mm), P_T					34.90	38.90	
Point Intensity (mm/h), P_{it}					98.08	109.32	
Area reduction factor (%),ARF_T					1.000	1.000	
Average intensity (mm/hour),I_T					98.078	109.319	
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Peak flow (m3/s)					12.3	16.5	

RATIONAL METHOD 3

Description of catchment	SC4						
River detail	Ncandu Tributary 4						
Calculated by	Daniel Fundisi			Date	07/02/2018		
Physical characteristics							
Size of catchment (A)	0.54	km^2		Rainfall region	V3B		
Longest watercourse (L)	1.06	km		**Area distribution factors**			
Average slope (S_{av})	0.04147	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		1.00	0	0	
Mean annual rainfall(MAR)	835	mm					
Rural				**URBAN**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C2**
Wetlands and pans (<3%)	2.00	0.03	0.06	**Lawns**			
Flat areas (3 - 10%)	65.00	0.08	5.20	Sandy,flat<2%	5	0.08	0.4
Hilly (10 - 30%)	30.00	0.16	4.80	Sandy,steep>7%	15	0.16	2.4
Steep Areas (>30%)	3.00	0.26	0.78	Heavy s,flat<2%	5	0.15	0.75
Total	100.00	0.53	10.84	Heavy s,steep>7%	2	0.3	0.6
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very permeable	0	0.04	0.00	Houses	18	0.5	9
Permeable	30	0.08	2.40	Flats	5	0.6	3
Semi-permeable	80	0.16	12.80	Industry			
Impermeable	20	0.26	5.20	Light industry	15	0.6	9
Total	130	0.54	20.40	Heavy industry	5	0.7	3.5
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush & plantation	0	0.04	0.00	City centre	5	0.8	4
Light bush & farm-lands	65	0.11	7.15	Suburban	15	0.65	9.75
Grasslands	20	0.21	4.20	Streets	10	0.75	7.5
No vegatation	15	0.28	4.20	Max flood		1	
Total	100	0.64	15.55	Total (C2)	100		49.9
Time of concentration (TC)							
Overland flow	Defined watercourse						
$T_C = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$			Use Defined watercourse			
0.851 hours	0.236 hours						

Run-off coefficient							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Run-off coefficient, C_1					0.468	0.468	
Adjusted for dolomitic areas, C_{1D}					0.468	0.468	
Adj factor for initial saturation, F_t					0.83	1	
Adjusted run - off coefficient, C_{1T}					0.388	0.468	
Combined run - off coefficient, C_T					0.388	0.468	
Rainfall							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Point rainfall (mm), P_T					52.20	58.20	
Point Intensity (mm/h), P_{it}					220.79	246.17	
Area reduction factor (%),ARF_T					1.000	1.000	
Average intensity (mm/hour),I_T					220.792	246.171	
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Peak flow (m3/s)					12.9	17.3	

RATIONAL METHOD 3

Description of catchment	SC5						
River detail	Ncandu Tributary 5						
Calculated by	Daniel Fundisi			Date	07/02/2018		
Physical characteristics							
Size of catchment (A)	1.64	km^2		Rainfall region	V3B		
Longest watercourse (L)	1.724	km		**Area distribution factors**			
Average slope (S_{av})	0.06806	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		1.00	0	0	
Mean annual rainfall(MAR)	835	mm					
Rural				**URBAN**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C2**
Wetlands and pans (<3%)	2.00	0.03	0.06	**Lawns**			
Flat areas (3 - 10%)	65.00	0.08	5.20	Sandy,flat<2%	5	0.08	0.4
Hilly (10 - 30%)	30.00	0.16	4.80	Sandy,steep>7%	15	0.16	2.4
Steep Areas (>30%)	3.00	0.26	0.78	Heavy s,flat<2%	5	0.15	0.75
Total	100.00	0.53	10.84	Heavy s,steep>7%	2	0.3	0.6
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very permeable	0	0.04	0.00	Houses	18	0.5	9
Permeable	30	0.08	2.40	Flats	5	0.6	3
Semi-permeable	80	0.16	12.80	Industry			
Impermeable	20	0.26	5.20	Light industry	15	0.6	9
Total	130	0.54	20.40	Heavy industry	5	0.7	3.5
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush & plantation	0	0.04	0.00	City centre	5	0.8	4
Light bush & farm-lands	65	0.11	7.15	Suburban	15	0.65	9.75
Grasslands	20	0.21	4.20	Streets	10	0.75	7.5
No vegatation	15	0.28	4.20	Max flood		1	
Total	100	0.64	15.55	Total (C2)	100		49.9
Time of concentration (TC)							
Overland flow		Defined watercourse					
$T_C = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$		$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$		Use Defined watercourse			
0.951 hours		0.284 hours					

Run-off coefficient						
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Run-off coefficient, C_1					0.468	0.468	
Adjusted for dolomitic areas, C_{1D}					0.468	0.468	
Adj factor for initial saturation, F_t					0.83	1	
Adjusted run - off coefficient, C_{1T}					0.388	0.468	
Combined run - off coefficient, C_T					0.388	0.468	
Rainfall							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Point rainfall (mm), P_T					41.10	45.80	
Point Intensity (mm/h), P_{it}					144.76	161.32	
Area reduction factor (%),ARF_T					1.000	1.000	
Average intensity (mm/hour),I_T					144.762	161.316	
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Peak flow (m3/s)					25.6	34.4	

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment		SC1					
River detail		Ncandu Tributary 1					
Calculated by		Daniel Fundisi			Date	07/02/2018	
Physical characteristics							
Size of catchment (A)	1.69	km^2		Days of thunder per year (R)		17	days
Longest watercourse (L)	2.407	km		Time of concentration, t		18.934	minutes
Average slope (S_{av})	0.10082	m/m		Time of concentration, T_c	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$		
SDF Basin	26						
2-year return period rainfall (M)	61	mm					0.3156
TR102 n-day rainfall data							
Weather Service Station	Nqutu			MAP		760	mm
Weather Service Station no.	336283			Coordinates			
Duration	**Return Period (years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$					53.5	61.6	
Area reduction factor (%),ARF_T					1.000	1.0000	
Average intensity (mm/hour),I_T					169.5	195.2841	
Run-off coefficient							
Calibration factors C_2 (%)	15		C_{100} (%)		50		
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T					0.458	0.500	
Peak flow (m3/s)					36.43	45.84	

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment		SC1					
River detail		Ncandu Tributary 1					
Calculated by		Daniel Fundisi			Date	07/02/2018	
Physical characteristics							
Size of catchment (A)	0.83	km^2		Days of thunder per year (R)		17	days
Longest watercourse (L)	1.21	km		Time of concentration, t		9.956	minutes
Average slope (S_{av})	0.13619	m/m		Time of concentration, T_c	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$		
SDF Basin	26						
2-year return period rainfall (M)	61	mm					0.1659
TR102 n-day rainfall data							
Weather Service Station	Nqutu			MAP		760	mm
Weather Service Station no.	336283			Coordinates			
Duration	**Return Period (years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$					39.9	46.0	
Area reduction factor (%),ARF_T					1.000	1.0000	
Average intensity (mm/hour),I_T					240.5	277.1658	
Run-off coefficient							
Calibration factors C_2 (%)	15		C_{100} (%)		50		
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T					0.458	0.500	
Peak flow (m3/s)					25.40	31.95	

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment	SC3						
River detail	Ncandu Tributary 3						
Calculated by	Daniel Fundisi				Date	07/02/2018	
Physical characteristics							
Size of catchment (A)	1.16	km^2		Days of thunder per year (R)		17	days
Longest watercourse (L)	2.33	km		Time of concentration, t		21.350	minutes
Average slope (S_{av})	0.06921	m/m		Time of concentration, T_c	$T_c = \left[\frac{0.87 L^2}{1000 S_{AV}}\right]^{0.385}$		
SDF Basin	26						
2-year return period rainfall (M)	61	mm					0.3558
TR102 n-day rainfall data							
Weather Service Station	Nqutu			MAP		760	mm
Weather Service Station no.	336283			Coordinates			
Duration	**Return Period (years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$					56.0	64.5	
Area reduction factor (%),ARF_T					1.000	1.0000	
Average intensity (mm/hour),I_T					157.4	181.3930	
Run-off coefficient							
Calibration factors C_2 (%)	15		C_{100} (%)		50		
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T					0.458	0.500	
Peak flow (m3/s)					23.23	29.22	

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment	SC4						
River detail	Ncandu Tributary 4						
Calculated by	Daniel Fundisi				Date	07/02/2018	
Physical characteristics							
Size of catchment (A)	0.54	km^2		Days of thunder per year (R)		17	days
Longest watercourse (L)	1.06	km		Time of concentration, t		14.185	minutes
Average slope (S_{av})	0.04147	m/m		Time of concentration, T_c	$T_c = \left[\frac{0.87 L^2}{1000 S_{AV}}\right]^{0.385}$		
SDF Basin	26						
2-year return period rainfall (M)	61	mm					0.2364
TR102 n-day rainfall data							
Weather Service Station	Nqutu			MAP		760	mm
Weather Service Station no.	336283			Coordinates			
Duration	**Return Period (years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$					47.4	54.6	
Area reduction factor (%),ARF_T					1.000	1.0000	
Average intensity (mm/hour),I_T					200.4	230.9502	
Run-off coefficient							
Calibration factors C_2 (%)	15		C_{100} (%)		50		
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T					0.458	0.500	
Peak flow (m3/s)					13.77	17.32	

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment		SC5					
River detail		Ncandu Tributary 5					
Calculated by		Daniel Fundisi			Date	07/02/2018	
Physical characteristics							
Size of catchment (A)	1.64	km^2		Days of thunder per year (R)		17	days
Longest watercourse (L)	1.724	km		Time of concentration, t		17.035	minutes
Average slope (S_{av})	0.06806	m/m		Time of concentration, T_c	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$		
SDF Basin	26						
2-year return period rainfall (M)	61	mm					0.2839
TR102 n-day rainfall data							
Weather Service Station	Nqutu			MAP		760	mm
Weather Service Station no.	336283			Coordinates			
Duration	**Return Period (years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$					51.3	59.1	
Area reduction factor (%),ARF_T					1.000	1.0000	
Average intensity (mm/hour),I_T					180.5	207.9997	
Run-off coefficient							
Calibration factors C_2 (%)	15		C_{100} (%)		50		
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T					0.458	0.500	
Peak flow (m3/s)					37.66	47.38	

MIDGLEY & PITMAN (MIPI) METHOD										
River Detail	**Catchment Area**	**MAP**	**S**	**L**	**Lc**	**Constant K_T**		**Catchment Parameter**	**Peak Flows**	
	(km^2)	(mm)	m/m	km	km	1: 50 year	1: 100 year	Dimensionless	1: 50 year	1: 100 year
SC1	1.69	835	0.10082	2.41	1.06	0.95	1.2	0.2103	30.00	37.89
SC2	0.83	835	0.13619	1.21	0.58	0.95	1.2	0.4335	22.63	28.58
SC3	1.16	835	0.06921	2.33	1.26	0.95	1.2	0.1039	20.79	26.25
SC4	0.54	835	0.04147	1.06	0.54	0.95	1.2	0.1937	14.88	18.80
SC5	1.64	835	0.06806	1.72	0.93	0.95	1.2	0.2657	30.87	38.99

APPENDIX 2: V3H7 HISTORICAL CHEMICAL WATER DATA

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007 Q01	Feb-1966	7.1	4.4	2	1	9	-	7	2	14.8	0.02	-	0.3	-	-
102753	V3H007 Q01	Oct-1966	6.9	6.7	6	3	7	-	11	2	25.4	0.02	-	0.1	-	-
102753	V3H007 Q01	Jan-1967	7.2	9.4	9	2	7	-	6	10	32.8	0.02	-	0.2	-	-
102753	V3H007 Q01	Jul-1977	7.3	7	4.3	2.4	4.1	0.91	1.5	2	33.3	0.02	0.04	0.1	0.003	7.79
102753	V3H007 Q01	Jul-1977	7.1	7	3.9	3.2	5	0.62	3.6	2	30.6	0.02	0.06	0.05	0.05	9.68
102753	V3H007 Q01	Aug-1977	7.43	31.1	15.1	12.1	25.4	0.92	24.9	13.4	103.8	0.23	0.07	0.43	0.025	9.44
102753	V3H007 Q01	Aug-1977	7.02	7.5	5.1	2.6	4.6	0.74	1.5	2	35.3	0.02	0.06	0.05	0.029	8.89
102753	V3H007 Q01	Aug-1977	7.3	15.7	5.6	3.6	3.8	1.02	3.5	2	36.3	0.07	0.04	0.05	0.025	8.91
102753	V3H007 Q01	Aug-1977	7.16	8	7.9	2.8	5.7	1.19	1.5	2	31.6	0.02	0.02	0.05	0.003	8.88
102753	V3H007 Q01	Aug-1977	4.32	16.7	15.9	5.4	4.6	1.46	40.3	2	5.2	0.04	0.02	0.15	0.04	8.73
102753	V3H007 Q01	Sep-1977	7.59	14.4	21	3.8	4.8	0.83	4.4	2	68.7	0.02	0.11	0.05	0.003	7.55
102753	V3H007 Q01	Sep-1977	6.98	9.6	6.3	4.1	5.4	1.96	1.5	2	51.6	0.05	0.05	0.05	0.014	8.59
102753	V3H007 Q01	Sep-1977	6.9	9.6	4.4	4.1	4.2	2.03	1.5	5.4	37	0.02	0.02	0.05	0.011	7.92

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Sep-1977	7.02	10.2	7.4	4.6	4.9	2.13	5.4	2	36.3	0.02	0.02	0.05	0.029	8.1
102753	V3H007Q01	Oct-1977	6.68	8	5.7	1.8	5.2	2.02	3.9	2	22.9	0.02	0.02	0.1	0.003	6.85
102753	V3H007Q01	Oct-1977	6.95	10.1	8.2	3.7	5.7	1.41	1.5	2	43.8	0.02	0.02	0.1	0.061	6.41
102753	V3H007Q01	Oct-1977	7.1	12.9	13.6	4.3	4.5	1.49	1.5	2	58.5	0.02	0.02	1	0.003	7.36
102753	V3H007Q01	Oct-1977	6.82	9.1	3.7	2.8	4.5	1.43	1.5	2	33.9	0.02	0.04	1.18	0.061	7.78
102753	V3H007Q01	Nov-1977	6.63	8.4	7.4	2.5	3.8	1.25	1.5	2	42.9	0.02	0.02	0.05	0.018	8.28
102753	V3H007Q01	Nov-1977	6.3	7.4	3.6	2.5	3.7	1.51	1.5	5.8	28.7	0.16	0.16	0.05	0.007	6.42
102753	V3H007Q01	Nov-1977	7.1	12.9	16.6	4.1	4.8	0.76	1.5	2	57.7	0.02	0.02	0.05	0.014	7.18
102753	V3H007Q01	Nov-1977	6.91	7.9	6.2	2.6	4.3	1.37	1.5	2	29.8	0.02	0.04	0.05	0.003	7.04
102753	V3H007Q01	Nov-1977	5.86	3.4	2.2	0.5	2.3	1.83	1.5	2	10	0.33	0.04	0.05	0.003	2.06
102753	V3H007Q01	Dec-1977	6.56	5.8	4.1	2.2	3.3	0.15	1.5	2	20.3	0.02	0.02	0.05	0.003	6.34
102753	V3H007Q01	Dec-1977	6.62	6.4	4.9	2.2	3.8	0.15	1.5	4.2	22.1	0.02	0.04	0.05	0.011	6.73
102753	V3H007Q01	Dec-1977	6.51	5.5	4.3	1.9	3.7	0.15	1.5	4.6	21	0.02	0.02	0.05	0.003	6.64
102753	V3H007Q01	Jan-1978	6.3	3.8	2.4	0.5	2.4	0.15	1.5	4	12.3	0.02	0.07	0.05	0.011	6.67

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jan-1978	6.4	4.7	3.7	1.4	2.7	0.39	1.5	2	17	0.02	0.02	0.05	0.018	7.18
102753	V3H007Q01	Jan-1978	6.61	5.1	3.5	0.5	3.2	0.43	1.5	2	18	0.36	0.05	0.05	0.007	5.15
102753	V3H007Q01	Feb-1978	7.01	5.4	4.4	2	3.8	0.15	1.5	2	20.7	0.02	0.22	0.05	0.003	7.36
102753	V3H007Q01	Feb-1978	7.08	4.8	3.3	1.4	3.5	0.15	1.5	2	16.2	0.02	0.11	0.05	0.003	7
102753	V3H007Q01	Mar-1978	6.82	5	4	0.5	3.7	0.15	1.5	2	18	0.02	0.09	0.05	0.007	6.9
102753	V3H007Q01	Mar-1978	6.89	4.7	4	0.5	4	0.34	1.5	2	14.8	0.02	0.06	0.05	0.007	6.61
102753	V3H007Q01	Mar-1978	7.19	5.3	3.6	2	3.7	0.35	1.5	2	20.4	0.02	0.21	0.05	0.003	7.31
102753	V3H007Q01	Apr-1978	6.98	10.2	3.9	2.3	3.7	0.46	1.5	2	21.7	0.02	0.16	0.05	0.022	7.58
102753	V3H007Q01	Apr-1978	6.92	5.7	3.4	2	3.7	0.59	1.5	2	17.6	0.02	0.16	0.05	0.022	6.83
102753	V3H007Q01	May-1978		5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1978	6.61	10	6.8	2.6	4.3	0.51	1.5	2	35.3	0.15	0.09	0.05	0.011	7.06
102753	V3H007Q01	May-1978	7.35	10.6	5.1	1.9	3.9	0.41	1.5	2	22.2	0.02	0.08	0.05	0.018	7.62
102753	V3H007Q01	May-1978	7.35	9.8	5.5	1.9	3.9	0.7	1.5	2	22.3	0.15	0.05	0.05	0.011	7.79
102753	V3H007Q01	May-1978	7.3	10.2	5.2	3	4.1	0.59	1.5	2	28.9	0.02	0.02	0.05	0.007	7.98

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jun-1978	6.8	10.1	6.3	2.6	4.7	0.68	1.5	2	28.3	0.02	0.09	0.14	0.007	7.85
102753	V3H007Q01	Jun-1978	7.09	9.7	6.3	3	4.9	1.22	1.5	2	29.8	0.02	0.07	0.05	0.003	8.06
102753	V3H007Q01	Jun-1978		6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jun-1978	7.21	10.4	6.1	2.5	4	0.57	1.5	2	29	0.02	0.06	0.05	0.018	8.21
102753	V3H007Q01	Jul-1978	7.4	9.9	6.6	3.4	4.5	0.53	1.5	2	32.2	0.02	0.1	0.05	0.011	7.93
102753	V3H007Q01	Jul-1978	7.25	10.1	6	3.2	4.7	0.52	1.5	2	33.7	0.02	0.16	0.45	0.011	7.83
102753	V3H007Q01	Jul-1978	7.4	9.8	5.2	2.5	4	0.77	1.5	2	29.7	0.02	0.09	0.05	0.003	7.87
102753	V3H007Q01	Jul-1978	7.4	10.1	6	2.6	4.7	0.83	3.5	2	29.8	0.12	0.26	0.15	0.007	7.88
102753	V3H007Q01	Aug-1978	7.3	9.8	5.5	3.7	4.1	0.66	1.5	2	31.8	0.02	0.24	0.05	0.003	8.11
102753	V3H007Q01	Aug-1978	7.19	9	7	3.4	4.7	0.87	1.5	2	32.6	0.02	0.02	0.05	0.025	8.24
102753	V3H007Q01	Aug-1978	7	9	8.1	3.9	5.1	1.47	1.5	2	38	0.02	0.02	0.05	0.043	8.42
102753	V3H007Q01	Aug-1978	7.1	8	5.9	1.1	5.4	2.08	1.5	2	26.3	0.02	0.16	0.05	0.018	7.08
102753	V3H007Q01	Sep-1978	6.91	9	7.3	2.8	4.7	2.45	1.5	4.8	28.6	0.02	0.11	0.05	0.036	6.94
102753	V3H007Q01	Sep-1978	7	10	6.9	3.2	5	1.98	1.5	2	31.9	0.02	0.08	0.19	0.014	7.39

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Sep-1978	6.7	10	6.1	2.5	5	1.39	1.5	2	23.9	0.02	0.09	0.3	0.011	6.33
102753	V3H007Q01	Sep-1978	6.95	10.1	7	2.9	4.5	1.46	1.5	7.2	30.5	0.02	0.05	0.05	0.011	6.33
102753	V3H007Q01	Oct-1978	7.1	10.1	8.5	3.7	4.4	1.14	1.5	2	35.7	0.02	0.07	0.05	0.011	7.16
102753	V3H007Q01	Oct-1978	6.7	9.9	5	2.6	4.7	1.51	3.3	2	24.8	0.02	0.06	0.05	0.018	6.09
102753	V3H007Q01	Oct-1978	6.92	9.4	9.2	3.1	4.6	0.58	1.5	2	39.8	0.13	0.09	0.05	0.55	6.74
102753	V3H007Q01	Oct-1978	6.74	10.2	5	2.1	4.4	0.69	1.5	2	22.4	0.04	0.12	0.05	0.007	6.44
102753	V3H007Q01	Oct-1978	6.68	10	5	2.6	5.1	0.68	1.5	2	23.5	0.02	0.1	0.05	0.007	6.34
102753	V3H007Q01	Nov-1978	5.68	4.1	2.6	1.3	3.5	1.88	1.5	14.7	8	0.28	0.06	0.05	0.029	3.65
102753	V3H007Q01	Nov-1978	7.74	9.9	3.4	1.8	4.2	1.01	1.5	4.3	24.7	0.02	0.04	0.05	0.011	6.58
102753	V3H007Q01	Nov-1978	6.71	10.8	5.4	2.3	4.1	0.87	1.5	4	25.3	0.02	0.02	0.05	0.018	6.24
102753	V3H007Q01	Nov-1978	7.08	10.9	5	1.7	4.1	0.48	1.5	8	25.8	0.04	0.05	0.12	0.014	6.14
102753	V3H007Q01	Dec-1978	6.35	5.2	2.6	1.4	3.3	1.57	1.5	16.8	9.8	0.29	0.12	0.05	0.093	4.93
102753	V3H007Q01	Dec-1978	6.69	4.5	3.3	1.1	3.9	0.61	1.5	2	13.8	0.05	0.06	0.05	0.007	5.66
102753	V3H007Q01	Dec-1978	6.99	4.8	3.7	1.1	3.9	0.53	1.5	2	23.6	0.02	0.04	0.05	0.003	5.65

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jan-1979	6.7	6.4	3.3	1.9	3.7	0.67	1.5	2	16.7	0.06	0.02	0.05	0.018	6.66
102753	V3H007Q01	Jan-1979	7.02	4.8	3.5	1	3.5	0.45	1.5	5.6	17.8	0.02	0.05	0.05	0.011	5.78
102753	V3H007Q01	Apr-1979	7.11	6.4	5.2	2.1	4.3	0.84	1.5	2	24.9	0.02	0.02	0.05	0.021	5.7
102753	V3H007Q01	May-1979	7.38	6.7	5.6	3.6	4.2	1.55	1.5	4.9	26.8	0.02	0.02	0.13	0.006	6.21
102753	V3H007Q01	May-1979	6.97	6.6	5.3	1.9	4.1	0.73	1.5	2	27.8	0.02	0.02	0.05	0.003	5.88
102753	V3H007Q01	May-1979	7.27	6.8	5.9	1.4	4.6	0.65	1.5	2	30.2	0.02	0.02	0.05	0.029	5.9
102753	V3H007Q01	May-1979	7.13	7.2	6	2.3	4.2	0.56	1.5	2	29.5	0.02	0.02	0.05	0.041	5.98
102753	V3H007Q01	May-1979	7.22	7.1	6.3	2.8	4.4	0.6	1.5	12.4	29.6	0.02	0.02	0.05	0.046	6.09
102753	V3H007Q01	Jun-1979	7.33	7.1	6.6	2.8	4.7	0.78	1.5	14.1	27.3	0.05	0.02	0.05	0.029	5.94
102753	V3H007Q01	Jun-1979	7.16	7.2	6.1	2.3	3.7	0.81	1.5	2	28.5	0.02	0.02	0.05	0.032	5.81
102753	V3H007Q01	Jun-1979	7.35	7.1	5.7	2.5	4.3	0.15	1.5	2	30.8	0.02	0.02	0.05	0.027	4.48
102753	V3H007Q01	Jul-1979	7.05	7.2	5.7	2.4	4.1	0.65	1.5	4.4	29.7	0.02	0.02	0.05	0.006	5.55
102753	V3H007Q01	Nov-1979	6.9	6.1	3.9	1.8	4	0.7	1.5	2	23	0.02	0.02	0.05	0.003	5.17
102753	V3H007Q01	Dec-1979	6.7	5.2	3.3	1.6	4.5	0.77	1.5	5.8	28.2	0.64	0.02	0.05	0.003	7.17

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Dec-1979	5.4	4.2	3.1	0.5	3.4	1.8	1.5	6.7	18.6	0.93	0.02	0.05	0.007	5.02
102753	V3H007Q01	Dec-1979	5.9	5.6	4.9	1.4	4.2	1.79	1.5	4.9	24	0.08	0.02	0.05	0.003	6.7
102753	V3H007Q01	Jan-1980	6.62	5	2.4	1.4	3.5	1.09	1.5	2	18.1	0.02	0.02	0.05	0.003	5.81
102753	V3H007Q01	Jan-1980	6.12	4.1	1.5	1.1	3.2	1	1.5	4.9	12.2	0.19	0.02	0.05	0.003	5.9
102753	V3H007Q01	Jan-1980	6.62	4.5	2.1	1	3.5	0.83	1.5	2	16.8	0.02	0.02	0.05	0.003	6.9
102753	V3H007Q01	Jan-1980	6.27	4.4	1.8	1.4	2.9	0.81	1.5	7.1	16.3	0.06	0.02	0.05	0.003	6.01
102753	V3H007Q01	Jan-1980	6	3.8	2.4	0.5	2.3	0.86	1.5	4.9	10.2	0.63	0.02	0.05	0.005	5.54
102753	V3H007Q01	Feb-1980	6.09	4.2	2.3	1	3.8	0.88	1.5	4.3	15.5	0.02	0.02	0.05	0.003	6.12
102753	V3H007Q01	Feb-1980	6.41	5	3.2	1.3	4.1	0.38	1.5	2	19.3	0.02	0.02	0.05	0.003	6.07
102753	V3H007Q01	Feb-1980	6.4	5.1	3.2	1.3	3.7	0.66	1.5	5.4	22.5	0.02	0.02	0.05	0.003	5.36
102753	V3H007Q01	Feb-1980	6.35	5.4	4	1.5	4	0.43	1.5	2	23.4	0.02	0.07	0.05	0.003	6.56
102753	V3H007Q01	Mar-1980	5.79	4.5	3.7	1.2	3.6	0.47	1.5	2	19.1	0.02	0.05	0.05	0.003	6.86
102753	V3H007Q01	Mar-1980	5.76	5.3	3.5	1.7	4	0.84	1.5	2	21.1	0.05	0.02	0.05	0.003	7.04
102753	V3H007Q01	Mar-1980	5.91	5.5	3.6	1.5	4	0.9	1.5	4.1	22	0.11	0.04	0.05	0.003	6.34

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Mar-1980	6.3	18.1	5.3	1.6	3.2	0.49	1.5	4.6	19.9	0.02	0.02	0.05	0.003	6.87
102753	V3H007Q01	Apr-1980	6.79	10.7	5.3	2.1	4	0.79	1.5	2	17.1	0.02	0.04	1.1	0.003	6.93
102753	V3H007Q01	Apr-1980	6.33	6.3	5.1	2.2	3.8	0.62	1.5	4.3	29.3	0.02	0.02	0.47	0.003	7.24
102753	V3H007Q01	Apr-1980	6.7	6.6	4.4	2	3.7	0.68	1.5	2	16.5	0.02	0.05	0.1	0.008	6.56
102753	V3H007Q01	Apr-1980	6.03	6.5	5.1	2.1	4	0.7	4.8	2	25.7	0.02	0.02	0.05	0.006	5.95
102753	V3H007Q01	Apr-1980	6.32	6.5	5	1.6	4.6	0.56	1.5	2	25.4	0.02	0.02	0.05	0.003	6.66
102753	V3H007Q01	May-1980	6.32	7	5	1.5	6.6	0.96	1.5	2	24.5	0.02	0.04	0.05	0.003	6.66
102753	V3H007Q01	May-1980	6.5	6.6	4.5	2.2	3.8	0.43	1.5	2	24.9	0.02	0.02	0.1	0.003	7.02
102753	V3H007Q01	May-1980	6.13	6.5	5.9	2.3	4.4	0.52	1.5	2	21.4	0.02	0.02	0.05	0.003	6.86
102753	V3H007Q01	May-1980	6.05	8	6.7	2.5	4.4	0.76	3.8	2	29.5	0.02	0.07	0.17	0.01	6.96
102753	V3H007Q01	Jun-1980	5.97	7.2	5.2	2.2	4.4	0.76	1.5	2	26.9	0.02	0.05	0.05	0.003	7.28
102753	V3H007Q01	Jun-1980	6.17	7.1	6.7	2.2	4.3	0.79	1.5	4.6	25.5	0.02	0.02	0.05	0.003	7.43
102753	V3H007Q01	Jun-1980	6.7	7.2	5.5	0.5	4.4	0.49	1.5	2	24.9	0.02	0.02	0.05	0.003	7.33
102753	V3H007Q01	Jun-1980	6.33	7.3	7.4	2.3	3.9	0.74	1.5	2	25.6	0.02	0.02	0.05	0.003	7.62

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jul-1980	6.76	7.6	5.9	2.7	3.8	0.77	1.5	4	31.9	0.02	0.02	0.05	0.003	8.1
102753	V3H007Q01	Jul-1980	6.68	8.2	6.9	2.9	5.1	0.86	1.5	2	37.8	0.02	0.02	0.05	0.003	8.12
102753	V3H007Q01	Jul-1980	6.44	7.8	6.7	2.9	4.9	0.69	1.5	2	36.4	0.02	0.02	0.05	0.003	7.11
102753	V3H007Q01	Aug-1980	6.62	7.9	6.5	3.4	4.7	0.88	1.5	4.5	37.3	0.02	0.02	0.05	0.003	7.77
102753	V3H007Q01	Aug-1980	6.56	8.3	7.1	3.3	4.7	0.92	1.5	4.9	34.4	0.02	0.02	0.16	0.003	7.58
102753	V3H007Q01	Aug-1980	6.42	8.6	7.1	3.2	4.8	1.11	1.5	2	39.3	0.02	0.02	0.05	0.005	7.62
102753	V3H007Q01	Aug-1980	6.42	8.7	6.9	3.1	5.9	1.05	1.5	2	40.3	0.02	0.02	0.05	0.003	7.52
102753	V3H007Q01	Sep-1980	6.34	10	7.6	2.9	5.4	1.5	1.5	2	41.5	0.02	0.11	0.05	0.003	7.32
102753	V3H007Q01	Sep-1980	6.47	9.6	8.1	3.5	5.1	1.33	1.5	2	40.4	0.02	0.02	0.05	0.005	7.32
102753	V3H007Q01	Sep-1980	6.47	10.1	7.6	3.4	6.2	1.92	1.5	2	43.9	0.02	0.02	0.05	0.003	6.95
102753	V3H007Q01	Sep-1980	6.5	10.3	9.5	4	4.9	3.67	1.5	2	43.4	0.02	0.02	0.05	0.003	6.79
102753	V3H007Q01	Sep-1980	6.05	7	5	2.2	4.1	1.52	1.5	5.1	27.6	0.02	0.05	0.05	0.008	6.61
102753	V3H007Q01	Oct-1980	5.92	7.4	5.3	2.2	5.4	1.39	3.8	6.7	19	0.02	0.04	0.05	0.003	4.87
102753	V3H007Q01	Oct-1980	6.01	8.4	6.4	2.9	5	1.44	4.4	6.1	24.6	0.02	0.02	0.05	0.003	4.51

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Oct-1980	6.24	8.7	8.2	3.2	5.3	1.65	4.5	5.4	27.6	0.02	0.04	0.05	0.003	5.25
102753	V3H007Q01	Oct-1980	6.09	9.4	7.5	3.7	5.3	1.3	1.5	5.5	37.9	0.02	0.02	0.1	0.006	5.69
102753	V3H007Q01	Nov-1980	6.21	8.8	5.8	2.7	6.1	1.77	5.2	4.8	26.8	0.02	0.02	0.05	0.005	5.47
102753	V3H007Q01	Nov-1980	6.33	8.2	6.6	2.7	5.2	1.22	1.5	2	32.5	0.02	0.05	0.05	0.003	5.57
102753	V3H007Q01	Nov-1980	6.6	8.8	7.4	2.9	5.6	1.75	3.5	7.5	32.6	0.02	0.02	0.05	0.006	5.08
102753	V3H007Q01	Nov-1980	5.42	5.1	2.5	1	3.7	2.26	1.5	6.6	11.1	0.54	0.02	0.05	0.005	3.95
102753	V3H007Q01	Dec-1980	6.13	6	4.4	1.4	4.6	1.15	1.5	8.4	18.7	0.02	0.13	0.05	0.003	5.14
102753	V3H007Q01	Dec-1980	5.58	3.9	2.5	0.5	3.2	1.47	1.5	8.7	10.2	0.19	0.13	0.05	0.003	3.42
102753	V3H007Q01	Jan-1981	6.1	6.6	3.1	2	4.8	1.45	3.3	4.7	20.9	0.02	0.12	0.05	0.003	5.58
102753	V3H007Q01	Jan-1981	6.09	6.6	3.2	2	4.6	1.95	3.3	5.1	20.9	0.27	0.12	0.05	0.006	4.93
102753	V3H007Q01	Jan-1981		6.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1981	5.87	7.9	4	1.8	4	1.48	1.5	9.7	23.6	0.18	0.07	0.28	0.011	4.11
102753	V3H007Q01	Feb-1981	5.95	4.7	3.6	1.3	4.2	0.63	3.5	6.1	14.9	0.02	0.02	0.05	0.012	6.36
102753	V3H007Q01	Feb-1981	5.7	4.6	3.5	1.4	4.6	1.27	1.5	6.7	16.2	0.08	0.09	0.05	0.007	6.26

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Feb-1981	6.2	5	5.2	2.6	3.8	0.85	1.5	7.5	13.5	0.18	0.02	0.05	0.007	6.2
102753	V3H007Q01	Mar-1981		5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Mar-1981	6.24	5.8	4.3	1.8	4.8	0.72	1.5	7.1	19.7	0.02	0.04	0.05	0.003	7.33
102753	V3H007Q01	Mar-1981	5.98	5.9	5.1	1.2	4.4	0.65	3.3	4.7	21.5	0.02	0.02	0.05	0.003	7.26
102753	V3H007Q01	Apr-1981		6.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1981	6.3	7.5	5.2	1.9	5.9	0.84	1.5	6.5	24.5	0.02	0.04	0.24	0.006	7.06
102753	V3H007Q01	Apr-1981		6.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1981		12.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1981		7.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1981		7.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1981		7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1981	6.15	7	5.6	2.1	5.3	0.74	1.5	9.6	26.1	0.02	0.02	0.05	0.003	6.59
102753	V3H007Q01	Jun-1981		6.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jun-1981		7	-	-	-	-	-	-	-	-	-	-	-	-

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jun-1981		7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jun-1981		10.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-1981	6.54	8.2	6.4	2.6	6.3	1.18	5.5	5	27.2	0.02	0.04	0.05	0.003	6.76
102753	V3H007Q01	Jul-1981		7.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-1981		6.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-1981		7.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-1981		8.3	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-1981	6.6	8.7	7.3	3.2	4.4	1.04	3	5.2	32.8	0.02	0.04	0.05	0.003	7.41
102753	V3H007Q01	Aug-1981		8.4	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Aug-1981		9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Aug-1981		9.3	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Aug-1981	6.3	10	7.8	3.4	5.6	1.11	1.5	9.1	39.3	0.02	0.02	0.05	0.003	7.71
102753	V3H007Q01	Sep-1981		8.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Sep-1981		8.3	-	-	-	-	-	-	-	-	-	-	-	-

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007 Q01	Sep-1981		4.8	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Sep-1981		5.8	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Sep-1981	6.1	7.1	6.8	2.9	5.8	1.29	1.5	8	26.9	0.08	0.08	0.05	0.003	7.08
102753	V3H007 Q01	Oct-1981		7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Oct-1981		7.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Oct-1981		7.4	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Oct-1981	6.3	7.5	6.8	2.6	6.1	1.49	3.7	9.7	30.7	0.02	0.02	0.05	0.005	4.98
102753	V3H007 Q01	Nov-1981		6.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Nov-1981	6	6.4	4.1	1.7	3.8	1.81	1.5	2	19.8	0.18	0.07	0.05	0.006	4.77
102753	V3H007 Q01	Dec-1981		7.1	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Dec-1981		5.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Dec-1981		6.3	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Dec-1981		6.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Dec-1981		6.9	-	-	-	-	-	-	-	-	-	-	-	-

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jan-1982	6.53	4.8	2.4	1.6	4.6	2.82	5.1	2	12.7	0.12	0.04	0.05	0.024	5.45
102753	V3H007Q01	Jan-1982		5.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Feb-1982		6.1	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Feb-1982		7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Feb-1982		19.3	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Feb-1982	7.37	7.4	5	2.2	4.6	1.11	1.5	2	29.6	0.15	0.04	0.05	0.003	5.56
102753	V3H007Q01	Mar-1982		7.4	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Mar-1982	6.6	5.7	4.3	1	5.6	1.23	3	2	18.1	0.13	0.02	0.05	0.003	4.76
102753	V3H007Q01	Mar-1982		7.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Mar-1982		6.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1982		7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1982		6.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1982		7.1	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1982	6.76	7	6.3	3.4	4.1	0.86	1.5	2	28.7	0.09	0.02	0.05	0.003	4.36

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007 Q01	May-1982		7.2	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	May-1982		8.1	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	May-1982		7.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	May-1982	6.6	7.6	6.3	2.3	5.9	1.32	1.5	2	22	0.02	0.06	0.05	0.01	3.3
102753	V3H007 Q01	Jun-1982		7.8	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Jun-1982		8.1	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Jun-1982	7	8	7.1	3.8	5.2	1.31	1.5	2	39	0.05	0.06	0.05	0.006	3.18
102753	V3H007 Q01	Jun-1982		8.4	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Jul-1982		9.2	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Jul-1982		8.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Jul-1982		8.3	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Jul-1982	6.97	8.7	7.6	3.1	6.6	1.89	1.5	2	37.6	0.02	0.04	0.15	0.018	3.1
102753	V3H007 Q01	Aug-1982		9.1	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007 Q01	Aug-1982		9.5	-	-	-	-	-	-	-	-	-	-	-	-

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Aug-1982		9.3	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Aug-1982	7.1	10.3	7.9	3.8	7.5	1.71	1.5	2	44.9	0.06	0.06	0.17	0.012	3.37
102753	V3H007Q01	Sep-1982		12.2	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Sep-1982		10.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Sep-1982		10.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Sep-1982		11.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Oct-1982		12.2	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Oct-1982		12.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Oct-1982	7.2	13.4	11.1	4.7	7	2.77	4.2	9.7	41.9	0.24	0.05	0.05	0.003	5.57
102753	V3H007Q01	Nov-1982		4.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Nov-1982		5.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Nov-1982		6.4	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Nov-1982	6.73	7.3	5	2.3	4.9	1.25	1.5	9.5	22.5	0.15	0.04	0.05	0.013	3.27
102753	V3H007Q01	Nov-1982		7.6	-	-	-	-	-	-	-	-	-	-	-	-

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Dec-1982		7.1	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Dec-1982		6.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Dec-1982		6.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Dec-1982	6.8	7.1	-	-	-	-	-	-	27.5	0.02	-	-	-	-
102753	V3H007Q01	Jan-1983		6.2	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1983		7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1983		7.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1983		6.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1983	6.73	6.1	4.1	1.6	4.2	1.33	1.5	9	15.4	0.04	0.04	0.05	0.003	5.17
102753	V3H007Q01	Feb-1983		5.8	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Feb-1983		5.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Feb-1983	6.32	5.1	-	-	-	-	-	-	16.8	0.04	-	-	-	-
102753	V3H007Q01	Mar-1983		10	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1983	6.51	7.2	5.3	1.7	4.5	2	1.5	10.9	25.5	0.14	0.02	0.13	0.008	2.36

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Oct-1983		7.1	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Nov-1983	6.35	6.8	4.3	1.7	4.1	1.26	8.1	2	6.1	0.15	0.09	0.05	0.032	5.29
102753	V3H007Q01	Dec-1983		6.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1984	7.1	11.2	8	4.7	8	2.28	7.8	6.5	30.7	0.17	0.06	0.13	0.657	7.77
102753	V3H007Q01	Feb-1984		5.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Mar-1984	5.7	6.4	4.2	1.5	4.4	0.87	5.1	9.6	2	0.19	0.06	0.05	0.011	6.77
102753	V3H007Q01	May-1984		6.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1984	6.41	8.8	5	2.6	5.7	0.86	7.9	8.1	28	0.05	0.05	0.05	0.015	8.1
102753	V3H007Q01	Jun-1984		6.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Sep-1984	7.1	9	5.8	2.7	6.1	0.84	7	7.4	17	0.02	0.02	0.05	0.009	6.94
102753	V3H007Q01	Oct-1984		7.8	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Nov-1984	6.07	8.7	6.3	3.1	6.7	1.58	7	6.1	16.8	0.04	0.1	0.14	0.02	6.72
102753	V3H007Q01	Jan-1985		7.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1985	7	8	4.7	1.8	4.4	0.55	4.9	6.1	17.6	0.06	0.04	0.05	0.008	6.22

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Feb-1985		4.3	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Mar-1985	7	8.1	5.2	2.3	5.5	0.81	1.5	10.6	33.3	0.23	0.04	0.05	0.003	6.87
102753	V3H007Q01	Apr-1985		7.2	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1985	5.95	11.5	6.3	2.9	4.7	0.64	6.1	7.1	23.6	0.02	0.04	0.05	0.016	7.59
102753	V3H007Q01	Jun-1985		8	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-1985	6.2	9.6	6.4	3.1	5.9	0.76	7.4	4.9	31.6	0.04	0.04	0.16	0.123	7.82
102753	V3H007Q01	Aug-1985		9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Oct-1985	7.2	12.6	8.2	4.4	6.6	2.19	6.7	7	34.8	0.02	0.02	0.12	0.01	7.02
102753	V3H007Q01	Oct-1985		10.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Dec-1985	6.48	8.1	4.4	1.6	3.8	1.29	6.5	10.5	19.4	0.17	0.04	0.05	0.01	6.18
102753	V3H007Q01	Jan-1986		6.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1986	5.4	6	4.5	1.6	3.9	0.64	1.5	8.4	18.8	0.02	0.06	0.05	0.006	6.49
102753	V3H007Q01	Feb-1986		6.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1986	7.05	8.6	5.9	2.3	4.4	0.69	6.9	5.1	27.2	0.02	0.05	0.05	0.008	6.37

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Apr-1986		6.2	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1986	7.1	8.4	5.6	2.4	3	0.43	1.5	4.8	33.9	0.02	0.04	0.05	0.005	6.79
102753	V3H007Q01	Jul-1986		11.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-1986	7.2	9.4	6.6	3	4.7	0.98	4.2	2	33.8	0.02	0.05	0.05	0.005	7
102753	V3H007Q01	Aug-1986		7.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Oct-1986	7.3	12.2	9.2	4.3	6.5	1.94	3.8	2	37.6	0.02	0.11	0.05	0.007	7.17
102753	V3H007Q01	Oct-1986		8.6	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Nov-1986	6.91	7.5	4.6	1.4	4.3	0.82	5.1	5.8	12.9	0.02	0.07	0.05	0.03	5.68
102753	V3H007Q01	Dec-1986		5.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1987	6.45	8	5.2	2.2	5	0.93	4.5	7.9	19.6	0.02	0.06	0.05	0.005	6.27
102753	V3H007Q01	Feb-1987		5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Apr-1987	7.05	8.4	6.2	2.1	4	0.83	3.4	4.4	22.8	0.1	0.07	0.05	0.015	6.5
102753	V3H007Q01	Apr-1987		7.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	May-1987	7	9	6.5	3.1	4.8	0.98	4.9	8.5	32.8	0.02	0.05	0.05	0.003	5.83

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jul-1987		7.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-1987	6.3	10.2	7.9	3.5	5.5	1.24	5.8	6.8	35.2	0.02	0.07	0.05	0.01	6.37
102753	V3H007Q01	Sep-1987		8.2	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Oct-1987	6.2	7.8	3.9	1.4	6	0.76	6.9	4.5	11.3	0.27	0.09	0.12	0.015	6.27
102753	V3H007Q01	Oct-1987		6.9	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Dec-1987	6.71	7.9	4.7	2	4.3	0.69	6.5	6.1	12.4	0.17	0.02	0.13	0.003	7.07
102753	V3H007Q01	Dec-1987		5.5	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jan-1988	6.4	6.8	4.8	1.8	4.1	0.7	6.2	4.1	12.9	0.09	0.05	0.17	0.008	6.69
102753	V3H007Q01	Mar-1988	6.35	5.8	3.6	1.4	3.5	1.14	1.5	8	12.3	0.54	0.04	0.05	0.008	3.76
102753	V3H007Q01	Jun-1988	6.58	8.3	5.5	2.5	4.9	0.76	1.5	2	24.2	0.02	0.06	0.1	0.011	7.2
102753	V3H007Q01	Sep-1988		6.7	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Oct-1988		8.3	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Nov-1988	6.23	8.3	4.4	1.7	5.4	0.69	8.2	4.4	12.9	0.07	0.04	0.14	0.01	6.46
102753	V3H007Q01	Mar-1989	7.17	6.5	5	1.7	3.5	0.46	5.7	8.6	17.6	0.13	0.02	0.05	0.01	7.11

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	May-1989	7.14	5.9	5.1	2.5	4.2	0.62	4.4	2	20.8	0.05	0.05	0.05	0.003	7.25
102753	V3H007Q01	Jul-1989	8.25	8	5.5	3	3.9	0.54	4.3	2	32.4	0.02	0.02	0.11	0.003	7.5
102753	V3H007Q01	Aug-1989	7.44	8.9	5.4	3.3	5	0.85	4.7	6.2	30.1	0.02	0.06	0.05	0.003	7.26
102753	V3H007Q01	Sep-1989	7.73	9.8	7.3	3.5	3.8	1.11	5.8	2	38	0.04	0.02	0.05	0.012	3.71
102753	V3H007Q01	Oct-1989	7.66	10.5	8.7	3.9	5.2	1.77	5.7	2	47.8	0.02	0.08	0.1	0.018	8.42
102753	V3H007Q01	Nov-1989	7.21	5	2.8	1.2	3.3	1.53	3.7	2	8.4	0.365	0.041	0.11	0.011	4.53
102753	V3H007Q01	Nov-1989	7.91	7.1	4.9	1.9	4.3	0.87	3	6.2	23.2	0.02	0.02	0.05	0.007	4.86
102753	V3H007Q01	Dec-1989	8.09	7.7	5	2	4.4	0.75	6.4	2	21.3	0.18	0.07	0.05	0.091	6.92
102753	V3H007Q01	Jan-1990	7.45	7.2	4.2	2	4.5	1.03	5.4	5	18.5	0.13	0.07	0.05	0.02	6.31
102753	V3H007Q01	Feb-1990	7.44	5	2.9	1.3	3.9	1.16	1.5	2	17.1	0.06	0.02	0.1	0.012	2.67
102753	V3H007Q01	Apr-1990	7.66	8.1	4	1.8	5.8	1.09	5.8	2	17.5	0.108	0.045	0.1	0.145	6.31
102753	V3H007Q01	May-1990	8.2	7.2	5.2	2	4.5	0.68	4.9	4	22	0.121	0.05	0.05	0.008	6.74
102753	V3H007Q01	Jun-1990	7.57	7.2	5.8	2.6	4.7	0.87	5.7	2	24.7	0.065	0.02	0.05	0.011	6.11
102753	V3H007Q01	Jul-1990	8.24	7.6	5.9	2.9	4.7	0.71	5.5	4.2	28.8	0.02	0.041	0.11	0.005	6.68

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Aug-1990	7.69	9	5.8	3.8	4.4	0.95	4.9	12.5	34.1	0.02	0.232	0.12	0.007	6.28
102753	V3H007Q01	Aug-1990	8.13	9.2	6.5	3.1	4.8	1.12	7.9	2	33.5	0.02	0.041	0.16	0.066	5.82
102753	V3H007Q01	Sep-1990	7.77	9.4	8.6	4.8	4.8	1.4	7.2	4.1	37.6	0.02	0.02	0.11	0.006	6.21
102753	V3H007Q01	Oct-1990	8.32	11.2	8	4.1	5.6	2.23	5.7	7.8	49.2	0.02	0.02	0.15	0.01	6.39
102753	V3H007Q01	Nov-1990	7.76	12.9	8.8	4	5.3	2.38	6.3	5.7	50.3	0.04	0.02	0.13	0.011	5
102753	V3H007Q01	Dec-1990	7.53	7	4.6	3.3	3.7	1.18	5.2	7	24.8	0.02	0.02	0.17	0.018	4.36
102753	V3H007Q01	Jan-1991	7.44	7.9	5.7	2.5	4.3	1.04	5	8.6	25	0.047	0.04	0.14	0.016	4.57
102753	V3H007Q01	Feb-1991	7.81	6.5	3	1.6	3.3	0.86	6.6	6.4	18.9	0.164	0.087	0.15	0.021	6.04
102753	V3H007Q01	Mar-1991	7.53	7.5	5.3	2.7	1	0.6	1.5	2	19	0.138	0.061	0.05	0.019	6.57
102753	V3H007Q01	Apr-1991	7.39	6.6	4.5	2.1	3.3	0.57	1.5	6.2	19.8	0.09	0.02	0.22	0.013	7.08
102753	V3H007Q01	May-1991	7.23	7.7	5	2.2	3.5	0.45	1.5	4.1	24.2	0.02	0.02	0.1	0.009	6.55
102753	V3H007Q01	May-1991	8.22	7.6	5.2	2.4	3.5	0.55	5.9	4.9	22.6	0.02	0.051	0.11	0.016	6.22
102753	V3H007Q01	Jun-1991	7.62	8.4	6	2.5	3.5	0.87	5.7	5.8	23.4	0.045	0.048	0.23	0.007	6.56
102753	V3H007Q01	Jul-1991	8.03	9	6.5	3.2	3.5	0.82	3.6	2	30.2	0.02	0.045	0.1	0.048	6.57

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Oct-1991	7.67	10.3	6.2	3.6	2.8	2.46	4.4	5.3	23.6	0.315	0.114	0.12	0.016	4.59
102753	V3H007Q01	Nov-1991	7.45	8.2	5.2	1.8	3.8	0.99	3.6	4.9	19.5	0.02	0.04	0.1	0.005	4.24
102753	V3H007Q01	Dec-1991	7.64	8	5.3	2.8	4.4	1	4.7	2	26.1	0.02	0.043	0.1	0.011	4.52
102753	V3H007Q01	Jan-1992	8.21	7.8	4.6	2	5	0.95	1.5	8.7	29.8	0.046	0.052	0.2	0.181	5.97
102753	V3H007Q01	Feb-1992	7.79	7.4	5.4	2.6	3.2	1.31	3	2	19.8	0.178	0.046	0.05	0.013	4.61
102753	V3H007Q01	Mar-1992	7.46	8	5.2	1.8	2.9	0.92	4.5	6.4	20.5	0.077	0.068	0.2	0.02	5.94
102753	V3H007Q01	Apr-1992	7.74	9.1	6.7	2.6	3.8	1.16	3	5.9	31	0.02	0.07	0.16	0.026	4.97
102753	V3H007Q01	Oct-1992	7.91	9.5	7.6	3.3	5.8	1.19	6.7	7.7	31.8	0.249	0.02	0.05	0.015	3.93
102753	V3H007Q01	Mar-1993	7.95	7.5	5	2.2	4.6	1.05	4	10.6	17.4	0.09	0.02	0.15	0.016	4.7
102753	V3H007Q01	Mar-1993	7.48	6.9	3.4	1.9	4.1	0.89	1.5	8.7	19.2	0.114	0.067	0.14	0.016	6.07
102753	V3H007Q01	Apr-1993	7.44	8.3	6.4	2.3	5.1	0.92	4.2	9.5	22.2	0.103	0.02	0.11	0.007	5
102753	V3H007Q01	May-1993	7.82	9.9	7.4	2.7	4.7	0.95	4.6	7.8	29.6	0.047	0.02	0.15	0.011	4.68
102753	V3H007Q01	Jun-1993	7.74	10.1	6.4	3.2	5	1.05	3.5	14.3	34.1	0.02	0.02	0.2	0.026	4.24
102753	V3H007Q01	Jul-1993	7.8	10.5	6.9	3.2	5.9	1.19	4	7	37.3	0.02	0.04	0.41	0.02	3.93

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Aug-1993	8.02	9.9	7.1	4.2	4.9	1.48	4.4	13.6	37.6	0.062	0.073	0.3	0.016	3.05
102753	V3H007Q01	Oct-1993	7.08	7.6	4.4	2.6	6.1	1.06	4.3	7.4	13.7	0.228	0.02	0.14	0.024	6.26
102753	V3H007Q01	Nov-1993	7.22	7.7	5.6	4	4.3	0.6	3.2	8.3	22.1	0.078	0.02	0.2	0.016	5.06
102753	V3H007Q01	Dec-1993	6.81	6.2	3.3	2.2	4.5	0.65	1.5	15.7	18	0.02	0.02	0.18	0.003	5.28
102753	V3H007Q01	Jan-1994	7.22	10.9	6.1	4.9	5.1	1.61	1.5	29	26.1	0.426	0.05	0.4	0.033	5.3
102753	V3H007Q01	Feb-1994	7.42	6.4	4.4	1.9	4.3	0.56	4.7	14.4	19.2	0.02	0.02	0.23	0.012	5.97
102753	V3H007Q01	Mar-1994	7.65	7.5	6.2	2.1	5.2	0.66	3.5	9.1	32.2	0.065	0.02	0.28	0.01	4.94
102753	V3H007Q01	May-1994	8.05	29	10.5	8.1	27.7	3.07	34.3	16.1	64.9	0.191	0.214	0.3	0.065	5.49
102753	V3H007Q01	Jun-1994	7.78	8.5	6	3.3	3.9	1.28	4	8.7	29	0.041	0.02	0.25	0.029	5.08
102753	V3H007Q01	Aug-1994	8.06	10.3	7.9	3.7	4.8	2.42	5	6.4	40.7	0.02	0.02	0.25	0.012	5.37
102753	V3H007Q01	Sep-1994	7.4	12.7	10.1	4.3	5.3	2.8	5	2	45.9	0.02	0.02	0.28	0.007	6.36
102753	V3H007Q01	Oct-1994	7.64	11.1	9.7	3.7	6.2	2.79	4.5	5.5	47.4	0.02	0.02	0.19	0.003	4.5
102753	V3H007Q01	Nov-1994	7.93	12	7.4	3	6.6	2.7	5	9.6	32.7	0.02	0.056	0.31	0.014	3.78
102753	V3H007Q01	Dec-1994	7.77	37.9	25.1	13.8	18.5	4.36	6.8	118.4	50.9	0.785	0.979	0.21	0.02	4.99

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jan-1995	8.01	10	8.1	2.9	6	2.74	4.8	5.8	38.4	0.101	0.02	0.25	0.017	4.25
102753	V3H007Q01	Feb-1995	7.3	8	5.7	2.3	5.1	2	1.5	11.5	30.4	0.051	0.02	0.23	0.013	5.25
102753	V3H007Q01	Mar-1995	7.63	8.3	6.2	2.5	5.3	2.41	6.1	5.8	27.8	0.055	0.02	0.18	0.013	5.19
102753	V3H007Q01	Apr-1995	7.61	7.7	6	2	4.4	2.2	1.5	9.9	28.6	0.069	0.02	0.3	0.011	5.05
102753	V3H007Q01	May-1995	7.59	7.2	4.4	2.4	5.2	2.13	1.5	9.5	23.4	0.064	0.02	0.24	0.015	4.61
102753	V3H007Q01	Jun-1995	7.9	10.2	8.2	2.8	6.6	1.84	3	11.7	35.4	0.02	0.02	0.5	0.019	3.82
102753	V3H007Q01	Jul-1995	7.95	9.1	7.4	3	5.8	2.41	3.5	10.3	37.1	0.02	0.02	0.21	0.009	3.77
102753	V3H007Q01	Aug-1995	8.08	39.5	26	14.2	38.2	2.91	22.7	18.6	154.2	0.02	0.02	0.3	0.023	2.72
102753	V3H007Q01	Nov-1995	8.05	15.1	12.7	4.3	7.3	3.45	4.6	11.6	59.8	0.067	0.02	0.15	0.023	4.72
102753	V3H007Q01	Dec-1995	7.66	9	7.4	2.4	4.1	2.52	5.2	14.4	30.5	0.083	0.02	0.05	0.016	4.21
102753	V3H007Q01	Jan-1996	7.6	6.3	5.9	1.4	3.1	2.13	4.3	7.3	17.7	0.129	0.02	0.11	0.018	5.46
102753	V3H007Q01	Feb-1996	6.97	4	3	1.1	1	2.45	1.5	12.1	13.6	0.02	0.02	0.11	0.015	4.3
102753	V3H007Q01	Mar-1996	7.25	6.2	4.1	1.3	4.2	1.28	3.9	7.7	24.7	0.02	0.02	0.12	0.013	7.13
102753	V3H007Q01	Apr-1996	7	6.1	5	1.7	2	2.6	3.2	7.3	23.1	0.02	0.02	0.11	0.007	5.17

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	May-1996	7.79	8.9	7.7	2.8	2.9	0.15	1.5	8.7	34.4	0.02	0.02	0.14	0.01	5.73
102753	V3H007Q01	May-1996	7.58	7.8	6.5	2.4	3.9	1.16	3.4	2	30.9	0.16	0.02	0.1	0.003	5.73
102753	V3H007Q01	Jun-1996	7.74	7.7	5.6	2.6	6.1	4	3.3	2	29.1	0.1	0.02	0.11	0.011	6.19
102753	V3H007Q01	Jul-1996	7.74	6.7	4.5	2.2	3.8	1.16	3.9	2	26.6	0.064	0.02	0.1	0.008	5.69
102753	V3H007Q01	Aug-1996	7.94	8	6.6	2.3	4.5	0.7	3.9	6.4	28.7	0.086	0.02	0.1	0.013	5.75
102753	V3H007Q01	Sep-1996	7.7	9	6.6	3.2	5	0.91	3.4	4.3	33.6	0.077	0.02	0.12	0.031	6.04
102753	V3H007Q01	Oct-1996	7.72	10.2	8.5	3.1	4.9	1.18	4.3	12.3	36.3	0.086	0.02	0.13	0.006	5.64
102753	V3H007Q01	Nov-1996	7.59	7.6	5.7	2.1	4.4	0.92	4.1	9.8	25.4	0.107	0.02	0.1	0.012	6.55
102753	V3H007Q01	Dec-1996	7.79	8.9	6.8	2.8	5.1	0.81	3.6	6.4	29.5	0.059	0.046	0.05	0.014	5.64
102753	V3H007Q01	Jan-1997	7.73	8.2	6.8	2.3	4.7	0.81	3.5	10.5	29.6	0.069	0.02	0.05	0.017	5.74
102753	V3H007Q01	Jan-1997	7.36	6.4	4.7	1.6	4.2	0.53	1.5	2	20.5	0.02	0.02	0.15	0.011	6.36
102753	V3H007Q01	Feb-1997	7.71	8.6	6.9	2.3	4.8	0.74	3.3	10	30	0.047	0.02	0.05	0.01	5.99
102753	V3H007Q01	Mar-1997	7.58	7.9	5.8	2.7	4.1	0.75	3.3	8.2	28.8	0.057	0.02	0.05	0.014	6.32
102753	V3H007Q01	Apr-1997	7.56	7.7	6.2	2.2	3.9	0.65	3.4	6.9	28.4	0.081	0.047	0.05	0.003	6.54

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	May-1997	7.61	7.6	5.8	2.6	4.4	0.63	1.5	8.2	32	0.084	0.05	0.05	0.014	6.35
102753	V3H007Q01	Jun-1997	7.56	7.2	5.8	1.9	4.5	0.67	3.1	6.2	28.7	0.102	0.02	0.11	0.012	6.01
102753	V3H007Q01	Jul-1997	7.46	6.9	5	2.3	4.4	0.6	3.7	7	30	0.072	0.02	0.05	0.005	5.72
102753	V3H007Q01	Aug-1997	7.54	7.3	5.9	2.4	4.5	0.59	3.4	9.8	31.5	0.086	0.02	0.1	0.003	5.46
102753	V3H007Q01	Sep-1997	7.9	8.4	7.2	3.5	11.4	1.46	12.2	19.6	30.2	0.17	0.059	0.13	0.035	5.74
102753	V3H007Q01	Oct-1997	7.38	9.4	6.8	2.7	5.4	1.13	3.8	8	34.2	0.02	0.02	0.1	0.015	5.97
102753	V3H007Q01	Nov-1997	7.51	7	4.9	2.2	4.1	1.08	5	8.6	24.4	0.171	0.066	0.16	0.007	5.18
102753	V3H007Q01	Dec-1997	7.77	7	6.1	2	4.3	0.96	3.5	10.7	24.2	0.173	0.02	0.05	0.012	6.2
102753	V3H007Q01	Dec-1997	7.69	8.2	6.2	2.4	4.4	0.68	4	9.4	31.2	0.089	0.02	0.1	0.009	5.52
102753	V3H007Q01	Feb-1998	7.66	5.6	3.8	1.4	3.5	0.83	3.3	11	15.7	0.199	0.02	0.05	0.015	5.17
102753	V3H007Q01	Mar-1998	7.62	7.9	6.7	3.1	5.5	0.64	3.4	9.2	32.6	0.073	0.02	0.05	0.024	6.13
102753	V3H007Q01	Apr-1998	7.61	8.8	8	2.2	4.3	0.6	3.6	4.5	35	0.075	0.02	0.05	0.017	6.18
102753	V3H007Q01	May-1998	7.78	8.5	7.1	2.9	4.7	0.61	1.5	10.6	34.4	0.236	0.082	0.1	0.021	6.33
102753	V3H007Q01	Jul-1998	7.79	9.8	7.6	2.9	4.7	0.69	4.2	5.1	40.6	0.069	0.02	0.1	0.009	5.96

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Aug-1998	8.13	10.3	8.9	3.9	5.2	0.79	3.9	6.7	46.3	0.046	0.02	0.13	0.012	4.95
102753	V3H007Q01	Sep-1998	7.83	11	9.4	4.5	5.6	1.29	4.9	10.3	47.2	0.064	0.079	0.14	0.016	5.67
102753	V3H007Q01	Oct-1998	7.67	7.3	5.4	2.1	4.7	0.86	4.7	12	17.9	0.065	0.02	0.11	0.003	5.01
102753	V3H007Q01	Nov-1998	8.1	10	8.5	3.1	5.3	0.96	4.3	12	35.9	0.099	0.044	0.18	0.012	4.62
102753	V3H007Q01	Dec-1998	7.59	6.4	4.2	2	3.8	0.65	3.7	7.6	19.8	0.088	0.041	0.15	0.012	5.73
102753	V3H007Q01	Jan-1999	7.66	7.4	5.7	2.4	4.9	0.52	3.7	6.8	27.1	0.091	0.02	0.18	0.015	5.54
102753	V3H007Q01	Feb-1999	7.6	6.5	5.2	1.7	4.2	0.56	4.2	7.2	18.3	0.05	0.02	0.1	0.015	6.01
102753	V3H007Q01	Mar-1999	7.57	6.6	4.7	1.8	4	0.54	8.6	6.4	23.4	0.041	0.02	0.05	0.013	6.2
102753	V3H007Q01	Apr-1999	7.84	9.2	7.9	2.9	4.6	0.88	3.8	6.1	36.6	0.065	0.02	0.1	0.041	6.43
102753	V3H007Q01	May-1999	7.71	8.7	7	2.6	4.8	0.71	4.6	5.3	31.2	0.061	0.02	0.13	0.01	5.22
102753	V3H007Q01	Jun-1999	7.6	9.7	7.9	3.2	4.8	0.73	3.6	7.7	38.4	0.042	0.02	0.12	0.011	4.77
102753	V3H007Q01	Jul-1999	8.05	10.7	8.526	3.44	4.984	0.78	5	4.135	42.328	0.084	0.02	0.117	0.01	4.964
102753	V3H007Q01	Aug-1999	7.85	10.9	10.5	4	4.9	0.86	3.5	5.7	45.5	0.02	0.02	0.13	0.011	4.27
102753	V3H007Q01	Sep-1999	8.133	12.6	12.959	5.294	5.463	1.134	5	9.41	50.118	0.02	0.02	0.136	0.019	4.56

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Oct-1999	8.208	12.19	10.003	4.472	5.732	1.347	5	6.109	48.932	0.02	0.02	0.134	0.015	4.569
102753	V3H007Q01	Nov-1999	7.995	12.36	10.305	3.932	5.527	1.673	5	6.127	44.248	0.02	0.055	0.138	0.016	3.692
102753	V3H007Q01	Dec-1999	7.599	7.01	5.347	1.771	3.967	0.894	5	18.24	18.058	0.152	0.02	0.109	0.019	5.752
102753	V3H007Q01	Jan-2000	7.558	6.33	4.225	1.72	3.793	0.822	5	8.73	12.406	0.156	0.02	0.149	0.022	10.479
102753	V3H007Q01	Feb-2000	7.671	7.46	5.47	2.188	4.291	0.693	5	7.637	23.47	0.129	0.02	0.152	0.02	7.488
102753	V3H007Q01	Mar-2000	7.776	7	5.296	2.004	4.304	0.575	5	7.601	26.06	0.08	0.02	0.115	0.012	6.414
102753	V3H007Q01	May-2000	7.685	7.35	4.748	2.176	4.802	0.727	5	6.553	27.052	0.085	0.02	0.123	0.009	6.506
102753	V3H007Q01	Jun-2000	7.667	7.96	6.729	2.054	4.477	1.083	5	5.977	32.835	0.081	0.02	0.107	0.018	6.325
102753	V3H007Q01	Jul-2000	7.724	8.8	7.075	3.178	4.498	1.508	5	6.952	27.833	0.044	0.02	0.05	0.011	6.558
102753	V3H007Q01	Aug-2000	7.855	9.01	6.834	3.001	5.37	0.997	5	2	35.289	0.044	0.02	0.112	0.017	6.201
102753	V3H007Q01	Sep-2000	7.568	9.39	8.026	3.477	4.53	1.239	5	6.185	37.646	0.145	0.02	0.123	0.034	6.671
102753	V3H007Q01	Oct-2000	8.232	7.71	5.302	2.468	5.566	0.801	5	12.568	24.302	0.051	0.02	0.05	0.011	4.946
102753	V3H007Q01	Nov-2000	7.857	9.02	9.658	2.423	4.708	0.712	5	13.283	35.228	0.02	0.02	0.11	0.01	6.197
102753	V3H007Q01	Dec-2000	7.568	6.78	5.016	2.076	3.715	0.706	5	7.404	18.649	0.109	0.02	0.11	0.011	6.018

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jan-2001	7.657	7.33	5.356	2.046	4.285	0.612	5	13.147	25.654	0.057	0.02	0.117	0.009	5.885
102753	V3H007Q01	Feb-2001	7.703	7.93	6.526	2.643	4.535	0.652	5	6.932	29.211	0.02	0.02	0.132	0.012	5.888
102753	V3H007Q01	Mar-2001	8.116	7.6	5.893	2.206	4.504	0.696	5	11.98	27.389	0.062	0.02	0.139	0.043	5.646
102753	V3H007Q01	Apr-2001	7.626	7.65	6.12	2.265	4.809	0.769	5	6.168	24.926	0.048	0.059	0.119	0.025	5.987
102753	V3H007Q01	May-2001	7.566	7.87	5.929	2.502	5.25	0.737	5	7.123	29.107	0.068	0.02	0.131	0.072	6.122
102753	V3H007Q01	May-2001	7.596	8.27	6.802	2.59	5.001	0.769	5	13.99	32.226	0.067	0.02	0.138	0.059	6.19
102753	V3H007Q01	Jun-2001	7.802	9.62	8.788	2.767	5.023	0.739	5	9.147	33.775	0.02	0.02	0.135	0.012	5.219
102753	V3H007Q01	Jul-2001	8.025	21.9	15.471	9.917	11.922	4.654	5	26.422	61.485	0.02	0.064	0.165	0.026	4.803
102753	V3H007Q01	Aug-2001	8.335	10.73	10.311	3.192	5.272	1.179	5	5.364	38.311	0.02	0.02	0.05	0.018	4.906
102753	V3H007Q01	Oct-2001	7.612	7.99	6.383	2.253	4.003	1.021	5	8.552	31.59	0.02	0.043	0.109	0.015	2.945
102753	V3H007Q01	Nov-2001	7.736	7.17	7.448	1.603	3.811	0.677	5	7.776	21.618	0.429	0.02	0.123	0.006	6.519
102753	V3H007Q01	Dec-2001	7.643	8.11	7.064	2.375	3.682	0.817	5	9.777	24.848	0.152	0.02	0.101	0.006	6.531
102753	V3H007Q01	Jan-2002	7.512	9.03	7.497	2.578	5.337	0.907	5	6.606	31.74	0.05	0.02	0.117	0.006	5.477
102753	V3H007Q01	Feb-2002	7.571	7.18	5.589	2.434	4.231	0.812	5	6.54	25.942	0.059	0.02	0.121	0.018	6.344

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Mar-2002	7.752	7.29	5.667	2.118	4.069	0.805	5	7.688	22.947	0.104	0.02	0.116	0.031	7.212
102753	V3H007Q01	Apr-2002	7.824	22.7	11.86	7.584	21.955	2.751	5	68.182	34.671	0.201	0.084	0.162	0.056	5.436
102753	V3H007Q01	May-2002	7.915	13.6	10.632	3.803	3.928	2.452	5	13.168	41.698	0.122	0.058	0.139	0.017	7.684
102753	V3H007Q01	Jun-2002	7.725	8.67	6.919	3.121	4.811	0.819	5	4.853	31.305	0.042	0.02	0.116	0.093	6.093
102753	V3H007Q01	Jul-2002	7.737	9.34	7.608	2.912	3.292	0.696	5	7.328	29.279	0.02	0.045	0.115	0.017	5.719
102753	V3H007Q01	Aug-2002	7.635	9.59	7.075	3.267	3.578	1.019	5	4.294	39.788	0.053	0.042	0.129	0.019	4.762
102753	V3H007Q01	Sep-2002	7.789	10.21	7.772	2.981	3.327	1.208	5	7.536	35.833	0.165	0.02	0.121	0.013	4.854
102753	V3H007Q01	Oct-2002	7.956	8.62	7.093	2.651	4.603	1.118	5	5.024	26.958	0.101	0.084	0.111	0.006	4.677
102753	V3H007Q01	Oct-2002	7.906	9.65	7.215	2.895	3.96	1.269	5	2	33.806	0.065	0.06	0.157	0.006	4.246
102753	V3H007Q01	Nov-2002	7.573	7.28	4.972	1.836	3.748	0.946	5	5.923	23.997	0.05	0.02	0.103	0.018	5.287
102753	V3H007Q01	Dec-2002	7.711	6.97	6.694	1.93	2.218	0.478	5	5.135	28.929	0.119	0.02	0.101	0.028	7.73
102753	V3H007Q01	Jan-2003	7.497	7.02	5.094	-	2.868	0.531	5	7.467	16.757	0.047	0.02	0.126	0.02	6.43
102753	V3H007Q01	Feb-2003	7.713	12.46	10.025	2.446	3.582	2.349	5	15.348	22.425	0.128	0.113	0.158	0.006	4.734
102753	V3H007Q01	Mar-2003	7.666	9.15	8.131	2.095	2.207	0.822	5	8.58	24.79	0.02	0.02	0.136	0.059	4.715

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Apr-2003	7.402	9.45	7.164	2.344	4.154	1.051	5	10.396	29.441	0.051	0.02	0.169	0.025	5.078
102753	V3H007Q01	May-2003	7.63	8.91	6.975	2.368	4.368	0.895	5	8.025	33.341	0.043	0.02	0.147	0.016	4.321
102753	V3H007Q01	Jun-2003	7.587	9.26	8.304	2.808	4.901	1	5	5.579	33.414	0.02	0.02	0.178	0.015	3.392
102753	V3H007Q01	Mar-2004	7.268	6.56	5.399	1.613	3.678	0.779	5.448	6.977	14.89	0.115	0.015	0.1	0.028	5.984
102753	V3H007Q01	Jul-2004	7.638	9.53	7.415	3.093	4.966	1.106	5.217	6.465	32.409	0.055	0.015	0.1	0.012	4.996
102753	V3H007Q01	Aug-2004	7.785	10.56	7.668	3.224	5.004	1.329	5.463	3	38.315	0.055	0.015	0.1	0.024	3.952
102753	V3H007Q01	Sep-2004	8.65	11.6	7.66	3.433	5.076	1.363	7.874	3	33.859	0.055	0.015	0.1	0.041	3.671
102753	V3H007Q01	Nov-2004	7.586	13.8	10.958	4.314	5.849	2.524	6.241	7.108	55.928	0.055	0.015	0.1	0.012	4.469
102753	V3H007Q01	Dec-2004	7.439	10.2	7.621	3.52	5.361	2.411	5.422	2	37.456	0.04	0.02	0.131	0.012	3.673
102753	V3H007Q01	Feb-2005	7.098	11.28	8.009	3.011	5.664	3.515	2	9.95	30.524	0.04	0.02	0.05	0.006	6.124
102753	V3H007Q01	Apr-2005	7.319	7.26	6.397	2.138	4.096	0.978	2	13.2	24.336	0.04	0.044	0.05	0.021	6.651
102753	V3H007Q01	May-2005	7.815	7.7	6.584	2.349	4.601	0.708	4.892	4.981	27.63	0.04	0.02	0.186	0.016	7.02
102753	V3H007Q01	May-2005	7.64	9.28	7.559	2.738	4.8	0.84	6.2	9.498	30.218	0.04	0.045	0.05	0.022	6.008
102753	V3H007Q01	Jul-2005	7.81	10.8	9.217	4.137	4.982	0.986	6.459	6.772	33.952	0.142	0.02	0.102	0.046	5.359

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Aug-2005	7.614	22.1	18.106	6.373	10.419	5.478	9.259	31.544	57.265	0.04	0.02	0.144	0.026	4.008
102753	V3H007Q01	Sep-2005	7.214	11.48	10.429	3.847	5.853	1.856	6.234	4.003	42.067	0.04	0.02	0.05	0.006	4.402
102753	V3H007Q01	Oct-2005	7.454	13.6	8.613	3.644	5.354	2.856	6.923	4.918	43.45	0.04	0.02	0.191	0.018	5.925
102753	V3H007Q01	Nov-2005	6.489	8.17	5.466	2.623	4.789	1.374	6.429	8.621	20.692	0.133	0.049	0.05	0.026	4.329
102753	V3H007Q01	Dec-2005	7.631	10.34	8.072	3.929	5.283	1.416	5.111	5.805	43.744	0.04	0.048	0.147	0.021	3.924
102753	V3H007Q01	Feb-2006	7.543	8.64	5.718	2.136	4.578	0.619	4.229	2	22.015	0.04	0.193	0.103	0.014	7.019
102753	V3H007Q01	Mar-2006	7.44	8.26	7.051	2.479	4.747	1.014	5.738	7.264	27.457	0.04	0.02	0.116	0.017	7.047
102753	V3H007Q01	Apr-2006	7.718	8.33	4.632	2.489	4.943	0.661	2	7.209	22.75	0.04	0.02	0.123	0.019	6.697
102753	V3H007Q01	May-2006	7.621	7.4	4.068	2.503	4.825	1.357	5.278	16.809	25.424	0.04	0.064	0.138	0.024	6.716
102753	V3H007Q01	May-2006	7.496	7.5	6.047	2.64	4.782	0.677	4.799	11.744	20.559	0.107	0.02	0.05	0.018	6.447
102753	V3H007Q01	Jun-2006	7.597	6.97	6.475	3.007	4.713	0.485	2	7.067	26.941	0.04	0.02	0.115	0.083	6.975
102753	V3H007Q01	Jul-2006	7.42	8.25	6.407	2.838	4.657	0.625	2	4.924	36.073	0.04	0.041	0.146	0.015	6.215
102753	V3H007Q01	Aug-2006	7.378	10.64	8.525	4.904	4.833	1.182	4.216	7.531	38.459	0.04	0.042	0.135	0.023	7.105
102753	V3H007Q01	Sep-2006	7.722	9.27	7.631	3.065	5.326	1.445	4.744	7.645	38.168	0.04	0.041	0.05	0.02	6.461

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Oct-2006	7.674	9.48	6.939	3.578	4.576	1.264	2	6.681	35.58	0.086	0.078	0.134	0.023	5.378
102753	V3H007Q01	Dec-2006	7.64	10.7	8.223	3.543	5.305	1.347	4.713	4.913	34.809	0.152	0.072	0.05	0.012	4.704
102753	V3H007Q01	Jan-2007	7.621	9	6.293	2.144	5.748	1.076	4.329	8.999	26.056	0.105	0.069	0.118	0.018	4.713
102753	V3H007Q01	Jan-2007	7.334	7.36	6.606	2.474	3.9	2.095	6.674	5.639	11.939	0.266	0.11	0.121	0.085	3.986
102753	V3H007Q01	Feb-2007	7.346	8.9	6.846	3.598	5.214	1.535	4.925	2	34.262	0.04	0.055	0.133	0.037	6.073
102753	V3H007Q01	Mar-2007	7.481	10.1	8.893	2.889	4.834	1.071	2	9.599	39.908	0.266	0.066	0.149	0.042	5.592
102753	V3H007Q01	Apr-2007	7.512	8.42	6.604	3.878	5.516	1.237	6.364	9.009	32.241	0.084	0.093	0.131	0.049	4.983
102753	V3H007Q01	May-2007	7.893	13.8	13.957	2.951	5.022	1.107	2	7.17	49.728	0.04	0.097	0.166	0.038	4.624
102753	V3H007Q01	Aug-2007	7.73	10.89	7.849	3.702	5.169	1.586	6.413	4.987	43.247	0.04	0.079	0.136	0.052	4.593
102753	V3H007Q01	Oct-2007	7.5	9.15	6.771	1.997	5.705	1.703	8.736	16.646	10.184	0.586	0.077	0.05	0.029	5.669
102753	V3H007Q01	Nov-2007	7.449	9.2	6.568	2.784	5.278	1.605	2	10.583	28.343	0.15	0.02	0.05	0.02	3.95
102753	V3H007Q01	Dec-2007	7.771	8.54	5.437	2.364	5.562	1.267	6.014	14.871	17.372	0.04	0.02	0.105	0.022	5
102753	V3H007Q01	Jan-2008	7.006	8.19	7.602	2.395	4.107	1.542	2	5.195	21.333	0.04	0.129	0.05	0.02	4.637
102753	V3H007Q01	Feb-2008	7.383	9.13	5.673	1.537	4.332	0.994	5.322	7.378	16.503	1.712	0.02	0.05	0.083	5.99

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Mar-2008	7.32	8	6.25	2.478	4.511	1.057	4.64	9.943	17.165	0.152	0.081	0.05	0.006	5.154
102753	V3H007Q01	Apr-2008	7.693	8.56	5.679	2.141	4.458	0.845	2	7.685	21.886	0.156	0.063	0.05	0.017	5.503
102753	V3H007Q01	May-2008	7.426	8.23	6.777	1.988	3.729	0.667	2	8.062	31.893	0.04	0.02	0.05	0.021	6.062
102753	V3H007Q01	Jun-2008	7.693	7.94	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jun-2008			4.638	2.353	-	1.2	3.725	5.107	-	-	-	-	-	-
102753	V3H007Q01	Jul-2008	7.795	9.19	-	-	-	-	-	-	-	-	-	-	-	-
102753	V3H007Q01	Jul-2008			7.012	3.213	-	1.7	3.474	4.057	-	-	-	-	-	-
102753	V3H007Q01	Aug-2008	7.613	9.08	7.721	2.218	3.259	0.839	3.719	2.68	33.443	0.005	0.025	-	0.671	4.793
102753	V3H007Q01	Sep-2008			7.726	3.094	-	-	3.248	2.34	37.174	0.056	0.025	-	0.006	6.212
102753	V3H007Q01	Nov-2008	7.73	12.2	8.217	2.205	7.356	2.264	6.128	5.301	51.631	0.025	0.025	0.406	0.005	4.894
102753	V3H007Q01	Mar-2009	7.703	7.58	4.537	0.75	2.581	1.652	3.265	6.866	23.109	0.061	0.025	0.025	0.005	6.84
102753	V3H007Q01	Aug-2009	8.007	8.97	6.267	4.474	-	1.8	4.402	7.423	22.179	0.072	0.025	-	0.006	4.888
102753	V3H007Q01	Aug-2010	7.848	9.34	7.222	4.019	3.695	1.857	1.996	1.5	38.239	0.025	0.025	0.138	0.005	5.555
102753	V3H007Q01	Sep-2010	7.921	9.83	8.295	5.007	2.841	2.137	3.274	3.065	41.284	0.025	0.025	0.025	0.005	5.103

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Feb-2011	7.13	8.21	3.469	1.896	5.531	1.885	3.059	4.061	29.615	0.025	0.025	0.052	0.018	4.448
102753	V3H007Q01	Mar-2011	7.662	10.88	1.969	3.461	7.433	2.254	5.096	13.278	30.738	0.095	0.025	0.025	0.005	5.232
102753	V3H007Q01	Apr-2011	7.534		4.159	4.066	4.707	1.919	2.884	6.169	-	0.025	0.025	0.08	0.005	5.622
102753	V3H007Q01	May-2011	7.761	8.61	5.417	1.991	5.649	1.97	3.351	5.162	26.683	0.1	0.081	0.225	0.011	5.482
102753	V3H007Q01	Jun-2011	7.902	8.45	4.911	3.059	5.477	2.073	1.825	4.198	28.548	0.025	0.025	0.025	0.005	5.873
102753	V3H007Q01	Jun-2011	7.89	11.48	5.928	3.883	7.971	2.715	5.032	12.049	30.739	0.114	0.025	0.127	0.005	5.169
102753	V3H007Q01	Jul-2011	7.746	8.86	6.325	0.75	5.425	2.021	1.052	1.5	34.799	0.025	0.183	0.231	0.005	5.891
102753	V3H007Q01	Aug-2011	7.441	8.35	5.125	0.75	5.102	2.145	2.634	1.5	14.26	0.025	0.025	0.025	0.005	4.474
102753	V3H007Q01	Sep-2011	7.504	7.65	4.874	0.75	8.579	1.512	2.05	7.053	16.405	0.025	0.025	0.348	0.005	4.552
102753	V3H007Q01	Oct-2011	7.538	8.38	5.156	2.21	4.068	2.179	1.591	3.939	25.738	0.219	0.025	0.197	0.005	4.468
102753	V3H007Q01	Nov-2011	7.752	9.33	6.694	3.276	5.005	2.266	5.386	8.584	35.752	0.059	0.025	0.167	0.005	4.257
102753	V3H007Q01	Nov-2011	7.621	8.63	5.762	2.741	9.052	1	1.302	5.156	32.723	0.025	0.068	0.108	0.015	4.03
102753	V3H007Q01	Dec-2011	7.458	7.91	6.221	3.189	4.402	2.187	1.309	4.028	40.951	0.025	0.025	0.622	0.005	2.013
102753	V3H007Q01	Feb-2012	7.844	8.36	4.621	2.03	5.073	1	1.946	5.339	24.742	0.025	0.025	0.15	0.005	5.081

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Mar-2012	7.689	11.33	5.542	3.014	7.032	1	1.543	3.157	40.954	0.166	0.025	0.099	0.005	5.262
102753	V3H007Q01	Apr-2012	7.972	12.09	7.554	2.248	6.728	1	4.881	1.5	33.027	0.426	0.052	0.074	0.027	4.347
102753	V3H007Q01	Jul-2012	8.256	22.83	11.503	9.257	10.698	2.633	9.436	10.434	68.661	0.105	0.025	0.15	0.027	1.976
102753	V3H007Q01	Jul-2012	7.891	11.44	5.702	3.303	6.452	2.098	1.991	1.5	34.598	0.025	0.06	0.094	0.015	2.938
102753	V3H007Q01	Aug-2012	7.99	10.45	7.826	2.277	2	2.134	2.824	1.5	46.329	0.025	0.025	0.109	0.005	2.882
102753	V3H007Q01	Sep-2012	7.939	14.26	10.528	4.504	8.186	3.068	5.027	17.432	37.235	0.234	0.025	0.167	0.005	5.05
102753	V3H007Q01	Oct-2012	7.031	8.26	8.365	0.75	6.732	2.107	2.223	6.938	19.37	0.025	0.025	0.025	0.005	7.458
102753	V3H007Q01	Oct-2012	7.545	7.86	4.639	1.514	2	1	2.831	7.316	17.057	0.145	0.055	0.065	0.017	5.984
102753	V3H007Q01	Dec-2012	7.666	13.4	6.7	2.37	8.057	2.453	3.903	16.58	36.418	0.068	0.025	0.312	0.011	4.808
102753	V3H007Q01	Dec-2012	7.705	11.09	9.639	2.308	2	1	2.44	6.044	36.292	0.069	0.025	0.104	0.005	5.785
102753	V3H007Q01	Jan-2013	7.744	10.03	6.009	0.75	2	2.06	3.557	7.481	24.447	0.025	0.025	0.422	0.005	6.396
102753	V3H007Q01	Feb-2013	7.31	8.33	4.641	0.75	5.954	2.235	3.595	7.959	20.664	0.059	0.025	0.267	0.014	6.678
102753	V3H007Q01	Mar-2013	7.315	7.54	8.125	0.75	2	2.165	3.322	6.842	16.758	0.025	0.025	0.123	0.023	5.858
102753	V3H007Q01	Apr-2013	7.677	8.11	3.83	0.75	7.053	1	0.5	6.265	17.757	0.071	0.025	0.246	0.005	6.011

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	May-2013	7.733	8.57	5.622	2.018	5.94	2.119	2.888	4.388	22.79	0.065	0.025	0.443	0.005	6.087
102753	V3H007Q01	Jul-2013	7.766	10.54	5.822	1.634	3.981	1	1.538	3.361	33.919	0.025	0.025	0.17	0.005	6.009
102753	V3H007Q01	Aug-2013	7.883	11.19	7.121	2.542	5.729	1	2.402	3.589	32.111	0.062	0.025	0.151	0.005	6.112
102753	V3H007Q01	Sep-2013	7.59	9.331	6.106	3.681	6.291	2.297	3.424	4.821	30.249	0.086	0.025	0.087	0.005	6.141
102753	V3H007Q01	Oct-2013	7.199	11.478	8.883	3.104	6.651	2.112	3.177	4.104	42.777	0.079	0.025	0.025	0.013	5.797
102753	V3H007Q01	Nov-2013	7.942	10.6	9.734	2.981	4.764	1	3.484	5.905	32.87	0.025	0.025	0.025	0.005	4.55
102753	V3H007Q01	Nov-2013	7.371	13.48	7.684	4.641	7.485	2.205	4.463	17.853	37.186	0.025	0.025	0.214	0.005	5.058
102753	V3H007Q01	Dec-2013	7.414	5.966	3.749	1.653	-	-	3.262	5.438	16.015	0.087	0.025	0.097	0.005	4.93
102753	V3H007Q01	Dec-2013	7.315	6.459	4.481	1.542	-	-	2.398	5.718	37.495	0.025	0.025	0.114	0.005	5.121
102753	V3H007Q01	Jan-2014	7.554	9.07	5.103	1.537	-	-	3.62	5.197	30.08	0.05	0.05	-	0.01	5.077
102753	V3H007Q01	Feb-2014	7.144	7.292	5.724	2.205	-	-	2.945	4.84	27.492	0.025	0.025	0.067	0.005	5.868
102753	V3H007Q01	Mar-2014	7.587	8.39	4.6	0.75	-	-	2.981	5.592	43.294	0.05	0.05	0.1	0.01	6.812
102753	V3H007Q01	Apr-2014	7.759	8.03	5.507	0.75	-	-	2.904	4.617	49.968	0.05	0.121	-	0.01	5.74
102753	V3H007Q01	May-2014	7.777	7.97	5.651	1.938	-	-	1.899	3.356	38.852	0.05	0.05	-	0.01	5.467

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Jun-2014	7.868	9.02	6.415	2.844	-	-	3.414	3.858	35.549	0.05	0.05	-	0.01	5.44
102753	V3H007Q01	Aug-2014	7.935	9.01	4.839	2.784	-	-	2.657	3.062	29.797	0.05	0.05	0.301	0.01	6.64
102753	V3H007Q01	Sep-2014	7.889	15.16	10.426	4.555	-	-	7.259	6.026	-	0.05	0.05	0.05	0.064	5.213
102753	V3H007Q01	Oct-2014	7.906	10.18	6.575	3.424	-	-	6.063	6.134	30.846	0.05	0.05	0.137	0.01	3.139
102753	V3H007Q01	Nov-2014	7.799	8.45	5.017	1.851	-	-	3.43	5.847	24.248	0.05	0.05	0.255	0.01	4.144
102753	V3H007Q01	Dec-2014	7.412	6.19	2.978	0.75	-	-	2.975	6.832	-	0.05	0.05	0.124	0.01	5.324
102753	V3H007Q01	Mar-2015	7.086	7.36	4.931	0.75	-	-	3.224	8.06	20.455	0.137	0.188	0.517	0.633	5.509
102753	V3H007Q01	Apr-2015	7.859	8.41	5.818	-	1.5	1.633	3.644	4.186	29.529	0.05	0.05	0.05	0.067	4.8
102753	V3H007Q01	May-2015	7.903	9.81	9.842	-	5.656	0.5	2.604	3.526	37.9	0.05	0.05	0.124	0.267	4.934
102753	V3H007Q01	Jun-2015	7.619	8.6	6.366	2.301	6.004	2.332	4.026	2.108	32.875	0.05	0.05	0.103	0.01	4.463
102753	V3H007Q01	Jul-2015	8.044	9.3	6.473	1.643	-	-	3.615	1.5	34.906	0.05	0.05	0.025	0.01	4.388
102753	V3H007Q01	Jul-2015	7.96	10.46	7.195	4.71	3.365	2.492	8.331	-	33.2	0.106	0.05	0.149	0.01	3.803
102753	V3H007Q01	Aug-2015	7.934	10.23	7.06	3.285	2.94	1.163	4.485	1.5	34.724	0.05	0.05	0.025	0.01	3.737
102753	V3H007Q01	Oct-2015	8.152	11.88	7.543	3.03	7.012	2.134	5.973	5.938	47.191	0.05	0.05	0.201	0.021	4.547

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissolved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102753	V3H007Q01	Feb-2016	7.6	9.1	5.4	1.8	7.2	0.5	3.5	5.8	19.9	0.05	0.05	0.65	0.035	3.4
102753	V3H007Q01	Mar-2016	7.7	8	4.9	1.9	3.7	1.9	4.2	6	26.7	0.143	0.05	0.267	0.052	4.6
102753	V3H007Q01	Apr-2016	7.8	8.2	6.1	2.1	6	1.5	2.1	6.1	37.9	0.141	0.14	0.72	0.034	6.4
102753	V3H007Q01	May-2016	7.8	8.3	5.9	2.3	6.3	0.5	2.9	3.8	27.2	0.05	0.05	0.025	0.047	5.6
102753	V3H007Q01	Jun-2016	7.6	9.1	9.3	2.6	4.6	1.4	4.1	4.3	-	0.05	0.05	0.358	0.01	4.9
102753	V3H007Q01	Jul-2016	8	9.9	7.5	2.6	3.2	0.5	2.5	3.7	36.1	0.05	0.05	0.759	0.01	4.8
102753	V3H007Q01	Aug-2016	7.6	9.4	6.3	3	5.7	1.6	2.6	6.7	34.9	0.05	0.05	0.218	0.056	4.4
102753	V3H007Q01	Sep-2016	7.9	11.6	8.8	2.9	8.9	1.4	4.9	3.2	38.4	0.05	0.05	0.378	0.034	4
102753	V3H007Q01	Nov-2016	7.5	9.1	5.5	2.1	4.1	0.5	2.9	9	20.1	0.05	0.05	0.11	0.021	6.1
102753	V3H007Q01	Feb-2017	7.6	9.8	6.9	2.1	5.5	0.5	1.3	4.5	30.5	0.323	0.05	0.025	0.01	6.9
102753	V3H007Q01	Apr-2017	7.9	9.5	5.4	2.5	5	0.5	3.5	8.7	28.5	0.119	0.105	0.278	0.01	7
102753	V3H007Q01	May-2017	7.7	9.8	4.9	2.7	7.3	3	2.1	6.3	34.8	0.05	0.05	0.548	0.01	5.9

APPENDIX 3: V3R2 HISTORICAL CHEMICAL WATER DATA

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Disslved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Jan-1980	6.76	20.40	13	4.2	11.8	13.31	11.9	29.5	32.8	2.97	0.02	0.31	0.003	6.68
102777	V3R002 Q01	Jan-1980	7	12.00	6.5	2.3	5.9	3.86	10.4	12.5	19.1	1.34	0.02	0.26	0.007	7.71
102777	V3R002 Q01	Feb-1980	3.5	14.90	9.7	4.1	8.7	6.25	6.3	20.7	28.8	0.39	0.02	0.2	0.005	7.55
102777	V3R002 Q01	Jun-1980	6.23	44.40	26.6	7	29.1	25.96	38.5	82.9	30.8	0.71	0.02	0.79	0.02	5.49
102777	V3R002 Q01	Jun-1980	6.8	49.00	27.9	8.1	31.5	34.05	42.6	93.2	33.6	0.79	0.02	0.84	0.006	4.8
102777	V3R002 Q01	Jun-1980	6.42	53.30	28.2	8.5	34.9	37.37	49.4	96.9	33.5	0.98	0.02	0.86	0.003	4.69
102777	V3R002 Q01	Jul-1980	7.08	59.60	30.4	7.8	37	38.06	56.3	109.8	38.5	4.63	0.02	0.93	0.006	4.08
102777	V3R002 Q01	Jul-1980	6.68	65.50	35.1	9.8	43.3	44.44	67	123.5	42.9	5.99	0.04	1.21	0.012	4.62
102777	V3R002 Q01	Jul-1980	6.65	68.60	36.5	10	46.8	50.07	73.3	132.4	41.9	5.78	0.02	1.13	0.005	3.63
102777	V3R002 Q01	Jul-1980	6.9	72.00	36.5	10.2	47.9	55.9	75.1	140	43.8	5.56	0.02	1.16	0.003	3.9
102777	V3R002 Q01	Aug-1980	6.7	73.20	41.6	11.6	51.1	60.92	79.2	147.9	49.2	5.6	0.04	1.26	0.003	3.86
102777	V3R002 Q01	Aug-1980	6.9	80.00	43.1	12.5	54.2	62.4	89.7	152.9	46.9	5.86	0.02	1.38	0.003	3.31
102777	V3R002 Q01	Aug-1980	6.59	83.10	44	13.1	58.9	66.31	91.6	180.2	44.3	5.18	0.02	1.38	0.005	3.39
102777	V3R002 Q01	Aug-1980	6.59	88.60	49.3	14.1	65.4	69.23	101.6	155.9	54.7	4.91	0.05	1.4	0.003	3.21

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	Sep-1980	6.88	96.90	50.3	14	70.3	69.58	110.1	184.3	57.6	5.12	0.02	1.5	0.026	3.06
102777	V3R002Q01	Oct-1980	6.62	89.50	40.7	12.3	67.2	81.14	98.8	150.8	73.4	7.13	0.06	1.58	0.146	5.21
102777	V3R002Q01	Nov-1980	7.1	80.80	36.1	12.1	63.2	81.03	82.2	131.7	88.8	2.97	0.05	1.63	0.013	3.87
102777	V3R002Q01	Dec-1980	6.11	22.40	12.7	4.4	13.6	12.73	15.2	34.2	30.8	0.75	0.13	0.36	0.009	6.27
102777	V3R002Q01	Feb-1981	5.84	6.10	3.5	1.1	3.4	2.68	3.3	7.3	11.1	0.36	0.1	0.05	0.025	4.94
102777	V3R002Q01	Apr-1981	6.15	19.60	11.7	4.2	12.2	10.66	14.8	26.5	28	1.32	0.05	0.4	0.003	7.33
102777	V3R002Q01	Jun-1981	6.27	55.50	32.1	8.9	35.1	42.15	61.3	105.5	35.6	3.97	0.02	0.89	0.042	5.34
102777	V3R002Q01	Jul-1981	6.47	63.20	36.9	10.7	43.3	54.27	69.3	115.8	43.6	3.33	0.02	0.95	0.008	4.84
102777	V3R002Q01	Aug-1981	6.27	76.30	43.1	12	53.2	47.67	84.6	136.5	54.4	2.65	0.05	1.11	0.003	0.45
102777	V3R002Q01	Dec-1981	6.94	21.10	13	4.6	12.8	13.39	19.1	34.4	31.4	0.79	0.02	0.33	0.003	6.27
102777	V3R002Q01	Jan-1982	6.68	11.20	7.4	2.7	6.6	4.87	7.9	12.6	21.6	0.73	0.02	0.16	0.008	6.11
102777	V3R002Q01	Feb-1982	6.91	25.00	15.3	6.2	17	10.65	18	36.7	41.1	0.44	0.02	0.05	0.003	5.71
102777	V3R002Q01	Mar-1982	6.97	50.20	29.3	8	35.9	17.57	47.9	83.3	51.3	2.94	0.02	0.78	0.096	5.97
102777	V3R002Q01	Apr-1982	7.37	40.30	21.7	8.1	24	24.97	41.2	62.3	45.9	0.98	0.02	0.73	0.014	4.32

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Jun-1982	7.32	54.70	28.1	9.6	38.1	46.04	57.5	84	59	1.25	0.02	0.9	0.009	3.44
102777	V3R002 Q01	Jul-1982	7.4	84.50	42.8	14	70.2	61.71	108.7	153.8	67.2	2.35	0.02	0.97	0.011	1.83
102777	V3R002 Q01	Aug-1982	7.26	106.00	55.9	16.8	91.3	70.92	145	219.9	64.9	3.14	0.02	1.1	0.007	1.69
102777	V3R002 Q01	Nov-1982	6.3	12.00	6.1	3.7	9.4	4.88	9.2	17	13.8	0.91	0.02	0.3	0.029	5.72
102777	V3R002 Q01	Dec-1982	7	55.10	-	-	-	-	-	-	69.5	1.07	-	-	-	-
102777	V3R002 Q01	Jan-1983	6.76	9.40	-	-	-	-	-	-	20.2	0.2	-	-	-	-
102777	V3R002 Q01	Feb-1983	6.48	27.50	-	-	-	-	-	-	40.1	1.16	-	-	-	-
102777	V3R002 Q01	Mar-1983	6.9	33.30	17.1	4.9	25.3	15.59	21.6	48.4	46	0.48	0.09	0.61	0.012	4.49
102777	V3R002 Q01	May-1983	7.02	40.40	22.4	6.5	34.7	19.4	31.9	74.3	49.8	0.67	0.05	0.42	0.021	4.38
102777	V3R002 Q01	Jul-1983	7.2	48.00	26.8	8.1	39.9	22.21	38.8	86.5	62.5	1.11	0.02	0.42	0.007	2.88
102777	V3R002 Q01	Sep-1983	7.37	58.10	30.3	9	48.4	25.88	47	106.7	59.6	0.75	0.02	0.5	0.003	1.58
102777	V3R002 Q01	Aug-1985	7.1	27.80	17	7.6	23.3	8.85	14.5	34.8	66.4	0.32	0.04	0.11	0.003	2.58
102777	V3R002 Q01	Oct-1985	7.6	31.60	21.4	8.7	25	9.69	23	42	72.3	0.14	0.17	0.12	0.01	1.77
102777	V3R002 Q01	Oct-1985	7.14	16.60	9.4	4.7	8.2	5.85	15.6	19.4	34.3	0.02	0.22	0.05	0.012	3.57

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Disslved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Dec-1985	6.77	15.80	10.5	3.4	6.5	6.85	8.6	36.7	19	0.5	0.06	0.23	0.023	5.15
102777	V3R002 Q01	Jan-1986	6.3	13.00	8.4	3.7	6.4	3.49	7.2	17.9	23.4	0.07	0.11	0.1	0.016	6.98
102777	V3R002 Q01	Apr-1986	6.69	14.80	8.3	4.2	7.2	2.62	10.5	16	32.2	0.14	0.1	0.1	0.016	6.89
102777	V3R002 Q01	Apr-1986	7.1	12.40	7.3	3.7	4.6	2.83	8.2	10.7	24.1	0.33	0.06	0.05	0.007	6.65
102777	V3R002 Q01	May-1986	7.2	14.60	9	4.2	6	3.59	7.7	14.5	30	0.13	0.1	0.05	0.003	6.31
102777	V3R002 Q01	Jul-1986		16.00	-	-	-	-	-	-	-	-	-	-	-	-
102777	V3R002 Q01	Jul-1986	7.05	17.80	12.8	5.6	10.3	5.65	9.7	22.8	42.8	0.14	0.07	0.12	0.003	4.34
102777	V3R002 Q01	Aug-1986	7.6	20.40	13.9	6.5	14.6	6.68	7.3	28	50.7	0.06	0.04	0.17	0.003	1.06
102777	V3R002 Q01	Sep-1986	7.7	32.00	17.9	9	26.3	8.11	30	32.5	57.6	0.06	0.1	0.13	0.006	2.51
102777	V3R002 Q01	Oct-1986	7.55	27.50	17.6	7.7	16.8	8.4	9.5	38.8	74.6	0.02	0.02	1.19	0.003	1.78
102777	V3R002 Q01	Nov-1986	6.7	10.40	6.3	3	6.4	1.9	6.7	9	25.8	0.16	0.06	0.05	0.015	5.83
102777	V3R002 Q01	Dec-1986	7	9.20	5	2	5.6	1.71	7.2	8.9	19.8	0.2	0.06	1.11	0.003	6.77
102777	V3R002 Q01	Jan-1987	7.1	13.10	8.9	3.5	6.4	3.92	6.6	14.3	26.5	0.12	0.11	0.12	0.005	6.58
102777	V3R002 Q01	Feb-1987	6.9	12.80	6.7	3.3	7	2.94	11.6	10.7	19.2	0.41	0.12	0.13	0.018	5.81

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Apr-1987	6.5	11.60	7.9	3.5	5.9	3.2	6.6	8.3	30.9	0.14	0.1	0.11	0.007	6.21
102777	V3R002 Q01	Apr-1987	7.3	16.00	10.4	4.3	8.7	6.04	7	19.8	37.2	0.12	0.08	0.14	0.007	6.62
102777	V3R002 Q01	May-1987	7	16.00	11.3	4	9.2	5.97	9.1	18.6	36.9	0.11	0.1	0.15	0.008	5.84
102777	V3R002 Q01	Jul-1987	7.25	19.80	11.8	5.2	9.9	6.49	11.6	27.1	37.6	0.04	0.06	0.1	0.003	3.03
102777	V3R002 Q01	Jul-1987	6.4	22.70	15.8	6	16.2	8.26	12.1	34.9	47.7	0.02	0.11	0.14	0.005	2.84
102777	V3R002 Q01	Sep-1987	7.4	27.50	18	7.1	15.9	11.01	20.3	48.2	50.6	0.15	0.09	0.2	0.005	1.5
102777	V3R002 Q01	Oct-1987	6.7	11.10	7.4	3.5	5.5	2.49	8	13.7	25.4	0.16	0.08	0.05	0.009	7.02
102777	V3R002 Q01	Dec-1987	5.9	12.10	7.5	3.9	5.1	2.1	7.6	12.4	19	0.02	0.04	0.11	0.012	7.53
102777	V3R002 Q01	Dec-1987	6.15	12.40	7.9	4.2	4.8	1.79	7	11.9	27.4	0.2	0.05	0.05	0.015	8.04
102777	V3R002 Q01	Jan-1988	6.5	10.80	6.5	3.1	5.7	1.99	8.8	8.5	22.5	0.13	0.09	0.11	0.008	7.11
102777	V3R002 Q01	Mar-1988	6.31	7.70	5.1	2	3.6	1.77	1.5	5.3	21.4	0.07	0.02	0.12	0.014	5.95
102777	V3R002 Q01	Apr-1988	6.2	10.50	6.4	3	4.8	3.26	5.2	7.6	21.2	0.46	0.58	0.05	0.017	6.11
102777	V3R002 Q01	Jul-1988	6.77	15.90	10.5	4.8	7.6	4.48	11.1	23.9	35.4	0.33	0.08	0.05	0.019	6.02
102777	V3R002 Q01	Jul-1988	6.37	14.60	8.2	4.5	8.4	3.85	7.2	14.6	35.4	0.44	0.02	0.13	0.013	5.84

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	Sep-1988	7.08	17.40	11.4	6.1	9.4	3.44	9.4	12.6	49.3	0.08	0.05	0.13	0.003	5.28
102777	V3R002Q01	Dec-1988	6.91	13.30	7.8	3.6	6.3	2.73	8.9	10.3	28.4	0.14	0.15	0.05	0.008	6.18
102777	V3R002Q01	Feb-1989	6.5	8.80	6.4	2.6	3.5	1.36	5.3	2	27.6	0.18	0.08	0.12	0.012	6.23
102777	V3R002Q01	Mar-1989	7.45	9.80	6.8	3.5	4.6	1.46	7.6	5.4	31.7	0.14	0.06	0.05	0.007	8.49
102777	V3R002Q01	May-1989	7.3	11.90	7.8	4.2	5.9	2.05	4.2	4.2	38.8	0.12	0.06	0.15	0.011	7.82
102777	V3R002Q01	Jun-1989	8.07	13.80	10	5.4	8.5	2.79	4.6	2	45.6	0.13	0.1	0.12	0.023	7.66
102777	V3R002Q01	Jul-1989	7.97	14.40	10.6	5.4	8.3	2.42	6.1	7	50.8	0.11	0.05	0.14	0.013	6.84
102777	V3R002Q01	Aug-1989	7.99	18.60	11.6	6.4	10.2	4.15	8.6	16.8	58.3	0.05	0.08	0.12	0.019	6.05
102777	V3R002Q01	Sep-1989	7.98	21.40	13.2	7.7	9.1	3.92	9	13.5	62.4	0.02	0.08	0.05	0.015	4.62
102777	V3R002Q01	Oct-1989	7.98	23.00	15.7	9.3	10.7	4.25	8	12.8	74.7	0.02	0.09	0.14	0.007	3.38
102777	V3R002Q01	Jan-1990	7.44	8.80	5.2	3	4.8	1.89	6.8	9.1	16	0.21	0.24	0.12	0.176	6.58
102777	V3R002Q01	Feb-1990	7.67	7.80	5.3	2.6	4	1.93	3.9	5.5	20.4	0.246	0.096	0.15	0.015	5.08
102777	V3R002Q01	Mar-1990	7.6	12.30	8.9	4	6.3	2.87	6.1	9	31	0.121	0.096	0.17	0.009	7.82
102777	V3R002Q01	Apr-1990	7.27	10.50	6.7	3.4	5.4	1.83	8.2	6	31.7	0.112	0.087	0.14	0.013	7.41

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	May-1990	7.42	12.60	8.2	4.1	7.1	2.73	6.6	9.2	36.2	0.197	0.222	0.16	0.005	6.89
102777	V3R002Q01	Jun-1990	7.15	14.60	9.4	5	7.6	2.78	5.6	10.4	43.2	0.155	0.045	0.15	0.005	6.47
102777	V3R002Q01	Jul-1990	7.84	16.10	10.4	6.8	8.6	3.89	10.2	17	46.2	0.231	0.119	0.12	0.007	6.18
102777	V3R002Q01	Aug-1990	7.71	19.00	13.2	7.4	10.6	4.12	10	9.8	57	0.05	0.047	0.16	0.003	5.3
102777	V3R002Q01	Aug-1990	7.95	18.00	14.5	6.8	11	4.33	14.6	19	57.3	0.105	0.09	0.19	0.014	4.87
102777	V3R002Q01	Sep-1990	7.32	22.30	15.5	7.9	11.5	5.02	13.5	17.2	64.3	0.057	0.126	0.22	0.014	3.32
102777	V3R002Q01	Nov-1990	8.08	21.90	16	7.8	12.3	5.2	9.1	20.2	77.4	0.053	0.02	0.24	0.01	2.97
102777	V3R002Q01	Nov-1990	8.29	24.80	17.5	8	13.4	5.45	10	22.5	81.1	0.089	0.078	0.21	0.017	2.38
102777	V3R002Q01	Mar-1991	6.58	13.60	8.5	3.4	6.9	3.42	7.3	10.8	34.1	0.196	0.191	0.11	0.018	8.06
102777	V3R002Q01	Apr-1991	8.26	9.20	6.4	3.3	4.4	1.7	4.7	6.8	27.6	0.064	0.02	0.1	0.013	7.31
102777	V3R002Q01	May-1991	8.32	12.40	7.6	4	6.2	2.25	7.4	8.9	31.3	0.116	0.098	0.12	0.068	7.38
102777	V3R002Q01	May-1991	7.71	12.90	9.1	4.5	6.9	2.84	8.8	8.5	34.9	0.138	0.08	0.23	0.011	6.87
102777	V3R002Q01	Jul-1991	7.81	18.10	11.9	5.8	7.8	4.23	7.4	15.1	43.9	0.02	0.047	0.17	0.007	5.07
102777	V3R002Q01	Aug-1991	7.78	20.90	13.6	6.6	9.1	5.41	7.5	23.5	47.8	0.02	0.056	0.18	0.011	3.26

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	Sep-1991	8.04	22.50	17.7	8.9	12.4	6.78	10.5	26.3	66.2	0.02	0.114	0.15	0.01	3.19
102777	V3R002Q01	Oct-1991	8.02	21.20	17.3	8.3	11.2	5.67	10	20.6	66.7	0.102	0.154	0.16	0.009	3.88
102777	V3R002Q01	Nov-1991	7.67	13.50	9.5	4.5	4.8	4.4	6.8	13.6	30	0.327	0.212	0.19	0.013	4.12
102777	V3R002Q01	Dec-1991	7.6	19.80	15.4	5.4	8.2	7.83	5.8	28.4	45.2	0.3	0.126	0.12	0.012	4.18
102777	V3R002Q01	Jan-1992	8.03	9.40	5.6	2.5	4	2.14	4.4	6.8	20.3	0.214	0.073	0.1	0.008	5.2
102777	V3R002Q01	Feb-1992	7.28	16.10	10	4.2	5.9	3.76	1.5	16.2	42.1	0.02	0.043	0.19	0.014	5.19
102777	V3R002Q01	Mar-1992	7.17	13.60	7.9	4.1	5.6	3.52	5.6	19.4	30.4	0.168	0.188	0.2	0.015	6.73
102777	V3R002Q01	Apr-1992	8.18	22.00	12.8	5.2	10.7	5.98	6.1	33.1	46.7	0.065	0.123	0.15	0.01	6.19
102777	V3R002Q01	May-1992	7.88	24.00	17	7.3	15.8	8.62	7.8	48.7	60.4	0.02	0.049	0.19	0.033	3.79
102777	V3R002Q01	May-1992	8.34	29.00	17.9	7.3	18.4	9.87	11.7	49.4	61.3	0.02	0.02	0.27	0.021	3.86
102777	V3R002Q01	Jun-1992	7.63	30.10	19.8	8.4	22	10.45	13.6	59.4	65.8	0.086	0.098	0.25	0.016	3.39
102777	V3R002Q01	Jul-1992	7.43	38.80	22.1	8.8	30	12.41	9.1	71.1	75	0.02	0.02	0.15	0.209	1.98
102777	V3R002Q01	Aug-1992	7.77	42.60	24.7	9.1	32.9	13.54	13.1	82.5	81.8	0.104	0.02	0.13	0.014	1.13
102777	V3R002Q01	Sep-1992	7.8	48.50	26.4	10.7	39.1	15.22	23.5	89.8	89.9	0.162	0.095	0.29	0.011	1.12

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Disslo ved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Oct-1992	8.1	46.00	28.1	10.8	45	17.3	24.8	88.4	101	0.221	0.113	0.29	0.01	1.53
102777	V3R002 Q01	Nov-1992	8.29	55.30	28.3	12.5	50	17.08	25.2	99.1	114	0.115	0.055	0.32	0.016	1.66
102777	V3R002 Q01	Dec-1992	8.23	50.50	28.4	11.5	49.9	15.52	28.7	89.9	110.7	0.02	0.045	0.33	0.022	2.33
102777	V3R002 Q01	Jan-1993	8.68	42.10	25.9	9.9	38.1	11.98	18.2	60.5	101.9	0.02	0.111	0.3	0.022	0.2
102777	V3R002 Q01	Feb-1993	8.07	41.60	25.5	9.7	38.2	14.03	18.3	57.3	109.6	0.099	0.02	0.42	0.022	0.87
102777	V3R002 Q01	Mar-1993	7.72	16.20	10.1	4.6	7.2	4.99	5	26.9	30	0.677	0.189	0.11	0.055	5.38
102777	V3R002 Q01	Mar-1993	7.9	11.80	8.1	3.9	5.7	3.01	5.4	14.5	30	0.329	0.112	0.23	0.052	6.04
102777	V3R002 Q01	Apr-1993	7.4	20.20	14.9	5.5	9.4	5.91	6.3	32.1	42.1	0.089	0.02	0.19	0.007	4.21
102777	V3R002 Q01	May-1993	7.6	27.90	19.9	7.2	14.3	8.41	7.4	45.9	61.2	0.052	0.218	0.37	0.031	1.82
102777	V3R002 Q01	Jun-1993	7.43	27.20	19.8	7.8	14.8	10.17	5.8	59	61.5	0.166	0.104	0.21	0.017	1.19
102777	V3R002 Q01	Aug-1993	7.77	41.30	29.5	11.6	31.2	16.19	15.1	102.4	80.6	0.141	0.02	0.3	0.021	0.8
102777	V3R002 Q01	Sep-1993	7.92	50.00	37.3	13	36.9	19.62	18.7	106.8	95.7	0.107	0.111	0.33	0.021	0.92
102777	V3R002 Q01	Oct-1993	7.34	12.50	7.8	3.9	6.5	3.06	5.4	17.8	23.3	0.661	0.087	0.15	0.041	6.31
102777	V3R002 Q01	Nov-1993	7.14	17.40	12.4	5.2	9.6	4.57	5.7	24.7	40.4	0.287	0.101	0.37	0.039	3.81

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	Dec-1993	7.47	12.90	8.3	3.9	7.7	2.9	3.6	22.8	33.1	0.357	0.02	0.26	0.02	5.13
102777	V3R002Q01	Jan-1994	7.12	8.40	5.8	3	5.4	1.97	3.1	19.8	25.6	0.221	0.02	0.18	0.021	5.35
102777	V3R002Q01	Mar-1994	7.73	13.60	10	5	7	3.14	4.1	19.7	44.4	0.108	0.02	0.18	0.015	6.63
102777	V3R002Q01	Jun-1994	7.57	18.90	12.5	5.3	10.7	5.11	5.9	24.7	46.7	0.484	0.02	0.23	0.027	4.63
102777	V3R002Q01	Aug-1994	8.07	33.80	18.8	8.8	25.3	9.23	17.6	52.3	67.5	0.826	0.087	0.26	0.094	2.02
102777	V3R002Q01	Sep-1994	7.76	45.60	42	15.4	30.2	2.54	11.2	161.7	40	0.02	0.02	0.57	0.029	6.78
102777	V3R002Q01	Oct-1994	7.94	40.90	24.3	10.6	35	10.44	20.8	56.5	102.5	0.526	0.02	0.3	0.075	2.44
102777	V3R002Q01	Nov-1994	7.51	25.50	18.2	7	17	5.84	10	29.3	74.3	0.02	0.02	0.22	0.005	3.84
102777	V3R002Q01	Jan-1995	8.17	22.30	16.1	6.6	15.5	5.47	8.9	24.2	69.5	0.02	0.02	0.26	0.021	2.75
102777	V3R002Q01	Feb-1995	7.13	15.10	12.4	4.9	8.2	5.97	4.8	31.7	41.8	0.02	0.02	0.21	0.003	6.51
102777	V3R002Q01	Mar-1995	7.55	18.20	11.8	5	10.1	5.14	5.3	25.2	50	0.467	0.16	0.36	0.021	5.65
102777	V3R002Q01	Apr-1995	7.66	10.90	7.1	3.3	6.7	3.27	1.5	16.7	30	0.143	0.087	0.27	0.027	5.8
102777	V3R002Q01	May-1995	7.71	11.80	8.1	3.6	8.1	3.13	4	19.3	37.2	0.208	0.072	0.5	0.169	5.26
102777	V3R002Q01	Jun-1995	7.68	16.60	10.4	4.8	11.1	4.39	4.1	23.1	42.9	0.106	0.077	0.38	0.015	4.95

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	Jul-1995	7.64	18.40	11.5	4.9	9.5	5.29	5.7	29	48.6	0.095	0.02	0.16	0.009	3.69
102777	V3R002Q01	Jul-1995	7.66	18.90	12.4	5	9.7	5.37	4.7	29.3	46.2	0.087	0.02	0.23	0.012	3.27
102777	V3R002Q01	Aug-1995	8.64	37.00	24	13.7	30.4	2.38	15.4	25.5	133.6	0.058	0.02	0.37	0.015	2.79
102777	V3R002Q01	Sep-1995	7.59	26.60	18	7.2	14.6	7.85	6.7	40.4	66.4	0.105	0.02	0.17	0.005	1.42
102777	V3R002Q01	Nov-1995	8.05	37.00	27.4	10.2	26	10.33	13.7	63.5	104.1	0.02	0.02	0.26	0.01	1.22
102777	V3R002Q01	Nov-1995	8.28	33.50	19.9	6.6	20.4	9.35	10.4	43.1	78.6	0.079	0.02	0.18	0.022	1.21
102777	V3R002Q01	Dec-1995	7.72	10.20	8.1	3.2	6.5	4.25	7.3	19	33.7	0.107	0.02	0.13	0.019	5.17
102777	V3R002Q01	Jan-1996	7.54	7.50	5.4	2.6	5.5	2.56	4.6	17.2	25	0.133	0.02	0.19	0.022	7.14
102777	V3R002Q01	Feb-1996	7.51	16.00	11	4.9	4.4	4.08	4.5	28	38.1	0.065	0.02	0.18	0.025	5.4
102777	V3R002Q01	Mar-1996	7.8	14.00	16.2	3.7	3.2	2.66	4.1	14.3	52	0.02	0.02	0.14	0.005	7.02
102777	V3R002Q01	Apr-1996	7.26	6.90	5.8	2.5	1	1.11	1.5	12.2	30.9	0.068	0.02	0.14	0.015	5.68
102777	V3R002Q01	Apr-1996	7.58	11.40	7.6	3.3	3.4	3.46	5.7	9.9	28.8	0.632	0.02	0.15	0.039	5.18
102777	V3R002Q01	May-1996	7.32	14.70	12.8	4.6	3.6	2.8	3.1	15.8	40.5	0.02	0.02	0.14	0.006	6.85
102777	V3R002Q01	May-1996	7.78	11.30	8.4	3.9	5.7	2.81	4.6	9.6	41.8	0.133	0.02	0.13	0.003	6.75

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Jun-1996	7.7	13.70	9.7	4.2	5.2	2.82	5.1	7.6	46.1	0.123	0.042	0.11	0.009	6.87
102777	V3R002 Q01	Jul-1996	8.05	12.00	8.1	4.3	5.1	2.92	6	12.2	40	0.121	0.02	0.14	0.007	6.14
102777	V3R002 Q01	Aug-1996	7.77	13.10	9.4	3.7	7.4	3.53	5.2	12.6	44.8	0.078	0.099	0.16	0.008	6.1
102777	V3R002 Q01	Sep-1996	7.9	15.50	10.5	5.2	8	1.92	6	11.9	51	0.02	0.04	0.12	0.07	5.75
102777	V3R002 Q01	Oct-1996	7.49	20.50	14.8	6.8	9.9	3.38	8.1	6.2	65.4	0.128	0.106	0.19	0.575	5.78
102777	V3R002 Q01	Nov-1996	7.6	13.80	10.1	4.2	6.7	2.52	5.5	18.5	40.6	0.223	0.314	0.13	0.028	7.04
102777	V3R002 Q01	Dec-1996	7.94	12.70	9.9	4.6	6.9	1.58	3.9	9.9	47.1	0.169	0.092	0.11	0.017	6.01
102777	V3R002 Q01	Jan-1997	7.76	12.00	9.2	3.9	6.1	1.72	4.8	16.1	40	0.173	0.113	0.12	0.017	6.5
102777	V3R002 Q01	Jan-1997	7.76	8.50	6.5	2.7	5.6	1.08	3.3	6.6	32.1	0.113	0.059	0.15	0.016	6.61
102777	V3R002 Q01	Feb-1997	7.9	12.50	9.5	4	6.4	1.94	3.4	10.7	43.2	0.097	0.097	0.12	0.013	6.81
102777	V3R002 Q01	Mar-1997	7.86	12.50	9.6	4.2	6.3	2.15	5.1	13.5	46.6	0.053	0.02	0.12	0.008	6.37
102777	V3R002 Q01	May-1997	7.7	13.00	10.8	4.7	7.5	1.99	4.1	15.4	49.5	0.133	0.054	0.11	0.015	7.05
102777	V3R002 Q01	Jun-1997	7.6	12.60	8.8	4.8	6.4	2.39	6.3	15.8	37.8	0.203	0.079	0.1	0.037	6.9
102777	V3R002 Q01	Jul-1997	7.52	14.60	10.4	4.9	6.7	1.54	4.1	10.3	48	0.056	0.047	0.13	0.011	6.24

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Jul-1997	7.58	12.60	9.8	5	6.9	2.1	5.8	15	44.4	0.139	0.046	0.1	0.011	6.61
102777	V3R002 Q01	Aug-1997	7.6	15.30	10.6	5.2	7.9	1.94	5.8	19.3	50.2	0.139	0.077	0.13	0.008	6.06
102777	V3R002 Q01	Sep-1997	7.9	17.40	13.8	6.1	8.4	2.78	5.2	19.1	64.2	0.169	0.074	0.14	0.02	6.73
102777	V3R002 Q01	Nov-1997	7.41	10.60	8.2	3.4	5.4	1.13	3.9	10.6	37.9	0.349	0.048	0.11	0.006	6.25
102777	V3R002 Q01	Dec-1997	7.62	9.40	6.6	2.9	4.7	1.45	3.8	16.5	29.3	0.251	0.042	0.05	0.022	7.44
102777	V3R002 Q01	Dec-1997	7.95	12.00	9.1	4.3	6.2	1.44	4.1	13.9	44.3	0.11	0.045	0.12	0.008	6.62
102777	V3R002 Q01	Feb-1998	7.84	9.60	6.7	3.1	4.3	1.39	3.5	14.3	34.6	0.175	0.052	0.15	0.024	5.49
102777	V3R002 Q01	Mar-1998	8.03	13.10	8.7	3.8	6.8	1.97	4.8	13.1	43.9	0.15	0.093	0.16	0.034	7.05
102777	V3R002 Q01	Apr-1998	7.62	13.40	9.1	3.8	6.1	1.8	3.5	12.4	45.4	0.156	0.107	0.1	0.014	7.33
102777	V3R002 Q01	May-1998	7.83	14.80	10.9	4.5	6.7	1.43	3.4	15.1	51.7	0.145	0.093	0.14	0.015	7.83
102777	V3R002 Q01	Jun-1998	8.24	17.70	13.5	6.1	8.8	2.29	4	17.7	60.6	0.139	0.057	0.12	0.035	7.82
102777	V3R002 Q01	Jul-1998	7.53	15.50	13.9	7.3	8.9	2.85	5.5	19.9	66.6	0.136	0.02	0.17	0.04	6.85
102777	V3R002 Q01	Aug-1998	8.08	21.70	17.2	7.7	10	3.58	6.9	21.8	69.5	0.041	0.05	0.17	0.015	5.98
102777	V3R002 Q01	Sep-1998	8	26.70	23.2	10.1	14.1	4.86	8.1	33.3	85.4	0.056	0.073	0.18	0.014	4.76

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	Oct-1998	8.08	20.20	16.9	6.7	9.5	3.57	7.5	21.5	63.6	0.205	0.301	0.17	0.015	7.09
102777	V3R002Q01	Nov-1998	7.99	17.40	14.2	5.6	8.4	3.08	6.8	22.3	57.3	0.104	0.02	0.15	0.013	4.03
102777	V3R002Q01	Dec-1998	7.89	9.90	7.6	3.2	5.1	1.48	5.1	8.9	29.9	0.242	0.02	0.11	0.031	6.9
102777	V3R002Q01	Jan-1999	7.81	14.60	12.2	5	6.7	2	5.3	14.5	48.1	0.106	0.02	0.12	0.014	7.19
102777	V3R002Q01	Feb-1999	7.59	11.50	8.8	3.8	5.8	1.91	5	12.4	38.8	0.133	0.109	0.11	0.026	6.78
102777	V3R002Q01	Mar-1999	7.7	9.60	7.9	3	6	1.19	5.8	10.8	37.3	0.02	0.08	0.15	0.035	7.23
102777	V3R002Q01	Apr-1999	7.81	19.80	17.3	5.6	8.2	5.06	6.7	31.5	51.6	0.17	0.04	0.14	0.024	5.09
102777	V3R002Q01	May-1999	7.64	22.30	16.9	6.2	10.8	4.86	7.2	32.7	63.9	0.137	0.083	0.18	0.019	6.04
102777	V3R002Q01	Jun-1999	7.99	26.50	19.8	7.6	13.5	5.86	9.6	42.1	63.6	0.097	0.076	0.18	0.013	5.9
102777	V3R002Q01	Jul-1999	7.77	27.40	19.3	7.5	14.1	5.38	8.5	36.8	70.2	0.078	0.058	0.17	0.009	5.04
102777	V3R002Q01	Aug-1999	8	29.70	21.3	7.9	15.4	5.99	11	47.2	75.2	0.02	0.041	0.18	0.012	4.99
102777	V3R002Q01	Oct-1999	9.37	28.70	18.141	8.795	17.45	5.265	5	43.152	75.152	0.02	0.02	0.181	0.017	3.121
102777	V3R002Q01	Nov-1999	8.2	32.80	24.382	8.805	17.318	5.277	11.445	46.928	83.163	0.02	0.02	0.204	0.014	4.313
102777	V3R002Q01	Dec-1999	7.67	8.65	6.138	2.341	4.548	1.628	5	9.269	22	0.223	0.123	0.127	0.03	5.559

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Jan-2000	7.68	9.47	7.653	2.738	4.468	1.322	5	12.21	23.496	0.23	0.02	0.135	0.01	6.679
102777	V3R002 Q01	Feb-2000	7.95	11.52	8.592	2.954	5.569	1.822	5	12.925	35.087	0.067	0.02	0.16	0.023	8.473
102777	V3R002 Q01	Mar-2000	7.31	9.06	6.213	2.668	4.616	0.941	5	8.414	31.265	0.02	0.02	0.11	0.011	7.794
102777	V3R002 Q01	May-2000	7.78	10.57	6.933	3.249	6.174	1.218	5	11.896	34.88	0.107	0.056	0.188	0.028	7.349
102777	V3R002 Q01	Jun-2000	7.86	13.60	10.215	2.925	6.521	1.654	5	14.892	40.919	0.103	0.047	0.13	0.008	7.258
102777	V3R002 Q01	Jul-2000	7.91	15.20	11.313	4.666	7.593	2.613	5	18.289	42.089	0.061	0.02	0.05	0.013	7.06
102777	V3R002 Q01	Aug-2000	7.83	16.90	13.166	5.318	8.884	2.971	5	19.942	53.849	0.02	0.02	0.148	0.013	6.93
102777	V3R002 Q01	Sep-2000	7.86	19.40	14.822	6.587	9.82	4.093	5	22.739	59.553	0.02	0.044	0.154	0.015	7.226
102777	V3R002 Q01	Oct-2000	9.55	12.29	9.329	3.895	7.464	1.713	5	11.091	41.861	0.045	0.02	0.112	0.028	5.678
102777	V3R002 Q01	Nov-2000	7.72	11.98	8.787	3.929	6.457	2.057	5	17.264	36.497	0.02	0.02	0.129	0.024	5.747
102777	V3R002 Q01	Dec-2000	7.53	13.50	9.285	4.081	5.682	2.512	5	15.544	33.704	0.177	0.063	0.159	0.018	6.458
102777	V3R002 Q01	Jan-2001	7.68	12.75	10.279	4.303	6.274	1.901	5	11.112	37.413	0.104	0.042	0.134	0.017	6.883
102777	V3R002 Q01	Feb-2001	7.84	13.80	10.671	4.547	6.835	2.279	5	12.403	42.672	0.062	0.045	0.141	0.021	6.974
102777	V3R002 Q01	Mar-2001	7.94	13.40	10.12	4.587	6.862	1.931	5	14.337	44.252	0.077	0.02	0.154	0.039	6.325

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	Apr-2001	7.72	12.05	9.296	3.949	6.559	1.802	5	10.545	37.284	0.105	0.096	0.159	0.394	6.257
102777	V3R002Q01	May-2001	7.55	13.70	11.698	4.107	7.575	2.253	5	7.958	45.314	0.183	0.13	0.149	0.183	6.295
102777	V3R002Q01	May-2001	7.31	15.30	11.164	4.971	9.074	2.872	5	19.95	49.703	0.058	0.06	0.15	0.164	6.896
102777	V3R002Q01	Jun-2001	7.87	19.30	14.102	5.772	10.437	3.464	5	20.86	57.673	0.02	0.045	0.155	0.029	5.273
102777	V3R002Q01	Jul-2001	7.85	26.60	12.64	6.907	24.984	2.177	5	66.454	39.309	0.086	0.06	0.175	0.029	4.757
102777	V3R002Q01	Aug-2001	8.14	22.60	16.666	7.055	11.574	5.388	5	34.441	63.191	0.02	0.02	0.154	0.017	3.766
102777	V3R002Q01	Sep-2001	7.56	12.70	4.935	6.726	5.885	3.129	5	17.916	27.045	0.403	0.103	0.112	0.016	5.386
102777	V3R002Q01	Oct-2001	8.74	14.80	10.41	3.926	6.39	3.389	5	19.476	40.786	0.041	0.02	0.14	0.025	4.281
102777	V3R002Q01	Dec-2001	7.69	10.19	8.291	3.351	4.559	1.545	5	13.307	29.613	0.271	0.071	0.131	0.017	7.616
102777	V3R002Q01	Jan-2002	7.58	11.00	8.894	3.317	5.197	1.61	5	7.272	38.09	0.042	0.02	0.125	0.012	6.765
102777	V3R002Q01	Feb-2002	7.57	8.88	6.35	2.811	4.281	1.273	5	11.14	30.783	0.086	0.02	0.118	0.006	6.892
102777	V3R002Q01	Mar-2002	7.58	7.83	6.133	2.505	4.086	0.935	5	6.738	24.83	0.02	0.02	0.115	0.033	7.477
102777	V3R002Q01	Apr-2002	7.87	11.11	10.333	2.507	4.685	2.057	5	10.421	35.472	0.111	0.072	0.131	0.015	6.502
102777	V3R002Q01	May-2002	8.03	13.60	10.702	4.04	4.145	2.438	5	15.069	39.693	0.139	0.067	0.17	0.018	7.652

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Jun-2002	7.71	16.20	11.703	5.113	7.687	3.28	5	16.484	43.807	0.106	0.056	0.137	0.013	6.391
102777	V3R002 Q01	Jul-2002	7.95	17.00	11.853	5.977	6.908	2.702	5	17.462	50.553	0.085	0.056	0.157	0.019	5.353
102777	V3R002 Q01	Oct-2002	7.7	17.50	12.575	4.976	6.611	2.682	5	10.4	47.645	0.11	0.088	0.138	0.012	4.312
102777	V3R002 Q01	Oct-2002	8.16	18.40	13.25	5.376	8.473	3.234	5	14.189	56.745	0.072	0.127	0.19	0.025	3.386
102777	V3R002 Q01	Nov-2002	8.01	16.30	11.233	4.795	7.221	1.962	5	7.843	51.495	0.08	0.153	0.138	0.019	4.575
102777	V3R002 Q01	Dec-2002	7.03	8.70	6.216	2.307	4.067	1.656	5	13.255	25.783	0.02	0.02	0.108	0.074	5.179
102777	V3R002 Q01	Mar-2003	7.52	15.00	11.43	3.337	4.816	2.564	5	14.892	37.57	0.02	0.02	0.204	0.016	4.76
102777	V3R002 Q01	Apr-2003	7.24	17.60	13.335	4.101	7.647	3.851	5	18.06	44.58	0.02	0.02	0.198	0.013	4.093
102777	V3R002 Q01	May-2003	7.78	18.30	12.396	4.829	7.705	4.176	5	21.062	52.828	0.02	0.02	0.188	0.023	4.35
102777	V3R002 Q01	Jun-2003	7.63	20.90	16.677	5.556	9.844	4.202	5	22.51	56.882	0.06	0.02	0.211	0.013	3.561
102777	V3R002 Q01	Jun-2004	7.46	20.30	15.235	6.588	10.968	4.811	6.5	38.917	55.706	0.256	0.015	0.1	0.012	5.202
102777	V3R002 Q01	Jul-2004	7.48	23.60	16.997	6.03	10.653	5.266	10.737	30.363	55.263	0.169	0.065	0.275	0.025	4.332
102777	V3R002 Q01	Aug-2004	7.59	22.50	16.808	6.542	9.817	4.851	9.838	29.107	56.171	0.055	0.015	0.1	0.012	2.478
102777	V3R002 Q01	Nov-2004	7.93	28.50	20.266	8.346	16.688	5.666	7.319	22.216	92.996	0.055	0.033	0.219	0.012	0.3

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Mar-2005	7.05	10.29	7.773	2.949	5.188	1.985	6.144	8.608	30.132	0.04	0.02	0.118	0.027	6.641
102777	V3R002 Q01	Apr-2005	5.96	10.25	7.387	3.379	4.429	1.546	4.184	6.483	25.365	0.091	0.02	0.05	0.02	6.448
102777	V3R002 Q01	Apr-2005	7.4	16.40	11.094	6.688	6.905	1.559	6.536	17.29	49.833	0.389	0.02	0.127	0.06	8.372
102777	V3R002 Q01	May-2005	7.7	11.68	9.239	4.059	6.046	1.756	4.884	11.127	38.876	0.131	0.042	0.233	0.032	6.732
102777	V3R002 Q01	Jun-2005	7.68	16.20	10.484	5.099	7.522	2.964	5.941	13.754	38.155	0.241	0.074	0.115	0.025	6.56
102777	V3R002 Q01	Jul-2005	7.84	21.20	14.813	5.824	9.697	3.766	11.065	16.63	58.707	0.273	0.02	0.169	0.012	5.144
102777	V3R002 Q01	Aug-2005	8.32	29.70	17.781	13.857	14.042	2.109	15.729	11.909	103.784	0.04	0.02	0.174	0.02	6.697
102777	V3R002 Q01	Sep-2005	7.77	24.40	16.23	6.82	10.674	4.895	11.036	25.272	62.278	0.04	0.02	0.16	0.006	3.057
102777	V3R002 Q01	Nov-2005	7.46	26.50	21.592	8.06	13.526	6.835	11.014	28.809	80.773	0.101	0.02	0.179	0.006	3.369
102777	V3R002 Q01	Nov-2005	6.89	11.55	8.867	3.402	5.848	3.325	6.242	13.498	27.691	0.359	0.02	0.12	0.085	5.014
102777	V3R002 Q01	Dec-2005	7.48	19.90	14.845	5.897	10.516	4.825	8.384	16.856	56.186	0.04	0.059	0.214	0.014	4.589
102777	V3R002 Q01	Jan-2006	7.62	10.64	6.851	3.473	5.201	3.167	6.238	11.903	23.617	0.04	0.02	0.121	0.033	6.594
102777	V3R002 Q01	Feb-2006	7.79	15.80	11.964	5.546	5.62	2.572	6.533	18.594	44.731	0.149	0.065	0.111	0.024	7.789
102777	V3R002 Q01	Mar-2006	7.17	14.90	10.41	5.159	5.876	6.385	9.724	14.024	44.819	0.04	0.02	0.118	0.063	6.788

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Apr-2006	7.6	15.10	10.07	4.389	6.622	3.636	6.932	19.218	34.369	0.04	0.02	0.111	0.018	7.234
102777	V3R002 Q01	Jul-2006	8.13	23.90	15.001	12.765	8.328	1.291	7.511	9.777	97.951	0.04	0.02	0.136	0.014	5.539
102777	V3R002 Q01	Dec-2006	7.49	18.00	14.314	4.978	7.563	4.369	5.645	13.922	52.717	0.437	0.02	0.05	0.021	6.412
102777	V3R002 Q01	Dec-2006	7.86	12.50	8.538	5.664	5.426	1.456	5.963	9.645	27.293	0.25	0.057	0.126	0.046	6.656
102777	V3R002 Q01	Jan-2007	7.95	14.20	10.05	3.507	6.288	2.074	5.358	10.909	44.257	0.104	0.02	0.116	0.059	7.095
102777	V3R002 Q01	Jan-2007	7.84	18.00	11.283	5.694	7.993	6.24	8.336	14.437	48.437	0.143	0.123	0.165	0.067	6.26
102777	V3R002 Q01	Feb-2007	7.7	20.40	13.656	6.22	8.45	7.477	9.436	22.669	46.132	1.952	0.141	0.174	0.162	7.24
102777	V3R002 Q01	Mar-2007	7.57	21.40	16.537	5.735	9.215	6.947	6.771	19.15	58.425	0.04	0.111	0.174	0.045	5.357
102777	V3R002 Q01	Apr-2007	7.65	21.80	17.978	5.685	7.032	5.514	7.506	24.683	58.463	0.095	0.156	0.136	0.014	5.792
102777	V3R002 Q01	May-2007	7.91	24.20	18.481	6.803	12.04	5.957	9.715	34.91	57.784	0.04	0.074	0.178	0.019	5.676
102777	V3R002 Q01	Aug-2007	7.81	35.60	22.993	9.837	17.83	8.521	14.205	40.038	81.539	0.202	0.091	0.199	0.025	2.782
102777	V3R002 Q01	Oct-2007	7.79	25.90	19.36	8.349	14.284	6.333	11.07	24.004	82.404	0.04	0.02	0.168	0.053	5.002
102777	V3R002 Q01	Dec-2007	7.34	12.20	8.386	3.384	7.372	2.528	6.995	17.569	34.605	0.213	0.065	0.178	0.031	5.858
102777	V3R002 Q01	Jan-2008	6.83	13.80	6.018	3.37	5.952	10.08	8.861	14.494	21.831	2.23	0.042	0.119	0.281	4.747

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Mar-2008	7.05	14.10	10.111	4.439	6.884	3.273	5.512	18.33	33.299	0.278	0.204	0.104	0.049	5.957
102777	V3R002 Q01	Apr-2008	7.53	18.20	10.207	4.393	7.762	5.314	9.83	19.162	41.214	0.04	0.051	0.115	0.038	6.577
102777	V3R002 Q01	Apr-2008	7.56	15.60	9.633	4.819	9.811	1.929	7.681	26.103	34.307	0.143	0.05	0.15	0.033	5.014
102777	V3R002 Q01	May-2008	7.19	15.00	9.826	4.11	6.375	1.928	4.012	16.008	44.719	0.04	0.048	0.05	0.028	7.119
102777	V3R002 Q01	Jun-2008	8.22	15.40	-	-	-	-	-	-	-	-	-	-	-	-
102777	V3R002 Q01	Jun-2008			9.628	5.932	6.6	2.2	7.026	14.456	-	-	-	-	-	-
102777	V3R002 Q01	Jul-2008	7.8	17.10	-	-	-	-	-	-	-	-	-	-	-	-
102777	V3R002 Q01	Jul-2008			11.359	5.237	-	3.1	8.228	16.315	-	-	-	-	-	-
102777	V3R002 Q01	Aug-2008	7.71	18.50	12.958	-	8.213	2.326	8.401	19.425	52.175	0.084	0.025	-	0.047	3.667
102777	V3R002 Q01	Sep-2008	7.7	19.90	16.224	8.748	9.2	2.8	8.811	18.174	58.956	0.099	0.025	-	0.006	3.111
102777	V3R002 Q01	Nov-2008	6.97	26.60	20.219	7.556	13.7	5.05	12.93	21.221	-	0.005	0.025	0.459	0.006	3.602
102777	V3R002 Q01	Jan-2009	7.76	11.85	7.222	3.619	6.2	3.8	6.675	12.601	33.384	0.005	0.025	-	0.025	6.521
102777	V3R002 Q01	Feb-2009	7.45	9.04	5.401	2.458	5	2.9	5.595	7.475	29.664	0.005	0.025	-	0.006	6.825
102777	V3R002 Q01	May-2009	7.93	13.70	9.304	4.436	8.9	2.9	5.216	10.804	40.367	0.005	0.025	-	0.006	-

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Aug-2009	7.14	17.20	11.358	5.706	9.6	3.4	9.272	20.213	41.087	0.005	0.025	-	0.006	5.786
102777	V3R002 Q01	Aug-2010	8.02	18.71	5.672	7.305	10.884	3.379	8.309	21.829	65.548	0.025	0.11	0.025	0.005	4.685
102777	V3R002 Q01	Sep-2010	8.11	22.70	17.187	10.601	10.654	3.879	9.721	19.06	73.938	0.083	0.025	0.147	0.005	4.082
102777	V3R002 Q01	Mar-2011	7.5	14.70	20.336	4.65	6.823	3.005	5.851	18.663	44.683	0.227	0.025	0.082	0.005	6.398
102777	V3R002 Q01	May-2011	8.04	15.66	10.561	4.6	8.521	3.096	6.31	-	48.663	0.396	0.07	0.27	0.016	6.829
102777	V3R002 Q01	Jun-2011	8.1	17.53	12.157	5.398	10.332	4.012	8.006	19.279	51.074	0.393	0.224	0.097	0.025	6.438
102777	V3R002 Q01	Jul-2011	8.03	39.60	29.202	-	13.147	2.329	9.971	-	63.5	0.025	0.025	0.182	7.637	7.637
102777	V3R002 Q01	Aug-2011	7.35	16.79	11.022	5.19	8.906	4.013	9.762	19.506	51.498	0.025	0.025	0.025	0.005	5.522
102777	V3R002 Q01	Sep-2011	7.57	14.83	10.29	5.32	11.01	2.451	5.463	15.322	38.917	0.054	0.025	0.225	0.005	4.838
102777	V3R002 Q01	Oct-2011	7.38	17.56	13.456	6.384	7.439	3.842	7.232	14.271	51.231	0.025	0.025	0.274	0.005	3.828
102777	V3R002 Q01	Nov-2011	7.34	21.21	15.03	6.479	11.04	-	11.648	21.785	-	-	0.025	0.296	-	4.196
102777	V3R002 Q01	Nov-2011	7.34	20.20	16.867	6.022	11.769	4.463	7.966	18.543	74.876	0.025	0.365	0.271	0.005	2.713
102777	V3R002 Q01	Mar-2012	7.56	23.94	9.945	5.702	18.249	7.292	27.777	16.955	52.438	0.025	1.546	0.147	0.052	5.361
102777	V3R002 Q01	Apr-2012	7.74	22.21	14.165	5.699	11.475	4.649	7.684	-	61.203	0.146	0.025	0.145	0.014	5.748

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	May-2012	7.55	24.12	15.113	5.931	11.803	4.279	8.994	23.475	66.942	0.025	0.025	0.299	0.005	3.991
102777	V3R002Q01	Jun-2012	7.96	13.96	7.55	5.106	4.695	2.63	4.828	8.358	37.974	0.025	0.025	0.254	0.015	2.478
102777	V3R002Q01	Jul-2012	8.13	30.22	18.838	8.383	18.416	5.089	13.743	40.006	68.351	0.025	0.025	0.261	0.02	3.538
102777	V3R002Q01	Aug-2012	7.92	30.56	24.405	8.393	19.109	5.387	15.326	46.081	80.944	0.085	0.073	0.218	0.06	3.731
102777	V3R002Q01	Sep-2012	7.96	32.50	28.748	9.793	-	6.545	15.624	46.046	-	0.025	0.08	0.309	0.005	3.69
102777	V3R002Q01	Nov-2012	8.01	15.04	9.979	6.367	6.49	1	3.644	21.705	39.197	0.105	0.025	0.136	0.014	6.196
102777	V3R002Q01	Jan-2013	7.27	16.45	15.699	3.481	8.007	3.336	5.336	8.87	46.097	2.256	0.025	0.379	0.278	8.429
102777	V3R002Q01	Feb-2013	7.87	14.16	10.417	3.3	8.457	2.392	4.407	8.665	44.895	0.025	0.025	0.147	0.087	6.853
102777	V3R002Q01	Mar-2013	7.8	11.80	10.726	3.639	2	2.953	5.497	8.802	23.419	0.025	0.025	0.025	0.02	7.23
102777	V3R002Q01	Apr-2013	7.79	14.20	8.511	3.768	8.602	2.67	6.211	15.525	33.282	0.179	0.081	0.178	0.005	6.335
102777	V3R002Q01	Apr-2013	7.78	11.69	8.197	4.534	7.947	2.704	4.615	11.342	31.346	0.15	0.025	0.186	0.005	6.303
102777	V3R002Q01	Jun-2013	8.02	17.18	11.946	5.07	8.161	3.099	6.14	20.413	43.455	0.497	0.232	0.176	0.016	6.525
102777	V3R002Q01	Jul-2013	7.93	18.43	13.389	5.571	8.472	2.252	5.667	20.456	59.785	0.495	0.174	0.161	0.005	5.911
102777	V3R002Q01	Aug-2013	7.91	20.37	13.603	5.538	11.385	3.918	6.749	25.185	56.371	1.007	0.088	0.522	0.011	5.256

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Sep-2013	7.63	20.25	15.085	7.744	11.652	3.605	7.485	26.222	68.311	0.267	0.057	0.299	0.011	3.584
102777	V3R002 Q01	Nov-2013	8.25	23.46	19.792	7.072	12.274	3.431	9.819	22.027	77.379	0.363	0.068	0.194	0.005	2.491
102777	V3R002 Q01	Dec-2013	7.64	15.53	8.298	3.914	4.269	-	5.489	16.143	44.237	0.352	0.18	0.156	0.005	5.139
102777	V3R002 Q01	Dec-2013	7.76	12.20	9.872	3.645	-	-	6.124	15.13	52.89	0.328	0.189	0.204	0.011	4.682
102777	V3R002 Q01	Jan-2014	7.56	10.63	7.622	3.943	-	-	5.424	6.848	35.67	0.025	0.025	0.113	0.005	4.323
102777	V3R002 Q01	Feb-2014	7.69	9.94	7.633	3.477	-	-	3.241	6.768	34.712	0.138	0.025	0.375	0.005	7.375
102777	V3R002 Q01	Mar-2014	7.73	12.55	7.764	3.055	-	-	5.135	10.929	52.649	0.134	0.05	0.127	0.01	7.59
102777	V3R002 Q01	Apr-2014	7.91	11.98	5.92	4.012	-	-	19.744	7.057	37.811	1.641	0.05	0.13	0.01	7.103
102777	V3R002 Q01	May-2014	7.96	13.54	8.72	4.496	-	-	5.265	12.65	44.161	0.829	0.05	-	0.01	6.773
102777	V3R002 Q01	Jun-2014	7.86	17.76	10.022	5.937	-	-	7.468	20.498	49.709	1.133	0.198	0.025	0.01	6.592
102777	V3R002 Q01	Jul-2014	7.83	21.29	12.496	6.54	-	-	10.22	21.705	62.278	0.959	0.494	0.025	0.01	6.596
102777	V3R002 Q01	Aug-2014	7.97	23.24	12.699	7.63	-	-	14.289	27.311	65.003	1.089	0.05	0.471	0.01	5.886
102777	V3R002 Q01	Sep-2014	8.24	27.74	20.792	8.123	-	-	15.309	24.435	87.712	0.358	0.05	0.371	0.069	5.26
102777	V3R002 Q01	Oct-2014	8.14	23.12	16.186	9.685	-	-	10.267	17.158	72.316	2.9	0.05	0.077	0.269	3.977

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Nov-2014	7.75	14.32	8.277	4.521	-	-	8.718	10.877	28.863	3.355	0.05	0.158	0.299	5.984
102777	V3R002 Q01	Dec-2014	7.78	10.07	5.923	2.534	5.595	0.5	4.805	6.484	27.424	0.05	0.05	0.107	0.01	5.238
102777	V3R002 Q01	Jan-2015	7.05	13.59	6.897	3.075	4.12	5.653	8.251	10.867	5	6.013	0.05	0.163	0.464	6.659
102777	V3R002 Q01	Feb-2015	7.71	9.40	4.872	3.287	-	-	1.718	7.456	23.529	0.05	0.05	0.135	0.01	7.407
102777	V3R002 Q01	Mar-2015	7.41	11.22	7.61	2.851	4.694	2.962	7.142	6.85	27.012	0.05	0.05	0.249	0.01	5.538
102777	V3R002 Q01	Apr-2015	8.11	12.45	9.991	2.779	7.533	3.875	6.193	5.591	56.717	0.05	0.05	0.19	0.026	6.514
102777	V3R002 Q01	May-2015	8.08	14.99	10.133	-	11.328	1.356	8.765	8.673	52.947	0.05	0.255	0.199	0.024	6.52
102777	V3R002 Q01	Jul-2015	7.54	24.16	17.15	7.231	12.995	4.684	16.551	16.258	76.956	0.247	0.316	0.283	0.01	6.721
102777	V3R002 Q01	Jul-2015	7.3	34.50	22.1	8.6	26	15	27.5	20.3	96.2	2.293	0.05	0.207	0.01	6.216
102777	V3R002 Q01	Aug-2015	8.14	17.18	11.925	5.233	7.054	0.5	8.42	8.766	60.586	0.05	0.229	0.22	0.01	6.78
102777	V3R002 Q01	Aug-2015	8.46	40.40	23.109	12.118	26.532	14.728	20.865	41.056	124.143	0.776	0.05	0.261	0.12	5.123
102777	V3R002 Q01	Sep-2015	7.5	35.40	29.617	10.847	22.614	11.189	23.238	4.182	148.275	0.935	0.05	0.48	0.01	4.317
102777	V3R002 Q01	Oct-2015	8.31	38.40	33.489	10.656	24.872	8.507	15.862	11.573	135.171	6.349	0.05	0.264	1.554	3.379
102777	V3R002 Q01	Nov-2015	7.5	27.20	26.1	8.3	19.5	2.3	10.8	8.6	117.5	0.05	0.05	0.707	0.043	4.9

Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Disslo ved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002 Q01	Dec-2015	8.2	26.60	19.3	7.2	14.6	6	12.4	14.5	75	5.247	0.05	0.234	0.816	5.8
102777	V3R002 Q01	Dec-2015	7.7	8.80	6.7	0.75	4.8	1.3	3.1	2.1	27.8	0.05	0.05	0.588	0.01	5.4
102777	V3R002 Q01	Mar-2016	6.8	10.30	6.8	1.6	6.6	1.7	2.5	10.3	27.2	0.561	0.05	0.025	0.06	6.4
102777	V3R002 Q01	Apr-2016	8.3	9.50	6.2	2.2	4.5	0.5	6	6.7	21.1	0.109	0.05	0.115	0.01	6.4
102777	V3R002 Q01	Apr-2016	7.7	13.90	11	3.9	9.2	2.1	8.1	5.6	49.2	0.05	0.05	0.025	0.01	6.9
102777	V3R002 Q01	May-2016	8	22.60	14.4	6.8	18.8	3.9	16.8	9.6	63.6	1.985	0.05	0.199	0.116	6.7
102777	V3R002 Q01	Jun-2016	8	22.80	14.9	5.9	14.9	5.9	14.8	22.9	60.9	0.125	0.723	0.467	0.028	5.6
102777	V3R002 Q01	Aug-2016	7.9	32.50	20.4	7.9	23.9	12	28.6	22.9	97.8	0.107	0.606	0.241	0.122	5.9
102777	V3R002 Q01	Aug-2016	7.3	25.80	19.8	7	17.1	9.7	19	24.3	66	0.05	0.05	0.49	0.01	5.1
102777	V3R002 Q01	Nov-2016	7.5	11.50	7.4	3.7	5.3	2.1	4.9	12.1	31.6	0.05	0.05	0.142	0.036	5.4
102777	V3R002 Q01	Dec-2016	7.8	16.10	11.9	6.2	6.6	2.7	5.3	22.1	37.5	0.05	0.05	0.135	0.01	5.4
102777	V3R002 Q01	Feb-2017	7.6	12.60	10.4	4.8	5.5	1.25	3.5	10.1	39.9	0.194	0.05	0.025	0.01	7.3
102777	V3R002 Q01	Mar-2017	7.3	13.10	10.2	4.6	5.3	1.25	3.8	12.6	37.5	0.112	0.05	0.109	0.01	7.4
102777	V3R002 Q01	Apr-2017	7.6	12.30	9.4	4	7.6	1.25	3.9	8.3	38.9	0.394	0.05	0.189	0.01	7.1

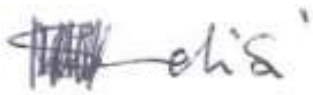
Monitoring ID	Station	Date	pH	EC	Dissolved Calcium (Ca)	Dissolved Maganesium (Mg)	Dissovled Sodium (Na)	Dissolved Potassium (K)	Dissolved Chloride (Cl)	Dissolved Sulphate (SO_4)	Total Alkalinity	NO3 & NO2	Dissolved Ammonium (NH_4) as N	Dissloved Fluoride (F)	Dissolved Phosphate (PO_4) as P	Dissolved Silica (Si)
102777	V3R002Q01	May-2017	7.3	13.10	7	4.3	6.7	9.9	6.5	10.1	40.7	0.05	0.05	0.473	0.01	6.2

APPENDIX 4: DECLARATION OF THE SPECIALIST

I, *Daniel Fundisi*, declare that –

General declaration:

- I acted as the independent specialist in this application;
- I have performed the work relating to the application in an objective manner, even if this resulted in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that compromised my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity (see Appendix 5 for my curriculum vitae);
- I have complied with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



GCS Water and Environment (Pty) Ltd

APPENDIX 5: SPECIALIST CURRICULUM VITAE

DANIEL FUNDISI
HYDROLOGIST

CORE SKILLS

- Water Resources Management Planning
- Water Availability Assessments
- Flood Line Assessments
- Hydro-chemical Analysis
- Storm Water Management Planning
- Soils, Land Use & Land Capability Assessments
- Water Balance Modelling
- Rainfall-runoff Modelling

DETAILS

Qualifications

- MSc (Hydrology): UKZN, South Africa
- BSc (Hons) (Hydrology Major): UZ, Zimbabwe
- BSc (Geography & Env. Science): ZOU, Zimbabwe.
- Dip. Scie. Ed. UZ, Zimbabwe.

Memberships

SACNASP: Pr.Sci.Nat.

Reg. No. 400034/17

Languages

- English - Fluent
- Shona - Fluent
- Sepedi - Fluent

Countries Worked In

- South Africa
- Zimbabwe
- Mozambique
- DRC
- Guinea
- Lesotho

PROFILE

Mr. Fundisi is a Hydrologist with GCS in Johannesburg. He has 6.5 years' work experience and specialises in water resources management planning, hydrological modelling, hydraulic modelling, hydrological research, hydro-chemical analysis, wetland assessments, and Soil, Land Use & Land Capability assessments. He has been primarily involved in the engineering hydrology, soils and water availability assessment projects for mines, municipalities and agricultural enterprises. Daniel has worked in 6 countries.

Daniel has specialist skills in the following areas:

- *Flood Line Assessments*
- *Storm Water Management Planning*
- *Rainfall-Runoff Modelling*
- *Water Resources Management Planning*
- *Water Balance Modelling*
- *Hydro-chemical Analysis*
- *Soil, land Use & Land Capability Assessments*
- *Water Availability Assessments*
- *Wetlands Studies*
- *Technical Report Writing*

Selected Project Experience

1. **CLIENT: Environmental Impact Management Services (EIMS) (Pty) Ltd. (2016)**
   PROJECT - An Environmental Impact Assessment (EIA) Study
   GCS Water and Environment (Pty) Ltd. (GCS) was appointed by Environmental Impact Management Services (Pty) Ltd. (EIMS) to undertake a hydrological impact assessment for the Storm Mountain Diamond (SMD) Mine situated in Lesotho.

   The surface water component included an extensive climate evaluation for the study. Climate data was evaluated to determine design precipitation depths which influence peak flows of specific return periods on the project site. The surface water study involved hydraulic modelling in HEC-RAS to determine the 1:50-year and 1:100-year flood lines, mine-wide water balance modelling, and water quality analysis in AquaChem and risk assessment.

2. **CLIENT: Total Coal South Africa (TCSA) (2015/2016)**
   PROJECT - Hydrological Impact Assessment for the Proposed Rietkuil Mine, in Mpumalanga, South Africa
   GCS Water and Environment (Pty) Ltd. (GCS) was appointed by Total Coal South Africa (Pty) Ltd. (TCSA) to undertake a specialist surface water impact assessment as part of the Environmental Impact Assessment (EIA) for the proposed Rietkuil Mine situated near Ga-Nala (Kriel) in the Mpumalanga Province of South Africa.

   The study involved hydrological assessment, flood lines modelling in HEC-RAS, water balance modelling and risk assessment for the study. The hydrological assessment was a key component in the study to provide input for flood lines modelling, stormwater modelling to compile the storm water management plan (SWMP) and for water balance modelling. The risk assessment integrated findings of all the key components of the project including flood lines, SWMP, water quality analysis and water balance modelling to determine overall impacts on water resources and mitigation measures.

3. **CLIENT: Transnet Engineering (2014/2015)**
   PROJECT - Integrated Water Resources Management for the Transnet Engineering Germiston Depot

   GCS Water and Environment (Pty) Ltd. (GCS) was requested by Transnet Engineering to develop an Integrated Water Resources Management Plan (IWRMP) and provide solutions to potential water use and water quality issues at their Germiston Rail site in the Gauteng Province of South Africa. This study involved assessment of surface water impacts resulting from operations at the Transnet Engineering Germiston Depot in terms of water quantity and quality. The main aim was to regularise water use and waste water disposal activities at the site to comply with the South African National Water Act, 36 of 1998, including Department of Water and Sanitation (DWS) Water Quality Guidelines Volumes 1 to 8, SANS 2015 Standards as well as with the Ekurhuleni Municipality legislation and guidelines.

   The project involved hydrological analysis, stormwater modelling (PCSWMM) and management planning, water quality analysis (AquaChem), water balance computations and risk assessment. Water quality issues were identified as viewed against the aforementioned guidelines and standards and mitigation measures were recommended in order to ensure compliance with National and Municipal Standards and guidelines.

4. **CLIENT: Platinum Group Metals (PTM) (2014/2015)**
   PROJECT - Baseline Hydrological Assessment for the Proposed Waterberg JV Project
   GCS Water and Environment (Pty) Ltd. (GCS) was appointed by Platinum Group Metals (PTM) (Pty) Ltd. to undertake a baseline hydrological assessment study for the Waterberg JV Project on Ketting 368 and Goedetrouw 366 Farms. Main components of the study included hydro-meteorological analysis and flood lines assessment for Sepabana and Mokudung Rivers proximal to the proposed project site. The study site is located within the Limpopo Water Management Area (WMA1) and in quaternary catchment A62H.

The project involved the undertaking of extensive climate evaluation, detailed runoff calculations to determine 1:50-year and 1:100-year flood peaks for the project site using various recommended and widely used methodologies in South Africa. The peak flows methods used included the Rational Method (Alternative 3), Standard Design Flood (SDF) method and Midgely and Pitman (MIPI) method. Representative peak flows were then used as input in HEC-RAS for hydraulic modelling to determine flood lines for the site.

5. **CLIENT: Triplo4 Sustainable Solutions (Pty) Ltd.(2015)**
   PROJECT - Hydrological Assessment for King Shaka Mall

   GCS Water and Environment (Pty) Ltd. (GCS) was requested by Triplo4 Sustainable Solutions (Pty) Ltd. (Triplo4) to undertake a Water Balance update for the proposed King Shaka Mall development. The development is proposed to take place in the KwaDukuza (formerly known as Stanger) Municipality located within the KwaZulu-Natal Province of South Africa.
   The Water Balance update was proposed in order to account for the potential hydrological post-development impacts of changes in some process water units, such as the removal of river abstraction (as included in the previous version of the water balance) and inclusion of an additional stormwater attenuation structure at the proposed King Shaka Mall project site. Hydrological impacts resulting from post-development activities only were addressed, as requested by the client.

   The study involved rainfall-runoff evaluation and Water Balance modelling as well as identifying the post-development hydrological impacts associated with the project and recommendation of mitigation measures.

6. **CLIENT: Airports Company South Africa (Pty) Ltd (ACSA) (2015/2016)**
   PROJECT - Water and Soil Impact Assessment for Waste Water Treatment Works Spills at King Shaka International Airport

   GCS Water and Environment (Pty) Ltd (GCS) was appointed by the Airports Company South Africa (ACSA) to undertake a hydrological and soils risk assessment for Waste Water Treatment Works (WWTW) South and North spills which occurred at King Shaka International Airport (KSIA) near Ballito in the KwaZulu-Natal Province of South Africa. The waste water spills occurred in October 2015 and January 2016 at the Southern Works and Northern Works, respectively.

   The study involved undertaking hydrological analysis, including the water and soil quality modelling in AquaChem in order to determine the impacts on water and soil resources of the sewage spills in the vicinity and downstream areas of the spillage sites. The assessment and quantification of the environmental risks associated with the spills and determination of associated mitigation measures, were undertaken.

7. **CLIENT: Eurasian Natural Resources Corporation (ENRC) (2014/2015)**
   PROJECT - Hydrological and Soils Impact Assessment Study for Estima Mine in Tete, Mozambique

   The Eurasian Natural Resources Corporation (ENRC) appointed GCS Water and Environment (Pty) Ltd. to carry out a hydrological assessment study for Estima Coal Mine. The proposed Estima Coal Mine site is located in the Tete Province of Mozambique, in Southern Africa. It is found approximately 20km south-east of Cahora Bassa Dam and the Town of Songo, adjacent to the R258 Sanangue River Bridge. It is bound by the Sanangue River as the major natural channel, together with its tributary, the Chitumbe River. Several other smaller tributaries contribute flows to the Sanangue River from a wide river channel network for the Estima catchment. The Sanangue River is a tributary of the larger Zambezi River that discharges into the Indian Ocean.

   The study involved undertaking a hydrological analysis and calculation of design peak flows for the 1:20-yr, 1:50-yr, 1:100-yr and the Regional Maximum Flood (RMF) and hydraulic modelling in HEC-RAS to determine flood lines for the Sanangue River and its tributaries. Peak