AQUATIC SPECIALIST REPORT
PROPOSED ESTABLISHMENT AND OPERATION OF A SEWAGE TREATMENT PACKAGE PLANT AT HEALDTOWN COMPREHENSIVE SCHOOL, FORT BEAUFORT, EASTERN CAPE PROVINCE OF SOUTH AFRICA

DEA REFERENCE NUMBER: 12/9/11/L894/1

Prepared for:

BKS (Pty) Ltd
35 Tecoma Street
Berea, East London
5241
Tel: +27 (0) 43 721 0565
Fax: +27 (0) 43 721 0566
Cell: +27 (0) 73 348 7795
Contact Person: Gareth Mitchell
Email: garethm@bks.co.za

Prepared by:

Coastal & Environmental Services
GRAHAMSTOWN
P.O. Box 934
Grahamstown, 6140
046 622 2364
Also in East London
www.cesnet.co.za

JUNE 2012

EXECUTIVE SUMMARY

Introduction

The proposed project entails the establishment and operation of a sewage treatment package plant at Healdtown Comprehensive School, Fort Beaufort. Such construction will aid the management of sewage and help eliminate the health and pollution hazard posed by raw sewage entering the nearby river.

The school previously dealt with sewage by employing a system of septic tanks; and more recently a series of sewage treatment ponds situated on the property. Due to vandalism, neglect and old age, it is now necessary to construct an entirely new system at the school to manage sewage and to eliminate the health and pollution hazard posed by raw sewage entering the river. A new gravity reticulation system is proposed with sewage flowing to a package plant for treatment. This eliminates the need for evaporation ponds, which are unsuitable because the school is situated in a residential area.,

Applicable legislation

The following legislation is relevant and applies to this project:

- The Conservation of Agricultural Resources Act (43 of 1983)
- The National Water Act (36 of 1998)
- The National Environmental Management: Biodiversity Act (10 of 2004)

Although applicable, the provisions of the National Environmental Management Act (1998) are not repeated, since details of this Act and its applicability to the project are contained in the Basic Assessment Report.

Description of the physical characteristics of the Kat River and KwaNgenu and Tyatyora tributaries

The Kat River Valley catchment includes the urban municipalities of Seymour and Fort Beaufort and many smaller communities and villages. In addition, the catchment includes extensive, privately owned citrus estates, some of which have environmental management systems that have been certified to international standards (ISO14001).Forty percent of the catchments population of close on 50 000 people (2001 figures) live in Fort Beaufort, located in the middle of the catchment. The remaining population lives on farms or within some 65 villages with populations ranging from 50 to 2500 persons (Birkholz 2007). An increasing number of villages are being supplied with tap water (as stand pipes), but many people still rely on the river as their main water source.

Many of South Africa's major rivers flow through former homeland areas. In these areas degradation of riparian zones are both a socio-economic concern and a widespread cause of perceived low ecological integrity. Rural areas in the former homelands are characterised by dense settlement and environmental stress. These areas lack electric and water supply infrastructure and are characterised by high levels of illiteracy, low human development indices and economic dependency on livestock grazed on communal lands and government transfers in the form of pensions. The communities in these areas are marginalised both politically and economically (Motteux & Rowntree, 1999a).

The main problems observed in these riverine and water resources can be summarised as follows:

- **an impaired riparian zone** due to the removal of riparian vegetation for fuel wood collection and grazing;
- **deteriorating water quality** due to the common presence of livestock in the water, in-stream bathing, laundry, run-off from pit latrines and degraded grazing lands;

- **high catchment sediment yields** in most catchment areas due to dirt roads and unsustainable land use practices lead to gully and sheet erosion; and
- **flow regulations** that are designed to meet the needs of upstream and downstream irritators (Motteux & Rowntree, 1999a).

Impact assessment

Construction phase

Three issues were identified within the construction phase. The first issue was land clearing for construction, and two impacts were identified within this, these being increased erosion and increased sedimentation. The following mitigation measures are required to adequately mitigate this issue:

- The sewage treatment package will be required to have some ground slope to facilitate drainage. Where the slope encountered is steeper than 2%, then increased cross-slope interceptor drains should be installed to avoid erosion, and these may need to be sub-surface drains.
- Ensure that a network of co-ordinated shallow drains are constructed during the land clearing phase
- Filter strips (grass buffer strips) must be implemented wherever possible but as a minimum around the edge of the entire development footprint as soon as construction is initiated.
- Ensure that site infrastructure such as buildings and fences are aligned with the natural drainage lines to minimise additional erosion
- Topsoil must be stockpiled and used for rehabilitation purposes. Any soil excavated and not utilised for rehabilitation must be removed from site and no large mounds of soil should be left behind after construction. If the unutilised soil is not excessive in quantity, it may be carefully spread within the environs, in particular, aggrade the Tyatyora banks opposite the settling ponds
- Soils must not be left bare for long periods of time, and areas should only be cleared just prior to construction to avoid excessive erosion
- No soil must be left exposed. It must be covered with mulch or vegetated.
- Any gardening and landscaping should consider planting plants at a right angle to the drainage lines to slow water velocities down and decrease erosion where possible.
- The sewage treatment package and related infrastructure must be designed in such a way that they do not concentrate flowing water (in other words that they consider the natural drainage of the site).
- Maintain maximum vegetation cover outside the built areas, particularly in marginal and riparian areas, to act as silt traps, site B in particular
- Ensure that all drainage lines are vegetated and not impeded.

All the vegetation along Tyatyora's edge must be kept intact because:

- The vegetation strip will act as a sediment trap.
- The vegetation strip will maintain the ecological functioning of the riparian areas during the operation phase at site B

The impact of increased erosion can be reduced to low negative significance post mitigation, and so to can increased sedimentation, be reduced to a low negative impact.

Issue 1: Land clearing for construction

Impact 1.1:Increased erosion

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Medium term	2	Study	2	Severe	4	Probable	3	11	**MODERATE -ve**
With mitigation	Short term	1	Study	2	Slight	1	May occur	2	6	**LOW -ve**
Site B										
Without mitigation	Short term	1	Study	2	Severe	4	Probable	3	10	**MODERATE -ve**
With mitigation	Short term	1	Study	2	Slight	1	May occur	2	6	**LOW -ve**

Impact 1.2: Increased sedimentation

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Long-term	3	Study area	2	Slight	1	Probably	3	8	**MODERATE –ve**
With mitigation	Short term	1	Localised	1	Slight	1	Probably	3	6	**LOW –ve**
Site B										
Without mitigation	Long-term	3	Study area	2	Slight	1	Probably	3	9	**MODERATE –ve**
With mitigation	Short term	1	Localised	1	Slight	2	Probably	3	7	**LOW –ve**

The second issue identified was the contamination of soils. In order to mitigate this impact the following measures must be implemented:
All construction must be undertaken according to the Construction Environmental Management Plan (CEMP). Details regarding the management of vehicles and an emergency response plan for accidental spillages of hazardous chemicals should be prepared. This will ensure that all hazardous chemicals are contained within specifically demarcated areas and these will be lined to avoid any contamination. All hazardous materials will be properly disposed of, thereby eliminating any potential environmental hazards that these could pose.

The following mitigation measures can be used to minimise the effects of hazardous substance leaks onto soil:

- Hazardous chemical substances used during construction must be stored in secondary containers (container within a container), and in a secure area in terms of the Material Safety Data Sheets (MSDS)
- The relevant MSDS must be available on site. Procedures detailed in the MSDS must be followed in the event of an emergency situation
- If potentially hazardous substances are to be stored on site, the Contractor must provide a Method Statement to the Construction Manager (CM) or Environmental Control Officer (ECO), detailing the substances/materials to be used, together with the storage, handling and disposal procedures of the materials
- No paint products may be disposed of on site and brush/roller wash facilities must be established to the satisfaction of the CM

- Oil-based paints and chemical additives and cleaners such as thinners and turpentine must be strictly controlled. A Method Statement detailing storage and cleaning must be submitted to and approved by the CM and ECO
- Roads and parking area surfaces will be on surfaces with no gradient, to prevent/ reduce runoff. Sufficient stormwater take-off points must be created in such a way that water does not have an opportunity to gather momentum. Stormwater ditches must contain structures that will reduce velocity of the runoff
- Vehicles must be serviced and maintained to minimise the risks of leakages of hydrocarbons and other pollutants, by sing drip trays.
- Storage areas that contain hazardous substances such as oil and other pollutants must be bunded with an approved impermeable liner.
- A designated, bunded area should be set aside for vehicle washing and maintenance.

If these mitigations are implemented, the impact can be reduced to low negative significance post mitigation.

Issue 2: Contamination of soils

Impact 2.1: Contamination of soils

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Long-term	3	Study area	2	Moderate	2	Probably	3	10	**MODERATE –ve**
With mitigation	Short term	1	Localised	1	Slight	1	May occur	2	5	**LOW –ve**
Site B										
Without mitigation	Long-term	3	Study area	2	Severe	4	Probably	3	12	**HIGH –ve**
With mitigation	Short term	1	Localised	1	Slight	1	May occur	2	5	**LOW –ve**

The third issue identified was the issue of waste. Within this issue, 3 impacts were identified, these being:

1. Impact 3.1: solid waste pollution in the estuary
2. Impact 3.2 lack of appropriate toilet facilities for construction workers
3. Impact 3.3 liquid waste pollution in the Tyatyora tributary

Mitigation measures that need to be implemented to deal with this issue are listed below:

- Follow all recommendations provided in the CEMP regarding the rescue of any species and the use of the cleared vegetation for site rehabilitation once the construction is completed. All other cleared vegetation must be removed from the site and transported to a suitable disposal site (for example a municipal composting facility).
- Chemical toilets shall be provided for all construction workers for the duration of the construction phase.
- Chemical toilets shall be kept in a hygienic and sanitary condition, supplied with toilet paper and be emptied regularly by an approved sub-contractor.
- Chemical toilets shall be placed as far as possible from the estuary on level ground to prevent them falling over in high wind conditions. Alternatively, the chemical toilets must be secured to the ground with guy ropes or similar. The toilets shall be placed on an impermeable surface.
- All leaks and spills from the chemical toilets shall be reported to the site supervisor who shall take immediate action to remedy the situation.
- The Environmental Control Officer (ECO) shall inspect the chemical toilets regularly for proper placement and functioning.

- All employees are to undergo environmental awareness training to alert them to the impacts of their actions during construction.
- The contractor must set up a contaminated water management system, and a Method Statement for approval is required in this regard. The Method Statement must state the collection facilities that are to be used to prevent pollution, as well as the proposed method of disposal of the contaminated water.
- The Contractor must notify the CM and ECO immediately of any pollution incidents on site.
- Wash areas must be placed and constructed in such a manner so as to ensure that the surrounding areas, which include groundwater, are not polluted.
- A Method Statement is required for all wash areas where hydrocarbon, hazardous materials and pollutants are expected to be used. This includes, but is not limited to, vehicle washing, workshop wash bays, paint washing and cleaning areas.
- Wash areas for domestic use must ensure that the disposal of contaminated "grey" water is approved by CM.
- The Contractor must prevent discharge of any pollutants, such as cements, concrete, lime, chemicals and fuels into any water sources.

Using the above mentioned mitigation will ensure that the impact of solid waste pollution in the estuary is of low negative significance post mitigation, with the impact of lack of toilet facilities also being low negative significance post mitigation and so to will the impact of liquid waste pollution being of low negative significance.

Issue 3: Construction waste

Impact 3.1: Solid waste pollution in the tributary

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Short-term	1	Study area	2	Slight	1	Probably	3	7	**LOW –ve**
With mitigation	Short term	1	Localised	1	Slight	1	Unlikely	1	4	**LOW –ve**
Site B										
Without mitigation	Long-term	3	Study area	2	Severe	4	Probably	3	12	**HIGH –ve**
With mitigation	Short term	1	Localised	1	Slight	1	Unlikely	1	4	**LOW –ve**

Impact 3.2: Lack of toilet facilities

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Short	1	Study area	2	Moderate	2	Probable	3	8	**MODERATE –ve**
With mitigation	Short	1	Localised	1	Slight	1	May occur	2	6	**LOW -ve**
Site B										
Without mitigation	Short	1	Study area	2	Moderate	2	Probable	3	8	**MODERATE –ve**
With mitigation	Short	1	Localised	1	Slight	1	May occur	2	6	**LOW -ve**

Impact 3.3: Liquid waste pollution in the Tyatyora tributary

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Medium-term	2	Regional area	3	Severe	4	Definitely	4	13	**HIGH –ve**
With mitigation	Short term	1	Regional	3	Moderate	2	Unlikely	1	7	**LOW –ve**
Site B										
Without mitigation	Medium-term	2	Regional area	3	Moderate	2	Unlikely	1	8	**MODERATE–ve**
With mitigation	Short term	1	Regional	3	Moderate	2	Unlikely	1	7	**LOW –ve**

Operation phase

One issue was identified during the operation phase, this being the potential contamination of the Tyatyora and KwaNgenu tributaries and Kat River. Within these four identified impacts were:

1. Impact 4.1: Poor sewerage system management leading to ongoing inadvertent sewage leakages
2. Impact 4.2: Treated effluent discharge from the sewage treatment package into Tyatyora tributary
3. Impact 4.3: Treated effluent discharge from the sewage treatment package onto Healdtown College recreational sport fields
4. Impact 4.4: Treated effluent discharge from the sewage treatment package into rehabilitated settling ponds

The following mitigation measures are required for these impacts:

1. It is imperative that the sewerage treatment package is properly managed and maintained at all times to ensure that there are no leaks. This will involve regular maintenance and inspections. In addition to this, only SABS accredited materials should be used when building the system. In addition, water quality monitoring needs to be undertaken every alternate month to assess physio-chemical properties (such as *E.coli* levels) at point of entry of the Tyatyora tributary, downstream, midway between Healdtown and Fort Beaufort, and at Fort Beaufort.
2. Water properties for the study site need to be similar/ equivalent to that of the Kat River which remains in a natural state. Water samples from the study site need to fall within the following parameter ranges, namely: -
   - An alkaline water pH ranging from 7.6 to 8.1, reflecting the total alkalinity of the water ranging from 1.2 to 5.4 mg/L CaCO3.
   - Moderate water salinity levels, ranging from 13.3 mS/m to 64 mS/m. Nitrate and phosphate concentrations are very low (0.5mg/L NO3, 1mg/L PO4) (Everitt, 1999).
3. Studies have highlighted the presence of faecal coliforms and high nitrate concentrations near some communities (Soviti, 2001). Rigorous monitoring needs to measure for faecal coliforms and nitrate concentrations at the study site.
4. Point of discharge needs to be opposite Site B on the Fort Beaufort side of the bridge as currently there are heavy boulders and rocks lining the river basin which will accommodate discharge and will reduce erosion impacts.
5. It is imperative that the sewerage treatment package is properly managed and maintained at all times to ensure that there are no leaks. This will involve regular maintenance and inspections. It is important to ensure that the treated effluent has had repeated water quality testing to ensure that physio-chemical properties are similar to that of the natural state the water currently flowing in Kat river.

The impacts of poor sewage management on the estuary will have a high negative significance even with post mitigation; treated effluent discharge into the Tyatyora can be mitigated to high positive significance, since these impacts would have very beneficial consequences due to the current state of the Tyatyora; treated effluent discharge as an irrigation means can be mitigated to high positive significance due to very beneficial consequences, whereas effluent discharge into settling ponds will only have a low negative significance post mitigation.

Issue 4: Contamination of the Tyatyora and KwaNgenu tributaries and Kat River

Impact 4.1: Poor sewerage system management leading to ongoing inadvertent sewage leakages

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Operational phase										
Sites A and B										
Without mitigation	Long-term	3	Regional Area	3	Very	8	Probably	3	17	**V.HIGH –ve**
With mitigation	Short term	2	Study Area	2	Very	8	Unlikely	1	13	**HIGH -ve**

Impact 4.2: Treated effluent discharge from the sewage treatment package into Tyatyora tributary

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Operational phase										
Site A and B										
Without mitigation	Long-term	3	Study Area	2	Very	8	Probably	3	16	**V.HIGH –ve**
With mitigation	Long-term	3	Study Area	2	Very Beneficial	8	Probably	3	15	**HIGH +ve**

Impact 4.3: Treated effluent discharge from the sewage treatment package onto Healdtown College recreational sport fields

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Operational phase										
Site A and B										
Without mitigation	Long-term	2	Regional Area	3	Very	8	Probably	3	16	**V. HIGH –ve**
With mitigation	Short term	1	Localised Area	1	Very	8	Probably	3	13	**HIGH +ve**

Impact 4.4: Treated effluent discharge from the sewage treatment package into rehabilitated settling ponds

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Operational phase										
Site A and B										
Without mitigation	Long-term	2	Regional Area	3	Very	8	Probably	3	12	**HIGH –ve**
With mitigation	Short term	2	Regional Area	3	Slight	1	Unlikely	1	7	**LOW -ve**

Conclusions and recommendations

Should the project go ahead the following recommendations need to be implemented:

- All construction must be undertaken according to the Construction Environmental Management Plan (CEMP).
- All sensitive areas must be clearly demarcated to ensure that they are preserved
- That site A is the preferred development site,
- That treated effluent discharge can either be discharged directly into the Tyatyora tributary with point of discharge described in impact 5.2 above, or as irrigation means for Healdtown College's recreational sport fields.

The following monitoring programmes will be required:

- Ongoing water quality monitoring of the Tyatyora and KwaNgenu tributaries. This must take place monthly during the construction and operation phase of the project. This should focus on two components:
    - Leaks in the sewerage system
    - Treated effluent discharge quality
- Monitoring of the riparian and marginal zone vegetation along the edge of the Tyatyora and KwaNgenu tributaries as well as at the edge of the site to ensure that the vegetation remains intact and is acting as a filter strip between the development and the tributaries.

The following should also be undertaken if not by the municipality with the support of the developer:

- Demarcation and implementation of no go zones (possible heritage sites)

Due to the poor health status of Healdtown's aquatic ecosystem, as compared to the healthy natural state of the majority of the Kat River Valley's river systems, the consideration of a no-go alternate is strongly opposed. The construction of a sewage treatment package at either site A or site B, albeit site preference, promotes numerous positive impacts that will either increase flow gauge, decreasing eutrophic levels and benefiting immediate and surrounding biota and flora. It will also help aggrade tributary banks and promote riparian and marginal zone growth.

TABLE OF CONTENTS

LIST OF FIGURES

1 INTRODUCTION

1.1 Background information on the project

The Historic Schools Restoration Project is proposing the establishment and operation of a sewage treatment package plant (STPP) at Healdtown Comprehensive School, Fort Beaufort. Such construction will aid the management of sewage and help eliminate the health and pollution hazard posed by raw sewage entering the nearby river.

The school previously dealt with sewage by employing a system of septic tanks; and more recently a series of sewage treatment ponds situated on the property. Due to vandalism, neglect and old age, it is now necessary to construct an entirely new system at the school to manage sewage and to eliminate the health and pollution hazard posed by raw sewage entering the river. A new gravity reticulation system is proposed with sewage flowing to a convenient point for treatment in a package plant. This eliminates the need for evaporation ponds, which are unsuitable because the school is situated in a residential area. Nevertheless, the client has requested that the Aquatic study investigates the option of using evaporation ponds, despite this technology being classified as unsuitable.

There are also several options (activity alternatives) for the disposal of the treated effluent:

- Discharge into the nearby river (Option 1);
- Evaporation ponds (Option 2); or
- Irrigation of agricultural fields or sports fields using the treated effluent (Option 3). This option would require either a lined holding pond or dam to cater for emergency overflow and a reed-bed type “polishing system”. The irrigation water will be used on agricultural lands (not to fruit or vegetables that are eaten without cooking, or to sports fields where there is not normally physical contact with the ground surface (that is, a golf course but not a rugby field), or to gardens within the College grounds).

A Becon Bio-Filter RBC plant will be used to treat sewage from the college. The unit consists of a primary combined settlement tank and anaerobic digester, a secondary aerobic process consisting of the Becon Bio-Filter RBC fixed film reactor units, followed by a humus settlement tank and a disinfection tank. Figure 1-2 below illustrates the Becon Bio-Filter RBC flow process.

Two alternative sites have been proposed for the establishment of the STPP. Two locality maps below (Figures 1.1 and 1.2) show the position of site A and site B, respectively. Important to note, however, is that the current drinking water supply for the school comes from a borehole that is eastward and less than 100m from the vicinity of site B. Due to this, site A is considered the preferred location for this assessment due to the lowered risk of groundwater contamination as a result of accidental sewerage overflow/spill at this site.

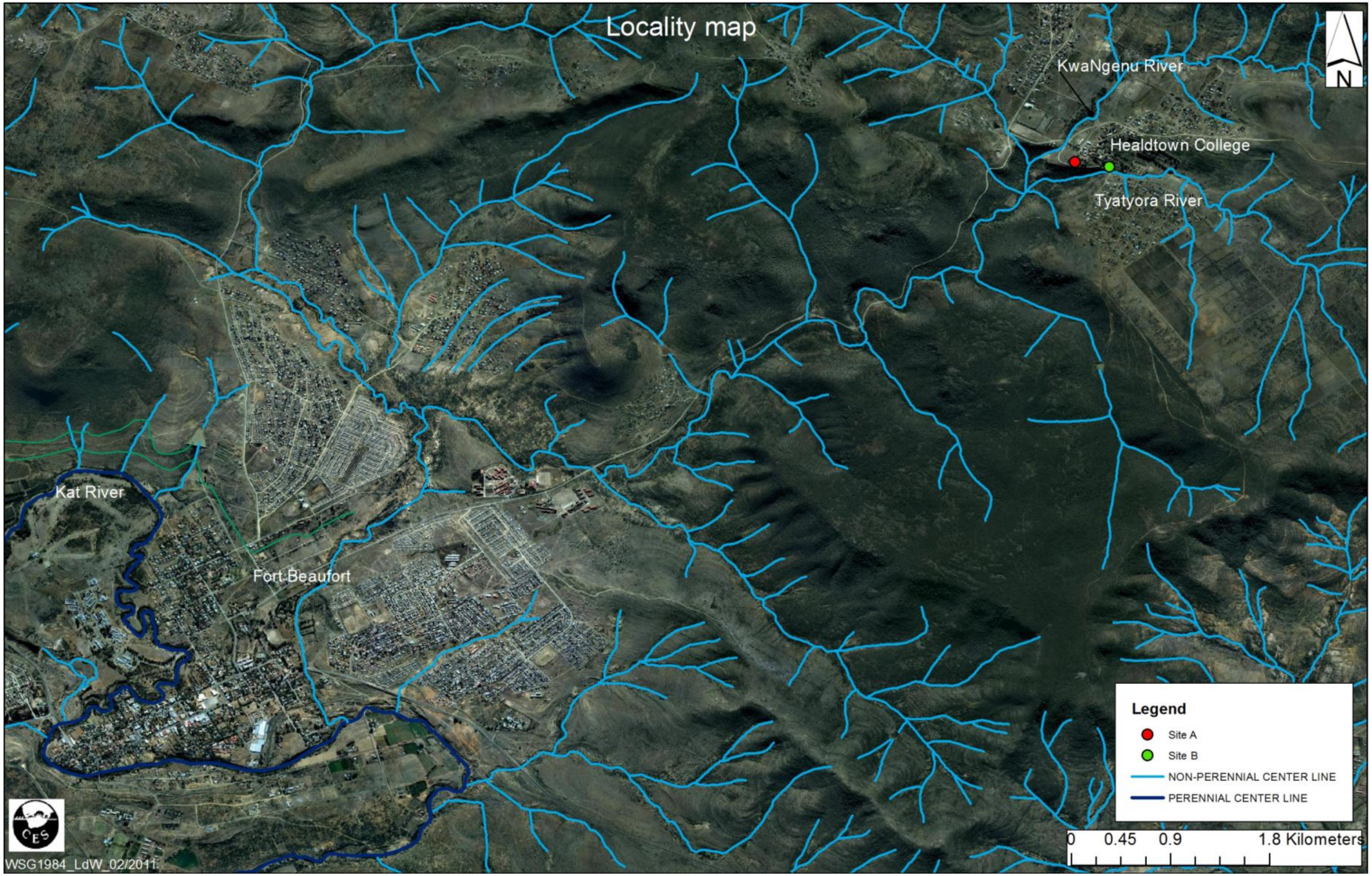

Figure 1.1: Locality map indicating the sites A and B at Healdtown Comprehensive School where the sewage treatment package plant is proposed in relation to the KwaNgenu and Tyatyora tributaries and Kat River.

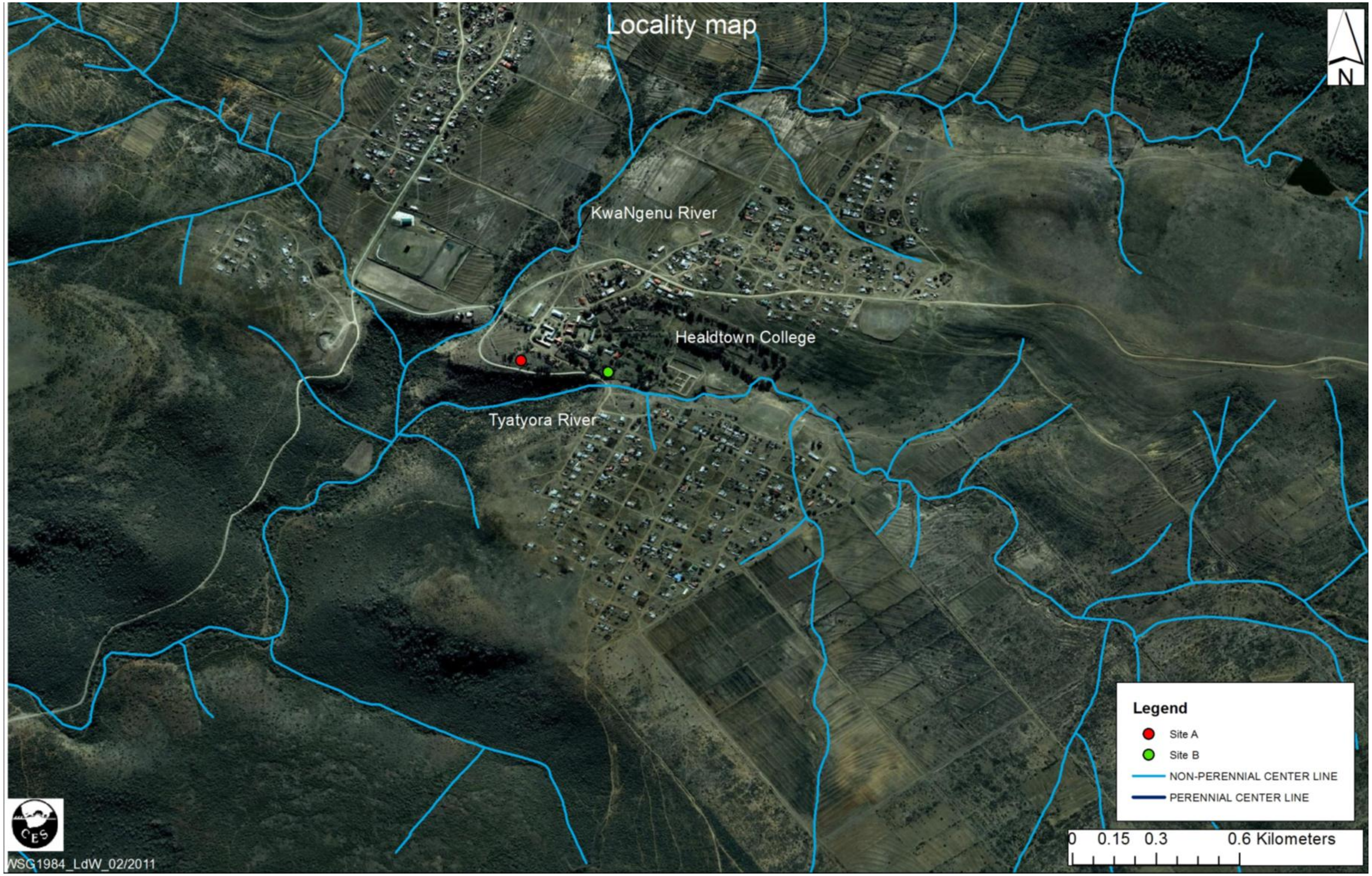

Figure 1.2: Locality plan (google image) showing Healdtown Comprehensive School in relation to where the sewage treatment package plant is proposed (Sites A and B)

1.2 Terms of reference

The assessment will determine the impacts of the proposed sewage treatment package plant at Healdtown Comprehensive School on the aquatic environment of the KwaNgenu and Tyatyora tributaries and Kat River. This study must include a site visit and review the Final Basic Assessment Report to determine the issues and concerns that are relevant to the study and address any key issues raised by interested and affected parties.

The specialist study will include but will not be limited to a site visit and desktop analysis –

- A detailed description of
    - the Kat River Catchment area within the vicinity of the proposed development including the physico-chemical characteristics:
    - the fauna and flora of the Kat River, and KwaNgenu and Tyatyora tributaries
    - the physical nature of the banks of the KwaNgenu and Tyatyora tributaries
- A discussion on the siltation and low flow patterns of the KwaNgenu and Tyatyora tributaries to see if the proposed sewage package development will have a direct effect on the Kat River and local community of Fort Beaufort.
- A discussion on the water and sanitation (sewage) requirements must include recommendations regarding the proposed system to ensure minimal impacts on the river and surrounding area.
- Identify and assess the magnitude and significance of the positive and negative impacts associated with the proposed project on nearby tributaries;
- Describe appropriate mitigation measures to minimize negative impacts or to maximize positive impacts on the river and tributaries and riparian features.
- The significance of the potential impacts and benefits must be assessed using the methodology prescribed by Coastal & Environmental Services (CES)

1.3 Details of the specialist

Hylton Newcombe – (*Aquatic specialist*)
Hylton holds a BSc degree with majors in general ecology (Zoology), Environmental Science and Ichthyology; and Honours in Ichthyology from Rhodes University and completed his MSc in Fisheries Science from Rhodes University. His Masters thesis, *The Contribution Towards the Development of a Management Plan for Tuna in South Africa* focused on quantifying and qualifying the size and shape of the tuna sport and baitboat fisheries coupled with biological research in age-growth analysis and genetics for yellowfin tuna *Thunnus albacares*. His interests are focused within a broad range of marine studies, namely biodiversity surveys, jetty EIAs, outfall EIAs, conservation plans and dredging specialist studies.

Naomi Richardson – (*Report reviewer*)
Miss Naomi Richardson is a senior environmental consultant at Coastal and Environmental Services (CES) and is an estuarine specialist who studied at undergraduate level in Southampton University, England. During these studies she completed an honours project on the fish community of the Solent Estuary. Naomi subsequently completed an Honours course at the Department of Ichthyology and Fisheries Science at Rhodes University (South Africa), where her research project dealt with the assessment of the fish community of the Kariega estuary. She has also completed an MSc at Rhodes which investigated the use of estuarine fish biomarkers in temporarily open/closed estuaries as indicators of anthropogenic pollution. Since joining CES in 2008 she has worked on a number of freshwater, estuarine and marine studies.

2 LEGISLATION

2.1 Introduction

This chapter outlines the requirements of national legislation that is relevant and applicable to the Kat River and KwaNgenu and Tyatyora tributaries. The provisions of the National Environmental Management Act (1998) are not repeated here, since details of the activities that are triggered by the development, and are contained in the Basic Environmental Assessment Report.

The National Water Act (36 of 1998) has the most relevance to this specialist report, and is therefore elaborated in some detail. Other relevant legislation is presented in a more brief format.

2.2 The National Water Act (36 of 1998)

The Act is of general application throughout South Africa. All relevant provisions therefore apply to the Kat River catchment area.

The management of water resources is a residual legislative competence of the National Government in terms of the Constitution. There are no provisions for delegating or assigning any powers or duties in respect of the management of water resources to the provincial or local spheres of government. These spheres of government do, however, have obligations in terms of the Act, particularly local government, since local authorities are major users of water to meet their constitutional mandate to provide water services to consumers in their areas of jurisdiction.

The relevant sections of the Act are detailed below:

Chapter 1 (Definitions)

Section1 finds applicable and defines the following :

- (iii) "**catchment"**, in relation to a watercourse or watercourses or part of a watercourse, means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points;
- (xxi) "**riparian habitat**" includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas;
- (xxv) "**water management area**" is an area established as a management unit in the national water resource strategy within which a catchment management agency will conduct the protection, use, development, conservation, management and control of water resources;
- (xxiv) "**watercourse**" means -
  - (a) a river or spring;
  - (b) a natural channel in which water flows regularly or intermittently

Chapter 4 (Use of water)

Water use, as defined in the Act (Section 21) includes:

a. Taking water from a water resource;
b. Storing water;
c. Impeding or diverting the flow of water in a watercourse;
d. Engaging in a stream flow reduction activity contemplated in section 36;
e. Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);

f. Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
g. Disposing of waste [1] in a manner which may detrimentally impact on a water resource;
h. Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
i. Altering the bed, banks, course or characteristics of a watercourse;
j. Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
k. Using water for recreational purposes.

Sub-sections (a), (e) (f),(g), (h), (i) and (k) relate to activities that could directly impact on the KwaNgenu and Tyatyora tributaries and Kat River are self-explanatory, whilst (b), (c), (d) and (j) could relate to indirect human impacts affecting a river and or tributary (respectively, recharging an aquifer, with waste or water containing waste - all of which can affect the quantity and quality of the water in the river and or tributary).

Chapter 4, Part 5 (Controlled activities)

This Part allows the Minister to regulate activities having a detrimental impact on water resources by declaring them to be controlled activities. Four such activities, irrigation using waste or water containing waste from certain sources - modification of atmospheric precipitation, altering the flow regime of a water resource as a result of power generation, and aquifer recharge using waste or water containing waste - are identified in the Act as controlled activities. Provision is made for the Minister to declare other controlled activities as the need arises, but in these cases public consultation is required. Following the identification or declaration of a controlled activity an authorisation for that particular category of activity is required under this Act.

Section 37(1) The following are controlled activities:

(a) irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterwork;
(b) an activity aimed at the modification of atmospheric precipitation;
(c) a power generation activity which alters the flow regime of a water resource;
(d) intentional recharging of an aquifer with any waste or water containing waste; and
(e) an activity which has been declared as such under section 38.

Section 37 (2) No person may undertake a controlled activity unless such person is authorised to do so by or under this Act.

Chapter 4, Part 6 (General Authorisations)

The Department of Water and Environmental Affairs has established geographically-differentiated general authorisations (GA) [2] in terms of Section 21, which covers water use as follows –

a. *Controlled activity - Irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterwork (s21(e))*
   In addition to detailed requirements in respect of the physico-chemical characteristics of the waste, and general requirements for the activity not to impact on a water resource or any other person's water use, property or land; and not to be detrimental to the health and safety of the public in the vicinity of the activity, irrigation may not take place within less than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering, whichever is further; or on land that overlies a Major Aquifer.

[1] Note that "waste" includes sediment in terms of the definition in s1(xxiii)

[2] The use of water under a general authorisation does not require a licence until the general authorisation is revoked, in which case licensing will be necessary. A general authorisation may be restricted to a particular water resource, a particular category of persons, a defined geographical area or a period of time.

b. *Discharge of waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit (s21(f)),* and
c. *Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process (s21(h))*
   i. The GA specifies the physico-chemical characteristics of the waste and volumetric limits for the discharge, beyond which a licence is required.
   ii. There is a general requirement for the activity not to impact on a water resource or any other person's water use, property or land; and not to be detrimental to the health and safety of the public in the vicinity of the activity.
   iii. The GA specifically excludes complex industrial wastewater.
   iv. The GA specifically prohibits any person from discharging stormwater runoff from any premises containing waste, or water containing waste emanating from industrial activities and premises, into a water resource.
d. *Disposing of waste in a manner which may detrimentally impact on a water resource (s21(g))*
   i. The GA deals with the storage of domestic and/or biodegradable industrial wastewater for the purpose of re-use or disposal.
   ii. It establishes volumetric limits for storage and disposal, beyond which a licence is required.
   iii. There is a general requirement for the activity not to impact on a water resource or any other person's water use, property or land; and not to be detrimental to the health and safety of the public in the vicinity of the activity.
   iv. The GA limits the disposal onto land of stormwater, to stormwater runoff from any premises not containing waste or wastewater from industrial activities and premises.
   v. Wastewater storage dams and wastewater disposal sites must be located: outside of a watercourse; above the 100 year flood line, or alternatively, more than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering, whichever is further; and on land that does not overlie, a Major Aquifer.
e. *Impeding or diverting the flow of water in a watercourse (s21c)*
   This GA has been substantially revised since its original publication in 1999; a new GA was published in December 2009 in Government Notice 1199. It is generally applicable throughout the country, except for certain specified areas, none of which include the Kat River or its tributaries.
f. *Altering the bed, banks or characteristics of a watercourse (s21(i))*
   This GA has been substantially revised since its original publication in 1999; a new GA was published in December 2009 in Government Notice 1199. It is generally applicable throughout the country, except for certain specified areas.

   In the GA "altering the bed, banks, course or characteristics of a watercourse" means any change affecting the resource quality within the riparian habitat. It is important to note that the GA does not mean that developments that may alter the bed, banks or characteristics of a watercourse. It does mean that such developments may not be authorised in terms of the GA, and will require a water use licence.

All the above require the water use to be registered with DWAF, and all require some form of monitoring programme to be implemented, and may require information on the water use to be submitted to DWAF at regular intervals.

Regulations in terms of the NWA

- Regulations requiring that a water use be registered (Sections 26 and 69), Government Notice No.R.1352, 12th November 1999.

This is relevant only in a general sense, in that the registration process was intended to identify all water users (in terms of abstraction of water and, to a limited extent, some aspects of waste discharge), and the nature and extent of their use.

Registration was the first step towards general (compulsory) licensing of all water use, one of the main prerequisites for achieving equitable and sustainable water use.

- Draft Regulations for the use of water for recreational purposes generally and in respect of a government waterworks and surrounding state-owned land, Government Gazette 29413, Notice 1188, 1st December 2006[3]. This refers to Section 21 (k) of the Act - using water for recreational purposes. The regulations are intended to regulate the recreational use of all water resources, in particular government waterworks (dams).

There is a general provision that the water use does not detrimentally impact any other water use, and that the water use is not harmful or potentially harmful to human health and safety or the water resource and the associated ecosystem.

Other provisions include the requirement to register such uses in terms of Government Notice R 1352, and adherence to precautionary practices in respect of, inter alia: general safety on the water; prevention of scour, erosion and sedimentation; compliance with reservations of areas for specific purposes; damage to or removal of riparian indigenous vegetation; and lawful disposal of waste.

An operational plan, to be approved by the responsible authority, must be prepared for high impact and commercial uses, but only when the user is notified in writing by the responsible authority [4] to do so.

Note: DWA's Draft Regulations for the use of water for recreational purposes are currently being scrutinised by the State Law Adviser, who is of the opinion that they cannot be made for water resources other than government waterworks in terms of the National Water Act.

2.3 The Conservation of Agricultural Resources Act (43 of 1983)

The Conservation of Agricultural Resources Act (43 of 1983) embodies two aspects that contribute to the maintenance of the ecological character of the river and tributary. It requires the maintenance of riparian vegetation (thereby providing a migratory corridor for fauna), and provides a list of invasive alien vegetation that must be controlled or eradicated (thereby reducing the effects of such vegetation on surface water runoff into the river/tributary).

2.4 The National Environmental Management: Biodiversity Act (10 of 2004)

The National Environmental Management: Biodiversity Act (10 of 2004) provides for the conservation of biological diversity, regulates the sustainable use of biological resources and ensures a fair and equitable sharing of the benefits arising from the use of genetic resources. Since the estuary is a protected area, biodiversity within the estuary is protected and conserved.

[3] In addition to the Draft regulations, there is a range of policy documents relating to recreational use on DWAF's website – www.dwaf.gov/za, Documents, Water-related Policy: Using water for recreational purposes - Recreational Water Use Manual, October 2007 (second release)

[4] The Department of Water and Environmental Affairs or, when the duty is delegated or assigned to it, the relevant catchment management agency.

3 DESCRIPTION OF THE KAT RIVER AND KWANGENU AND TYATYORA TRIBUTARIES

3.1 Introduction

The Kat River Valley catchment includes the urban municipalities of Seymour and Fort Beaufort and many smaller communities and villages. In addition, the catchment includes extensive, privately owned citrus estates, some of which have environmental management systems that have been certified to international standards (ISO14001).Forty percent of the catchment's population (estimated to be approximately 50 000 people (2001 figures)) live in Fort Beaufort, located in the middle of the catchment. The remaining population lives on farms or within some 65 villages with populations ranging from 50 to 2500 persons (Birkholz 2007). An increasing number of villages are being supplied with tap water (as stand pipes), but many people still rely on the river as their main water source.

Many of South Africa's major rivers flow through former homeland areas. In these areas degradation of riparian zones are both a socio-economic concern and a widespread cause of perceived low ecological integrity. Rural areas in the former homelands are characterised by dense settlement and environmental stress. These areas lack electricity and water supply infrastructure and are characterised by high levels of illiteracy, low human development indices and economic dependency on livestock grazed on communal lands and government transfers in the form of pensions. The communities in these areas are marginalised both politically and economically (Motteux & Rowntree, 1999a).

The main problems observed in these riverine and water resources can be summarised as follows:

- **an impaired riparian zone** due to the removal of riparian vegetation for fuel wood collection and grazing;
- **deteriorating water quality** due to the common presence of livestock in the water, in-stream bathing, laundry, run-off from pit latrines and degraded grazing lands;
- **high catchment sediment yields** in most catchment areas due to dirt roads and unsustainable land use practices lead to gully and sheet erosion; and
- **flow regulations** that are designed to meet the needs of upstream and downstream irritators (Motteux & Rowntree, 1999a).

This chapter details the Kat River and its surrounding tributaries, with particular emphasis on KwaNgenu and Tyatyora from an abiotic and biotic perspective. An assessment of the impacts of the proposed development and its alternatives is presented in Chapter 5.

3.2 Physical characteristics

3.2.1 Catchment area

The Kat River Valley forms part of the proposed Catchment Management Agency CMA[5] (CMA) of the Fish to Tsitsikamma Water Management Area (WMA)[6] (DWAF 1999). The Kat River is roughly

[5] CMA are described in the National Water Act News as "statutory bodies established under Chapter 7 of the Act. They are governed by a Board representing broad stakeholder groups together with experts and must seek cooperation and agreement on water-related matters from various stakeholders and interested persons" (1999, p.1).
6 The National Water Act News explains that "South Africa has been divided into 19 Water Management Areas (WMA) as part of the development of the National Water Resource Strategy. The Act provides for the establishment of a CMA in each Water Management Area" (1999, p.1).

80km in length (Motteux 2001) and has a catchment area of 1716 km^2 and an altitudinal range from 1800 to 300 m amsl that is mirrored by the mean annual precipitation and runoff. The Kat River has the boundaries defined by the Kroomieberg in the west, the Katberg mountains and the Ndidima range in the north west, the Elandsberg mountains in the north east, and the Menziesberg and Juannasberg in the east (Motteux & McMaster, 2001). The Kat River valley climate can be described as mild with summer temperatures ranging between 20 and 35 degrees Celsius, and winter temperatures ranging between freezing and 20 degrees Celsius (Magni, 1999). According to Midgely et al. (1994), the headwater catchments receive a mean annual precipitation of between 700 and 800 mm, which translates into a mean annual runoff of 70 to 90 mm. The lower catchment receives a mean annual precipitation of 482 mm, translating to a mean annual runoff of only 11 mm. The middle and lower catchment therefore rely heavily on river water for irrigated agriculture.

3.2.2 Kat River and surrounding tributaries

The condition of the Kat River has been significantly modified and has signs of deterioration. The Kat River can be described as a work horse river. The tributaries of the Kat River were recognised as having unreliable flows (Logie, 1997).

The headwaters of the Kat River system are the Elands River, the Eyre Stream, the Lushington River and the Wellsdale Stream, all of which meet in the Kat Dam. The main tributaries of the Kat include the Readsdale and Fairbairn, Balfour, Buxton, Blinkwater and Xuxuwa rivers, which rise in the west, and the Hertzog and Tamboekiesvlei and Mankazana rivers which rise in the east. The coordinates of the confluence of the Kat River with the Fish River at the south of the catchment are 26,78 degrees east and 33,00 degrees south (Motteux & McMaster, 2001).

3.2.3 Geomorphological setting

Agricultural and livestock land uses are the major influences on the geomorphology of the Kat River and surrounding tributaries. In addition, the Kat River Dam situated at Seymour influences flow regimes. These land uses impact on the condition of riverbanks by enhancing erosion through intensive trampling and grazing by cattle and goats removing riparian vegetataion. Flow modification caused by the construction of weirs and causeways also contributes to the deterioration of the geomorphological condition of the Kat River which, in turn, impacts on the ecological health of the river. Alien vegetation along tributaries has also had a significant effect on channel morphology and sediment loading.

At the KwaNgenu, there is evidence of bed aggradation where invasive *Acacia karoo* has stabilised the channel negatively contributing to reduced flow (Figure 3.1). However, the Tyatyora suffers from the removal of riparian vegetation caused by local community location and livestock activity in the immediate vicinity of the settling ponds which explains the presence of bank erosion and incision at this site (Figure 3.2a and Figure 3.2b).

Figure 3.1 High abundance of acacia karoo overgrowing the banks of the KwaNgenu

Figure 3.2a Local community bordering the banks of the Tyatyora and visible footpaths accessing the tributary.

Figure 3.2b Clear evidence of bank erosion caused by the lack of riparian vegetation and the frequent trampling by accessing livestock.

3.2.4 Fish and invertebrates of the Kat River and KwaNgenu and Tyatyora tributaries

The biological integrity of the Kat River has been severely modified. The JLB Smith Institute of Ichthyology collection shows that seven species of fish have been collected from the Kat River system. The species include the chubbyhead barb (*Barbus anoplus*), moggel (*Labeo umbratus*), Largemouth Bass (*Micropterus salmoides*), Banded tilapia (*Tilapia sparrmanii*), Cape kurper (*Sandilia capensis*), the Eastern Cape Rocky (*Sandilia bainsii*) and Redbreast tilapia (*Tilapia rendalli*).

Recent bio-monitoring studies in the Kat River (Everitt, 1999) identified Chubbyhead barb (*Barbus anoplus*) and Redbreast tilapia (*Tilapia rendalli*) at various sites. *B.anoplus* prefers cool waters and is associated with marginal vegetation or cover provided by fallen logs. They feed on zooplankton, insects, seeds, green algae and diatoms. *T.rendalli* tolerates a wide range of temperatures (11^{o} – 37^{o} C) and salinity to 19ppt. It is found in quiet, well-vegetated water along riverbanks where it feeds primarily on water plants and algae, but it may also feed on invertebrates and small fish. The presence of these fish implies that the river is seriously modified, with lower flows and higher nutrient induced algal populations than normal.

Most invertebrates found in the Kat River fall into the more tolerant class groups – those scoring between 5 and 8 (SASS4) were more dominant than those scoring between 1 and 4 (Figure 3.3) (Everitt 1999).

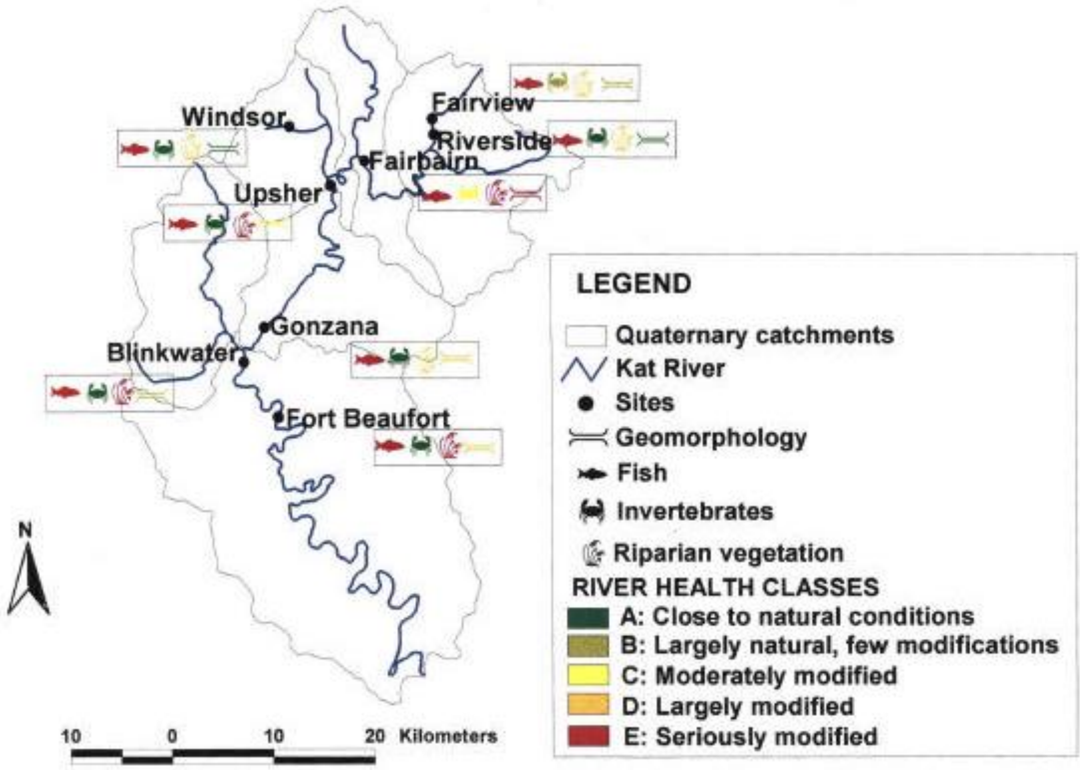

Figure 3.3 Location and Health of Kat River Valley catchment area (Everitt 1999).

The mayfly *Leptophlebiidae* was found in all reaches of the river, suggesting that while water pollution is minimal, habitat diversity is poor. This does result in the more tolerant families being dominant, however not to the exclusion of the more sensitive (Everitt, 1999). Even though the majority of the length of the Kat River has minimal pollution, the Tyatyora (Figure 3.4a) and KwaNgenu (Figure 3.4b) tributaries at Healdtown College has severe nutrient loading from high pollution levels and waste. These high levels are described by severe algal growth and visible waste scattered along the degraded banks. Little to no marginal and riparian vegetation (Tyatyora tributary) would reduce the diversity of habitats for invertebrates, which would result in low SASS4 scores.

Figure 3.4a Signs of high levels of pollution and waste within the Tyatyora tributary

Figure 3.4b Signs of high levels of algal growth within the KwaNgenu tributary.

3.2.5 Riparian vegetation

Riparian vegetation – in all reaches of the Kat River – has been seriously modified as indicated by Riverine Vegetation Index scores of 6.4 to 8.9 (Kemper, 1999; Everitt, 1999). In most cases, degraded riparian vegetation can be attributed to the influence of the surrounding land use, in particular cultivation and livestock. A high degree of invasion of the riparian zone by terrestrial tree species is also evident in all reaches of the river, and by the lower reaches of the Tyatyora (Figure 3.5).

Figure 3.5 A high degree of invasion of the riparian zone by terrestrial tree species is also evident along the lower reaches of the Tyatyora

Little or no marginal vegetation is present at most sites. This can be attributed to the general lack or absence of the finer sediment needed for the establishment of species appropriate to the water's edge, for example, sedges and reeds.

3.2.6 Water quality

Although land use impacts on the riverine habitat have resulted in modification to the riverine vegetation and geomorphology, water quality along the Kat River appears natural. Water quality analysis (Motteux 2002) revealed that there were no high concentrations of nutrients, and modified SASS4 scores suggested that water quality was natural in all reaches of the river. However at the Tyatyora, there were high concentrations of nutrients as described by the prolific growth of algae in pools resultant of severe pollution and waste from nearby communities and faecal matter from free-roaming livestock. Sovitis' (2001) study highlights the presence of faecal coliforms and high nitrate concentrations associated with nearby communities (Soviti, 2001). However the water quality near Fort Beaufort was scored as being in natural state (Motteux 2002).

3.3 Historic importance of the Tyatyora tributary

The presence of the Tyatyora tributary played a crucial role in the establishment of Healdtown College. Such importance is emphasised by the writings within the Healdtown Centenary 1955 booklet:-

The story of the Healdtown begins with a spring of living water upon a hill: 'When I was in search of a site for the station, I took an old 'Black African' with me who knew the country well, to assist in selecting a spot where there should be abundance of water. A stranger cannot judge of this in such a country, and it is worse than folly to select a site for a station, and lay out a large sum of money, where there is not a permanent and abundant supply of good water. This has not always been *attended to. The 'Black African' took me past several very likely looking fountains, and such a stranger would probably have chosen. We at length came to one apparently not so good, and not sending forth such a stream as a neighbouring one was doing. He stood over the fountain, and said, 'This is the fountain. This does not die. It does not hear the rain'. It was not a mere surface spring, flowing only after rain, but its source was in the deep rock, and not affected by slight changes of weather, but when most required apparently abundant. I was struck with the expression, 'It does not hear rain'. We sat down and drank of the fountain, while I guided his mind to the blessed Fountain that never dies and never changes, which is opened to the house of David and to the inhabitants of Jerusalem, for sin and for uncleanness'. 'That was the site of my station, which became known as Birklands'.*

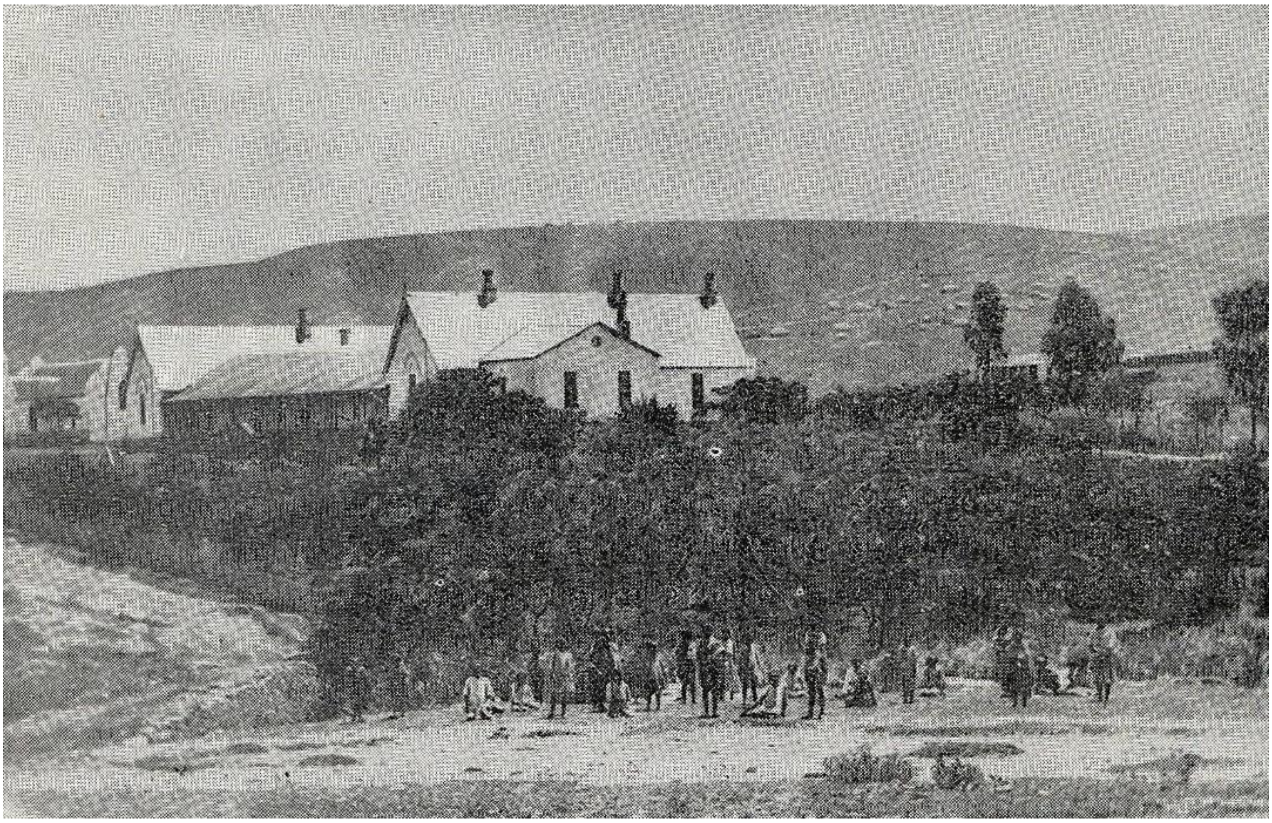

Figure 3.6 Healdtown in 1867 indicating the position of the Tyatyora tributary

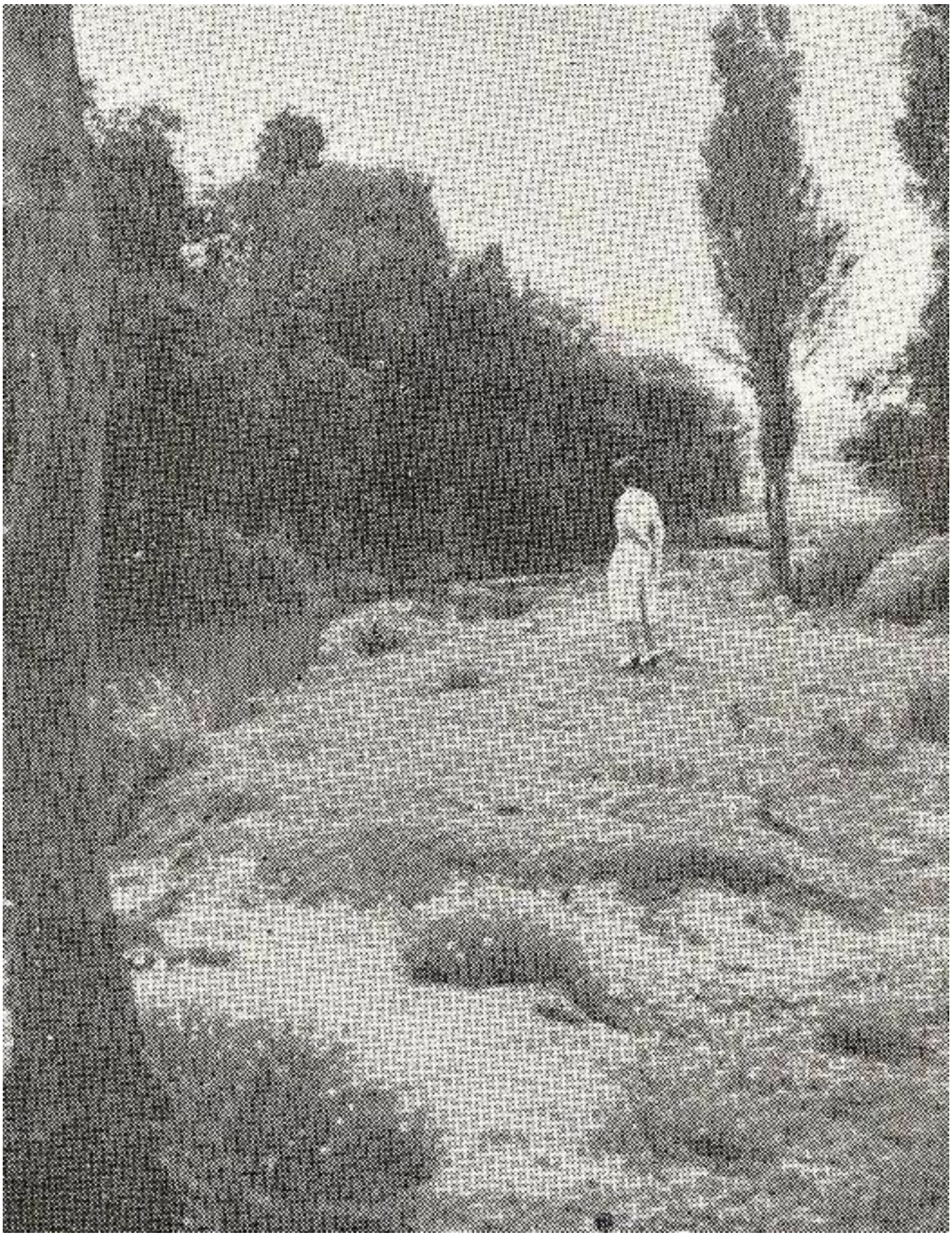

Figure 3.7 The Tyatyora tributary

4 IMPACT ASSESSMENT

4.1 Introduction

The proposed development has the potential to impact on both the KwaNgenu and Tyatyora tributaries and Kat River during the construction and operation phases. This chapter will systematically analyse issues associated with different stages of the proposed development and provide measures by which the impacts can be avoided, and if this is not possible, mitigation measures to minimise negative impacts associated with these will be provided. All positive impacts identified will be enhanced as far as possible.

The direct impacts associated with the proposed development are assessed first, followed by the indirect impacts, and finally cumulative impacts are discussed. These are assessed in terms of the construction and operation phases.

4.2 Construction phase

The construction of the residential units and associated infrastructure will necessitate the clearing of land. Exposed soils can result in a number of impacts such as erosion and loss of topsoil. Eroded material can be transported from the site via surface water runoff into the estuary and cause sedimentation.

4.2.1 Issue 1: Land clearing for construction

Impact 1.1: Increased erosion

Cause and Comment

Vegetation clearing results in the soils on the land becoming more prone to erosion. This is because there are less structures within the soils, such as root systems (which "bind' the soil) and plant cover (which reduces raindrop impact on bare soil). This can lead to excessive erosion. A secondary impact linked to this is the loss of topsoil. Topsoil is critical to successful plant growth and must be conserved at all times. It consists of the O and A horizons, which contain the large proportion of nutrients required for plant establishment. Once lost, topsoils are extremely difficult to restore.

Mitigation Measures

- The sewage treatment package will be required to have some ground slope to facilitate drainage. Where the slope encountered is steeper than 2%, then increased cross-slope interceptor drains should be installed to avoid erosion, and these may need to be sub-surface drains.
- Ensure that a network of co-ordinated shallow drains are constructed during the land clearing phase
- Filter strips (grass buffer strips) must be implemented wherever possible but as a minimum around the edge of the entire development footprint as soon as construction is initiated.
- Ensure that site infrastructure such as buildings and fences are aligned with the natural drainage lines to minimise additional erosion
- Topsoil must be stockpiled and used for rehabilitation purposes. Any soil excavated and not utilised for rehabilitation must be removed from site and no large mounds of soil should be left behind after construction. If the unutilised soil is not excessive in quantity, it may be carefully spread within the environs, in particular, aggrade the Tyatyora banks opposite the settling ponds
- Soils must not be left bare for long periods of time, and areas should only be cleared just prior to construction to avoid excessive erosion
- No soil must be left exposed. It must be covered with mulch or vegetated.

- Any gardening and landscaping should consider planting plants at a right angle to the drainage lines to slow water velocities down and decrease erosion where possible.
- The sewage treatment package and related infrastructure must be designed in such a way that they do not concentrate flowing water (in other words that they consider the natural drainage of the site).

Significance Statement (Site A)

The impact of increasing erosion in the study area will probably have a medium-term severe impact on the Tyatyora tribuatary. This will be a MODERATE significant impact.

The implementation of all the mitigation measures listed above will decrease the severity of this impact to slight, resulting in an impact of LOW significance.

Significance Statement (Site B)

The impact of increasing erosion in the study area will probably have a short-term severe impact on the Tyatyora tributary due to its close proximity. This will be a MODERATE significant impact.

The implementation of all the mitigation measures listed above will decrease the severity of this impact to slight, aided by high vegetation cover, resulting in an impact of LOW significance.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Medium term	2	Study	2	Severe	4	Probable	3	11	**MODERATE -ve**
With mitigation	Short term	1	Study	2	Slight	1	May occur	2	6	**LOW -ve**
Site B										
Without mitigation	Short term	1	Study	2	Severe	4	Probable	3	10	**MODERATE -ve**
With mitigation	Short term	1	Study	2	Slight	1	May occur	2	6	**LOW -ve**

Impact 1.2: Increased sedimentation

Cause and Comment

This impact is directly related to Impact 1.1. Increased erosion will lead to increased sedimentation. Sedimentation can have severe negative impacts on surrounding aquatic environments including increased turbidity (which decreases light penetration into water thereby reducing photosynthetic activities in the water column), reduced oxygen concentration in the water column and benthic environment, smothering of benthic biota resulting in loss of food, smothering of spawning beds. This can have severe long term negative impacts on aquatic habitats. However sedimentation can also have a positive impact, providing the finer sediment needed for the establishment of riparian vegetation.

Mitigation Measures

The mitigations mentioned for Impact 1.1 should reduce the likelihood of this impact; however, in addition to those mitigations listed, the following actions should also be undertaken:

- Maintain maximum vegetation cover outside the built areas, particularly in marginal and riparian areas, to act as silt traps, site B in particular

- Ensure that all drainage lines are vegetated and not impeded.

All the vegetation along Tyatyora's edge must be kept intact because:
- The vegetation strip will act as a sediment trap.
- The vegetation strip will maintain the ecological functioning of the riparian areas during the operation phase at site B

Therefore, although this impact is linked to construction, the mitigation measures will be applicable to the operation phase.

Significance Statement (Site A)

The impact of sedimentation as a result of erosion issues will likely result in slight long term negative impacts in the Tyatyora tributary. This will be a MODERATE significant impact.

The mitigation measures that have been recommended will ensure that sedimentation is reduced to a minimum. This will probably result in short term, slight localised impacts that will be of LOW significance.

Significance Statement (Site B)

The impact of sedimentation as a result of erosion issues will definitely result in slight long term positive impacts in the Tyatyora tributary. This will be a MODERATE significant impact.

The mitigation measures that have been recommended will ensure that sedimentation is reduced to a minimum. This will probably result in short term, slight localised impacts that will be of LOW significance.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Long-term	3	Study area	2	Slight	1	Probably	3	8	**MODERATE –ve**
With mitigation	Short term	1	Localised	1	Slight	1	Probably	3	6	**LOW –ve**
Site B										
Without mitigation	Long-term	3	Study area	2	Slight	1	Probably	3	9	**MODERATE –ve**
With mitigation	Short term	1	Localised	1	Slight	2	Probably	3	7	**LOW –ve**

4.2.2 Issue 2: Contamination of soils

Impact 2.1: Contamination of soils

Cause and Comment

Construction activities could lead to the contamination of soils, for example by accidentally spilling hydrocarbons or heavy metals. These could contaminate the soil and subsequently be washed into the tributary. The accumulation of oils and other pollutants as a result of inappropriate location of vehicle parking and servicing areas can result in accumulation in soil and pollution of ground and surface water.

Mitigation Measures

All construction must be undertaken according to the Construction Environmental Management Plan (CEMP). Details regarding the management of vehicles and an emergency response plan for accidental spillages of hazardous chemicals should be prepared. This will ensure that all hazardous chemicals are contained within specifically demarcated areas and these will be lined to avoid any contamination. All hazardous materials will be properly disposed of, thereby eliminating any potential environmental hazards that these could pose.

The following mitigation measures can be used to minimise the effects of hazardous substance leaks onto soil:

- Hazardous chemical substances used during construction must be stored in secondary containers (container within a container), and in a secure area in terms of the Material Safety Data Sheets (MSDS)
- The relevant MSDS must be available on site. Procedures detailed in the MSDS must be followed in the event of an emergency situation
- If potentially hazardous substances are to be stored on site, the Contractor must provide a Method Statement to the Construction Manager (CM) or Environmental Control Officer (ECO), detailing the substances/materials to be used, together with the storage, handling and disposal procedures of the materials
- No paint products may be disposed of on site and brush/roller wash facilities must be established to the satisfaction of the CM
- Oil-based paints and chemical additives and cleaners such as thinners and turpentine must be strictly controlled. A Method Statement detailing storage and cleaning must be submitted to and approved by the CM and ECO
- Roads and parking area surfaces will be on surfaces with no gradient, to prevent/ reduce runoff. Sufficient stormwater take-off points must be created in such a way that water does not have an opportunity to gather momentum. Stormwater ditches must contain structures that will reduce velocity of the runoff
- Vehicles must be serviced and maintained to minimise the risks of leakages of hydrocarbons and other pollutants, by sing drip trays.
- Storage areas that contain hazardous substances such as oil and other pollutants must be bunded with an approved impermeable liner.
- A designated, bunded area should be set aside for vehicle washing and maintenance.

Significance statement (Site A)

The impact of soil contamination during construction activities would probably have moderate negative impacts in the long term. This would affect the study area and would be of HIGH significance.

With mitigation, this impact may have slight impacts in the short term and would affect the local area. This impact is of LOW significance.

Significance statement (Site B)

The impact of soil contamination during construction activities would probably have severe negative impacts in the long term. This would affect the study area and would be of HIGH significance.

With mitigation, this impact may have slight impacts in the short term and would affect the local area. This impact is of LOW significance.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Long-term	3	Study area	2	Moderate	2	Probably	3	10	**MODERATE –ve**
With mitigation	Short term	1	Localised	1	Slight	1	May occur	2	5	**LOW –ve**
Site B										
Without mitigation	Long-term	3	Study area	2	Severe	4	Probably	3	12	**HIGH –ve**
With mitigation	Short term	1	Localised	1	Slight	1	May occur	2	5	**LOW –ve**

4.2.3 Issue 3: Construction waste

Impact 3.1 Solid waste pollution in the tributaries Tyatyora and KwaNegenu

Cause and Comment

Site B is currently vegetated, and tree stumps and other vegetation will need to be removed from the site. This waste could potentially pose a threat to the aquatic environment if it is not handled correctly (for example if it is dumped into other remaining riparian areas or into the Tyatyora itself).

Care must be taken when clearing the site to ensure that the vegetation is not allowed to enter the Tyatyora tributary as this could restrict flow, increasing sedimentation and negatively impact on river bank stability.

Mitigation Measures

Follow all recommendations provided in the CEMP regarding the rescue of any species and the use of the cleared vegetation for site rehabilitation once the construction is completed. All other cleared vegetation must be removed from the site and transported to a suitable disposal site (for example a municipal composting facility).

Significance Statement (Site A)

As solid waste is minimal, the impact of solid waste pollution in the aquatic environment will probably result in slight short term negative impacts in the Tyatyora. Bank erosion and sediment loading will result in a MODERATE significant impact.

The recommended mitigation measures will ensure that the probability of the impact occurring are reduced to a minimum. This will probably result in short-term, slight localised impacts that will be of LOW significance.

Significance Statement (Site B)

As vegetative cover is high, the impact of solid waste pollution in the aquatic environment will probably result in severe long term negative impacts in the Tyatyora tributary. Bank erosion and sediment loading will result in a HIGHLY significant impact.

The recommended mitigation measures will ensure that the probability of the impact occurring are reduced to a minimum. This will probably result in short-term, slightly severe localised impacts that will be of LOW significance.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Short-term	1	Study area	2	Slight	1	Probably	3	7	**LOW –ve**
With mitigation	Short term	1	Localised	1	Slight	1	Unlikely	1	4	**LOW –ve**
Site B										
Without mitigation	Long-term	3	Study area	2	Severe	4	Probably	3	12	**HIGH –ve**
With mitigation	Short term	1	Localised	1	Slight	1	Unlikely	1	4	**LOW –ve**

Impact 3.2: Lack of appropriate toilet facilities for construction workers

Cause and Comment

The lack of appropriate toilet facilities for construction workers and inappropriate placement of latrines (i.e. near the tributary) can result in human waste contamination of rivers and site. The environmental impact of this occurring is determined to be **low** negative with mitigation.

If nothing were built on the site, the environmental significance would be a **low** negative.

Mitigation and Management

The following mitigation measures can be used to minimise the effects of this impact:

- Chemical toilets shall be provided for all construction workers for the duration of the construction phase.
- Chemical toilets shall be kept in a hygienic and sanitary condition, supplied with toilet paper and be emptied regularly by an approved sub-contractor.
- Chemical toilets shall be placed as far as possible from the estuary on level ground to prevent them falling over in high wind conditions. Alternatively, the chemical toilets must be secured to the ground with guy ropes or similar. The toilets shall be placed on an impermeable surface.
- All leaks and spills from the chemical toilets shall be reported to the site supervisor who shall take immediate action to remedy the situation.
- The Environmental Control Officer (ECO) shall inspect the chemical toilets regularly for proper placement and functioning.
- All employees are to undergo environmental awareness training to alert them to the impacts of their actions during construction.

Significance statement without mitigation (Sites A and B)

The impact of lack of appropriate toilet facilities on the environment will probably have *moderate* short term negative impacts. This would affect the *study area* and would be of MODERATE negative significance.

Significance statement with mitigation (Sites A and B)

The impact of lack of appropriate toilet facilities on the environment may have *slight* short term negative impacts. This would affect the *local area* and would be of LOW negative significance.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Short	1	Study area	2	Moderate	2	Probable	3	8	**MODERATE –ve**
With mitigation	Short	1	Localised	1	Slight	1	May occur	2	6	**LOW -ve**
Site B										
Without mitigation	Short	1	Study area	2	Moderate	2	Probable	3	8	**MODERATE –ve**
With mitigation	Short	1	Localised	1	Slight	1	May occur	2	6	**LOW -ve**

Impact 3.3: Liquid waste pollution in the Tyatyora tributary

Cause and Comment

Liquid pollution during the construction phase can have many sources and will generally be a result of runoff which carries pollutants down-slope to the tributary and seepage which pollutes groundwater. Pollutants include cement-laden water, oil and fuel from construction vehicles, and hazardous waste substances such as chemicals used to treat wooden structures and paint residue.

Mitigation Measures

The following mitigation measures must be used to minimise the effects of stream contamination:

- The contractor must set up a contaminated water management system, and a Method Statement for approval is required in this regard. The Method Statement must state the collection facilities that are to be used to prevent pollution, as well as the proposed method of disposal of the contaminated water.
- The Contractor must notify the CM and ECO immediately of any pollution incidents on site.
- Wash areas must be placed and constructed in such a manner so as to ensure that the surrounding areas, which include groundwater, are not polluted.
- A Method Statement is required for all wash areas where hydrocarbon, hazardous materials and pollutants are expected to be used. This includes, but is not limited to, vehicle washing, workshop wash bays, paint washing and cleaning areas.
- Wash areas for domestic use must ensure that the disposal of contaminated "grey" water is approved by CM.
- The Contractor must prevent discharge of any pollutants, such as cements, concrete, lime, chemicals and fuels into any water sources.

Significance Statement (Site A)

The impact of contaminating the Tyatyora tributary and Kat River would definitely have severe medium-term negative impacts. This would affect the *regional area* (due to the downstream flow toward Fort Beaufort) and would be of HIGH negative significance.

The implementation of all the above mentioned mitigating measures will greatly reduce the likelihood of this impact occurring, making it unlikely. Should such an impact take place, it would be regional, moderately severe and short term, therefore of LOW negative significance.

Significance Statement (Site B)

The impact of contaminating the Tyatyora tributary and Kat River is unlikely to occur due to locality of site, but will have severe medium-term negative impacts. This would affect the *regional area* (due to the downstream flow toward Fort Beaufort) and would be of HIGH negative significance.

The implementation of all the above mentioned mitigating measures will greatly reduce the likelihood of this impact occurring, making it unlikely. Should such an impact take place, it would be regional, moderately severe and short term, therefore of LOW negative significance.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Site A										
Without mitigation	Medium-term	2	Regional area	3	Severe	4	Definitely	4	13	**HIGH –ve**
With mitigation	Short term	1	Regional	3	Moderate	2	Unlikely	1	7	**LOW –ve**
Site B										
Without mitigation	Medium-term	2	Regional area	3	Moderate	2	Unlikely	1	8	**MODERATE–ve**
With mitigation	Short term	1	Regional	3	Moderate	2	Unlikely	1	7	**LOW –ve**

4.3 Operation phase

4.3.1 Issue 4: Contamination of the Tyatyora and Kat River

Impact 4.1: Poor sewerage system management leading to ongoing inadvertent sewage leakages

Cause and comment

Several negative impacts could result from the poor management and maintenance of the sewerage treatment package including the formation of unpleasant odours and the contamination soils, ground, surface waters and nearby streams as a result of leakage.

Mitigation measures

It is imperative that the sewerage treatment package is properly managed and maintained at all times to ensure that there are no leaks. This will involve regular maintenance and inspections. In addition to this, only SABS accredited materials should be used when building the system. In addition, water quality monitoring needs to be undertaken every alternate month to assess physio-chemical properties (such as *e.coli* levels) at point of entry of the Tyatyora tributary, downstream, midway between Healdtown and Fort Beaufort, and at Fort Beaufort.

Significance statement (Sites A and B)

The impact of poor management, maintenance and inspections of the sewerage treatment package would probably have very severe negative impacts in the long term. This would affect the region because of the Tyatyora tributary joins the Kat River further downstream, which is used heavily by local people from Fort Beaufort for everyday needs, hence the impact would be of VERY HIGH significance.

The implementation of the ongoing monitoring and inspections will reduce the severity of this risk to slight. However, due to the non-perennial nature and low flow gauge of the Tyatora, it is highly susceptible to high level contamination and eutrophication within the study area. This could have disastrous consequences for the immediate area and therefore despite the mitigations presented being the only possible measures; the impact remains MODERATE post mitigation.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Operational phase										
Sites A and B										
Without mitigation	Long-term	3	Regional Area	3	Very	8	Probably	3	17	**V.HIGH –ve**
With mitigation	Short term	2	Study Area	2	Very	8	Unlikely	1	13	**HIGH -ve**

Impact 4.2: Treated effluent discharge from the sewage treatment package into Tyatyora tributary

Cause and comment

One of the effluent discharge options is to discharge treated effluent into the Tyatyora tribuatary. In light of this, it is important to ensure that the treated effluent has had repeated water quality testing to ensure that physio-chemical properties are similar to that of the natural state the water currently flowing in Kat river

Mitigation measures

Water properties for the study site need to be similar/ equivalent to that of the Kat River which remains in a natural state. Water samples from the study site need to fall within the following parameter ranges, namely: -

- An alkaline water pH ranging from 7.6 to 8.1, reflecting the total alkalinity of the water ranging from 1.2 to 5.4 mg/L $CaCO3$.
- Moderate water salinity levels, ranging from 13.3 mS/m to 64 mS/m. Nitrate and phosphate concentrations are very low (0.5mg/L $NO3$, 1mg/L $PO4$) (Everitt, 1999).

Studies have highlighted the presence of faecal coliforms and high nitrate concentrations near some communities (Soviti, 2001). Rigorous monitoring needs to measure for faecal coliforms and nitrate concentrations at the study site.

Point of discharge needs to be opposite Site B on the Fort Beaufort side of the bridge as currently there are heavy boulders and rocks lining the river basin which will accommodate discharge and will reduce erosion impacts (Figure 4.1).

Figure 4.1 Heavy boulders and rocks lining the river basin at Tyatyora which will accommodate effluent discharge and will reduce erosion impacts

Significance statement (Site A and B)

Due to the non-perennial nature and low flow gauge of the Tyatora, it is highly susceptible to high level contamination and eutrophication within the study area. This could have disastrous consequences for the immediate area. Consequently, if effluent discharge water quality is unmonitored and poor quality water enters the Tyatyora tributary, this could elevate nitrate levels promoting eutrophication within the study area and possible *E.coli* breakout due to high levels of faecal coliforms within the effluent. Such an outbreak will probably occur, having a long-term effect and will be of a very severe nature, thus will have VERY HIGH significance.

Due to the non-perennial nature and low flow gauge of the Tyatora, it is highly susceptible to high level contamination and eutrophication within the study area. This could have disastrous consequences for the immediate area. If well monitored, natural state effluent is discharged, the treated effluent will dilute such concentrations and will increase stream flow supporting surrounding biota and flora. The effect of discharging treated effluent into the tributary of the study area will probably occur over a long-term period and will be very beneficial, thus will have HIGH POSITIVE significance.

Impact	**Effect**						**Risk or Likelihood**		**Total Score**	**Overall Significance**
	Temporal Scale		**Spatial Scale**		**Severity of Impact**					
Operational phase										
Site A and B										
Without mitigation	Long-term	3	Study Area	2	Very	8	Probably	3	16	**V.HIGH –ve**
With mitigation	Long-term	3	Study Area	2	Very Beneficial	8	Probably	3	15	**HIGH +ve**

Impact 4.3: Treated effluent discharge from the sewage treatment package onto Healdtown College recreational sport fields

Cause and comment:

The supplementation of municipal water source for treated discharge effluent in irrigating proposed rehabilitated Healdtown College recreational sports fields nearby of site A.

Mitigation measures

It is important to ensure that the treated effluent has had repeated water quality testing to ensure that physio-chemical properties are similar to that of the natural state the water currently flowing in Kat river The following mitigation measures should be implemented to minimise this risk:

- Refer to water quality monitoring mitigation measures for impact 4.2
- Either a lined holding pond or dam to cater for emergency overflow and a reed-bed type “polishing system” will be required.
- The irrigation water will be used on agricultural lands (not to fruit or vegetables that are eaten without cooking, or to sports fields where there is not normally physical contact with the ground surface (that is, a golf course but not a rugby field), or to gardens within the College grounds.

Significance statement

If effluent discharge water quality is unmonitored and poor quality water enters both the Tyatyora and KwaNgenu tributaries via run-off or ground water seepage, this could elevate nitrate levels promoting eutrophication within the study area and possible *E.coli* breakout due to high levels of faecal coliforms within the effluent. Additional, this will have a very severe negative affect on human health both in the immediate vicinity and regionally. Such an outbreak will probably occur, having a long-term effect and will be of a very severe nature, thus will have VERY HIGH significance.

Using the proposed mitigation will make this impact unlikely, and would be a long-term local impact. It would be a very beneficial impact and would have HIGH POSITIVE significance.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Operational phase										
Site A and B										
Without mitigation	Long-term	2	Regional Area	3	Very	8	Probably	3	16	**V. HIGH –ve**
With mitigation	Short term	1	Localised Area	1	Very	8	Probably	3	13	**HIGH +ve**

Impact 4.4: Treated effluent discharge from the sewage treatment package into rehabilitated settling ponds

Cause and comment:

The redirection of effluent discharge into settling ponds for the onset of evaporation, will be both a costly exercise in the rehabilitation of the existing infrastructure (ruined settling ponds) already in place and the unnecessary excavation of land for the running of underground pipes to the ponds from the either of the proposed sites.

Mitigation measures

It is imperative that the sewerage treatment package is properly managed and maintained at all times to ensure that there are no leaks. This will involve regular maintenance and inspections. It is important to ensure that the treated effluent has had repeated water quality testing to ensure that physio-chemical properties are similar to that of the natural state the water currently flowing in Kat river The following mitigation measures should be implemented to minimise this risk:

- Refer to water quality monitoring mitigation measures for impact 4.2

Significance statement

There will be an unpleasant odour dispelled from the settling tanks that will affect both the immediate hillside communities and Healdtown College. Additionally if effluent discharge water quality is unmonitored and poor quality water enters the Tyatyora tributary via ground water seepage from both pipes and pond wall or via pond wall breakage, this will elevate nitrate levels promoting eutrophication within the study area with *E.coli* breakout due to high levels of faecal coliforms within the effluent that will in addition affect the Fort Beaufort region. Additional, this will have a very severe negative affect on human health both in the immediate vicinity and regionally. Such a leakage may occur, having a long-term effect and will be of a very severe nature, thus will have VERY HIGH significance.

Using the proposed mitigation will make this impact unlikely, and would be a short-term local impact. It would be a slight impact and would have LOW significance.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Operational phase										
Site A and B										
Without mitigation	Long-term	2	Regional Area	3	Very	8	Probably	3	12	**HIGH –ve**
With mitigation	Short term	2	Regional Area	3	Slight	1	Unlikely	1	7	**LOW -ve**

NO-GO

Due to the poor health status of Healdtown's aquatic ecosystem, as compared to the healthy natural state of the majority of the Kat River Valley's river systems, the consideration of a no-go alternate is strongly opposed. The construction of a sewage treatment package at either site A or site B, albeit site preference, promotes numerous positive impacts that will either increase flow gauge, decreasing eutrophic levels and benefiting immediate and surrounding biota and flora. It will also help aggrade tributary banks and promote riparian and marginal zone growth.

5 CONCLUSIONS AND RECOMMENDATIONS

Collating the conclusions reached in the BAR, it may be that the overall assessment of the project finds that this proposed development is desirable, showing indicating positive mitigatory measures which will benefit not only the surrounding community of Healdtown College, but that of Fort Beaufort and in addition when considering all biota components. In such a case the following recommendations need to be implemented:

- All construction must be undertaken according to the Construction Environmental Management Plan (CEMP).
- All sensitive areas must be clearly demarcated to ensure that they are preserved
- That site A is the preferred development site,
- That treated effluent discharge can either be discharged directly into the Tyatyora tributary with point of discharge described in impact 5.2 above, or as irrigation means for Healdtown College's recreational sport fields.

The following monitoring programmes will be required:

- Ongoing water quality monitoring of the Tyatyora and KwaNgenu tributaries. This must take place monthly during the construction and operation phase of the project. This should focus on two components:
    - Leaks in the sewerage system
    - Treated effluent discharge quality
- Monitoring of the riparian and marginal zone vegetation along the edge of the Tyatyora and KwaNgenu tributaries as well as at the edge of the site to ensure that the vegetation remains intact and is acting as a filter strip between the development and the tributaries.

The following should also be undertaken if not by the municipality with the support of the developer:

- Demarcation and implementation of no go zones (possible heritage sites)

6 REFERENCES

Birkholz S. 2007. Situation assessment: Kat River Valley, Eastern Cape. Unpublished report to the Water Research Commission, Project no. K5/1496. Institute for Water Research, Rhodes University, Grahamstown.

DWAF, 1994: *Water Supply and Sanitation Policy*, DWAF, Cape Town.

Everitt V. 1999. *The Kat River Valley Project, Biomonitoring Report,* Unpublished KRVP report, Geography Department, Rhodes University, Grahamstown.

Kemper N. 1999. *RVI: Riparian Vegetation Index*, In, WRC Report K5/850, Pretoria, South Africa.

Logie B. 1997. *A History of Land Ownership and Land Management in the Kat River Valley from 1829 to the Present*, unpublished BA Honours Project, Department of Geography, Rhodes University, Grahamstown.

Motteux N, Rowntree K. 1999. *The Transitional Shift in Riverine Management Methodologies: A Move Towards a Critical Spirit*, In, The Second Australian Stream Management Conference, Challenge of Rehabilitating Australia's Streams, vol 2., pp. 457 - 461.

Motteux N. 2002. Evaluating people-environment relationships: Developing appropriate research methodologies for sustainable management and rehabilitation of riverine areas by communities in the Kat River Valley, Eastern Cape Province, South Africa, Unpublished PHd Thesis, Rhodes University, Grahamstown.

Motteux N, McMaster A. 2002. Kat River Valley User Association: particulars of public consultation process, Catchment Research Group, Rhodes University

Soviti M. 2001. An assessment of the impact of black village communities, their associated land-use and related practices, on water quality of the Kat River in the Eastern Cape, South Africa, Unpublished MSc Thesis, Rhodes University, Grahamstown.