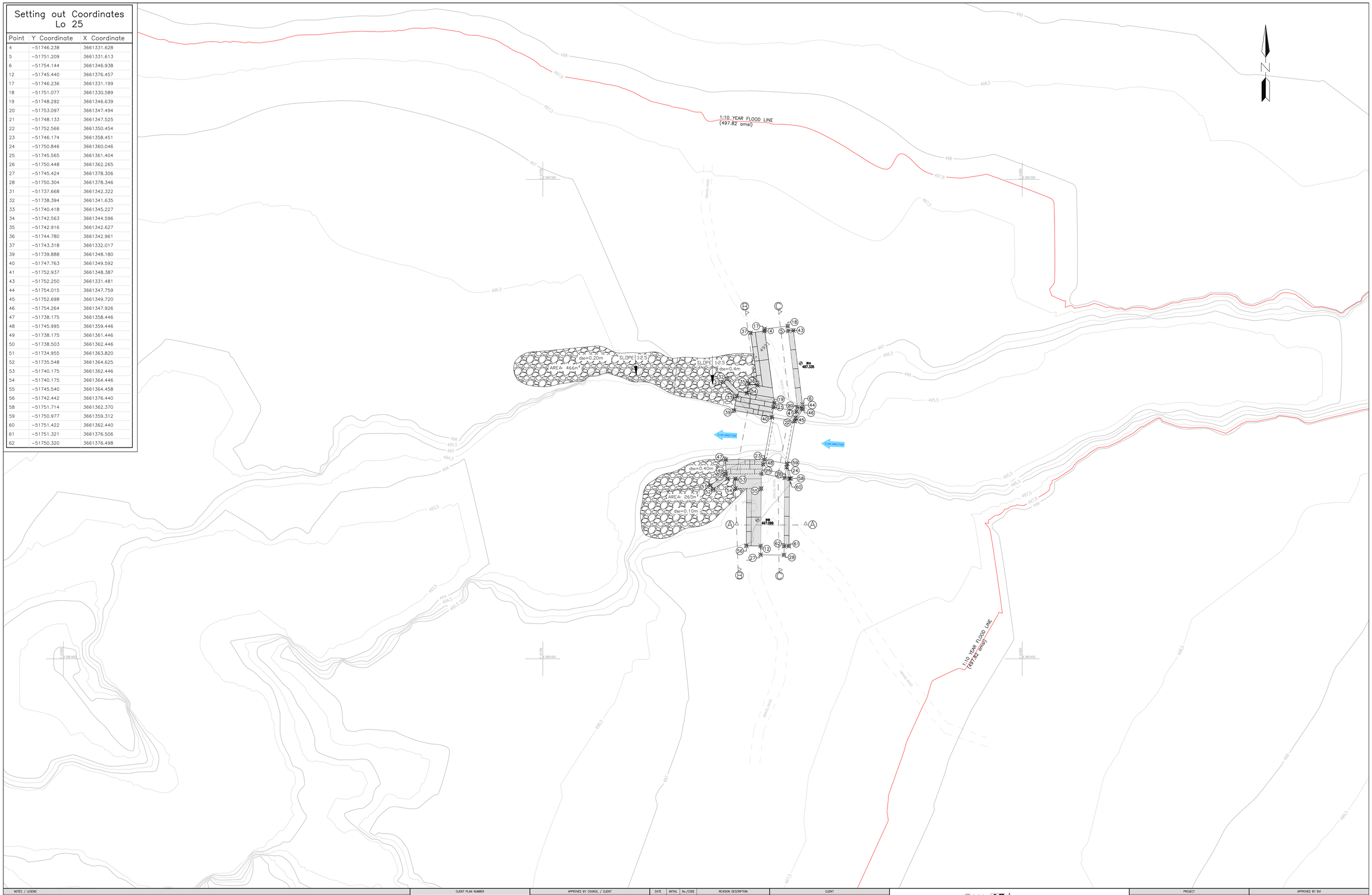
Appendix C: Design Drawings

Setting out Coordinates Lo 25

Point	Y Coordinate	X Coordinate
4	-51746.238	3661331.628
5	-51751.209	3661331.613
6	-51754.144	3661346.938
12	-51745.440	3661376.457
17	-51746.236	3661331.199
18	-51751.077	3661330.589
19	-51748.292	3661346.639
20	-51753.097	3661347.494
21	-51748.133	3661347.525
22	-51752.566	3661350.454
23	-51746.174	3661358.451
24	-51750.846	3661360.046
25	-51745.565	3661361.404
26	-51750.448	3661362.265
27	-51745.424	3661378.306
28	-51750.304	3661378.346
31	-51737.668	3661342.322
32	-51738.394	3661341.635
33	-51740.418	3661345.227
34	-51742.563	3661344.596
35	-51742.916	3661342.627
36	-51744.780	3661342.961
37	-51743.318	3661332.017
39	-51739.888	3661348.180
40	-51747.763	3661349.592
41	-51752.937	3661348.387
43	-51752.250	3661331.481
44	-51754.015	3661347.759
45	-51752.698	3661349.720
46	-51754.264	3661347.926
47	-51738.175	3661358.446
48	-51745.995	3661359.446
49	-51738.175	3661361.446
50	-51738.503	3661362.446
51	-51734.955	3661363.820
52	-51735.548	3661364.625
53	-51740.175	3661362.446
54	-51740.175	3661364.446
55	-51745.540	3661364.458
56	-51742.442	3661376.440
58	-51751.714	3661362.370
59	-51750.977	3661359.312
60	-51751.422	3661362.440
61	-51751.321	3661376.506
62	-51750.320	3661376.498



NOTES / LEGEND

CLIENT PLAN NUMBER: 93413/85

REFERENCE DRAWINGS

NUMBER	REVISION	DRAWING DESCRIPTION

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT _____ REG. NO. _____ DATE _____

A,B,C../ : BEFORE TENDER
0 / : TENDER DRAWING
1,2,3.../ : AFTER TENDER
2 / : AS-BUILT

/A : BY CLIENT
/B : BY ARCHITECT
/C : BY MECHANICAL OR ELECTRICAL
/D : BY EIA
/E : BY OTHER ( )

DATE	INITIAL	No./CODE	REVISION DESCRIPTION
11/12	JS	0	RIP-RAP CONTOURS ADJUSTED, UPDATE DRAWINGS

CLIENT

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PROJECT: SKOENMAKERS RIVER REHABILITATION

DRAWING TITLE: BRIDGE 1 LAYOUT

APPROVED BY BVI

ENGINEER/TECHNOLOGIST _____ REG. NO. _____ DATE _____

SCALE	1:250	DRAWN	JS
DESIGNED	JS	CHECKED	FVG
PLAN NUMBER		REVISION NO.	DATE SAVED
PE0622C_120_01		C	13 Jan 2015 NAME

Setting out Coordinates Lo 25

Point	Y Coordinate	X Coordinate
1	–49425.399	3661563.778
2	–49430.717	3661560.957
3	–49436.331	3661575.807
4	–49439.752	3661572.761
5	–49442.286	3661582.759
7	–49446.200	3661587.304
8	–49449.451	3661583.599
10	–49462.146	3661598.424
11	–49464.276	3661608.401
12	–49467.409	3661604.559
13	–49471.225	3661612.270
14	–49473.590	3661608.001
15	–49432.194	3661590.689
16	–49438.171	3661590.227
17	–49448.469	3661575.682
18	–49455.801	3661611.123
19	–49461.531	3661605.202
20	–49455.416	3661617.111
21	–49424.095	3661566.875
22	–49429.001	3661560.563
23	–49448.895	3661581.547
24	–49448.154	3661575.720
25	–49471.470	3661603.076
26	–49471.591	3661602.801
27	–49474.046	3661607.095
28	–49469.686	3661614.847
29	–49462.358	3661610.751
30	–49460.860	3661609.028
31	–49457.588	3661612.626
32	–49456.752	3661611.973
33	–49456.425	3661617.164
35	–49452.691	3661608.529
36	–49458.454	3661601.615
37	–49440.125	3661592.509
39	–49432.117	3661589.692
40	–49438.864	3661588.009
41	–49437.718	3661586.671
42	–49440.015	3661584.704

NOTES / LEGEND

CLIENT PLAN NUMBER: 93413/85

REFERENCE DRAWINGS

NUMBER	REVISION	DRAWING DESCRIPTION

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT — REG. NO. — DATE

A,B,C../ : BEFORE TENDER
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DATE	INITIAL	No./CODE	REVISION DESCRIPTION

CLIENT

DEPARTMENT OF WATER AFFAIRS

BVI CONSULTING ENGINEERS EASTERN CAPE PTY (Ltd)
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	Cradock	(048) 881-2344	cdk@bvi.co.za
Western Cape	Cape Town	(021) 418-2626	cpt@bvi.co.za

PROJECT: SKOENMAKERS RIVER REHABILITATION

DRAWING TITLE: BRIDGE 2 LAYOUT

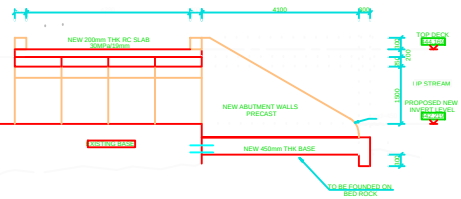
APPROVED BY BVI

ENGINEER/TECHNOLOGIST — REG. NO. — DATE

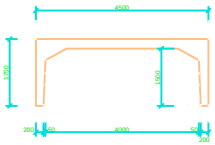
SCALE	1:200	DRAWN	DC
DESIGNED	JS	CHECKED	FVG
PLAN NUMBER		REVISION NO.	DATE SAVED
PE0622C_120_02		C	13 Jan 2015 NAME

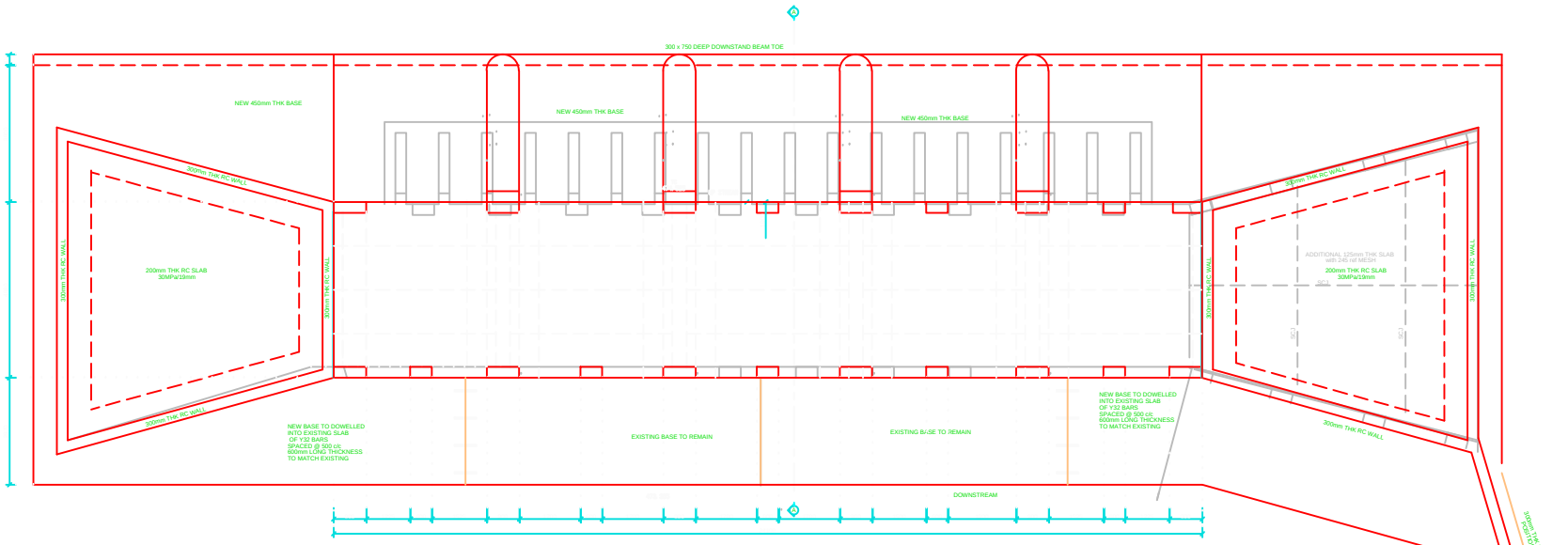
CONCEPTUAL SIZING

DEPTH (m)	WIDTH (m)	NO. OF BARRELS	CULVERT INVERT LEVEL	TOP OF DECK LEVEL	EX. ROAD WIDTH (m)	NEW ROAD WIDTH (m)	COMMENTS
1.5	4	5	442.219	444.169	4.60	4.880	REMOVE DEBRIS CATCHER RAISED AND RE-ALIGNED SOUTHERN APPROACH ROAD TO PREVENT ROAD EROSION AND SHORTEN THE APPROACH SLAB

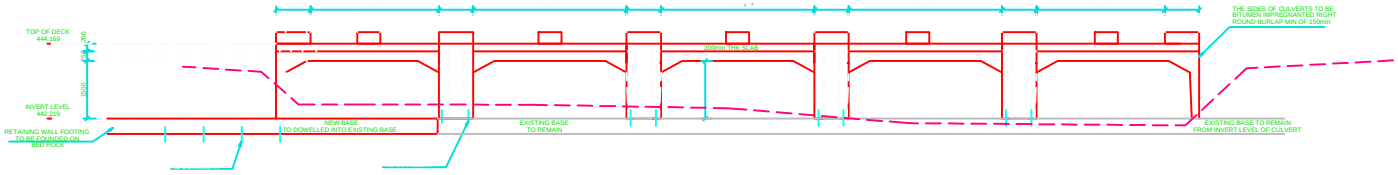


SECTION A-A
SCALE 1:50

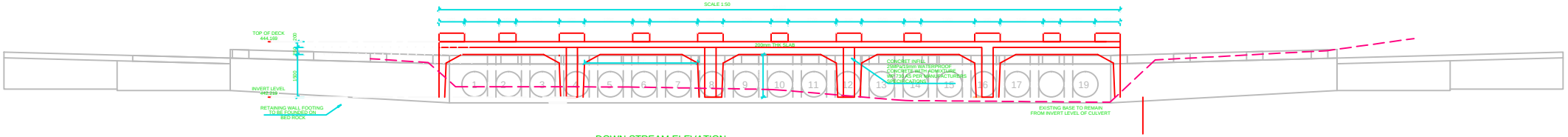




BRIDGE LAYOUT
SCALE 1:50



UP STREAM ELEVATION
SCALE 1:50



DOWN STREAM ELEVATION
SCALE 1:50

NOTES / LEGEND

IF IN DOUBT, REFER TO DRAWING OFFICE

CLIENT PLAN NUMBER

REFERENCE DRAWINGS

NUMBER	DRAWING DESCRIPTION
–	–

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT	REG. NO.	DATE

AMENDMENTS CODE

A-Y / / REPORT/DESIGN/TENDER
Z-M / / CONSTRUCTION
Z / / AS BUILT

A: BY CLIENT
B: BY ARCHITECT
C: BY MECHANICAL OR ELECTRICAL
D: BY BV
E: BY OTHER ( )

DATE	INITIAL CODE	REVISION DESCRIPTION
24-04-2014	AC	A FOR REPORT
30-05-2014	AC	C PIPES CHANGED TO CULVERTS

CLIENT

DEPARTMENT OF
WATER AFFAIRS

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PROVINCE OFFICE EMAIL
Eastern Cape Port Elizabeth +27 41 373 4541 bvi@bviepe.co.za

PROJECT

SKOENMAKERS RIVER
REHABILITATION

DRAWING TITLE

BRIDGE 3

APPROVED BY BV

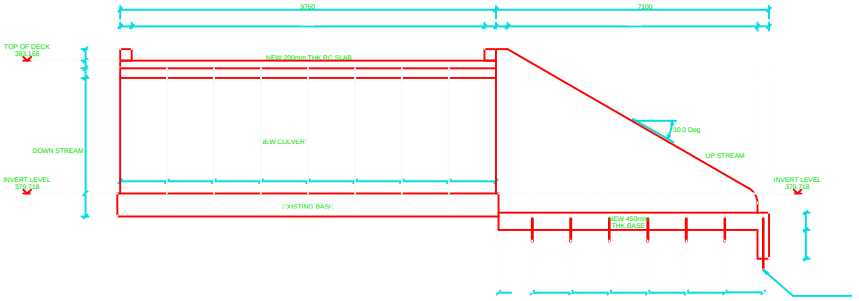
H.RAS.	950/47	2014
ENGINEER/TECHNOLOGIST	REG. NO.	DATE

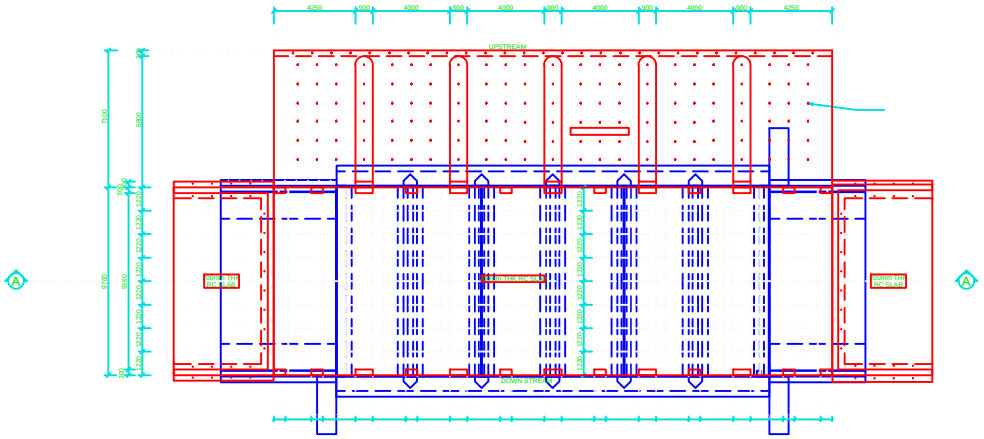
SCALE	AS SHOWN	DRAWN	ND
DESIGNED	MM	CHECKED	HR

PLAN NUMBER: PE0622S-201-03
REVISION NO.: C
DATE SAVED: 10-11-2014
A0

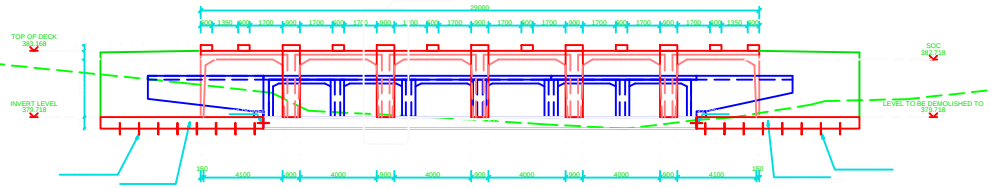
CONCEPTUAL SIZING

DEPTH (m)	WIDTH (m)	NO. OF BARRELS	CULVERT INVERT LEVEL	TOP OF DECK LEVEL	EX. ROAD WIDTH (m)	NEW ROAD WIDTH (m)	COMMENTS
3	4	6	379.718	383.168	9.9	9.76	REMOVE DEBRIS CATCHER,RAISED AND RE-ALIGNED SOUTHERN APPROACH ROAD TO PREVENT ROAD EROSION AND SHORTEN THE APPROACH SLAB

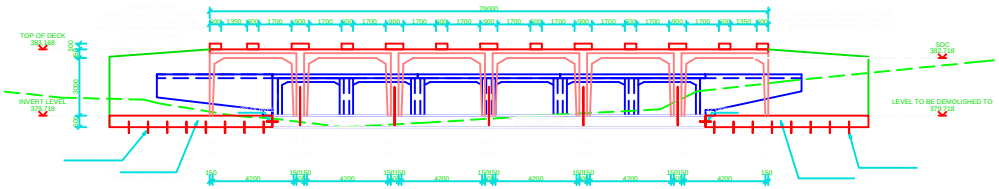




BRIDGE 6 LAYOUT PLAN
SCALE 1:100



UP STREAM ELEVATION
SCALE 1:100



DOWN STREAM ELEVATION
SCALE 1:100

NOTES / LEGEND

IF IN DOUBT, REFER TO DRAWING OFFICE

CLIENT PLAN NUMBER: -

REFERENCE DRAWINGS

NUMBER	DRAWING DESCRIPTION

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT | REG. NO. | DATE

AMENDMENTS CODE

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B/W : / CONSTRUCTION
Z : / AS BUILT

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DATE	INITIAL	CODE	REVISION DESCRIPTION
07-03-2014	LF	A	FOR REPORT
-	-	B	FOR REPORT
05-11-2014	AC	C	FOR REPORT
11-11-2014	LF	D	MINOR CORRECTIONS ON DRAWING
14-11-2014	LF	E	CULVERTS SIDES CHANGED TO 3m x 4m

CLIENT

DEPARTMENT OF WATER AFFAIRS

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PROJECT

SKOENMAKERS RIVER REHABILITATION

DRAWING TITLE

BRIDGE 6

APPROVED BY BVI

H.RAS | 950347 | 2014
ENGINEER/TECHNOLOGIST | REG. NO. | DATE

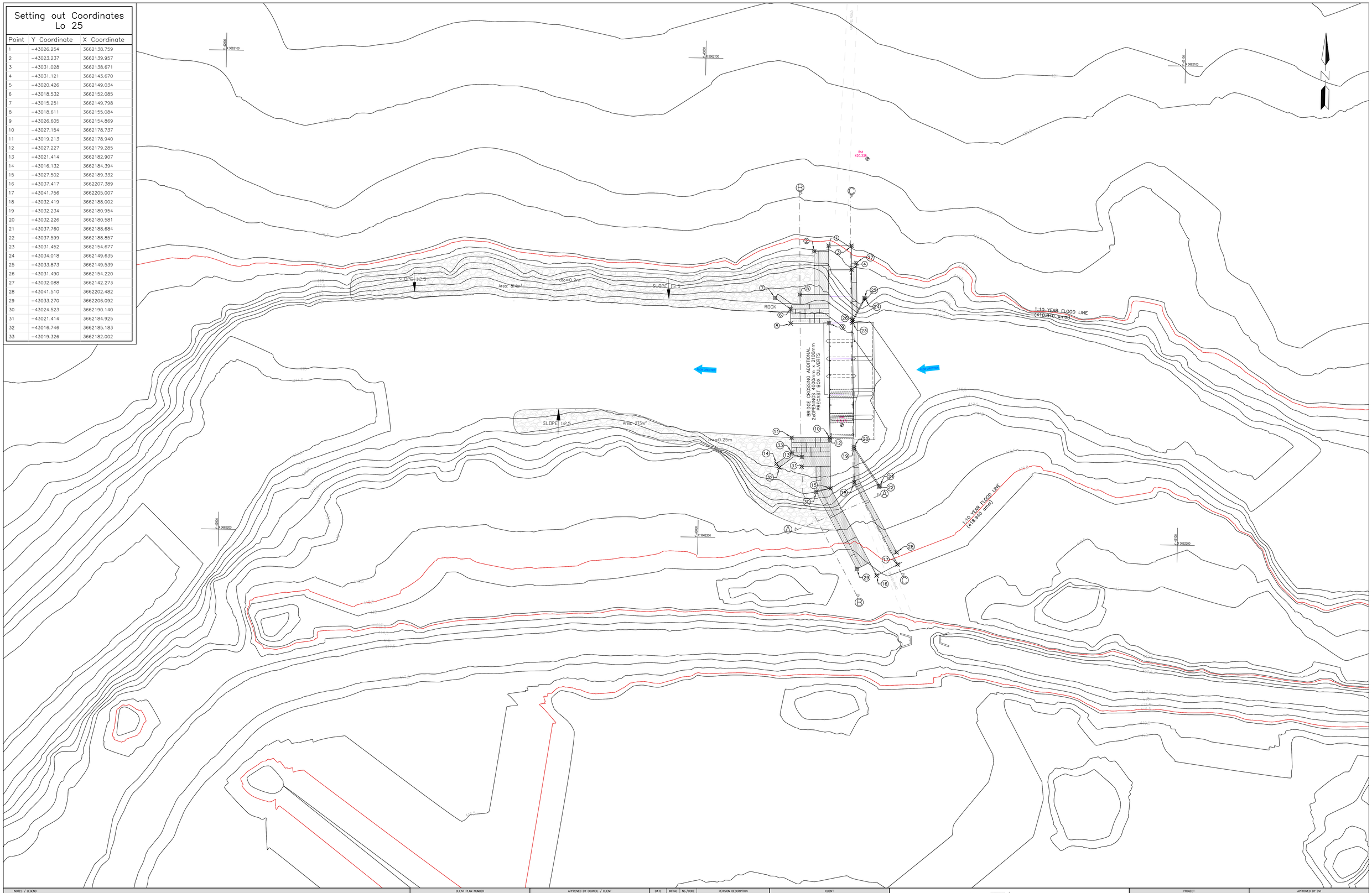
SCALE	AS SHOWN	DRAWN	AC
DESIGNED	RS	CHECKED	HR

PLAN NUMBER	REVISION NO.	DATE SAVED
PE0622S-201-06	E	14-11-2014

A0

Setting out Coordinates Lo 25

Point	Y Coordinate	X Coordinate
1	−43026.254	3662138.759
2	−43023.237	3662139.957
3	−43031.028	3662138.671
4	−43031.121	3662143.670
5	−43020.426	3662149.034
6	−43018.532	3662152.085
7	−43015.251	3662149.798
8	−43018.611	3662155.084
9	−43026.605	3662154.869
10	−43027.154	3662178.737
11	−43019.213	3662178.940
12	−43027.227	3662179.285
13	−43021.414	3662182.907
14	−43016.132	3662184.394
15	−43027.502	3662189.332
16	−43037.417	3662207.389
17	−43041.756	3662205.007
18	−43032.419	3662188.002
19	−43032.234	3662180.954
20	−43032.226	3662180.581
21	−43037.760	3662188.684
22	−43037.599	3662188.857
23	−43031.452	3662154.677
24	−43034.018	3662149.635
25	−43033.873	3662149.539
26	−43031.490	3662154.220
27	−43032.088	3662142.273
28	−43041.510	3662202.482
29	−43033.270	3662206.092
30	−43024.523	3662190.140
31	−43021.414	3662184.925
32	−43016.746	3662185.183
33	−43019.326	3662182.002



NOTES / LEGEND

CLIENT PLAN NUMBER

93413/85

REFERENCE DRAWINGS		
NUMBER	REVISION	DRAWING DESCRIPTION

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT _____ REG. NO. _____ DATE _____

A,B,C../ : BEFORE TENDER
0 / : TENDER DRAWING
1,2,3.../ : AFTER TENDER
2 / : AS BUILT

/A : BY CLIENT
/B : BY ARCHITECT
/C : BY MECHANICAL OR ELECTRICAL
/D : BY EIA
/E : BY OTHER ( )

DATE	INITIAL	No./CODE	REVISION DESCRIPTION

CLIENT

DEPARTMENT OF WATER AFFAIRS

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KwaZulu Natal	Durban	(031) 266-8362	dbn@bvi.co.za
	Empangeni	(035) 792-1785	emp@bvi.co.za
Eastern Cape	Port Elizabeth	(041) 373-0430	ptb@bvi.co.za
	Cradock	(048) 881-3344	cdk@bvi.co.za
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PROJECT

SKOENMAKERS RIVER REHABILITATION

DRAWING TITLE

BRIDGE 4 LAYOUT

APPROVED BY BVI

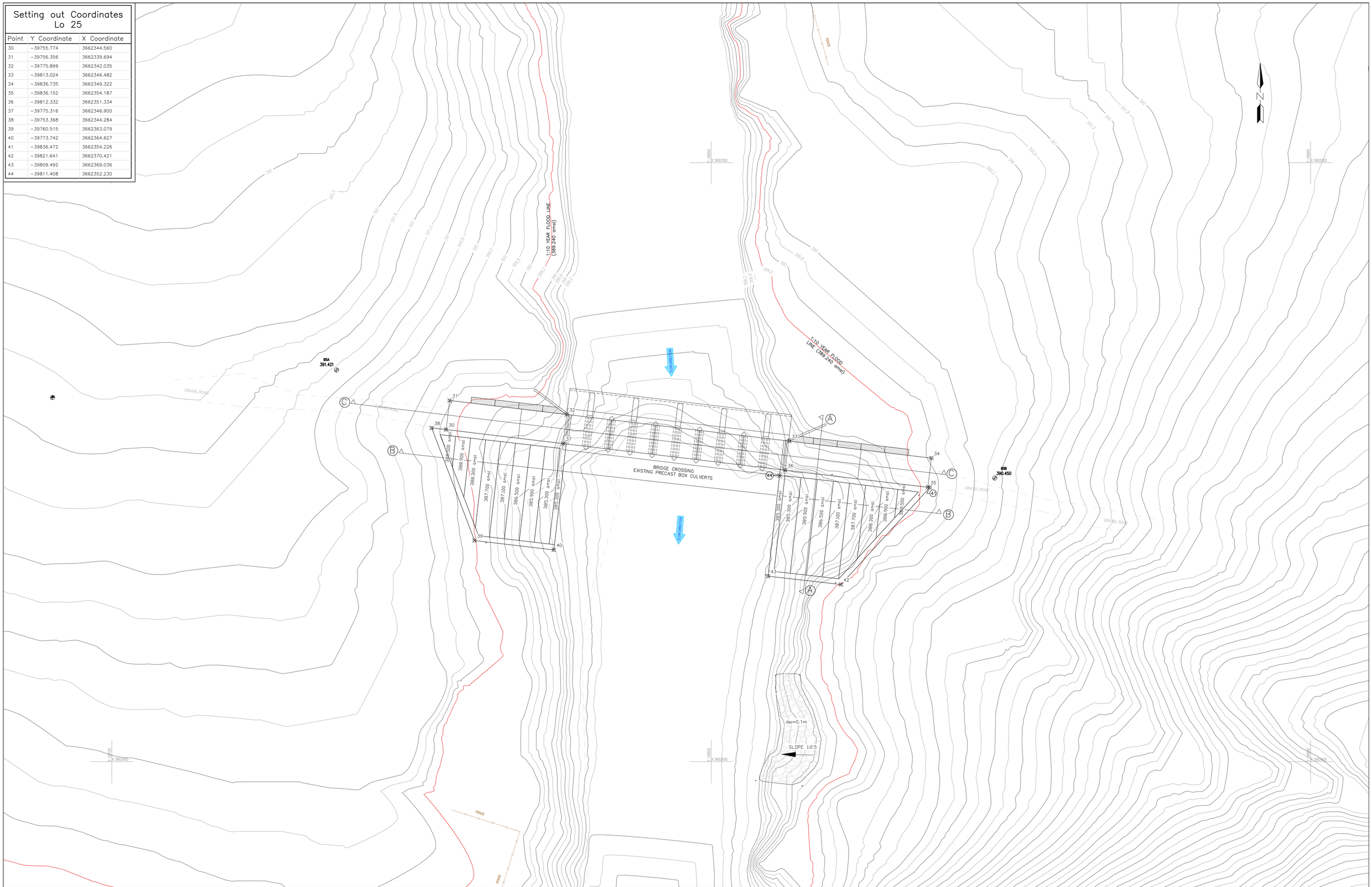
ENGINEER/TECHNOLOGIST _____ REG. NO. _____ DATE _____

SCALE	1:250	DRAWN	JS
DESIGNED	JS	CHECKED	FVG

PLAN NUMBER	REVISION NO.	DATE SAVED
PE0622C_120_04	C	13 Jan 2015 NAME

Setting out Coordinates Lo 25

Point	Y Coordinate	X Coordinate
30	−39755.774	3662344.560
31	−39756.356	3662339.694
32	−39775.899	3662342.035
33	−39813.024	3662346.482
34	−39836.735	3662349.322
35	−39836.152	3662354.187
36	−39812.332	3662351.334
37	−39775.316	3662346.900
38	−39753.368	3662344.284
39	−39760.515	3662363.079
40	−39773.742	3662364.627
41	−39836.472	3662354.226
42	−39821.641	3662370.421
43	−39809.492	3662369.036
44	−39811.408	3662352.230



NOTES / LEGEND

CLIENT PLAN NUMBER: 93413/85

REFERENCE DRAWINGS

NUMBER	REVISION	DRAWING DESCRIPTION

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT _____ REG. NO. _____ DATE _____

A,B,C../ : BEFORE TENDER
0 / : TENDER DRAWING
1,2,3,.. AFTER TENDER
2 / : AS BUILT

/A : BY CLIENT
/B : BY ARCHITECT
/C : BY MECHANICAL OR ELECTRICAL
/D : BY BVI
/E : BY OTHER ( )

DATE	INITIAL	No./CODE	REVISION DESCRIPTION

CLIENT

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	Springbok	(027) 712-3010	spb@bvi.co.za
KwaZulu Natal	Durban	(031) 268-6302	dbn@bvi.co.za
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ENGINEERING PROCUREMENT MANAGEMENT

CESA GREEN BUILDING COUNCIL

PROJECT: SKOENMAKERS RIVER REHABILITATION

DRAWING TITLE: BRIDGE 5 LAYOUT

APPROVED BY BVI

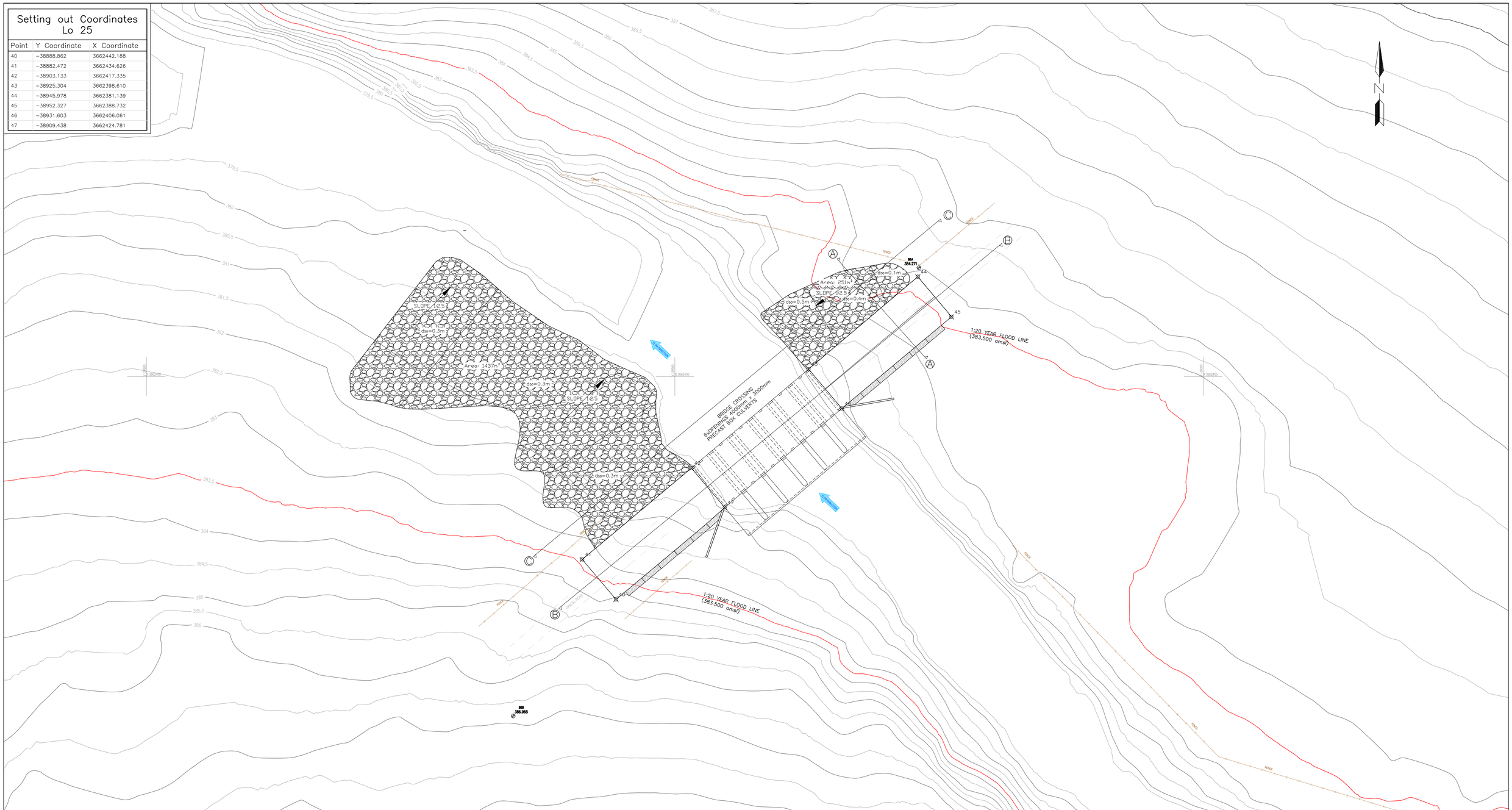
ENGINEER/TECHNOLOGIST _____ REG. NO. _____ DATE _____

SCALE	1:200	DRAWN	DC
DESIGNED	JS	CHECKED	FVC

PLAN NUMBER	REVISION NO.	DATE SAVED
PE0622C_120_05	C	13 Jan 2015 NAME

Setting out Coordinates Lo 25

Point	Y Coordinate	X Coordinate
40	-38888.862	3662442.188
41	-38882.472	3662434.626
42	-38903.133	3662417.335
43	-38925.304	3662398.610
44	-38945.978	3662381.139
45	-38952.327	3662388.732
46	-38931.603	3662406.061
47	-38909.438	3662424.781



NOTES / LEGEND

CLIENT PLAN NUMBER: 93413/85

REFERENCE DRAWINGS		
NUMBER	REVISION	DRAWING DESCRIPTION

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT _____ REG. NO. _____ DATE _____

A,B,C../ : BEFORE TENDER
0 /' : TENDER DRAWING
1,2,3.../ : AFTER TENDER
2 : AS BUILT

/A : BY CLIENT
/B : BY ARCHITECT
/C : BY MECHANICAL OR ELECTRICAL
/D : BY BM
/E : BY OTHER ( )

DATE	INITIAL	No./CODE	REVISION DESCRIPTION

CLIENT

DEPARTMENT OF WATER AFFAIRS

BVI CONSULTING ENGINEERS EASTERN CAPE PTY (Ltd)
Registration no. 1998/000322/07
ENGINEERING PROCUREMENT MANAGEMENT
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PROJECT: SKOENMAKERS RIVER REHABILITATION

DRAWING TITLE: BRIDGE 6 LAYOUT

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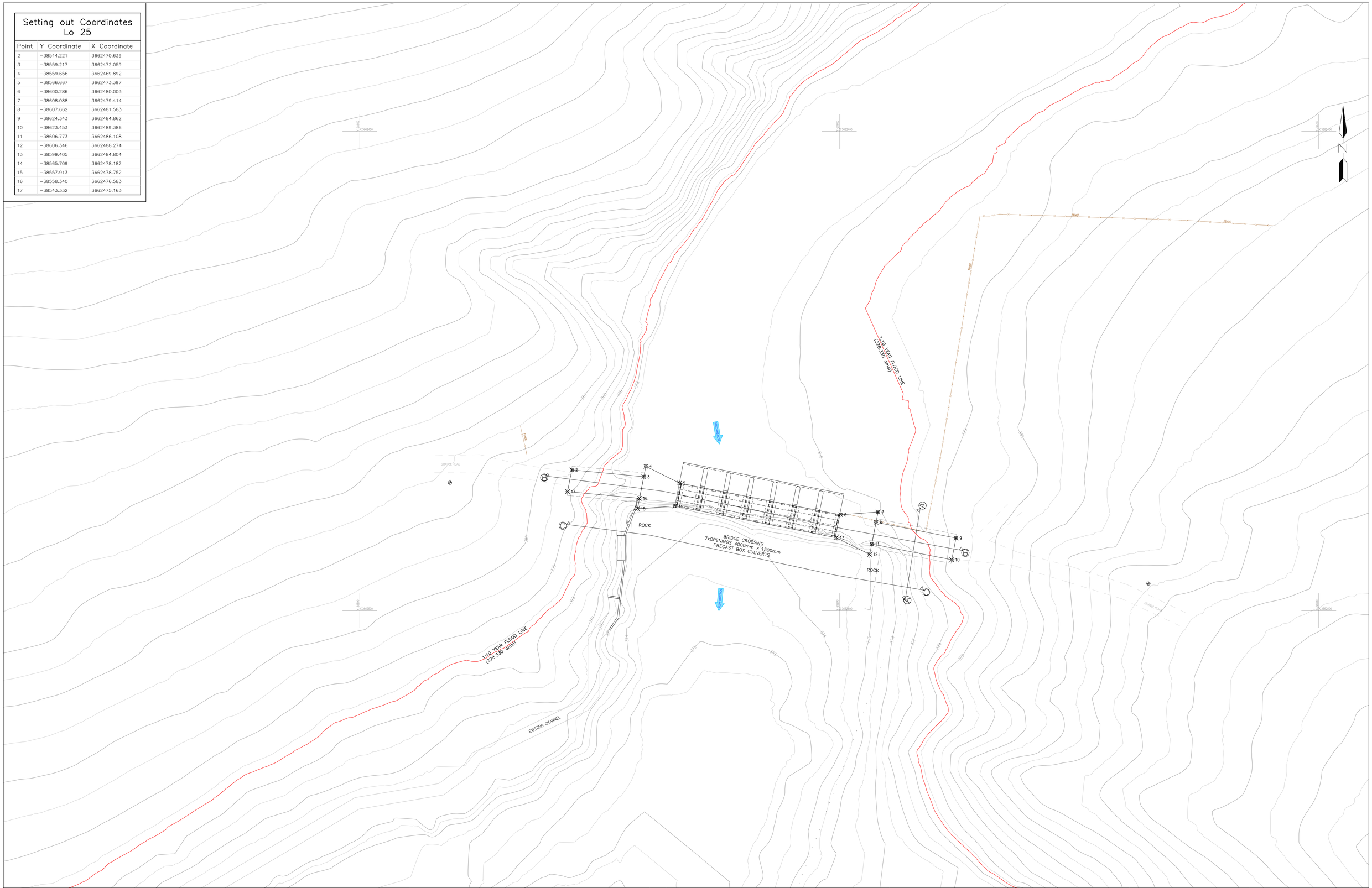

NOTES / LEGEND

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PROJECT

SKOENMAKERS RIVER REHABILITATION

DRAWING TITLE

BRIDGE 7 LAYOUT

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Setting out Coordinates
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49	−33139.377	3662426.354
50	−33134.538	3662425.624
51	−33144.630	3662392.850
52	−33139.808	3662392.093
53	−33147.284	3662378.299
54	−33142.761	3662377.459

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PROJECT

SKOENMAKERS RIVER REHABILITATION

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BRIDGE 8 LAYOUT

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5	−27068.736	3662718.945
6	−27099.764	3662704.561
7	−27104.617	3662700.074
8	−27115.649	3662694.960
9	−27118.509	3662701.129
10	−27101.816	3662708.989
11	−27071.060	3662723.246
12	−27063.284	3662726.851
13	−27034.613	3662734.649
14	−27008.845	3662739.356
15	−27005.940	3662739.887

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PROJECT: SKOENMAKERS RIVER REHABILITATION

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5	−26107.132	3662625.796
6	−26098.157	3662623.021
7	−26098.260	3662622.687
8	−26107.814	3662625.641
9	−26106.674	3662620.629
10	−26154.062	3662609.846
11	−26155.203	3662614.858
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13	−26162.776	3662608.318
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18	−26259.647	3662629.042
19	−26258.845	3662633.855
20	−26156.896	3662619.647
21	−26165.726	3662625.218
22	−26165.566	3662625.471
23	−26156.286	3662619.616
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25	−26062.534	3662643.695

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PROJECT: SKOENMAKERS RIVER REHABILITATION

DRAWING TITLE: BRIDGE 10 LAYOUT

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Appendix D: Specialist Reports

PROJECT INCEPTION REPORT INCLUDING THE FAUNAL, FLORAL, WETLAND AND AQUATIC CONSIDERATIONS FOR THE PROPOSED UPGRADE AND REHABILITATION OF BRIDGE STRUCTURES TRAVERSING THE SKOENMAKERS RIVER IN THE EASTERN CAPE

Prepared for

SRK CONSULTING

May 2014

Prepared by: **Scientific Aquatic Services**
Report author **L. Zdanow (Bsc. Hons)**
Report reviewers **S. van Staden (Pri. Sci. Nat)**
Report Reference: **SAS 214121**
Date: **May 2014**

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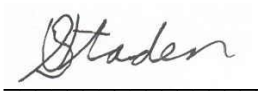
Declaration

This report has been prepared according to the requirements of Section 32 (3b) of the Environmental Impact Assessments EIA Regulations, 2010 (GNR 543). We (the undersigned) declare the findings of this report free from influence or prejudice.

Project Manager:

Stephen van Staden *Pr Sci Nat* (Ecological Sciences) 400134/05
BSc. Hons (Aquatic Health) (RAU);
M.Sc. Environmental Management (RAU).

Field of expertise:
Wetland, aquatic and terrestrial ecology.



Stephen van Staden

Date: 12/05/2014

EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal, wetland and aquatic assessment as part of the Environmental Impact Assessment (EIA) and authorisation process for the proposed upgrade and rehabilitation of bridge structures traversing the Skoenmakers River within Addo in the Eastern Cape Province. The portion of the river to be assessed is located to the east of the R400 and to the west of the R335 and will hereafter be referred to as the study area.

The study area is surrounded by open veld as well as small areas of land used for agriculture. The ecological assessment was confined to the study area and did not include an ecological assessment of surrounding properties. The surrounding area was however considered as part of the desktop assessment of the area.

The following general conclusions were drawn on completion of the inception report:

- The study area is located within the Great Karoo and the Drought Corridor Ecoregions and within the Fish to Tsitsikama Water Management Area (WMA);
- The Skoenmakers River is a perennial river that is classified as a system in a Category E-F condition (Not acceptable). The river is not a flagship river, is not free flowing and is not indicated as a Freshwater Ecosystem Priority Area (FEPA) River (National Freshwater Ecosystems Priority Areas (NFEPA), 2011);
- Five channelled valley bottom wetlands are associated with the Skoenmakers River;
- Channelled valley bottom wetlands are indicated to be in AB (good or natural) and C (moderately modified) conditions and three of the features located to the west of the study area are indicated as FEPA wetlands;
- According to the National List of Threatened Terrestrial Ecosystems (2011) the study area is not located within the remnants of threatened ecosystems;
- According to the National Biodiversity Assessment (NBA, 2011), the study area is not located within a formal or informal protected area. However, the western portion of the study area is located on the boundary of the Addo Elephant National Park which is a Nationally Protected Area;
- According to the National Protected Areas Expansion Project (NPAES, 2010) the western portion of the study area is located within the Baviaans-Addo focus are; and
- The study area is located within the Albany Broken Veld vegetation type which is listed as least threatened for the region (Mucina and Rutherford, 2006).

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ACRONYMS

ABSP	Addo Biodiversity Sector Plan
BGIS	Biodiversity Geographic Information System
CBA	Critical Biodiversity Areas
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EAP	Environmental Assessment Practitioner
EMPr	Environmental Management Programme
ESA	Ecological Supporting Areas
GIS	Geographic Information System
GPS	Global Positioning System
IUCN	International Union for the Conservation of Nature
NBA	National Biodiversity Act
NEMA	National Environmental Management Act
NEMBA	National Environmental Management Biodiversity Act
NFEPA	National Freshwater Ecosytem Priority Areas
NPAES	National Protected Area Expansion Strategy
PES	Present Ecological State
PRECIS	Pretoria Computer Information Systems
QDS	Quarter Degree Square
RDL	Red Data Listed
REC	Recommended Ecological Category
SAFAP	South African Frog Atlas Project
SABCA	South African Butterfly Conservation Assessment
SANBI	South African National Biodiversity Institute
SARCA	South African Reptile Conservation Assessment
SA RHP	South African River Health Program
SAS	Scientific Aquatic Services
WMA	Water Management Area

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal, wetland and aquatic assessment as part of the Environmental Impact Assessment (EIA) and authorisation process for the proposed upgrade and rehabilitation of bridge structures traversing the Skoenmakers River within Addo in the Eastern Cape Province. The portion of the river to be assessed is located to the east of the R400 and to the west of the R335 and will hereafter be referred to as the study area.

The study area is surrounded by open veld as well as small areas of land used for agriculture. The ecological assessment was confined to the study area and did not include an ecological assessment of surrounding properties. The surrounding area was however considered as part of the desktop assessment of the area.

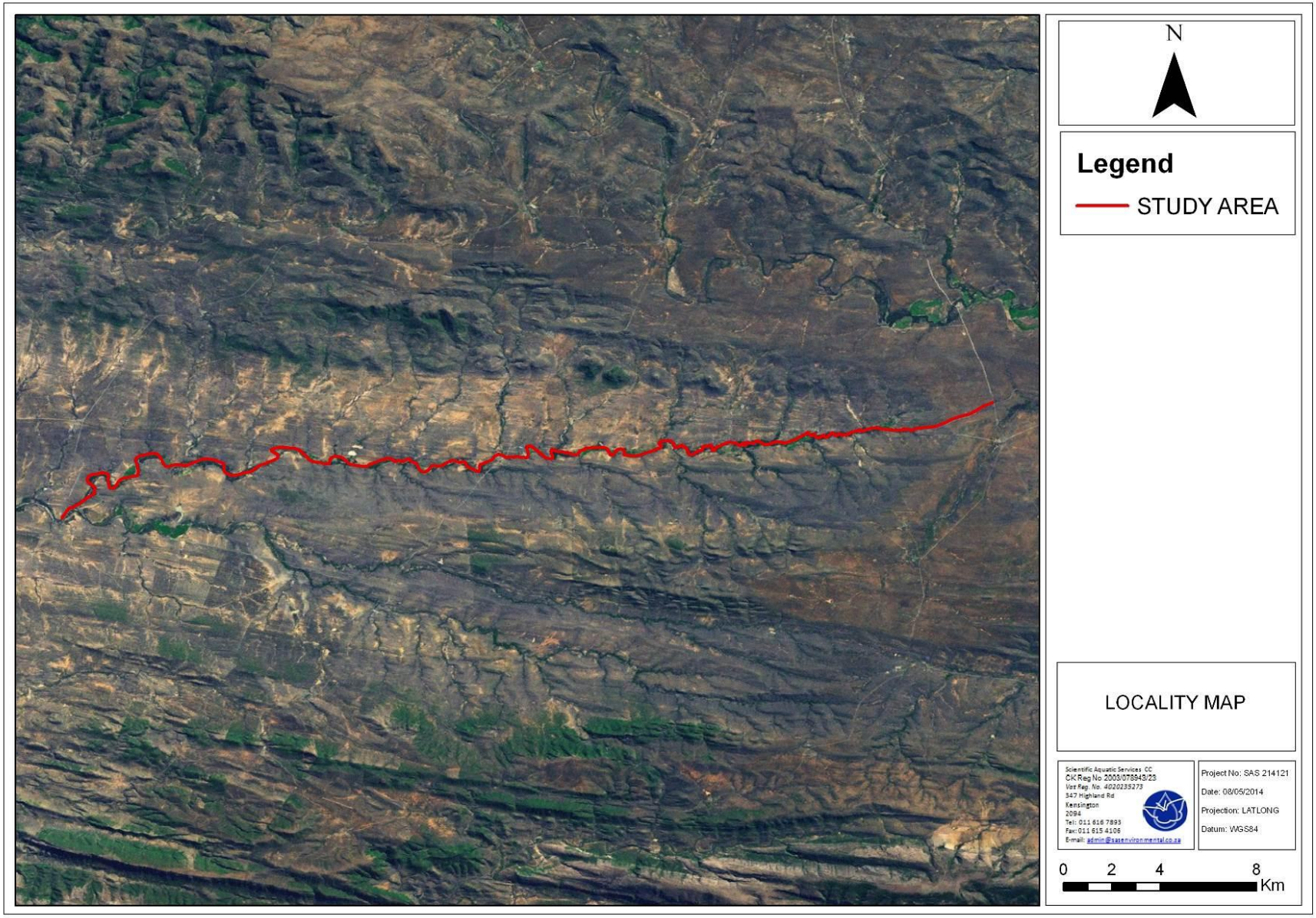

Figure 1: Digital satellite image depicting the location of the study area in relation to the surrounding area.

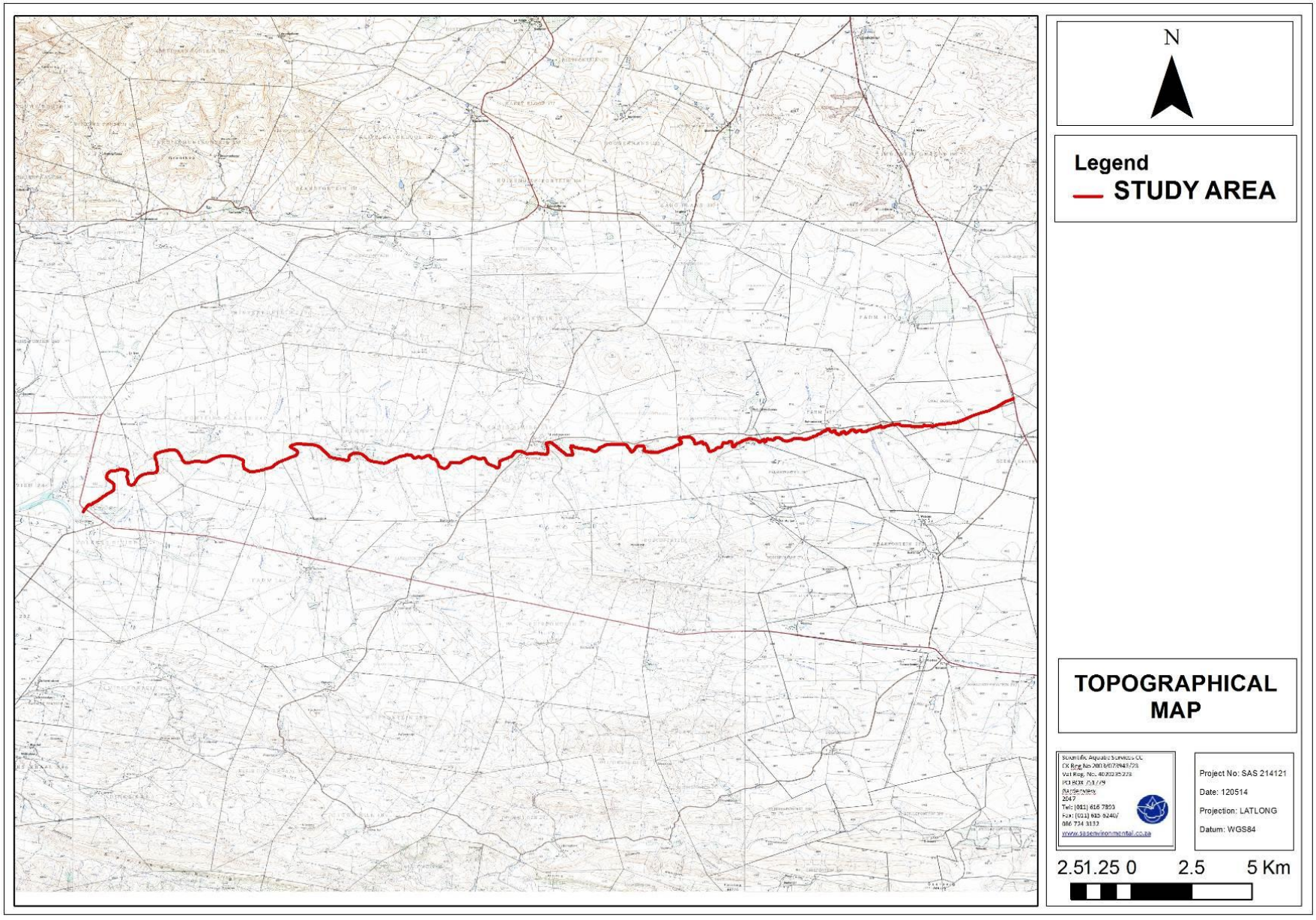

Figure 2: The study area depicted on a 1:50 000 topographical map in relation to its surrounding area.

1.2 Project Scope

Terrestrial Scan

Specific outcomes in terms of the terrestrial assessment report are outlined below:

- A desktop review of distribution lists (including Red Data species) and available literature will be conducted;
- The vegetation type of the area will be defined according to Mucina and Rutherford (2006);
- Extensive consideration will be given to determining the Ecological Importance and Sensitivity (EIS) of the study area according to the Biodiversity Geographic Information Systems (BGIS) database, the SIBIS databases, any national or provincial fine scale plans and the National Biodiversity Assessment (NBA, 2011);
- The South African National Biodiversity Institute (SANBI) and Pretoria Computer Information Systems (PRECIS) databases for the Quarter Degree Square (QDS) will also be consulted in order to determine potential floral and faunal species which may occur in the area;
- Distribution and preferred habitat of faunal species listed within the SIBIS and International Union for the Conservation of Nature (IUCN) databases will also be noted; and
- Taxa specific lists will also be compiled with the use of databases such as the South African Frog Atlas Project (SAFAP), the South African Butterfly Conservation Assessment (SABCA) and the South African Reptile Conservation Assessment (SARCA).

Aquatic Assessment

Specific outcomes in terms of the aquatic assessment report are outlined below:

- The aquatic assessment will include a survey of general habitat integrity, habitat conditions for aquatic macro-invertebrates and aquatic macro-invertebrate community integrity;
- The protocols of applying the indices will be strictly adhered to and all work will be done by a South African River Health Program (SA RHP) accredited assessor;
- Representative aquatic ecological assessment points will be identified which will be used to define the Present Ecological State (PES) of the riverine features in the vicinity of the dam options and proposed infrastructure;
- The aquatic assessment section of this report will serve to document the condition at the time of sampling to indicate the state of the riverine ecological integrity; and

- The results of the study can be used to aid in the development of design criteria for the bridge crossings and the rehabilitation works to be undertaken on the riverine system.

Wetland Assessment

Specific outcomes in terms of the wetland assessment report are outlined below:

- The classification of wetland features according the Classification System for Wetlands and other Aquatic Ecosystems in South Africa as defined by Ollis *et al*., 2013 will be applied;
- The wetland services provided by the resources in the study area according to the Method of Kotze *et al* (2008) will be determined;
- The wetland Health according to the resource directed measures guideline as defined by Macfarlane *et al*., (2009) will be determined;
- The wetland temporary zone will be delineated according to "DWA (Department of Water Affairs), 2005: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones";
- The Environmental Importance and Sensitivity will be determined;
- A Recommended Ecological Category (REC) will be recommended, where applicable, based on the findings of the EIS assessment;
- The environmental impact on the wetland and rivers will be determined;
- Mitigatory measures to minimise impacts will be recommended should the proposed activities proceed;
- Wetland features located further from the proposed activities that will still fall within the 500 m boundary of applicability of General Notice no. 1199 as it relates to the National Water Act will be identified; and
- The results of the study can be used to aid in the development of design criteria for the bridge crossings and the rehabilitation works to be undertaken on the riverine system.

2 ECOLOGICAL DESKTOP DESCRIPTION

The following sections (Sections 2.1 – 2.8) present data accessed as part of the desktop assessment. This section is divided into terrestrial (includes floral and faunal assessments) as well as wetland and aquatic conservational importance. It is important to note, that although all data sources used provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the study area's actual site characteristics. This information is however considered to be

useful as background information to the study. Thus, this data will be used as a guideline to inform the assessment and special attention will be afforded to areas indicated to be of higher conservation importance.

2.1 Ecoregions

The study area falls within the Great Karoo and Drought Corridor Aquatic Ecoregions and the Fish to Tsitsikama Water Management Area (WMA). This database was used as reference for the catchment of concern in order to define the EIS, PEMC and DEMC. Figure 3 below indicate the aquatic ecoregion and quaternary catchments of the study area:

The study area is located within the N23A quaternary catchment. The results of the assessment are summarised in the table below.

Table 1: Summary of the ecological status of quaternary catchment N23A based on Kleynhans 1999.

Name	Rivers	EIS	DEMC	PEMC
N23A	Main Sundays (dam)	Moderate	C: Moderately Sensitive Systems	CLASS E or F: not acceptable

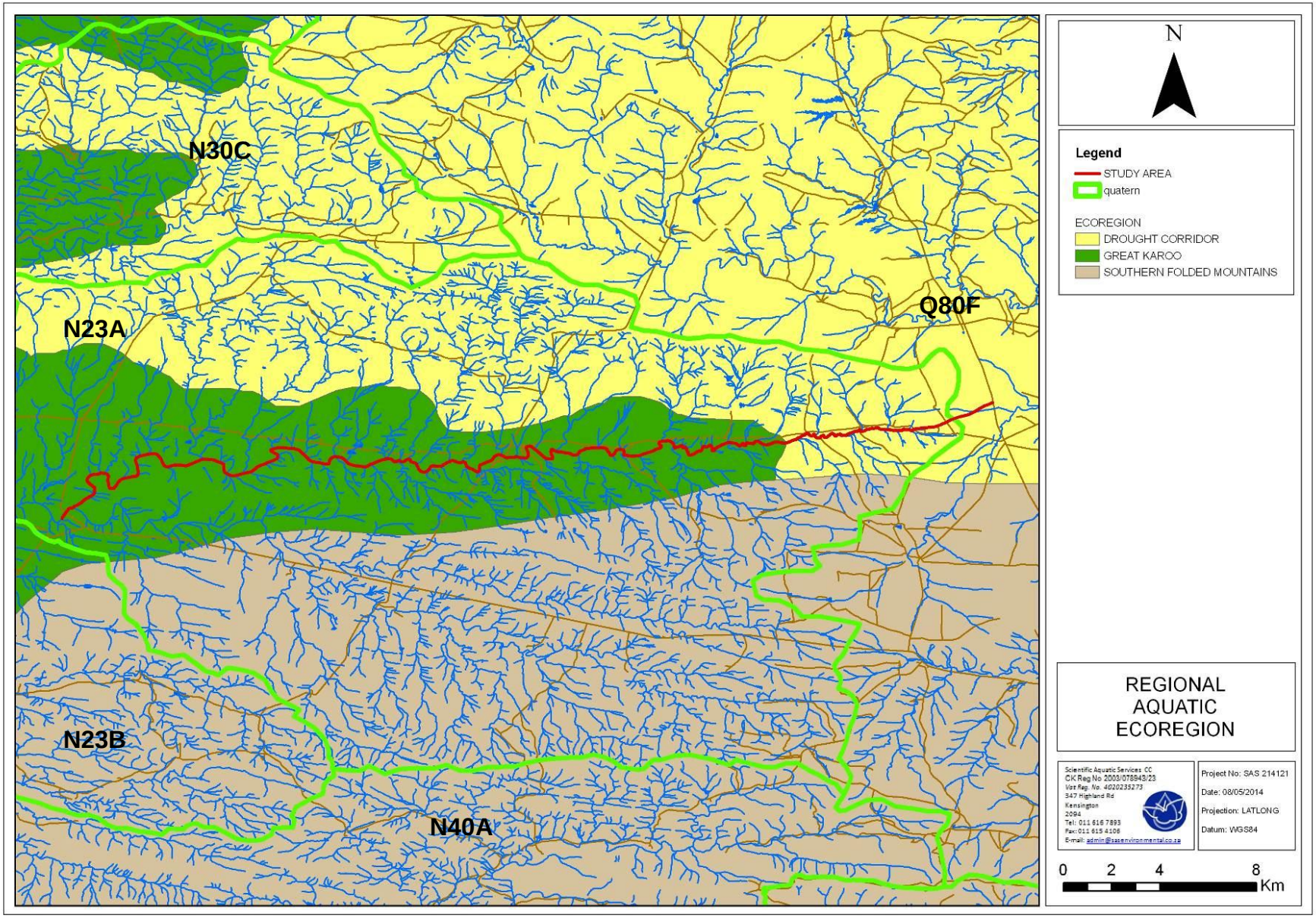

Figure 3: Ecoregion and quaternary catchment associated with the Study area.

2.2 National Freshwater Ecosystem Priority Areas (NFEPAs; 2011)

The National Freshwater Ecosystem Priority Areas (NFEPA) database was consulted to define the aquatic ecology of the wetland systems close to or within the study area that may be of ecological importance.

Aspects applicable to the study area are discussed below:

- The study area falls within the Fish to Tsitsikama Water Management Area (WMA). Each Water Management Area is divided into several sub-Water Management Areas (subWMA), where catchment or watershed is defined as a topographically defined area, which is drained by a stream, or river network. The subWMA indicated for the study area is the Sundays subWMA;
- The subWMA is not regarded as important with regards to fish migrational corridors, fish translocation or fish rehab;
- The Skoenmakers River is a perennial river that is classified as a system in a Category E-F condition (Not acceptable). The river is not a flagship river, is not free flowing and is not indicated as a Freshwater Ecosystem Priority Area (FEPA) River;
- The wetland vegetation group indicated for the stretch of river is the Lower Nama Karoo vegetation group;
- Five channelled valley bottom wetlands are associated with the River;
- Channelled valley bottom wetlands are indicated to be in AB (good or natural) and C (moderately modified) conditions (Figure 4) and three of the features located to the west of the study area are indicated as FEPA wetlands (Figure 5).

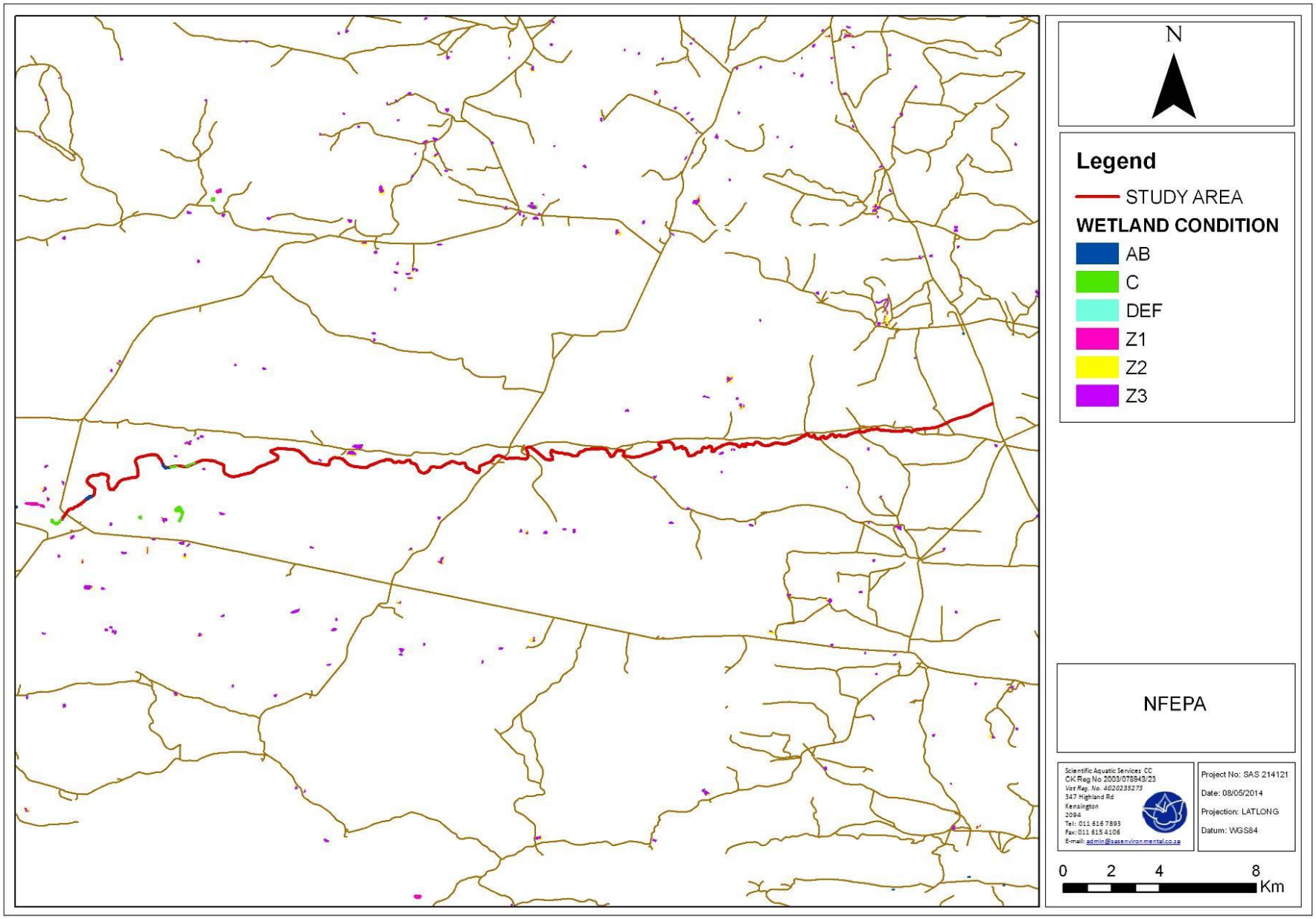

Figure 4: Wetland condition indicated by the NFEPA database.

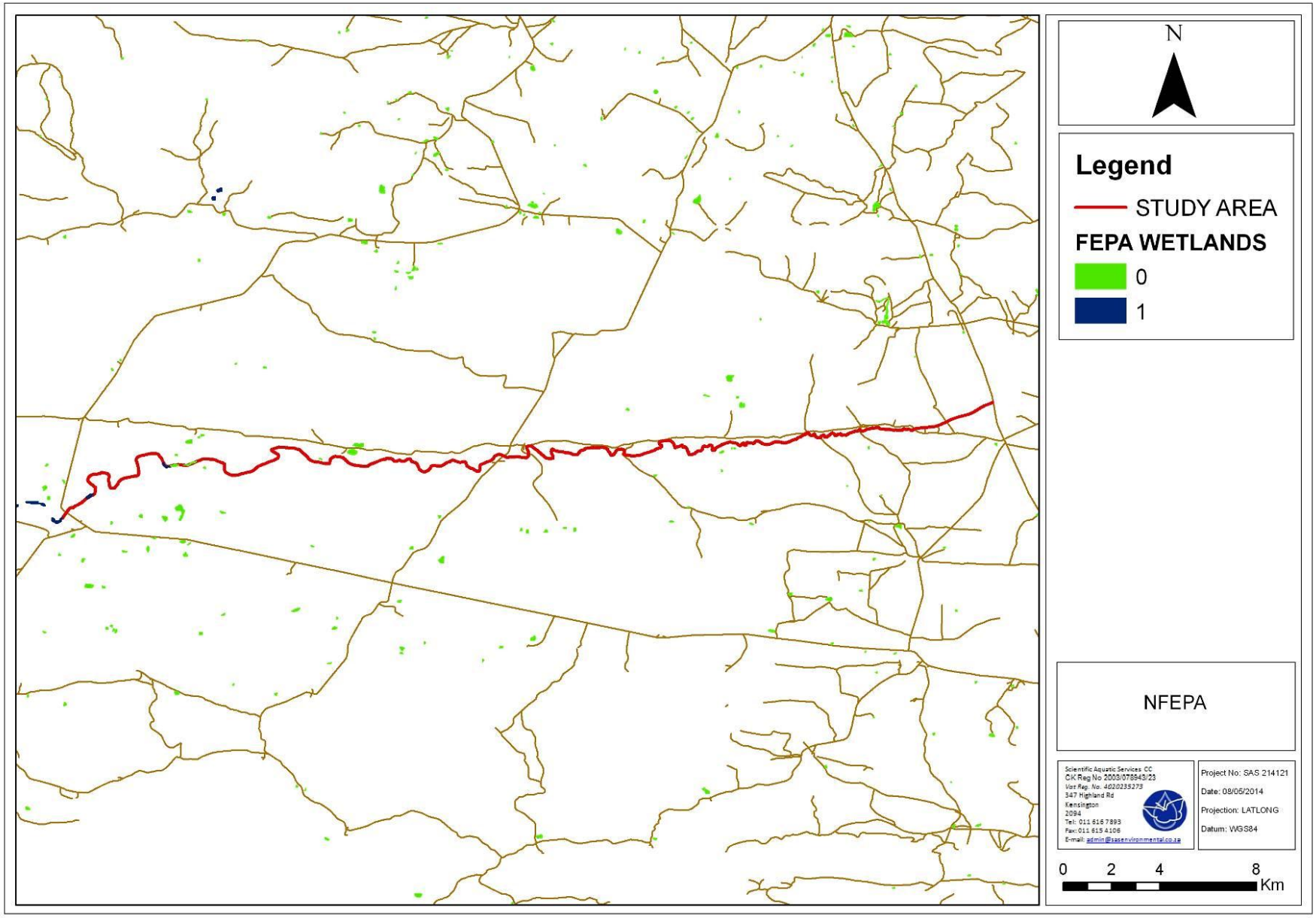

Figure 5: FEPA wetlands (1= FEPA wetland, 2= non-FEPA wetland).

2.3 National List of Threatened Terrestrial Ecosystems for South Africa (2011)

The National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA) provides for listing of threatened or protected ecosystems, in one of four categories: critically endangered, endangered, vulnerable or protected. Threatened ecosystems are listed in order to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to conserve sites of exceptionally high conservation value (SANBI, BGIS).

According to the National List of Threatened Terrestrial Ecosystems (2011) the study area is not located within a threatened terrestrial ecosystem.

2.4 National Protected Area Expansion Strategy (NPAES, 2010)

The goal of NPAES is to achieve cost effective protected area expansion for ecological sustainability and adaptation to climate change. The NPAES sets targets for protected area expansion, provides maps of the most important areas for protected area expansion, and makes recommendations on mechanisms for protected area expansion. It deals with land-based and marine protected areas across all of South Africa's territory (SANBI BGIS).

According to the NPAES database, the western portion of the study area intersects a portion of the Baviaans-Addo focus area (Figure 6). However, focus areas should not be seen as future boundaries of protected areas, as in many cases only a portion of a particular focus area would be required to meet the protected area targets set in the NPAES.

2.5 National Biodiversity Assessment (NBA, 2011)

The recently completed NBA provides an assessment of South Africa's biodiversity and ecosystems, including headline indicators and national maps for the terrestrial, freshwater, estuarine and marine environments. The NBA was led by the SANBI in partnership with a range of organisations. It follows on from the National Spatial Biodiversity Assessment 2004, broadening the scope of the assessment to include key thematic issues as well as a spatial assessment. The NBA includes a summary of spatial biodiversity priority areas that have been identified through systematic biodiversity plans at national, provincial and local levels (SANBI BGIS).

According to the NBA, the western portion of the study area is located on the boundary of the Addo Elephant National Park which is a National Protected Area.

2.6 Importance According to the Addo Biodiversity Sector Plan (ABSP; 2012)

The Addo Biodiversity Sector Plan (BSP) is intended to guide land-use planning, environmental assessments and land-use authorisations, as well as natural resource management, in order to promote the sustainable development agenda. The BSPs have been developed to further the awareness of the areas unique biodiversity, the value this biodiversity represents to people and to promote management mechanisms that can ensure the protection and sustainable utilization of the regions biodiversity.

The BSP of the study area has indicated that:

- The majority of the study area is located within a Critical Biodiversity Area (CBA) which is associated with the Skoenmakers River (Figure 7);
- CBAs are terrestrial and aquatic areas which must be safeguarded in their natural or near-natural state as they are critical for conserving biodiversity and maintaining ecosystem functioning;
- The western portion of the study area is located on the border of the Addo Elephant National Park which is a national protected area (Figure 7).

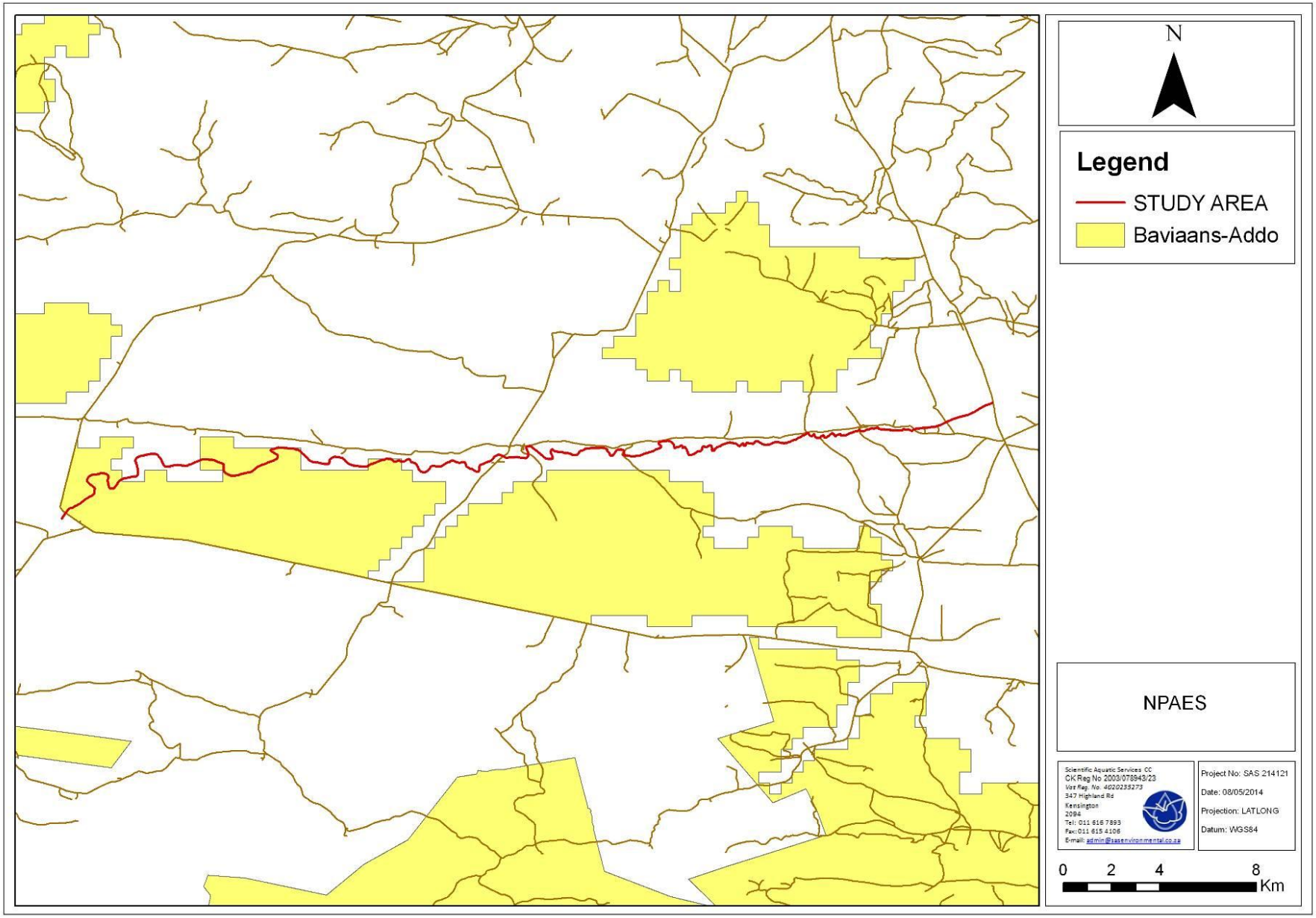

Figure 6: NPAES Focus Areas associated with the study area.

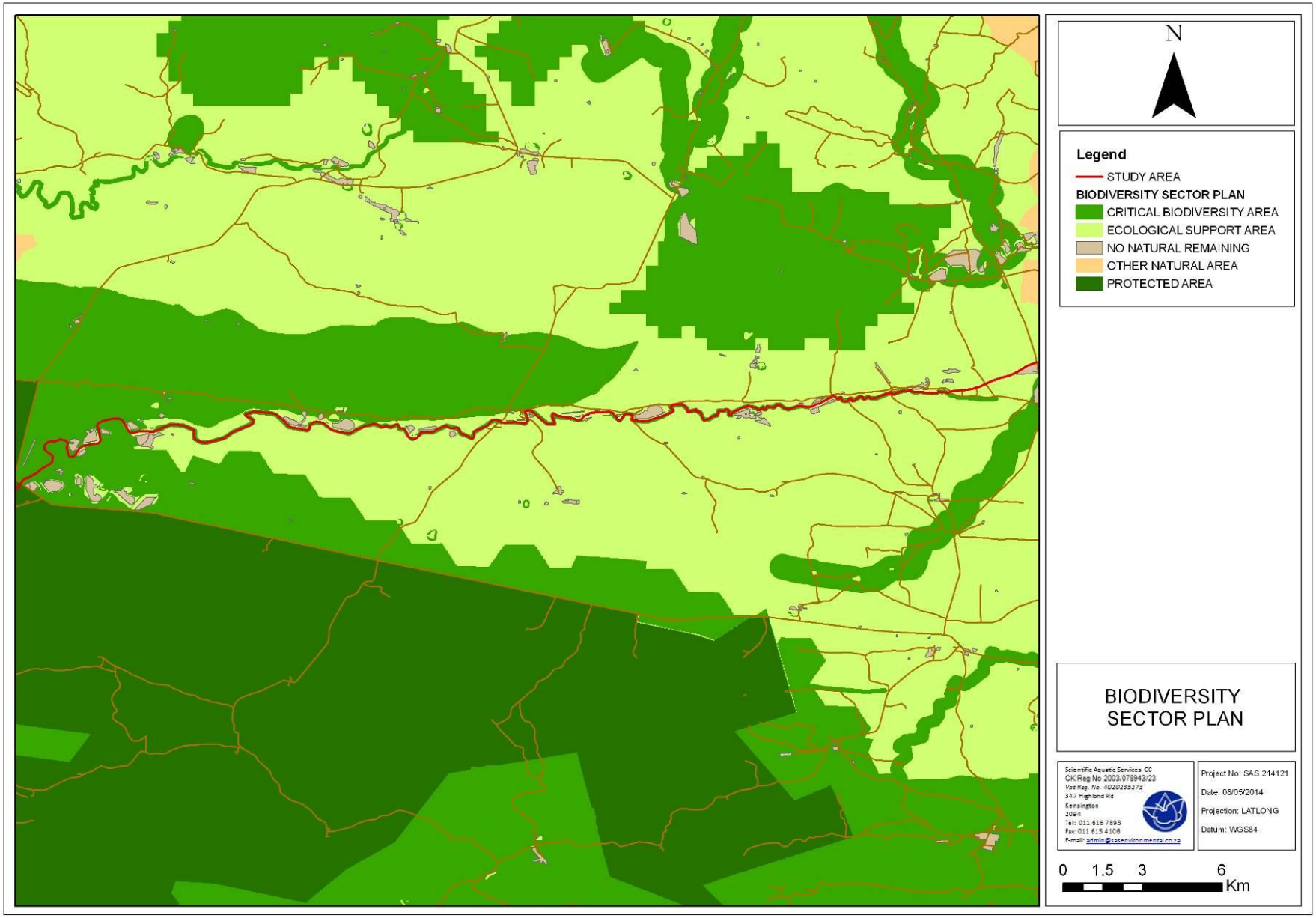

Figure 7: Critical Biodiversity Areas and Ecological Support Areas associated with the study area.

2.7 Biome and Bioregion

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford, 1997). The study area falls within the Nama-karoo biome (Rutherford and Westfall, 1994). Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. The study area falls within the Lower Karoo Bioregion (Mucina and Rutherford, 2006) (Figures 8 and 9).

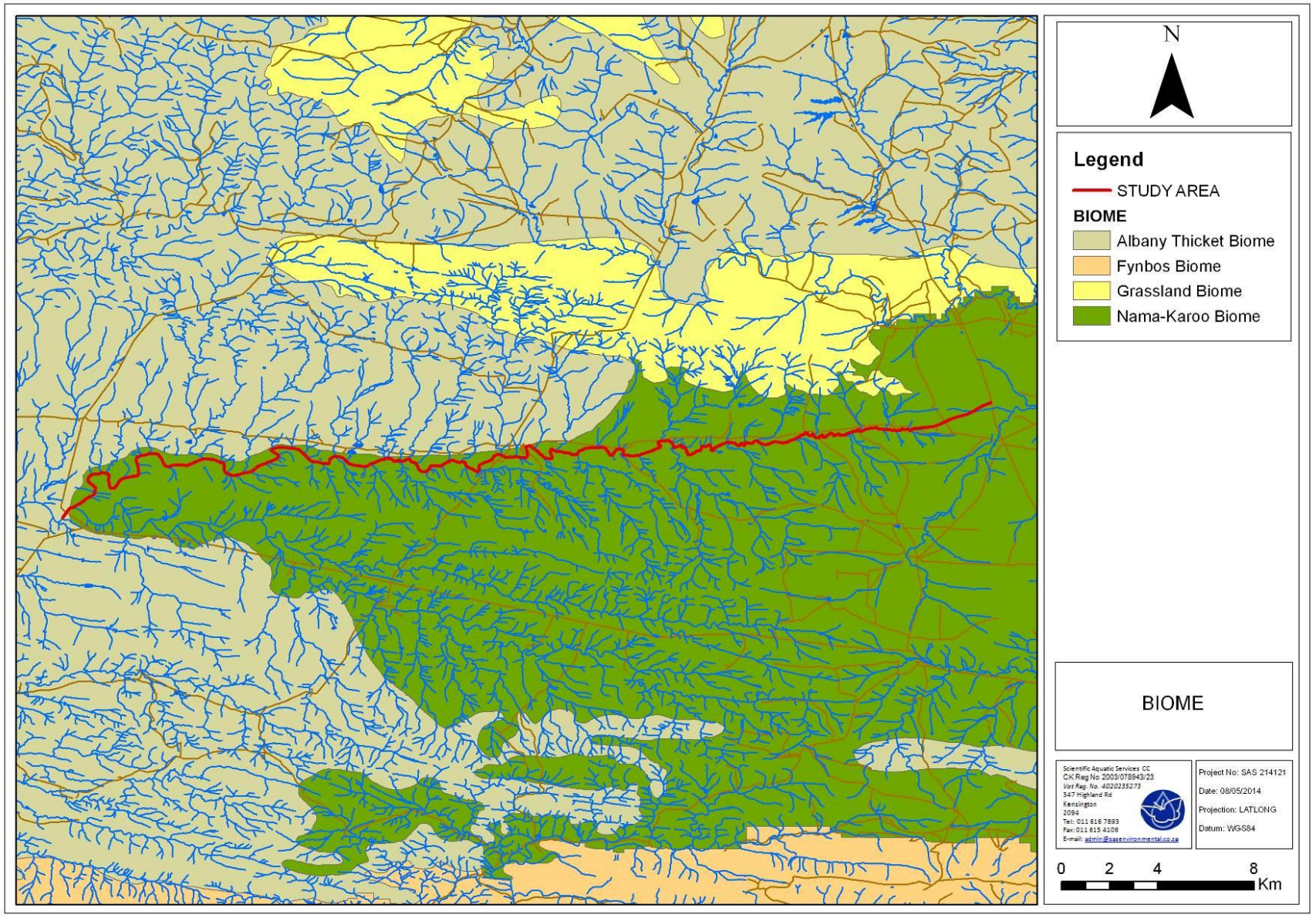

Figure 8: Biomes associated with the study area (Mucina and Rutherford, 2006).

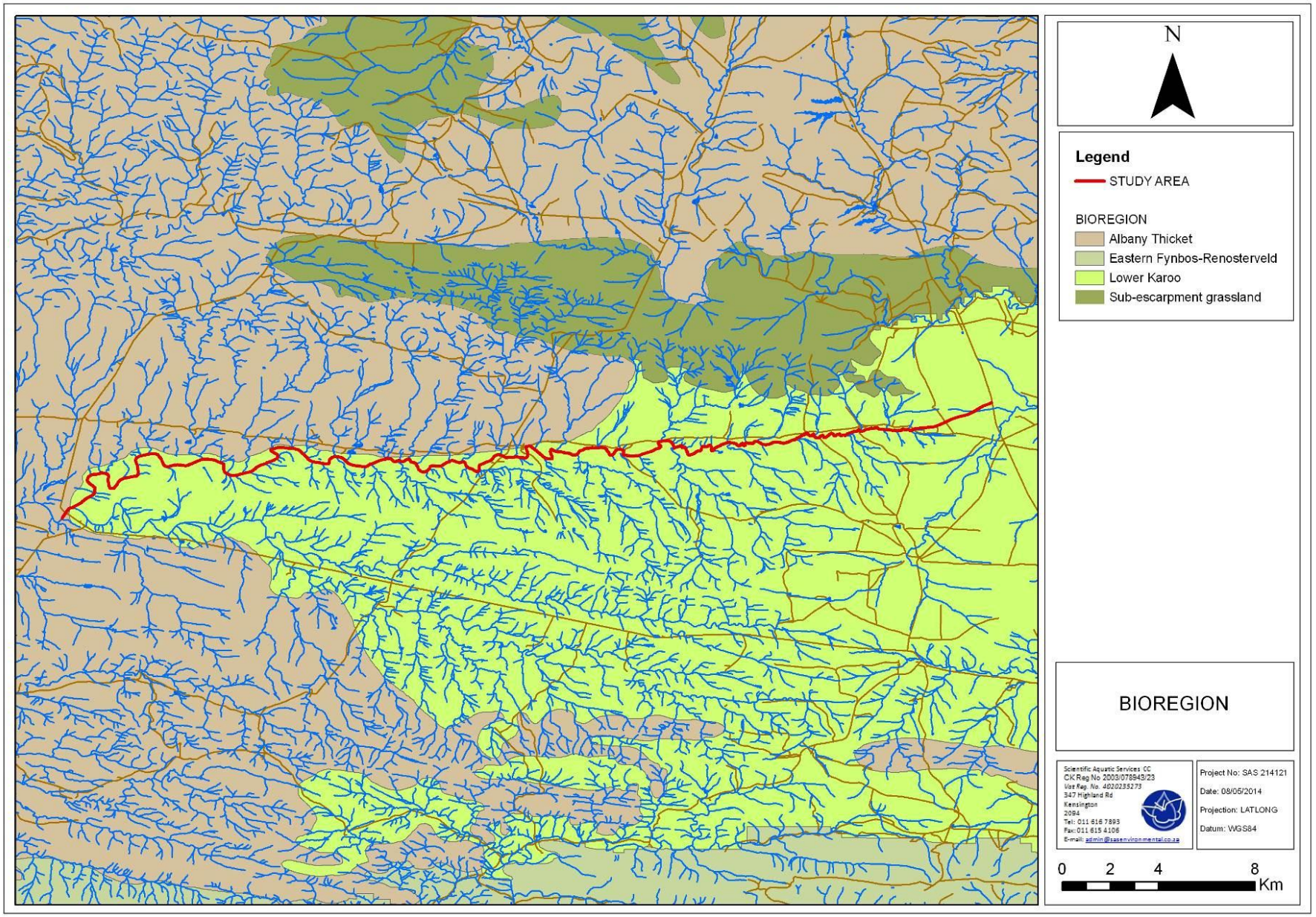

Figure 9: Bioregions associated with the study area (Mucina and Rutherford, 2006).

2.8 Vegetation Type

2.8.1 Albany Broken Veld

2.8.1.1 Distribution

Eastern Cape Province: Immediately to the north of the Zuurberg Mountains and south of Middelwater, Ripon and the area around the confluence of the Great and Little Fish Rivers and extending eastwards, north of the mountain ridges around Riebeeck East to the Carlisle Bridge are and south of these in the upper Bushman's River Valley past Alicedale and up the New Years River Valley. Including also some irregular linear patches east of Riebeeck East. Altitude varies mostly from 300-800 m.

2.8.1.2 Climate

Albany Broken Veld has a bimodal rainfall with main peak in March and secondary peak in November. Some rain falls in the winter months. Rainfall relatively high for the Nama-Karoo. Incidence of frost is low, with less than a tenth of the area experiencing more than 10 frost days per year. Mean annual precipitation ranges from about 290 mm in the west (in the rainshadow of the Zuurberg) to about 500 mm in the east.

2.8.1.3 Geology and soils

Mainly shales and some sandstones of various stratigraphic units within the Witteberg Group of the Cape Supergroup and the Beaufort, Ecca and Dwyka Groups of the Karoo Supergroup. Mainly Glenrosa and/or Mispah soils (Fc land type) with some red-yellow, apedal, drained soils, with a high base status, generally <300 mm deep, typical of Ag land type.

2.8.1.4 Conservation

This vegetation type is considered least threatened with a target of 16%. Only a small percentage is statutorily conserved in Greater Addo Elephant National Park, but considerable share (12%) enjoys protection in private reserves (Kuzuko Game Reserve, Frontier Safaris Game Reserve, Aylesbury Nature Reserve, Rockdale Game Ranch and Woodlands Game Reserve). About 3% transformed for cultivation. Erosion is moderate (68%), low (16%) or high (14%).

2.8.1.5 *Floral characteristics of the Albany Broken Veld* vegetation type

This vegetation type differs in a number of respects from those of the rest of the Nama-Karoo. Apart from climatic differences (highest rainfall, least frost), this type has a number of important species that are regarded as not important elsewhere in the Nama-Karoo. It is also the only vegetation type within the Nama-Karoo in which species such as *Enneapogon desvauxii* do not qualify as an important species.

The following flora is indicators of the *Albany Broken Veld* vegetation type ([T]Cape Thickets, [W]Wetlands):

Succulent Tree: *Aloe ferox*;

Small trees: *Acacia natalitia* (d), *Euclea undulata* (d), *Pappea capensis* (d), *Schotia afra* var. *afra* (d), *Boscia oleoides*, *Cussonia spicata*;

Tall shrubs: *Grewia robusta, Lycium cinereum, Putterlickia pyracantha, Rhigozum obovatum, Rhus incisa* var. *effuse;*

Low Shrubs: *Asparagus striatus* (d), *A. suaveolens* (d), *Becium burchellianum* (d), *Chryscoma ciliata* (d), *Selago fruticosa* (d), *Asparagus acocksii*, *A. racemosus, Eriocephalus ericoides* subsp. *Erocoides, Felicia filifolia, F. muricata, Gnidia cuneata, Helichrysum dregeanum, Hermannia linearifolia, Indigofera sessilifolia, Limeum aethiopicum, Nenax microphylla, Pentzia incana, Polygala aethiopicum, Nenax microphylla, Pentzia incana, Polygala seminuda, Rosenia humilis*;

Succulent Shrubs: *Cotyledon campanulata, Drosanthemum lique, Euphorbia meloformis, E. rectirama, Faucaria britteniae, F. tigrina, Mestoklema tuberosum*;

Herbs: *Gazania krebsiana, Hermannia pulverata, Hibiscus pusillus;*

Geophytic herbs*: Bulbine frutescens, Drimia anomala, Eriospermum dregei, Ornithogalum dyeri;*

Succulent Herbs: *Gasteria bicolor, Ophionella arcurata subsp. arctuata, Platythyra hackeliana, Senecio radicans, Stapeliopsis pillansii;*

Graminoids: *Aristida congesta* (d), *Eragrostis obtuse* (d), *Sporobolus fimbriatus* (d), *Tragus berteronianus* (d), *Cynodon incompletes*, *Digitaria eriantha*, *Ehrharta calycina*, *Eragrostis curvula, Setaria sphacelata, Tragus koeleroides*.

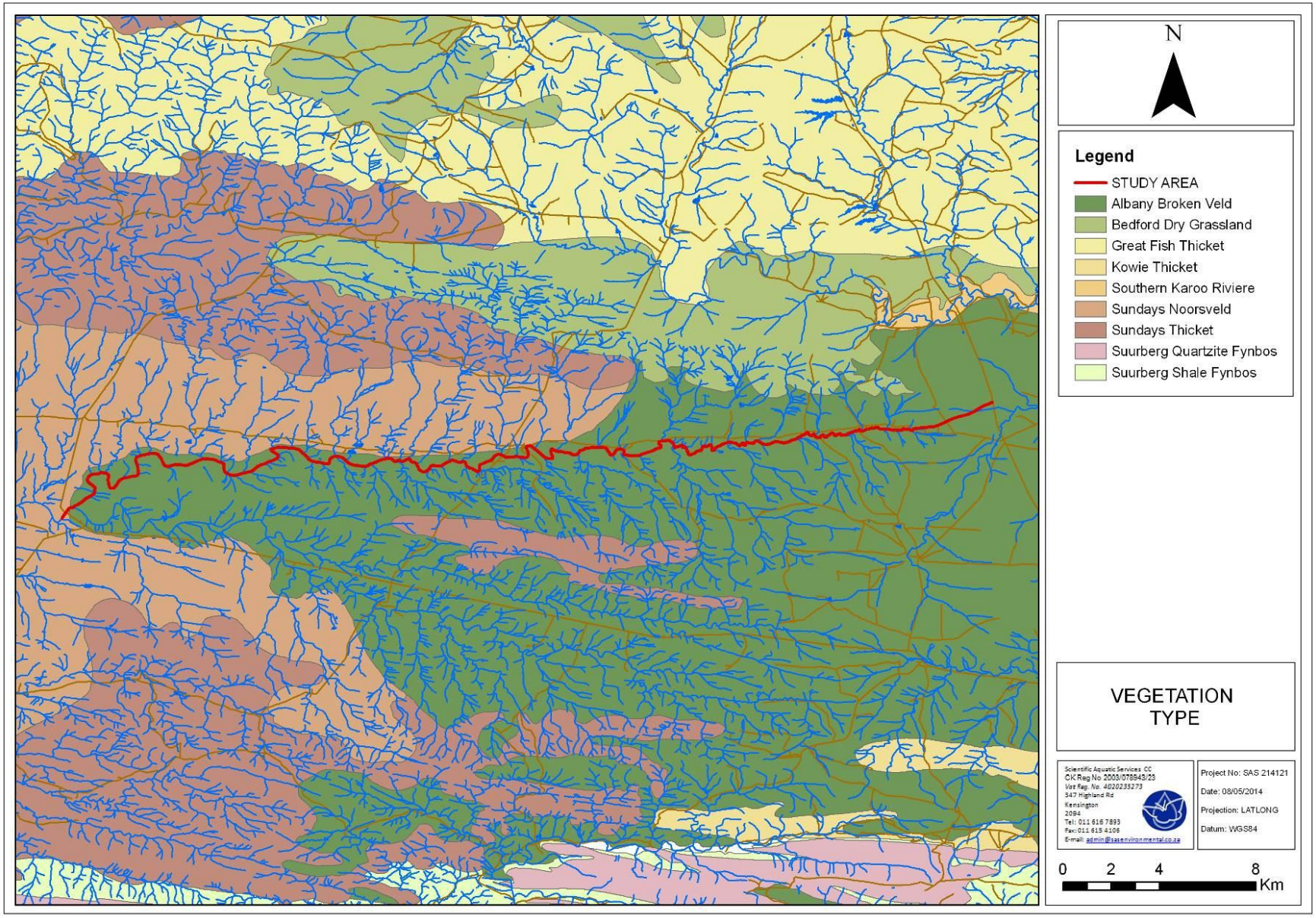

Figure 10: Vegetation types associated with the study area (Mucina and Rutherford, 2006).

3 PLAN OF STUDY FOR EIA/EMPR PHASE

3.1 Floral Method of Assessment

A desktop review of distribution lists and available literature will be conducted. The vegetation type of the area will be defined according to Mucina and Rutherford (2006). Extensive consideration will also be given to determining the EIS of the study area according to the BGIS and SIBIS databases.

A brief site visit will be undertaken to establish an understanding of the general floral characteristics within the study area. Prior to the field visit, a record of Red Data List plant species and their habitat requirements will be acquired from SANBI for the quarter degree grid squares 3325AB and 3325BA. Throughout the floral assessment special attention will be paid to identification of any of these RDL species as well as identification of suitable habitat that could potentially sustain these species.

Potential floral rescue and relocation requirements will be identified and any specific requirements for protected floral species that will need to be utilised during rehabilitation will be discussed.

3.2 Faunal Method of Assessment

Consideration will be given to determining the EIS of the riparian feature according to the BGIS, any National or Provincial fine scale plans applicable to the region as well as the National Biodiversity Assessment. Distribution and preferred habitat of faunal species listed within the SIBIS and IUCN databases will also be noted. Taxa specific lists will also be compiled with the use of databases such as the SAFAP, the SABCA and the SARCA.

A brief site visit will be undertaken to establish an understanding of the general faunal characteristics within the study area. Special attention will be paid to the identification of RDL faunal species as well as potential habitat that may sustain these species and the probability of occurrence of RDL faunal species within the study area will be discussed.

3.3 Wetland Method of Assessment

3.3.1 Classification System for Wetlands and other Aquatic Ecosystems in South Africa (2013)

All wetland or riparian features encountered within the study area will be assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the "classification system" (Ollis *et al*., 2013). A summary of Levels 1 to 4 of the classification system are presented in Table 2 and 3, below.

Table 2: Proposed classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table 3: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

3.3.2 Level 1: Inland systems

From the classification system, Inland Systems are defined as **an aquatic ecosystem that have no existing connection to the ocean**[1] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but **which are inundated or saturated with water, either permanently or periodically.** It is important to bear in mind, however, that certain Inland Systems may have had an historical connection to the ocean, which in some cases may have been relatively recent.

3.3.3 Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that will be included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland (figure below). DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) group's vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) will be derived by further splitting Bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

[1] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

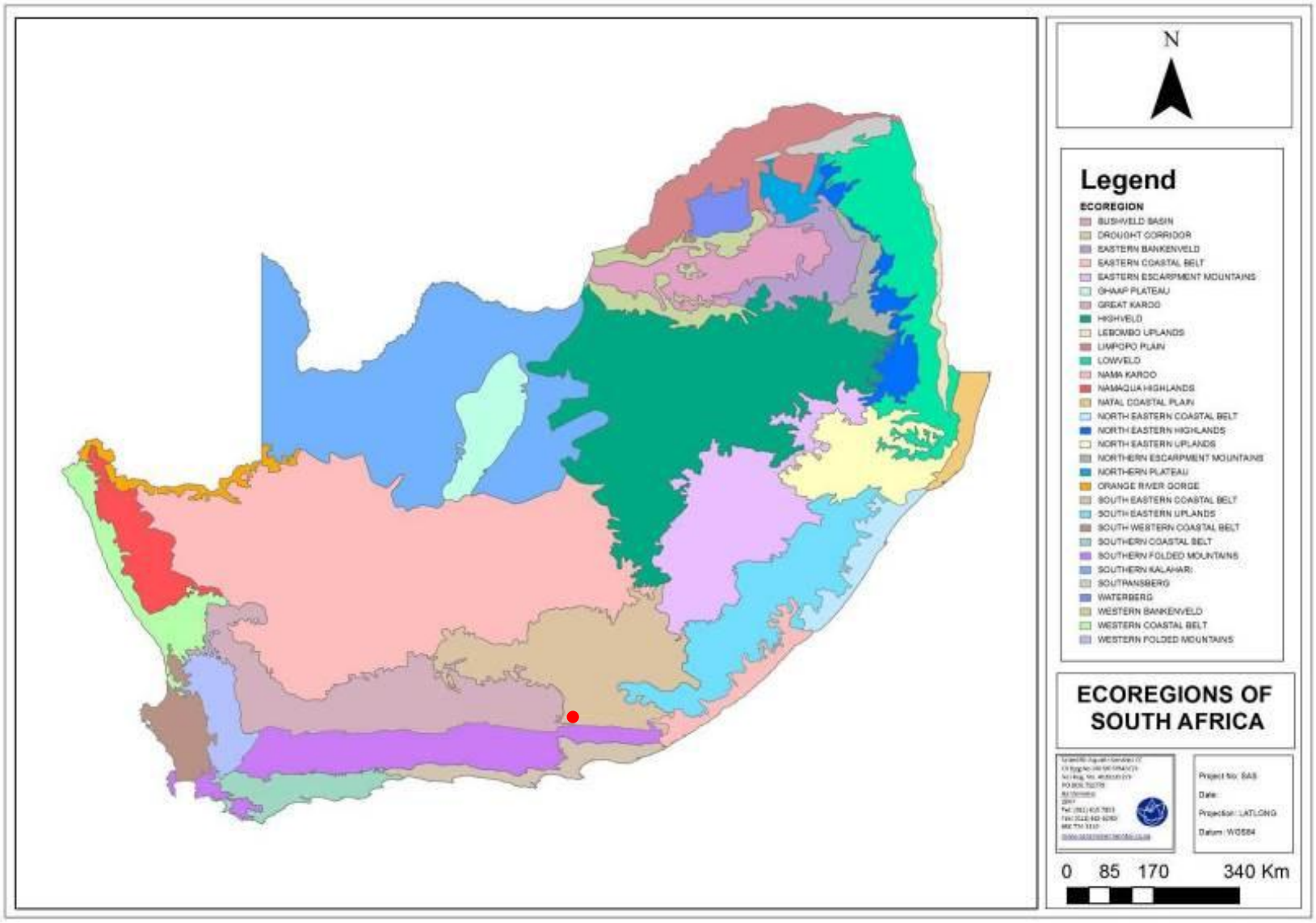

Figure 11: Map of Level 1 Ecoregions of South Africa, with the approximate position of the study area indicated in red.

3.3.4 Level 3: Landscape Setting

At Level 3 of the proposed classification System, for Inland Systems, a distinction will be made between four Landscape Units on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

3.3.5 Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the classification system, on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank; and
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.

- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms will be used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2008).

3.3.6 Wet-Ecoservices (2008)

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[2] The assessment of the ecosystem services supplied by the identified wetlands will be conducted according to the guidelines as described by Kotze *et al* (2008). An assessment will be undertaken to examine and rate the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and

[2] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999*

- Education and research.

The characteristics will be used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic will be scored to give the likelihood that the service is being provided. The scores for each service will then be averaged to give an overall score to the wetland.

Table 4: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

Table 5: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

Ecological Category	PES % Score	Description
A	90-100%	Unmodified, natural.
B	80-90%	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. 20-40% Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E	20-40%	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible.

3.3.7 Index of Habitat Integrity (IHI)

To assess the PES of the drainage feature the Index of Habitat Integrity (IHI) for South African floodplain, channelled and channelled valley bottom wetland types (DWAF Resource Quality Services, 2007) will be used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A – F ecological categories (Table 6 below), and provide a score of the PES of the habitat integrity of the wetland system being examined.

Table 6: Descriptions of the A – F ecological categories (after Kleynhans, 1996, 1999).

Ecological Category	PES % Score	Description
A	90-100%	Unmodified, natural.
B	80-90%	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. E 20-40% Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E	20-40%	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

3.3.8 Ecological Importance and Sensitivity (EIS)

The method that will be used for the EIS determination was adapted from the method as provided by DWA (1999) for wetlands. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed.

A series of determinants for EIS will be assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants will then be used to assign the EIS category as listed in Table 7 below.

Table 7: Descriptions of the EIS Categories.

EIS Category	Range of Mean	Recommended Ecological Management Class[3]
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

3.3.9 Riparian Vegetation Response Assessment Index (VEGRAI; 2007)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: '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.

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results[4]. Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Table 8: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39

[3] Ed's note: Author to confirm exact wording for version 1.1
[4] Kleynhans *et al*, 2007

F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

3.4 Aquatic Method of Assessment

The sections below describe the methodology that will be used to assess the aquatic ecological integrity of the various sites based on water quality, instream and riparian habitat condition and biological impacts and integrity.

3.4.1 Visual Assessment of Aquatic Assessment Points

Each site will be selected in order to identify current conditions, with specific reference to impacts from surrounding activities where applicable. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the systems identified, will be identified by observing conditions and relating them to professional experience. Photographs of each site will be taken to provide visual records of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments will include the following:

- upstream and downstream significance of each point, where applicable;
- significance of the point in relation to the study area;
- stream morphology;
- instream and riparian habitat diversity;
- stream continuity;
- erosion potential;
- depth flow and substrate characteristics;
- signs of physical disturbance of the area; and
- other life forms reliant on aquatic ecosystems.

3.4.2 Physico-chemical Water Quality Data

On site testing of biota specific water quality variables will take place on all sites where surface water is present. The results of on-site biota specific water quality analyses will be used to aid in the interpretation of the data obtained by the biomonitoring. Results will be discussed against the guideline water quality values for aquatic ecosystems (DWAF, 1996 vol. 7). *In situ* measurements of the following parameters will take place:

- pH pH units
- Electrical Conductivity (EC) mS/m

- Dissolved Oxygen (DO) mg/l
- Temperature Degrees Centigrade

3.4.3 Intermediate Habitat Integrity Assessment (IHIA; 1999)

It is important to assess the habitat of riverine systems in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the sites will be assessed based on the application of the Intermediate Habitat Integrity Assessment (IHIA) described by Kemper (1999). The IHIA protocol will be employed using the site specific application protocols. This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996). The IHIA will be conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site will be scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The instream and riparian zones will be analysed separately, and the final assessment will then be made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone will be primarily interpreted in terms of the potential impact on the instream component. The assessment of the severity of impact of modifications will be based on six descriptive categories with ratings. Analysis of the data will be carried out by weighting each of the criteria according to Kemper (1999). By calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the PES of both the in-stream and riparian habitats of the sites. The method will classify Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

3.4.4 Invertebrate Habitat Suitability (Invertebrate Habitat Assessment: IHAS)

The Invertebrate Habitat Assessment System (IHAS) will be applied to the primary sites only according to the protocol of McMillan (1998). This index will be used to determine specific habitat suitability for aquatic macro-invertebrates, as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index will be interpreted according to the guidelines of McMillan (1998) as follows:

- <65%: habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community;

- 65%-75%: habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community; and
- >75%: habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community.

3.4.5 Aquatic Macro-Invertebrates: South African Scoring System (SASS5; 2001)

Aquatic macro-invertebrate communities of the primary sites will be investigated according to the method, which is specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and will be adapted for South African conditions by Dr. F. M. Chutter (1998). The assessment will be done according to the South African Scoring System (SASS) protocol as defined by Dickens and Graham (2001). All work will be undertaken by an accredited South African Scoring System, version 5 (SASS5) practitioner.

Interpretation of the results of biological monitoring will depend, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score in conjunction with a low habitat score can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score together with a high habitat score would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

The perceived reference state for the local streams will be determined in consideration of the ecoregion conditions as well as local habitat conditions. Limited information for the great Karoo ecoregion is also available and, therefore, inaccuracies in terms of reference conditions are deemed possible. Reference scores for the upper Great Karoo will be defined as a SASS5 score of 120 and an Average Score Per Taxon (ASPT) of 6. Interpretation of the results in relation to the reference scores will be made according to the classification of SASS5 scores presented in the SASS5 methodology published by Dickens and Graham (2001) as well as according to Dallas (2007).

Table 9: Definition of Present State Classes in terms of SASS and ASPT scores as presented in Dickens and Graham (2001).

Class	Description	SASS Score%	ASPT%
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100 80-89	Variable >90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89 70-79 70-89	<75 >90 76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79 50-59 50-79	<60 >75 60-75
D	Largely impaired. Mostly tolerant taxa present.	50–59 40-49	<60 Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

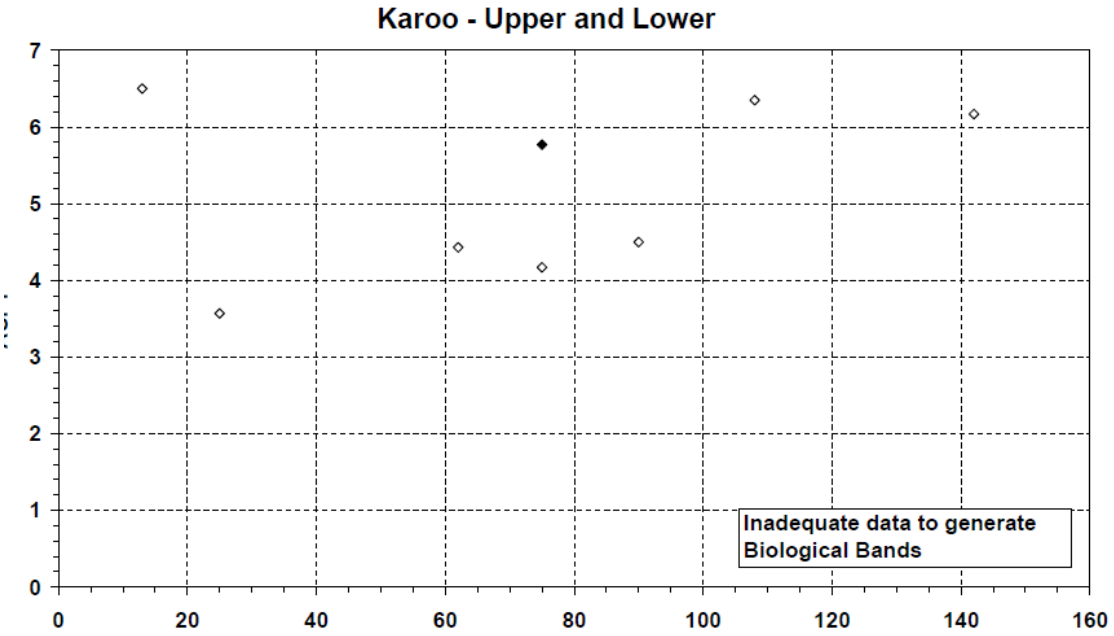

Figure 12: SASS5 Classification scatterplot data for the Great Karoo upper and lower ecoregion (Dallas, 2007).

3.4.6 Aquatic Macro-Invertebrates: Macro-invertebrate Response Assessment Index (MIRAI)

The four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs. An interplay between these factors (particularly habitat and availability of food sources) result in the discontinuous, patchy distribution pattern of aquatic macro-invertebrate populations. As such aquatic invertebrates shall respond to habitat changes (i.e. changes in driver conditions).

To relate drivers to such changes in habitat and aquatic invertebrate condition, two key elements are required. Firstly habitat preferences and requirements for each taxa present

should be obtained. As such reference conditions can be established against which any response to drivers can be measured. Secondly habitat features should be evaluated in terms of suitability and the requirements mentioned in the first point. As a result expected and actual patterns can be evaluated to achieve an Ecostatus Category (EC) rating.

Based on the three key requirements, the MIRAI will provide an approach to deriving and interpreting aquatic invertebrate response to driver changes. The index will be applied to primary sites following methodology described by Thirion (2007). Aquatic macro-invertebrates expected at each point will be derived both from previous studies of rivers near the area as well as habitat, flow and water parameters (Thirion 2007).

3.4.7 Fish Biota: Habitat Cover Rating (HCR) and Fish Habitat Assessment (FHA)

This approach was developed to assess habitats according to different attributes that are surmised to satisfy the habitat requirements of various fish species. At the primary sites, the following depth-flow (df) classes will be identified, namely:

- Slow (<0.3m/s), shallow (<0.5m) - Shallow pools and backwaters.
- Slow, deep (>0.5m) - Deep pools and backwaters.
- Fast (>0.3m/s), shallow - Riffles, rapids and runs.
- Fast, deep - Usually rapids and runs.

The relative contribution of each of the above mentioned classes at a site will be estimated and indicated as:

0 = Absent

1 = Rare (<5%)

2 = Sparse (5-25%)

3 = Moderate (25-75%)

4 = Extensive (>75%)

For each depth-flow class, the following cover features (cf) -considered to provide fish with the necessary cover to utilise a particular flow and depth class- will be investigated:

- Overhanging vegetation
- Undercut banks and root wads
- Stream substrate
- Aquatic macrophytes

The amount of cover present at each of these cover features (cf) will be noted as:

0 = absent

1 = Rare/very poor (<5%)

2 = Sparse/poor (5-25%)

3 = Moderate/good (25-75%)

4 = Extensive/excellent (>75%)

The fish habitat cover rating (HCR) will be calculated as follows:

- The contribution of each depth-flow class at the site was calculated (df/Σdf).
- For each depth-flow class, the fish cover features (cf) were summed (Σcf).

  HCR = df/Σdf x Σcf.

The amount and diversity of cover available for the fish community at the selected sites was graphically expressed as habitat cover ratings (HCR) for different flow-depth classes as a stacked bar chart.

3.4.8 Fish Biota: Fish Response Assessment Index (FRAI)

The FRAI (Kleynhans 2008) is based on the premise that “drivers” (environmental conditions) may cause fish stress which shall then manifest as changes in fish species assemblage. The index employs preferences and intolerances of the reference fish assemblage, as well as the response of the actual (present) fish assemblage to particular drivers to indicate a change from reference conditions. Intolerances and preferences are divided into metric groups relating to preferences and requirements of individual species. This will allow cause-effect relationships to be understood, i.e. between drivers and responses of the fish assemblage to changes in drivers. These metric groups will subsequently be ranked, rated and finally integrated as a fish Ecological Category (EC).

3.5 Impact Assessment Methodology

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts will be assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructures that are possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[5]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact will then be assessed by rating each variable numerically according to the defined criteria. Refer to the table below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and

[6] The definition has been aligned with that used in the ISO 14001 Standard.

consequence of the impact will then be read off a significance rating matrix and are used to determine whether mitigation is necessary[6].

The assessment of significance will be undertaken twice. Initial, significance will be based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment will take into account the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, will be considered post-mitigation.

The model outcome of the impacts will then be assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances where a variable or outcome requires rational adjustment due to model limitations, the model outcomes will be adjusted.

LIKELIHOOD DESCRIPTORS

Probability of impact	**RATING**
Highly unlikely	1
Possible	2
Likely	3
Highly likely	4
Definite	5
Sensitivity of receiving environment	**RATING**
Ecology not sensitive/important	1
Ecology with limited sensitivity/importance	2
Ecology moderately sensitive/ /important	3
Ecology highly sensitive /important	4
Ecology critically sensitive /important	5

CONSEQUENCE DESCRIPTORS

Severity of impact	**RATING**
Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	**RATING**
Activity specific/ < 5 ha impacted / Linear features affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / Linear features affected < 1000m	2
Local area/ within 1 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m	3

[6] Some risks/impacts that have low significance will however still require mitigation

Regional within 5 km of the site boundary / < 5000ha impacted / Linear features affected < 10 000m	4
Entire habitat unit / Entire system/ > 5000ha impacted / Linear features affected > 10 000m	5
Duration of impact	**RATING**
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5

Table 10: Significance Rating Matrix.

	CONSEQUENCE (Severity + Spatial Scope + Duration)														
LIKELIHOOD (Frequency of activity + Frequency of impact)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 11: Positive/Negative Mitigation Ratings.

Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150	Critically consider the viability of proposed projects Improve current management of existing projects significantly and immediately	Maintain current management
High	101-125	Comprehensively consider the viability of proposed projects Improve current management of existing projects significantly	Maintain current management
Medium-high	76-100	Consider the viability of proposed projects Improve current management of existing projects	Maintain current management
Medium-low	51-75	Actively seek mechanisms to minimise impacts in line with the mitigation hierarchy	Maintain current management and/or proposed project criteria and strive for continuous improvement
Low	26-50	Where deemed necessary seek mechanisms to minimise impacts in line with the mitigation hierarchy	Maintain current management and/or proposed project criteria and strive for continuous improvement
Very low	1-25	Maintain current management and/or proposed project criteria and strive for continuous improvement	Maintain current management and/or proposed project criteria and strive for continuous improvement

The following points will be considered when undertaking the assessment:

- Risks and impacts will be analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develop or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts will be assessed for all stages of the project cycle including:
  - Pre-construction;
  - Construction;
  - Operation; and
  - Rehabilitation.
- If applicable, transboundary or global effects will be assessed;
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status will be assessed.
- Particular attention will be paid to describing any residual impacts that will occur after rehabilitation.

3.5.1 Mitigation measure development

The following points present the key concepts which will be considered in the development of mitigation measures for the proposed development:

- *Mitigation* and *performance improvement measures* and actions that address the risks and impacts[7] will be identified and described in as much detail as possible.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation.
- Desired outcomes will be defined, and will be developed in such a way as to be *measurable events with performance indicators, targets and acceptable criteria* that can be tracked over *defined periods*, with estimates of the *resources* (including human resource and training requirements) *and responsibilities for implementation.*

[7] *Mitigation measures should address both positive and negative impacts*

4 SENSITIVITY MAPPING

All sensitive features and or habitats (including localities of RDL/protected floral species, wetlands, rivers and ridges) will be mapped utilising a Geographical Positioning System (GPS) and a sensitivity map will be compiled. This sensitivity map will aim to guide the design of the study area in order to have the least ecological impact on the receiving environment.

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