Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

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Appendix F14:

Hydropedology Assessment

20 Years of Water & Environmental Science

WETLAND FLOW DRIVER ASSESSMENT

FOR

DUNBAR COLLIERY

GPT Reference Number:	EOKAL-19-4285
Client Reference Number:	N/A
Version:	Final
Date:	October 2019

Compiled for:

VANDABYTE (PTY) LTD

Geo Pollution Technologies - Gauteng (Pty) Ltd
81 Rauch Avenue
Georgeville
0184

P.O. Box 38384
Garsfontein East
0060

Tel: +27 (0)12 804 8120
Fax: +27 (0)12 804 8140

GEO Pollution Technologies

Report Type:	WETLAND FLOW DRIVER ASSESSMENT
Project Title:	DUNBAR COLLIERY
Compiled For:	Totapix Pty Ltd
Compiled By:	V. Naidoo, M.Sc.
Reviewed By:	M. Burger; M.Sc., Pr.Sci.Nat
GPT Reference:	EOKAL-19-4285
Version:	Final
Date:	October 2019

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The results and conclusions of this report are limited to the Scope of Work agreed between GPT and the Client for whom this investigation has been conducted. All assumptions made and all information contained within this report and its attachments depend on the accessibility to and reliability of relevant information, including maps, previous reports and word-of-mouth, from the Client and Contractors. All work conducted by GPT is done in accordance with the GPT Standard Operating Procedures. GPT is an ISO 9001 accredited Company.

Declaration:

I hereby declare:

1. I have no vested interest (present or prospective) in the project that is the subject of this report as well as its attachments. I have no personal interest with respect to the parties involved in this project.
2. I have no bias with regard to this project or towards the various stakeholders involved in this project.
3. I have not received, nor have I been offered, any significant form of inappropriate reward for compiling this report.

(*electronic signature*)

V. Naidoo, M.Sc.

Geo Pollution Technologies – Gauteng (Pty) Ltd

This report was reviewed by:

(*electronic signature*)

M. Burger; M.Sc., Pr.Sci.Nat

Professional Natural Scientist (No 400296/12)

Geo Pollution Technologies – Gauteng (Pty) Ltd

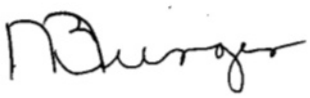
Customer Satisfaction:

Feedback regarding the technical quality of this report (i.e. methodology used, results discussed and recommendations made), as well as other aspects, such as timeous completion of project and value of services rendered, can be posted onto GPT's website at address: http://www.gptglobal.com/feedback.htm.

Declaration of Independence

I, **Morne Burger** in my capacity as the specialist (Hydrogeology) consultant, hereby declare that I -

- Act as an independent Environmental Assessment Practitioners:
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member; and
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement.



3 October 2019

M. Burger; M.Sc., Pr.Sci.Nat
Hhydrogeology
Professional Natural Scientist (No 400296/12)

Date

NEMA Regs (2014) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report	**M. Burger; M.Sc., Pr.Sci.Nat** **Professional Natural Scientist (No 400296/12)**
The expertise of that person to compile a specialist report including a curriculum vita	**M. Burger; M.Sc., Hydrogeology Pr.Sci.Nat** **Professional Natural Scientist (No 400296/12)**
A declaration that the person is independent in a form as may be specified by the competent authority	See signed specialist declaration
An indication of the scope of, and the purpose for which, the report was prepared	Wetland flow driver reduction assessment
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	June 2019
A description of the methodology adopted in preparing the report or carrying out the specialised process	The SANBI Biodiversity Series 22, (2013) Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems was consulted in determining the estimated flow losses to the catchment systems due to mining
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Wetland features
An identification of any areas to be avoided, including buffers	See section 1.5 and 1.6
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;	See figure 1
A description of any assumptions made and any uncertainties or gaps in knowledge;	See section 1.3
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	See section 1.5 and 1.6
Any mitigation measures for inclusion in the EMPr	See section 1.5 and 1.6
Any conditions for inclusion in the environmental authorisation	See section 1.5 and 1.6
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	See section 1.5 and 1.6
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	If mitigated there should be no reason for mining not to continue
If the opinion is that the proposed activity 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	
A description of any consultation process that was undertaken during the course of carrying out the study	Not applicable
A summary and copies if any comments that were received during any consultation process	Not applicable
Any other information requested by the competent authority.	None

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LIST OF ABBREVIATIONS

Abbreviation	**Explanation**
ARD	Acid Rock Drainage
BPG	Best Practice Guidelines
CMS	Catchment Management Strategy
CSM	Conceptual Site Model
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
IWRMP	Integrated Water Resources Management Plan
IWRM	Integrated Water Resources Management
Km^2	Square Kilometre
L/s	Litres per second
mamsl	Metres above mean sea level
Ml/d	Megalitres per day
m	meter
mm	Millimetre
mm/a	Millimetres per annum
mS/m	Millisiemens per metre
m^3	Cubic metre
MAP	Mean Annual Precipitation
MPRDA	Mining and Petroleum Resources Development Act (Act No. 73 of 2002) 1989)
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NWA	National Water Act (Act No. 36 of 1998)
ppm	Parts per million
RDM	Resource Directed Measures
RQO	Resource Quality Objective
RWQO	Resource Water Quality Objective
TDS	Total Dissolved Solids
WMA	Water Management Area
WMP	Water Management Plan

1 WETLAND FLOW DRIVER IMPACT

The proposed mining activity could impact on the flow drivers of the wetland systems through interception systems such as berms, trenches, opencast dewatering and quality changes.

1.1 Normative references

The following normative references are indispensable to this study:

- August 2019 - Aquatic and Surface Water Assessment for the Proposed Dunbar Coal Mine, near Bethal, Mpumalanga Province - Confluent Environmental
- July 2019 - High-level soil, land capability, agricultural potential and hydropedology assessment: proposed Dunbar mining project, Mpumalanga Province – Terrasoil Science

1.2 Wetland catchment flow reduction

The SANBI Biodiversity Series 22, (2013) Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems was consulted in determining the estimated flow losses to the specific wetland catchment systems due to mining.

Many wetlands are hydrologically and ecologically linked to adjacent groundwater bodies, but the degree of interaction can vary greatly. Some wetlands may be completely dependent on groundwater discharge under all climatic conditions, whilst others may have very limited dependence such as only under very dry conditions – and some may have no connection with groundwater at all. Some aquifers are dependent almost entirely on recharge (see Figure 1). Based on the SANBI Biodiveristy Series 22, the following to water systems are present on the proposed mining area:

- **Channelled valley bottom**- Dominant water inputs to these wetlands are from the river channel flowing through the wetland, either as surface flow resulting from flooding or as sub-Water surface flow, and/or from adjacent valley-side slopes Water generally moves through the wetland as diffuse surface flow, although occasional, short-lived concentrated flows are possible during flooding events.. Water generally exits a channelled valley-bottom wetland in the form of diffuse surface or subsurface flow into the adjacent river, with infiltration into the ground and evapotranspiration of water from these wetlands also being potentially significant.
- **Unchanneled valley bottom (splits opencast between north & south)** - Water inputs are typically from an upstream channel that becomes dominated by diffuse (surface and subsurface) flow as it enters the wetland and seepage from adjacent slopes. There may also be groundwater input into the wetland. Water characteristically moves through the wetland in the form of diffuse surface or subsurface flow, but the outflow may be in the form of either diffuse or concentrated surface flow
- **Seepage Wetlands (south of southern opencast)** - Water inputs are primarily via subsurface flows from an up-slope direction. Water movement through the seep is mainly in the form of interflow, with diffuse overland flow (known as sheetwash) often being significant during and after rainfall events.

1.3 Assumptions

The impact on flow drivers of the wetland catchment is detailed below and is based on the following assumptions. A water balance[1] on the wetland catchment is represented by (see Table 1):

- Rainfall 100% of flow input
- Evapotranspiration is 65 – 70% of rainfall (outflow)
- Runoff is 10% (outflow)[2]
- Groundwater recharge is 5%[3] (outflow)
- 15 % of the water being left in or stored the unsaturated zone or interflow zone feeding the wetland

The impact assessment is only valid for the proposed mining activity, based on the site visit historic and agricultural activities has impacted on the wetland systems. Current flow driver impacts from existing and neighboring mines/agricultural activities was not part of the impact assessment.

1.4 Model scenarios

The water balance model was run for three scenarios from the edge of the delineated wetland:

- No buffer
- 60 m buffer
- 100 m buffer

1.5 Flow driver impact

Based on the water balance the impact on the wetland flow drivers is expected to be in the order of (see Table 2):

- Channelled valley bottom < 10% (0 m buffer), < 9% (60 m buffer) and 8% (100 m buffer)
- Unchanneled valley bottom < 40% (0 m buffer), < 36% (60 m buffer) and 34% (100 m buffer)
- Seepage Wetlands <19% (0 m buffer), < 14% (60 m buffer) and 13% (100 m buffer)

The unchanneled valley bottom wetland system between the two opencast is expected to be impacted to the largest extent irrespective of a buffer. There is a reduction of flow driver impact by applying a buffer, however as the impacts are calculated on wetland catchments the reduction of impact by applying 60 to 100 m buffers is in the order of 1%.

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[1] Dynamics of MODIS evapotranspiration in South Africa, Nebo Jovanovic1*, Qiaozhen Mu2, Richard DH Bugan1 and Maosheng Zhao3, 1CSIR, Natural Resources and Environment. ISSN 0378-4738 = Water SA Vol. 41 No. 1 January 2015

[2] Midgley, D.C., Pitman, W.V. & Middleton, B.J. (1994) Surface Water Resources of South Africa 1990. Water Research Commission Report No 298/5.1/94, Pretoria, South Africa.

[3] An investigation into recharge in South African underground collieries by P.D. Vermeulen* and B.H. Usher. The Journal of The Southern African Institute of Mining and Metallurgy- Volume 106 - November 2006

The above values should be read with caution as it is worst case estimate based on the catchments surrounding the wetland systems bound within the mining rights area and the total opencast area being mined.

1.6 Impact assessment

The wetlands on site are a reflection of the behaviour of water, predominantly rainfall, and its behaviour following interception and infiltration into the soils. Thus, activities that affect the movement of water as well as its quality in the catchment areas supporting wetlands, translate into changes in the pans to which they are invariably linked. Expected impacts include:

- Change in hydrology;
- Change in water quality; and
- Loss of wetlands and the biodiversity supported by these wetlands.

Impacts that lead to a change in hydrology include all impacts that influence the quantity (e.g. increased or decreased run-off) and velocity (e.g. concentration of flows) of flows leaving the site.

Increased flows and increased velocity of flows could result in increased erosion within the receiving environment, while decreased flows could result in a decreased pans extent.

Impacts that lead to deteriorating water quality, together with the impacts that change the hydrology, are expected to be the most significant impacts on site. From a wetland perspective, mitigation measures and management plans should focus on these impacts and it will need to be clearly shown in the EIA and EMP how these impacts will be ameliorated to prevent significant deterioration of the quality and quantity of water discharged to downstream areas.

The impacts on the seepage and unchanneled valley bottom wetlands are expected to be on the footprint of the site, the duration of the impact will be permanent, the intensity will be very high and the impact irreversible.

The impacts on the channelled valley bottom are expected to be on the footprint of the site, the duration of the impact will be permanent, the intensity will be low and the impact partly reversible.

1.7 Mitigation measures

The following mitigation measures are recommended to mitigate flow losses:

- A buffer of at least 50 m from the edge of the wetland

<u>During operations</u>

Flow driver impact can be mitigated through replacement of the following volumes of clean water into the wetland system:

- Channelled valley bottom 558451.6 m3/a
- Unchanneled valley bottom 558451.6 m3/a
- Seepage Wetlands 177140.0 m3/a

The above volumes should be taken with caution as it will have to reflect seasonal fluctuations. Therefore, a wetland specialist should be consulted for the best approach as to when and how this water should be replaced.

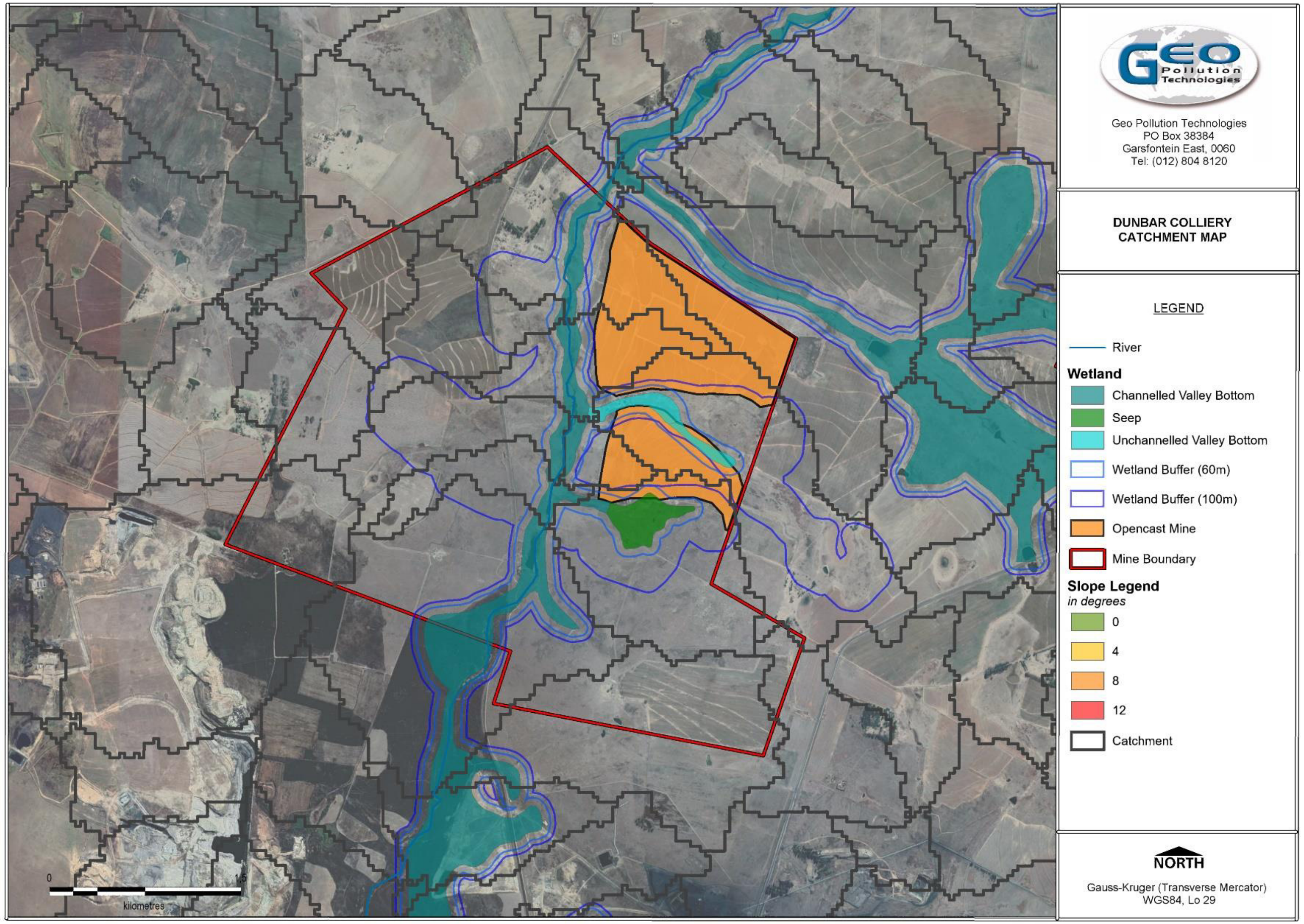

Figure 1: Delineated Wetlands with watersheds

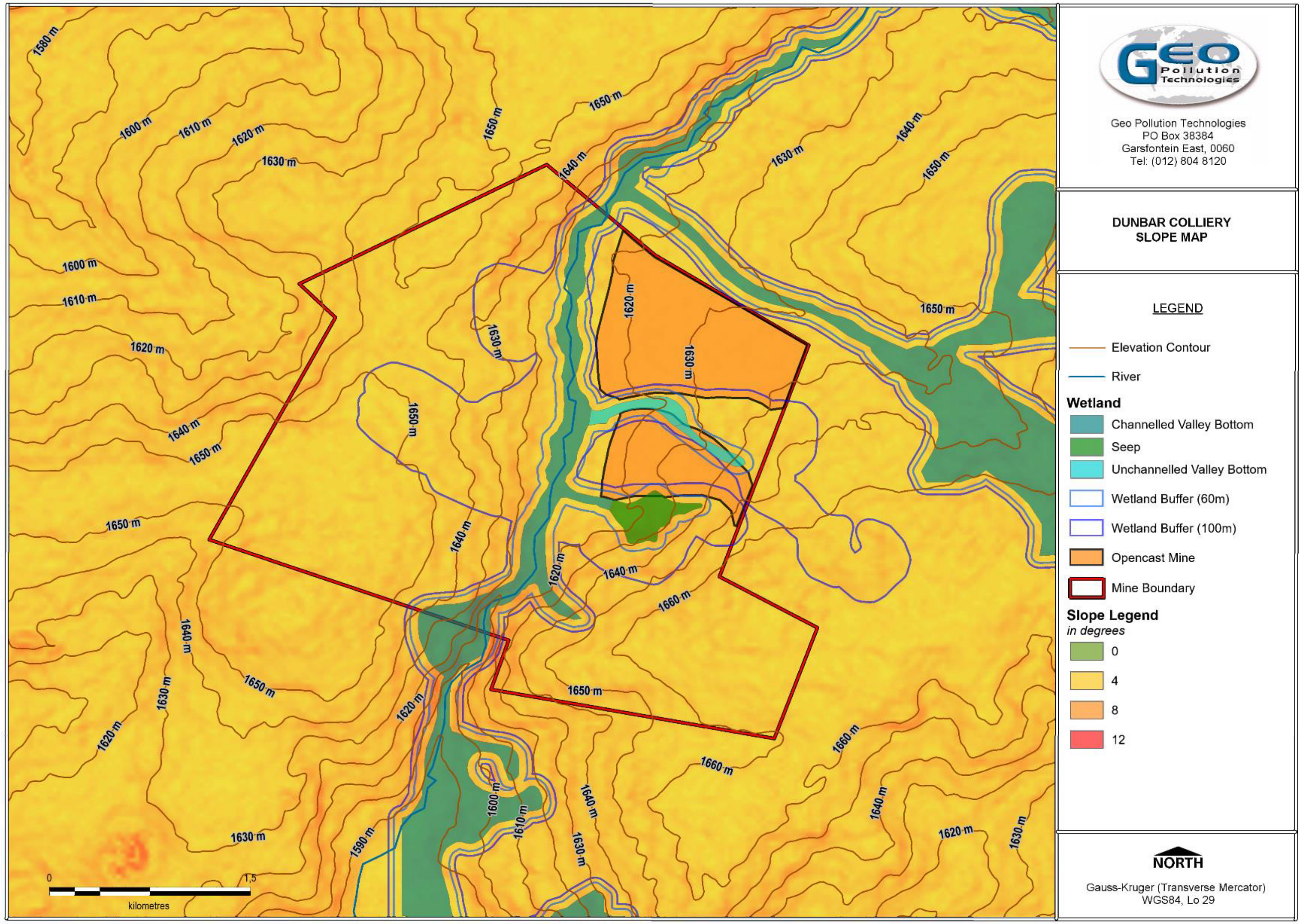

Figure 2: Surface slope map

Table 1: Area information

Area information				
Rainfall	0.675	m/annum	100.0	%
Evaporation	0.473	m/annum	70.0	%
Groundwater Recharge	0.034	m/annum	5.0	%
Mean Annual Runoff	0.068	m/annum	10.0	%
Water in wetland soils	0.101	m/annum	15.0	%

Table 2: Wetland flow driver impacts (no buffer)

Wetland system	Pre development total flows	Post development total flow	Total loss of flow	Loss
	m3/a	m3/a	m3/a	%
Channelled valley bottom	5648241.8	5089504.0	558737.8	10
Unchanneled valley bottom	1412033.5	853295.8	558737.8	40
Seepage Wetlands	952368.1	775228.0	177140.0	19

Table 3: Wetland flow driver impacts (60 m buffer)

Wetland system	Pre development total flows	Post development total flow	Total loss of flow	Loss
	m3/a	m3/a	m3/a	%
Channelled valley bottom	5648241.8	5137556.5	510685.3	9
Unchanneled valley bottom	1412033.5	901348.2	510685.3	36
Seepage Wetlands	952368.1	815242.8	137125.2	14

Table 4: Wetland flow driver impacts (100 m buffer)

Wetland system	Pre development total flows	Post development total flow	Total loss of flow	Loss
	m3/a	m3/a	m3/a	%
Channelled valley bottom	5648241.8	5170480.9	477760.9	8
Unchanneled valley bottom	1412033.5	934272.6	477760.9	34
Seepage Wetlands	952368.1	826679.7	125688.4	13

Table 5: Summary of wetland flow driver impacts

Flow driver loss %			
Wetland system	0 m buffer	60 m buffer	100 m buffer
Channelled valley bottom	10	9	8
Unchanneled valley bottom	40	36	34
Seepage Wetlands	19	14	13

APPENDIX I: HYDROPDEDOLOGICAL FLOW DRIVER CALCULATIONS

Wetland system	Pre development groundwater flows	Post development groundwater flows	Loss of groundwater flows	Loss
	m3/a	m3/a	m3/a	%
Channelled valley bottom	706030.2	636188.0	69842.2	10
Unchanneled valley bottom	176504.2	106662.0	69842.2	40
Seepage Wetlands	119046.0	96903.5	22142.5	19
Wetland system	Pre development surface flows	Post development surface water flows	Loss of surface water flows	Loss
	m3/a	m3/a	m3/a	%
Channelled valley bottom	1129648.4	1017900.8	111747.6	10
Unchanneled valley bottom	282406.8	170659.2	111747.6	40
Seepage Wetlands	190473.6	155045.6	35428.0	19
Wetland system	Pre development interflow	Post development interflow	Loss of interflow	Loss
	m3/a	m3/a	m3/a	%
Channelled valley bottom	3812563.2	3435415.2	377148.0	10

Unchanneled valley bottom	953122.8	575974.9	377148.0	40
Seepage Wetlands	642848.4	523278.9	119569.5	19
Wetland system	Pre development total flows	Post development total flow	Total loss of flow	Loss
	m3/a	m3/a	m3/a	%
Channelled valley bottom	5648241.8	5089504.0	558737.8	10
Unchanneled valley bottom	1412033.8	853296.1	558737.8	40
Seepage Wetlands	952368.1	775228.0	177140.0	19