CULLINAN & ASSOCIATES
Environmental and green business attorneys

TRANSMITTED BY EMAIL

Date: 30 May 2022

TO:	**Nicholas Smith Attorneys**		
ATT:	Mr Smith	nicks@nsmithlaw.co.za	
FROM:	Hercules Wessels	hercules@greencounsel.co.za	
Total pages:	3	Our ref:	O 023-002

Dear Sir

OBSERVATORY CIVIC ASSOCIATION AND ANOTHER V LLPT AND OTHERS – SUPPLEMENTARY FOUNDING AFFIDAVIT

1. I refer to your comments concerning the filing of the applicants' supplementary founding papers in your email correspondence with Mr. Owen on 26 May 2022, as well as your unilateral demands to the same effect in your correspondence of 17 May 2022.

2. Please be advised that the applicants will not be in a position to file their supplementary founding affidavit tomorrow. We are not in agreement with your position that this is the filing deadline imposed by the uniform rules given that the fourth and fifth respondents' complete record was only filed on 26 May 2022. By our calculation, our clients' supplementary founding affidavit and amended notice of motion are due in terms of the rules on 9 June 2022. We will file the supplementary affidavit as soon as possible after that date as we are able.

Expertise grounded in experience
Cullinan & Associates Incorporated (2001/001024/21)
DIRECTOR: CP Cullinan
ATTORNEYS: B Adams, GD Daniels, M Groenink, K Handley, P King, SD Kvalsvig, R Stone, HD Wessels, PM Keichel

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3. In any event, having regard to our duties to our clients (and the Court) and in view of the fact that the rule 53 records now run to some 30 000 pages between them, we could not reasonably or responsibly submit to your demand that the supplementary founding affidavit be filed by tomorrow, 31 May 2022.

4. Nonetheless, you have our assurance that the applicants' attorneys and counsel are doing their utmost to ensure that our supplementary papers are filed as soon as possible, mindful of the need to proceed expeditiously with the review.

5. You will be aware that the 4th, 5th, 6th and 7th respondents (i.e. the Province and the City) were required to file their respective records of decision in terms of Rule 53(1)(b), within 15 days after receiving the applicants' notice of motion.

   5.1. The City and Province was served with the notice of motion on 3 August 2021. It follows therefore, that the records of the Province and City were due on 25 August 2021.

   5.2. The City only served a copy of its record on our offices, electronically on 29 April 2022 after 17h00, and thereafter only provided us with a filing notice of the record on 12 May 2022. This record was therefore filed 8 months late.

   5.3. The Province served a copy of its record on our offices, electronically on 17 May 2022, filed its supplementary record, electronically on 26 May 2022, and have yet to provide a stamped filing notice, indicating that its record and supplementary record has been filed at court. This record was therefore filed 9 months late.

6. In contrast to the current unreasonable demands being made of the applicants, you have not raised any objection to these delays. Moreover, apart from their length, the time taken to assemble the records is indicative of the scale of the task of preparing a supplementary founding affidavit in response.

7. As regards your contention, based on my use of the word "peruse", that the applicants' counsel had made a thorough examination of the fourth and fifth respondents' 14 000-page record by 18 May (i.e. in a single day), I should clarify that what had occurred was in fact a cursory exercise of traversing the record to determine its contents. It was neither humanly possible, nor a responsible performance of the duty owed to clients, to read and analyse this record for purposes of preparing a supplementary founding affidavit in a single day.

8. We trust that the above clarifies the applicants' position. We will apply for condonation of any failure to adhere to the rules in due course, should this become necessary.

Yours sincerely

CULLINAN & ASSOCIATES INC.
per: Hercules Wessels

COPIES TO:

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The State Attorney	
Mr Owen	mowen@justice.gov.za

NICHOLAS SMITH ATTORNEYS
ENVIRONMENTAL LAW SPECIALISTS

Cullinan and Associates Inc.
Attention: Mr. Hercules Wessels
By email: hercules@greencounsel.co.za

Our ref: NDS/sg/L38-001
Your ref: O23-002

3 June 2022

Dear Sirs

***RE: OBSERVATORY CIVIC ASSOCIATION AND ANOTHER v LIESBEEK LEISURE PROPERTIES TRUST AND OTHERS* (CASE NUMBER: 12994/2021 IN THE WESTERN CAPE DIVISION OF THE HIGH COURT)**

1. We acknowledge receipt of your letter of 30 May 2022.

2. We again remind you that the applicants' senior counsel made an unequivocal undertaking during argument before Goliath DJP in Part A of the present application in January this year. Senior counsel's undertaking was to the effect that the applicants, their attorneys of record, and their counsel would ensure that there are no delays in their conduct of the pending review application. In open court he tendered utmost expedition in the applicants' pursuit of the review. For you now to suggest that the delivery by the state attorney of the Province's 7-page supplementary record on 26 May 2022 re-sets *ab initio* the 10-day period afforded your clients for delivery of their supplementary founding papers is untenable in the circumstances.

3. Furthermore, any delay by the City and the Province in providing their rule 53 records is irrelevant to your clients meeting their obligation in terms of rule 53(4) of the *Uniform Rules of Court* if they see fit to deliver supplementary founding papers in Part B. You did not exercise your clients' right in terms of the *Uniform Rules* to compel the delivery of the aforesaid records if you were so inclined.

4. In any event, it is indisputable that the full rule 53 records are in your possession. All but 7 pages of the records have been in your possession for a significant period of time already. You acknowledge in terms that you have had the City's complete record since the end of April this year, and the Province's record since the middle of May (but for the supplementary (7-page) record filed on 26 May this year).

5. You and your clients have been involved in the decision-making processes that are the subject of your clients' pending review for a significant period of time. Your clients' representatives have been involved since the inception of the public participation processes that culminated in the decisions they now seek to review. Your firm's involvement in this matter goes back to at least late 2020. Much of what is in the rule 53 records thus constitutes information already well-known to you and to your clients. Some of the information included in the records was generated by your clients' representatives.

6. We dispute your assertion that the end of 9 June 2022 marks the expiry of the 10-day period. We maintain that it expired on 31 May 2022. Our instructions are nonetheless to afford you an indulgence to deliver your clients' supplementary founding papers in the review by the end of next Thursday, 9 June 2022.

7. In the event that your clients' supplementary founding papers are not filed by the date indicated directly above, we will assume that you do not intend filing supplementary founding papers. The respondents in the review will then deliver their respective answering affidavits within 30 court days of 9 June 2022, and as provided for in the *Uniform Rules*. As soon as possible after 9 June 2022 we will also request the respective counsel in the matter to arrange a meeting with the Judge President in order to obtain directions regarding the further conduct of the review up to and including the hearing thereof.

8. For present purposes, we will not debate your self-serving attempts to avoid or dilute statements you've made in your previous correspondence, or your attempts now to prevaricate on certain aspects. We do point out however that your reference previously, in paragraph 2 of your letter of 18 May 2022, to your perusal of the contents of the Province's record does not refer to your counsel doing so, as your letter under reply now asserts. Your previous statement was clearly and unequivocally a reference to the review of the Province's record by you (and presumably your colleagues) as the applicants' attorneys of record.

9. We await your clients' supplementary founding papers by or before the end of 9 June 2022.

Yours faithfully,
NICHOLAS SMITH ATTORNEYS
Per:

NICHOLAS SMITH

Copies to:

Heritage Western Cape
Attention: Ms. Penelope Meyer
By email: penelope.meyer@westerncape.gov.za

Webber Wentzel Attorneys
Attention: Ms. Sabrina De Freitas
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The State Attorney
Attention: Mr. Mark Owen
By email: mowen@justice.gov.za

Basson Petersen Attorneys Inc.
Attention: Mr. Petersen
By email: Bpinc.law@gmail.com

Legal Resources Centre on behalf of the Forest Peoples Programme (*amicus curiae*)
Attention: Ms. Lelethu Mgedezi
By email: lelethu@lrc.org.za

PRE-APPLICATION CONSULTATION MEETING IN TERMS OF SECTION 70 OF THE CITY OF CAPE TOWN MUNICIPAL PLANNING BY-LAW

VENUE: Table Bay District Muncipality, Media City Building, Cape Town

DATE: Wednesday 11 October 2017

PROJECT: The River Club (Erf 151832 Cape Town)

ATTENDANCE:

Project team

Name	Abb	Organisation	Tel. / Cell. No.	E-Mail
Geoff Underwood	GU	Planning Partners	[redacted]	[redacted]
Tim Florence	TF	Planning Partners	[redacted]	[redacted]
Imraan Ho Yee	IH	Vivid Architects	[redacted]	[redacted]
Marise Potgieter	MP	Urban Concepts	[redacted]	[redacted]
Carshif Talip	CT	Aurecon	[redacted]	[redacted]
Jannie Conradie	JC	Aurecon	[redacted]	[redacted]
Jacques Taljaard	JT	Aurecon	[redacted]	[redacted]
Matthew Law	ML	SRK Consulting	[redacted]	[redacted]
Charles Selkirk	CS	Selkirk and Selkirk	[redacted]	[redacted]

City of Cape Town

Name	Abb	Department	Tel.	E-Mail
Juliet Leslie	JL	Land Use Management	[redacted]	[redacted]
Pete van Heerden	PvH	Spatial Planning	[redacted]	[redacted]
Mark Bell	MB	EHM: Heritage	[redacted]	[redacted]
Dimitri Georgeades	DG	District Head: EHM	[redacted]	[redacted]
PC Wasserman	PW	Urban Design	[redacted]	[redacted]
Benito Coghill	BC	Building Development Management	[redacted]	[redacted]
Ronelle Clarke	RC	EHM: Environmental	[redacted]	[redacted]
Anthony Damonze	AD	UCI	[redacted]	[redacted]
Melvin Engelbrecht	ME	Water & Sanitation	[redacted]	[redacted]

* Note: CoCT officials from Transport for Cape Town, Traffic Impact Assessment & Development Control, Stormwater Management and Electricity Services were invited to the meeting but were not able to attend.

MINUTES:

1. INTRODUCTION

1.1 GU noted that meeting is convened in terms of section 70 of the City of Cape Town MPBL. Minutes to be taken and circulated to ensure a correct record.

1.2 Components of the project were presented in the form of a PowerPoint presentation. A copy of the presentation can be made available to CoCT officials on request.

2. PROJECT TEAM PRESENTATIONS

2.1 Town planning

2.1.1 GU presented the town planning context, including *inter alia:*

- Site context;
- Applicable planning policy;
- Zoning (OS3).

2.1.2 GU noted that despite the fact that the River Club is located within TRUP, the River Club planning application will be submitted whether or not any TRUP Local Spatial Development Framework has been completed by CoCT. The reason for this is primarily because the River Club proponent cannot afford to delay the planning application until mid-2018, which is when the TRUP Local Spatial Development Framework is expected to be promulgated.

2.1.3 GU introduced the project. Important features of the project include:

- Mixed use (office, retail, residential, community);
- Bulk of ± 150 000 m²;
- Building heights range from 1 – 12 storeys;
- Raise ground level by ± 3m (to approx. 7m m.s.l);
- Implementation of a portion of Berkley Road extension;
- Rehabilitation of the canal into a congruent riverine corridor;
- Vegetated stormwater swale along old Liesbeek River;
- Publicly accessible spaces (green and hard);
- Recreation and leisure facilities; and
- Pedestrian friendly NMT features.

2.1.4 GU provided some factors for project motivation, including *inter alia*:

- Raising the ground level above 100-year flood elevation will have limited flood impact on neighbouring properties;
- The terrestrial site has been transformed and has limited ecological value;
- Opportunity to create a congruent and legible riverine corridor along lower Liesbeek River;
- Improved public access to the rivers, wetland and open areas;
- Financial viability (150 000m² of floor space is required to make the project viable);
- The project represents significant private sector investment (± R4 billion);
- Substantial job creation;
- Increased municipal income in rates and taxes (± R40 million per annum);
- There is substantial market demand for office, retail and residential uses;
- The site is at the western gateway into TRUP;
- The River Club can become a destination place within Cape Town.

2.1.5 An initial town planning application will be submitted for:

- Deviation from Table Bay District SDP, which currently categorises the site as "open space", core 2" and "buffer 1" land.
- Rezoning from Open Space 3: Special Open Space to Subdivisional Area.
- Raising the level of the ground (in terms of in terms of section 42(i) of the MPBL and item 126 of the DMS).

2.1.6 Subsequent town planning applications will be submitted for *inter alia*:

- Bulk services agreement;
- Precinct plans;
- Block subdivision;
- Deemed zoning;
- Internal subdivision;
- Site Development Plans

2.2 Urban design indicators and recommendations

2.2.1 MP presented the urban design indicators, including *inter alia*:

- Natural environment;
- Viewlines;
- Height;
- Connectivity.

2.2.2 MP presented the urban design recommendations, including *inter alia*:

- Provision of an 'eco-corridor' through the site;
- Retaining viewlines towards Devils Peak;
- Height.

2.3 Development proposal

2.3.1 IH presented the more detail about the development proposal, including *inter alia*:

- The proposal to rehabilitate the existing canal into a visually congruent and publicly accessible riverine corridor (with resulting ecological and social benefits) along the lower reaches of the Liesbeek River;
- The proposal to infill the majority of the existing old Lisebeek River channel, leaving only a narrow vegetated stormwater swale along its current course;
- Development setbacks of 25 – 60m along the rehabilitated riverine corridor (setback to the building line, perimeter roads to occur within these setbacks);
- Development setbacks of 10 – 15m along the vegetated stormwater swale (setback to the building line, perimeter roads to occur within these setbacks);
- The construction of a portion of Berkley Road extension, including a bridge over the Black River, as part of the development proposal;
- The construction of a bridge over the old Liesbeek River linking the development with Liesbeek Parkway;
- Mix of uses (retail, office, residential, community);
- Inclusion of inclusionary housing in the residential component;
- Floor areas;
- Raising of the roads, entrances to basements and ground floor levels of buildings above the 1:100-year floodline;
- Open space;
- Parking;
- Massing models;
- Viewlines;

- Acknowledgement of the forthcoming SKA development on the adjacent site, Portion 1 of Erf 26423 Cape Town.

2.4 Surface water hydrology

2.4.1 CT presented the findings of the surface water hydrology study conducted by Aurecon, including *inter alia* information relating to the following:

- Acknowledgement of previous surface water hydrology studies in the area;
- Methodology (including the consideration of climate change factors);
- Reasons for flooding;
- Illustration of pre-development and post-development flood levels over the surrounding area (there is minimal difference);
- Conclusion that raising the ground level above the 1:100-year flood elevation will have a very limited flood impact on neighbouring properties.

2.5 Civil engineering services

2.5.1 CT noted that CoCT has provided confirmation of water and sewage capacity for 120 000m² of development. Aurecon will be applying to CoCT for confirmation of capacity for 150 000m².

2.5.2 CS noted 12-MVA of electricity will be required to service the development. However, based on correspondence received from the CoCT Electricity Department, there is currently only ± 9-MVA available to service the entire extent of TRUP. Thus, it is suggested that the CoCT Electricity Department urgently commence with planning proposals to augment the current capacity. The River Club project team is engaging with CoCT regarding availability of supply.

2.6 Traffic and transport

2.6.1 JC presented the findings of the Transport Impact Assessment conducted by Aurecon, including *inter alia* information relating to the following:

- The current road network;
- The proposed implementation of Berkley Road extension;
- Proposed access onto the site;
- Indicative trip generation and how this will impact on the surrounding road network;
- Indicative parking ratios; and
- Public transport proposals.

3. DISCUSSION

3.1 Town planning

3.1.1 PvH confirmed that the River Club is not obliged to wait for the TRUP Local Spatial Development Framework to be promulgated before submitting the planning application. The application can proceed based on current spatial planning policy.

3.1.2 JL asked if the riverine corridor areas will be publicly accessible. GU responded that the entire site will be publicly accessible (only the buildings themselves will be secured), and in particular the public will be encouraged to use the open space areas, inclusive of the riverine corridors.

3.1.3 JL noted that the CoCT Draft Spatial Development Framework (2017) gives limited guidance for development in riverine corridors.

3.1.4 JL asked if Berkley Road extension would form part of Phase 1 of the development. GU confirmed that a portion of the road will be constructed (i.e. the bridge over the Black River and access to the development will be constructed by the River Club as a Development Contribution offset; the construction of the remainder of the road connecting into Liesbeek Parkway / Malta Road will need to be negotiated with CoCT.

3.1.5 PVH asked if the layout can change to take access off Station Road if the SKA development (proposed for Portion 1 of Erf 26423 Cape Town) does not go ahead as planned. GU said that this would be unlikely, as the spacing to the Liesbeek Parkway / Station Road intersection is too small to accommodate the necessary vehicle stacking into Station Road.

3.1.6 PVH asked if the Berkley Road extension would be constructed at grade. CT responded that in terms of the CoCT's Floodplain and River Corridor Management Policy (2009) the road needs to be constructed above the 1:100-year floodline, and will therefore be constructed on fill material.

3.2 Environmental

3.2.1 RC asked if sustainable green infrastructure / design is being considered. IH responded that the client has a good track record in relation to green building technology.

3.2.2 RC asked if there are any open space areas on the site that will be reserved exclusively as ecological areas. GU responded that the riverine corridors carry an ecological function whereby appropriate vegetation will be planted in accordance with ecological requirements, and that the public will be encouraged to stick to the paths located alongside the riverine corridors. With regards to the park / eco-corridor running through the site, ML advised that there is no dedicated Western Leopard Toad corridor, as per the recommendations of the herpetologist on the project team. However, the detailed design stage of the landscaped areas will incorporate landscaping for active public use and landscaping to support ecological functions.

3.2.3 RC asked how will flooding of basements be dealt with. CT responded that the entrance to the basements will be above the 1:100-year floodline. The basements below the new ground level will be waterproofed and/or pumped.

3.3 Hydrology

3.3.1 MB asked if the surface water hydrology study had considered the effect of spring tides on flood levels. CT confirmed that the 50-year sea level rise projection has been taken into account in the modelling (including spring tides), as per the CoCT's requirements.

3.4 Heritage

3.4.1 MB noted that Bridget O' Donoghue was involved in the initial stages of the heritage study, but has since been replaced. GU explained the reasons why Bridget O' Donoghue is no longer the heritage specialist on the project.

3.4.2 MB pointed out that development within TRUP is part of an ongoing Heritage Western Cape process. GU said he is aware of the HWC process and any outcome will have to be factored into the River Club application. However, the River Club application will proceed.

3.4.3 MB said that Melanie Attwell's HIA in relation to the TRUP development initiative has got a strong pre-colonial focus to it and asked if pre-colonial history has been considered as part of the River Club HIA. GU responded that pre-colonial history has been considered and will be presented accordingly in the HIA.

3.4.4 MB noted that the preferred development alternative erases the historic Liesbeek River channel, and that this element of the proposal needs to be well motivated in the HIA. GU acknowledged this point.

LL54

Accessed on 9 June 2022 at: https://www.wcpdf.org.za/wcg_economic_war_room/

Skip to content

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076 721 0135

WCPDF
WESTERN CAPE PROPERTY DEVELOPMENT FORUM

- HOME
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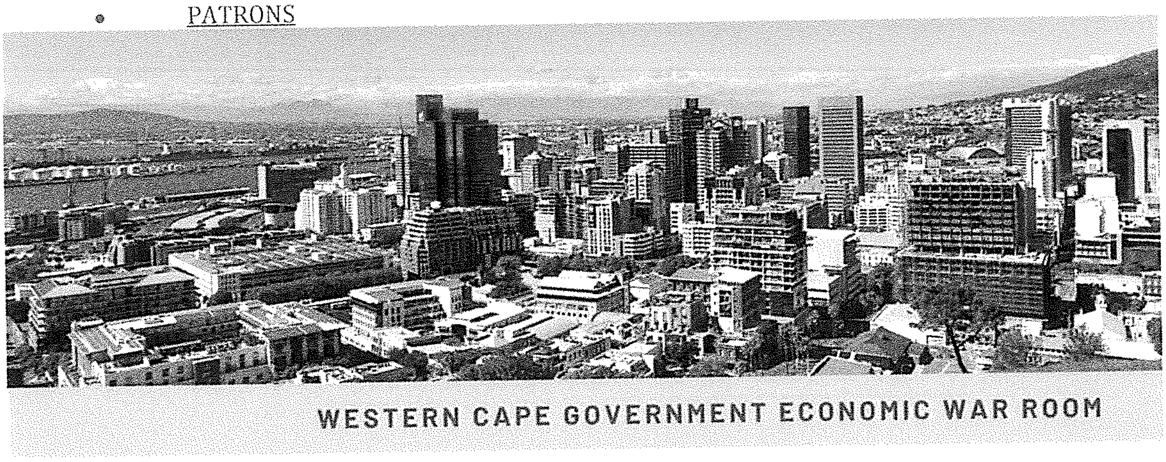
- PATRONS



Western Cape Government Economic War Room

At its annual conference held in May 2018, the WCPDF initially proposed the idea of an economic war room at government level to deal with the South African economic crisis in general and, in particular, to begin to alleviate the constraints and red tape that were stifling growth and job creation in the property development and construction industries. This was a theme expanded upon extensively in the WCPDF's annual conference held in 2019 under the theme *The Perfect Storm: Investment and jobs or bureaucracy and stagnation.*

In November 2018, a meeting between the WCPDF chair, Deon van Zyl, and the then Western Cape Government (WCG) Minister of Economic Opportunities, Alan Winde, planted the seeds firmly in the ground, with the Minister committing to the setting up of such a war room. With the Minister becoming the WCG Premier in 2019, work on the war room escalated culminating in a launch in September 2019, during the Premier's first 100 days in office, and incorporating five economic areas deemed to be those most crucial to kickstarting the provincial economy and creating much-needed jobs.

The property and construction sector in the Western Cape was incorporated under the category of "Fixed Capital and Property Development" and was highlighted as a primary enabler that would allow the WCG to achieve its growth vision for the province. At the launch of this sector's incorporation (see report here), the Premier also acknowledged that the crisis currently faced by this sector needed to be urgently addressed.Other sectors incorporated into the war room include commuter mobility, informal light manufacturing, IT and business process outsourcing, and the creation of manufacturing jobs in Atlantis.

In terms of the property development and construction sectors, a pilot programme launched in September saw a WCG-appointed task team interview various private sector members and organisations to identify the key issues to be tackled. A report outlining progress made up to November 2019, submitted to the WCPDF by Premier Alan Winde, can be found here.

But then, Covid-19 hit, substantially stalling the work of the War Room. However, gradually during the course of 2020, the various workgroups convened once again. As a result and at long last, The Western Cape Government released its initial report in March 2021, with "Fixed Capital and Property Development" making up a substantial portion of the report. The full report on all five industry sectors that form part of the War Room can be accessed here, with details on our category to be found across pages 139 to 157.

War Room team leader for our sector, Gerhard Gerber (Chief Director of Development Planning in the Western Cape Government), has also presented the WCPDF with a copy of a PowerPoint summary delivered on 9 March 2021. This includes an opener on the War Room presented by Minister Anton Bredell (Local Government, Environmental Affairs and Development Planning), and Gerber's presentation entitled "Phase 2 – What we did during the Covid-19 Lockdown." The PowerPoint is available here.

The methodology being followed by the War Room allows for work groups, consisting of various officials in different spheres and departments in government, to interview industry role players. Feedback received leads to a "problem-driven iterative adaptation" assessment during which symptomatic problems are analysed to identify root causes of problems.

Reading the findings of the various workgroups, it becomes clear that officials suffer under an audit culture management environment instead of a growth vision driven culture. This mirrors the frustration experienced by the private sector. We now look at the political leadership and ask: "*Quo vadis*?"

We also now wait with bated breath to see what impact the first report results will have on setting a clear growth vision for the Western Cape and each municipality in the province. As always, please subscribe to the WCPDF's monthly newsletters to be kept up to date on progress on the War Room.

Keagan-leigh Adriaanse

From:	Matthew Law <MLaw@srk.co.za>
Sent:	Friday, February 28, 2020 3:02 PM
To:	Zaahir Toefy; Mxolisi Dlamuka; Gerhard Gerber; Michelle Couzyn-Rademeyer
Cc:	Taryn Dreyer; Keagan-leigh Adriaanse; Waseefa Dhansay; 'geoff@planpart.co.za'; Eldon van Boom; Karin Dugmorestrom; Marshallene Harris
Subject:	RE: River Club BAR: Request for Meeting with HWC
Attachments:	River Club HIA HWC IACom Issues and Responses_200227_Following final comment_Master.docx

Dear All

Please find attached the LLPTs responses to the issues raised by HWC on the HIA for the River Club in their final comments (together with the responses already provided to the interim comments made by HWC, noting the issues which have been repeated).

The responses are informed by inputs from the specialists on the project team.

These will be referenced to at the workshop scheduled for Wednesday, 4 March 2020.

Kind regards,

Matthew

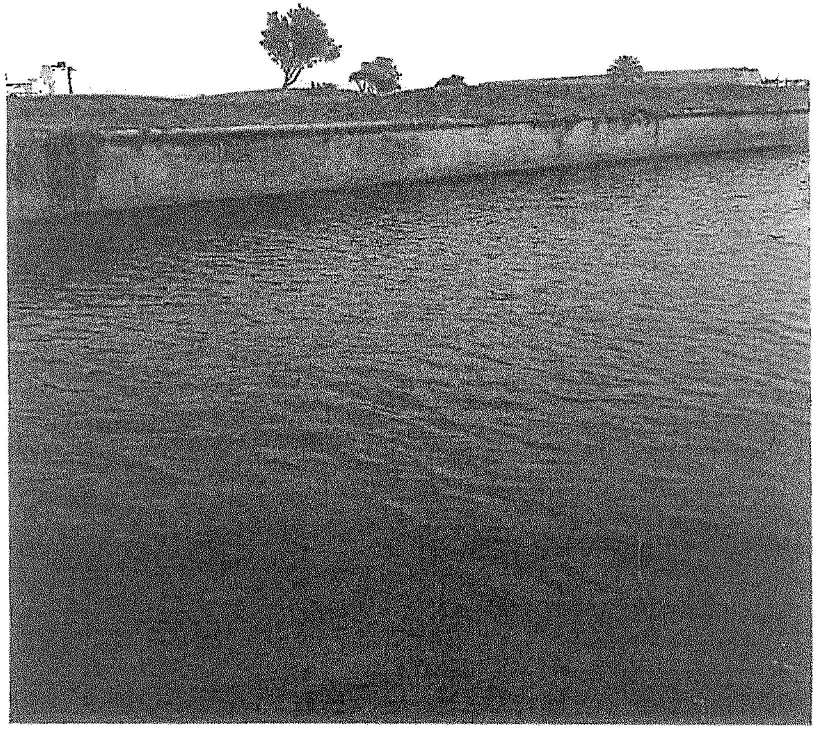
From: Zaahir Toefy <Zaahir.Toefy@westerncape.gov.za>
Sent: Wednesday, 26 February 2020 13:25
To: Mxolisi Dlamuka <Mxolisi.Dlamuka@westerncape.gov.za>; Gerhard Gerber <Gerhard.Gerber@westerncape.gov.za>; Matthew Law <MLaw@srk.co.za>; Michelle Couzyn-Rademeyer <michelle@zenprop.co.za>
Cc: Taryn Dreyer <Taryn.Dreyer@westerncape.gov.za>; Keagan-leigh Adriaanse <Keagan-Leigh.Adriaanse@westerncape.gov.za>; Waseefa Dhansay <Waseefa.Dhansay@westerncape.gov.za>; 'geoff@planpart.co.za' <Geoff@planpart.co.za>; Eldon van Boom <Eldon.vanBoom@westerncape.gov.za>; Karin Dugmorestrom <Karin.Dugmorestrom@westerncape.gov.za>; Marshallene Harris <Marshallene.Harris@westerncape.gov.za>
Subject: RE: River Club BAR: Request for Meeting with HWC

Dear Mr Dlamuka, Thank you very much for your response below. The original request for a meeting was directed to our office and we were in the process of coordinating such. From your response below it appears that your office is now making the necessary arrangements. I certainly have no problem with that, we await further communication in this regard as expressed in your email below.

Kind Regards
Zaahir

From: Mxolisi Dlamuka
Sent: Wednesday, February 26, 2020 1:08 PM
To: Gerhard Gerber <Gerhard.Gerber@westerncape.gov.za>; Matthew Law <MLaw@srk.co.za>; Zaahir Toefy <Zaahir.Toefy@westerncape.gov.za>; Michelle Couzyn-Rademeyer <michelle@zenprop.co.za>
Cc: Taryn Dreyer <Taryn.Dreyer@westerncape.gov.za>; Keagan-leigh Adriaanse <Keagan-Leigh.Adriaanse@westerncape.gov.za>; Waseefa Dhansay <Waseefa.Dhansay@westerncape.gov.za>; 'geoff@planpart.co.za' <Geoff@planpart.co.za>; Eldon van Boom <Eldon.vanBoom@westerncape.gov.za>; Karin

Appendix G3:
Surface Water Hydrology Impact Assessment



aurecon

Proposed River Club Redevelopment

Investigation into the impact of the proposed redevelopment of the River Club on flooding and flood abatement in the Salt River Catchment

Liesbeek Leisure Properties Trust

12 March 2018
Revision: 3
Reference: 112405

bringing ideas to life

Document control record

Document prepared by:

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Document control aurecon

Report title	Investigation into the impact of the proposed redevelopment of the River Club on flooding and flood abatement in the Salt River Catchment
Document ID	Project number 112405
File path	P:\Projects\112405 River Club Redevelopment\03 PRJ Del\5 DEL\Surface Water Hydrology 2017\Report\Draft 3.docx
Client	Liesbeek Leisure Properties Trust
Client contact	Stuart Walls — Client reference: Surface Water Hydrology

Rev	Date	Revision details/status	Author	Reviewer	Verifier (if required)	Approver
0	20 October 2017	Draft 0	Lloyd Fisher-Jeffes	Mike Shand		
1	8 November 2017	Draft 1	Lloyd Fisher-Jeffes	Mike Shand		Fareed Nagdi
2	23 November 2017	Draft 2	Lloyd Fisher-Jeffes	Mike Shand		
3	12 March 2018	Final Draft	Lloyd Fisher-Jeffes	Mike Shand		Fareed Nagdi
Current revision		3				

Approval

Author signature		Approver signature	
Name	Lloyd Fisher-Jeffes	Name	Fareed Nagdi
Title	Graduate Engineer	Title	Technical Director

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Disclaimer

This study was commissioned by Liesbeek Leisure Properties Trust (LLPT) to investigate the impact that their proposed development might have on flooding in the vicinity, downstream and upstream of their property. The City of Cape Town and other affected parties made a number of requests for the modelling to consider a range of alternatives. Aurecon has modelled these with the best available information at the time. The findings of this report should only be used to assess the impact of the River Club Proposal, and cannot / should not be used when considering alternative proposals (e.g. TRUP, NRF, PRASA etc.).

Executive Summary

Introduction

Aurecon South Africa (Pty) Ltd was appointed to undertake a definitive, detailed study of the impact of the proposed River Club development on the potential flooding. This study is intended to be used to guide the decision-making process with respect to the approval, and if successful, the design of the proposed redevelopment of the River Club site. The objectives of this investigation were therefore to determine the following:

- The effect that developing the River Club site would have on the extent of flooding along the Salt and Liesbeek Rivers;
- The implications that any changes to the surface water hydrology might have on flood levels which would affect infrastructure and private property in the vicinity of the Salt and Liesbeek Rivers;
- The cumulative impacts of the River Club development and all other likely / planned developments in the surrounding area; and
- The potential ecological impacts of developing the River Club site – particularly on the Raapenberg wetlands.

The City of Cape Town (City) agreed that reference to other accepted studies would be necessary as these address some of the above-mentioned objectives.

Literature Review

A review of the relevant literature details the following: the history of the site which once formed part of an extensive wetland; the changes to the City's policies; the effects of urban development, climate change and sea level rise; seven recent studies relating to flooding in the Liesbeek / Salt River Catchments; and which currently conceptualised developments are likely to take place in the vicinity of the River Club site. The literature review found that:

- The River Club site is prone to flooding by events with a frequency of recurrence of about once in every 2 to 5 years.
- There are a significant number of recent studies that incorporate the River Club site - some of these studies provide contradictory results.
- There is significant interest in the future development of the River Club site:
  - There are a wide range of stakeholders.
  - There are a variety of contradictory 'visions' of what should, and should not be done.
- There have been changes to the City's policies relating to developing within the floodplain.
- There is concern that infilling of the River Club site will result in significant increases in flood levels.
  - Some stakeholders have openly rejected any study that indicates a negligible or insignificant impact on flood levels.
- There was a need for a detailed analysis of the potential for flooding in the vicinity of the River Club site.

Method of Investigation

To assess the potential impacts of the proposed development on flooding in the vicinity of the site, Aurecon developed a series of PCSWMM and HEC-RAS two-dimensional models. These models were used to determine the existing (status-quo) flooding and the extent of flooding if the proposed development were to be allowed – and thus any changes as a result of the proposed development. A range of development and mitigation scenarios were considered. These include: pre- and post-development flood models; the effect of widening the Salt River Canal; the effect of sediment build up in the channel; the effect of different storm surges; the change in the hazard associated with the flooding; and the sensitivity of the models to different input parameters. As far as possible this analysis has been conservative. Furthermore, it has taken account of the full range of development proposals for the area.

Results and Conclusions

This study has reviewed seven relevant studies, and has undertaken extensive modelling with both HEC-RAS and PCSWMM 2D. The report presents (Chapter 4) the results for each scenario that was considered, without making definitive findings or conclusions due to the complexity of the site. Therefore, it is necessary to consider all the separate findings from the different scenarios together before drawing any definitive conclusions. Considering any 'question' or 'issue' raised in isolation may lead to a misinterpretation of the results. Furthermore, hydrology and hydraulic modelling should be considered as a tool for analysing potential impacts and scenarios, and as this is not an 'exact science', rather engineering judgement and experience is important in interpreting the results. Therefore, Aurecon involved three of its staff who have extensive experience of the circumstances at this site in order to ensure that the analyses were undertaken and interpreted in the most reasonable and appropriate manner.

Based on a review of all the available studies, the extensive modelling, and engineering judgement, it is Aurecon's opinion (as stated in Chapter 5) that:

- The results (magnitude of impact) appear to be relatively consistent for each study, even where study methods and elevations may differ slightly.
- The development of the River Club, along with the TRUP, PRASA and NRF sites is likely to have an impact on flood levels, in the order of 0.01m – 0.15m depending on the storm recurrence interval and location. The greatest differences in flood levels occur in the vicinity of the South African Astronomical Observatory. The impacts of these changes were deemed to be insignificant.
- Were the River Club to be developed in isolation (i.e. TRUP, NRF, PRASA were not to be developed), then the impacts on flood levels would be of a similar magnitude for all recurrence intervals, but less by approximately 0.00m – 0.03m, than the levels for the scenario where all the proposed developments went ahead. These impacts were also considered to be insignificant.
  - The differences between the post development scenarios are also well within the uncertainties of the modelling tools.
  - It is important to note that if any of the proposed TRUP, NRF and PRASA developments were to be undertaken in isolation, then the results must not be interpreted to mean that they would only have an impact equal to the differences between the post development scenarios for the River Club, TRUP, PRASA, and the NRF sites together, and the post development scenario for the River Club alone– as indicated in the RHDHV Study. This is because of the complexities of the hydrology and hydraulics in the vicinity of the River Club site.
- The design of changes to the Liesbeek Canal should aim to maintain the existing hydraulic functioning of the wetland during smaller recurrence interval events. The current proposal would have little to no effect, but further detailed design refinements – during detailed design – should be reanalysed.
- It would be advisable, in consultation with the Fresh Water Consultant, to consider reversing the intervention undertaken by the TRUPA, Friends of the Liesbeek and the South African Astronomical Observatory (SAAO) – as this is likely to increase flows into the wetland.

- The site is unlikely to be developed by the City as an attenuation facility.
- PRASA should not be allowed to close the existing overland flood route that extends across its property, as this is important for mitigating flood risk – regardless of whether the proposed River Club development proceeds.
- The extension to Berkley Road should be designed in such a manner as to not impact on the water levels determined by this study and any changes to the preliminary design would need to be re-evaluated. The detailed design of the extension of Berkley Road should consider raising the portion of the road that is within the floodplain.
- There is a need to address the localised change in risk along Liesbeek Parkway. This could be done through raising the road locally (as discussed in the report) to eliminate the potential flooding by the 1 in 100-year event, however ponding due to local stormwater is also likely to occur at this location for which the provision of warning signs would probably suffice.
- The impact of the proposed development on flood levels and the areal extent of the additional flooding are considered to be negligible.
- The combined impacts on flood levels of the proposed development together with the proposed development of the Two Rivers Urban Park and their extent are considered to be negligible.
- Widening the Salt River would reduce the flood levels for all scenarios, but as the capital cost would be very high and the benefits very small this is unlikely to be viable in the foreseeable future.

The main conclusion of this study is that the proposed development would have an insignificant effect on flooding in the vicinity of the existing River Club site. Although the development would have some limited localised effects on flows and water levels in the Liesbeek and Black Rivers, the modelled impacts in terms of increased hazard and potential damage to properties are insignificant and can be considered to be negligible – provided that the above-mentioned findings are adhered to.

Although the proposed development would not have a significant impact on flooding, it would none the less require the following deviations in terms of the City's *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a):

- Section 9.2: Flood Management and Public Safety
  - Permission to develop / obstruct the free flow of water within the 20-year flood line area would need to be granted.
- Section 10.5: Table 1: Framework for the assessment of Proposals
  - The current assessment framework forbids development (including filling) within the 50-year flood plain. It notes: "*In exceptional circumstances minor "smoothing" of the 50 / 100-year flood line may be considered, provided equivalent compensatory stage storage volume is provided within the development precinct*".
  - As the proposed development falls under the 50-year flood line, a deviation from the policy, allowing the developer to fill (considered development) would need to be granted.

Although the two development layouts (Section 3.2) would both have similar impacts, Layout Option 1 (focus of this study) would be the preferable option as it aligns with the vision of the City's *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a) in that, in comparison to Layout 2) it provides an improved ecological corridor, and the potential for improved amenity and biodiversity in accordance with the principles of Water Sensitive Urban Design (WSUD) principles.

It is recommended that the City should take account of the findings of this study to determine whether in terms of the policy and based on consideration of the "*geomorphological, maintenance, social and economic aspects*" (presented by other specialists) the proposed development of the River Club Site should be approved.

Contents

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Tables

Abbreviations

1D	One Dimensional
2D	Two Dimensional
AED	African Environmental Development
CC	Climate Change
CMC	Cape Metropolitan Council
CSRM	Catchment, Stormwater, and River Management Branch
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
EGL	Energy Grade Line
EL	Energy Level
GIS	Geographical Information Systems
LiDAR	Light Detection and Ranging
LLPT	Liesbeek Leisure Properties Trust
NRF	National Research Foundation
PRASA	Passenger Rail Agency of South Africa
PRDW	Prestedge Relief Dresner Wijnberg
RH-DHV	Royal HaskoningDHV
RI	Recurrence Interval
RSA	Republic of South Africa
SAAO	South African Astronomical Observatory
TRUP	Two Rivers Urban Park
TRUPA	Two Rivers Urban Park Association
WCG	Western Cape Government
WS	Water Surface Level

Symbols

C	Runoff Coefficient
ha	Hectares
km	Kilometre
km^2	Square kilometres
m	Metre
m^3	Cubic metres
m^3/s	Cubic metres per second
N	Manning's Roughness

1 Introduction

1.1 Background

The Liesbeek Leisure Properties Trust (LLPT) currently owns and operates the River Club in Observatory, Cape Town (Figure 1-1). LLPT proposes to develop the site as a mixed commercial, institutional, residential site and therefore as part of the scoping study for the proposed development it acquired the services of African Environmental Development (AED) to undertake a flood line determination study and to assess the impacts of the proposed development on the River Club site and surrounding properties. This study considered the flooding in the vicinity of the River Club site as a result of flows in the Salt River Catchment (Figure 1-1) – which drains by the Elsieskraal, Black and Liesbeek Rivers that discharge into the Salt River.

Concurrently, while LLPT's scoping studies were being undertaken, the Western Cape Government (WCG) were undertaking similar studies aimed at developing a spatial development framework for an area known as the Two Rivers Urban Park (TRUP) – shown in Figure 1-1. The TRUP area is predominantly owned by government (City of Cape Town (City) and Western Cape Government) but also includes some privately-owned erven, such as the River Club site.

Following the release of the Draft Scoping Report for LLPT's proposed development a number of queries were raised with regard to AED's study titled "*Flood Line Determination for the Salt and Liesbeek Rivers at the Cape Town River Club, Cape Town, Western Cape Province, RSA*". It was also noted that there were differences in flood levels determined by the studies commissioned by LLPT and by the WCG as well as in the results of previous studies commissioned by CCT – undertaken by Ninham Shand (2003; 2004) and SRK (2013).

In 2016 Aurecon South Africa (Pty) Ltd was appointed by LLPT to undertake a peer review of the AED study. This necessitated a review of the WCG study and of the previous 2003, 2004 and 2013 studies in order to investigate the identified discrepancies. As a result of the review of these studies it was decided, in consultation with LLPT, that it was necessary to undertake further investigations to confirm the extent, if any, of the impact of the proposed development of the River Club site on the flooding of properties in the areas surrounding this site. This study indicated that the proposed River Club development, in isolation, would have an insignificant impact on flood levels and that there were a number of significant differences between these results and the results of both the AED and WCG studies.

In 2017 Aurecon South Africa (Pty) Ltd was appointed to undertake a definitive, detailed study of the implications on flood levels of the proposed River Club development together with the proposed TRUP development.

This report documents the process and findings of the review of the previous flood studies and of the further investigations carried out by Aurecon. The report also describes the additional investigations and provides comment and conclusions about the potential impacts of the proposed development on flooding and inundation of the River Club site and surrounding properties.

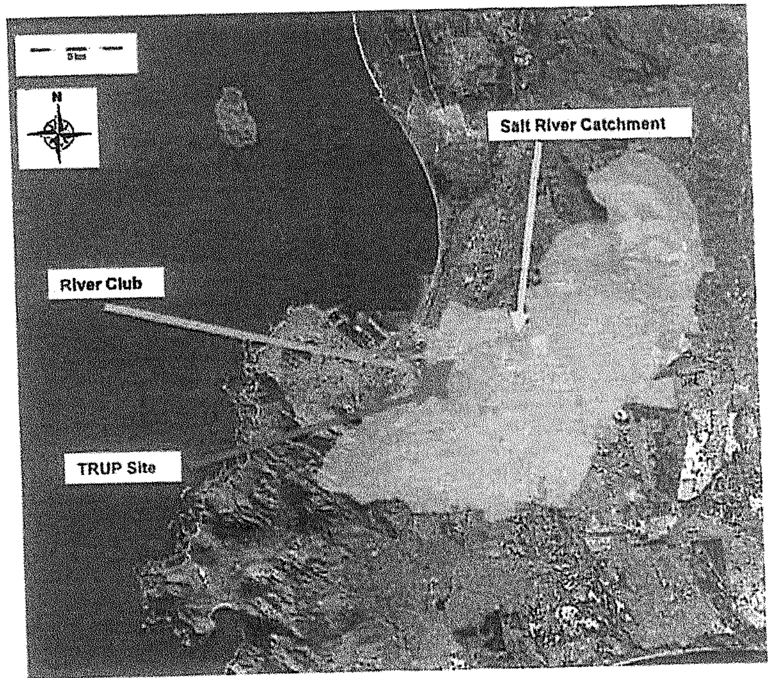

Figure 1-1 Location, and size of the River Club site, within the TRUP area and greater Salt River Catchment

1.2 Objectives

The objectives of this investigation are, *inter alia*, to determine:

- The effect that developing the River Club site would have on the extent of flooding along the Salt and Liesbeek Rivers;
- The implications that any changes to the surface water hydrology might have on flood levels which would affect infrastructure and both public and private property in the vicinity of the Salt and Liesbeek Rivers;
- The cumulative impacts of the River Club development and all other likely / planned developments in the surrounding area; and
- The potential ecological impacts of developing the River Club site – particularly on the Raapenberg wetlands and bird sanctuary.

As agreed with the City, reference to other accepted studies would be necessary to address some of the above-mentioned objectives.

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1.3 Limitations

It is important to note that this investigation is based on the City's latest hydrologic models – SRK (2012). Aurecon has previously highlighted concerns about the correctness of this hydrological modelling of various sub-catchments within the catchment area of the Salt River and has made proposals for addressing potential shortcomings. Never the less Aurecon is of the opinion that the Two-Dimensional (2D) models that have been configured for this study provide a reasonable basis for making informed judgements regarding the flood levels for both the pre- and post-development of the River Club site flooding and adjacent areas. This is because the water levels and flow paths determined from the modelling correspond closely with observations by experienced Aurecon employees who visited the sites during major flooding events over the last 15+ years.

2 Literature review

2.1 General background

2.1.1 History of the Salt River Catchment

The histories of the rivers and wetlands in Cape Town are comprehensively documented in Brown & Magoba (2009) and therefore are not repeated in detail here. The histories include the impacts that urbanisation has had on the 'rivers and wetlands' in Cape Town. A literature and internet search of historic images highlighted the changes, over the last century, to the environment in the vicinity of the confluence of the Liesbeek, Black and Salt Rivers. These changes are highlighted in Figure 2-1, Figure 2-2, Figure 2-3 and Figure 2-4, to provide context for this report.

Figure 2-1 shows that historically the Liesbeek and Black Rivers flowed into an extensive wetland. By 1958 this had had changed with the initial canalisation of the rivers as evident from Figure 2-3. In 1960 the (re)canalisation of the Black River took place as well as the creation and canalisation of the Liesbeek Canal along the Eastern boundary of the River Club Site (Whittemore & Gorgens, 2007). By 1968 (Figure 2-3) the impact of urbanisation is clearly evident including a number of changes that impacted on what was previously a more extensive wetland. The last remnants of this once extensive wetland are now known as the 'Raapenberg Wetlands'. The historic presence of an extensive wetland in this area is not surprising, as the area is relatively flat and low lying.

Of interest for this study, is that it is apparent that the course of Liesbeek River changed a number of times between 1937 and the present. Today the abandoned river course is fed by limited runoff from the adjacent urban area, and the majority of the Liesbeek River Catchment's flow is channelled down the Liesbeek River Canal as shown in Figure 2-3 and as evident in Figure 2-4.

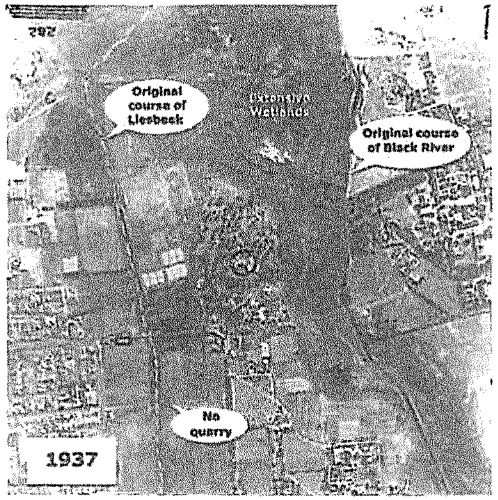

Figure 2-1 Aerial footage from 1937 indicating the 'original' course of the Black and Liesbeek Rivers (Richard.F. 2016)

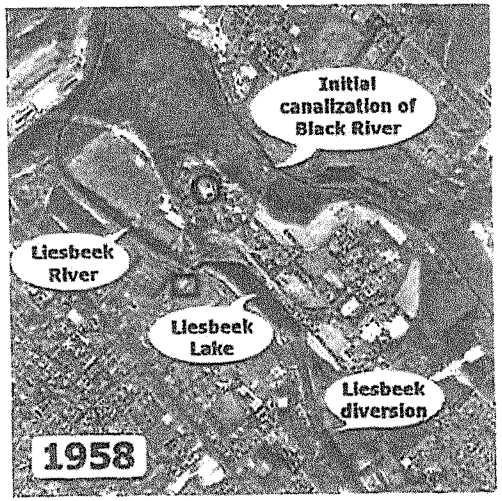

Figure 2-2 Aerial footage indicating the changes between 1937 – 1958 to the course and structure of the Liesbeek and Black Rivers (Richard.F, 2016)

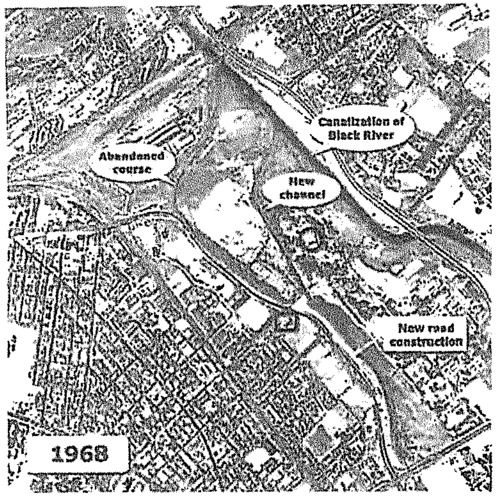

Figure 2-3 Aerial footage indicating the changes between 1958 – 1968 to the course and structure of the Liesbeek and Black Rivers (Richard.F, 2016)

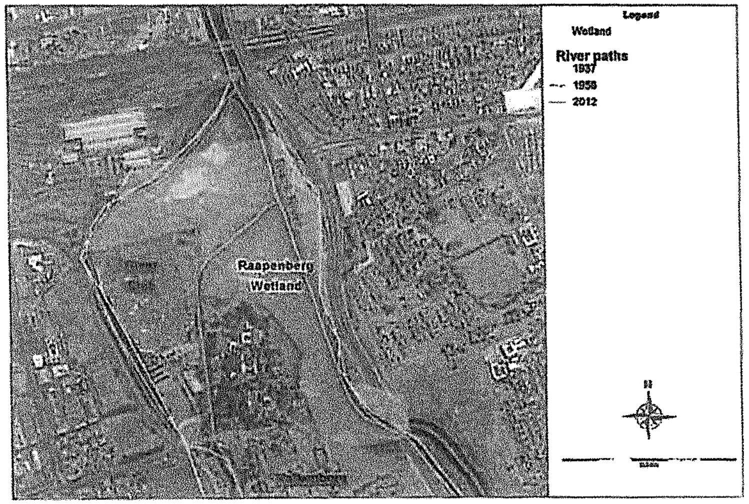

Figure 2-4 Map overlaying the changes between 1937 and the present to the course of the Liesbeek and Black Rivers.

2.1.2 Potential Ecological impacts

The ecological value of the lower reaches of the Liesbeek and Black Rivers is dealt with in a separate report compiled by Dr Liz Day (Freshwater Consulting Group). Dr Day highlighted that the Raapenberg Wetlands (Figure 2-4) are of particular importance and that the change in water depths, particularly for intra-year storm events, was of concern as it may impact on the local fauna and flora. The approach to assessing the impact of the proposed development on the Raapenberg Wetlands is described in Section 3.5.

2.1.3 Policy changes

It is important to recognise that over the last 20 years there have been significant shifts in policy relating to the management of stormwater and flooding in the City. Prior to 2000 general practise was to limit development to above the 50-year flood line (CMC, 2000). ARCUS GIBB (2000) noted that there was no legislation which stipulated whether it was permissible to develop and fill within the 100, 50 or 20-year flood plains; and that the City had no by-laws preventing filling of the 50 year flood plain. Subsequently the City made significant changes to its policies which are presented in the following documents:

- In 2000
  - *'Development Control Guidelines in Flood Prone Areas'*(CMC, 2000)
- In 2003
  - *'Floodplain Management Guidelines'* (CSRM, 2003)

- In 2009
  - '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a)
  - '*Management of urban stormwater impacts policy*' (CSRM, 2009b)

The latest two policy documents, published in 2009, provide the basis for the assessment of development plans in regard to stormwater management and flooding, in the City. Together these require the following:

- Development such as that proposed for the River Club site is required to be elevated above the 1 in 100-year flood line.
- Future upstream developments are required to ensure that properties downstream of any such development are not affected, and if downstream properties are affected then the upstream development would not be permitted in terms of the "Framework for assessment of proposals".
- Future developments are also required to manage their runoff so as to not to increase and preferably to reduce peak flows.

2.1.4 Construction of a berms along the banks of the Liesbeek River

The construction, in September 2013, of berms and infilling along the banks of the Liesbeek Canal by the, then tenant, of the River Club property has been a contentious issue. Cape Argus (2017) reported that "*Friends of the Liesbeek secretary, Francine Becker, said they saw large Ross Demolition trucks dumping soil on the river banks. This activity continued over the weekend and up to 10 large tks loaded with soil were observed driving into the River Club in the space of an hour. It seems the River Club, desperate to deal with flooding, has illegally dumped material in and along the Liesbeek.*" In the same article it is noted that "*Becker said she spoke to a River Club representative, Nick Ferguson, who said it had been decided to cover the bank to make it 'neat and tidy'...'He said he could not wait for authorisation as the soil was available and too expensive to truck in later. The dumped soil would be compacted mechanically and planted with grass.*' "

During the scoping phase of the project it became evident that the construction of the berm in 2013 remains a contentious issue. The extent of infilling for the berm is shown in Figure 2-5. A process with City's legal section is currently underway concerning the construction of berms along the Liesbeek Canal without authorisation (Construction of a Berm Along the Liesbeek Canal by the River Club, Ref: 16/1/1/11/243).

According to the proponent of the current development proposal, the berm was built by the previous tenant and is not connected to the current ownership. A notice concerning the removal of the berm was issued by the City to the Liesbeek Leisure Club (Pty) Ltd of which the current owners were not directors or shareholders.

It is Aurecon's understanding that the process is currently ongoing and the results of the development application will be considered in determining the course of any further action.

During the course of this investigation it became apparent that the South African Astronomical Observatory (SAAO) had constructed a berm on the opposite bank to that of the River Club as indicated in Figure 2-6. The construction of this berm appears to have been undertaken without the permission of the City of Cape Town.

For the assessment of the impact of the infilling on the River Club property the status of both berms presents a difficulty in determining the "predevelopment" status quo. Therefore, for this impact assessment it was decided that the worst-case scenario would be considered – i.e. the "status quo" for

which the largest impact on the SAAO would be realised. This is considered to be the case where neither the River Club, nor the SAAO would have constructed berms (i.e. the status quo in 2012).

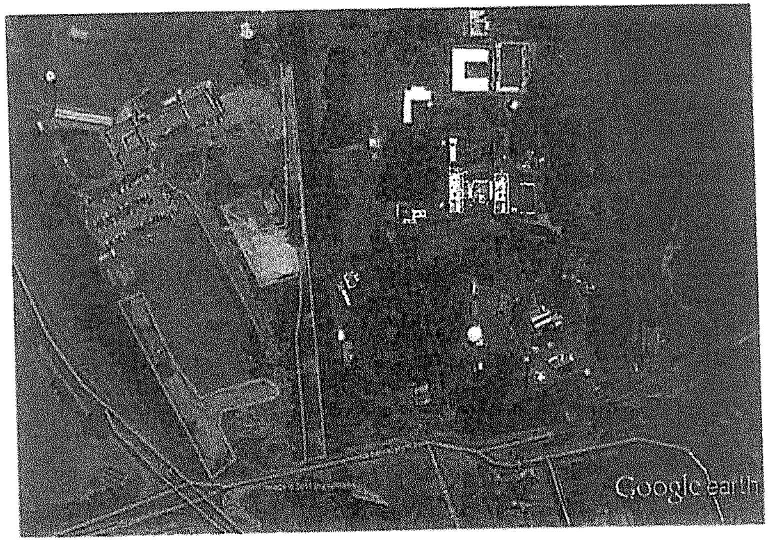

Figure 2-5 Extent of infilling on site (outlined in green) (Source: Google earth (11/01/2014))

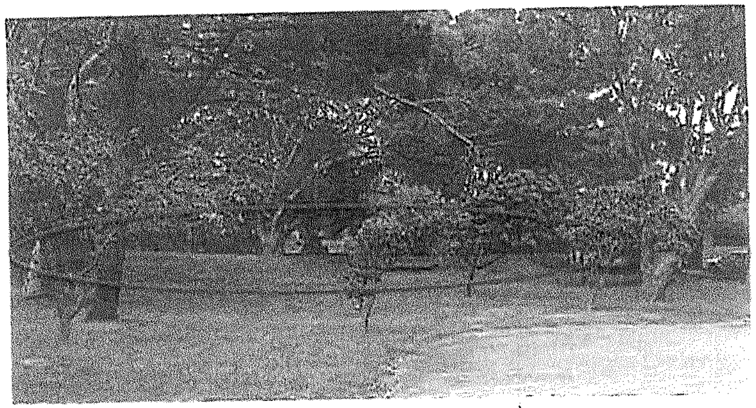

Figure 2-6 Berm on the South African Astronomical Observatory (SAAO) side of the Liesbeek Canal – constructed sometime between 2013 – 2016

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2.1.5 Climate Change considerations

'Human interference with the climate system is occurring, and climate change poses risks for human and natural systems' (IPCC, 2014b). Within urban areas, it is generally predicted that the increase in global temperatures associated with climate change will be exacerbated as a result of the urban heat island effect (IPCC, 2014a). Willems et al. (2012) indicate that rainfall intensities are typically expected to be increase by the end of this century (2100) at small urban hydrology scales by between 10% and 60% from historic levels recorded between 1961 and 1990. A recent stormwater master planning report for the City, SRK (2012) indicated that it was necessary to increase the modelled rainfall depth for design storms by 15% to account for changes in the intensity of extreme events. This was based on an analysis of the potential impact that climate change might have on rainfall intensities in Cape Town, and incorporated into this study.

Other expected impacts of climate change are a rise in the global sea level and increased storm intensities. PRDW (2010) undertook a study to provide estimates of the expected storm surge and wave setup corresponding 1:20 year, 1:50 year and 1:100-year frequencies and provided best and upper estimates of sea level rise in 2035 and in 2060. It was agreed with the City that the levels provided by PRDW (2010), and used for Royal Haskoning DHV's (RH-DHV's) (2017) investigation of the TRUP site, should be used for the current investigation.

2.1.6 The effect of further urbanisation / changes in land-use within the greater Salt River Catchment

Urbanisation typically results in an increase in the impervious surface area, which has significant impacts on a watershed's hydrology (Shuster et al., 2005; CSIR, 2005; Leopold, 1968; Walsh, 2000). Leopold (1968) noted that the volume of runoff is primarily determined by the soil's infiltration characteristics. The increase in the impervious area associated with urbanisation results in greater volumes of runoff and higher peak flows. Urbanisation can also result in significant changes in how runoff is conveyed in most urban areas (Marsalek et al., 2006). Historically, natural channels have often been replaced with hydraulically highly efficient concreted channels. While the increase in impervious areas results in increased runoff volumes, Fletcher et al. (2008) highlighted that 80% to 90% of the increase in peak flows can be attributed to the nature of the conveyance network. The impacts of possible uncontrolled and unmanaged urbanisation are also important.

Long-term catchment planning and management is the responsibility of the City, and not the developers of individual sites within a catchment that is significantly larger than the individual sites. In the case of the River Club the area of the site is less than 0.1% of the area of the Salt River Catchment. The City has, fortunately, been progressive in implementing two critical policies to manage the impact of urbanisation and densification on flooding within the City. These are the City's *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a) and *'Management of urban stormwater impacts policy'* (CSRM, 2009b) – as discussed above.

This report describes the determination of the impacts that the proposed development is expected to have on properties in its vicinity – in accordance with the policies discussed in Section 2.1.3.

2.1.7 Flooding in urban areas

It is important to recognise that not all flooding in an urban area is necessarily related to the flows in a nearby river. The piped underground stormwater system is typically sized for smaller recurrence interval events (typically for flood magnitudes smaller that than the 1 in 2-year, 1 in 5-year and 1 in 10-year events – depending on the design criteria) (CSIR, 2005). It is usually planned that during larger storm events (with flood magnitudes greater than the 1 in 2-year, 1 in 5-year or 1 in 10-year events –

depending on design criteria) the excess flows will discharge overland via the road network which is intentionally designed to serve as part of the surface drainage system (CSIR, 2005). While this may be considered as 'flooding', it is intentional and not related to the flooding caused by flows in a nearby river – in this case the Liesbeek and the Black/Salt Rivers.

Additionally, for small storm events, should the stormwater infrastructure (inlets and/or pipes) become blocked it is expected that stormwater will be conveyed via the road network – which may appear to be flooding but is often unrelated to the flow in the river.

2.1.8 Perceptions about flooding

In the public discourse – both in media articles and comments submitted as part of the EIA process – there appears to be a perception that the River Club site frequently floods and that the development of the site "will" have an impact on the flooding of properties in the surrounding area – with some interested and affected parties 'rejecting' any studies that do not indicate this. While it is correct that the site has flooded relatively frequently (every few years) in recent history – as discussed in Section 2.3 – it is important to differentiate flooding as a result of high runoff, and flooding that results due to the capacity of the drainage system being limited due to inadequate maintenance and or structural failure.

One specific question that will not be answered by the modelling and analysis is "Why it is necessary for the River Club to raise itself out of the floodplain, whilst it is not necessary for the surrounding areas to be raised above the floodplain (TRUP Assoc, 2017)." This is an important question as it implicitly suggests that if the River Club's proposed development takes place this will worsen the flooding affecting properties that have already been developed, and that if the River Club is not developed these properties will not be affected by flooding. Furthermore, it has been suggested that if the proposed development of the River Club is unaffected by flooding this will increase the impact of flooding of the surrounding properties. It is therefore important to note:

- The reason that there are properties developed on land lower than the existing flood lines is that historically (see Section 2.1.3) properties were allowed to be developed within the 100-year flood plain. Therefore, properties such as those identified as being below the 100-year flood line would, if developed today, be required to elevate themselves out of the floodplain – as is being required for the proposed development on the River Club site.
- The purpose of this report is to assess the impact that the proposed development will have on surrounding properties, in accordance with the provisions of the City's *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a).

2.2 Previous investigations

The River Club and surrounding areas have been the focus of a number of hydrological and hydraulic studies over the last 20 years. These include the following studies: ARCUS GIBB (2000), Ninham Shand (2003 and 2004); SRK (2012); AED (2016) and RH-DHV (2016). Table 2-1 shows the flood levels determined by these studies at the various locations in the vicinity of the River Club shown in Figure 2-7.

There has been a lack of consistency in the modelling methods and in the resolution at which the upstream catchment area has been modelled. In addition, the more recent models have incorporated climate change considerations. Therefore, undertaking comparisons between the different results is not directly possible. On the other hand, it is evident from Table 2-1 that there are inconsistencies in the results of the various studies. An overview of each of these flood line determinations and other relevant investigations is provided below.

There have also been a number of academic research projects that have considered aspects related to flooding of the River Club Site. These include Lurie (1954), Giermek (2015) and Fisher-Jeffes (2015).

All the above-mentioned studies are briefly described below.

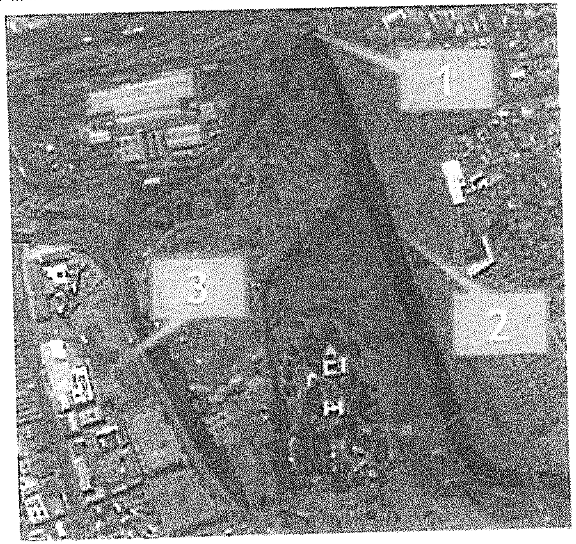

Figure 2-7 Locations at which flood levels are compared in the table below

Table 2-1 Flood levels determined / used in different studies

Report	Year	Climate Change		1:100 Year Storm Event – Water Surface Elevation (mamsl)		
		Increased Rainfall	Increased Sea Level	Location 1	Location 2	Location 3
ARCUS GIBB[1]	2000			Approximately 5.45-5.55m (50 year)		
Ninham Shand[2]	2003/2004			4.26	4.45	Flooded
SRK[2]	2012	✓	✓[5]	4.54	4.95	Flooded
AED[3]	2016	✓		5.40	5.40	Flooded
Royal HaskoningDHV[4]	2017	✓	✓	4.45	4.55	'Limited'

[1]ARCUS GIBB refers to the City as having provided these levels, the source of the levels are not clear. [2]Hec-Ras Model, [3]Spreadsheet based model developed by AED, [4]PCSWMM 2D Model,
[5] The study considered both current sea level and sea level rise due to climate change. The model made available by CCT for this investigation did not include sea level rise.

2.2.1 ARCUS GIBB (2000)

In 2000 ARCUS GIBB was appointed by the then tenant of the 'River Club' to prepare a report '*giving details relating to flood levels, options for detention ponding and mitigating measures to reduce the impact of the proposed development on the flood conditions.*' ARCUS GIBB determined 1 in 50-year flood levels of between 5.4 mamsl and 5.5 mamsl. While the more recent studies do not show significant differences in the flood levels between the 1 in 50-year and 1 in 100-year events, it is evident that the flood levels determined by the ARCUS GIBB (2000) study are significantly higher than those determined all other studies except the AED (2016) study. Unlike the AED (2016) study it is not possible to determine how these flood levels were determined by ARCUS GIBB.

2.2.2 Ninham Shand (2003)

As part of a study commissioned by the City and undertaken with input from a number of consulting engineering companies, Ninham Shand developed flood lines for the Black and Salt Rivers (including the area surrounding the River Club site). This was done with input from BKS who undertook the hydrological modelling and the determination of flood lines for the Liesbeek River Catchment. Ninham Shand's flood line determination indicated that:

- For large recurrence interval storm events (i.e. greater than the 1:20 year event) flooding would occur over the PRASA site.
- The fields adjacent to the old Liesbeek River would be flooded.
- The peak flow in the Liesbeek River (as determined by BKS) is approximately 160 m³/s for the 1:100 year recurrence interval flood event.
- The peak flow from the Salt River Catchment, including the Liesbeek River Catchment is approximately 240 m³/s for a 1:100 year recurrence interval storm event.

2.2.3 SRK (2012)

As part of a study commissioned by the City, titled "Stormwater Infrastructure Asset Management Plan (Phase 2A) Rainfall Analysis and High-Level Master Planning", SRK developed both hydrological and hydraulic models for the Salt River Catchment (including the Liesbeek River Catchment). It is worth noting the following:

- The models considered the impact of climate change on rainfall and sea level rise.
- The modelling was undertaken in one dimension (1D) making use of PCSWMM (hydrology and basic hydraulics) and HEC-RAS (hydraulics for flood line determination).
- It is unclear whether Energy Levels or Water Surface Levels were used in determining the flood lines. Communication with the City and a review of the HEC-RAS models indicated the likelihood that Energy Levels were used. This is significant as PCSWMM, the City's choice for modelling the site in 2D does not report Energy Levels directly.

Flood lines determined in this study have been adopted by the City's Stormwater and Sustainability Branch as those to be used for planning purposes. As such, the 2012 SRK study supersedes the 2003 and 2004 Ninham Shand studies.

2.2.4 Giermek (2015)

As part of a Master Degree research project Giermek (2015) undertook an investigation of the benefits of the attenuation provided by the Valkenberg wetlands immediately upstream of the River Club site. The study found that the wetland (+- 2 hectares) was most effective at attenuating rainfall events with "*sudden spikes in peak flow, where a 42 per cent reduction of peak flow was observed. For a scenario with lower flow rates yet a prolonged peak flow rate, the wetland was less effective, with a 20 per cent reduction observed.*" It is important to note that the model for this study was not calibrated and only considered three rainfall events, all in 2013.

2.2.5 Fisher-Jeffes (2015)

Fisher-Jeffes (2015) undertook an investigation of the viability of rainwater and stormwater harvesting in the residential areas of the Liesbeek River Catchment, City of Cape Town. The study focused exclusively on the Liesbeek River Catchment and did not consider the effect of the greater Salt River catchment on the River Club Site. While the study indicates that stormwater harvesting (SWH) throughout the catchment (in a decentralised manner) may have the potential to significantly attenuate peak flows and flooding in the catchment, this does not necessarily equate to the same benefits being experienced if stormwater harvesting / attenuation were to take place on the River Club Site. The study only assessed storms with recurrence intervals of less than 1 in 20 years. Furthermore, the study noted that a decentralised approach to attenuating stormwater would not be practical (to retrofit the catchment at this point) as, apart from the open space at the River Club (which would require a centralised approach) it was shown that the majority of the remaining open space is either not situated in areas where it could be used for SWH – i.e. at the edge of the catchment – or is used for other purposes such as school sports fields. Thus, the study recommended SWH be considered at the planning stage of any future settlement.

2.2.6 AED (2016)

LLPT appointed African Environmental Development (AED) to undertake a flood line determination study as part of the scoping study for the proposed development. LLPT subsequently appointed Aurecon to review the AED study. The review indicated the following:

- The results of AED's hydrological analyses were significantly more conservative than any of the other studies with the 1:100-year storm event having a peak flow of 336 m^3/s. The other studies indicated a 1:100-year peak flow of approximately 250 m^3/s. AED's peak flows for lower recurrence interval storm events are also higher than those of the other studies. The difference in flow rates between the AED study and other studies is a result of the methods used for runoff determination and routing of the runoff through the catchment.
- AED used an in-house developed spreadsheet based model for determining flood levels. The spreadsheet utilised seven river channel / floodplain cross-sections and took account of bridge backwater effects by increasing channel roughness coefficients at bridge locations. The spreadsheet did not take tidal effects or sea level rise due to climate change into account. The higher AED flow rates and the coarser spreadsheet based determination of flood levels resulted in higher flood levels for all recurrence interval events. In the case of the 1:100-year event, the AED flood levels are between 0.5m and 1.0 m higher than those of the other studies.
- The configuration of AED's hydrological and hydraulic models made it difficult for AED to respond to queries regarding the impact of the proposed development on surrounding areas during lower order flood events (i.e. the annual, 2 year and 5-year events). Also, the effects of tides and sea level rise on flood levels at the River Club site could not be accurately assessed in the spreadsheet model.
- AED identified, as did previous studies, a need to maintain the overland flow route through the PRASA owned land.

2.2.7 RH-DHV (2017)

As a part of the planning for the development of the TRUP area by the Western Cape Government (WCG), Nisa Mammon & Associates (NM&A) was appointed to provide professional services as part of this project. RH-DHV were appointed by NM&A to provide various specialist services, which included the assessment of flooding and flood mitigation measures in the TRUP area. A review of their analysis models and study reports indicated that RH-DHV:

- Made use of the City's existing SWMM stormwater models (i.e. the SRK 2012 models) to provide the hydrology for the investigation.
- Modelled potential flooding in the TRUP area using a 1D-2D approach.
- Had expressly indicated their preference for the use of the HEC-RAS model for undertaking the work, however the City had indicated their preference for the use of PCSWMM.
- Did not identify any flooding over the PRASA site, nor flooding of the fields adjacent to the old Liesbeek River using their base line models.

Aurecon reviewed the RH-DHV models, and identified possible improvements. Following a request from Mr Gerhard Gerber (WCG's TRUP Project Manager), these concerns were conveyed to the TRUP project team. Aurecon and RH-DHV then engaged on the approaches and technical aspects of the RH-DHV models. RH-DHV subsequently revised their model (Model D1). The engagement and results are detailed in Hirschowitz (2017). The results indicated that the revisions to the models increased the 1:100-year flood level by approximately 0.5 m near the River Club, indicating that flooding would occur over the PRASA site, and that flooding of the fields adjacent to the old Liesbeek River would occur. This brought the flood levels determined by RH-DHV in line with those of the other studies.

The TRUP study as a whole has not yet been finalised, however for the purpose of this report the focus is on the RH-DHV: Task 2 Final Report - Modelling of Flood Mitigation Options on the Salt River.

2.2.8 Conclusions based on the review of recent studies

The review of the above studies revealed that the Ninham Shand (2003) study predicted the lowest 1:100 flood levels in the vicinity of the River Club site. This is expected as the study predated the availability of climate change data for rainfall and sea level rise and thus did not consider these circumstances. Considering that the impact of sea level rise on flood levels at the River Club was not found to be significant, and that the effect of climate change on rainfall is an approximate 15% increase in total storm volume, the difference in flood levels between the Ninham Shand (2003) study and the subsequent SRK (2012) study is considered to be reasonable.

Given the differences in hydraulic modelling methods between the SRK (2012) and the RH-DHV (2017) studies (i.e. 1D modelling in the SRK study and 2D in the RH-DHV study), the differences in the predicted flood levels are also reasonable.

The AED study (2016) predicts the most conservative flood levels which are between 0.5 m and 1 m higher than those of the other studies for the same recurrence interval floods. The methodologies and software used for the AED study are considered to be too simplistic for the complexities of a system of this nature which makes justification of the results difficult. It was also difficult for AED to respond to the more detailed modelling requirements of City (i.e. assessment of lower order flood events, tidal effects and seal level rise).

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2.3 Recorded flood events

The available records for the last 17 years shown in Figure 2-8 indicate that there have been approximately 7 occasions when the River Club Site was inundated with water – generally considered 'flooded'. This is not surprising as most modelling indicates that any event greater than about the 1 in 2-year flood event is likely to result in flooding – depending on the spatial and temporal distribution of the storm event in the catchment. Therefore 'roughly' it is not unreasonable to expect a number of storm events to have resulted in flooding on the site in the past 17 years. It is worth highlighting that:

- Four of these events take place in a five-year period between 2007 and 2012. During this period the lower reaches of the Liesbeek River shown in Figure 2-9 were partially obstructed due to a structural failure in the canal wall and a lack of maintenance. These partial obstructions resulted in a reduced capacity in the canal and likely increased the depths of flooding during this period. While the frequency of these events highlights the need to maintain / rehabilitate the canal when failures occur, it would be misleading to incorporate them into a frequency analysis.
- The recurrence interval of a storm event does not imply that it occurs on a regular basis. A five-year storm does not take place once every five years – it could happen 5 years in a row and then not again for the next 20 years.

Therefore, it is Aurecon's opinion that the flooding on the site is consistent with the modelling to date of floods with a frequency of recurrence of about once in every 2 to 5 years.

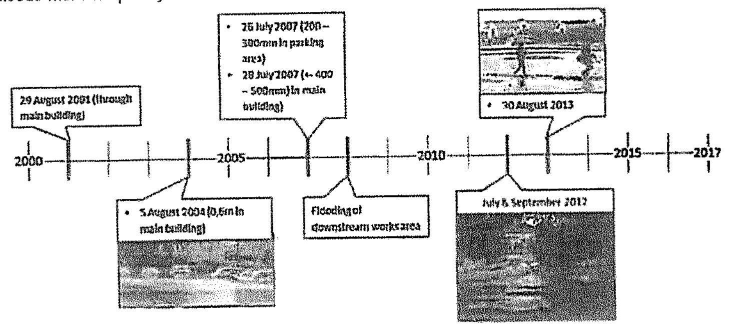


Figure 2-8 Timeline of recorded floods in the vicinity of the River Club

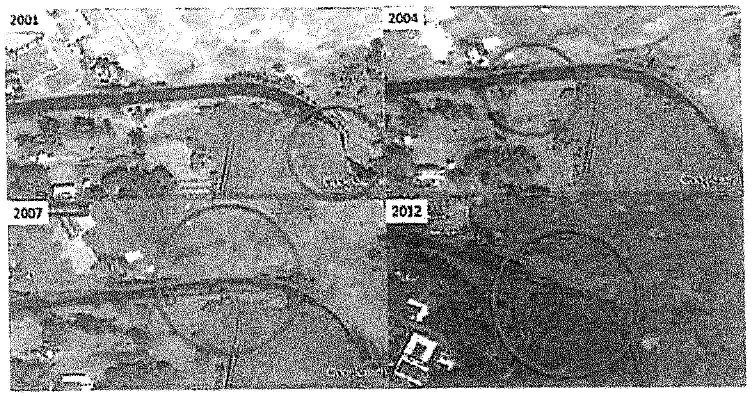


Figure 2-9 Partial obstructions in the Lower Liesbeek River between 2007-2012

2.4 Future development scenario's

2.4.1 TRUP

The Two Rivers Urban Park (TRUP) Programme is an initiative resulting from a partnership between the City and the Western Cape Government (WCG). The intention is to enhance the area's natural and cultural resources while concurrently developing the TRUP area for residential, commercial, institutional, manufacturing and recreational activities, aimed at generating a wide range of housing, recreation, business and employment opportunities, with the aim of creating an *'open opportunity society for all'* so that people can live lives that they value.

Following extensive work undertaken primarily by NM&A, a concept for future development of the TRUP was developed in order to make a preliminary assessment of the capacity of services in the area as indicated in Figure 2-10. Although the TRUP development proposals are not yet available, this conceptual layout provides a good indication of the potential spatial extent of TRUP. It should be noted that the developable area (on the River Club site) according to the TRUP 'vision' is significantly less than that proposed by LLPT for the development of this site.

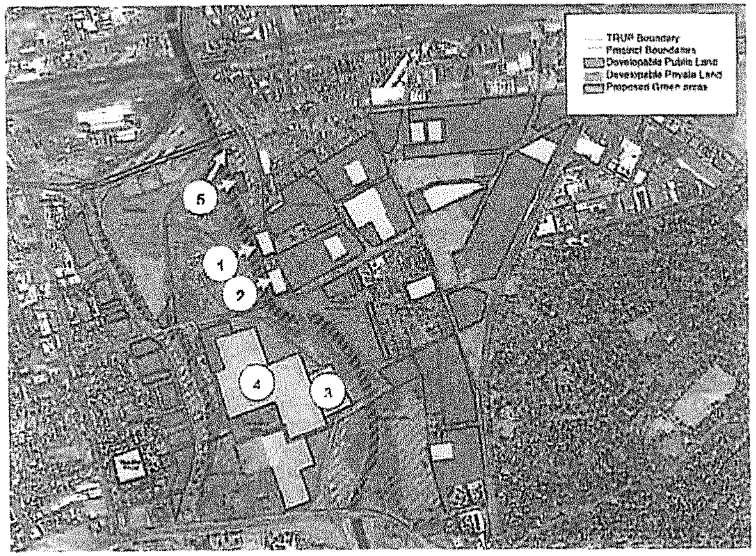


Figure 2-10 Proposed TRUP Layout indicating developable area's

2.4.1.1 Comments on the concept design

Aurecon raised a few queries with regard to the existing concept design and the impact it may have on the flood plain. These questions, and answers, included:

- Whether the proposed open space (No. 1 & 2 in Figure 2-10) will go ahead as they overlay the existing M5?
  - Mammon (2017) noted that these areas are part of a long term landscape scenario to deck over the M5. Mammon (2017) further noted that it is highly unlikely to be implemented in the short to medium term but potentially could be considered in the next 50 + years. Mammon (2017) concluded that "*It is an idea and not a realistic proposal for where we are at as a government and city.*"
  - Aurecon would agree it is unrealistic and therefore has not incorporated it into the modelling.
- Whether the developable land (No. 3 in Figure 2-10) will be limited to the South West and not cross the road as it currently does / the road will not be moved nearer to the river?
  - Mammon (2017) noted that the response here is similar to that above.
  - Aurecon allowed for this development, assuming the road could move – even if it is unlikely – as this would potentially affect the floodplain.
- Whether there is an intention to develop areas such as No.4 in Figure 2-10?
  - Mammon (2017) noted that the intention is to develop the Valkenberg Hospital Site in the long term notwithstanding the fact that this site has upgrade plans in place. The dark grey corner portion can be considered for development in the medium term.

- What it is the intention regarding the development of the two pieces of land labelled as No.5 in Figure 2-10, as depending on how these are to be developed and linked to the surrounding areas, they could have a significant impact on the floodplain?
  - Mammon (2017) noted that these areas have been identified for the proposed docking feature associated with an information centre and a small-scale restaurant/coffee shop. These areas are dealt with comprehensively in the TRUP Specialist Study: Watercourse Management & Creating a Docking / Waterfront Feature.

2.4.1.2 Conclusions of the RH-DHV Report

The following comments are made with regard to the RH-DHV: Task 2 Final Report - Modelling of Flood Mitigation Options on the Salt River:

- During January 2017 Aurecon had the opportunity to review and comment on the RH-DHV model. The comments made, and responses, are documented in Hirschowitz (2017). Importantly, the subsequent adjustments had a significant impact on the results of the analyses and as such it is worth noting the following:
  - Not all the models were rerun.
  - Not all the suggested changes were made.
  - Aurecon did not review the models prior to their finalisation.
- The City views the RH-DHV study as a high-level planning study that sought to address the key challenges and to identify options for possibly reducing / attenuating peak flows. While the study provided some insight into the potential flood levels, both the report and the City recognised that more detailed studies – such as the current study described in Section 3 – would be required to address local / specific questions.
- RH-DHV had a number of concerns relating to the use of PCSWMM2D and advised the City not to use PCSWMM for any further 2D Hydraulic Modelling.
  - It is Aurecon's view that PCSWMM2D provides a useful tool for assessing flooding in an urbanised area. While HEC-RAS may be better suited for modelling the river hydraulics, it is unable to model the greater stormwater network, surcharging and runoff trapped at low points.
  - PCSWMM 2D has been tested by CHI using the, now standardised, 'Benchmarking the latest generation of 2D hydraulic modelling packages (Neelz & Pender, 2013)' tests. The results indicated that PCSWMM2D performed relatively well in comparison with fully 2D models for other catchments.
  - PCSWMM2D has been utilised for 2D modelling in a range of catchments around the world.

On account of RH-DHV's concerns regarding PCSWMM2D, the 'Status Quo' has been modelled both with both PCSWMM2D and HEC-RAS 2D. The results are discussed in Section 4.

2.4.2 PRASA

The Passenger Rail Agency of South Africa (PRASA) currently intends to further develop its site to the North of the 'Old' Liesbeek River – Figure 2-11. Although significant additional development is proposed, this is not expected to have any effect on the flooding of the Liesbeek/Salt Rivers. It is important to note that there is an overland flood route over the PRASA land, which might be blocked by the proposed PRASA development and result in ponding. This would be the case regardless of any development on the River Club site.

AED (2016) and RH-DHV (2016) discussed the proposed closing by PRASA of the flood route. In this regard the following should be noted:

- It is generally agreed that this would cause flooding upstream; and
- The City would not knowingly allow PRASA to close the flood route. The City has already prevented this happening on one occasion, and an extensive study would be required before a departure from the City's policy would be granted.

The impact of closing this flood route is none the less assessed as part of this study.

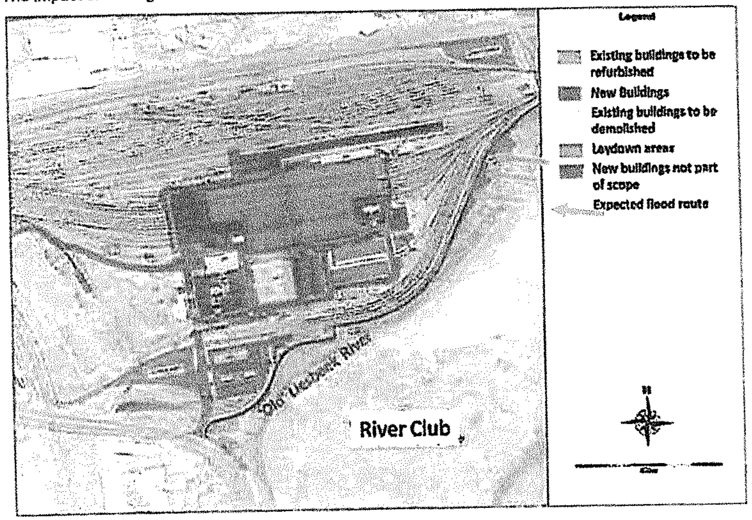


Figure 2-11 Existing PRASA development proposal

2.4.3 NRF

The National Research Foundation (NRF) owns the land at the South African Astronomy Observatory and at the entrance to the River Club (Erf 26423 RE, 26426 and 151833 (26423)) shown in Figure 2-12. The NRF currently intends to develop ERF 151833. As for the proposed River Club site, any development would need to consider the potential impacts on flooding both upstream and downstream. The NRF is also an important stakeholder as there is concern that the proposed development would affect flooding of the Observatory site (ERF 26423 RE). For this analysis, it has been assumed that an office building for the SKA will be constructed on Erf 151833 and a parking area on Erf 26426 as indicated in Figure 2-13.

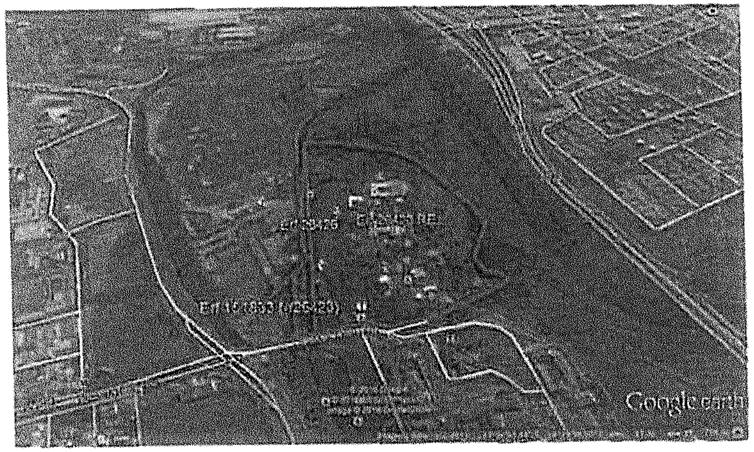


Figure 2-12 NRF owned land in the vicinity of the River Club

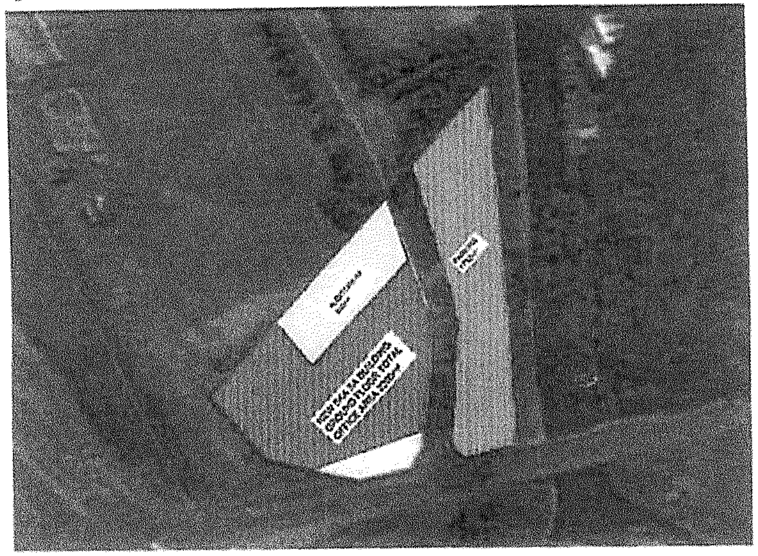


Figure 2-13 Existing NRF development proposal

2.5 Summary of literature review

The above review of the available literature indicates that:

- The River Club site is prone to flooding by events with a frequency of recurrence of about once in every 2 to 5 years (however as noted above it was not possible to undertake a statistical analysis with the available data).
- There are a significant number of studies that incorporate the River Club site.
  - Some of these studies provide contradictory results.
- There is a significant interest in the future development of the River Club site.
  - There are a wide range of stakeholders.
  - There are a variety of contradictory 'visions' of what should, and should not be done.
- There have been changes to the City's policies relating to developing within the floodplain
- There is concern that infilling of the River Club site will result in significant increases in flood levels.
  - Some stakeholders have openly rejected any study that indicates a negligible impact on flood levels.
- There is a need for a detailed analysis of the potential for flooding in the vicinity of the River Club site.

3 Methods of Investigation

3.1 Hydrology & Hydraulic parameters

For the purposes of this investigation it was assumed that the currently accepted hydrological and hydraulic data for the greater Salt River catchment, as incorporated in the SRK (2012) PCSWMM and HEC-RAS models, and provided to Aurecon by the City, are correct. Within the detailed modelling area (the study area), the SRK/City models were interrogated and where inconsistencies and/or inaccuracies were identified these were rectified based on the available data. Although considerable effort was taken to improve the data it is possible that all the errors were not identified.

3.1.1 Hydrological parameters

It is important to note that the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) refers to the '1:100 year flood'. While it is generally assumed that the 1:100-year flood event is synonymous with the 1:100-year rainfall event, this is not always the case. Several factors affect the relationship between rainfall and runoff, including: the extent of rainfall in a catchment, antecedent soil moisture conditions and the size and shape of the catchment. For the purposes of this study and in accordance with City's requirements, the 24-hour 1:100-year SA SCS Type 1 design rainfall event, adjusted to allow for climate change in accordance with SRK (2012), was used to simulate events with recurrence intervals of between 1 in 2 years and 1 in 100 years.

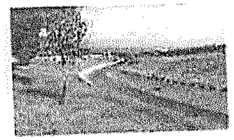
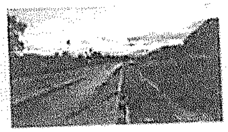
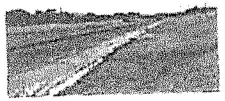
As noted above, all the remaining catchment / hydrologic parameters used in the SRK (2012) models were adopted.

3.1.2 Manning's roughness

The increased resolution of modelling of the hydraulic system (rivers and stormwater network) for the current study necessitated the reassessment of the roughness parameters assumed for the area that was modelled. The roughness coefficients used for modelling in this study were based on the following: a site inspection; a review of relevant literature shown in Table 3-1; a review of SRK (2012); and a review of the roughness coefficients used in the RH-DHV (2017) study. It was decided to use a Manning's coefficient of 0.015 for all stormwater pipes. The Manning roughness coefficients used for channels and for flood plains are shown in Figure 3-1.

The selection of Manning's Roughness coefficients was further checked against those advised by the Kruger & Gomes (2007).

Table 3-1 Typical Manning's Roughness used in modelling

Component	Suggested Manning's roughness range	Typical condition
Storm water pipes & Culverts	0.010-0.014 (Brunner, 2010) 0.010-0.015 (Brown et al., 2013) 0.011-0.015 (Rossman, 2008) Laboratory tests 0.010-0.011 (Brown et al., 2013)	The use of 0.01 was deemed too low and more representative of laboratory conditions. It is likely that the effective roughness in the stormwater pipes is higher than the selected value. This would have the effect of attenuating peak flows. As such an "average value" was selected.
Overbank roughness (1D Modelling)	Earth channel straight and uniform covered with grass some weeds: 0.022-0.033 Earth channel winding and sluggish covered with grass some weeds: 0.025-0.033 Short grass: 0.025-0.035 High grass 0.03-0.05 (Brunner, 2010)	
Floodplains (2D Modelling)	Short grass: 0.025-0.035 High grass 0.03-0.05 (Brunner, 2010; Hamill, 1995)	
Concrete channels (1D and 2D modelling)	Concrete float finished: 0.013-0.016 (Brunner, 2010) Concrete channel: 0.011-0.02 (Rossman, 2008)	
Grassed Channels / Channel formed by Levees (1D and 2D Modelling)	Earth channel straight and uniform covered with grass some weeds: 0.022-0.033 (Brunner, 2010) Earth channel winding and sluggish covered with grass some weeds: 0.025-0.033	

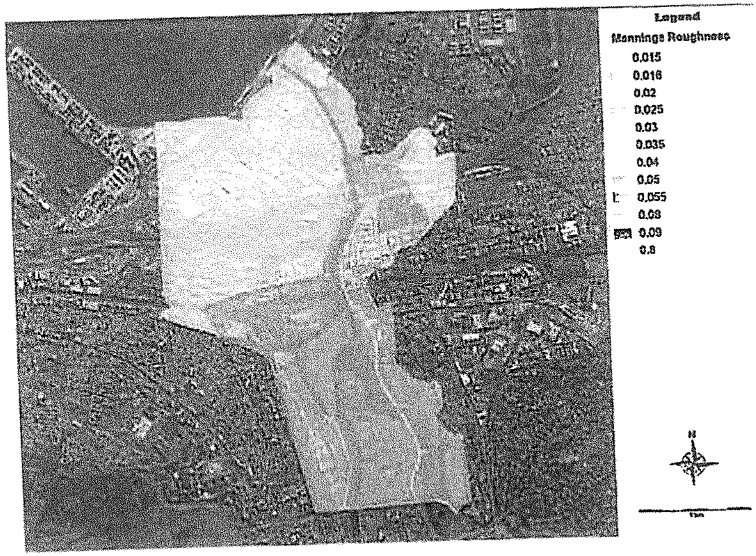


Figure 3-1 Manning's Roughness used for modelling

3.1.3 Digital Terrain Model (DTM)

To undertake 2D modelling – as required by the City – it was necessary to make use of an accurate Digital Terrain Model (DTM). This DTM was generated as follows:

- A 0.15 m DTM was created from the LiDAR ground points provided by the City.
  - These LiDAR points did not represent the river bed profiles (as LiDAR does not penetrate the water surface).
  - RH-DHV (2017) identified that a comparison between the various topographical surveys undertaken for the River Club and the original LiDAR data indicated that the LiDAR levels were generally lower than the corresponding ground surveys. Therefore, the levels of all the LiDAR points were raised by 0.25 m.
  - RH-DHV (2017) further noted that "*it was later confirmed by the City of Cape Town surveyor that a correction in the order of 0.25m was deemed necessary in other studies in the TRUP area as well.*"
  - Aurecon requested a topographical dataset from the City which had already been corrected. As this is the most recent topographical data, and appeared to best represent the site, it was used by Aurecon for all modelling.
- The underwater profiles of the river channels were generated as follows:
  - The 1D HEC-RAS Model created from a bathymetric survey undertaken as part of the RH-DHV (2017) study was provided by the City.

- RAS Mapper was used to interpolate and "export" 0.15 m DTMs of the various river channels.
- DTMs of the bridges were generated, based on the levels of the top of the railings (conservative assumption) surveyed for the RH-DHV (2017) study.
- These three DTMs were then merged to create a single representative DTM as indicated in Figure 3-2.

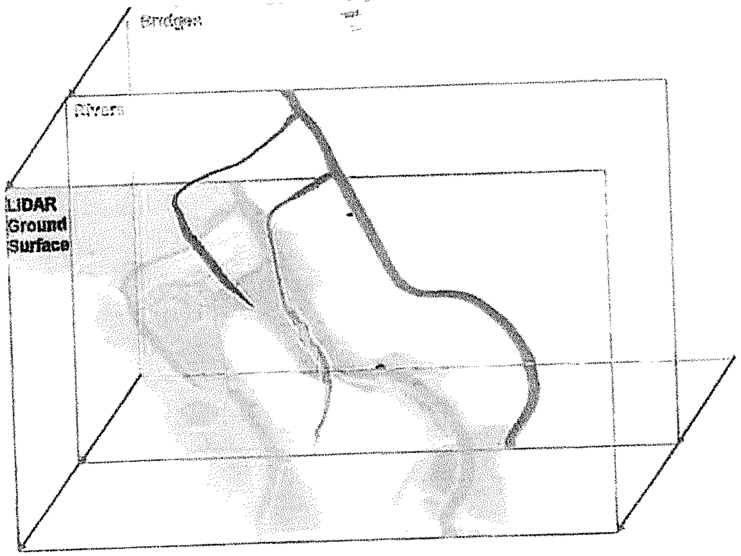


Figure 3-2 Merging of LIDAR, River and Bridge DTM's

3.1.4 Modelling of bridges / culverts

PCSWMM/PCSWMM2D does not contain a "Bridge modelling tool". To ensure that the HEC_RAS model and the PCSWMM models could be compared, PCSWMM's tool for importing hydraulic structures (e.g. bridges, culverts, weirs) from HEC-RAS was utilised. PCSWMM automatically converts bridges / culverts into a series of parallel conduits: one to convey bridge overtopping flow (high chord), and one or more to represent the opening(s) underneath the bridge deck. The high chord may be best represented by an irregular cross-section (transect), and each opening below the bridge deck by a custom cross section. The conversion from HEC-RAS to PCSWMM is illustrated in Figure 3-3.

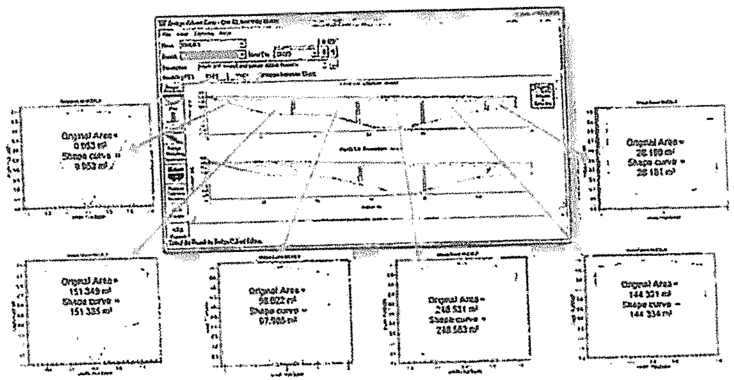


Figure 3-3 Importing of bridges from HEC-RAS into PCSWMM

For the PCSWMM model, energy loss coefficients were determined for bridges to account for the contraction and expansion of the flows under bridges (which are modelled by HEC-RAS in accordance with normal procedures). Loss coefficients were determined for the different bridges in accordance with James et al. (2012) to be as follows:

- Entrance Loss Coefficients (ELC) equivalent to the contraction coefficient used in HEC-RAS, and
- Average Loss Coefficient (ALC) equivalent to the expansion coefficients used in HEC-RAS.

The coefficients utilised for the SRK (2012) PCSWMM models were, typically, ELC 0.1, and ALC 0.3.

3.1.5 Boundary conditions

For both the PCSWMM2D and the HEC-RAS modelling the boundary conditions were as follows:

- The SRK (2012) hydrographs for the Black River and the Liesbeek Rivers were used as upstream boundary conditions.
- Within the modelling area, for the PCSWMM2D model only, the minor stormwater system was modelled.
- The boundary conditions at the outer edges of the floodplain assumed normal flow depth.
- The downstream boundary conditions for the Salt River Canal at the coast are shown Table 3-2. These conditions are based on the PRDW (2010) estimates which in turn were based on the SA Navy (2010). The peak tidal level was assumed to coincide with the peak flow in the Salt River which is a very conservative assumption as the tidal cycle is approximately 12.5 hours. PRDW (2010) also stated that *"It is also understood that the maximum flows expected in the Salt River Canal, and by implication the flood causing events, are expected approximately 12 hours after the maximum rainfall events in the catchment. This effect will further be complicated with varying local precipitation within the catchment."*

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Table 3-2 Tidal levels used in modelling

Recurrence Interval	High (mamsl)	Low (mamsl)	Explanation
100	2.53	0.9	PRDW (2010) 90th percentile tidal ranges and tidal levels – 50-year RI as used in RH-DHV (2017)
50	2.53	0.9	PRDW (2010) 90th percentile tidal ranges and tidal levels – 50-year RI as used in RH-DHV (2017)
20	2.45	0.83	PRDW (2010) – 20-year RI as used in RH-DHV (2017)
10	1.99	0.5	Current MHWS/MLWS allowing for: • 0.45m storm surge • 0.55m for sea level rise as a result of climate change
<5	1.76	0.27	Current MHWS/MLWS allowing for: • 0.25m storm surge • 0.55m for sea level rise as a result of climate change

Note: These are the Still Water Levels excluding individual wave crest and excluding wave run up. These latter processes are not relevant here since the levels here are used for the downstream water level boundary in the SWWM model which will not resolve individual wind-waves.

It is important to recognise that a 1 in 100-year recurrence rainfall (which is assumed to cause the 1 in 100-year flood) and a 1 in 100-year tidal event do not necessarily coincide. In principle, the probability of each occurring separately is 1% and occurring simultaneously is 0.01% or equivalent to a 1 in 10 000-year event. However, there is likely to be some relationship between storm events at sea, and flood events on land – but not necessarily of equal magnitude and recurrence interval.

PRDW (2010) investigated the correlation of storm surge and rainfall events using 24 years of data at the South African Weather Service's Observatory rainfall station. Their investigation found that "*Preliminary results show limited correlation of extreme rainfall and storm surge. The maximum rainfall from the correlated data set (~90 mm representing a return period between 1:20 and 1:50 years) occurred with small positive storm surge (~0.1 m representing a return period less than 1:10). While the maximum storm surge from the correlated data set (~0.75 m for a return period > 1:100) occurred with a relatively small rainfall (~30 mm for a return period < 1:10).*"

PRDW (2010) concluded that "*based on the level of uncertainty of the response of the catchment hydrograph to precipitation events, specifically with respect to the time delay in peak flow, it is recommended that the calculations for return period floods are calculated with the equivalent return periods for rainfall (i.e. 1:100-year flood and 1:100-year rainfall) and a lower return period for storm surge for the sea interface (i.e. 1:10 year storm surge for example).*"

As noted by PRDW (2010) the correlation between storm surge and rainfall is complicated due to a range of factors including timing, rainfall distribution across the Salt River Catchment and tidal cycle (Spring high or Spring low). Therefore, a simple analysis was undertaken using 10 years of rainfall data at the Newlands rainfall station which provides an indication of high rainfalls in the Liesbeek River Catchment as a result of the orographic effect caused by Table Mountain. This analysis indicated that approximately 30% of rainfall events occurred on a day when the peak sea level exceeded the Mean High-Water Spring (MHWS) tidal level. An analysis of the 10 largest rainfall events with precipitation of between 90 mm and 130 mm (per day), roughly equivalent to 1-5-year Recurrence Interval events, indicated that 4 of the 10 events occurred when tidal levels exceeded the MHWS level.

Based on the above findings, particularly those of PRDW (2010), it is considered that the assumptions used for the RH-DHV (2017) study are reasonable and have been adopted for the analyses described below.

3.1.6 Accounting for intra year events

The City has developed standard design storms and hydrological models for 1 in 2-year, 5-year, 10-year, 20-year, 50-year, and 100-year recurrence interval events. These storm rainfalls and flood discharges were analysed and both were found to have linear relationships when plotted with a log normal distribution. Using this relationship, it was possible to estimate the flows at the boundary of the modelling area, as well as the precipitation parameters for the 0.5-year and 1-year storm events.

Providing the parameters for a 1-year or smaller storm event is, statistically speaking, not possible as it implies that every year, without fail, an event of that magnitude or greater will take place. As was evident in 2017, it is possible that such an event does not take place. However, for the purposes of this analysis it was felt that such an approach was reasonable and would provide the required insights.

3.2 Development Layouts

The layouts for the proposed development have evolved through a number of iterations with the proposals increasingly gaining a focus towards transforming the Liesbeek River Canal into a more natural river channel that provides habitat for a variety of fauna and flora. This would link with the Raapenberg wetlands and is seen as improving the overall functioning of the ecological systems in the area. The changes have resulted in two primary development options:

- Option 1 (Figure 3-4) – which envisions the transformation of the Liesbeek canal and the partial filling of the 'old' Liesbeek River; and
- Option 2 (Figure 3-5) – which leaves the Liesbeek canal and 'old' Liesbeek River largely untouched.

On account of the backwater effects of the downstream railway bridges – essentially causing a damming effect that impacts on the River Club site – the differences between Options 1 and 2 are inconsequential. Therefore, this study has been based on the Option 1 layout which is also perceived to be the preferred layout.

It should be noted that the proposed development is not explicitly in accordance with the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) and would require the City to make exceptions for the following provisions:

- Section 9.2: Flood Management and Public Safety
  - Permission to develop / obstruct the free flow of water within the 20-year flood line area would need to be granted.
- Section 10.5: Table 1: Framework for the assessment of Proposals
  - The current assessment framework forbids development (including filling) within the 50-year flood plain. It notes: "*In exceptional circumstances minor "smoothing" of the 50 / 100-year flood line may be considered, provided equivalent compensatory stage storage volume is provided within the development precinct*".
  - As the proposed development falls under the 50-year flood line, a deviation from the policy, allowing the developer to fill (considered development) would need to be granted.

Notwithstanding the above, the City could approve the development based on the "*geomorphological, maintenance, social and economic aspects*" (presented by other specialists), and on the findings of this study.

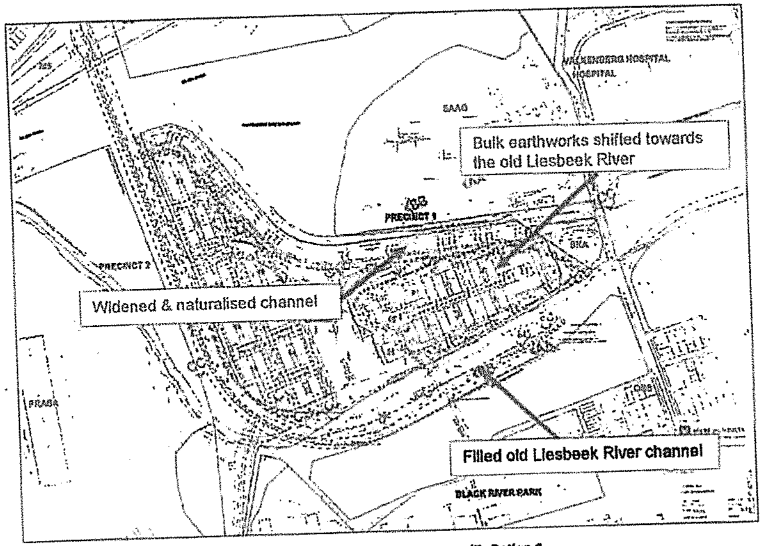

Figure 3-4 Layout option 1, showing the most significant difference with Option 2

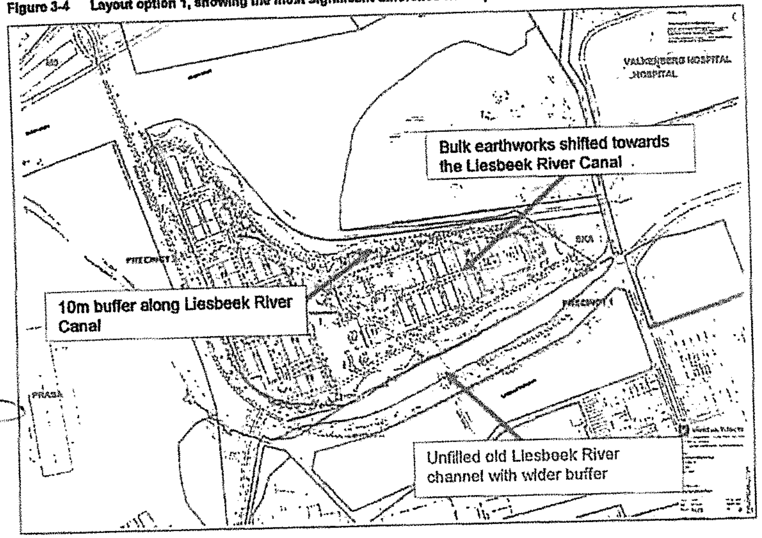

Figure 3-5 Layout option 2, showing the most significant difference with Option 1

3.3 PCSWMM-2D

PCSWMM-2D was used as the primary tool for analysing the impact of the proposed River Club development on the surrounding areas. PCSWMM was selected because:

- The City had recently used PCSWMM for a similar study of the area and therefore the use of PCSWMM for the current study would facilitate comparisons;
- PCSWMM incorporates the minor stormwater system into the model – which is important within an urban area; and
- The background models – previous studies prepared for the City – were SWMM based.

For the current study the PCSWMM models were set up as 1D-2D models. This models the minor stormwater system and the river channel as 1D conduits and the floodplain as a 2D mesh. The selection of the mesh resolution was important as higher resolution meshes result in longer model run times, whereas lower resolution meshes might affect the reliability of the results. The selected mesh resolution used within the modelling area is shown in Figure 3-6. As is evident from Figure 3-6, the mesh in the vicinity of the River Club was generated with a significantly higher resolution than the mesh for areas of less interest – e.g. Paarden Eiland.

Figure 3-6 Area modelled in 2D showing the resolution of mesh in each area

3.4 HEC-RAS

HEC-RAS 5.0.3 was used in this study to model the site in 2D. This was in response to comments made in RH-DHV (2017) which questioned the use and appropriateness of PCSWMM. Both PCSWMM and HEC-RAS have their own strengths and weaknesses for modelling and therefore it was decided to undertake the additional HEC-RAS modelling as a confirmatory check – not to replace the PCSWMM model.

The 2D mesh for the HEC-RAS model was developed using QGIS and the 'RiverGIS' plugin. For the HECRAS mesh (Figure 3-7), the same break lines that were used for the PCSWMM model were used and supplemented by break lines along the centres and edges of the respective rivers. The addition of the break lines representing the centres and edges of the respective rivers in the HEC-RAS model was utilised due to the HEC-RAS model being a fully 2D model, and because of HEC-RAS's computational methods. It was also necessary to ensure that the edges of the river (sometimes elevated above the surrounding area) were clearly defined to prevent 'leakage' within the modelling.

HEC-RAS is currently unable to model bridges in the fully 2D modelling environment, and as noted in Neelz & Pender (2013) there is a degree of uncertainty concerning the linking of 1D channels and the 2D flood plain. Therefore, it was decided to use HEC-RAS in a fully 2D modelling environment (rather than the 1D-2D modelling environment) and to overcome the existing restriction with regard to modelling of the bridges within the 2D environment, two approaches were followed:

- Both approaches make use of open source software, and therefore once the 2D mesh was generated it was imported into HEC-RAS where the Mesh was edited, finalised and the relevant 2D modelling parameters were generated.
- HEC-RAS made use of the same DTM's and land-use / roughness parameters as SWMM.

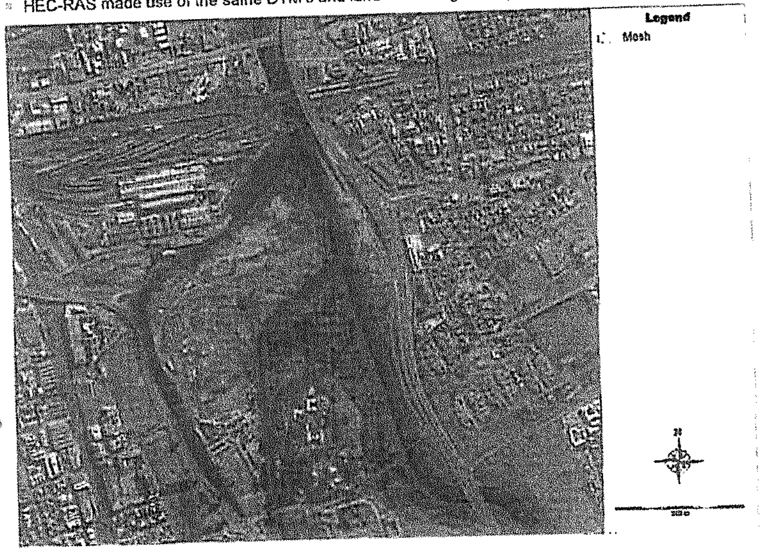

Figure 3-7 HEC-RAS 2D Mesh – showing varying resolutions

3.5 Accuracy of Models

The City has, historically, preferred two models for hydraulic and hydrological modelling. The hydrological determinations have typically been undertaken with PCSWMM; and the hydraulic modelling with HEC-RAS. It is worth noting that the PCSWMM routes the runoff from multiple sub catchments by performing hydraulic calculations, and therefore that it is not purely a hydrological model. PCSWMM's routing can therefore have an impact on the HEC-RAS outputs. More recently the City has preferred PCSWMM 2D for its 2D modelling. It should be noted that modelling hydraulic and hydrological systems is not an exact deterministic science – different models and modellers may obtain different results. This is further complicated by the selection of modelling approach. PCSWMM 2D Modelling approach – sometimes called 'quasi-2D – is equivalent to the 'diffuse wave solution' in that it does not incorporate the full 2D momentum equation. On the other hand, HEC-RAS uses the 'diffuse wave solution' – as opposed to the 'full momentum solution' – which runs faster and is more stable. While the full momentum solution is considered more accurate it does require calibration – as do all models – and HECRAS also contains more parameters for which values are uncertain – especially when calibration is not possible.

The variation in modelling results is evident in the recent 2D bench marking studies – based on the original benchmarking study by Neelz & Pender (2013) – where the results varied for a variety of reasons between the different models as shown in Figure 3-8. It is worth noting that when PCSWMM modelled the scenario the results (overlaid on top of the original study) appeared to be reasonable. HEC-RAS also modelled the same scenario and its results were also reasonable. There were differences between the full momentum and diffuse wave solutions of about 300mm – as shown in Figure 3-9.

Essentially, a review of both the PCSWMM and the HEC-RAS models indicated that both provide reasonable 2D modelling results.

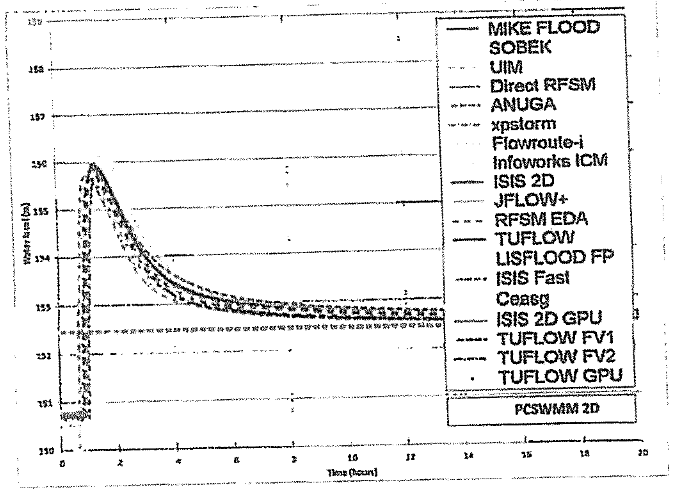

Figure 3-8 Comparison of the 2D modelling results for a valley flooding scenario (Test 5 , Point 3) (Neelz & Pender, 2013)

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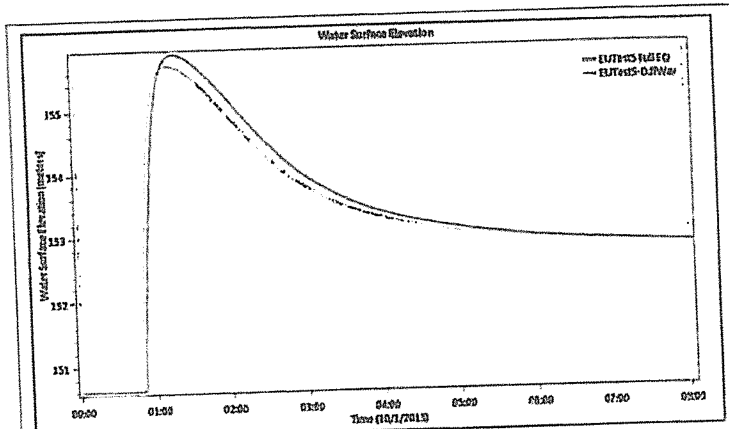

Figure 50. Test Point 3 - Water Level (depth) for Full Equations and Diffusion Wave.

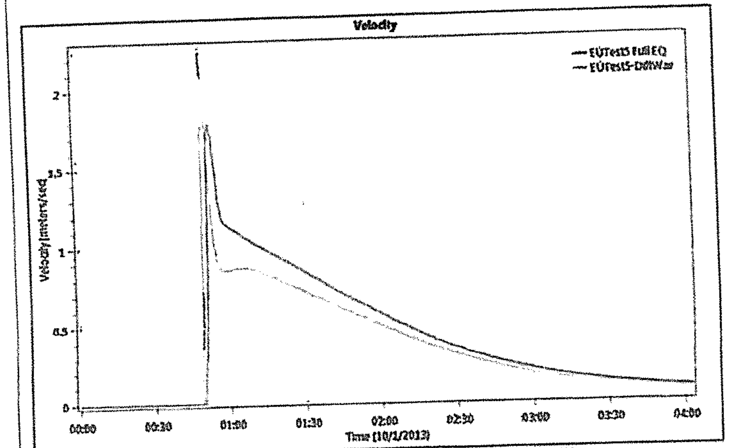

Figure 51. Test Point 3 - Velocity Time Series for Full Equations and Diffusion Wave.

Figure 3-9 Comparison of the 2D modelling results for a valley flooding scenario (Test 5 , Point 3) (Brunner, 2016)

3.5.1 Model complexity

It is important to recognise the context, especially with regard to data availability, within which these models have been developed. Wainwright & Mulligan (2013) state that an *'optimal model is one that contains sufficient complexity to explain phenomena, but no more'*. James (2005) suggests that it is sometimes assumed that the reliability of a model will increase with its complexity to a certain point, and that beyond this, the reliability will decrease (Figure 3-10). James (2005) notes that this has never been proven for surface water models. Therefore taking a parsimonious approach to modelling – developing a model with the greatest explanatory power and the fewest parameters or complexity – *is a particularly important principle in modelling since our ability to model complexity is much greater than our ability to provide the data to parameterize, calibrate and validate those same models'*(Wainwright & Mulligan, 2013).

It is difficult to determine the required level of complexity, as there is no accepted measure of this (James, 2005). However, experience and intuition will assist in the development of good models (Wainwright & Mulligan, 2013).

Data are crucial for the development and calibration of reliable models. In theory, the more data available, the more reliable the model should be (James, 2005). There is a relationship between complexity and the amount of data that is available as shown in Figure 3-11 which suggests that a more complex model will be more uncertain than a less complex model with minimal data, but less uncertain than a less-complex model with a lot of data.

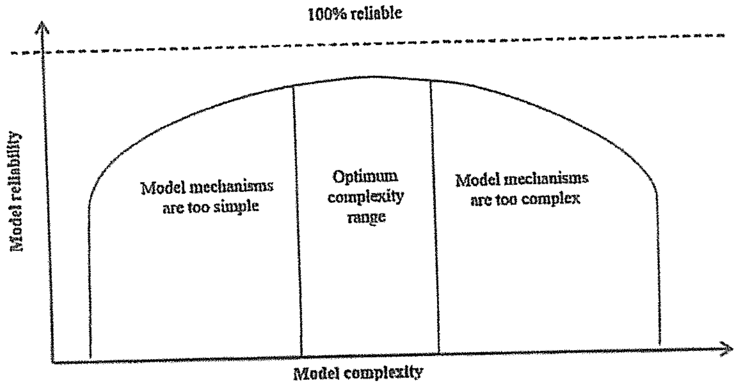

Figure 3-10: Relationship between complexity and reliability (After James, 2005)

In essence, choosing the correct level of complexity is a difficult but important part of modelling. Models should be neither overly complex nor too simple. Overly complex models will consume more time and money and potentially offer less reliable results. On the other hand, a model that is too simplistic may not offer adequate reliability (Wainwright & Mulligan, 2013; James, 2005; van Waveren et al., 1999). Ideally it is preferable to select *'no more complex a model or representation of reality than is absolutely necessary'* (Wainwright & Mulligan, 2013).

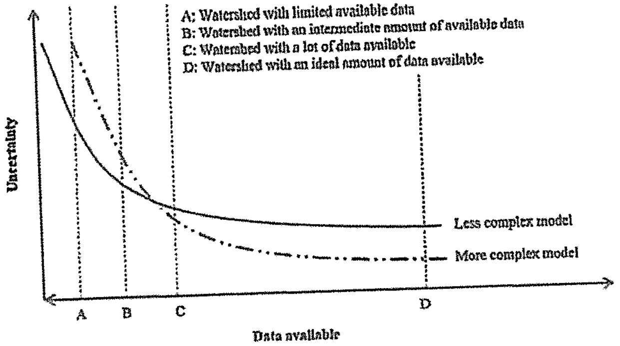

Figure 3-11: Relationship between data, uncertainty and complexity (After James, 2005)

Considering that this catchment has limited functional and reliable flow or depth gauges, it is not reasonable to expect a very complex model (i.e. full momentum 2D model) to be of much additional value as there is too much uncertainty – especially concerning the modelling of bridges.

3.5.2 Advantages and disadvantages of the different models

Both HEC-RAS and PCSWMM provide reasonable results. Each model has its own advantages and disadvantages as follows:

- HEC-RAS is generally better for modelling large river systems:
  - HEC-RAS 1D is better at modelling bridges and inline structure
  - HEC-RAS 1D provides a more accurate Energy Grade Line (see Section 3.7)
  - HEC-RAS 2D is currently not capable of modelling bridges and instead assumptions – much as for SWMM – need to be made.
  - HEC-RAS 2D can implement the full momentum 2D modelling equations, but without calibration this adds further uncertain parameters which may affect the results.
- PCSWMM is generally better for modelling in urban areas:
  - Models the stormwater system – both major and minor – which allows it to highlight potential trapped low points and back flooding through the stormwater system
  - Does not discretely model bridges, but approaches have been developed and tested that account for the energy losses at the bridges in the SWMM model (e.g. James et al., 2012).
  - SWMM 2D – a 'quasi' 2D model – allows for the incorporation of the minor stormwater system with surface flows.

While the Black River is a 'large river' for Cape Town, it is not particularly large when compared to other rivers in South Africa and across the world. The surrounding urban areas are relatively low lying and thus being able to incorporate the minor stormwater systems in the modelling is important and useful as there is evidence that some of the flooding is due to the minor systems surcharging. Therefore, while

both HEC-RAS and PCSWMM could be used, it is considered that because of the urban nature and various types of flooding (e.g. surcharging of minor systems) PCSWMM is likely to provide the best representation of the flooding for the various flood recurrence intervals. On the other hand, HEC-RAS was used to confirm that the PCSWMM results were reasonable.

3.6 Quantifying the Risk to the Raapenberg Wetlands

Dr Day – the appointed Fresh Water Ecologist – identified the need to quantify the risk of changes to the hydrological and hydraulic regime in the Raapenberg wetlands as a critical component of her study. Initially, this was to be achieved by utilising flow data collected by the City. Of the two gauging stations, only the downstream station (Glamis Close) was in operation. After an analysis, and cleaning of the data it was determined that the data was not reliable. This meant that any analysis undertaken by Dr Day would have a low level of confidence, and so would not be of use in assessing the impact on the Raapenberg Wetlands. It was therefore decided that it would be necessary to approach this aspect of the surface water study differently. This was done by surveying the Raapenberg wetlands, and using biological indicators (e.g. reed and other plant zonation) to deduce what were the critical potential hydrological and hydraulic impacts. The survey identified a number of important features of the area:

- The water level in the Raapenberg wetlands is approximately 250mm lower than that in the surrounding Rivers.
- There is evidence of wetland vegetation that grows in brackish water.
- There was an informal intervention shown in Figure 3-12 which was to excavate with the intention of increasing / allowing flows into the wetland. This intervention was performed by a "Friends of the Liesbeek" maintenance team following concerns raised by SAAO and members of TRUPA regarding the lack of water in the Raapenberg wetland. The intention was to try and divert water into the wetland.
- There is an artificial channel that seems to have been created along the boundary of the SAAO property. This is not linked to the Liesbeek or Black River Systems.

Figure 3-12 Intervention that encourages flows into the wetlands

The findings of the site visit suggested:

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- An increase in the recurrence interval of flooding would have a negative effect on the functioning of the wetland. Therefore, the pre- and post (proposed) development scenarios were modelled to determine when the wetland would fill with water.
- The increase in volume flowing into the wetland would have a negative impact on the functioning of the wetland as the wetland is not primarily a freshwater system, and because increased water depths would result in a change in the distribution of different plant species (Flow into the wetland cannot drain out due to the differential in the water levels in the wetland and in the nearby rivers). As such the pre- and post (proposed) development scenarios were modelled to determine when the wetland would fill with water.

3.7 Widening the Salt River Channel

In 2004 Ninham Shand undertook a study on behalf of City which investigated the possible widening of the Salt River Canal. This emanated from a review of a 1957 Council proposal for flood relief which involved widening, and in some areas, concrete lining of the river channel. This scheme would entail the widening of the Salt River Canal from the original current width of 46 m to 61 m (an increase of 15 m). In 1974, the City's Executive Committee approved a recommendation by the Utilities and Works Committee that the Salt River Canal (canal downstream of the Railway Bridges) be widened (by 15m) and that land adjacent to the canal, that was required to effect the widening, be acquired by the City. To date, some of the required land is still not owned by the City and the widening of the canal has not been implemented.

In the 2004 Ninham Shand study, and in line with the 1974 scheme approved by the Executive Committee, all existing road and rail bridges over the Salt River Canal were evaluated in terms of requirements for widening of the canal.

The results indicated some significant changes in the elevation of the flood line. When these elevations are plotted on the latest DTM, the benefits of this scheme are only realised in the vicinity of the PRASA site – Figure 3-13. It is important to note that the Ninham Shand report of 2004 was produced prior to the adoption of climate change and sea level rise factors.

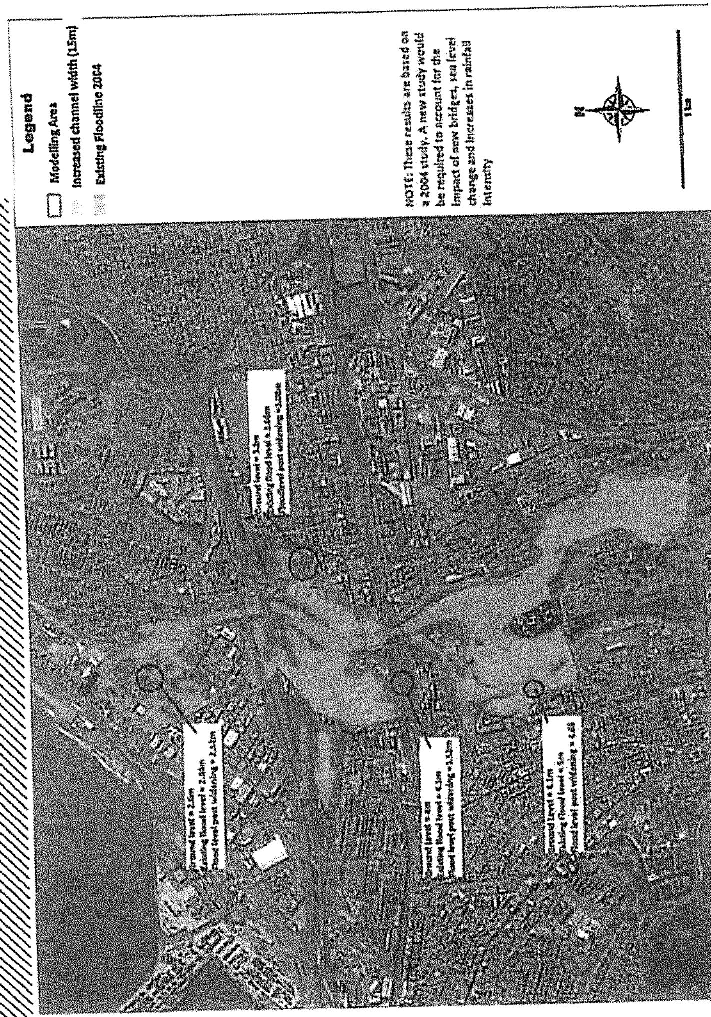

Figure 3-13 The effect of widening the Salt River Canal and associated bridges based on Ninham Shand 2004

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The TRUP study (RH-DHV, 2017) also considered widening of the Salt River Canal. The study examined the potential benefit of widening the canal by modelling an additional 25 m wide rectangular canal in parallel with the Black River channel and the existing Salt River Canal, together with widening of the bridges crossings. It is uncertain why 25m was selected, and it is unlikely that it would be possible to widen more than the 15m originally proposed. RH-DHV found that immediately downstream of the N2, there would be a predicted reduction of 0.83 m in the water level due to the 15 m widening. The RH-DHV report noted that canal enlargement would involve significant capital costs.

The City, none the less requested that this study also consider the possible effect of widening the canal and removing any restrictions (e.g. bridges). The following assumptions were made:

- The bridges could be engineered / re-engineered to not affect the flow in the Salt River – i.e. span the river.
- The canal was assumed to be a 61m rectangular cross-section – with the same invert levels as the existing canal.

Such a scenario would represent the 'absolute best case' scenario and is, in Aurecon's view, unlikely to ever be realised. The City, however requested, that no option / possibility should be excluded.

3.8 Sediment build up at the canal outfall

It was noted that the survey showed that sediment had built-up at the Salt River Canal outfall into the ocean. A review of historic images – on Google Earth – indicated that since 2000 there was only one year (Figure 3-14) in which the canal was clear – i.e. no sediment build up – meaning it had 100% of its capacity. Aurecon believes that during any significant flood this sediment would erode effectively leaving the canal with its full capacity. This may not happen for smaller floods. Therefore, all recurrence intervals were modelled assuming the sediment would not erode (worst case scenario), except the 100-year event which was modelled twice assuming that the sediment would / would not erode.

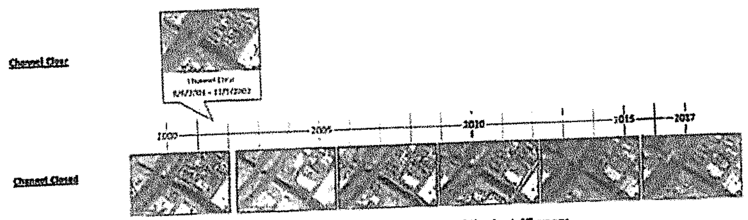

Figure 3-14 Evidence of sediment at the mouth of the Salt River for 16 of the last 17 years.

3.9 Closing the 'PRASA' overland escape

As highlighted in Section 2.2, all the previous studies have identified a major storm event flood route across the PRASA site. There has been concern about what would happen if this flood route were to be closed. While doing so would be illegal and counter to the City's policies, the City nonetheless requested that this scenario be modelled. In order to do so it was assumed that PRASA would berm the 'old'

Liesbeek so that flood waters would not flow onto its property. This scenario was tested for both the status quo and the post development scenarios.

3.10 Water Surface vs Energy Level

It is important to note that all results in this report, and all conclusions drawn from the reported results are based on simulated Water Surface Elevations (WS) and not on Energy Levels (EL). This is contrary to the City's *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a) (developed prior to the widespread use of 2D modelling) which requires that "*all flood lines must be based on the theoretical energy level as opposed to the water surface level*". These requirements are most appropriate for 1D models, whereas on this site the City has indicated a preference for 2D modelling. The use of energy levels is not appropriate for 2D modelling as for 2D models the extent of flooding is determined by the boundary between "wet" and "dry" cells. At the edge of the flood extent flow velocities are typically minimal / non-existent and therefore the Energy Level is, approximately, the same as the Water Surface level.

Where the energy level has been provided, this has been done by adding the energy head ($V^2/2g$) to the water level.

3.11 Hazard Analysis

The City's *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a) considers, as part of its flood plain management, the hazard that flooding may pose to life and property. The hazard posed by flood waters (excluding water quality) is based on the ability to wade or gain vehicular access as well as the stability of structures such as dwellings or boundary walls. If these are likely to be seriously compromised, the area is considered to be in the High Hazard Zone. In terms of the City's *'Floodplain and River Corridor Management Policy'* "*No new or additional rights or the exercising of existing development rights will be granted to properties located within the high hazard zone*" as determined in accordance with Figure 3-15 (CSRM, 2009a).

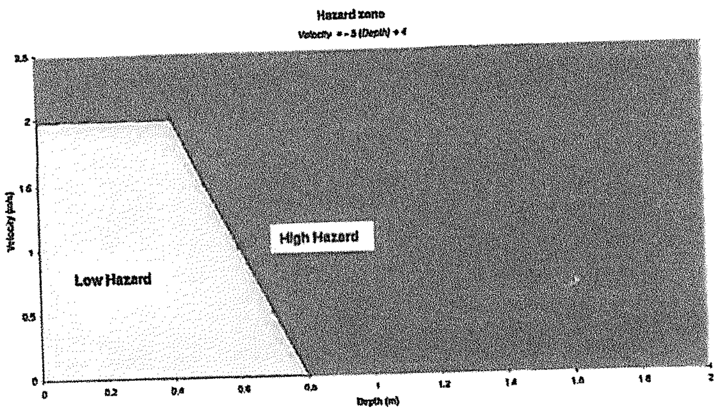

Figure 3-16 Flood Hazard Zones

Furthermore, the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) notes that: *"The permissible extent and nature of land use, development or activities within floodplains must be subject to stringent evaluation and control in the interests of public safety. In particular, obstruction to the free flow of water within the 20-year flood line area shall not be permitted. However, between the 50 and 100-year flood lines, some developments or activities may be permitted, subject to such conditions as the City may in its discretion impose, while developments with particular evacuation or emergency response issues and high risk developments will only be permitted above the 100-year flood line"*

3.12 Sensitivity Analysis

In order to ensure that any queries relating to the accuracy / reliability of the City's hydrologic models for the greater Salt River catchment could be quantified, a sensitivity analysis was undertaken by modelling a storm with a 1 in 200-year Recurrence Interval using the same approach as discussed in Section 3.1.6 for the scaling of intra-year events.

4 Modelling Results

This study assessed 35 Scenario's with a total of 39 model runs utilising two 2-Dimensional hydraulic modelling software packages (PCSWMM and HEC-RAS) as summarised in Table 4-1 – making it the most comprehensive study of the site to date. It is not possible to present all output data in this report, and therefore only relevant information from the over 900GB of output data which was generated is presented.

Table 4-1 Overview of the scenarios that were modelled and the model runs undertaken as part of this study.

Scenario	PCSWMM	HEC-RAS
Status Quo: 0.5-year	✓	✓
Status Quo: 1-year	✓	✓
Status Quo: 2-year	✓	
Status Quo: 5-year	✓	
Status Quo: 10-year	✓	
Status Quo: 20-year	✓	
Status Quo: 50-year	✓	
Status Quo: 100-year	✓	✓
Status Quo: 100-year (with widened Salt River canal)	✓	
Status Quo: 100-year (with 10-year sea level)	✓	
Status Quo: 100-year (PRASA overland route closed)	✓	
Status Quo: 100-year (PRASA overland route closed, Bridges obstructed)	✓	
Status Quo: 200-year	✓	
Post-development (River Club only): 0.5-year	✓	
Post-development (River Club only): 1-year	✓	
Post-development (River Club only): 2-year	✓	
Post-development (River Club only): 5-year	✓	
Post-development (River Club only): 10-year	✓	
Post-development (River Club only): 20-year	✓	
Post-development (River Club only): 50-year	✓	
Post-development (River Club only): 100-year	✓	
Post-development (River Club only): 200-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 0.5-year	✓	✓
Post-development (River Club, TRUP, NRF, PRASA): 1-year	✓	✓
Post-development (River Club, TRUP, NRF, PRASA): 2-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 5-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 10-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 20-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 50-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 100-year	✓	✓
Post-development (River Club, TRUP, NRF, PRASA): 100-year (with widened Salt River canal)	✓	
Post-development (River Club, TRUP, NRF, PRASA): 100-year (with PRASA overland route closed)	✓	
Post-development (River Club, TRUP, NRF, PRASA): 100-year (with PRASA overland route closed and bridges obstructed)	✓	
Post-development (River Club, TRUP, NRF, PRASA): 100-year (with 10-year sea level)	✓	
Post-development (River Club, TRUP, NRF, PRASA): 200-year	✓	
Total model runs:	35	6

For the purposes of this report the twelve key 'monitoring points' indicated in Figure 4-1 were selected for comparison purposes throughout Section 4 in this report. These points were selected to represent areas where any impacts of the proposed developments are most likely to be realised / be of concern. If necessary, the models can be used for comparisons at any point within the modelling area.

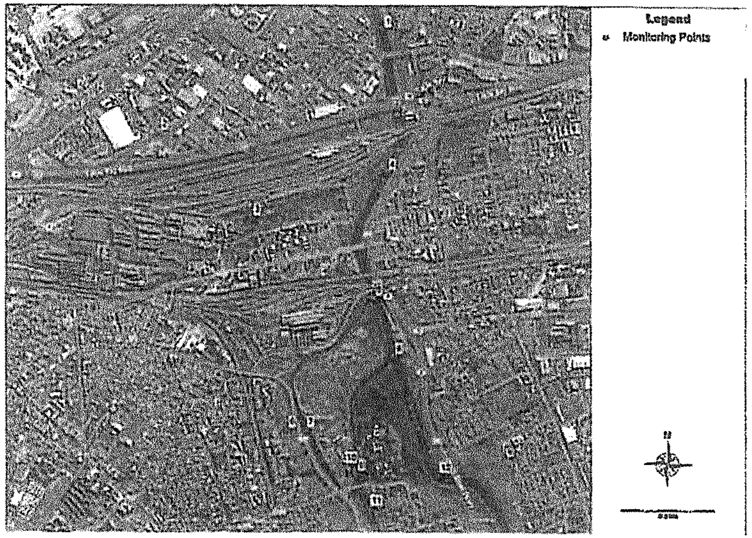

Figure 4-1 'Monitoring points' used for comparison between the different scenario's

4.1 Accuracy of the models

The PCSWMM models performed well, as all the models had 'routing continuity' and 'runoff continuity' errors of less than 1% which is considered acceptable (Rossman, 2008; CHI, 2017).

A comparison of the PCSWMM and HEC-RAS models showed the following:

- The HEC-RAS (Diffusion Wave model with the bridges modelled as 1D gates) and the PCSWMM models provided results that were within 0.01m of each other. Such differences were considered to be very good, especially considering the differences in ways that each of these programs models the flow.
- When HEC-RAS (Full Momentum equation with the bridges modelled as 1D gates) was used there appeared to be an increase in the backwater effect of the bridges immediately downstream of the River Club site. This appears to be as a result of a combination of adding the momentum component of the 2D equation and the manner in which the bridges were modelled (1D) within the 2D mesh. The results were compared with the results of previous models (especially Ninham Shand, 2004) and it seemed that the use of the full momentum equation with 1D elements within the 2D mesh (Bridges) resulted in some modelling instability.
- For both models the comparative increases in water levels between pre- and post-development were effectively the same.

- When modelling the lower recurrence intervals it was possible to model the Bridges in 2D (by adding the piers into the model). For this scenario the results of the PCSWMM model and the HEC-RAS model were again within less than 0.1m. Unfortunately, as a result of the bridges all acting as controls, and the water levels potentially overtopping the bridges it was not possible to analyse the 1 in 100-year events.

All models have their limitations, however (with reference to Section 3.5) Aurecon is of the opinion that the models used for this investigation balance the complexity, uncertainties and data availability. PCSWMM and HEC-RAS both provided reasonable results in the 2D benchmark tests, and therefore the results presented herein, provide a reasonable basis for assessing the impacts of the proposed developments.

It is important to note that configuring the models was based on engineering judgement, and experience (Aurecon has more than 15-years' experience in this specific area), as there is no reliable data to calibrate the models.

4.2 Impact of the proposed development on flooding in the surrounding urban area

This section of the report presents and discusses the results of the modelling undertaken in order to determine the potential impacts that the proposed development might have on the adjacent properties.

4.2.1 Runoff from the site

The runoff from the site would have no impact on the flood level for a number of reasons:

- The conceptual design envisages a system of swales to attenuate and treat the flow – in accordance with the City's '*Management of urban stormwater impacts policy*' (CSRM, 2009b); and
- For larger storm events (e.g. 1 in 100-year recurrence interval flood events) the peak runoff from the site would occur approximately 1 to 3 hours before the peak flow in the adjacent rivers, and therefore the site's local runoff has an insignificant impact on the flows in the adjacent rivers

4.2.2 Flooding as a result of overland flow / minor system surcharging

Figure 4-2 highlights what is discussed in Section 2.1.7, concerning the flooding that occurs within the adjacent urban area and affects a number of houses. This flooding is the result of local overland flows that occur within the adjacent urban area when the local stormwater runoff exceeds the capacity of the local minor (piped) stormwater system. Figure 4-2 indicates that for storms equal to or smaller than the 1 in 20-year recurrence interval event local flooding in the highlighted area is a result of the stormwater system surcharging and resulting in overland flow.

As evident in Appendix B there is an increase in the extent of flooding extent of the Valkenberg wetland and the sports fields. It is Aurecon's view that the change in extent is exaggerated due to the computational and design of the model. As noted throughout this document the increase in water surface elevation that has been modelled is insignificant. It is more likely that during a storm event these areas will be inundated in any case.

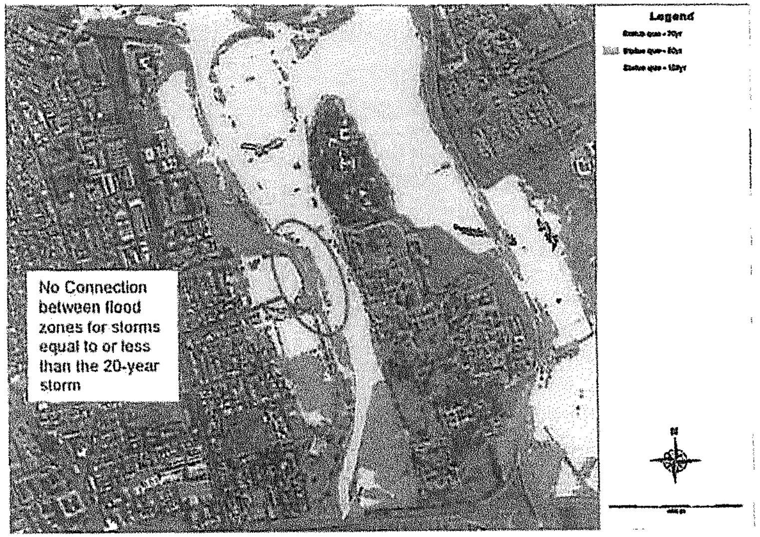

Figure 4-2 Flooding as a result of overland flow / minor system surcharging

4.2.3 Impact on water surface elevations

As expected, the most significant changes in water surface elevations would occur for the post-development scenario that includes the River Club, TRUP, PRASA and NRF developments. Table 4-2 provides a high-level overview of the differences in modelled water surface levels, based on the PCSWMM models, at 10 of the 12 monitoring points shown in Figure 4-1 – the results for all scenarios are provided in Appendix A. The TRUP development proposes that the sports fields along Liesbeek Parkway (Monitoring Point 6) are partially developed – resulting in no comparison between these two scenarios. Monitoring Point 2 consistently showed differences of between 0.01 m and 0.03 m for all recurrence intervals.

Table 4-2 indicates the following:

- For the 0.5-year and 1-year recurrence interval storm events the combined impacts of the developments would be small, possibly even reducing the water levels slightly. This is due to the small flows during these storms and the additional capacity, and perhaps the local attenuation volume that would be provided by the proposed new Liesbeek Canal design.
- The proposed developments would have minimal impact along the Salt River Canal. This is due to the canal overtopping and then flooding the neighbouring areas (Monitoring Points 1-4) except at Point 3 (appears to be in a wetland) at a low point where the level would increase by 0.08 m during the 1 in 5-year flood event.
- The greatest increases in water levels would be in the immediate vicinity of the River Club – Monitoring Points 5 through 12 – with the maximum expected increase in water level of up to 0.13 m (13 cm) for all flood events between the 1:5 year and 1:100-year return intervals.

- The impact of discharging runoff from the suburb of Observatory into the Liesbeek Canal (Post development scenario) rather than into the 'Old' Liesbeek, as well as cutting off the overland flow route over the River Club site connecting the Liesbeek Canal and the 'Old' Liesbeek appears to increase flow down the Liesbeek Canal and contributes to the increased water levels.

Aurecon would suggest consideration might be given to investigating ways of connecting the 'Old' Liesbeek and the Liesbeek Canal – this would aid in alleviating the above, negligible, effects.

Appendix A provides the results for the scenario where only the River Club is developed. While it is noted that the changes in water level are of a similar magnitude (differences typically +- 0.00m – 0.03m) to Table 4-2. It is important to note that if each of the TRUP, NRF and PRASA sites were to be developed in isolation, these results do not mean that they would only have an impact equal to the difference (typically +- 0.00m – 0.03m) between the post development scenarios including River Club, TRUP, PRASA, and the NRF sites and the post development scenario only including the River Club – as indicated in the RHDHV Study. This is due to the complexities of the hydrology and hydraulics in the vicinity of the River Club site.

Table 4-2 Summary of differences (m) in Water Surface elevation at the different monitoring points (Figure 4-1) between the existing status quo and the post development scenario (including TRUP, PRASA and NRF).

Recurrence Interval (Description)	Monitoring Point									
	1	3	4	5	7	8	9	10	11	12
0.5-year	-0.04	0	0.01	0.01	Filled 'old' Liesbeek	-0.01	0.02	0	0.02	-0.02
1-year	-0.03	Has surface water	0	0.01		-0.03	-0.02	0	0	-0.01
2-year	0.02		0.02	0.04		0.01	0.04	0.03	0.04	0.01
5-year	0.02	0.08	0.02	0.04	-0.01	0.04	0.11	0.11	0.12	0.04
10-year	0.01	0.01	0.02	0.05	0	0.06	0.12	0.12	0.14	0.06
20-year	0.02	0.01	0.02	0.05	0.01	0.07	0.11	0.11	0.12	0.07
50-year	0.02	0.01	0.02	0.08	0.04	0.1	0.13	0.13	0.12	0.1
100-year	0.02	0.02	0.01	0.07	0.07	0.09	0.11	0.11	0.11	0.09
200-year	0.01	0.01	0	0.07	0.1	0.1	0.13	0.13	0.13	0.1
100-year (PRASA overland route closed)	0.02	0.01	0.01	0.08	0.1	0.1	0.12	0.12	0.12	0.1
100-year (Opened Salt River mouth)	0.02	0.01	0.01	0.07	0.07	0.09	0.11	0.11	0.11	0.09

The increases in water surface elevations shown in Table 4-2 need to be seen in the context of the uncertainties associated with modelling, the effects of wave action, the size of the storm event and the extent of inundation (as discussed in Section 4.2.4). In the light of all these considerations the increase in the modelled water surface elevations is relatively insignificant.

4.2.4 Impact on the extent of inundation

The increases in water level shown in Table 4-2 would result in limited changes in the extent of inundation for all recurrence intervals as is evident from Appendix B and discussed below. The relatively minor local changes in the depths of inundation shown in Table 4-2 has little impact on the extent of flooding, and it requires a detailed inspection of the modelling results to identify differences in the extents of flooding – except for the 20-year where the extent increases into the Valkenberg wetland and into public open space. While the results for all the different scenarios are available – Appendix B – the only scenarios that would, potentially cause flooding of already developed properties are the 1 in 50-year flood event (Figure 4-3 and Figure 4-4) and the 1 in 100-year flood event (Figure 4-5 and Figure 4-6). These properties would be affected by flooding, to some extent whether the additional developments take place or not.

There are two minor exceptions where additional flooding would occur on account of overland flow. These are the properties discussed in Section 4.2.2 and the SAAO building which is discussed in Section 4.3. Therefore, the remainder of this section focuses on the main differences in flood extents for the 1 in 50-year and the 1 in 100-year recurrence interval storm events.

Figure 4-3 to Figure 4-6 show insignificant changes to the extent of flooding i.e. the area that would be flooded. The most noticeable changes are highlighted (Red Circles) and mainly comprise very shallow flooding on the PRASA site. The very small increases in the extent of flooding do not appear to compromise any infrastructure that is not already affected – most of the additional areas that would be flooded being railway lines. The other noticeable change is to the south of the modelling area as indicated in Figure 4-6, which would not have a significant impact on the existing flooding situation.

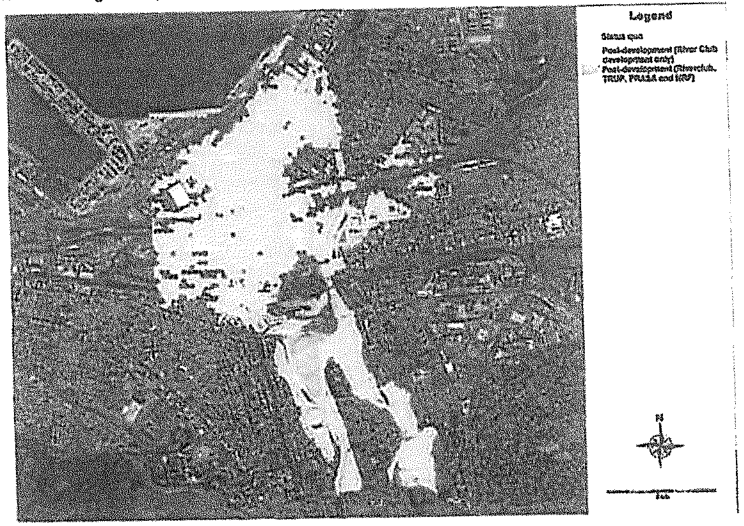

Figure 4-3 Maximum extent of inundation for the 50-year flood (whole model)

Figure 4-4 Maximum extent of inundation for the 50-year flood (Vicinity of River Club)

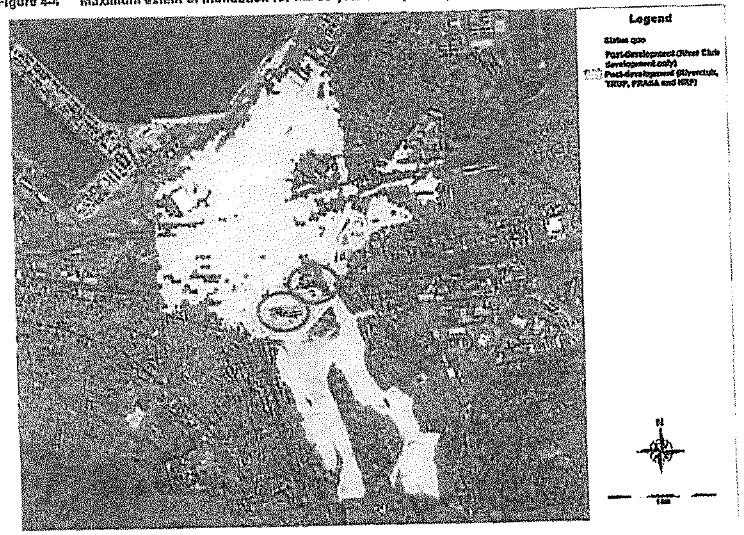

Figure 4-5 Maximum extent of inundation for the 100-year flood (whole model)

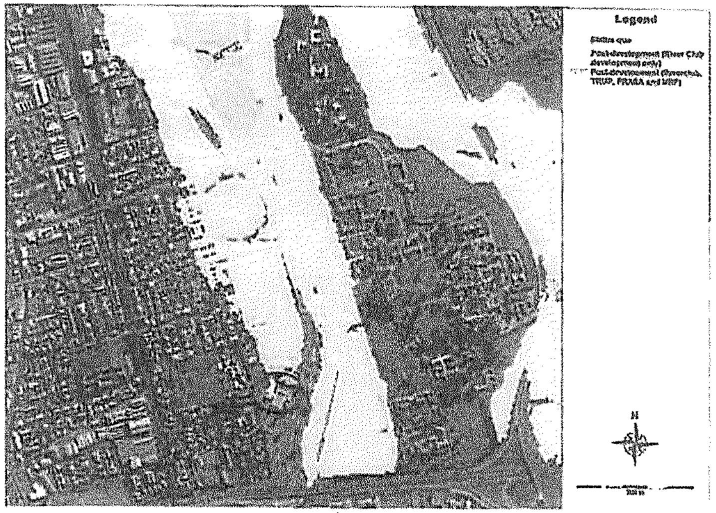

Figure 4-6 Maximum extent of inundation for the 100-year flood (Vicinity of River Club)

4.2.5 Changes in flow

The flows were assessed at the seven locations shown in Figure 4-7, and Table 4-3 provide a high-level overview of changes in the flow characteristics as a result of the proposed development/s.

Table 4-3 indicates the changes in the characteristics of the 1 in 100-year flood that would occur at various locations on account of the proposed developments. The main increases in flows would occur at the Salt Left and at the Black@River_Club. These increases are also evident from the hydrographs shown in Figure 4-8. The total volume of the flood at the Salt Left would increase by 4% as a result of the 7% increase in the peak flow. As discussed in Section 4.2.4, this change would have little effect on the aerial extent of flooding, as it would have little impact on the depth of flooding as discussed in Section 4.2.3. The additional flooding would also have little impact on the extent of the high hazard zone further downstream as discussed in Section 4.2.6. As the flood peak would occur marginally earlier as indicated in Figure 4-8 – which equates to a few minutes earlier rather than hours earlier and is thus of little significance.

The flow at Black@River_Club shows a significant, 24% increase in the peak flow that would occur for a couple hours. This increase in peak flow would occur because the proposed River Club development would effectively block the existing flow route that would have connected to the 'Old' Liesbeek River. This would force all the flow down the Liesbeek Canal route. This increased flow results in the slightly greater increases in flood levels in the vicinity of SAAO (Section 4.2.3). The effect though is localised along the course of the Liesbeek Canal (alongside the River Club site as is evidenced by the flow characteristics upstream (Black_River and Liesbeek) and downstream (Salt@Railway) in Table 4-3 and Figure 4-8. Figure 4-8 clearly demonstrates that the flow, and timing of the peak, under the railway bridges immediately downstream (Salt@Railway) is largely unaffected. As such, the effect is localised,

does not significantly affect any properties other than the River Club and SAAO, the impact of potential in the damage to property and the loss of human life is considered small. It is worth noting that the detailed design of the 'new' Liesbeek Canal, and extension to Berkley Road Bridge would need to account for the above changes in flow.

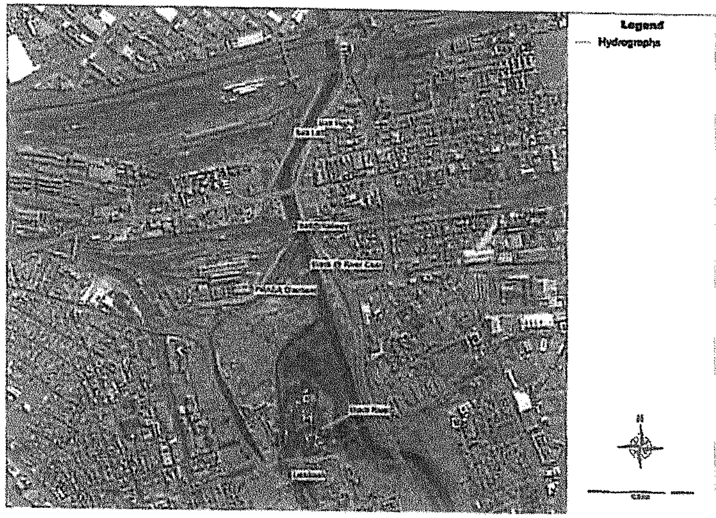

Figure 4-7 Locations at which flow was analysed

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Table 4-3 High level overview of changes in the 1 in 100-year flood characteristics as a result of the proposed developments

Objective Function	Black @ River Club		Black River		Liesbeek		PRASA Overland		Salt Left		Salt Right		Salt@Railway	
	Status Quo	Post-development	Status Quo	Post-development	Status Quo	Post-development	Status Quo	Post-development	Status Quo	Post-development	Status Quo	Post-development	Status Quo	Post-development
Maximum Flow(m^3/s):	202.2	249.1	212	215.1	96.29	96.38	6.046	9.319	125.4	134.2		*	242.5	249.9
Minimum Flow(m^3/s):	13.86	15.67	11.13	12.8	-1.428	-1.054	-0.1065	-0.1359	-0.02391	-0.01814			16.05	16.51
Mean Flow(m^3/s):	106.4	121.7	97.28	97.26	24.81	24.59	0.5272	0.8095	35.72	37.11			123.4	123
Total Flood Volume(1000m^3):	10930	12490	9990	9988	2548	2525	54.14	83.14	3659	3811	-462.3	-486.3	12680	12640

*Due to a significant stormwater culvert crossing the flow path the estimation of peak discharges is distorted

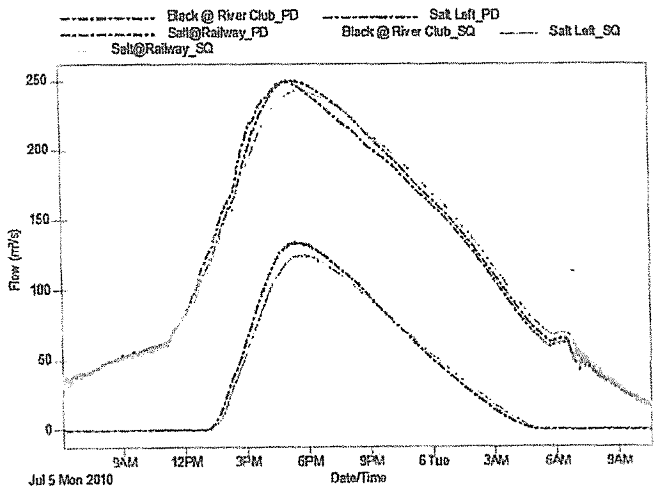

Figure 4-8 Hydrographs at locations where noticeable changes in flow were detected (SQ = Status quo; PD = Post development with NRF, TRUP, PRASA, River Club)

4.2.6 Environmental and Proposed Development Considerations and Constraints

The increased water levels at Monitoring Point 5 shown in Table 4-2 and in Figure 4-1 arise mainly from the additional losses at the railway bridges on account of the higher flows. The additional increases in water levels further upstream appear to arise from the following:

- The increased flow in the channel between Points 5 and 8 with no improvements to the channel.
- The proposed configuration of the channel from Points 9 and 10 which was determined in accordance of the environmental constraints which include the approximately 25 m wide buffer strip to be provided within the boundary of the proposed River Club development.

4.2.7 Hazard Analysis

The hazard analysis indicates that currently a significant portion of the River Club Site falls within the High Hazard zone. In terms of the City's 'Floodplain and River Corridor Management Policy' (CSRM, 2009a) development would not be allowed. Should the development be elevated out of the flood plain – as is proposed – and there be adequate, safe access the development would no longer fall within the High Hazard Zone. This would however require a deviation from Section 9.2 of the City's 'Floodplain and River Corridor Management Policy' (CSRM, 2009a) which prohibits new or existing rights within the High Hazard zone – and considers 'Filling' as development.

The analysis indicates rather limited changes to the type and extent of flood hazards – highlighted in Figure 4-9 and Figure 4-10. The impacts at the locations of the numbered circles in Figure 4-10 are described below:

- Circles 1& 2: The affected area on the PRASA site is discussed in Section 4.2.4. This increase would have little or no impact.
- Circle 3 highlights a potential change in hazard that appears to border / incorporate one lane of Liesbeek Parkway. This could have a significant impact. It is necessary to raise the road locally – where the hazard changes and for a short distance (e.g. 50m either side), as agreed with the City, to eliminate the potential high hazard caused by flooding in the 1 in 100-year. There would also be value providing warning signs.
- Circle 4 highlights the increase hazard evident in the vicinity of the Hartleyvale sports complex. This increase hazard is very localised and unlikely to have any impact – the area would normally be flooded and is unlikely to be used during extreme events such as the 1 in 100-year storm event.
- Circle 5 highlights that the existing Berkley Road is within the 100-year flood line and low hazard zone. This is section of road is also affected in storm events greater that the 1 in 20-year event. This should be considered and analysed in the final design

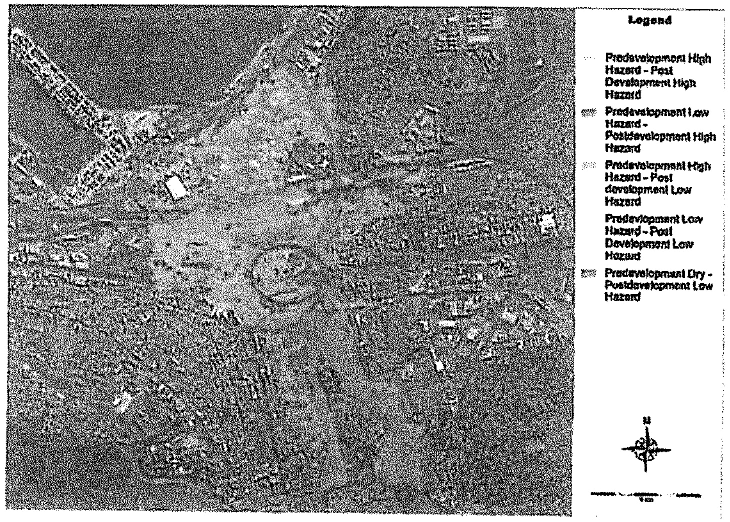

Figure 4-9 Impact of the development of the hazard of flooding (Whole model)

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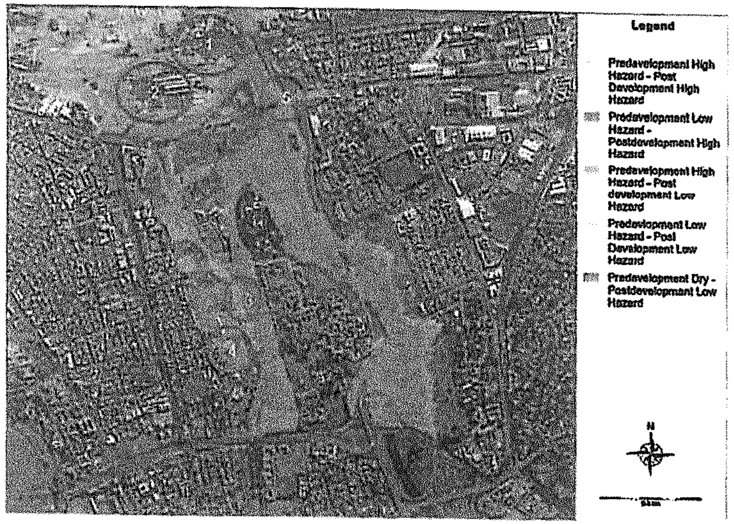

Figure 4-10 Impact of the development of the hazard of flooding (in the vicinity of the River Club)

4.2.8 Impact of the closure of the PRASA overland escape

The analysis of the impact of closing the PRASA overland escape route indicated, surprisingly, that it would have an insignificant impact on the extent of inundation during a storm event – as indicated in Figure 4-11 – assuming the flow through the bridges downstream of the site remained unobstructed. The change in water surface level for the 1 in 100-year flood event remains small at the monitoring points as highlighted in Appendix A.

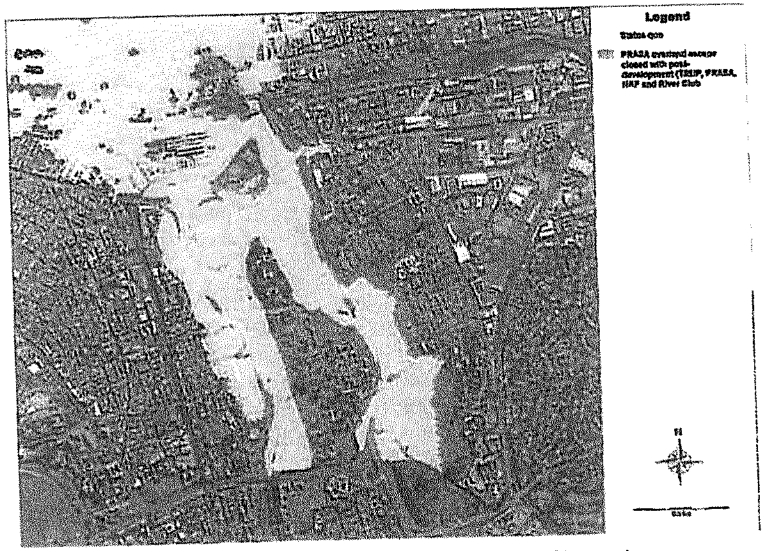

Figure 4-11 Impact on flooding of possible PRASA escape route during the 100-year Storm event

Should the flow through the bridges become obstructed (e.g. by debris flowing down the river) the importance of the PRASA escape flow route would increase. Therefore, is would be preferable for the City to ensure that this escape route is maintained for the following reasons:

- Should, for any reason, the railway bridges immediately downstream of the River Club site become blocked, the PRASA escape route would become critical – as shown in Figure 4-12.
- Once such a flood route is closed it is unlikely that it would be possible to re-establish it.

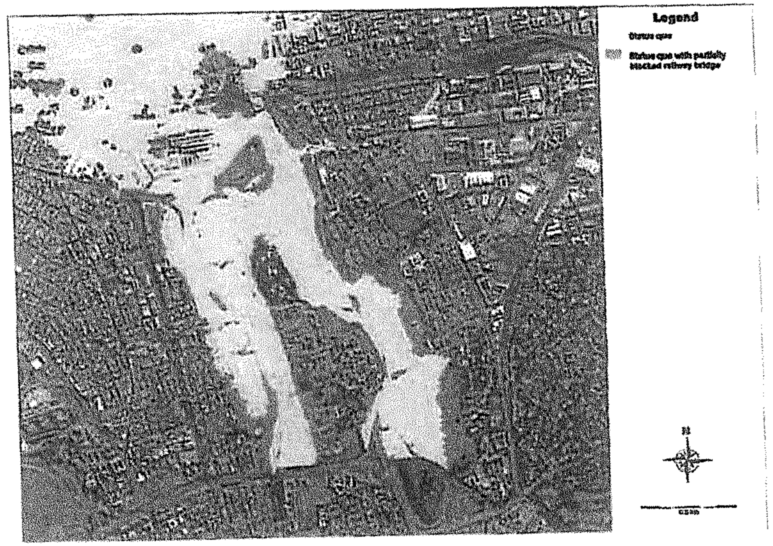

Figure 4-12 Impact of partially blocking the railway bridge immediately downstream of the River Club site

4.2.9 Impact of Sea Level rise

For the TRUP study conducted by RH-DHV (2017), which is discussed in Section 3.1.5, the City and RH-DHV agreed on certain boundary conditions based on the recommendations of PRDW which are discussed in Section 3.1.5 and summarised in Table 3-2 (PRDW, 2010). PRDW (2010) noted that preliminary results indicate that extreme rainfall events should be considered with storm surge events of a lower return period (i.e. 1 in 10 year storm surge – for which they did not offer an estimate in their study – with a 1 in 100 year flood event). As the City and RH-DHV had already agreed to using the 1 in 50 year storm surge with a 1 in 100 year flood event for the TRUP study and the surface water hydrology study is particularly contentious, Aurecon decided to use what RH-DHV had agreed with the City – 50 year storm surge. However for completeness, Aurecon also modelled the 10 year storm surge with a 100 year flood event. The results of the modelling are shown in Figure 4-13 which indicates very little difference in the extent of flooding. Aside from the area around Paarden Eiland, the water surface elevations remain within 1 cm (0.01 m) of each other – well within acceptable modelling error. There is a slight greater difference in modelled water surface elevations in the vicinity of Paarden Eiland – approximately 0.08 m – which is likely due to slightly less flooding from the canal and lower estimated tidal levels, but this is independent of the proposed developments and rather the selection of boundary conditions

These results are not entirely surprising as the tidal levels in Section 3.1.5 make provision for 0.55 m to account for sea level rise as a result of climate change and a storm surge which together add more than 0.8 meters to the Mean High Water Spring tidal level – which was used for previous studies. This larger sea level rise would seriously constrain the capacity at the outfall, likely contributing to the flooding. An investigation of the impacts of sea level rise is beyond the scope of this study, however it would be in the City's interest to undertake further modelling to assess how climate change and sea level rise impacts could be mitigated.

Another reason for the limited differences, regardless of the tidal levels, is that a significant portion of the flooding is as a result of the Salt River exceeding its capacity. However, as discussed in Section4.2.10, even if the Salt River Canal were to be widened, the benefit would be relatively minor.

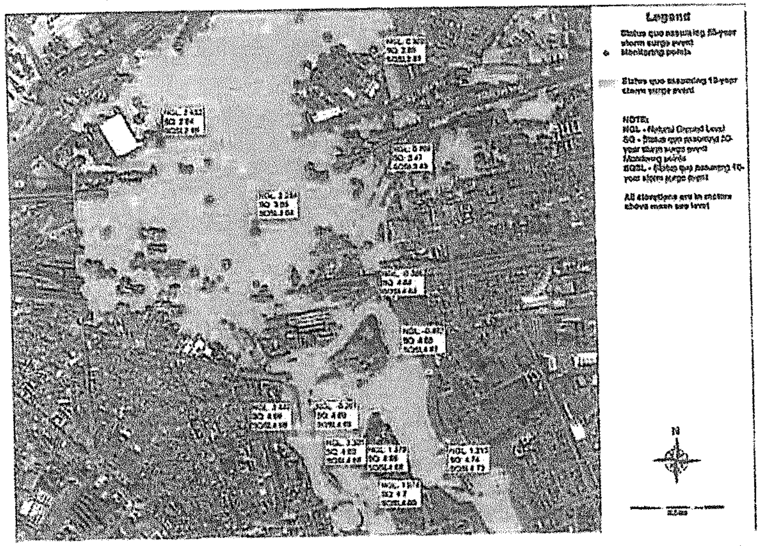

Figure 4-13 Comparison of the inundation considering the 100-year flood event in combination with the 50-year and 10-year storm surge events

Effectively this study indicated that due to the projected sea level rise, resulting from climate change, there would be flooding in the lower parts of the catchment – regardless of whether the development went ahead or not, and that the development is unlikely to have any effect on the extent of flooding.

4.2.10 Impact of widening the Salt River Canal

The City requested that this study should also consider the possible effect of widening the Salt River Canal and removing any restrictions (e.g. bridges). As discussed in Section 3.7, the modelling of this scenario would represent the 'absolute best case'. In Aurecon's view, such improvements are unlikely to ever be realised for a number of reasons, including both practical and economic considerations. The modelling considered the 1 in 100-year storm event and the following scenarios:

- Existing status quo (existing channel and development) – SQ;
- The status quo (existing development) with a widened channel (Section 3.7) – SQW; and
- The proposed River Club development together with the proposed TRUP, PRASA and NRF developments and a widened channel – PDTW.

The results which are summarised in Figure 4-14 indicate that widening the channel and removing the hydraulic effects of the bridges would reduce the maximum water surface level by between 0.1m and 0.8m. Interestingly this would have little impact on the extent of inundation, except as follows:

- The sports fields would not be inundated as the 'old' Liesbeek would not over top, although the fields would be lower than the water level in the canal and thus would be considered to be within the floodplain; and
- The PRASA land, also because the 'old' Liesbeek would not overtop.

There are some other minor differences between the status quo and the post-development scenarios with the Salt River Widened. These are most marked near the existing entrance to the River Club site about 0.35m. This effect is localised. For both scenarios with the widened Salt River channel, the extent of flood inundation would be reduced – but not significantly.

Widening of the canal would potentially have a negative environmental impact on the Raapenberg Wetland due to the lower water levels which would result in the wetland being flooded less frequently. Therefore, unless the value of development on the PRASA site were significant or critical as part of long-term city/town planning and the City were to undertake further modelling of the design of any widened channel, it is unlikely that widening the Salt River would be an economic or practical solution to flooding in the Salt River Catchment – whether the River Club development goes ahead or not.

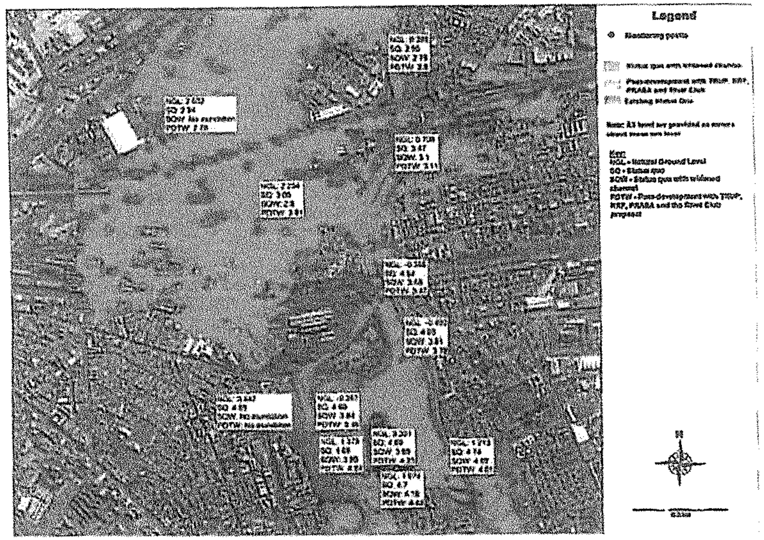

Figure 4-14 Impact of widening the Salt River on the extent of inundation of the 100-year flood

4.2.11 Sensitivity analysis

The sensitivity analysis, discussed in Section 3.12, indicated that although the proposed River Club and other developments would cause small increases in flood levels (as expected due to the increases in flow), the maximum differences between pre- and post-development flood levels would only be about 0.01 m (10 cm). Even if future models indicate increased or decreased flows in the Black and Liesbeek Rivers, it is likely that these would show similar differences in the pre- and post-development flood levels.

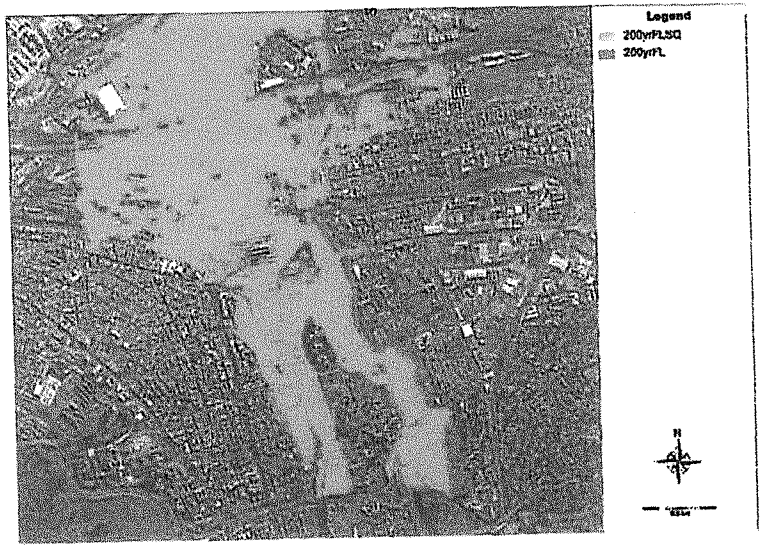

Figure 4-15 Maximum extent of inundation for the 200-year flood (whole model)

4.2.12 Summary of the analysis

It is evident that the modelling results show that "no matter what" is done, the impact is "insignificant". This is borne out by the following:

- The development of the River Club, along with the TRUP, PRASA and NRF sites is likely to have an impact on flood levels, in the order of, 0.01m – 0.15m depending on the storm recurrence interval and location. With the greatest differences expected in the vicinity of the SAAO.
- The insignificant changes in the extent of inundation whether the River Club proposal is taken forward in isolation or in combination with the TRUP, PRASA and NRF proposals;
- The insignificant changes in the extent of inundation when the PRASA overland escape route is closed;
- The insignificant changes in the extent of inundation for minor storm events that may have an impact on the functioning of the Raapenberg Wetlands; and

- The insignificant change to the extent of inundation, when the 10-year or 50-year storm surge is used as a boundary condition.

This is not entirely surprising as the River Club site is located in what historically was an extensive wetland which likely drained to the ocean as discussed in Section 2.1. As discussed in (Brown & Magoba, 2009) the site itself is in places only 2 m above mean sea level and the slope of the canal to the ocean is very flat, in some areas it is completely flat, and there are a number of hydraulic obstructions along its route (e.g. bridges).

4.3 Impact of the proposed River Club development on the SAAO buildings

4.3.1 Impact of developing the River Club and surrounding sites

Assessing the impact of flooding on the SAAO buildings is complicated as the SAAO has constructed its own berm (Section 2.1.4). As noted in Section 2.1.4, these berms were not considered as part of this analysis. The analysis was further complicated as some of the buildings indicated in Figure 4-16, some which might also have heritage value, were developed in what is clearly the flood plain and are therefore are prone to flooding.

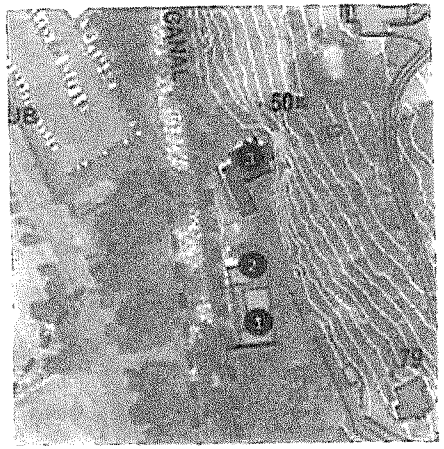

Figure 4-16 SAAO buildings on the edge of the Liesbeek River canal. Dark blue – 3 – buildings are considered to have possible heritage value

The modelling indicated that for the 1-year recurrence interval storm event, none of the buildings would be flooded under any development scenario and that there would be no flooding onto the SAAO property. The modelling indicates that for the 1 in 2-year recurrence interval storm event the land surrounding the buildings would be inundated and that there is a high likelihood that water would enter Building 1 as evident from Figure 4-16. For the Status Quo scenario the water level around the building (3.36 mamsl) would be just below floor level (3.33 mamsl) during the 1 in 2-year flood whereas for the post development scenarios (River Club Including / Excluding TRUP PRASA, NRF) the modelled water surface elevation would be 3.6 mamsl and 3.7 mamsl.

As mentioned throughout this report, the modelled results should be carefully considered, especially considering small differences in water levels of less than 0.1 m. However, for the post development scenario Building 1 (not identified as having heritage value) would be flooded slightly more frequently and its floor is likely to be damaged by the 1 in 2-year flood and by all larger flood events. Therefore, for the post development scenario the frequency of damage may be increased. Quantifying the differences in damage is not possible – except to indicate that this would be marginal.

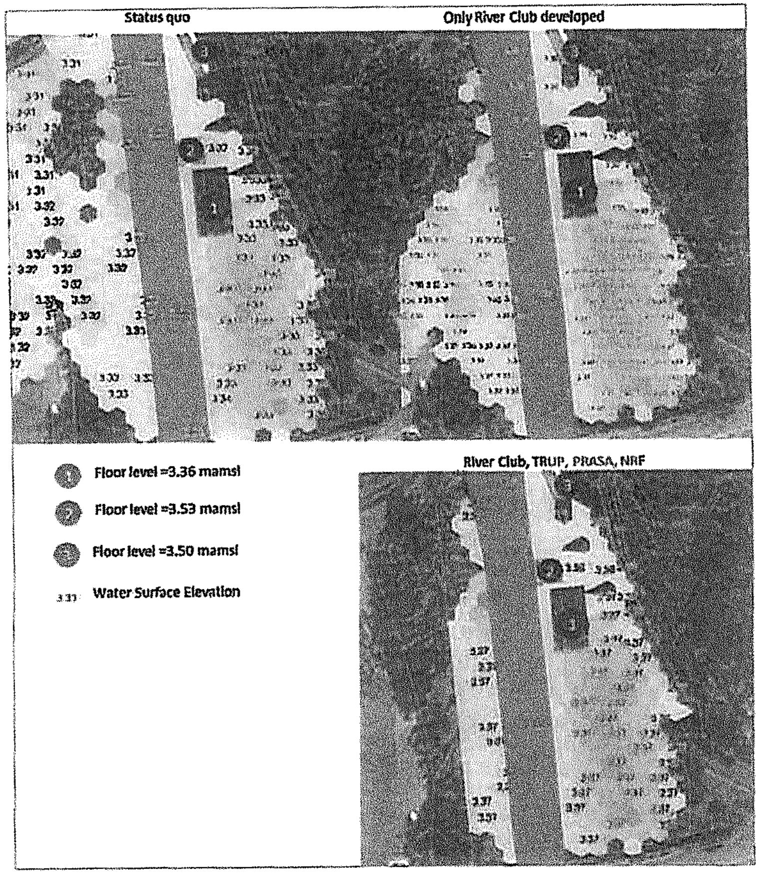

Figure 4-17 Impact on flooding during the 2-year recurrence interval storm event for various development scenarios

For the 5-year recurrence interval storm events, all the buildings of concern would be inundated by flood water. The differences between the status quo and the post-development scenarios are evident from Figure 4-18 – an increase in depth of 0.12 m (12cm). It is worth noting that the floor level of Building 3 (which has heritage value) is 3.50 mamsl and therefore the building would be inundated about once in 5 years to a depth of about 0.15 m deep. Although the increased depth would have an impact, this would not have a significant impact on the cost of repairs as the 1 in 5-year water depth in the building would be less than 0.3 m.

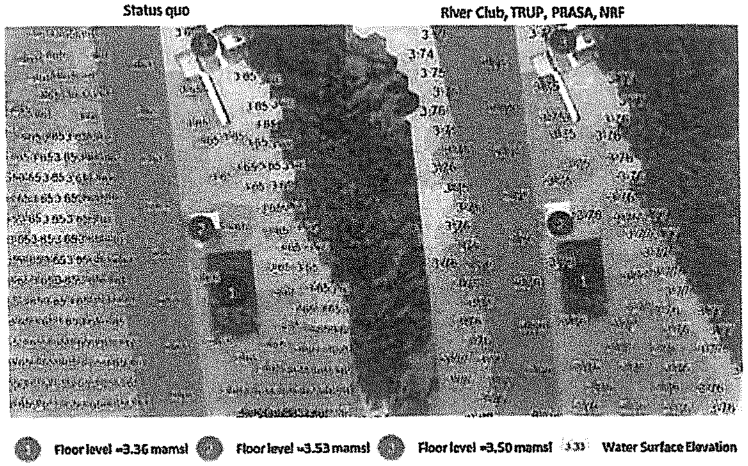

Figure 4-18 Water surface elevations during the 5-year recurrence interval storm event for different development scenarios

For larger storm events the pre- and post-development impacts would be similar with very slightly higher flood levels for the post development scenarios.

4.3.2 Mitigation options

It is important to recognise that these properties were built within the 1 in 2 to 1 in 5-year flood plain and therefore are prone to flooding. The only real option to protect these buildings would be to construct a protective berm. As mentioned in Section 2.1.4, without the knowledge of the City's stormwater department the SAAO constructed a berm along the boundary of their property. The top of the berm varies between 3.6 mamsl and 4.14 mamsl. It is likely that this will only protect the SAAO buildings from the 1 in 2-year recurrence interval storm events. This berm could be raised to protect these properties, from larger storm events. Raising the crest the berm to about 4.8 mamsl would provide protection for the 100-year recurrence interval event although this would pose a significant risk to the occupants of the buildings if the berm failed. The berm would probably not have any significant impact on flooding elsewhere.

4.4 Impact of the proposed development on flooding in the surrounding ecosystems

In Section 3 it was mentioned that estimating the rainfall for a storm with a recurrence interval of less than about 1 in 2 years is statistically problematic. Based on the modelling undertaken as part of this study – both in PCSWMM and HEC-RAS modelling - it would appear that the wetlands would receive inflows from the Liesbeek Canal when the water surface elevation is in the region of about 2.5 mamsl as indicated in Figure 4-19. This would equate to the wetland filling in a storm with a recurrence interval of between ½-year and 1-year. Once water enters the wetland, and the wetland is filled to +-2.5 mamsl the wetland becomes part of the flood plain area offering limited offline storage. The wetland does not appear to drain below a level of +-2.5 mamsl (the level at which flow enters the wetland). This would equate to approximately 1 m of standing water at the deepest points in the wetland. It seems that this water evaporates over time. Evaporation at Observatory is estimated to be approximately 1.5 m/annum, and rainfall about 0.6 m/annum. This would suggest that over a typical / average year the water levels would fluctuate in the wetland. If there were successive droughts – as in 2015, 2016, 2017 – it is possible that the wetland could dry out should there not be a storm of sufficient magnitude to result in flooding into the wetland.

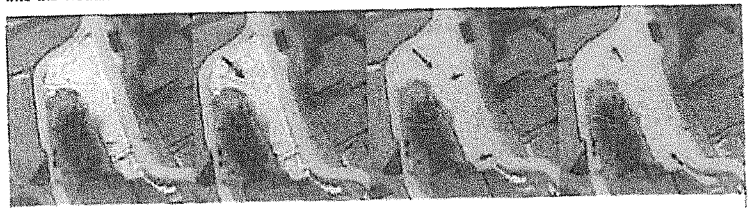

Figure 4-19 Overview of how flow enters and then leaves the Raapenberg wetland

The intervention undertaken by the Friends of the Liesbeek, TRUPA and SAAO which is shown in Figure 3-12 has effectively reduced the level at which the wetlands are likely to fill and empty, to about 2.25 mamsl. While Dr Day (Freshwater Consultant) will address the potential impacts of the increased frequency of inundation on the ecology, the intervention effectively has the impact of adjusting the level to which the wetlands would drain after flooding to about 2.25 mamsl (instead of about 2.5 mamsl). This equates to 250 mm lower. Assuming an evaporation rate of about 4 mm/day, the reduced water level would equate to a reduction of about 60 days before the water volume stored in the wetland is evaporated away. This could be compensated by more frequent flooding, but it is Aurecon's understanding from Dr Day, that an increase in flood frequency may have a negative impact on the wetlands performance as it could decrease the salt levels in the wetland.

An interesting observation on site which is confirmed by the survey, is that the water levels in the Black and Liesbeek Rivers are higher than the water level in the wetland by approximately 100-150 mm – Figure 4-20. This indicates that the wetlands are not, typically, filled with water from the surrounding rivers – although the hydraulic gradient would indicate a flow direction into the wetlands. In fact, it would appear that the hydraulic conductivity of the soil / peat that makes up the wetland is equal to or lower

than the evaporation rate. The part of the wetland South of the footpath extending from Observatory Road towards the M5 appears to be connected to the river System at some point upstream and also has a higher surface water level that the primary wetland that borders the SAAO.

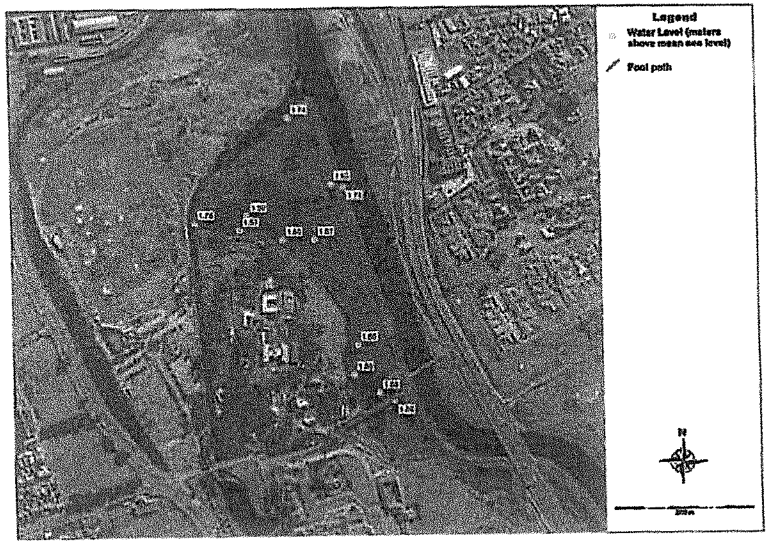

Figure 4-20 Surveyed water levels in, and surrounding, the Raapenberg wetlands

While not explicitly tested, the attenuation benefits of the wetland are clearly limited. Prior to canalisation of the rivers, the wetlands would have been far more extensive and offered significantly more attenuation capacity – unfortunately this situation is not reversible.

An interesting outcome of the analysis is that the current post development scenario would suggest that the water level would drop – albeit by 0.03 m – for the 1-year storm event. Therefore, it is possible that the proposed wider channel would offer some attenuation benefits over the existing situation for this event although this is within the margin of error and relatively insignificant. For larger storm events (greater than 1-year recurrence interval) there would be no attenuation benefit.

Effectively, the analysis indicates little to no significant change in the performance of the wetland, as long as the recent intervention is reversed.

4.5 Opportunity cost of not using the River Club for attenuation of runoff

In order to assess the opportunity cost of developing the site – instead of using it for attenuation – the City agreed previous studies could be referred to. The results of each of these is reviewed below and the implications summarised thereafter.

4.5.1 Ninham Shand (2004)

Ninham Shand (2004) investigated the idea of creating a attenuation pond by excavating high ground between the "Canalised" and "Old" Liesbeek River channels (i.e. The River Club) and along the side of Black River Parkway to provide additional flood attenuation in this area. Their analysis revealed that the 1:50 and 1:100-year flood volumes were simply too large for a pond in this area to have any attenuating effect on the downstream flow rates. It was also evident that, to be effective, significant throttling of the river flow would be required at the confluence of the Black and Liesbeek Rivers rather than just provision of additional attenuation capacity. Throttling of the river would in turn result in an unacceptable rise in flood levels in the vicinity of the River Club as well as increases in flood levels further upstream along the Liesbeek and Black Rivers. As a result, the idea of a retention pond was abandoned.

Subsequent to this study the City incorporated Climate Change and Sea Level rise into their modelling. These changes are likely to further reduce any benefits offered by an attenuation system.

4.5.2 Fisher-Jeffes (2015)

Fisher-Jeffes (2015) undertook a PhD study to assess the viability of rainwater and stormwater harvesting in South Africa. The study made use of the Liesbeek River Catchment as a case study to test the viability of rainwater and stormwater harvesting.

Fisher-Jeffes (2015) also indicated, as did Ninham Shand (2004), that providing attenuation in the region of the confluence of the Black and Salt Rivers could provide additional benefits in the form of flood attenuation. Fisher-Jeffes (2015) however only looked at records of events between 2003 and 2012 – due to the lack of data before that period. The largest recurrence interval event during this period was estimated to have been a 1:20 year event.

Fisher-Jeffes (2015) study was focused on utilising the Liesbeek River Catchment as a 'typical' catchment and did not model the greater Salt River Catchment as was done in Ninham Shand (2004).

4.5.3 RH-DHV (2017)

As part of the RH_DHV study two alternatives were considered for the River Club Island: either flood storage or infill and development. RH-DHV concluded that flood storage should only be considered in combination with storage at the Rondebosch and King David Mowbray golf courses or other upstream measures, as on its own it would not have a significant effect on flooding within TRUP. The effect of the combined flood storage above would have to be evaluated using a hydraulic model extending further upstream, with additional surveys of the upstream Black River cross-sections.

4.5.4 Conclusions

Based on a review of the above studies, it was apparent that the potential benefits of using the site for flood attenuation purposes would be negligible. It was also evident that the construction of an attenuation

facility would require the City to invest significant resources in design, operation and maintenance with limited benefit in terms of reduced impacts of flooding. If an alternative to flood attenuation is required it would likely be more appropriate to implement the original long-term plan of widening the channel. However, were the City to consider the potential for utilising the site to attenuate storm events, it would need to consider the following:

- The site would need to be excavated to provide additional storage.
- Additional storage / attenuation capacity would probably also have to be provided at the Rondebosch and King David Mowbray Golf Courses.
- The City would have to have the resources, to actively manage the site as either a Real-Time Control attenuation facility or a Stormwater Harvesting facility.
- The Owners of the River Club would need to be willing to sell their land, which would likely be at a high price and from which the City would not receive the financial benefits of the property rates.

Considering the above, it is unlikely, that the River Club site will be developed as an attenuation facility. Based on the available literature the benefits are unlikely to be significant - in terms of reduced flood damage.

5 Impact Assessment

Section 4 provides a detailed discussion of the potential hydrological and hydraulic impacts of the proposed development. This discussion is summarised in Section 6. The assessment of the impact was completed as shown in Table 5-1. The impact for the proposed development (any alternative) without mitigation is assessed to be insignificant, and with the proposed mitigation the impact is assessed to be low (+ve) significance. This impact is manageable to a limited extent, but once the site is develop will not be reversible.

Table 5-1 Significance of increased flood hazard

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Both Alternatives								
Without mitigation	Local	Medium	Long-term	Medium	Possible	LOW	-ve	Medium
	1	2	3	6				
Essential mitigation measures:								
• Raise the Liesbeek Parkway locally (as discussed in Section 4.2.7) to eliminate potential High Hazard flooding at this location (at 33°56'14.80" S, 18°28'34.13" E).								
With mitigation	Local	Low	Long-term	Low	Improbable	VERY LOW	+ve	Medium
	1	1	3	5				

In the case of the No-Go alternative, the site will continue to be used as a commercial, recreational and conference facility. There would be no change to the flood risks – except those as a result of climate change, or development on surrounding / upstream properties.

6 Conclusions

This study has reviewed seven relevant studies, and undertaken extensive modelling with both HEC-RAS and PCSWMM 2D. The site is extremely complicated, and it is necessary to consider all the separate findings together before drawing any definitive conclusions. Considering any 'question' or 'issue' raised in isolation may lead to a misinterpretation of the results. Furthermore, hydrology and hydraulic modelling should be considered as a tool for analysing potential impacts and scenarios and as this is not an 'exact science', engineering judgement and experience in interpreting the results are important. As such the findings based on the complete analysis are presented and interpreted using Aurecon's knowledge of the site. For these reasons, Aurecon involved three of its staff who have extensive experience of this site in order to ensure the analyses were undertaken and interpreted in the most appropriate manner.

Therefore, based on a review of all the available studies, the extensive modelling, and engineering judgement, it is Aurecon's opinion that:

- The results (magnitude of impact) appear to be relatively consistent for each study, even where study methods and elevations may differ slightly.
- The development of the River Club as well as the TRUP, PRASA and NRF sites is likely to have an impact on flood levels, in the order of between 0.01 m and 0.15 m depending on the storm recurrence interval and the location. The greatest differences between the results are in the vicinity of the SAAO. The impacts of these differences are insignificant.
- If the River Club is developed in isolation (i.e. TRUP, NRF, PRASA were not developed), the impacts would be of similar magnitude for all recurrence intervals, but less by approximately 0.00m – 0.03m, to the scenario where all the proposed developments went ahead. This difference is considered to be insignificant because the differences between the post development scenario's are well within the uncertainties of the modelling tools.
- It is important to note that if the TRUP, NRF, PRASA were to be developed in isolation, then the results must not be interpreted to mean that they would only have an impact equal to the difference (typically +- 0.00m – 0.03m) between the post development scenarios including River Club, TRUP, PRASA, and the NRF sites and the post development scenario for the River Club alone – as indicated in the RHDHV Study. This is because of the complexities of the hydrology and hydraulics in the vicinity of the River Club site.
- The design of changes to the Liesbeek Canal should aim to maintain the existing hydraulic functioning of the wetland during smaller recurrence interval events. The current proposals would have little to no effect, but further detailed design refinements – during detailed design – should be reanalysed.
- It would be advisable, in consultation with the Fresh Water Consultant, to consider reversing the intervention undertaken by the TRUPA, Friends of the Liesbeek and SAAO – as this is likely to increase flows into the wetland.
- The site is unlikely to be developed by the City as an attenuation facility.
- PRASA should not be allowed to close the existing overland flood route that extends across its property, as it is important for mitigating flood risk – regardless of whether or not the proposed River Club development proceeds.
- The extension to Berkley Road should be designed in such a manner as to not impact on the water levels determined by this study and any changes to the preliminary design would need to be re-evaluated. The detailed design of the extension of Berkley Road should consider raising the portion of the road that is within the floodplain.
- There is a need to address the localised change in risk along Liesbeek Parkway. This could be done through raising the road locally (as discussed in the report) to eliminate the potential flooding by the

1 in 100 year event, however ponding due to local stormwater is also likely to occur at this location for which the provision of warning signs would probably suffice.

- The impact of the proposed development on flood levels and their extent are considered to be negligible.
- The impacts of the proposed River Club development and of the proposed Two Rivers Urban Park development on flood levels and their extent are considered to be negligible.
- Widening the Salt River Canal would reduce the flood levels for all scenarios, but that this would come at a significant cost with very little benefit and is unlikely to be in the foreseeable future.

The main conclusion of this study is that the proposed development would have an insignificant effect on flooding in the vicinity of the existing River Club site. Although the development would have some limited and localised effects on the flows and water levels in the Liesbeek and Black Rivers, the modelled impacts in terms of increased hazard and damage to properties are insignificant and can be considered negligible – as long as the above findings are appropriately dealt with.

Although the proposed development might not appear to have a significant impact on flooding, it would none the less require the following deviations in terms of the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a):

- Section 9.2: Flood Management and Public Safety
  - Permission to develop / obstruct the free flow of water within the 20-year flood line area would need to be granted.
- Section 10.5: Table 1: Framework for the assessment of Proposals
  - The current assessment framework forbids development (including filling) within the 50 year flood plain. It notes: "*In exceptional circumstances minor "smoothing" of the 50 / 100-year flood line may be considered, provided equivalent compensatory stage storage volume is provided within the development precinct*".
  - As the proposed development falls under the 50-year flood line, a deviation from the policy, allowing the developer to fill (considered development) would need to be granted.

With regard to the two development layouts (Section 3.2), both would have similar impacts, although Layout Option 1 (focus of this study) would appear to be the preferable option as it aligns with the vision of the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) in that, in comparison to Layout 2) it provides an improved ecological corridor, provides the potential for improved amenity and biodiversity in line with the principles of Water Sensitive Urban Design (WSUD) principles.

It is recommended that the City should take account of the findings of this study to determine whether in terms of the policy and based on consideration of the "*geomorphological, maintenance, social and economic aspects*" (presented by other specialists) the proposed development of the River Club Site should be approved.

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Appendix A

Table A1 Water Surface Elevations (mamsl) at Point 1 (Natural Ground Level = 0.389 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	1.98	1.94	1.94
1-year	2.19	2.16	2.16
2-year	2.37	2.39	2.39
5-year	2.52	2.54	2.54
10-year	2.63	2.64	2.64
20-year	2.81	2.82	2.83
50-year	2.91	2.93	2.93
100-year	2.95	2.96	2.97
200-year	3.00		3.01
100-year (Widened Channel)	2.79	Not modelled	2.8
100-year (PRASA overland route closed)	2.95		2.97
100-year (Opened Salt River mouth)	2.95		2.97

Table A2 Water Surface Elevations (mamsl) at Point 2 (Natural Ground Level = 2.651 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	No water on the surface		
1-year			
2-year			
5-year			
10-year			
20-year	2.79	2.81	2.81
50-year	2.9	2.91	2.92
100-year	2.94	2.95	2.97
200-year	3.01		3.01
100-year (Widened Channel)	No water on the surface	Not modelled	2.76
100-year (PRASA overland route closed)	2.94		2.96
100-year (Opened Salt River mouth)	2.94		2.96

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Table A3 Water Surface Elevations (mamsl) at Point 3 (Natural Ground Level = 2.238 mamsl)

Recurrence interval (Description)	Status Quo	Development Scenario: Post-development (River Club only)	Development Scenario: Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	No water on the surface		
1-year	No water on the surface		2.27
2-year			2.41
5-year	2.76	2.79	2.84
10-year	2.90	2.9	2.91
20-year	2.97	2.97	2.98
50-year	3.02	3.03	3.03
100-year	3.05	3.06	3.07
200-year	3.05	Not modelled	3.10
100-year (Widened Channel)	2.90		2.91
100-year (PRASA overland route closed)	3.05		3.06
100-year (Opened Salt River mouth)	3.05		3.06

Table A4 Water Surface Elevations (mamsl) at Point 4 (Natural Ground Level = 0.709 mamsl)

Recurrence interval (Description)	Status Quo	Development Scenario: Post-development (River Club only)	Development Scenario: Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.16	2.17	2.17
1-year	2.51	2.52	2.51
2-year	2.77	2.79	2.79
5-year	3.04	3.06	3.06
10-year	3.18	3.19	3.2
20-year	3.31	3.33	3.33
50-year	3.42	3.43	3.44
100-year	3.47	3.48	3.48
200-year	3.52	Not modelled	3.52
100-year (Widened Channel)	3.11		3.12
100-year (PRASA overland route closed)	3.48		3.49
100-year (Opened Salt River mouth)	3.47		3.48

Table A5 Water Surface Elevations (mamsl) at Point 5 (Natural Ground Level = -0.374 mamsl)

Recurrence interval (Description)	Status Quo	Development Scenario: Post-development (River Club only)	Development Scenario: Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.48	2.49	2.49
1-year	2.84	2.85	2.85
2-year	3.2	3.24	3.24
5-year	3.58	3.61	3.62
10-year	3.83	3.86	3.88
20-year	4.11	4.14	4.16
50-year	4.44	4.49	4.52
100-year	4.64	4.68	4.71
200-year	4.81	Not modelled	4.88
100-year (Widened Channel)	3.58		3.49
100-year (PRASA overland route closed)	4.67		4.75
100-year (Opened Salt River mouth)	4.64		4.71

Table A6 Water Surface Elevations (mamsl) at Point 6 (Natural Ground Level = 3.443 mamsl)

Recurrence interval (Description)	Status Quo	Development Scenario: Post-development (River Club only)	Development Scenario: Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	No water on the surface		Developed as part of TRUP Proposal
1-year			
2-year			
5-year			
10-year			
20-year	3.84	3.72	
50-year	4.49	4.52	
100-year	4.69	4.75	
200-year	4.85	Not modelled	
100-year (Widened Channel)	No water on the surface		
100-year (PRASA overland route closed)	4.71		
100-year (Opened Salt River mouth)	4.69		

Table A7 Water Surface Elevations (mamsl) at Point 7 (Natural Ground Level = -0.23 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.48	Section of 'Old' Liesbeek filled	
1-year	2.84		
2-year	3.21		
5-year	3.63	3.61	3.62
10-year	3.88	3.86	3.88
20-year	4.16	4.14	4.17
50-year	4.49	4.52	4.53
100-year	4.69	4.75	4.76
200-year	4.85		4.95
100-year (Widened Channel)	3.84		3.49
100-year (PRASA overland route closed)	4.71	Not modelled	4.81
100-year (Opened Salt River mouth)	4.69		4.76

Table A8 Water Surface Elevations (mamsl) at Point 8 (Natural Ground Level = -0.492mamsl)

Recurrence interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.53	2.52	2.52
1-year	2.92	2.89	2.89
2-year	3.28	3.29	3.29
5-year	3.63	3.66	3.67
10-year	3.88	3.92	3.94
20-year	4.15	4.20	4.22
50-year	4.48	4.55	4.58
100-year	4.68	4.74	4.77
200-year	4.85		4.95
100-year (Widened Channel)	3.81		3.78
100-year (PRASA overland route closed)	4.71	Not modelled	4.81
100-year (Opened Salt River mouth)	4.68		4.77

Table A9 Water Surface Elevations (mamsl) at Point 9 (Natural Ground Level = 1.379 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.54	2.56	2.56
1-year	2.97	2.95	2.95
2-year	3.33	3.36	3.37
5-year	3.65	3.75	3.76
10-year	3.89	3.99	4.01
20-year	4.17	4.26	4.28
50-year	4.49	4.58	4.62
100-year	4.69	4.77	4.80
200-year	4.85		4.98
100-year (Widened Channel)	3.90		4.24
100-year (PRASA overland route closed)	4.72	Not modelled	4.84
100-year (Opened Salt River mouth)	4.69		4.80

Table A10 Water Surface Elevations (mamsl) at Point 10 (Natural Ground Level = 3.299mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	No water on the surface		
1-year			
2-year	3.33	3.36	3.36
5-year	3.65	3.75	3.76
10-year	3.89	3.99	4.01
20-year	4.17	4.26	4.28
50-year	4.49	4.58	4.62
100-year	4.69	4.77	4.8
200-year	4.69		4.98
100-year (Widened Channel)	4.85		4.23
100-year (PRASA overland route closed)	4.72	Not modelled	4.84
100-year (Opened Salt River mouth)	4.69		4.80

Table A11 Water Surface Elevations (mamsl) at Point 11 (Natural Ground Level = 1.974 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.55	2.57	2.57
1-year	2.96	2.96	2.96
2-year	3.35	3.38	3.39
5-year	3.69	3.81	3.81
10-year	3.93	4.05	4.07
20-year	4.20	4.29	4.32
50-year	4.51	4.59	4.63
100-year	4.70	4.77	4.81
200-year	4.86		4.99
100-year (Widened Channel)	4.17	Not modelled	4.44
100-year (PRASA overland route closed)	4.72		4.84
100-year (Opened Salt River mouth)	4.70		4.81

Table A12 Water Surface Elevations (mamsl) at Point 12 (Natural Ground Level = 1.206 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.69	2.67	2.67
1-year	3.11	3.10	3.10
2-year	3.41	3.42	3.42
5-year	3.71	3.74	3.75
10-year	3.95	3.99	4.01
20-year	4.22	4.27	4.29
50-year	4.54	4.60	4.64
100-year	4.74	4.80	4.83
200-year	4.90		5.00
100-year (Widened Channel)	4.05	Not modelled	4.04
100-year (PRASA overland route closed)	4.76		4.86
100-year (Opened Salt River mouth)	4.74		4.83

Appendix B

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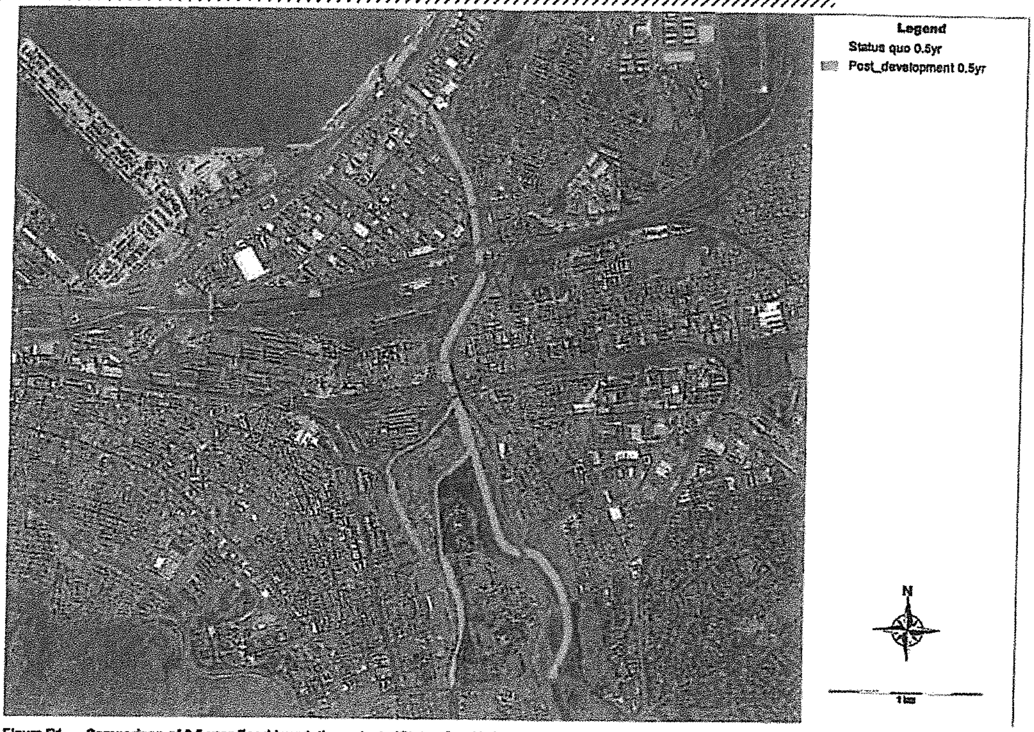

Figure B1 Comparison of 0.5-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, PRASA)

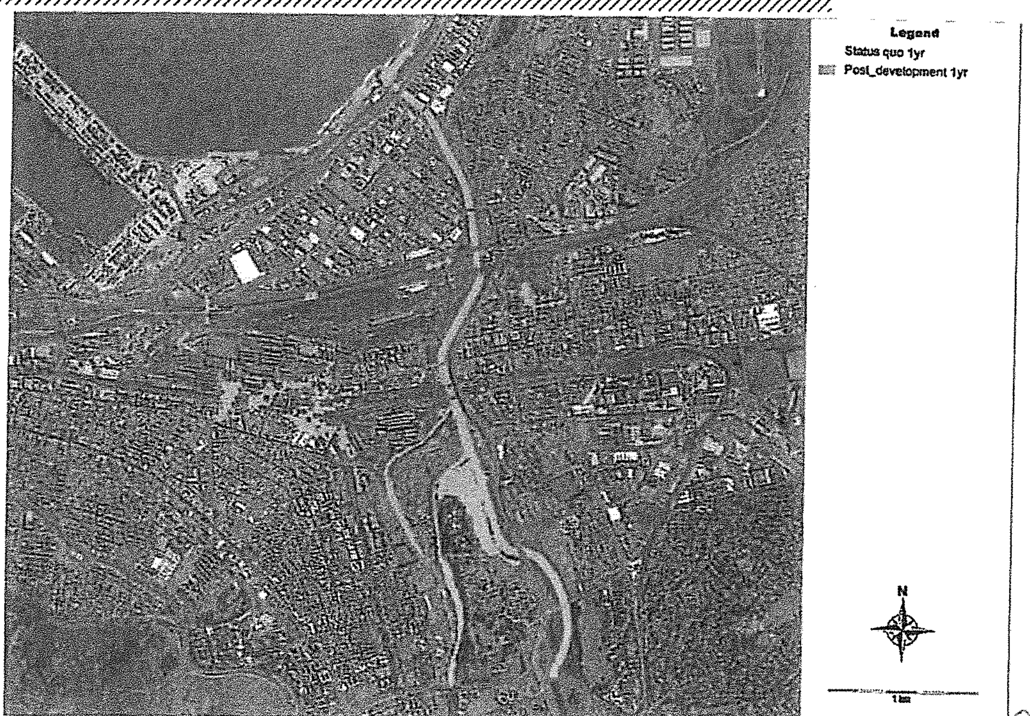

Figure B2 Comparison of 1-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, PRASA)

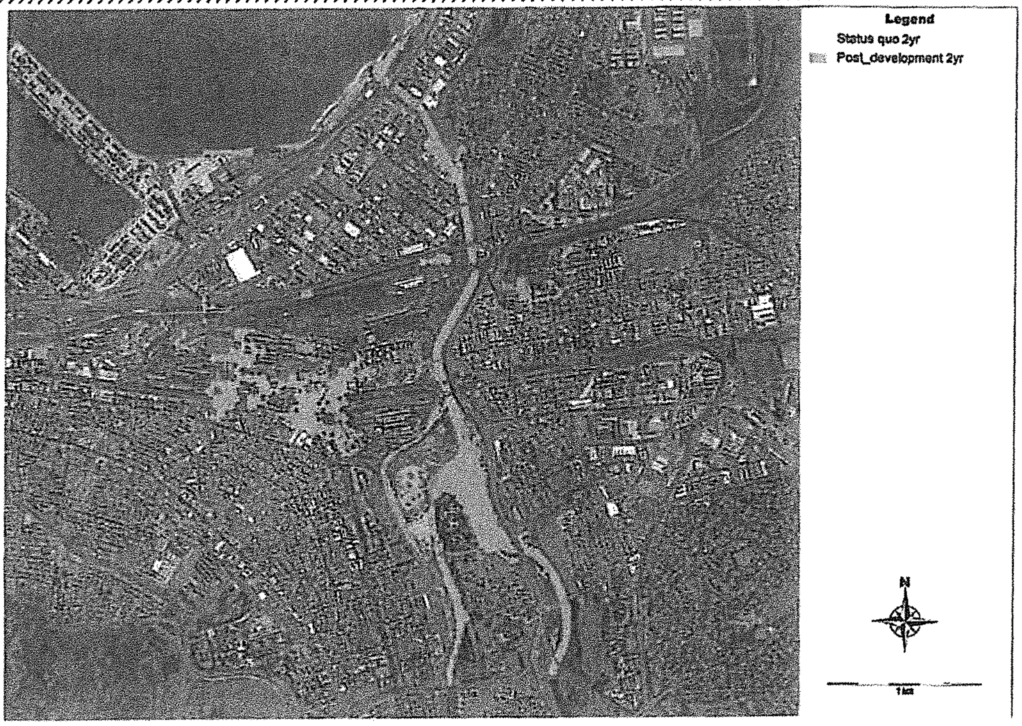

Figure B3 Comparison of 2-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

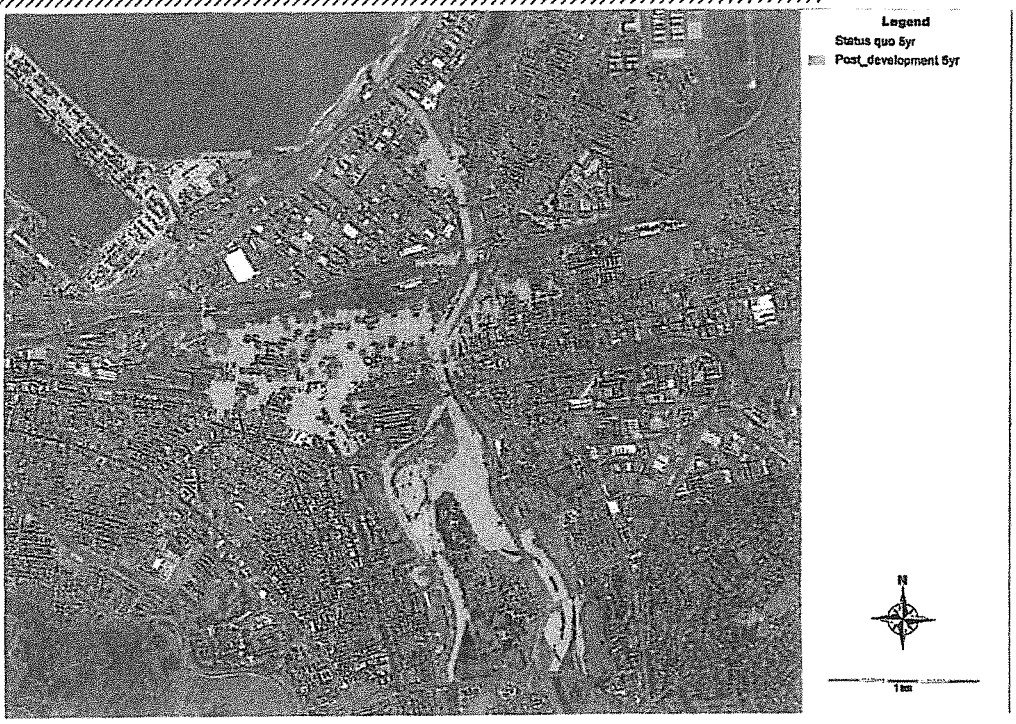

Figure B4 Comparison of 5-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

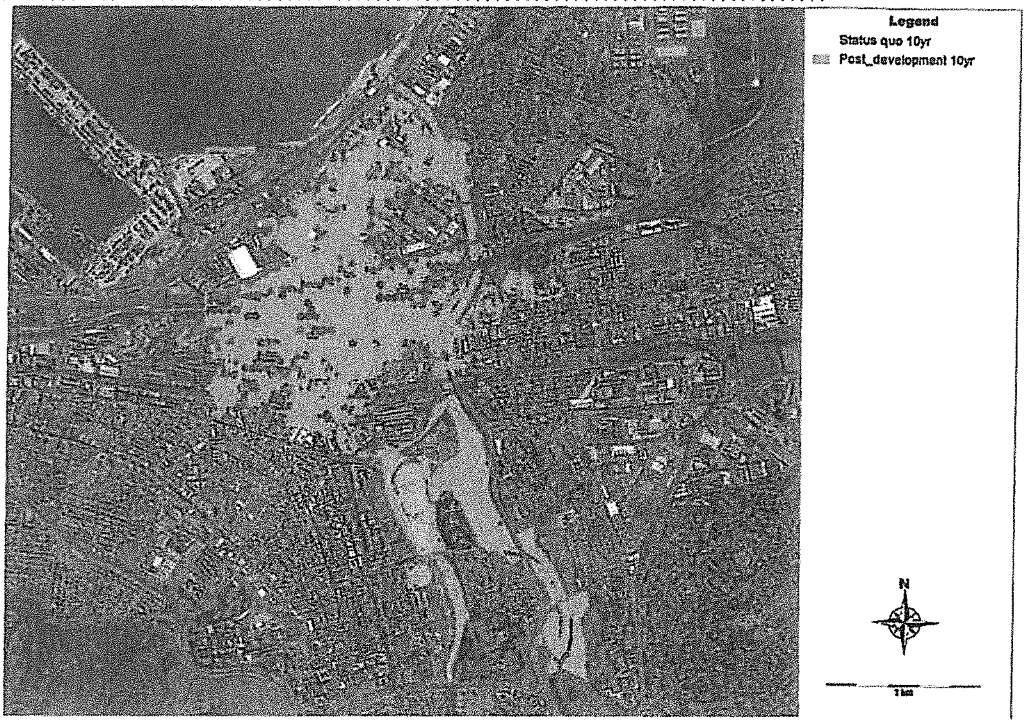

Figure B5 Comparison of 10-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

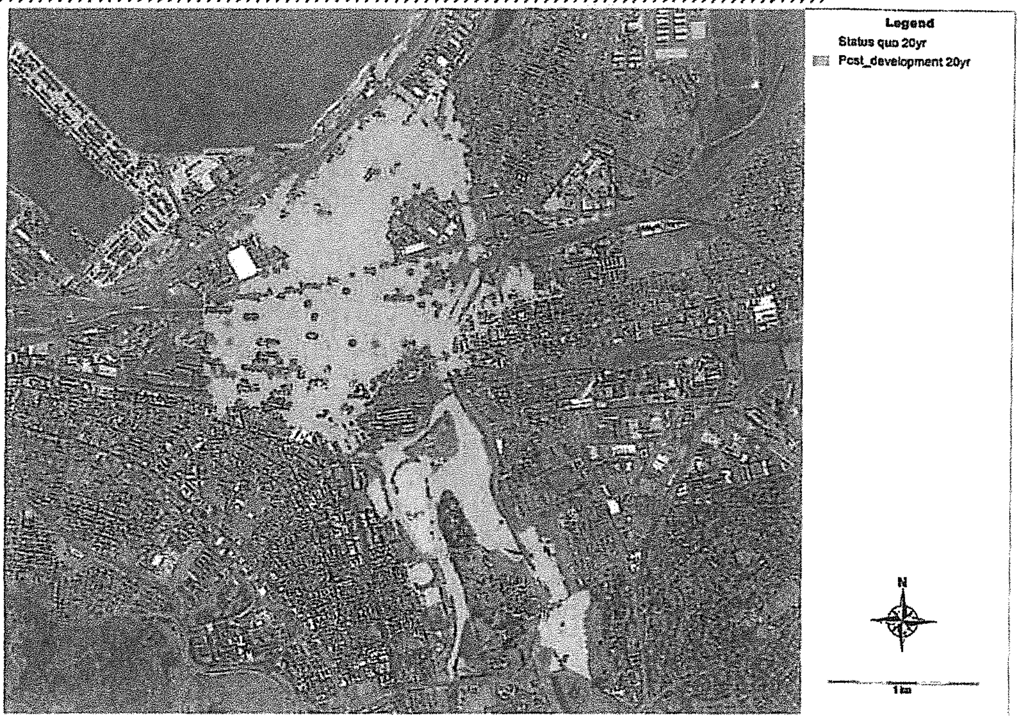

Figure B6 Comparison of 20-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

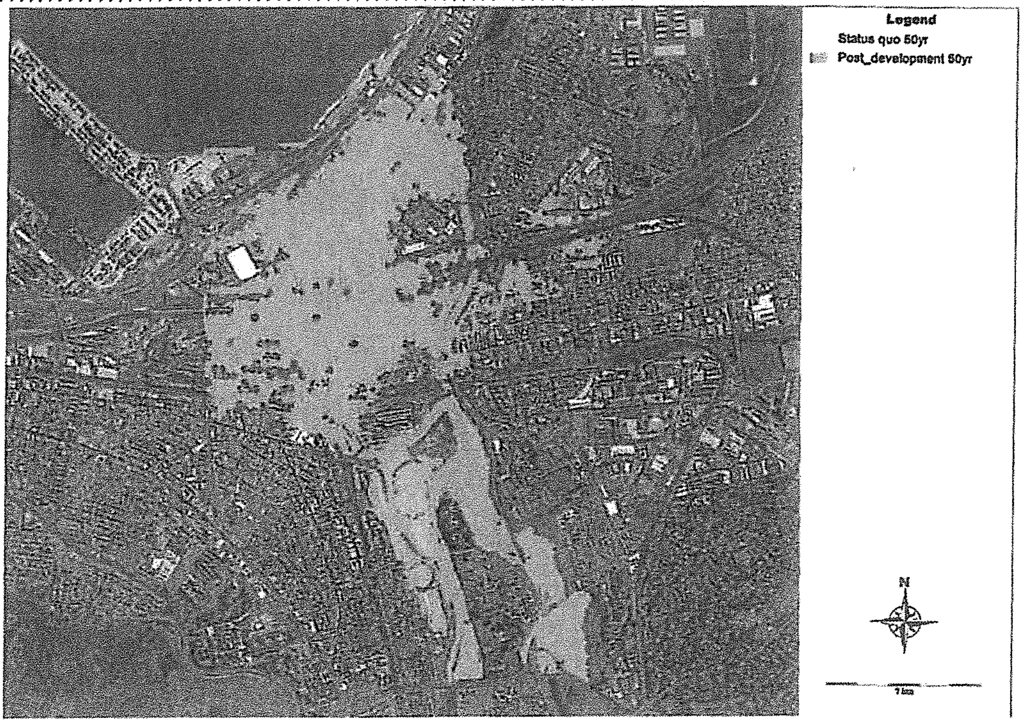

Figure B7 Comparison of 50-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

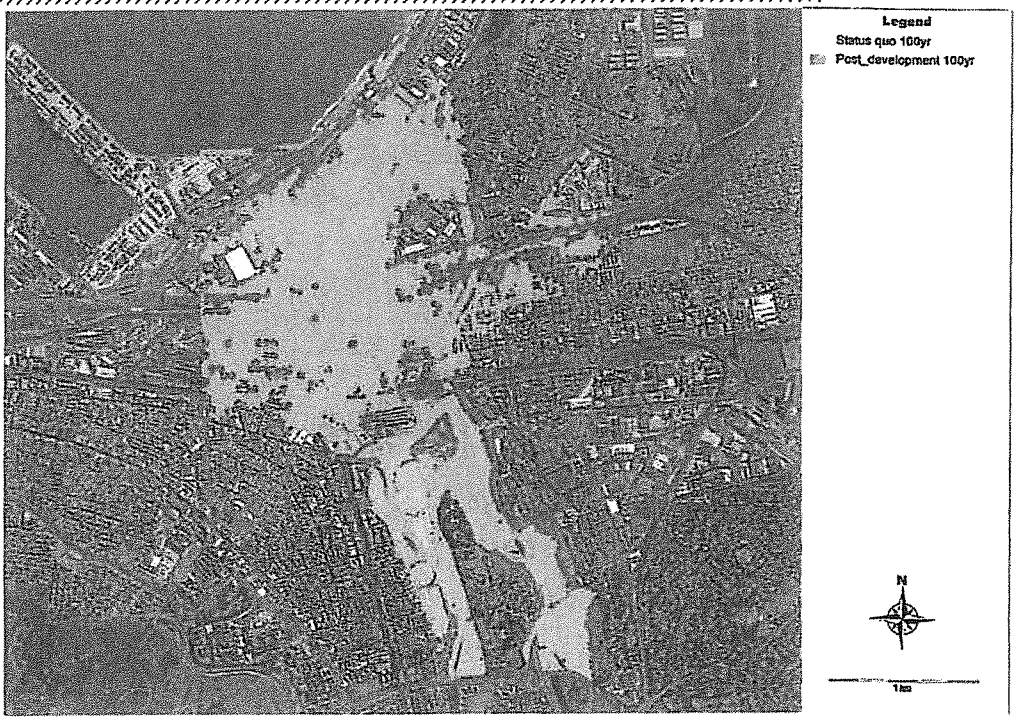

Figure B8 Comparison of 100-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

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Ben de Wet
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17 January 2020

Joy San Giorgio
Senior Professional Officer, Development Management

RE: COMMENTS ON DAMS CASE 70396369, RIVER CLUB DEVELOPMENT, OBSERVATORY, CAPE TOWN

Several motivation reports have been uploaded to the DAMS system with the most recent one being an application for permission to hold a New Year's Eve party on Dec 31, 2018. This response addresses the Motivation Report Rev 4, Sep 2018, called Application for Deviation from Table Bay District Plan etc.

Furthermore, our comments are informed by the Aurecon report into flooding of the site, Rev 3, dated March 2018 while the report uploaded to DAMS is Rev 2 dated Nov 2017.
The earliest flooding report commissioned by the River Club in 2015 and undertaken by AED, laments the historical mistakes made by City fathers in allowing development of the foreshore and infilling of the salt river lagoon. This as part of an application to develop the last bit of open green land left in the system.

<u>CCT Stormwater Bylaw and Policies</u>

The CCT Bylaw relating to Stormwater management allows the City to prohibit or impose conditions on developments in areas adjacent to watercourses and wetlands.
The CCT Stormwater Policies attempt to give guidance on how and when such conditions should be imposed. The Floodplain and river corridor management policy aims to safeguard aquatic environments and human health in addition to reducing the impact of flooding and maintaining recreational water bodies. It requires balanced consideration of flood risks, environmental impacts and socio economic needs with one of the policy objectives being the protection and enhancement of environmental goods and services provided by water bodies. The policy considers water bodies to be public resources which need protection by, amongst others, offsetting riparian development. The policy explicitly states that no development rights will be granted in the high hazard zone.
The Stormwater Impacts Policy aims to mitigates changes to runoff characteristics brought about by development

Deviations Requested

The CSRM branch is largely satisfied with the work done and findings made by Aurecon in their report of their "Investigation into the impact of the proposed development of the River Club on flooding and flood abatement in the Salt river catchment" Rev 3 dated 12 March 2018. These are not disputed.

The Stormwater policies prohibit the exercising of development rights in the High Hazard zone and also does not permit housing or business development below the 1:50 year floodline. It is not clear why the application is for deviation from restrictions on development below the 1:20 year floodline.

It is beyond the authority of the branch to authorize the manipulation of ground levels aimed at changing floodlines below the 1:50 year flood line. Furthermore, while in-filling of the "old Liesbeek" has been shown to be hydraulically unimportant, it goes against the other aspects of the City's stormwater strategies and policies as discussed above. While it may have a limited effect, the "old Liesbeek" currently acts as polishing facility for stormwater coming from the suburb Observatory.

In addition to the applicant wishing to obtain approval for a departure from the flood related aspects of the Floodplain and River Corridor Management Policy, the developers are in essence also requesting a departure from the need to provide a buffer along the river section (which is proposed to be infilled to create a stormwater swale). A departure from the ecological principles and guidance provided in the latter policy needs to be taken in the context of the wider system and catchment. It needs to be acknowledged that the area that will be infilled represents part of the last remains of the historic Liesbeek River channel which has ecological and eco-historical importance.

There a few opportunities to undertake rehabilitation of degraded rivers in the Cape Town and developers generally seldom actively pursue such positive initiatives. Endorsing the River Club proposals that would essentially result in further degradation of this historic channel should not be supported

In its current form, the historic river channel should be buffered by at least 40m (in terms of the City's 2002 buffer line spatial informants recommended by Southern Waters). A more recent study undertaken for the entire TRUP site (Blue Science freshwater assessment dated 2016) provides a more accurate assessment of the present status and ecological importance and sensitivity of the watercourses in the TRUP area (which included the watercourses and wetlands of the River Club site). This report recommends at least a 35m buffer along/around these systems (page 62: A buffer area of approximately 35m should be maintained adjacent to the delineated edge of the aquatic features"). The report made use of the 2015 WRC buffer tool which is regarded to be an acceptable industry standard and thus the 35m buffer which is of similar order of magnitude to the City's earlier 2002 data would be supported by the City's Catchment, Stormwater and River Management Branch.

The branch would not oppose the manipulation of the 1:50 year floodline when other mitigation measures such as raised floor levels and escape routes are taken and when a spatial development framework is also presented for approval. This would enable a more specific discussion of the location and extent of deviations requested. There are places where the models show a small increase in possible flood levels. The applicant should get the

approval of the affected property owners and/or indemnify the City against claims in this regard. The flooding report should discuss errors and assumptions made and their effect on results in more detail. Practical interventions to prevent flooding of the astronomical observatory and of Liesbeek parkway must be undertaken.
The location of the site is such that on-site generated post development stormwater detention will most likely be counterproductive and this branch supports doing away with the "Control quantity and rate of runoff" requirements of the Management of Urban Stormwater Impacts Policy. The water quality improvement aspects of the policy must still be met.

It has been already pointed out in the City's comments on the draft BAR for this development that the River Club site and nearby sites such as the Raapenburg wetlands, the Observatory, the river corridors themselves etc represent an integrated complex of open space areas with high green infrastructure value. Not only does the area offer value in terms of social/recreational benefits and ecological / biodiversity features, but also represents green infrastructure important for flood, water quality and water provision management. The site should not be viewed alone but within the context of the greater Salt Catchment (213 km^2) which, apart from the upper reaches of the Elsieskraal, the extreme upper reaches of the Liesbeek River and the broader TRUP area (and River Club), has already been intensively developed and hardened. These last open space remnants therefore have even greater value. Indeed, Section D of the draft Basic Assessment Report (Need and Desirability) notes that in terms of the City's EMF, the site is listed as a "structuring open space which forms part of the coast to coast greenway". In the Table Bay Spatial Development Plan the site is classified as Open Space and Buffer 1 and thus the proposed development represents a major departure from this. The proposed development will require that the area which is currently zoned "Special Open Space" be rezoned, and thus development of the River Club site will irrevocably change and reduce the green infrastructure and open space value of the area as a whole.

The proposed infilling and conversion of the river channel to a stormwater swale will alter the green infrastructure engineering and ecological value of this site. The Environmental Management Department of the City will also point out that the biota in this system (Western Leopard Toad - confirmed breeding site), fish (indigenous Galaxias zebratus likely to thrive in this system), frogs and avifauna will be displaced due to the complete loss of habitat in this section.

It seems to be very risky for the City to grant blanket deviations from policy without knowing exactly what development is proposed where and the CSRM branch would be more comfortable discussing relaxation of policy requirements in terms of development plans.

Yours Sincerely

PP

Ben de Wet

Head: Catchment, Stormwater & River Management

Appendix G2:
Biodiversity Impact Assessment

MAIN ENVIRONMENTAL CONSULTANT
SRK Consulting

CLIENT:
Liesbeek Leisure Properties Trust

Proposed redevelopment of the River Club, Observatory:

Assessment of potential biodiversity impacts - Incorporating the findings of the aquatic ecosystems (rivers and wetlands), botanical, faunal, avifaunal and groundwater specialists

December 2019

Prepared by
Liz Day (PhD; Pr Nat Sci)
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EXECUTIVE SUMMARY

E1 Introduction

This report summarises the findings of the specialist biodiversity assessment of the environmental impacts likely to be associated with the proposed re-development of the River Club, Observatory, by Liesbeek Leisure Properties Trust. The report has been compiled by Freshwater Consulting cc, and integrates the findings of a number of specialists, who provided input into the baseline studies and (where relevant) into the Environmental Impact Assessment component of the study as well. The full specialist reports are provided in appendices to this report, noting that the specialist aquatic ecology report is provided as the main body of the report, into which additional biodiversity components relating to fauna, flora and geohydrology has been inserted. The following specialists provided input into this document:

- Dr Liz Day (freshwater ecologist – rivers and wetlands (Freshwater Consulting cc);
- Mr Marius Burger (faunal specialist);
- Mr Barrie Low (botanical specialist - COASTEC);
- Dr Tony Williams (avifaunal specialist);
- Mr Leon Groenewald (groundwater specialist - SRK).

E2 Important assumptions

The findings of this study are based on a number of important aassumptions that, if unfounded, would require substantial components of these findings to be reconsidered. Key assumptions include:

- The City of Cape Town would be amenable to the changes proposed to the function and management of the natural channel of the Liesbeek River on City land, as part of Alternative 2. The natural channel abuts the River Club site boundary but does not in fact lie within the site;
- The findings of the hydrological study, particularly with regard to the impact of the proposed infill on flooding of the adjacent Raapenberg wetlands, are accurate;
- The development of either alternative, if approved, would be in accordance with the full detailed description of the development as outlined in this report, unless altered by explicit biodiversity mitigation. No items would be excluded from the development, without confirmation from the biodioversity team that they were immaterial to the development outcomes / impacts;
- The additional recommendations included in the report, and intended to improve certainty that the proposed development would be able to achieve its untended ecological benefits, would also be conditions of Authorisation.

E3 Affected natural systems

E3.1 Overview

The River Club site lies in the Salt River catchment (quaternary catchment G22C). The site is highly disturbed, and the botanical specialist noted that it includes no indigenous terrestrial vegetation. It is edged along its eastern and south eastern boundary by the **Liesbeek Canal**, which lies between the River Club and South African Astronomical Observatory (SAAO) sites, and separates the site along its south eastern boundary from the **Raapenberg Wetlands** – an important wetland conservation area. The site is bounded to the south by a relatively small parcel of land that is intended in the future to accommodate administrative buildings for the Square Kilometre Array (SKA) programme; to the west by an earth-lined channel referred to in this report as the **natural channel of the Liesbeek River**, which lies on land owned by the City of Cape Town, between Liesbeek Parkway and the River Club boundary, and to the north by the road reserve for the planned Berkley Road extension, which lies between the River Club boundary and an area of open space extending as far as the lower reaches of the natural Liesbeek River channel. The **Black River** forms the southern boundary of the site, between the confluence of the Liesbeek Canal and the natural channel of the Liesbeek River (Figure E1).

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Figure E1

Location of The River Club, Observatory. Site

E3.2 Aquatic ecosystems on and near the site

Condition

All of the rivers and their associated riparian wetlands that pass along the site boundaries were assessed as highly transformed from their natural condition, and associated with the following Present Ecological State (PES) (or condition) ratings:

- **The Black River**: PES Category F, indicative of a system that has undergone Extreme changes from its natural condition, being affected by (amongst others) channelization, long-term inflows of treated and (at times untreated) sewage effluent, major changes in flow regime from a seasonal to a perennial system, nutrient enrichment, largescale loss of indigenous vegetation and invasion by alien aquatic plants;
- **The Liesbeek River**:
  - The western channel (**natural Liesbeek channel**): PES Category E, indicative of a system that has undergone a Serious change from its natural conditions, with changes in natural river morphology being major contributors to this poor condition rating, along with water quality impacts from urban and suburban landuse, changes in natural flow regime (upstream river flows have been largely diverted away), extensive loss of indigenous vegetation and invasion of the river channel by alien plants. The channel and its vegetated margins are however used by several species of waterfowl, while Giant Kingfishers nest in sections where the bank is vertical. Endemic Cape Galaxias fish occur in the river upstream and may possibly also occur in these reaches;
  - The eastern (concrete lined) current channel of the Liesbeek River (**Liesbeek canal**): PES Category F, indicative of a canalised system that has lost almost all natural stream function;

- **The Raapenberg wetlands:**
  - These include seasonal clay flats renosterveld wetland, with nine endemic or near-endemic wetland plant species being associated with them within the adjacent SAAO site alone.
  - Water quality assessments and mapping of wetland vegetation indicated that these wetlands are at times highly saline and comprise a mosaic of wetland plant communities, the distribution of which is driven by subtle changes in water depth as well as by salinity.
  - The Raapenberg wetlands have also been rated as of importance from an avifaunal perspective, supporting mainly waterfowl and have been identified as providing breeding habitat to endangered Western Leopard Toads;
  - PES: Category C;
- **Artificial golf course ponds**

A number of seasonally to perennially inundated ponds have been created on the golf course. These artificial water features may provide suitable breeding sites for western Leopard Toads and other amphibians, but are easily replaceable habitats, and of low current habitat quality.

Sensitivity

The key biodiversity sensitivities of the River Club and its immediate natural surroundings can be summarised as:

- The Raapenberg wetlands – these wetlands include important remnant seasonal clay flats renosterveld wetland, of high conservation importance, which would be particularly vulnerable to impacts such as increased hydroperiod / prolonged or more frequent wetting;
- The SAAO site includes important Threatened terrestrial renosterveld vegetation (Peninsula Shale Renosterveld) including several endemic and/or red data species;
- The wetlands also support numerous birds as well as amphibians such as endangered western leopard toads – maintenance of habitat quality for indigenous fauna requires maintenance of seasonal flow regimes and inundation patterns, which in turn affect salinity and other water quality issues. The wetlands are thus highly sensitive to:
  - Increased flood velocity, frequency, duration, or magnitude (depth);
  - Channelisation / drainage of water from the wetlands;
  - Diversion of (particularly fresh) water into the wetlands;
  - Removal of existing berms / other structures that have "accidentally" protected the wetlands from hydrological and/or water quality impacts associated with the changed hydrology, hydraulics, position and water quality of the Black River
- The Liesbeek Canal is not sensitive as a riverine habitat in its current form;
- The natural channel of the Liesbeek River is disconnected from the Liesbeek River and now functions as a backwater wetland – it does however provide habitat to important bird species and may provide breeding areas to western leopard toads;
- Connectivity across the site, especially from the Raapenberg wetlands across to the natural channel and east-west across the site is important for wetland fauna – in particular western leopard toads;
- Provision of adequate safe, vegetated terrestrial habitat for western leopard toads during their non-breeding season is critically important for the sustainability of this species on and near the site.

E3.3 Integrated botanical and faunal (including avifauna) specialist findings

The terrestrial areas of the site were described as highly disturbed by all specialists, and rated as of no importance from a botanical or avifaunal perspective, although the botanical study indicated that there was a possibility that they could contribute to renosterveld conservation if they were

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rehabilitated by bringing fill of a shale nature onto the site, with local quarry areas beig suggested as possible suitable donor areas.

With regard to non-avian fauna, the faunal study found:

- 29 indigenous mammal species might occur on the site – their conservation status ranks are all listed as being of Least Concern (LC), with only one species (African Clawless Otter) with a global (IUCN) and regional listing of Near Threatened (NT);
- A total of 32 indigenous reptile species may occur on the River Club grounds – again, the conservation status of these reptiles are almost all listed as being of LC, except for the Cape Dwarf Chameleon which currently is listed as Vulnerable (VU). The latter has been recorded on the grounds of the adjacent South African Astronomical Observatory, and might possibly also occur within the River Club grounds;
- A total of eight indigenous amphibian species may potentially occur on the River Club grounds and immediate surroundings. The conservation status of these amphibians are almost all listed as being of LC, with the notable exception of the Western Leopard Toad (WLT) which is Endangered (EN). The faunal specialist noted that although the presence of an endangered species on the site does not trigger a fatal flaw response in respect of the development intentions, the prevalence of WLTs in this area does call for special considerations to adequately accommodate this species here. **The WLT represents the most significant faunal concern in respect of the proposed River Club development intentions. Of relevance to this study is the following:**
    - The only known WLT breeding sites in the region of the River Club are the wetlands of the Raapenberg Bird Sanctuary / Raapenberg Wetlands and about 1.5 km south-east in the Oude Molen area;
    - The WLT population of this specific area appears to be somewhat disjunct and seemingly completely separated from breeding populations further south on the Cape Peninsula;
    - The following four components are critical for the viability of any WLT population:
        i. Availability of suitable **breeding habitat**: In this case, the conservation and management of the Raapenberg Wetlands are of outmost importance;
        ii. Availability of habitat to provide **shelter and food (forage)**: Enough natural or semi-natural habitat must be available within at least a 2 km radius of breeding habitats to sustain WLT individuals for the non-breeding period (i.e. about 10 months of the year). Such sectors must provide the adequate shelter and foraging requirements to sustain the WLTs until the next breeding season. Thus substantial green belts must remain undeveloped, especially in the areas near to the Raapenberg Wetlands and along the rivers and also within an dispersal corridors;
        iii. Availability of **dispersal corridors**: Multiple dispersal options between breeding habitat and year-round occupancy habitat must be maintained, i.e. barriers must be limited. Connectivity must be maintained between the Raapenberg Wetlands and the river regions to the west, including the area of the former Liesbeek flow, which must either be rehabilitated as an accessible high quality wetland habitat or converted into high quality terrestrial habitat with some pools/ponds that would retain water into the summer and could be used as WLT breeding grounds. One broad (>65 m wide) east/west belt must be established in the northern reaches of the property, and additional minor (>10m wide) east/west corridors must also be created along the northern and southern site boundaries.
        iv. Limiting the extent of **hazardous features** and **high-risk areas**: Toad exclusion barriers must be erected to prevent/limit toad access to high-risk zones such as roads, large unvegetated areas and various pitfall structures.

- Mitigation measures implemented for WLTs will by default also serve to mitigate for the other faunal assemblages that are not of significant conservation concern.

E4 The proposed development

Two development alternatives plus the no-development alternative were assessed. The full details of these developments should be accessed in the main biodiversity report, but they both allow for infilling of the existing 1:100 year Liesbeek and Black River floodlines, to create a building platform. The development alternatives comprise:

- Alternative 1 (preferred alternative): This entails rehabilitation of the canal into a more natural, un-lined channel, and the infilling of the natural channel to create a landscaped open space and stormwater swale system;
- Alternative 2: This allows for retention of the canal, with minor landscaping and softening of its edges, and the protection and rehabilitation of the natural channel into an (albeit disconnected and rendered unnatural but still functional) wetland.

The key features of both alternatives that are of importance from a biodiversity perspective (and which were designed largely in discussion with the biodiversity team) comprise inclusion of:

- Ecological corridors, including:
    - A wide (ranging from 65 m at its narrowest to 100m wide at its widest point east-west ecological corridor, connecting the Liesbeek Canal / rehabilitated riverine corridor (to the east) and the natural Liesbeek channel / stormwater swale (to the west). This corridor has been designed in terms of both development alternatives for faunal movement through the site – in particular, movement and the provision of high quality terrestrial habitat during non-breeding periods for the western leopard toad. The open space of the ecological corridor would also allow for flood attenuation during periods of high rainfall, as well as perform the function of a landscaped public space on the site
    - A minimum 10m wide corridor along the southern (SKA) boundary of the site;
    - With the exception of one building on the western corner of the development, a minimum 10m wide corridor between the toe of Berkley Road extension and the building edge – access to the site would be from this new road;
    - Provision for at least two culverts under Berkley Road extension to allow for faunal passage into the presently undeveloped open space to the north, between the natural Liesbeek channel and Berkley Road;
    - A corridor along the western edge of the site – this area, which presently includes the natural Liesbeek channel, is however treated differently in the two alternatives;
- Various roads and bridges – these were designed to minimise ecological fragmentation, and all roads abutting ecological corridors / rehabilitated areas were designed actively to prevent accessibility by WLTs;
- The development platform – this was designed also to minimise accessibility by small fauna and WLTs in particular;
- A stormwater system, that allows for the creation of WLT breeding ponds;
- Infrastructure such as sewers and water lines.

E5 Key hydrological and geohydrological findings

Crucial findings of other specialist studies that informed the present assessment included:

- The fact that, despite their close proximity to the Liesbeek canal and the Black River, the geohydrological study found that the Raapenberg Wetlands are mainly groundwater-fed, with flow from the two rivers towards the wetlands being minor (and likely to be confined to flood events). The study also noted that the Raapenberg wetlands lie up-gradient of the River Club,

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and are separated from these wetlands by the Liesbeek Canal, which acts as an hydraulic "buffer" between the River Club and the Raapenberg wetlands. There thus appears to be no connection between shallow groundwater on the River Club site and that on the Raapenberg wetland site appears to exist today, although the systems would have been connected under natural circumstances;

- The specialist hydrological study (Aurecon 2017) findings that:
  - Alternative 1: For the 0.5-year and 1-year recurrence interval storm events, only slight increases (1 to 2cm) if any, and in some cases decreases (1 to 2 cm) in water level in the Black and Liesbeek Rivers would occur, with decreases in flood level as a result of increased capacity in the rehabilitated Liesbeek canal. These findings are important, because (at least prior to the ill-considered opening up of a connecting channel into the wetland from the Liesbeek Canal, the wetland is assumed to be hydrologically connected to the Liesbeek Canal at a surface elevation of 2.5m amsl, equating to a recurrence interval of between 0.5 and 1 year. The infilling of the River Club site would thus exert a negligible effect on the hydrological regime of the Raapenberg wetlands, and is not considered a threat in this regard. This compares with the 125mm lowering of the level of inflows and outflows into the wetland as a result of the linking channel, which is likely to exert a significant negative effect on wetland function;
  - Alternative 2: Flood changes would also be negligible, although the decrease in flood level resulting from changes in canal capacity would not apply.

E6 Impact assessment findings

Important Note:

During the course of FCG's involvement in this project, the proposed development footprint and the layouts of both development alternatives underwent a number of changes, largely as a result of extensive, iterative feedback into the project, by biodiversity specialists and other members of the design team. This process resulted in issues such as the avoidance of (ecologically) sensitive areas, the incorporation of ecological setback areas and faunal movement corridors in accordance with biodiversity specialist requirements and the strategic selection of opportunities that would enhance ecosystem function, quality or sustainability, while affording various development opportunities. To some extent, then, the development alternatives considered in this study already include a substantial level of mitigation, and the significance of the impacts considered in this section tend to be positive, or low to medium even without mitigation, despite the scale of development proposed.

Table E1 summarises the assessment of biodiversity impacts associated with the proposed development.

Positive impacts would be associated with improved connectivity between the Raapenberg Wetlands and the site (e.g. as a result of canal rehabilitation) as well as the active establishment of large areas of indigenously vegetated open space corridors and riverine buffer areas.

The only impacts that were considered High (negative) were those associated with potential fatalities to WLTs. Prior to additional mitigation, both Alternatives carried risk in this regard – in the case of Alternative 1 this revolved around increased access by toads to Liesbeek Parkway, while Alternative 2 does not include barriers to toad movements onto the development platform from ecological corridors and open space areas. These potential impacts are however readily mitigable to Low, through design interventions.

Table E1
Significance of impacts to natural ecosystems and biodiveristy as a result of the proposed development.
See main body of report for detailed impact descriptions

Nature of impact	Consequence	Probability	Signif.	Confid.
IMPACTS FROM DESIGN AND LAYOUT				
1. Changes in the habitat quality and ecological functioning of the Liesbeek Canal				
ALT 1 Without Mitigation	High	Probable	High (Pos.)	Medium
ALT 2 Without Mitigation	Low	Possible	Very Low (Pos.)	High
2. Loss of extent of terrestrial habitat for indigenous fauna				
Both alternatives Without Mitigation	Low	Definite	Low (Neg.)	Medium
With mitigation	None recommended			
3. Loss / degradation of indigenous floral communities / important floral populations				
Both alternatives Without Mitigation	Negligible impact			
Both alternatives With Mitigation	Medium	Possible	Medium (Pos.)	Medium
4. Changes in faunal connectivity				
ALT 1 Without Mitigation	Medium	Possible	Low (Neg.)	Medium
ALT 2 Without Mitigation	Medium	Probable	High (Neg.)	Medium
ALT 1 With Mitigation	Medium	Possible	Low (Pos.)	High
ALT 2 With Mitigation	Medium	Possible	Low (Neg.)	Medium
5. Increased western leopard toad mortalities				
ALT 1 Without Mitigation	High	Probable	**High (Neg.)**	Medium
ALT 2 Without Mitigation	High	Probable	**High (Neg.)**	Medium
ALT 1 With Mitigation	Medium	Possible	Low (Neg.)	Medium
ALT 2 With Mitigation	Medium	Possible	Low (Neg.)	Medium
6. Changes in flow regime into the Raapenberg wetlands				
ALT 1 and 2	Very Low to Low	Improbable	Insignificant to very low	Medium

Nature of impact	Consequence	Probability	Signif.	Confid.
Without Mitigation			(Neg.)	
7. Loss and degradation of riverine wetlands along the Black River margins				
ALT 1 and 2 Without Mitigation	Medium	Definite	Medium (Neg.)	Medium
ALT 1 and 2 With mitigation	Very Low	Probable	Very Low (Neg.)	Medium
8. Loss and/or changes in wetland habitat quality and availability in the areas of the natural Liesbeek River channel				
ALT 1 Without Mitigation	Medium	Definite	Medium (Neg.)	High
ALT 2 Without Mitigation	Low	Probable	Low (Pos.)	High
ALT 1 With Mitigation	Low	Probable	Low (Neg.)	Medium
ALT 2 With Mitigation	Low	Probable	Low (Pos.)	Medium
CONSTRUCTION PHASE				
9. Faunal fatalities (particularly western leopard toads) as a result of construction activities				
ALT 1 Without Mitigation	Medium	Probable	Medium (Neg.)	Medium
ALT 2 Without Mitigation	Medium	Probable	Medium (Neg.)	Medium
ALT 1 With Mitigation	Low	Probable	Low (Neg.)	Medium
ALT 2 With Mitigation	Low	Probable	Low (Neg.)	Medium
10. Water quality and habitat deterioration as a result of diversion of river (Black River and Liesbeek Canal) and wetland (natural Liesbeek channel) flows during construction				
ALT 1 Without Mitigation	Very low	Probable	Very low (Neg.)	Medium
ALT 2 Without Mitigation	Very low	Probable	Very low (Neg.)	Medium
ALT 1 With Mitigation	Very low	Probable	Very low (Neg.)	High
ALT 2 With Mitigation	Very low	Probable	Very low (Neg.)	High
11. Degradation of downstream habitat in the Liesbeek Canal, lower natural Liesbeek channel and Black River resulting from activities other than flow diversion				
Both Alternatives Without Mitigation	Medium	Probable	Medium (Neg.)	Medium

Nature of impact	Consequence	Probability	Signif.	Confid.
Both Alternatives With Mitigation	Very Low	Probable	Very Low (Neg.)	Medium
12. Disturbance of watercourse bed and banks during infrastructure installation				
Both Alternatives Without Mitigation	Low	Probable	Very Low (Neg.)	Medium
Both Alternatives With Mitigation	Very Low	Probable	Very Low (Neg.)	Medium
OPERATIONAL PHASE				
13. Degradation of habitat quality or failure to realise opportunities for improved habitat quality and biodiversity conservation / improvement as a result of inadequate or ill-advised channel and open space maintenance activities				
Both Alternatives Without Mitigation	Medium	Probable	Medium (Neg.)	Medium
Both Alternatives With Mitigation	Low to Very Low	Possible	Insignificant to Very low (Neg.)	Medium
14. Contribution to deterioration of water quality in the Liesbeek and Black Rivers				
Both Alternatives Without Mitigation	Medium	Probable	Medium (Neg.)	Medium
Both Alternatives With Mitigation	Low	Probable	Low (Neg.)	Medium

Table E2 summarises changes in the ecological condition of the aquatic ecosystems on and abutting the site, these being the only natural habitats identified of any ecological significance. The table assumes full implementation of the stated designs and their required mitigation measures, as well as implementation of additional requirements listed in the report that are intended to improve confidence that the development alternatives would inpractice achieve their anticipated outcomes.

Table E2

Summary of anticipated changes in aquatic ecosystem condition assuming full implementation of mitigation measures

System	Condition		
	Alternative 1	**Alternative 2**	**Current state / No development alternative**
Liesbeek River Canal	C	F	F
Natural channel of the Liesbeek River	Non-existent	D	E
Raapenberg wetland	C	C	C

E5 Cumaltive development impacts

The following impacts were identified as of concern:

- Increasing development in the broader TRUP area resulting in loss of open space areas, and thus affecting mainky non-breeding habitat availability for WLTs;
- Increased traffic in the vicinity of the site, resulting in increased WLT mortalities (e.g. at the Observatory Road crossing to Liesbeek Lake from the site).

E7 Impacts associated with the no-development alternative

If neither development alternative was approved and the *status quo* remained:

- The Liesbeek Canal would remain *in situ* – but would be likely to require repair in the near future;
- The (natural) Liesbeek channel would remain *in situ*, and would continue to convey stormwater into the Black River. Ongoing removal of alien vegetation (e.g. water hyacinth) would be required, but the channel might provide breeding habitat to western leopard toads;
- The terrestrial open spaces of the River Club would remain undeveloped and potentially available as non-breeding habitat for western leopard toads – however, ongoing activities associated with the driving range would continue to hamper the ecological wellbeing of this species as would physical barriers to migration such as the Liesbeek Canal.
- The main negative impact associated with the no-development alternative would be the lost opportunity to rehabilitate the Liesbeek Canal. Without development funding, it is extremely unlikely that this bold approach would ever be affordable.

E8 Summary and Conclusions

E8.1 Discussion of alternatives

In the case of the River Club, both terrestrial and natural ecosystems are considered degraded, having suffered a long history of manipulation, including (in the case of aquatic ecosystems) variously, diversion, channelization, fragmentation and canalisation. Terrestrial ecosystems have been assessed by the faunal, avifaunal and botanical specialists as highly altered and affording very low levels of habitat quality. No indigenous flora of any concern was found on the site, although important renosterveld communities including red data species did occur on the adjacent SAAO site and Raapenberg wetlands. These communities were not however considered likely to be affected by development of the River Club site.

Despite the level of infilling that would be associated with development of the site, the adjacent Raapenberg wetlands were shown by the hydrological assessment of Aurecon (2017a) to be unlikely to be impacted by changes in flood height, frequency or duration.

Of the two development alternatives assessed in this study, both would be acceptable from an ecological perspective, and preferable to the no-development alternative, since they both address the key concerns potentially associated with development of the River Club site, namely:

- The potential risks of development to the resilience of important indigenous fauna – in this case, populations of endangered western leopard toads occurring on and adjacent to the site, and requiring safe migration routes through the site as well as access to both breeding and non-breeding habitats;
- The likelihood of impacting negatively on adjacent watercourses and/or wetlands;
- The need to improve ecosystem resilience through rehabilitation and /or remediation activities aimed at improving terrestrial and aquatic (river and wetland) habitat quality.

Both development alternatives have furthermore addressed, through a long period of iterative design by the project team as a whole, issues such as ecological connectivity through the site, and both provide terrestrial habitat for western leopard toads, while including structural devices (toad barriers, culverts, landscaped refugia and connecting corridors) to reduce mortalities for this flagship species as well as other fauna on the site, which would be expected in theory to be positively affected by the proposed landscape rehabilitation and remediation activities.

Of the two alternatives, from an ecological perspective, there would however be a very clear preference for selection of **Alternative 1.** This alternative hinges on the rehabilitation of the currently canalised reaches of the lower Liesbeek River, and the planned creation of an unlined vegetated channel, that has sufficient space to function as a natural river within a broad connecting riverine corridor, to establish adequate longitudinal and lateral linkages into natural areas of the site and the adjacent Raapenberg wetlands, and which would significantly improve faunal connectivity and toad migration routes across the site. Implementation of this alternative would, from a biodiversity and general aquatic ecosystems perspective, be a positive impact, and its implementation is recommended.

This positive outcome has not however been rated as of high significance – this reflects the acknowledged risks of implementation, as well as the impacts to any sensitive natural ecosystems that would be associated with a development of the scale of the proposed River Club development. Against rehabilitation of the canal is also set the infilling and landscaping of the remnant (but historically fragmented and highly altered / diverted) "natural" channel of the Liesbeek River. This loss is considered ecologically acceptable in the context of substantial river rehabilitation, and the proposed development of vegetated swales in landscaped terrestrial areas suitable for colonisation by western leopard toads in their non-breeding season is considered an acceptable use of this space without significant negative biodiversity or other ecological costs.

Alternative 2 would nevertheless provide adequate mitigation against development-associated threats, and would improve the existing (degraded and fragmented) aquatic habitat on the site. Selection of this alternative would however, in this author's opinion, result in a significant biodiversity opportunity cost that could not be realised in the future once development had occurred. A similar opportunity cost applies to the No Development alternative - without significant development funding, it is extremely unlikely that rehabilitation of the canal would ever be feasible.

E8.2 Approach to increasing certainty of anticipated outcomes

One of the problems in compiling this assessment was, ironically, the degree to which the development layouts had already considered ecological impacts, and addressed and incorporated these in layout and design. While the resultant layouts are thus largely acceptable in their current form, two problems are presented with this approach:

1. Without medium or high negative significance being attached to particular layouts, it is difficult to motivate for the essential inclusion of additional subtle mitigation measures that would improve the final outcomes – this weakens the mitigation requirements;
2. If a layout is approved, there is a risk that some of the essential original mitigation thinking and approaches could be "lost", as it is not explicitly listed as mitigation.

In this report, these two issues have been addressed by:

- Including requirements for additional control measures (provided in the main body of the report) and aimed at improving uncertainty over the projected outcomes measures to be included in a potential development authorisation;
- Including requirements for the development descriptions included in this report to be considered part of the approved design; and

Including requirements for the authorised (if any) layout to be worked up as a detailed, annotated plan with written dimensions and ecological specifications, to be used as an auditable document going forward.

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12 November 2017

DECLARATION OF INDEPENDENCE AND EXPERTISE IN THE FIELD OF STUDY

I, Elizabeth (Liz) Day as a partner of Freshwater Consulting cc (t/a The Freshwater Consulting Group / FCG), hereby confirm my independence as a specialist and declare that I do not have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which SRK was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for work performed, specifically in connection with the Environmental Impact Assessment for the proposed development of the River Club site, Observatory, Cape Town.

Full Name: ~~Elizabeth~~ Day
Freshwater Consulting cc
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Title / Position: Dr
Qualification(s): BA, BSc, BSc Hons, PhD
Experience: Over 22 years in freshwater ecosystems, specialising in urban wetlands and watercourses, particularly in the City of Cape Town.

Liz has worked on both the Liesbeek and Black Rivers, has carried out numerous environmental impact assessments of rivers and wetlands in the City, and has been involved in several river rehabilitation projects, including the design of the Sir Lowry's Pass channel re-alignment, rehabilitation of the Pagasvlei stream (Constantia) and rehabilitation of the Langvlei Canal (Retreat). Liz was also the project leader and lead author on the (2016) Water Research Commission's publication of The Technical Manual for the Rehabilitation of South African Rivers, including technical guidelines and case studies. Liz has experience in wetland delineation and assessment and in integrating biodiversity specialist reports and concerns.

Registration(s): Member of IAIA; Member of SAIEES; Registered Professional Natural Scientist by SACNASP (Reg No 400270/08) for fields of Biological Science, Ecological Science and Zoological Science

Freshwater Consulting cc trading as "The Freshwater Consulting Group" (FCG)
Members:E Day, JL Ewart-Smith, CD Snaddon, DJ Ollis
Reg. No. 2007/064216/23

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1 INTRODUCTION

1.1. Background

Redevelopment of the River Club, Observatory, is currently being considered by Liesbeek Leisure Properties Trust, referred to hereafter as "the developer". SRK Consulting (South Africa) (Pty) Ltd (SRK) has been appointed by the developer to undertake the Environmental Impact Assessment (EIA) and associated application processes required for consideration of authorisation of the proposed activities in terms of (inter alia) the National Environmental Management Act (NEMA) (Act 107 of 1998) and the National Water Act (NWA) (Act 36 of 1998).

Since the River Club site is bounded by both the Liesbeek and the Black Rivers, as well as several associated wetlands and/or watercourses, Freshwater Consulting cc (t/a/ The Freshwater Consulting Group / FCG) was appointed by SRK to provide input into the project planning and assessment phases of the proposed project from a freshwater ecosystems perspective.

In addition, FCG was appointed to integrate the findings of a number of other specialists, whose input was required to inform and supplement FCG's overall input, primarily from a biodiversity perspective. Additional specialists were:

- Mr Marius Burger (faunal specialist)
- Mr Barrie Low (botanical specialist - COASTEC)
- Dr Tony Williams (avifaunal specialist)
- Mr Leon Groenewald (groundwater specialist - SRK)
- [1]Dr Lloyd Fisher-Jeffes (hydrological specialist – Aurecon).

The original findings of the above specialists are presented in Appendices A – D, with the exception of input from the hydrological specialist, which was drawn from the hydrological report (Aurecon 2017a).

1.2. Overall terms of reference

1.2.1. Overall terms of reference for the inputs into this report

FCG's input into this project had the following overall terms of reference, namely to:

- Describe the existing baseline characteristics of the study area and place this in a regional context;
- Describe opportunities and constraints for the redevelopment of the site,
- Identify and assess potential impacts of the Project and the alternatives, including impacts associated with the construction and operation phases, using SRK's prescribed impact rating methodology;
- Indicate the acceptability of alternatives and recommend a preferred alternative (if applicable);
- Identify and describe potential cumulative impacts of the proposed development in relation to proposed and existing developments in the surrounding area;
- Recommend mitigation measures to avoid and/or minimise impacts and/or optimise benefits associated with the proposed project; and
- Recommend and draft a monitoring campaign, if applicable.

[1] Note that input from this specialist was drawn from the over-arching Aurecon specialist hydrological report, submitted to SRK, as well as from meetings and discussions with the specialist

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More specifically, FCG in conjunction with SRK refined these terms of reference as follows, requiring the specialist to:

- Undertake a desktop study and site survey in order to characterise and delineate wetlands, pans and aquatic ecosystems at and surrounding the Site and assess their function, present ecological state and recommended ecological category
- Place freshwater ecosystems in a regional context;
- Describe wetland dependent fauna and flora species present;
- Map wetlands in terms of their ecological sensitivity and functional value;
- Comment on sensitivity in terms of ecologically important habitats, ecological corridors and linkages with other ecological systems on and adjacent to the site;
- Include the findings of the botanical, faunal, avifaunal and groundwater specialists;
- Assess the significance of the potential direct and indirect impacts of the redevelopment on freshwater ecosystems;
- Identify and describe potential cumulative freshwater ecology impacts resulting from the redevelopment in relation to proposed and existing developments in the surrounding area;
- Recommend mitigation measures to minimise impacts and enhance benefits associated with the redevelopment;
- Address comments by stakeholders relating to freshwater ecology impacts; and
- Identify applicable legislation and/or license/permit applications that may be required in terms of aquatic ecosystems.

Following input from Stakeholders into the Scoping Phase of this project, FCG was also asked to provide input into the control of the invasive alien weed Purple loose-strife (*Lythrum salicaria*).

1.2.2. *Scope of additional studies*

Note that the detailed Terms of Reference and Approach to the various studies outlines below are presented in the studies themselves (see Appendices A – D).

- **Faunal study**
  - Conduct a faunal screening study of three vertebrate groups, i.e. mammals, reptiles and amphibians and comment on their conservation importance, habitat requirements, development sensitivity, and links with adjacent systems.
- **Botanical study**
  - Confirm that the River Club site has no indigenous botanical value;
  - Establish the location, extent and quality of the renosterveld/ sand fynbos on the adjacent (SAAO) site; prepare a list of species found on the site and establish which Red List species (*Moraea aristata* and others) occur here;
  - Provide an annotated map of this indigenous vegetation and its proximity to the River Club development, in particular those areas abutting the wetland environment;
  - Assess potential impacts, if any, on this vegetation based upon impacts articulated in the Biophysical Report. Impacts would include potential loss of species (notably *Moraea aristata*), indigenous vegetation and terrestrial (dryland) connectivity.
- **Geohydrological study**
  - Based on detailed survey information for the site and adjacent watercourses as well as publically available; desktop information, describe local groundwater hydrology at the site and in adjacent freshwater systems;
  - Comment on the degree to which the Raapenberg wetlands are fed by the water table versus floodflows; and

  - Comment on potential changes to the groundwater flow regime from developing the River Club (noting that the current elevation of the site will generally be the ground level of a basement of the new proposed development).
- **Hydrological assessment**
  - In addition to other aspects of the hydrological specialist study, Aurecon was requested to address some of the queries / concerns raised by the freshwater specialists (this author) in the project Scoping Study - specifically to model the effect of infilling of the River Club site on the frequency and depth of flooding on the adjacent Raapenberg wetlands.
    Note however that the available flow data for the Black River proved, in the end, too inaccurate for any value to be attached to such modelling, and an alternative approach was taken instead – see Section 2.5.
- **Avifaunal assessment**
  - Conduct a desktop assessment, accompanied by site ground-truthing, to provide specialist input into the sensitivity of the proposed development from a bird perspective, and consider opportunities and constraints associated with the site, in terms of bird habitat and conservation.

1.3. Site Location

The study area, shown in **Figure 1.1**, is located in Observatory, Cape Town, and is accessed off Observatory Road, over the Liesbeek River. It is edged along its eastern and south eastern boundary by the Liesbeek Canal, which lies between the River Club and South African Astronomical Observatory (SAAO) sites; to the south by a relatively small parcel of land that is intended in the future to accommodate administrative buildings for the Square Kilometre Array (SKA) programme; to the west by an earth-lined channel referred to in this report as the natural channel of the Liesbeek River, which lies on land owned by the City of Cape Town, between Liesbeek Parkway and the River Club boundary, and to the north by the road reserve for the planned Berkley Road extension, which lies between the River Club boundary and an area of open space extending as far as the lower reaches of the natural Liesbeek River channel, which themselves edge property owned by the Passenger Rail Association of South Africa (PRASA).

Figure 1.1
Location of The River Club, Observatory. Site boundary outlined in red.

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1.4. Report Informants

This report has been informed by the following inputs and/or activities:

- An initial site visit on 29 June 2015, accompanied by Dr Tony Williams (avifaunal specialist), during which time the overall site was assessed and its development opportunities and constraints were workshopped;
- Multiple subsequent site visits for watercourse assessment between June 2015 and November 2017;
- Assessment of the Raapenberg wetlands in September 2017, accompanied by the project hydrologist (Dr Lloyd Fisher-Jeffes, Aurecon and the survey team (Biff Lewis Geomatics) during which time:
    - Transects through wetland systems were surveyed, with wetland plant community types being linked to topography and / or depth of inundation;
    - Plant communities were identified and described;
    - Existing impacts to wetland function were noted and (where possible) mapped (e.g. trenches conveying flows from the Liesbeek River canal into the Raapenberg wetlands);
- Consideration of existing ecological information pertaining to the site, and internal FCG photographs and reports obtained during previous projects carried out in the broader area;
- Perusal of the City of Cape Town's wetland prioritisation data (Snaddon and Day 2009);
- Assessment of historical aerial imagery for the site;
- Assessment of bacteriological data obtained from the City of Cape Town for sites on the Black and Liesbeek Rivers up to January 2017;
- Overlay of the City of Cape Town's (2017) wetland delineation data onto GOOGLE imagery for the site and ground-truthing of these data;
- Consideration of the aquatic and botanical specialist findings of the Two Rivers Urban Park (TRUP) project with regard to this site;
- Discussions with local residents with particular interest in the site – Mrs Jean Ramsey in particular provided photographs and commentary on past flood events and the occurrence of western leopard toads on and in the vicinity of the site;
- Numerous iterative discussions with the project team as a whole, and with the biodiversity specialists regarding appropriate mechanisms / layout approaches to address concerns regarding the impacts of the proposed development on aquatic ecosystems and general floral biodiversity on and in the vicinity of the site;
- Incorporation of the relevant findings of the various biodiversity specialists (section 1.1) into a single assessment report;
- Compilation of the present report.

1.5. Limitations and assumptions

The findings of this study are based on a number of important aassumptions that, if unfounded, would require substantial components of these findings to be reconsidered. Key assumptions include:

- The City of Cape Town would be amenable to the changes proposed to the function and management of the natural channel of the Liesbeek River on City land, as part of Alternative 2. The natural channel abuts the River Club site boundary but does not in fact lie within the site;
- The findings of the hydrological study, particularly with regard to the impact of the proposed infill on flooding of the adjacent Raapenberg wetlands, are accurate;

- The development of either alternative, if approved, would be in accordance with the full detailed description of the development as outlined in this report, unless altered by explicit biodiversity mitigation. No items would be excluded from the development, without confirmation from the biodioversity team that they were immaterial to the development outcomes / impacts;
- The additional recommendations included in Section 6 of the report, and intended to improve certainty that the proposed development would be able to achieve its untended ecological benefits, would also be conditions of Authorisation.

1.6. Definitions

All reference to wetlands and water courses in this document are based on the following definitions of wetlands and water courses, as stipulated in the National Water Act (NWA) (Act 36 of 1998):

***"watercourse"** means -*
(a) a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the Gazette, declare to be watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;

***"wetland"** means -*
land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

1.7. Updates to the specialist reports

During the Public Participation Phase of the Basic Assessment process, concerns were raised that the Faunal Biodiversity Specialist Reports were outdated, having been compiled in 2017. Both the avifaunal specialist (Mr Tony Williams) and the herpetologist / other faunal specialist (Mr Marius Burger) have confirmed that their findings remain relevant.

Confirmation of this is supplied in **Appendix G**.

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2 ASSESSMENT METHODOLOGIES

2.1. Assessment of river and wetland condition

River and wetland condition were assessed using the desk-top Present Ecological State (PES) methodology, adapted from DWAF (1999). The methodology is based on the rated current attributes of the river or wetland, which are scored against those of a desired baseline or reference condition, resulting in the assignment of a wetland to one of six PES categories, as defined in DWAF (1999) and described in Table 2.1. The methodology is applicable to natural systems only.

Table 2.1
Interpretation of PES score, using the DWAF (1999) methodology.

PES Score	Wetland Description	PES Category	Comment
> 4	Unmodified or approximates natural condition	A	Acceptable Condition
> 3 <=4	Largely natural with few modifications, minor loss of habitat	B	
> 2 <=3	Moderately modified with some loss of habitat	C	
= 2	Largely modified with loss of habitat and wetland functions	D	
> 0 < 2	Seriously modified with extensive loss of habitat and wetland function.	E	Unacceptable Condition
0	Critically modified. Losses of habitat and function are almost total, and the wetland has been modified completely.	F	

2.2. Assessment of sensitivity and conservation importance of rivers and wetlands

A number of protocols exist for the assessment of river and wetland conservation importance and condition, with different protocols having been developed for particular wetland types and conditions, as well as to allow measurement of particular aspects of wetland function, structure or their value to the management of human socio-economic structures or activities. The assessment protocols selected have all been developed in South Africa and are currently being used in wetland assessment here. They aim to provide a measure of either or both the present condition, value and / or conservation-worthiness of the wetlands in question.

This report utilised the Ecological Importance and Sensitivity (EIS) methodology developed by DWAF (1999b and c) to derive EIS ratings for wetlands and rivers. DWAF (1999b) defines the ecological **importance** of a river or wetland as an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales, while ecological **sensitivity** (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity.

Importantly, it should be noted that EIS ratings are strongly biased towards the potential importance and sensitivity of particular system as would be expected under unimpaired conditions. This means that the present ecological state or condition (PES) is generally not considered in determining the ecological importance and sensitivity *per se* (DWAF 1999). The following components are considered in an EIS assessment, namely:

- The presence of rare and endangered species, unique species (i.e. endemic or isolated populations) and communities, intolerant species and species diversity should be taken into account for both the instream and riparian components of the river;
- Habitat diversity;
- Biodiversity in its general form;
- The importance of the particular wetland, river or stretch of river in providing connectivity between different sections of the river;
- The presence of conservation or relatively natural areas along the river section; and
- The sensitivity (or fragility) of the system and its resilience (i.e. the ability to recover following disturbance) to environmental changes.

The above biotic and abiotic determinants are scored using the table presented in **Appendix E**, and the median score is calculated to derive the ecological importance and sensitivity category. These categories are defined in **Table 2.2**.

Table 2.2
Ecological importance and sensitivity categories (Table after DWAF 1999)

Ecological Importance and Sensitivity Categories	General Description
Very high	Quaternaries/delineations that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These ecosystems (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.
High	Quaternaries/delineations that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use.
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use.
Low/marginal	Quaternaries/delineations that are not unique at any scale. These wetlands (in terms of biota and habitat) are generally not very sensitive to flow modifications.

2.3. Conservation importance

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In this study, the approach adopted by Ewart-Smith and Ractliffe (2002) was used. This approach uses a range of criteria to identify conservation importance categories for different wetlands. The criteria are indicated in **Table 2.3**.

Table 2.3
Criteria used to assign low, moderate or high conservation importance to wetlands identified in and associated with the current study area. The highest category applicable to any wetland, based on any one criteria, is the one accorded the wetland as a whole.
Table after Ewart-Smith and Ractliffe (2002).

Low conservation importance: • does not provide ecologically or functionally significant wetland habitat, because of extremely small size or degree of degradation, and/or • of extremely limited importance as a corridor between systems that are themselves of low conservation importance.
Moderate conservation importance: • provides ecologically significant wetland habitat (e.g. locally important wetland habitat types), and/or • fulfils some wetland functional roles within the catchment, and/or • acts as a corridor for fauna and/or flora between other wetlands or ecologically important habitat types, and/or • supports (or is likely to support) fauna or flora that are characteristic of the region and/or provides habitat to indigenous flora and fauna, and/or • is a degraded but threatened habitat type (e.g. seasonal wetlands), and/or • is degraded but has a high potential for rehabilitation, and/or • functions as a buffer area between terrestrial systems and more ecologically important wetland systems, and/or • is upstream of systems that are of high conservation importance.
High conservation importance: • supports a high diversity of indigenous wetland species, and/or • supports, or is likely to support, red data species; supports relatively undisturbed wetland communities, and/or • forms an integral part of the habitat mosaic within a landscape, and/or • is representative of a regionally threatened / restricted habitat type, and/or • has a high functional importance (e.g. nutrient filtration; flood attenuation) in the catchment, and/or • is of a significant size (and therefore provide significant wetland habitat, albeit degraded or of low diversity).

2.4. Wetland identification and delineation

DWAF (2005) notes that wetlands must have one or more of the following attributes to classify as such:

i. Saturated soils within the top 50cm of soil surface;
ii. Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;
iii. The presence, at least occasionally, of water loving plants (hydrophytes.

These criteria were used as the basis on which to identify wetland areas on the site, using a hand-held auger to allow soil hydromorphic features to be identified.

In practice, the extent of infill on the site meant that augering to identify soil hydromorphic features was rendered irrelevant in these areas.

2.5. Raapenberg wetland survey

The Raapenberg wetland was identified early on in this study as the most sensitive aquatic ecosystem in the vicinity of the proposed development, and potentially vulnerable to even slight changes in flood regime. Initially, the hydrological team was asked to use existing flow data to model such changes. However, the data were deemed too coarse and unreliable to provide answers at the high level of confidence required. Instead, the aquatic ecologist (this author), the hydrologist (Dr Lloyd Fisher-Jeffes) and a team of surveyors surveyed the height of a number of selected points along three cross-sections that were walked through the wetlands. Points were selected on the basis of vegetation type, with the purpose of correlating vegetation type / zoning with particular heights. The known habitat preferences in terms of inundation and drought periods was used to deduce the current hydrological regime. Plants that had known salinity preferences were also noted, and deductions about current wetland function were made on this basis. Water level in low points the wetland was also surveyed, as well as water level in the adjacent Black and Liesbeek Rivers, and water samples were collected from the Raapenberg Wetland and the Black River, and analysed for various parameters including electrical conductivity. The latter was measured *in situ* while other variables were measured at the UIS laboratory in Johannesburg.

The hydrological specialist used the annotated topographical data from the survey to make inferences as to the current and likely future recurrence interval and depth of flooding in the wetlands, and the movement of flow into and out of the wetlands (Aurecon 2017a).

The geohydrological specialist (Appendix C) also referred to these data in his assessment of the likely influence of groundwater on wetland function.

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3 NATURAL ECOSYSTEMS IN AND ASSOCIATED WITH THE STUDY AREA

This section describes aquatic and other habitats of biodiversity significance on and immediately adjacent to the River Club site itself. It includes excerpts and summaries from the other specialist reports listed in Section 1.1. The full specialist reports should however be referred to for more details, as well as for the assumptions and limitations of their assessments.

3.1. Aquatic ecosystems

3.1.1. Catchment context

The River Club site lies in the Salt River catchment, in the Department of Water and Sanitation's (DWS) Berg-Olifants Water Management Area (WMA), in quaternary catchment G22C.

The site is bounded by two of the major river systems in this catchment, namely the Liesbeek River and the Black River (Day and Clark 2012). Of these, the **Liesbeek River** comprises two channels – an unlined channel along the western and northern site boundaries, now disconnected from the main river channel upstream (referred to in this report as the natural channel of the Liesbeek River), and the mainly canalised portion of the current main stem of the river, that passes along the southern and south eastern site boundaries (referred to in this report as the Liesbeek Canal). The **Black River** forms the eastern site boundary (see **Figure 3.1**). Both "channels" of the Liesbeek River pass into the Black River along the River Club site boundary. The Black River passes under a railway bridge immediately downstream of the site, and is canalised shortly thereafter.

Figure 3.1
The River Club and its environs in the context of rivers and wetlands, as shown in the City of Cape Town's (2017) wetland layers (green polygons indicate wetlands)

Downstream of the confluence of the Liesbeek River, the system is referred to as the Salt River Canal, and passes into the Atlantic Ocean in Table Bay, some 2.2 km downstream of the Salt River bridge.

The [2]Raapenberg wetlands lie immediately south of the site, just upstream of the confluence of the Liesbeek canal with the Black River.

3.1.2. Context in the Western Cape Biodiversity Spatial Plan

Data from the Western Cape Biodiversity Spatial Plan (WCBSP) of Stanvliet et al (2017) shows the Liesbeek Canal, the Black River, the Raapenberg wetlands and a section of the natural channel of the Liesbeek River as Protected Areas (see **Figure 3.2**). They are not however rated as Critical Biodiversity Areas, Ecological Support Areas or "Other Ecological Support Areas".

Figure 3.2
River Club site in the context of the Western Cape Biodiversity Spatial Plan of Stanvliet et al (2017

3.1.3. Context in terms of the National Freshwater Ecosystems Priority Area (NFEPA) project

The Liesbeek River as a whole is classified as a Fish Support Area or Fish Corridor (FEPACODE 2) in the (2011) NFEPA database. Two threatened or near-threatened fish species are listed in this dataset, namely Cape Kurper (*Sandelia capensis*) and *Galaxias mollus* (*Galaxias sp.* 'zebratus cf. Mollus'). Of these, the former is listed as Data Defficient and the latter as Near Threatened (due to its limited distribution).

See Section 3.3.1 for a discussion of the likely presence of these species in the river reaches abutting the current study area.

[2] Note that the area referred to in this report as the Raapenberg wetlands includes the Raapennnbnmjberg Bird Sanctuary

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3.1.4. *Overview of historical changes in river function and alignment*

Historically, the Black River and its tributaries other than the Liesbeek River were probably seasonal, draining into the former mudflats and wetlands of the Black River estuary at Paarden Eiland (Day 1997) and linking to the estuarine wetlands and coastal marshes of the Diep and Salt Rivers. These are described in Brown and Magoba (2009), who also describe the natural course of the lower Liesbeek River as splitting into two "arms" or channels, one of which flowed directly into the Black River and the other into the Salt River Lagoon, some distance downstream. The Diep, Salt and Black Rivers appear to have flowed at least at times into this lagoon as well.

Extensive urbanization of the catchment, canalisation, wetland drainage and industrial development of Paarden Eiland have effectively led to the complete separation of the Diep River from the Salt River system and canalisation of the latter effectively constrains any natural tidal flushing of the river bed and severely alters the ecological functioning of the river;

The **Black River** itself has also undergone significant changes from its natural function and alignment. Brown and Magoba (2009) describe it as a seasonal system that rose in the sand dunes of the Cape Flats. It was associated with extensive wetlands in the area just east of the Observatory – remnants of these include the Raapenberg wetlands (see Section 3.1.8 (D)) as well as the Vincent Palotti and Valkenberg wetlands (Turpie 1994). However, construction of Settlers Way and its intersection with the Black River Parkway required the natural course of the river to be shifted some 100m west, and the wetlands on the eastern side to be infilled (Brown and Magoba 2009). Work by FCG along the Black River in the broad vicinity of the present study area has highlighted the presence of deep organic soils in some of the M5 road reserves and highway off-ramp clover-leaf areas. The presence of these organic soils, beneath layers of rubble and other fill, supports the idea that the river in these reaches once comprised broad wetland flats.

The Black River has also undergone substantial changes in flow regime, and it is now a perennial system, owing much of its volume to effluent from the Athlone and Borchard's Quarry Waste Water Treatment Works WWTWs) as well as stormwater inflows. In summer, virtually all of the flows in the river now comprise sewage effluent and stormwater runoff from the surrounding areas, including runoff from poorly serviced informal and backyard settlements north of the N2.

Not surprisingly, the high levels of nutrient enrichment in the Black River, coupled with permanent, slow flowing, deep water have resulted in a proliferation of various exotic aquatic plants in the river. These include parrot's feather (*Myriophyllum aquaticum*) and water hyacinth (*Eichhornia crassipes*), although patches of indigenous pondweed (*Potamogeton pectinatus*) also occur in places in the river channel. Annual mechanical removal of litter and aquatic plants by the City of Cape Town, mainly to reduce the risk of flooding in the wet season, perpetuates the steep river banks within these reaches (Day 2013). Large-scale efforts to remove water hyacinth using manual and mechanical labour have taken past over the past few years, and the lower reaches of the Black River have been relatively uninfested over the past two years.

The **Liesbeek River** is one of the major tributaries of the Black River. It rises as a number of seasonal to perennial mountain streams on the eastern slopes of Table Mountain, between Kirstenbosch Botanical Gardens and Rhodes Memorial. As the streams flatten out into their foothill reaches, they flow through progressively more urbanized areas. Most of the lower reaches of the river downstream of Kirstenbosch are channelized and/or canalised (i.e. a mixture of concrete and earth

canals), at least as far as the N2 crossing, just upstream of the present site. Between the N2 and the Observatory Road river crossing (just upstream of the River Club), the Liesbeek River flows within an unlined channel, but is diverted again into a concrete canal immediately downstream of Observatory Road, and flows along the River Club boundary.

Aurecon (2017a) provides a series of historical photographs detailing changes in river course in the lower Liesbeek River since the turn of the 20th Century, and make the point that the present river channel and canal have both undergone changes from their natural alignment / linkages. Drawing from information contained in Brown and Magoba (2017), the following changes are most pertinent to this study:

- Extensive canalisation of the Liesbeek River itself took place between 1942 and 1962, largely as a response to flooding of rapidly urbanising areas, which encroached into the river floodplains;
- The "Liesbeek Lake" area of the river (just upstream of Observatory Road and the current site – **Figure 3.1**) was created in 1943, as part of a (never-realised) scheme to construct a boating lake in the river channel, which saw the river diverted into a series of borrow pits along its margins, to widen it, and the infilling of riparian wetland areas with spoil;
- The channelized (but not canalised) western arm of the Liesbeek River is likely to follow at least in part the original course of the "arm" of the Liesbeek River that once flowed directly into the Salt River Lagoon – the channel has however now been diverted sharply into the Black River – this re-alignment occurred circa 1942;
- The above westerly channel (termed the "natural channel of the Liesbeek River" in this report) remains a feature between Liesbeek Parkway and the River Club, but is now physically cut off from the main river channel upstream by Observatory Road. Although a pipeline under Observatory Road is understood to provide a limited level of connection with water impounded in a weir upstream of the road, this pipeline appears by all accounts to have been blocked for several years, and it is assumed that most of the flows in the channel now comprise stormwater runoff and intercepted subsurface seepage, while the main river flows pass along the canalised eastern portion.

3.1.5. *Overview of water quality*

Poor water quality in the Black River is generally considered to be the most significant problem affecting the river in these reaches from an ecological perspective. A study by the City of Cape Town (Day and Clark 2012) showed that water quality in the Black River downstream of the N2 bridge was consistently in a Category F+ (or "Z" Category) – the most impacted category to which river water quality can be assigned in these river health assessments. High concentrations of orthophosphate and total ammonia, and low oxygen concentrations were found to be the main contributors to poor water quality. Blue Science (2016) corroborated these findings.

Water quality in the Liesbeek River, by contrast, tends to be considerably less impacted than in the Black River, receiving runoff from a catchment dominated by well-serviced residential and commercial areas, with no sewage works feeding into the system. The river is thus polluted to a much lesser extent, with the main contaminants being runoff from parking areas and nutrients seeped from gardens in residential areas. The river was rated in the above study as a Category D in

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its reaches just upstream of the Black River (as measured at the Observatory Road crossing at the River Club entrance), and thus acts to dilute poor water quality in the Black River, at least downstream of its confluence. Low concentrations of dissolved oxygen primarily drove the Category D rating with respect to water quality, although orthophosphate concentrations have also been elevated historically in these reaches (Day and Clark 2012).

Figure 3.3 shows the location of the City of Cape Town's water quality sampling sites in the Black and Liesbeek Rivers in the vicinity of the River Club.

Figure 3.3
Water quality sites (prefixed NR) on the Black and Liesbeek Rivers for which microbacteriological data were sourced from the City's Scientific Services Department, Athlone. Site boundary shown in red polygon. Note data not available for NR13.

Escherichia coli bacteriological data were sourced from the City of Cape Town by FCG for sites NR06 and NR07 (upstream of the Liesbeek River and downstream of the Elsieskraal Canal, the Vygekraal Canal and the Athlone WWTW inflows), NR08 on the Liesbeek Canal and NR09 on the Back River downstream of all of the above inflows. These data have been summarised in Figures 3.3 A-C and indicate that:

- Bacteriological (specifically *E. coli*) contamination of the Black River is generally far worse than in the Liesbeek River (site NR08) which had generally low levels, as shown by the low median and short range between minimum and maximum readings (Figure 3.4A);
- Up until late 2010, bacterial contamination in the Black River was characterised by multiple "spikes" showing high bacterial concentrations along the watercourse, with some reflecting contamination from large spills / loads moving from upstream, and others reflecting localised point source inflows – spikes at NR07 that do not echo upstream spikes are likely to reflect contaminated point source inflows – a stormwater pipeline opens into the river just upstream of this site, discharging stormwater from the Maitland area (Ms Candice Haskins, City of Cape town, pers. comm. to Liz Day);

- Since 2010, bacterial contamination has reduced substantially in the Black River, attributed both to the refurbishment of the Athlone WWTW and to the more recent and ongoing construction of formal, well-serviced housing, without backyard dwellers, in the catchment in the Langa area;
- Periodic spikes in contamination did however continue in the vicinity of reaches represented by NR07, and appear to indicate recurrent sewage overflows / leaks in the Maitland catchment;
- NR09 downstream of the Liesbeek River confluence also showed periodic spikes – again assumed to reflect point-source inputs in the river reaches upstream of the monitoring point, and most likely sewer overflows or pump station failures. It is however assumed that inflows of cleaner water from the Liesbeek River to some extent diluted such bacterial contamination;
- Despite improved water quality post 2010, *Escherichia coli* data remained at high levels in the Black River – and several orders of magnitude above the threshold maximum concentration of 4 000 counts per 100ml considered "Unacceptable" for intermediate contact recreation purposes, as cited by Day and Clark (2012);
- Even in the Liesbeek River, although bacterial contamination was well below that in the Black River, bacterial levels in the dataset shown in Figure 3.4C were frequently higher than the maximum thresholds for intermediate recreation. Elevated bacterial counts occurred mainly during the winter months, and are assumed to reflect both periodic sewage leaks or overflows as well as surface wash-off of terrestrial areas contaminated with dog and/or human faeces and relatively large numbers of homeless people inhabiting and using the river corridor upstream of the site;
- With the exception of the isolated pointy-source "peaks" described above, some improvement in bacterial contamination generally occurred in any one monitoring period with distance downstream of the Raapenberg Bridge, as far as the Salt River Bridge (monitoring point NR09) immediately downstream of the River Club site. This is attributed to two factors, namely:
  - natural recovery in water quality with distance downstream of a source of contamination – *E. coli* bacteria, for example, die off rapidly when exposed to sunlight; and
  - the dilution effect of inflows from the Liesbeek River, which enters the Black River between NR07 and NR09;

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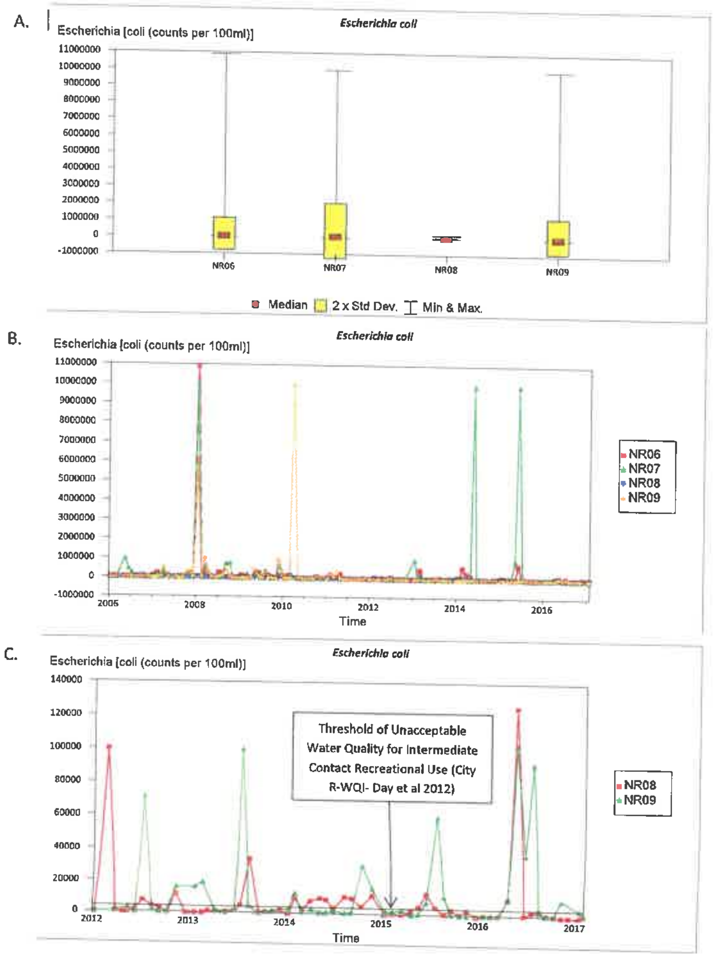

Figure 3.4
Escherichia coli data for three City of Cape Town monitoring sites in the Black / Liesbeek Rivers (see Figure 3.3 for locations) between 2006 and 2017. A: All data combined. B: All four sites over the full period. C: Only sites NR08 and NR09 post 2012

3.1.6. *Aquatic ecosystems condition*

Day (2013) provided an update of the Southern Waters (2001) assessment of condition or Present Ecological State (PES) of both the Liesbeek and the Black Rivers in their reaches in the vicinity of the River Club, using the approach described in Section 1.9. The following PES categories were accorded to the rivers:

- The Black River: PES Category F, indicative of a system that has undergone Extreme changes from its natural condition;
- The Liesbeek River:
  - Western channel past the site (natural Liesbeek channel): PES Category E, indicative of a system that has undergone a Serious change from its natural conditions, with changes in natural river morphology being major contributors to this poor condition rating, along with water quality, changes in natural flow regime, extensive loss of indigenous vegetation and invasion of the river channel by alien plants, including invasive Purple Loosestrife (*Lythrum salicaria*);
  - [3]Eastern (lined) current channel of the Liesbeek River past the River Club (Liesbeek canal): PES Category F, indicative of a canalised system that has lost almost all natural stream function.

These categories are still applicable at the time of this report.

Blue Science (2016) assessed Instream and Riparian Habitat Integrity (another measure of condition), with compatible results, showing Instream Habitat in the Black and Liesbeek Rivers (natural channel) to be in a Category D/E and E respectively, but with Riparian Habitat Integrity in a Category F for both systems, indicating a near complete loss / alteration in indigenous riparian vegetation.River and wetland importance

The Black River

The Black River has importance as one of the largest and most visible rivers of Cape Town. Its ecological importance is currently low, given the extent of its degradation, but its rehabilitation potential is high – if water quality issues were addressed through better servicing and management of upstream developments, water quality would probably improve rapidly, and in this context, rehabilitation of the steep-sided river banks and sedimented beds would be readily achievable, albeit not to natural conditions. Its current importance rests however on its role in stormwater and effluent conveyance, and its provision of habitat to some birds.

The Liesbeek River

Despite the significant levels of change from its natural condition, and the plethora of management problems (alien invasives, litter, water quality, abstraction of flows, canalisation) that afflict the Liesbeek River just upstream of the present study area, in the context of other urban rivers in Cape Town, the river is considered relatively unimpacted and it has a high rehabilitation potential, at least in its uncanalised reaches and, downstream of the N2 crossing, in its reaches where riverine wetlands remain, including the Raapenberg wetlands.

[3] Note that this assessment was not included in Day (2013) and was made instead in the current study

The Raapenberg wetlands

These remnant riverine wetlands are considered of high importance in an urban context, where many of the floodplain and riparian wetlands once associated with foothill and lowland rivers have been lost to urbanisation, and the Raapenberg wetlands in particular are recognised as an important breeding site for many duck species. Using the criteria outlined in Table 2.3, the Raapenberg Wetlands would be rated as of High conservation importance, on the basis that the wetlands:

- Support a high diversity of indigenous wetland species, and
- Support red data species; support relatively undisturbed wetland communities, and
- Form an integral part of the habitat mosaic within a landscape, and
- Aare representative of a regionally threatened / restricted habitat type, and
- Are of a significant size (for an urban environment) (and therefore provide significant wetland habitat, albeit degraded or of low diversity).

The above wetlands are described in more detail in Section 3.1.8 (D).

3.1.7. *Ecological importance and sensitivity*

Using the methodology outlined in Appendix E, which can be applied to both rivers and wetlands,

- The (lower) Black River has been assigned an Ecological Importance and Sensitivity (EIS) rating of Low to Moderate;
- The lower (natural) channel of the Liesbeek River has an EIS rating of Moderate to High;
- The Liesbeek Canal has an EIS of Low;
- The Raapenberg wetlands have an EIS of High.

It should be noted that the above EIS ratings have been somewhat artificially applied to the lower reaches of the Liesbeek River likely to be affected by the proposed development. Blue Science (2016) assessed an extended section of the lower Liesbeek River including both canalised and uncanalised reaches and accorded the river as a whole an EIS of Moderate to High and the Black River an EIS of Moderate to Low.

3.1.8. *Existing rehabilitation activities along the Black and Liesbeek Rivers*

Consideration of the implications of the proposed River Club upgrade need to take into account existing rehabilitation and management initiatives along the rivers and wetlands in these areas.

The following initiatives / interventions are understood to focus at least in part on the Black and Liesbeek Rivers and their associated wetlands:

- The City of Cape Town's alien clearing teams, who remove litter and alien aquatic vegetation (mainly water hyacinth – *Eichhornia crassipes*) from the Black River, using an integrated approach of mechanical and manual labour;
- The Friends of the Liesbeek River, who participate (and largely drive) litter removal and alien clearing along both rivers, and particularly the Liesbeek River – removal of the alien weed Purple loose-strife (*Lythrum salicaria*) is particularly challenging (**Box 3.1** provides background information and clearing recommendations for this species);
- The Friends of the Liesbeek River who intervened in the channelized Liesbeek River just downstream of the N2 bridge by breaching the berm and allowing peak flood flows to

dissipate into the adjacent floodplains immediately downstream of the N2 (in the vicinity of Valkenberg Manor House) and further downstream, into the Raapenberg Wetlands [Note that the ecological implications of the latter are discussed in Section 3.1.8 *D: Raapenberg Wetlands*].

In addition, the Raapenberg Bird Sanctuary forms part of the Two Rivers Urban Park (TRUP). This wetland is located between the Liesbeek Canal and the Black River, and lies immediately south east of the River Club.

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Box 3.1 Purple loose-strife (*Lythrum salicaria*)
Fact sheet and control methods

This information has been taken largely from USA based control guidelines – and control measures should be considered suggestions rather than tested measures for application in South Africa.

This plant, well-established established in the Liesbeek River, is native to Europe, Asia, Northern Africa and Australia. It is invasive in Canada, U.S.A, West Africa and South Africa, where the only place it has been found thus far is the Liesbeek River (http://www.sanbi.org/information/infobases/invasive-alien-plant-alert/lythrum-salicaria). The plant is described as an erect perennial herb that develops a strong taproot, and may have up to 50 stems arising from its base (https://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?SpeciesID=239). It is a wetland plant that grows in a wide variety of habitat types, from fresh to saline, low and high nutrient, sun and shade, calcareous to acid soils and once established it can survive in drier seasonal wetlands. Thompson et al. (1987) estimated that on average, a mature plant produces about 2,700,000 seeds annually. Seeds are relatively long-lived, retaining 80% viability after 2-3 years of submergence (Malecki 1990). In South Africa, invasion by this plant is likely to be mostly by seed distribution, although it also spreads by regrowth from broken off roots and stems (SANBI citation).

The plant is problematic because of its ability to outcompete other plants, forming dense homogeneous stands that make river banks inaccessible to small mammals and birds, and removes nesting and resting areas.
Control: Five biological control agents (mainly beetle and weevil species) have been developed for use in the control of this plant in the USA and are described as able to suppress weed populations to a nonsignificant level (Rees et al. 1996). No South African biocontrol agents have yet been developed.

Other methods of control include:

- Targeted grazing by sheep (Kleppel and LaBarge 2011)
- Revegetation of disturbed riparian sites to prevent purple loosestrife establishment
- Physical removal: [4]Most mechanical and cultural attempts to control purple loosestrife are considered ineffective, other than when infestations are very small and localised. In such cases the following should be considered:
  - Small infestations and isolated plants should be pulled before seed is set – they are readily identifiable when they are in flower. The entire root system must be removed, but that the roots should not be dug up as that might simply release seeds buried in the soil or produce root fragments that can re-grow. Instead, roots should be carefully teased out using a hand tool, and all plant parts should be bagged to prevent dispersal or resprouting. Follow-up treatments are likely to be required for at least 3 years;
  - Frequent cutting of the stems at ground level is also effective but should be continued for several years (Courtney 1997).
  - Mowing is generally not effective as it exposes the seed bank.
  - Fire is not an effective management tool as the dead plants do not burn well;
- Chemical controls: Only herbicides permitted for wetland use may be used to control purple loosestrife. Broadleaf-specific herbicides which do not harm species such as wetland grasses and sedges should be used to prevent the exposure of large areas with a large seedbank. Species specific approaches involving cutting and treating the stems with herbicide are preferred although foliar spray can be used by applying herbicide after the period of peak bloom. Follow-ups would be necessary. In South Africa, no herbicides are registered for this plant, but SANBI (above citation) notes that Seismic, an aquatic friendly systematic glyphosate (approved by the register on a trial basis) has been effective.

[4] Ohio EPA 2001 cites a single known exception being cutting followed by flooding – a strategy unlikely to be viable in the Liesbeek River

Photo A
Western channel of the Liesbeek River, showing steep road-side banks and disturbed banks on the River Club grounds (foreground)

Photo B
Liesbeek River (western channel) – slow flows result in dense invasion by *Commelina benghalensis* and other weedy aquatic and semi-aquatic plants across the channel

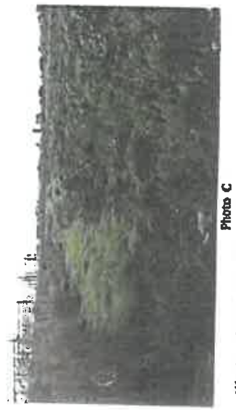

Photo C
Western channel along PRASA boundary, showing reedbeds lining the channel, stepping up to kikuyu grass invaded, infilled channel and former wetland floodplain on the River Club site

Photo D
Steep banks, extensive alien vegetation in the western channel and the creation of berms along the river edge, where (it is assumed) dredged vegetation has been dumped in the past

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Photo E
Alien vegetation (in this case *Sesbania puniceo* and Manatoka (*Myoporum montanum*)) provide roosting / perching habitat and shelter for birds along the PRASA boundary – see Night Heron in photo (arrowed).

Photo F
Infilled floodplain wetlands in the northern and north western portions of the site, along the western channel (PRASA boundary side) and the Black River

Photo G
Phragmites australis / *Typha capensis* reedbed wetlands on opposite side of the western channel, at the confluence with the Black River

Photo H
Railway line bridge immediately downstream of the site, on the Black River – this bridge acts as a bottleneck on the passage of flows downstream

Photo I
Left hand bank of the Black River, just upstream of confluence with the western channel of the Liesbeek River, showing infill and alien invasion

Photo J
Kikuyu lined river bank (Black River), looking upstream towards the bird hide (arrowed), immediately downstream of the eastern channel of the Liesbeek River

Photo K
Artificial pond on the River Club showing sterile marginal-areas and (assumed) nutrient enriched water

Photo L
Eastern channel of the Liesbeek River, looking upstream from the Black River confluence, showing the start of channel lining

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Photo M
Canalised section of the eastern channel of the Liesbeek River

Photo N
Creation of berms along the eastern channel of the Liesbeek River, to reduce flooding

Photo O
Raapenberg wetlands, south of the eastern channel of the Liesbeek River

Photo P
Broken section of the canalised eastern channel of the Liesbeek, showing collapsed canal liners on the right hand river bank

Photo Q
Bermed river bank on the western channel of the Liesbeek River, in the reach parallel with Liesbeek Parkway, showing building within the recommended buffer / ecological setback area

Photo R
Flood protection berm along the eastern Liesbeek River canal, looking upstream towards the weir

3.1.9. *Detailed description of aquatic ecosystems on and associated with the River Club site*

Site overview

The River Club site itself is a highly disturbed environment, with most of the aquatic ecosystems assumed to have been associated with this area under natural conditions (i.e. extensive floodplain wetlands set around and within the broad lowland river channels of the Black and Liesbeek Rivers) having been diverted, re-aligned, canalised, infilled or drained. Outside of the three channel systems described in Section 3.2 (the Black, the western (natural) Liesbeek channel and the mainly canalised, eastern Liesbeek River canal, and the (artificial, isolated) golf course ponds, no wetland ecosystems remain on the site today.

Hydrology

Berms along the western and eastern channels of the Liesbeek River cut off at least low level floods from what would have been their natural floodplains – these floodplains have however been largely infilled on the site itself, although wetland areas do still exist in places along the [5]left hand river bank of the natural river channel. **Figure 3.5** shows the extent of inundation of the site and its surrounds in different flood conditions, illustrating that the only portions of the site that lie above the 1:50 year floodline are the infilled north eastern portion of the site, and various artificial berms. Large portions of the site lie within the 1:5 and even 1:2 year floodplains.

Figure 3.5
Existing floodlines of the Black and Liesbeek Rivers in the vicinity of the River Club.
1: 2 year Return Interval (RI) floodlines in blue, 1: 5 RI in yellow; 1:50 year RI shown in red.
Data provided by SRK Consulting. Berms along the Liesbeek Canal and natural channel not shown – they were constructed after this survey was completed (L. Fisher-Jeffes, Aurecon, pers. comm. to Liz Day).

[5] By convention, left hand as seen when facing downstream

Geohydrology

Drawing on the findings of a geotechnical investigation, as well as on water level and Electrical Conductivity (EC) data from test holes on the site and (where available) from adjacent water bodies, SRK (2017) provided comment on the linkages between groundwater and surface wetlands on the River Club and adjacent Raapenberg wetlands. These comments are presented in full with their supporting data in Appendix C, but those most useful in assisting this specialist in arriving at an understanding of the role of groundwater in determining aquatic ecosystem function are summarised as follows:

- Large areas of the River Club site have been infilled (geotechnical data show depth of infilling to some 1.5 to 2 m, underlain by sediments, which are in turn underlain by bedrock (shale)). Measured groundwater levels on the River Club site were mainly at the contact zone between fill and sediments – this reflects the fact that the northern section of the River Club was naturally part of the Raapenberg wetlands prior to construction of the Liesbeek Canal;
- Early summer (January 2015) river water levels were lower than measured groundwater levels on the River Club site, possibly suggesting groundwater flow into the river – although the geohydrological specialist warns that there may be some influence of a deeper aquifer as a result of drilling into the bedrock. This relationship differed from that in the Raapenberg wetlands to the east of the canal, where surveyed data (this study) showed river water levels to be some 150mm higher than wetland water;
- River EC was considerably lower than borehole (7.8-16.3m below ground) and shallower test hole EC on the River Club site. The latter levels were similar to EC measured by FCG in the Raapenberg wetlands, which were also found to be substantially higher than in the river at the time of FCG's Raapenberg survey in September 2017. It is expected that if there was regular inflow from the rivers to the wetlands that a much lower EC would have been recorded at the wetlands;
- The Raapenberg wetlands are thus assumed to be mainly groundwater-fed - flow from the two rivers towards the wetlands is minor (and likely to be confined to flood events – this author's interpretation);
- The geohydrological study noted also that, on the basis of measured water level, the Raapenberg wetlands lie up-gradient of the River Club, and are separated from these wetlands by the Liesbeek Canal, which acts as an hydraulic "buffer" between the River Club and the Raapenberg wetlands;
- No connection between shallow groundwater on the River Club site and that on the Raapenberg wetland site appears to exist today, although the systems would have been connected under natural circumstances.

Aquatic ecosystems

This section describes aquatic ecosystems on and abutting the site that are considered potentially vulnerable to River Club development impacts.

A The "natural" channel of the Liesbeek River past the site

The left hand bank of the channel abuts first Liesbeek Parkway and then, as it swings east and away from the site, the railway line, meaning that the undeveloped portions of the River Club itself are the least developed sides of the river, and also the only sides along which there are real opportunities for channel / wetland rehabilitation. The channel is steep-sided-to-vertical, and its banks on both sides show signs of recent and probably ongoing disturbance, including raising of the right hand bank in places, presumably to address flooding of the River Club (see Photos A and Q). Nevertheless, the base

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of the channel supports (patchy) dense stands of *Phragmites australis* reeds, forming good cover for water fowl and likely to provide nesting habitat for other birds as well.

The open water habitat was densely invaded with mainly alien aquatic plants at the time of the site visits, with *Commelina benghalensis* being one of the more significant invaders (Photo B). Manual clearing of this plant was being carried out – an approach likely to result in less disturbance to the adjacent banks than mechanical removal.

Along the south eastern site boundary, the right hand bank steps steeply up to the infilled former floodplain that lies just north of the River Club boundary – an area that is now subject to litter, minor dumping and invasion by weedy and /or alien plants, including kikuyu grass (*Pennisetum clandestinum*) (Photos C and D).

Mature alien trees line the left hand bank in places, with the main species comprising Manotoka and Sesbania (Photos E – G). Although both of these are listed alien species in terms of the National Environmental Management Biodiversity Act (NEMBA) (Act 10 of 2004), they still provide useful shelter as well as roosting and perching areas for birds (see Appendix C).

In the lower reaches of the channel, the channel is separated from a mixed *Phragmites australis* and *Typha capensis* reedbed by the bermed left hand river bank. This reedbed lies outside of the River Club boundary, but is considered an important part of the river / wetland system in these reaches, assumed to comprise a relic of the former more extensive riverine wetlands that wold have occurred in this now highly altered part of the catchment.

<u>Sensitivity</u>

- The floodplain environment north of the River Club site is considered of extremely low sensitivity from an ecological perspective, with its only present functions being provision of a degree of buffering of the channel from adjacent noise and physical disturbance – such buffering derives only from the physical space provided by this area, and not from any quality of habitat it affords;
- The channel itself currently provides a transformed and disturbed aquatic habitat, which would not be sensitive to slight changes in water quality but which could be affected by significant deterioration in habitat quality (e.g. high nutrient concentrations promoting plant growth and resulting in low oxygen availability, or potential toxins such as unionised ammonia). Such effects would be more significant if these reaches were shown to support indigenous Cape Galaxias fish;
- Although the channel is connected to the Black River and thus eggs and tadpoles would probably be exposed to predation by Carp, Burger (2017) notes that it is at least partially suited as a western leopard toad breeding habitat, and for the purposes of this study it is assumed that they do indeed currently breed there;
- The adjacent reedbed wetlands would be potentially sensitive to even slight changes in flood height, if these resulted in extended deep inundation of wading areas (unlikely) or even periodic inundation of reedbed nesting areas, as a result of elevated flood heights;
- Avian fauna in the channel and reedbed areas may be moderately sensitive to increased disturbance of the site – but discussions with Dr Williams (see Appendix D) suggested that for the most part birds would adjust to increased human proximity, provided that vegetated shelters and habitat quality remained unchanged.

B The mainly canalised eastern channel of the Liesbeek River

This channel conveys most if not all of the flows from the Liesbeek River. It is canalised on both sides in its reaches immediately downstream of Observatory Road (Photos M – P and R), and is only unlined

for the last (approximately) 200m of its length upstream of its confluence with the Black River. Within the canalised section, habitat diversity is low, and the canal provides a generally sterile aquatic ecosystem, unlikely to support a high diversity of flora and fauna, despite the relatively good water quality in this river. Although past projects have made recommendations around how to improve habitat quality, both the availability of space on both sides of the canal (at least initially in its upper reaches) and high costs have prevented their rehabilitation to date. In places, the existing canal lining has however collapsed and the exposed earth wall is in danger of erosion and back cutting (Photo P). Further downstream, the canal gives way to vegetated, albeit still steep banks, lined with *Phragmites australis* reeds (right hand bank) and mixed reeds and (mainly alien) trees along the left hand bank. The left bank (abutting the River Club) has also been bermed along most of its length, presumably to reduce its flood potential.

On the right hand side of the channel, a low berm, in places lined with metal sheeting, occurs between the channel and the adjacent Raapenberg Wetlands. At the time of the September 2017 Raapenberg survey, this berm had been breached and a shallow trench excavated, apparently to allow elevated river flows into the Raapenberg wetlands. This issue is discussed in more detail in Section D, below: *The Raapenberg Wetlands*.

Thereafter, the berm extends along the whole right hand river bank as far as the Black River. The berm is vegetated with weedy and/or alien vegetation (e.g. Brazilian Pepper trees (*Schinus terebinthifolia*), occasional *Sesbania punicea*, nasturtiums (*Tropaeolum* sp.), wandering jew (*Commelina benghalensis*)), and these give way on the other side of the berm to dense *Phragmites australis* reedbed, interspersed with stands of equally dense alien ginger lilies (*Heydichium* sp. ?).

The Raapenberg wetlands and the Black River reedbeds that lie south of the river are accessible by non-flying fauna from these river reaches only downstream of where the berm has been breached, where access up the steep, densely vegetated bank and berm is possible.

<u>Sensitivities</u>

- The canalised portion of the river would have low sensitivity to any activities on the River Club site, unless these produced substantial levels of pollution - this is considered an unlikely outcome of development;
- The short, uncanalised sections of the river in these reaches, which currently offer a better quality of riverine habitat, could be sensitive to development-related activities along its margins, in terms of noise and physical disturbance;
- Avian fauna in the reedbed wetlands are unlikely to be affected by development of the River Club site, given their distance from the site and the fact that they are already in close proximity to the M5 highway and its associated noise;
- Hydrological connectivity from the canal to the Raapenberg wetland is a critically important issue from a biodiversity perspective and one that, if altered, could potentially result in significant degradation of wetland function and structure.

C The Black River

The Black River in its reaches along the site boundary is a degraded environment. The river banks are lined mainly with alien kikuyu grass and other invasive aliens such as cannas, and are bermed in places. The opposite (right hand) river bank, abutting the M5, is also sterile, with little marginal vegetation or use of the floodplain for the creation of wetland habitat. On the River Club site, near the confluence of the Liesbeek canal, a small treed island has been established in the channel, and both this and the reedbed along the Liesbeek Canal form the focal area for a bird hide, constructed on the edge of the

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golfing area. The avian specialist describes the small island (referred to as the "palm islet" in his report (see Appendix D) as one of only two " patches of habitat currently within the River Club Area that merit preservation", the other being the willow trees along the canal, both of which provide day roosting habitat to Darters and Cormorants.

Sensitivities

The Black River is not considered a sensitive environment, and its degree of ecological impairment means that it presents many opportunities for rehabilitation. Activities that encroached to such a degree that they reduced the quality of habitat between the Liesbeek Canal, Raapenberg Wetlands and the Black River would however be viewed with concern, and would include (unlikely) extended canalisation, channel lining or the establishment of additional alien vegetation.

D The Raapenberg wetlands

Although likely to have extended well north of their present extent prior to excavation of the canal and infilling of wetlands on the site, the off-channel Raapenberg wetlands now occur only south east of the site, and are separated from the site by the Liesbeek Canal. Of all the aquatic ecosystems considered in this assessment, the Raapenberg wetlands are the only ones with significant ecological value, and are considered by far the most sensitive to changes in flow, hydroperiod, water quality or fragmentation. They are considered part of the seasonal clay flats renosterveld wetland described in the specialist botanical report on the SAAO site (see Appendix A), the eastern boundary of which extends into the Raapenberg wetlands. The latter report listed that nine endemic or near-endemic wetland plant species within the SAAO site alone – namely *Agrostis lachnantha* var. *lachnantha* vinkagrostis, *Bolboschoenus maritimus* snygras, *Cotula coronopifolia* ganskos, *Lobelia erinus* wild lobelia, *Pauridia capensis* geelsterretjie, *Sarcocornia* cf. *capensis* seekoraal (new record), *Sparaxis bulbifera* fluweelblom, the semi-parasite *Thesium funale* and *Zantedeschia aethiopica* arum lily.

The wetlands are considered brackish to saline systems, with late winter 2017 salinities ranging between 2700 and 2800 mS/m in standing water areas north of the bermed pedestrian pathway leading to the Black River pedestrian crossing. This accords with their classification by COASTEC (2017) as shale renosterveld wetlands, with shale usually associated with elevated salt concentrations.

Salinities in the wetlands are generally considerably higher than those in the adjacent Liesbeek Canal and Black River – EC readings made in September and October 2017 respectively in the southern Raapenberg wetland pools and the Black River resulted in the following readings:

- Raapenberg Pan: 2840 mS/m; 2800 mS/m
- Black River: 239 mS/m and 270 mS/m.

The exception to this is the section of wetland (labelled "backwater" in Figure 3.6) that lies immediately south of the bermed access path leading to the M5 and Black River crossings. EC readings in this water body, which also lay at a level compatible with water levels in the Black River at the same time, had an EC of 209mS/m in September 2017.

Figure 3.5

Alignment of surveyed cross-sections through the Raapenberg wetlands. Plant zonation highlighted in Figure 3.6. Numbers 1-4 indicate cross section numbers. A and B indicate water quality sampling points

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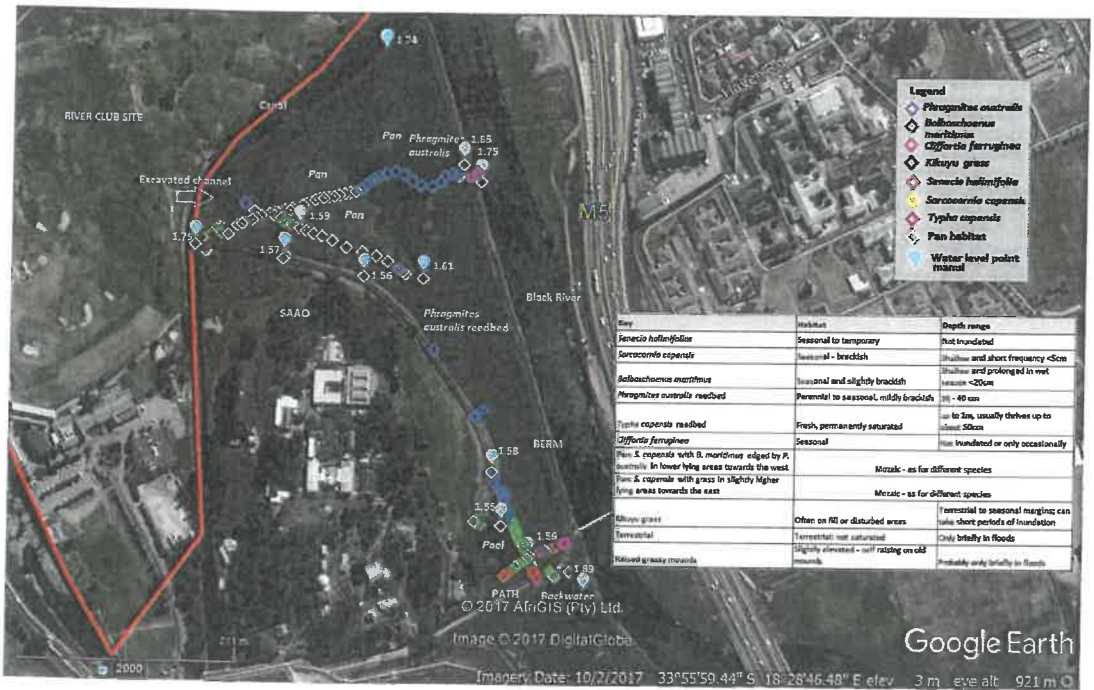

Figure 3.6

Summary of surveyed vegetation zones across wetland. "Pans"vegetated with *Sarcoconrnia capensis* and (where inundated (Sep 2017)) *Bolboschoenus maritimus* and edged by *Phragmites australis*. Surveyed water levels shown in mamsl. Notes on habitat preferences and depth range are estimates only, derived from FCG observational data over 20 years.

Figure 3.7

Heights of surveyed vegetation zones across wetland. Colour codes as per Figure 3.6. Levels shown in mamsl

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**Raapenberg wetland photos
September 2017**

Photo S
Relatively fresh "backwater" wetland south of berm and pathway (arrowed). Photo T taken looking north from the path

Photo T
Open water in brackish to saline pan just north of the berm / pathway in Photo S

Photo U
Mozaic perennial to seasonal open water wetland – looking north from Photo T

Photo V
Shallow wetland margins suitable for wading birds – spring 2017

Photo W
Standing water *in Bolboschoenus maritimus / Phragmites australis* wetlands edging dense *P. australis* reedbed

Photo X
Trench along the "fenced" edge of the SAAO – purpose of trench assumed to be to convey water from the SAAO boundary to deep water habitats to the south

Photo Y
Broken canal wall, facing east (downstream) along Liesbeek canal

Photo Z
Trench dug ostensibly to connect Liesbeek River canal water with the Raapenberg wetlands (see Box 3.2)

Photo AA
Grass tussocks creating high lying areas around low pans – tussocks restrict flow but flow past and over these high points must take place.

Photo AB
Edge of *Sarcocornia capensis* pan

SRK (2017) suggests that these results show little linkage between the river and the main body of the wetlands (i.e. north of the bermed pathway), with wetland salinity more closely mirroring groundwater levels (SRK (2017) (Appendix C) cites EC values of 4099, 2985 and 851 mS/m for boreholes on the River Club site in January 2015). This said, it is also likely that salinity in the wetlands is strongly influenced by evapo-concentration, resulting in increasingly elevated EC values as surface waters shrink through evaporation.

Salinity in the "backwater" south of the berm appears to be closely linked to river salinity, and may reflect inflows at the southern (upstream) end of the wetland, which are blocked from entering the Raapenberg wetland by the berm. These salinity levels have relevance for the suitability of different parts of the Raapenberg wetlands as breeding sites for *inter alia* Western Leopard toads. This issue is discussed in Section 3.3. The backwater wetland, with its lower salinity and deep, standing water pools, supports the least diverse and ecologically important wetland habitat, with water hyacinth (*Eicchornia crassipes*) growing in the standing water, and dense stands of *Phragmites australis* edging the open water area, their extent presumably limited by water depth.

Figure 3.5 shows the alignments of the four cross sections surveyed / walked through the site, while **Figures 3.5 and 3.6** show plant zonation and elevation through the wetlands as measured in these cross sections during the ecological and hydrological survey. The overall findings of this survey are as follows:

- The Raapenberg wetlands comprise a mosaic of different wetland habitats, which range from areas of perennial saturation (mainly in the south of the wetland) through to areas that are seasonally shallowly inundated and dry out in early summer, or areas that are only periodically inundated in flood events, and potentially remain un-inundated for several years consecutively between flood periods – Photos S–AB illustrate the diversity of dominant vegetation communities and habitat types. Of these, the *Sarcocornia capensis* salt marsh habitat is particularly important, with *Sarcocornia* spp. salt marsh habitat generally very threatened in the Cape Town urban area, with the only significant patches known to this author occurring in the Westlake wetlands, Lake Michelle and the Diep River estuary salt pans;
- In addition to variation in saturation frequency and duration, there is also considerable variation in the depth of water in different parts of the wetland – at the time of the wetland survey, water depth ranged from pools with 0.5m of standing water to areas that had no standing water at all – such heterogeneity contributes to the diversity of faunal species utilising the wetlands at different times, with swimming waterfowl (e.g. Yellow Billed Ducks) utilising deeper standing water while various waders forage in shallow open pans and damp mud flats;
- Salinity is assumed to be a significant driver of habitat heterogeneity and plant community structure – dense *Phragmites australis* reedbeds dominate higher areas of the wetland including those closer to the river (**Figure 3.7**). Since the lower lying areas are within the inundation range for this species, it is assumed that the main control over the spread of *P. australis* into the open pan habitats is primarily salinity, with *P. australis* generally not able to tolerate as high a salinity as saltmarsh plants such as *Sarcocornia capensis* which dominates the open pans. The salinity in these pans is assumed to be higher than in higher-lying areas, as the pans are (a) exposed to the more saline water table and (b). are the area where the effects of evapo-concentration are most likely to be experienced, as water pools in these zones, increasing in salinity as it dries out;
- Areas with standing water in the pans tends to be dominated by *Bolboschoenus maritimus* – this low-growing sedge usually occurs in fresh to brackish water, but requires shallow inundation for at least a few months in the wet season – hence its occurrence almost wholly in the pans that were inundated in September 2017. These plants require shallow inundation – prolonged deep inundation would result in their disappearance from the system. Similarly, other wetland endemics identified by COASTEC (2017) such as *Cotula coronopifolia* occur along the damp margins of seasonally shallowly inundated, brackish systems.

Hydrological regime and connectivity

A visual assessment of the wetland showed the following significant controls on wetland drainage:

- A berm that intersects the wetlands from east to west in their southern extent, between the "backwater" area and the seasonal wetland ponds and pans in the north – this berm is fenced, and includes a footpath / cycle track – it appears to act as a control on surface and subsurface flow linkages between the Black River and the Raapenberg wetlands. This might have the effect of increasing wetland salinity in this system over time, if it is not periodically flushed, but it also has the perhaps more important (and opposing) effect of protecting the wetland north of the berm from the water quality and other impacts associated with the Black River;
- An excavated channel along the boundary line of the SAAO – this appears to have been constructed to convey water from north to south through the wetland (it connects to a low lying area just south of the canal), and possibly also to drain the lower boundary area of the SAAO.

- A recently excavated channel, dug to convey water from the Liesbeek Canal into the Raapenberg wetlands – it is my understanding that this channel was constructed by members of the Friends of the Liesbeek River Society out of a concern that the wetland was getting "too dry" – if successful, it could have profound negative implications for the functioning of the wetland north of the footpath berm, by decreasing salinities and increasing the period and frequency of inundation / saturation (see **Box 3.2** in this regard).

  Aurecon (2017a) assessed the likely effects of the excavated channel on wetland hydrology, and suggested that, prior to the excavation of the channel, the Raapenberg wetland was likely to fill and drain at a river height of 2.5 m amsl, with evaporation drying out much (but not all) of the wetlands thereafter – standing water pools would be expected to last possibly all summer in the lowest lying parts of the site, outside of prolonged drought periods. The excavated channel would however alter this effective filling and draining pattern, so that the wetland would fill at a lower river level and drain to a lower level (2.25m amsl) amounting to a 250mm change in water level in the wetland – Aurecon estimates that the wetland would then hold water for 60days less than prior to excavation of the channel, before evaporation essentially dried it out. The effects of this intervention are likely to include increased frequency of inundation of the wetlands, increased frequency of flushing of water out of the wetland as floodwaters drain out of the wetland and reduced depth and duration of standing water habitat in the wetland. The ecological consequences associated with such change are likely, if the channel remains in place, to include:
    - Freshening of the wetland and an associated expansion of *Phragmites australis* reedbed into the open *Sarcocornia capensis* pans;
    - Loss of open wading areas for birds and their replacement with locally common reedbed;
    - Reduced duration of shallow inundation of remaining pans / channels, and thus reduced feeding habitat for birds;
    - Reduced extent and duration of open water habitat for waterfowl;
    - General biodiversity deterioration.

  It is ironic that the seasonal salt marshes of the Raapenberg wetlands appear to have been accidentally conserved to date from impacts associated with perenniality and nutrient enrichment of the Black River by the construction of berms along the Black River and Liesbeek Canal, as well as by the infilled pathway leading to the pedestrian bridge over the Black River. The well-intentioned construction of a trench that would seek to undo such protective function was, in this author's opinion, ill-advised from an ecological perspective and should be rectified as a matter of urgency.
- A berm along the Black River channel – this is assumed to reduce the frequency of overtopping of flows from the river into the wetland, and thus maintain salinities in the wetland but also potentially trap floodwaters that do overtop the berm, within the wetland area.

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BOX 3.2
Seasonal wetlands - The importance of drying out

Seasonal wetlands are one of the most threatened wetland types in the Western Capes, being vulnerable both to development (they are easily drained / infilled) and to permanent change as a result of receiving too much water, and becoming perennial.

Changes from a system that dries out in summer to one that is permanently inundated or saturated can have profound impacts on biodiversity. Many of the animal species that occur in these wetlands, and sometimes form the foodchain base for wading birds, rely on annual drying out as cues for hibernation / diapause and on flooding / wetting as a cue to emerge. If the wetlands are permanently submerged or even damp / saturated, instead of dry in summer, such cues are lost. The result is that the important ephemeral wetland fauna (much of which is endemic to relatively small areas of the Western Cape) disappear, and give way to common, mainly insect fauna, that would not establish in seasonal systems.

Salt marsh systems such as the *Sarcocornia capensis* pans at Raapenberg are highly vulnerable to inundation changes. If fresh (e.g. river) water was added to these wetlands, and they became both fresher and wetter than at present, they would be vulnerable to invasion by *Phragmites australis* or even Typha capensis, resulting in a significant loss of open wading habitat, and an expansion of dense reedbed.

The idea that it is problematic for a seasonal wetland to dry out must therefore be challenged – over inundation / saturation of these systems it is probably a far greater biodiversity threat. Thus efforts to channel river flows into the wetlands are in fact highly undesirable from a biodiversity perspective, and likely to alter salinity and hydroperiod.

The geohydrological assessment suggests that the Raapenberg wetlands are connected primarily to the water table, and are not connected to groundwater on the River Club site, downslope. With regard to surface flows, Aurecon (2017a) suggests on the basis of hydrological modelling, supplemented by on-site observations and measurements [6]that:

- Outside of flood conditions, the water levels in the Black and Liesbeek Rivers are higher than the water levels in the Raapenberg wetlands by approximately +-150mm. This indicates that the wetlands are not, typically, filled with water from the surrounding rivers. Although the hydraulic gradient would normally indicate a flow direction into the wetlands, in fact it

[6] This information extracted from Aurecon (2017a) with minimal editing for context

appears that the hydraulic conductivity of the organic matrix that underlies the wetland is equal to or lower than the evaporation rate, and thus connectivity under normal flow conditions appears negligible;
- This said, the part of the wetland south of the footpath extending from Observatory Road towards the M5 appears to be connected to the river system at some point upstream and also has a higher surface water level than the primary wetland that borders the SAAO;
- The Raapenberg wetlands north of the pedestrian berm probably receive inflows from the Liesbeek Canal when the water surface elevation is in the region of +-2.5 mamsl, equating to the wetland filling in a storm with a recurrence interval of between the ½-year and 1-year;
- Once water enters the wetlands, and the wetland is filled to +-2.5 mamsl, it becomes an ineffective flow area, offering limited offline storage (**Figure 3.7** after Aurecon 2017a);
- The wetland does not appear to drain below a level of +-2.5 mamsl (the level at which it enters the wetland). This would equate to approximately 1 m of standing water at the deepest points in the wetland;
- This water then probably evaporates over time –evaporation in the suburb of Observatory is estimated at approximately +-1.5m, with rainfall in the region of 600mm. This would suggest that over a typical / average year the water levels would fluctuate in the wetland – but that the wetland would not completely dry out. Aurecon (20127a) notes that if there were successive droughts – as in 2015, 2016, 2017 –the wetland might dry out should there not be a storm of sufficient magnitude to result in flooding into the wetland.

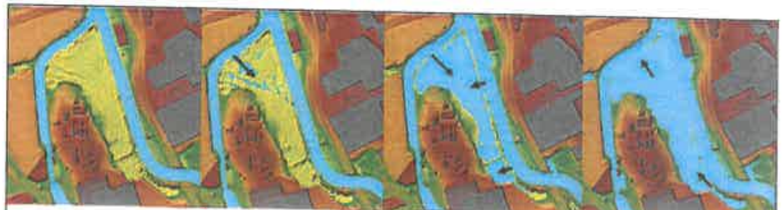

Figure 3.7
Overview of how flow enters and then leaves the Raapenberg wetland (figure after Aurecon 2017a)

Habitat importance

Of the different vegetation types, the open salt marsh pans (*Sarcocornia capensis* dominated) and the seasonally inundated *Bolboschoenus maritimus* marshes are probably the most important from a conservation perspective, although the biodiversity importance of the Raapenberg wetlands as a whole really owes itself to the spatial and temporal diversity of habitat types that support a wide range of indigenous and in many cases locally to regionally endemic fauna and flora.

Of particular significance is the importance of the Raapenberg wetlands from the perspective of their provision of habitat to a high diversity of birds (mainly waterfowl) as well as for the provision of habitat for endangered western leopard toad populations (*Sclerophrys pantherina*) (see avifaunal and faunal reports in Appendices D and B respectively and further comments in Section 3.3).

Sensitivity

The open salt marsh pans and the shallow seasonally inundated pools and flats of the Raapenberg wetlands are considered highly sensitive to changes in both hydrology / hydroperiod and salinity (see

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Box 3.2). Activities that increase the volumes, velocities, frequency or duration of flows into the wetland are likely to bring about changes in current wetland functioning, particularly if such flows are of lower salinity than the existing wetlands, and thus likely to promote the growth of salt intolerant species such *as Phragmites australis*, which would reduce spatial heterogeneity /habitat diversity considerably.

While it is arguable that the present hydrological regime has been altered from natural, and that change might be restorative rather than impacting, in the absence of hard evidence as to past wetland conditions, and given the known importance and present apparent level of sustainable functioning of the system, it is recommended that no changes in hydroperiod, flow regime or water quality should be encouraged. It is noted in this regard that even slight changes in flow height might have significant implications for plant zonation. Figure 5.6 for example shows the difference of only 12cm height between parts of the *Sarcocornia capensis* pans and the adjacent *Phragmites australis* reedbeds, and a similar range in the southern part of the wetland differentiating between inundated shallow suitable for waders and dry pans, while a further 20cm depth into the pans makes them (at that time) too deep for most waders and likely to accommodate swimming ducks only. Such deep pools would, however, presumably be suitable for breeding western leopard toads, assuming they can tolerate such salinities. This aspect is discussed in more detail in Section 3.3, as the extent of salinity measured in all areas of the Raapenberg wetlands outside of the "backwater pool" area appear to be outside of the tolerance range suggested by M. Burger (faunal specialist) for western leopard toads. Actual predicted hydrological changes are however described in Section 5.1.7.

The botanical specialist (Coastec 2017 – Appendix A) also stresses the importance of maintaining a seasonal inundation regime, noting that "If inundation of the rare renosterveld wetlands, particularly along the SAAO eastern boundary, becomes more perennial, this would compromise this habitat in a major way and would also impact on efforts to rehabilitate and even augment this habitat".

E The golf course ponds

A number of seasonally to perennially inundated ponds have been created in the golf course. These artificial water features have been noted by the faunal specialist (Appendix B) as potentially suitable breeding sites for western Leopard Toads and other amphibians. They are however easily replaceable habitats, and little effort has been made in their landscaping / design to replicate natural standing water habitats in this area.

3.1.10. Watercourse classification

An important aspect of this EIA is the legal classification of different aquatic ecosystems likely to be affected by implementation of the proposed project. In the present case, the following classifications have been made, based on the definitions provided in Section 1.6:

- The Black River – a watercourse (a natural channel, albeit diverted and impacted, in which water flows regularly or intermittently);
- Natural channel of the Liesbeek River –the main channel of the Liesbeek River has been diverted into the canal, and the natural channel (which has already been partially diverted from its original alignment), no longer receives flow from the Liesbeek River. Were it not for its wetland character, this would mean that the channel was not in fact a watercourse, as the DWA (2012) policy states that "A channel containing diverted water from an original watercourse, which remains functional" is not considered to be a watercourse, whereas "where a watercourse is canalised *in situ* or where the original flow path of a watercourse is altered entirely, these waterways are regarded as watercourses".. However, the point

is moot, because wetlands are also included in the definition of a watercourse (see Section 1.6), and the natural channel is thus regarded as both a watercourse and a wetland;
- Golf course ponds – these are artificial depressional wetlands and are not regarded as watercourses;
- Raapenberg wetlands: wetlands and watercourses ("wetland, lake or dam into which, or from which, water flows").

3.2. Terrestrial vegetation

Coastec (2017) (see Appendix A) assessed the terrestrial habitats of the River Club and the adjacent SAAO site, and derived the map shown in **Figure 3.8**. The following key information has been drawn from this work, presented in full in Appendix A.

The River Club site

The River Club site was found to support no terrestrial indigenous plant communities, being located on old fill material, and its sensitivity to development was deemed negligible from a floral perspective.

The South African Astronomical Observatory (SAAO) site

- The assessment confirmed the presence of Critically Threatened Peninsula Shale Renosterveld ("renosterveld") vegetation on this site, albeit in a greatly disturbed condition and soils analysis confirmed the presence of clay-rich soils, typical of renosterveld;
- The total 9.19 ha SAAO site was mapped as follows (see **Figure 3.8**):
  - 3.97 ha alien trees;
  - 3.02 ha developed areas;
  - 1.40 ha dryland renosterveld;
  - 0.8 ha wetland renosterveld vegetation – described in Section 3.1.8 D;
- Most of the natural vegetation is located in the central west, northern and central eastern part of the site, and is mainly in a poor condition, lacking the shrub layer which is so characteristic of this vegetation type (Low & Rebelo, 1996);
- Grasses are locally prominent on the site, particularly along the western boundary. Together with annuals and bulbs, grasses form a key component of renosterveld (Low & Rebelo, 1996);
- 87 indigenous plant species from were recorded dryland habitats, with key dryland renosterveld species and indicators being: shrubs and climbers - *Searsia tomentosa* korentebos (new record), *Elytropappus rhinocerotis* renosterbos (extremely rare on the site, although dominant in most renosterveld habitats, especially where there is marked disturbance), *Eriocephalus africanus* kapokbos, *Otholobium hirtum* gryskeurtjie, *Olea europaea* subsp. *africana* wild olive, *Asparagus capensis* haakdoring; bulbs – *Lachenalia mediana*, *Ornithogalum thyrsoides* chincherinchee, *Babiana fragrans* bobbejaantjie, *Chasmanthe aethiopica* suurkanolpypie (new record), [7]*Moraea aristata* blou-ooguintjie (endemic to the SAAO grounds – Mustart 2010), *M.gawleri* renosteruintjie, *M.vegeta* bruintulp, *Sparaxis* cf. *grandiflora* subsp. *fimbriata* perskalkoentjie, *Watsonia meriana* var. *meriana* rooikanol (new record) and *W.spectabilis*; annuals – *Arctotheca*

[7] The original distribution of *M. aristata* was on clay flats and slopes in the Northern Cape Peninsula, between Cape Town and Rondebosch (Goldblatt, 1976 & 1986, in Mustart, 2010). Most of this habitat has been lost to farming and residential development. The role of the SAAO for the conservation of this species is therefore crucial

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calendula gousblom, *Dimorphotheca pluvialis* witbotterblom and *Ursinia anthemoides* margriet; grasses – *Ehrharta calycina* rooigras and *Hyparrhenia hirta* thatch grass;

- Red List terrestrial species occurring on the site are: the peas, *Indigofera psoraloides* (Endangered) and *Podalyria sericea* (Near Threatened), the bulbs *Lachenalia mediana* var. *mediana* viooltjie (Vulnerable), *Babiana fragrans* bobbejaantjie (NT), *Xia maculata* geelkalossie (NT) and *Moraea aristata blou*-ooguintjie (Critically Endangered, endemic to SAAO site);
- Given that the renosterveld habitat at the SAAO is severely disturbed, there is a strong likelihood that species numbers would be far higher under natural conditions;
  - In addition, there is a strong likelihood the renosterveld of the site is quite different from that of Signal Hill (the north-western limit of Peninsula Shale Renosterveld) - the floristic differences suggest, perhaps, a different (new?) type of Shale Renosterveld vegetation type on the SAAO site.

Coastec (2017) also discussed the site in terms of three "conservation" areas designated in the Observatory Landscape Framework (OLF) after Van der Walt and Strong (2010). Given the context of the present report in assessing the implications of development on the River Club site for terrestrial ecosystems, and Coastec (2017)'s conclusion that the proposed development at the River Club is highly unlikely to impact negatively on the dryland renosterveld vegetation at the SAAO site and the security of the Critically Endangered *Moraea aristata* is thus likely assured, provided acceptable conservation measures are introduced on the SAAO site, no further details regarding the treatment of the different OLF zones are provided here, although these can be sourced in the specialist report in Appendix A.

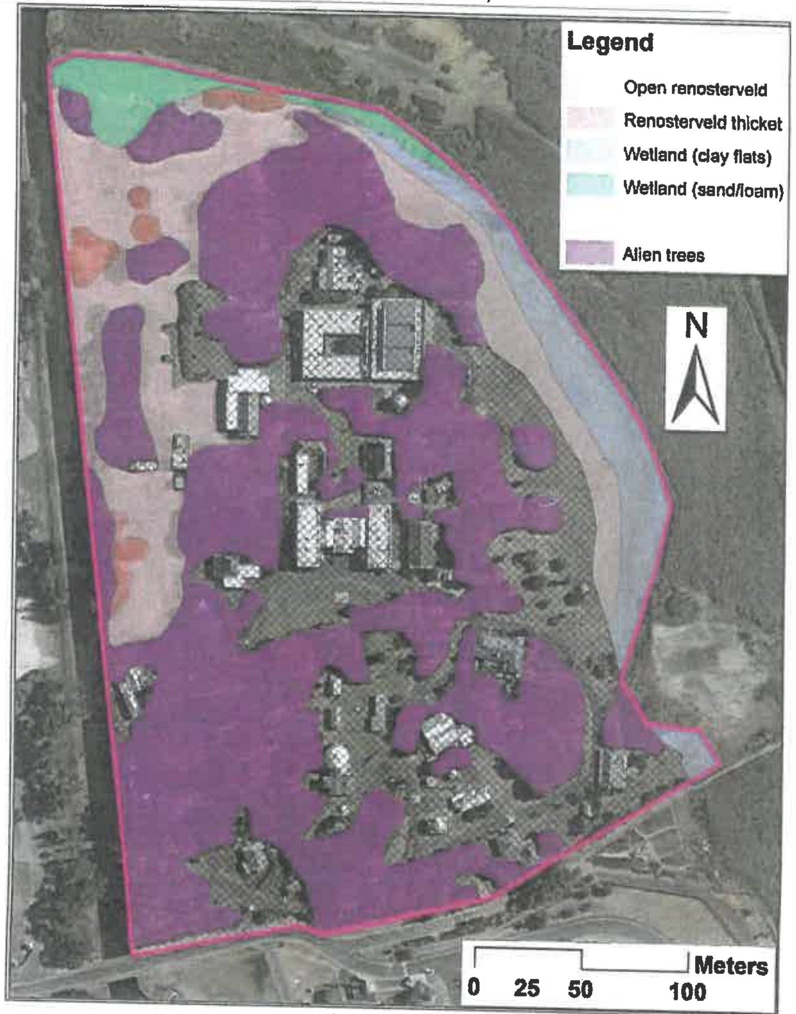

Figure 3.8
Vegetation of the SAAO site showing the distribution of open and closed (thicket) renosterveld and wetlands as well as the main clumps of introduced trees. Figure after COASTEC (2017) – see Appendix A.

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3.3. Fauna on and in the vicinity of the River Club site

3.3.1. *Fish*

The **Black River** is considered generally poor in indigenous biodiversity, largely as a result of habitat transformation, ongoing maintenance disturbance as a result of dredging of the channel; invasion by alien plants of both aquatic and marginal habitats; and poor water quality. Although no quantitative data had been sourced at the time that this document was produced, two alien fish species are understood from popular literature and comments by local resident to occur in the Black River, namely common carp (*Cyprinus carpio*) and African Catfish (*Clarias gariepinus*) (Day and Ross-Gillespie 2008).

The considerably less-impacted Liesbeek River is believed to support two indigenous fish species, namely Cape Kurper (*Sandelia capensis*) and Cape Galaxias (*Galaxias mollus* (*Galaxias sp.* 'zebratus cf. Mollus') (*Galaxias zebratus)*, a Western Cape endemic fish, as well as a more diverse suite of aquatic macroinvertebrates than those occurring in the Black River (FCG internal data). [8]Brown and Magoba (2009) suggest that, under natural conditions, the Liesbeek River may also have supported endemic redfin minnows of the genus *Pseudobarbus.*

The actual likelihood of any of these endemic fish occurring in the natural channel of the Liesbeek in its reaches past the River Club is however questionable, given both that this channel is largely disconnected from the upstream river and that water backs up into the channel from the polluted Black River, presumably also allowing access by alien fish species from this system.

3.3.2. *Birds*

The following information regarding birds on and in the vicinity of the River Club site has been summarised from Williams (2015) as presented in full in Appendix D, on the basis of [9]two site visits and extensive literature research:

- The junction of the Liesbeek and Black River channels is a focal point in the wetland systems of central-north Cape Town. The conjoined Black-Liesbeek River is ecologically linked via Zoar Vlei to the Diep River system that extends northwards to beyond Malmesbury and includes the Rietvlei nature reserve, a registered Internationally Important Bird Area (IIBA). The only other significant wetlands in this central- northern area of Cape Town are at or near the Century City Intaka Island nature reserve wetlands; a large detention "pond"; and, just east of Century City, the pan between the N1 and the railway line. The wetland system of southern Cape Town – based on the False Bay Eco-park (Rondevlei- Seekoevlei-Strandfontein- Sandvlei and associated streams) is within ready flight distance for most waterbirds that use the northern Liesbeek-Black-Diep river wetlands;

[8]These authors also suggest that the longfin eel (*Anguilla mossambica*) occurred in the Liesbeek system – however, this is considered unlikely , as the distribution of this species is confined to south and east coast rivers flowing into the Indian Ocean, east of Cape Agulhas, and does not include west-coast draining rivers (Skelton 2001).

[9] The specialist noted that, in the Western Cape, waterbirds tend to disperse to ephemeral wetlands as soon as winter rains cause temporary local flooding. Consequently the number and diversity of waterbirds seen during the two (wet season) visits to the River Club are likely to be lower than would occur in the summer when ephemeral wetlands have dried out and waterbirds are restricted to the use of permanent wetland areas such as the river channels around the River Club study area.

- The current significance of the River Club site for birds resides in the attraction of the peripheral waterbodies for waterbirds and their sometime use of the banks of the natural channel of the Liesbeek River abutting the River Club for roosting and/or nesting;
- The majority, 21 of 33 species, of the birds recorded in the two visits were related to wetland habitats, and these included several species of provincial conservation interest in addition to the two nationally rated conservation species (Great White Pelican and Greater Flamingos, both rated as near threatened);
- Greater Flamingos were observed in the Raapenberg wetlands, as well as (at times) in the Black River channel, where their presence is assumed to be encouraged by the accumulation of banks of sediment in the river channel, resulting in shallow sandy flats, rich in nutrients and therefore probably supporting blue green algae and other micro-organisms on which these birds feed;
- Great White Pelicans are piscivorous and their presence on the Black River and in the natural channel of the Liesbeek River is probably largely because of the presence of (alien) fish;
- By contrast the immediately adjacent Raapenberg nature reserve, though of a far smaller area, has a higher value for birds. The birds of greatest interest, and conservation significance, are waterbirds;
- Waterbird use of the River Club area is heavily influenced by the availability of wetland habitats in the Raapenberg wetlands. The major drawback of the area for waterbirds, despite reasonable foraging areas and apparent food availability, is the lack of safe, undisturbed breeding habitat for the larger species. This situation applies along the greater part of the two rivers. The nearest significant breeding populations of larger waterbirds are at Intaka Island in Century City and at Rondevlei, near Grassy Park;
- Despite the poor availability of habitat for birds on the River Club site, its location at the confluence of the Liesbeek and Black Rivers means that the site has excellent wetland linkages across the centre-north of the Cape Town metropol;
- In ecological terms the Black River, which is broader and more stable offers the greatest potential for birds. The Liesbeek canal is sterilized by concrete walls and is richest in terms of birdlife where the walls give way to "natural" banks near its confluence with the Black River;
- Weak flow in the natural channel of the Liesbeek River has resulted in shallowing and clogging aquatic plants. These plants inhibit most bird use of the clogged waterbody, although the steep banks of this channel provide Giant Kingfisher nesting sites;
- Apart from the open water habitats of the river channels, there are few habitat patches of value for birds within the River Club site itself.

3.3.3. *Mammals*

The faunal specialist (Burger 2017) provided the following summary information – see Appendix B for the detailed assessment:

- Most of the larger mammal species that would have occurred naturally on the site have become locally extinct, leaving only a subset of small species that still manage to maintain meagre populations there. The conservation status of these mammals are almost all listed as being of Least Concern (LC), with only one species (African Clawless Otter) with a global (IUCN) and regional (Child *et al.* 2016) listing of Near Threatened (NT). Otter activity has been confirmed from the general region. The River Club itself is however unlikely to have a resident population of otters, but rather a few individuals probably move in and out of this area throughout the year;

- A total of 29 indigenous mammal species may potentially occur on the River Club grounds and immediate surroundings, but the more realistic probable mammal richness here is about 19 or so species;
- The Faunal Importance Assessment (FIA) score for Mammals on the River Club site is considered MODERATE at regional and LOW to MODERATE at national scales;
- The most important consideration in respect of local mammal assemblages is the maintenance and/ or rehabilitation of the ecological integrity of the Liesbeek and Black rivers, including a buffer region along the banks of these rivers and corridors between them.

3.3.4. *Reptiles*

The faunal specialist also found (see Appendix B for details) that:

- A total of 32 indigenous reptile species could potentially occur on the River Club grounds and immediate surroundings, but a more realistic probable reptile richness would be about 20 species;
- Of these, the conservation status of these reptiles are almost all listed as being of LC, except for the Cape Dwarf Chameleon which currently is listed as Vulnerable (VU). This particular species was recorded on the grounds of the adjacent South African Astronomical Observatory, and it may possibly also occur within the River Club grounds;
- The Faunal Importance Assessment (FIA) score for reptiles in the context of the River Club site is MODERATE at regional and LOW to MODERATE at national scales;

3.3.5. *Amphibians*

The faunal specialist provided extensive input into the presence and ecological importance of a number of amphibian species that occur on the site. While these are outlined in full on Appendix B, the most significant findings are summarised briefly below:

- A total of eight indigenous amphibian species may potentially occur on the River Club grounds and immediate surroundings, but the more realistic probable amphibian richness is about six species;
- The conservation status of these amphibians are almost all listed as being of Least Concern (LC), with the notable exception of the western leopard toad, which is Endangered (EN);
- Even allowing for the presence of a species of conservation concern (SCC) (that is, the western leopard toad), the Faunal Importance Assessment (FIA) score for amphibians in the context of the River Club site is MODERATE at regional and LOW to MODERATE at national scales;
- The following points are highlighted specifically with regard to the presence of western leopard toads on and in the vicinity of the River Club, namely:


Western leopard toad (*Sclerophrys pantherina*) Photo M. Burger

- The only known western leopard toad breeding sites in the region of the River Club are the wetlands of the Raapenberg Bird Sanctuary (RBS), and about 1.5 km south-west in Oud Molen region;
- The western leopard toad population of this specific area (that is, Observatory and surroundings), appears to be somewhat disjunct and seemingly completely separated from western leopard toad breeding populations further south on the Cape Peninsula;
- western leopard toads were found by the faunal specialist within the golf course areas of the River Club, where it is probable that some specimens spend their non-breeding season (M. Burger pers. comm. to Liz Day);
- The following four components are critical for the viability of any western leopard toad population:
  - Availability of suitable **breeding habitat**: In this case, the conservation and management of the Raapenberg wetlands are of utmost importance, as would be the creation of additional western leopard toad breeding habitat (e.g. along the western reaches of the site) in order to improve the resilience of the localised Observatory western leopard toad population;
  - Availability of habitat to provide **shelter and food (forage)**: Sufficient natural or semi-natural habitats must be available within at least a 2 km radius of breeding habitats to sustain western leopard toad individuals for the non-breeding period (i.e. about 10 months of the year). Such sectors must provide the adequate shelter and foraging requirements to sustain the animals through until the next breeding season examples of such habitats would include substantial green belts – on the River Club site, examples would include undeveloped corridors between the two rivers and especially in the areas near to the Raapenberg wetlands and the northern sector near the confluence of the rivers, and also within east/west dispersal corridors;
  - Availability of **dispersal corridors**: Multiple dispersal options between breeding habitat and year-round occupancy habitat are critical and barriers to dispersal must be limited. Connectivity must be maintained between the Raapenberg wetlands and the river regions to the west, including the area of the natural Liesbeek channel.
  - Limiting the extent of **hazardous features** and **high-risk areas**: Toad exclusion barriers to prevent/limit toad access to high-risk zones such as roads, large unvegetated areas (where they would dry out rapidly) and various pitfall structures.

With regard to the presence of breeding populations of western leopard toads in the Raapenberg wetlands, the Raapenberg wetland survey highlighted a possible anomaly, in that salinity values measured in early spring in the only standing water areas (see Photo T) in the wetland north of the footpath at that time (September and October 2017 - 2700 and 2800 mS/m respectively) were significantly higher than the highest recorded [10]salinity (594 mS/m) for water in which breeding Western leopard toads have been observed (unpublished data from M. Burger, the faunal specialist). By contrast, the so-called "backwater" wetland (south of the footpath – Photo S), had a salinity of 209

[10] Note that electrical conductivity (EC) is used in this study as a surrogate measure for salinity

mS/m, which was well within the known salinity range for breeding toads. These data suggest that the toads might in fact be breeding in the water body to the south, which is hydraulically connected to the Black River, rather than the wetlands to the north, which are connected to the water table. It is however my understanding (based on discussions with M. Burger and with reference to the faunal report) that breeding choruses from western leopard toads are often heard in the open *Sarcocornia capensis* pans immediately in front of the SAAO bird hide (Photo Ab). No standing water remained in these wetlands in the 2017 site survey, after a particularly poor wet season in the middle of a drought and it is likely that the pans would have standing water following overtopping of the river channels in wetter years, or as a result of an elevated wet season water table. Under such conditions, if they were filled with water from a flood event, their salinity would be likely to be reduced – however, it seems unlikely that such shallow systems would retain standing water long enough for tadpoles to metamorphose into toadlets – some three months later. Increasing salinities would also be experienced in these pans as a result of evapo-concentration, and the presence of *Sarcocornia capensis* suggests that salinities are likely to be well above 600 mS/m as the pans dry out.

Further west towards the SAAO boundary, a few deeper trenches / low lying areas that support *Bolboschoenus maritimus* vegetation (Photo W) might be fed mainly by river water (artificially diverted by local communities) and thus provide a better toad breeding habitat – albeit at high plant and possibly invertebrate biodiversity cost (see Box 3.2).

The above discussion around salinity and breeding habitat is not necessarily of relevance to the EIA that is the focus of this report. However, it does highlight the need for more detailed assessments of the Raapenberg wetlands including those south of the berm, during western leopard toad breeding cycles, and for a long-term salinity assessment of the wetland system, to determine exactly which of the Raapenberg salt pans and/or peripheral wetlands and "backwater" areas are being utilised as western leopard toad breeding habitat.

3.4. Summary of key ecological sensitivities

Based on the information provided in the preceding sections, the key biodiversity sensitivities of the River Club and its immediate natural surroundings can be summarised as:

- The Raapenberg wetlands – these wetlands include important remnant seasonal clay flats renosterveld wetland, of high conservation importance, which would be particularly vulnerable to impacts such as increased hydroperiod / prolonged or more frequent wetting;
- The SAAO site includes important Threatened terrestrial renosterveld vegetation (Peninsula Shale Renosterveld) including several endemic and/or red data species;
- The wetlands also support numerous birds as well as amphibians such as endangered western leopard toads – maintenance of habitat quality for indigenous fauna requires maintenance of seasonal flow regimes and inundation patterns, which in turn affect salinity and other water quality issues. The wetlands are thus highly sensitive to:
    - Increased flood velocity, frequency, duration, or magnitude (depth);
    - Channelisation / drainage of water from the wetlands;
    - Diversion of (particularly fresh) water into the wetlands;

    - Removal of existing berms / other structures that have "accidentally" protected the wetlands from hydrological and/or water quality impacts associated with the changed hydrology, hydraulics, position and water quality of the Black River
- The Liesbeek Canal is not sensitive as a riverine habitat in its current form;
- The natural channel of the Liesbeek River is disconnected from the Liesbeek River and now functions as a backwater wetland – it does however provide habitat to important bird species and may provide breeding areas to western leopard toads;
- Connectivity across the site, especially from the Raapenberg wetlands across to the natural channel and east-west across the site is important for wetland fauna – in particular western leopard toads;
- Provision of adequate safe, vegetated terrestrial habitat for western leopard toads during their non-breeding season is critically important for the sustainability of this species on and near the site.

The above issues are considered in assigning significance levels during the Impact Assessments outlined in Section 5.

3.5. Rehabilitation opportunities

The degraded nature of much of the River Club site means that its development could present opportunities for rehabilitation / remediation of ecological function, as well as possible negative impacts. The following rehabilitation opportunities were raised by various biodiversity specialists during early Opportunities and Constraints analyses – some of these are recommended as development mitigation or offset activities in Section 5:

3.5.1. Opportunities for renosterveld rehabilitation on the River Club site:

The specialist report (Coastec 2017) identified the following possibilities for augmenting renosterveld conservation on the River Club site, namely through:

- The establishment and rehabilitation of links north and south of the site along the Black River;
- The use of shale soil and overburden, perhaps from one of the Malmesbury shale aggregate mines in the Tygerberg, to provide potential additional renosterveld substrate on the River Club site - this would be an option if infilling of the site is required, as is the case with both development alternatives considered here;
- The development of a joint initiative between the River Club and the SAAO to extend the area of dryland renosterveld on both sites.

3.5.2. Opportunities for faunal conservation / habitat rehabilitation on the River Club site

- *Birds*

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The avifauna specialist report (Appendix D) strongly advocated the inclusion of rehabilitated wetlands and other areas on the degraded portion of land to the [11]north of the River Club site into development planning, in order to:

- Improve general river and wetland habitat condition and biodiversity, using birds as a biodiversity surrogate;
- Provide an environmental node in this urbanising area, which would attract visitors to the development for bird viewing, allow for environmental education and facilitate the above two objectives.

- *Mammals and reptiles*

  The specialist recommended that a mosaic of green belts/nodes within the proposed development should be created, in order to maintain a degree of ecological resilience for the remaining faunal groups. For species like the Cape Dwarf Chameleon for example, the habitat quality of such ecological nodes could be enhanced to better suit their needs and thus improve the likelihood of maintaining a sustainable population.

- *Amphibians*

  The existence of as-yet undeveloped and rehabilitable portions of the former floodplain of the Black and Liesbeek Rivers offers opportunities to improve habitat for western leopard toads, during both breeding and non-breeding periods, through the establishment of safe ecological corridors through the site, the provision of appropriately vegetated terrestrial areas, the management of risk to these animals outside of their breeding period and the creation of suitable new breeding ponds / pans - potentially in the floodplain margins, for which rehabilitation has already been recommended.

3.5.3. *Opportunities for general river and wetland rehabilitation*

The specialist aquatic ecosystems Scoping Report (Day 2016) noted the following rehabilitation opportunities:

The natural channel of the Liesbeek River

The extent of degradation of the channel, the fact that it has not been lined (i.e. canalised) and the fact that the floodplain, although infilled, has not yet been developed, mean that the area presents extensive opportunities for rehabilitation to a point which, while unlikely ever to approach natural conditions, could provide a substantially better quality of habitat, including improved integration between permanent aquatic habitat within the channel and floodplain-to-terrestrial habitat.

From a freshwater ecosystem perspective, recommended rehabilitation interventions would include:

- Re-grading of the banks, at least on the right hand side of the river where space permits, to provide a gently sloping bank (no steeper than 1:5 and preferably as flat as 1:7 in places), vegetated with indigenous riverine and wetland vegetation – phasing of rehabilitation activities might be necessary to retain certain habitat types. The landscaping design should allow for slight variation in the position of the toe of the bank with distance along the channel, thus creating slight variation in bank steepness and a more hydraulically diverse marginal area;
- Inclusion of areas of seasonally inundated off-channel zones, along the channel margins, which would mimic more natural floodplain zones;

[11] Note that this land was included in the original terms of reference of the avifaunal specialist report. In fact, this land lies outside of the site and other than in terms of a formally agreed on off-site offset, would not be available for use in mitigation requirements

- Removal of alien vegetation, ideally including the removal of kikuyu grass but in particular (ongoing) removal of *Commelina benghalensis*, and (phased) removal of woody alien species such as Manotoka, replacing them with indigenous species that can perform the same functions in terms of habitat type (e.g. Milkwood trees (*Sideroxylon inerme*) and indigenous Willow (*Salix mucronata*);
- Possible improvement of the left hand river banks by planting the bottom of the bank with soil-stabilising indigenous vegetation; provision of indigenous trees (or dead alien tree stumps) for roosting or perching by birds); retention of stable, but vertical bare banks on the left hand channel, for use by birds that nest in banks (e.g. some kingfishers).

The mainly canalised eastern channel of the Liesbeek River

- The extent of canalisation along the channel limits opportunities for low-cost rehabilitation, without removal of the canal itself. This said, removal of all or sections of the concrete canal, and its replacement with an alternative lined structure (e.g. stepped gabion baskets with allowance for planting, particularly along the lower, wetter steps) would result in a significant improvement in river quality in these reaches, improving ecological connectivity along the marginal vegetation zone. Such measures would need to be informed by input from a hydrologist regarding their implications for flood conveyance. Given that there is already clearly a need to address collapse of sections of the canal (Photo P), such interventions should be designed with a view to improving river habitat and not simply maintaining it;
- An alternative approach would be the removal of the canal altogether and its replacement with a more natural lowland river channel – this would be a major (but highly beneficial) intervention in terms of cost and design.

The Black River

Recommended rehabilitation interventions could include:

- Re-grading of the left hand river bank, to provide a gently sloping bank (no steeper than 1:5 and preferably as flat as 1: 7 in places), vegetated with indigenous riverine and wetland vegetation;
- Inclusion of areas of seasonally inundated off-channel zones, along the channel margins, which would mimic more natural floodplain zones;
- Removal of alien vegetation, ideally including the removal of kikuyu grass, cannas and exotic trees (e.g. *Salix babylonica*) and replacing the latter with indigenous species that can perform the same functions in terms of habitat type, e.g. Milkwood trees (*Sideroxylon inerme*) and indigenous Willow (*Salix mucronata*).
- The opposite side (right hand banks) of the Black River also offers opportunities to rehabilitate / create broad wetland areas along the opposite bank of the river, between the M5 and the river bank;
- In addition, as outlined in the avian report in some detail, the proximity of the various river channels and their associated wetlands to the development area also offers opportunities for the development of an important recreational and ecological amenity area, of enhanced value for bird- and other aquatic ecosystem function and condition, but also offering opportunities for walking trails along the river and improved human connectivity within the Two Rivers Urban Park (TRUP) area.

3.6. Opportunities to improve amenity value and public access

It is also recognised that re-development of the River Club site potentially affords opportunities to improve connectivity along the Black and Liesbeek Rivers, by tying into existing walking trails. Such approaches would, if considered further, need to take cognisance of broader community initiatives to improve community access and amenity value, as well as to ensure that measures included did not

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compromise important ecological issues around habitat quality, rehabilitation and sustainable management.

4 DEVELOPMENT PROPOSALS FOR THE RIVER CLUB

During the course of FCG's involvement in this project, the proposed development footprint and layout of both development alternatives have undergone a number of changes, largely as a result of extensive, iterative feedback into the project, by specialists and other members of the design team.

Two development alternatives are being considered, as well as the "no development" / maintain the *status quo* alternative.

This section outlines this specialist's understanding of these alternatives, at the time of this report compilation. The assessment of impacts to aquatic ecosystems outlined in Section 6 is based wholly on the premise that this understanding is substantially correct.

4.1. Development overview

Aurecon (2017b) describes the proposed River Club development as comprising approximately 150 000m² of mixed-use development, including retail, office, residential, hotel, community and institutional uses. Development would occur in 2 precincts, namely:

- Precinct 1, located in the southern portion of the site (between the SKA boundary, the SAAO boundary and natural channel of the Liesbeek River) – if developed this would contain approximately 65 000m² of mixed-use floor space (office, retail, hotel, community and residential) in buildings of between 1-10 storeys; and
- Precinct 2, located in the northern portion of the site (bounded by the natural channel of the Liesbeek River on the PRASA and Liesbeek Parkway edges) – if-developed this would accommodate approximately 85 000m² of residential and office floor space in buildings of between 10-12 storeys. Both precincts would be set upon super basements containing parking.

Integral to the above development would be the following components:

- Implementation of the Berkley Road extension, linking Berkley Road (to the east of the site beyond the Black River) with Liesbeek Parkway (to the west) – this would require construction of a bridge over the Black River, as shown in, and a bridge over the natural channel of the Liesbeek River (**Figure 4.1**);
- Approximately 80 000m² (± 55%) of the site would be raised above the 100-year flood elevation to approximately 7m above mean sea level.

4.2. Development alternatives

The main differences between the two development alternatives shown in **Figures 4.1-4.6** revolve around the proposed treatment of the Liesbeek Canal and the natural channel of the Liesbeek River, with Alternative 1 allowing for the rehabilitation of the canal into a more natural, un-lined channel, and the infilling of the natural channel to create a landscaped open space and stormwater swale system, while Alternative 2 would allow for retention of the canal, with minor landscaping and softening of its edges, and the protection and rehabilitation of the natural channel into an albeit disconnected and rendered unnatural but still functional wetland.

Both development alternatives would incorporate a wide (ranging from 65m at its narrowest to 100m wide at its widest point – T. Florence, Planning Partners, email to Liz Day) ecological corridor that would extend across the site in an east-west direction between the development parcels of Precinct 1 and Precinct 2, connecting the Liesbeek Canal / rehabilitated riverine corridor (to the east) and the natural Liesbeek channel / stormwater swale (to the west). This corridor has been designed in terms

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of both development alternatives for faunal movement through the site – in particular, movement and the provision of terrestrial habitat during non-breeding periods for the western leopard toad. The open space of the ecological corridor would also allow for flood attenuation during periods of high rainfall, as well as perform the function of a landscaped public space on the site. Sizing of the corridor was carried out with input from the wetland ecologist and the faunal specialist.

In addition to the main east-west corridor, the landscape plan also allows for:

- A minimum 10m wide corridor along the southern (SKA) boundary of the site – this would not be crossed by any roads in terms of the proposed design;
- With the exception of one building on the western corner of the development (15 in Figure 4.1) a minimum 10m wide corridor between the toe of Berkley Road extension and the building edge – access to the site would be from this new road;
- Provision for at least two culverts under the road to allow for faunal passage into the presently undeveloped open space to the north, between the natural Liesbeek channel and Berkley Road;
- A corridor along the western edge of the site – this area, which presently includes the natural Liesbeek channel, is however treated differently in the two alternatives.

Proposed redevelopment of the River Club, Observatory:
Environmental Impact Assessment: Biodiversity

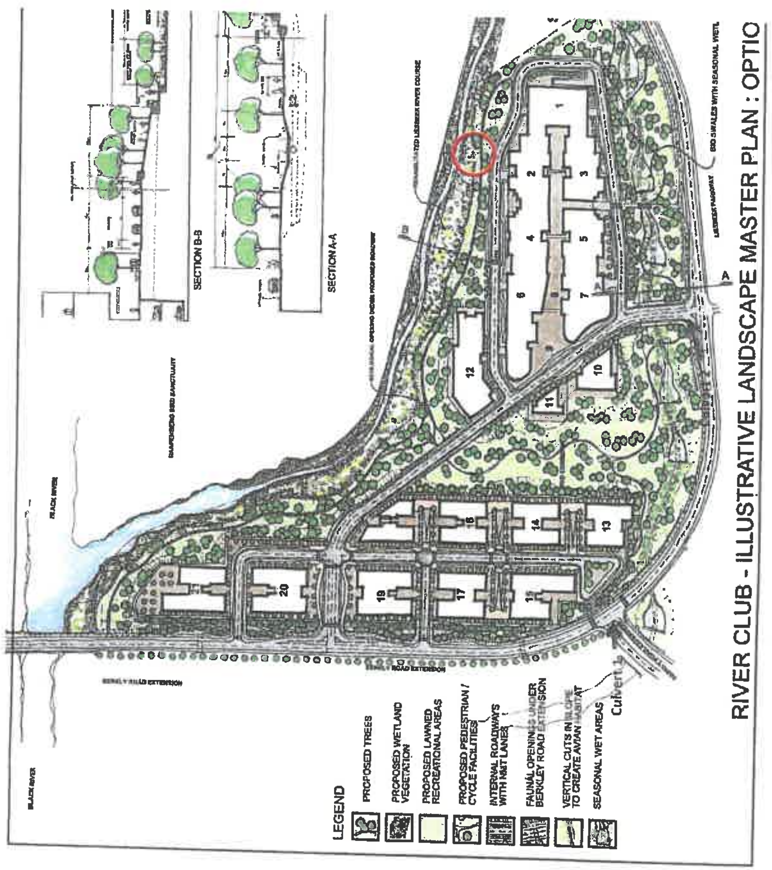

Figure 4.1
Alternative 1 with open space areas shown in green. Figure as supplied by Planning F
Red circle added to show area where corridor is at its narrowest – and at the widths indicated in F

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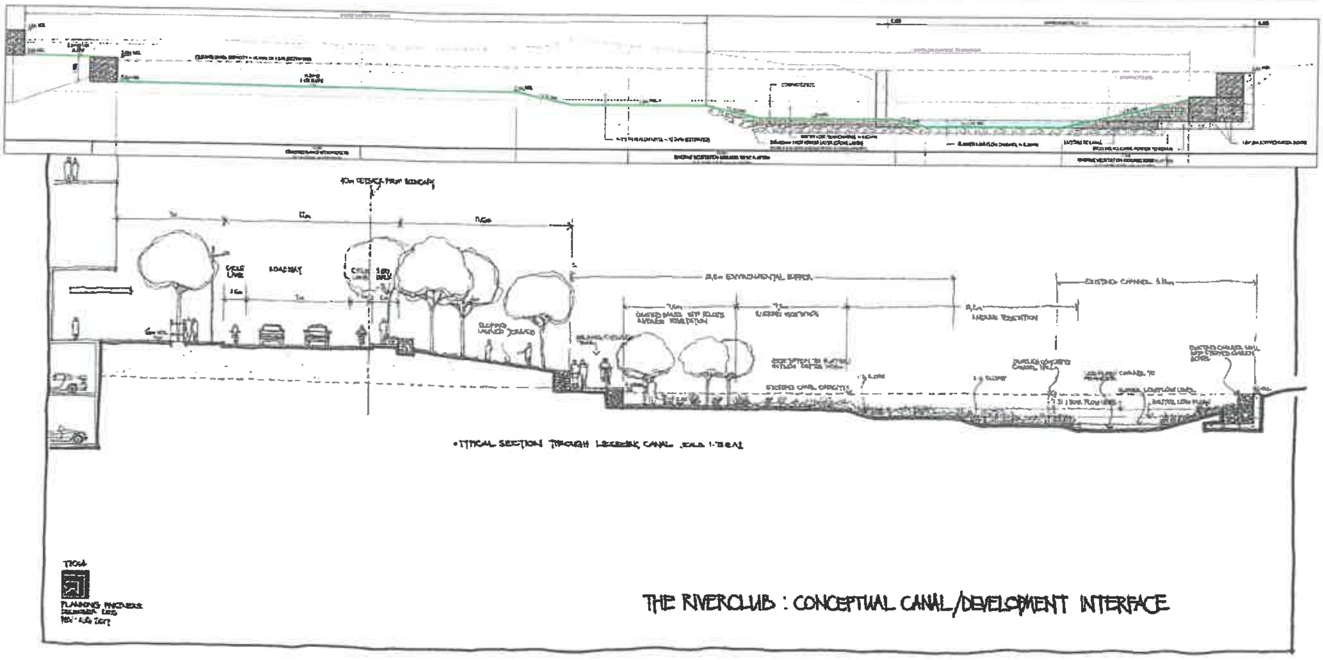

Figure 4.2
Alternative 1: Canal rehabilitation layout (Cross section BB in Figure 4.1). Figure as supplied by Planning Partners. Inset (top): showing flow levels and velocities – section supplied by Aurecon.

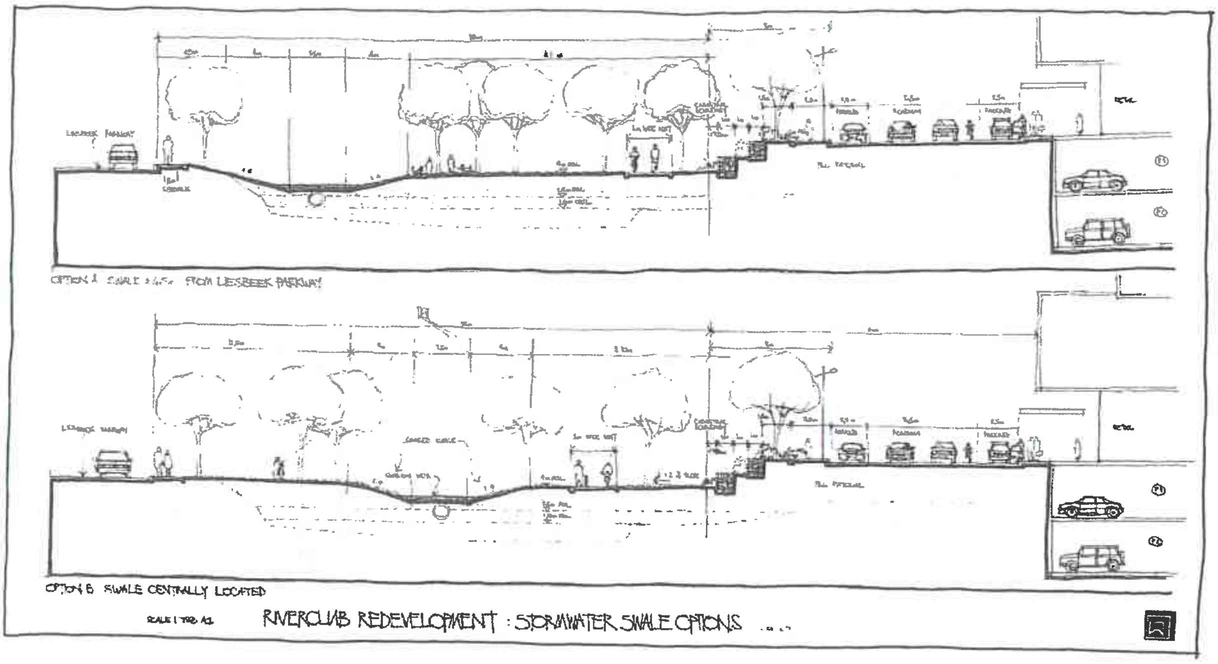

Figure 4.3
Alternative 1: Treatment of the natural Liesbeek River channel area (Cross section AA in Figure 4.1). Figure as supplied by Planning Partners

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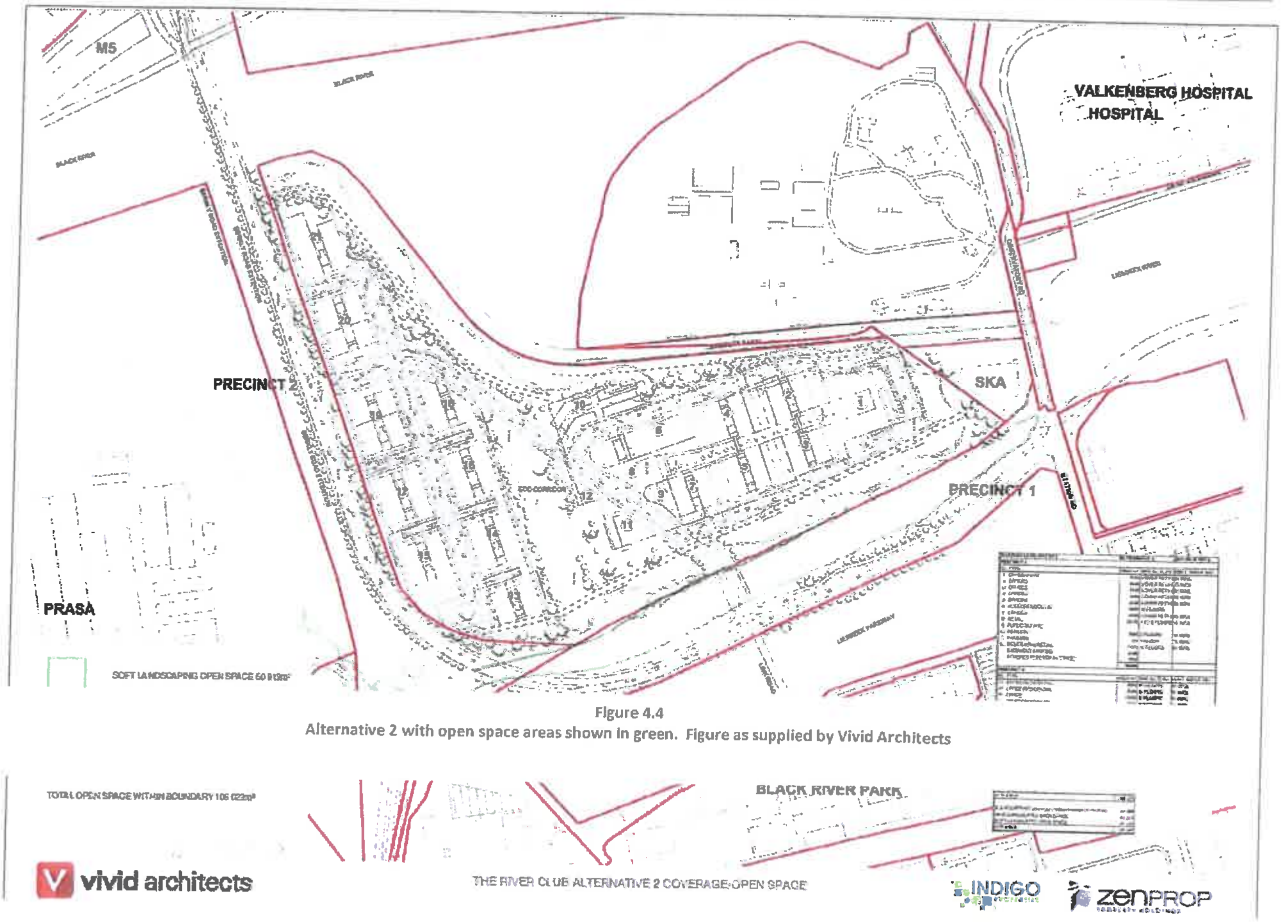

Figure 4.4
Alternative 2 with open space areas shown in green. Figure as supplied by Vivid Architects

Proposed redevelopment of the River Club, Observatory:
Environmental Impact Assessment: Biodiversity

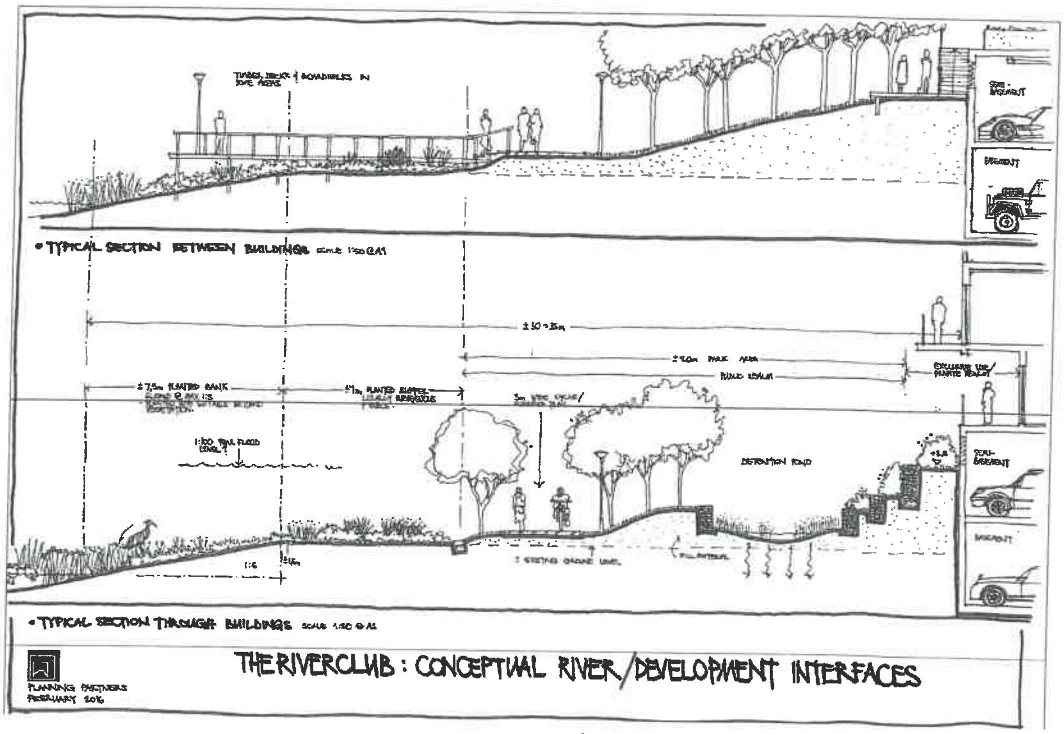

Figure 4.5
Alternative 2: Treatment of the natural Liesbeek River channel area. Figure as supplied by Planning Partners

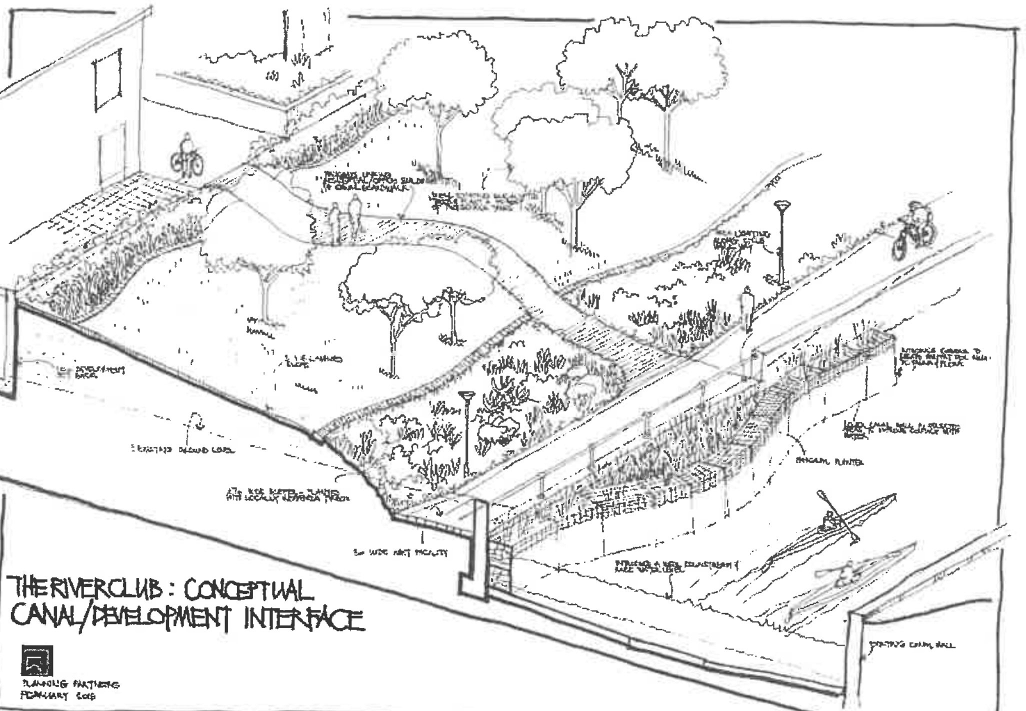

Figure 4.6
Alternative 2: Treatment of the canal area. Figure as supplied by Planning Partners

4.2.1. *Development alternative 1*

This is the developer's preferred alternative, developed as an iterative process between the engineering, landscape architect and biodiversity specialists. The treatment of the canal and natural Liesbeek channel, shown in cross-section in **Figures 4.2** and **4.3** can be summarised as follows:

The Liesbeek Canal

The design intention of this measure would be to create a largely unlined (except for the right hand river bank) river channel that mimics natural lowland river function and has sufficient space to allow for flooding and channel migration processes that do not result in channel incision or significant erosion of the riverine corridor or development platform. It is understood on the basis of conversations with the design engineers for this approach that the space allocation for the rehabilitated river is sufficient to address these concerns.

The design allows for:

- Removal of the existing left hand wall of the Liesbeek canal and its floor (barring a short section on the right hand abutting the canal wall;
- Use of stepped gabion baskets to stabilise the right hand canal wall, which abuts the steep hillslope of the SAAO;
- Provision of sufficient space to allow for the river low flow channel to meander across a relatively flat, reed-lined bed – it is assumed that the river would form its own channel – a width of some 10m is assumed for the summer base flows with the Aurecon hydrological specialists modelling the height of wet season base flows and with an allowance of an additional 15.2m lateral space to accommodate the estimated height of the 1:1 year return interval flood, as illustrated in **Figure 4.2**, and allowing for a slight, low bank, shaped roughly to a slope of 1:4 to create a slightly elevated floodplain to accommodate within-year floods;
- At the narrowest point in the corridor (circled in **Figure 4.2**) at the upstream extent of the site, an ecological buffer area of at least 15m has been allowed upslope from the 1:1 year floodline, and the landscape intention is to vegetate this with appropriate low-growing vegetation for the first 7.5m and thereafter to allow for the establishment of vegetation including riparian trees within the next 7.5m of ecological buffer / corridor;
- A 1m high gabion wall then steps up to a cyclist / pedestrian pathway – the gabion wall is intended to restrict the passage of fauna such as western leopard toads out of the ecological corridor and into the development area;
- Upslope from the pedestrian pathway is a further buffer area some 11.5m wide – the landscape intention here is that the area would be lawned and would permit social uses such as playing, picnicking, but it would also serve as an additional buffer area;
- The 'recreational' buffer area would be edged by a second pedestrian pathway / cycle lane, abutting the roadway – this path would also be edged on its riverine side by a raised gabion wall, again intended to discourage access by western leopard toads;
- The above is the narrowest point in the river corridor – **Figure 4.1** shows that where there is more space, both the lower river corridor and the upper recreational corridor vary and widen as space permits.

The natural channel of the Liesbeek River

In this alternative, the ecological focus is on rehabilitating the canal to more natural riverine function. Rehabilitation of the natural channel to riverine function was not deemed feasible, given the extent of development in the area, which precludes the necessary channel re-alignment to accommodate more concentrated flows than would have been the case in the past. Connecting the channel with the channel upstream of Observatory Road was also considered problematic. In this scenario, then, the following concept would apply (see **Figure 4.3**):

- Infilling of the channel to create a wide vegetated open space area, with both amenity and stormwater polishing function, as well as the provision of terrestrial and possibly breeding season habitat for western leopard toads;
- Stormwater from the site would be piped to the swale, and daylight as open channel vegetated bioretention swales;
- Allowance has been made for the creation of a few seasonally inundated areas within the swale, by the placement of low weirs at intervals, behind which water can back up;
- Stormwaterflows that currently enter the channel at a low level from the urban development to the west of Liesbeek Parkway would be piped under the infilled swale;
- The development side of the swale would step up steeply using gabions, to discourage western leopard toad passage into the development, and toad barriers would be used as described for the pathways edging the rehabilitated canal;
- The Liesbeek Parkway side of the swale would slope gently up to a walkway, potentially to be created along the edge of the road;
- A minimum setback of 10m from the swale was agreed on by the development team – where the swale is located further from the edge of the site, development could in theory extend to the edge of the site. This principal was agreed on with the development team, in order to create additional space along the riverine corridor. The two swale concepts shown in **Figure 4.3** illustrate this idea.

4.2.2. *Development alternative 2*

This alternative (shown in layout form in **Figure 4.4**) allows for the following treatment of the canal and natural channel:

The natural channel of the Liesbeek River

This system forms the ecological focus of this alternative, the layout and landscape design of which allow for improvement of wetland function in this system, by flattening of banks, replanting and the creation of broad seasonally inundated fringing wetlands and ecological buffers with some amenity value. The alternative, shown in **Figure 4.5**, would allow for:

- Grading of the existing right hand channel bank at a grade of 1:5 or flatter, over a width of about 7.5m, followed by an area of some 7m planted with locally indigenous vegetation with the emphasis on habitat creation;
- The remainder of the low-lying corridor is shown as an area of about 20m width in which footpaths / cycle tracks and stormwater detention and treatment can take place;

- The low-lying area is stepped steeply up to the development platform with gabion baskets.

The Liesbeek Canal

This system is not the focus of ecological improvement in this alternative and the landscape intention is to provide aesthetic improvement to the canal but not to attempt to improve habitat diversity or river function. The canal (shown in **Figure 4.6**) would be treated in this alternative as follows:

- It would be edged by a minimum buffer of 20m between the top of the canal and the hardened development edge – this area would include paths and cycle tracks and would be planted with locally indigenous plants;
- The existing gum trees along the canal would be felled and replaced with locally indigenous plantings including trees;
- A low weir could be introduced to allow for a spread of water across the canal to facilitate water sports such as canoeing;
- The top of the left hand canal could be pulled back to create planting areas along the top of the bank.

4.3. Common development aspects

- Raising of the development platform: A large portion of the site is currently likely to be flooded by storm events with an approximate return interval (RI) of two years (Aurecon 2017a). Development of the site would require raising of the built environment to levels above the 1:100 year RI. Aurecon (2017b) notes that this would be achieved by imports of substantial fill material (approximately 220 000m^3) that would be placed on the built perimeter of the site, while the central part of the site would be raised with basement structures. The conservation areas, ecological corridors, Liesbeek canal and natural channel of the Liesbeek River / open space swales would not be filled but would remain at natural ground level, unless otherwise required as part of the respective rehabilitation and landscaping programmes for these areas.
- Construction processes: Due to the shallow groundwater table and poor founding conditions on the site, deep excavations will be avoided where the underlying bedrock is deep below the existing ground level and the water table. Where the bedrock is at relatively shallow depth (on the southern portion of the site) it may be feasible to excavate down to the bedrock and install one basement level below the existing ground level. Therefore, where the rock is deep, basement structures would be constructed on grade with fill placed around them. Bulk excavation would be limited in most cases to the excavation of 300 to 500 mm of loose topsoil and rubble to be replaced with a 300 mm thick end tipped crushed rock pioneer to create a stable working platform for construction. Where the rock is shallower (at the southern end of the site) consideration will be given to constructing one of the basements level below the existing ground level. This would entail taking foundations and perimeter walls down to the underlying rock levels. Alternatively, the same procedure can be followed as for basements where the underlying bedrock is deep. [This information courtesy of Zenprop]
- Construction phasing: **Figure 4.7** shows the conceptual phasing of construction activities on the site, with the Berkley Road Bridge over the Black River and onto the site being proposed as the first construction activity. Activities such as the treatment of the natural river channel and Liesbeek canal are not shown in this phasing programme. Note however that subsequent

to initial discussions around project phasing, it was noted by the development team that the numbered phases shown in **Figure 4.7** might not necessarily be consecutive, as they might be dictated by funding availability. The ecological implications of this are addressed in Section 5.2;

- Stormwater management design:
    - Attenuation of peak flows: Aurecon (2017b) notes that application will be made to the City of Cape Town for a departure from its Management of Urban Stormwater Impacts Policy with regard to stormwater attenuation, on the grounds that the site is so low-lying that attenuation will add no significant value;
    - Water quality amelioration: The City of Cape Town's Management of Urban Stormwater Impacts policy (City of Cape Town 2009) would be implemented, using a system of vegetated swales (designed for extended detention where necessary) on the perimeter of the site, underlain by a formalised piped drainage network (Aurecon 2017b). **Figure 4.8** illustrates such a swale, after Aurecon (2017b).
- Irrigation water: Aurecon (2017b) notes that the use of treated sewage effluent as well as of river water for irrigation of landscaped areas has been ruled out, as a result of ecological concerns regarding its impact on aquatic ecosystems. This issue is not considered further in this assessment.

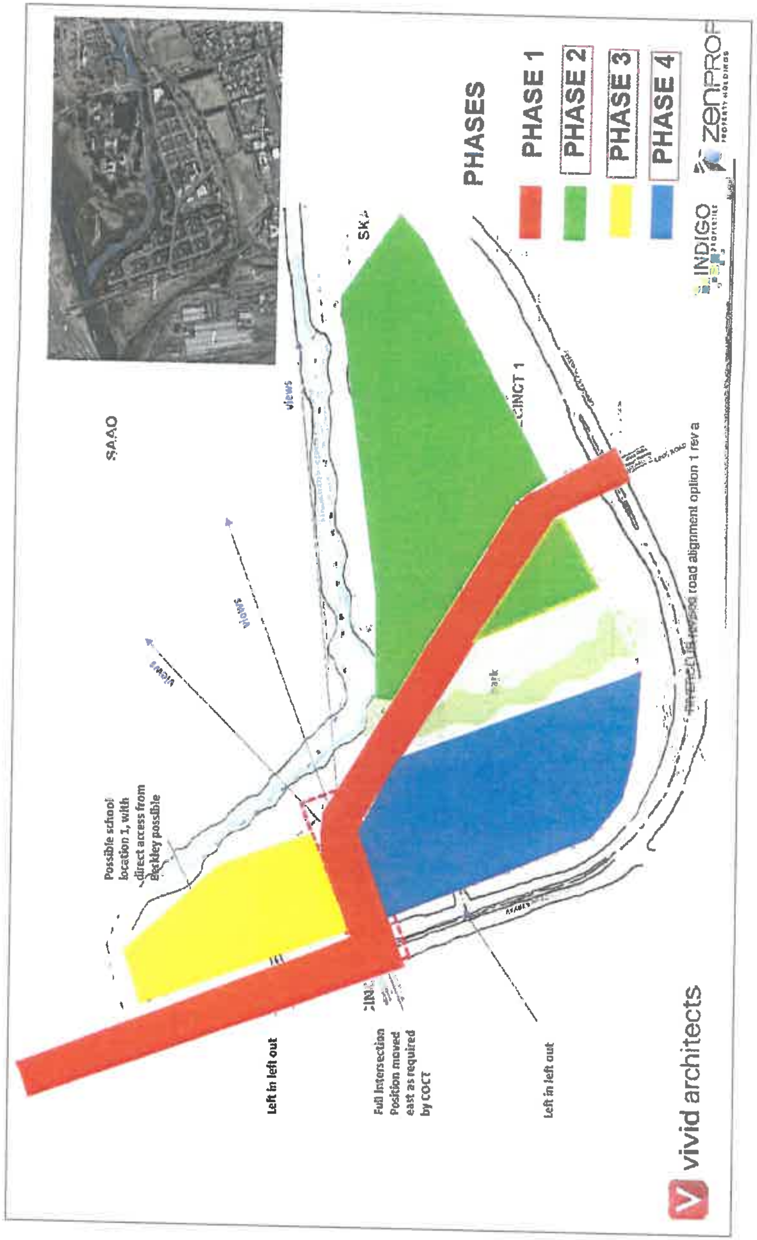

Figure 4.7
Proposed development phasing. Figure as supplied by Vivid Architects

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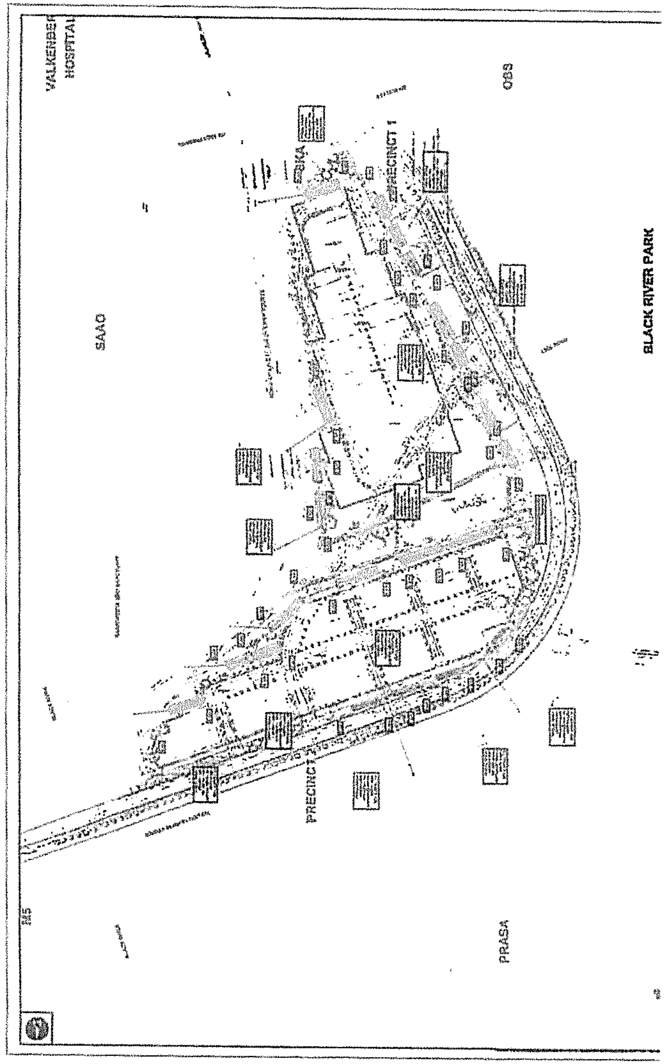

Figure 4.8
Layout of proposed stormwater swales. Figure supplied by Aurecon

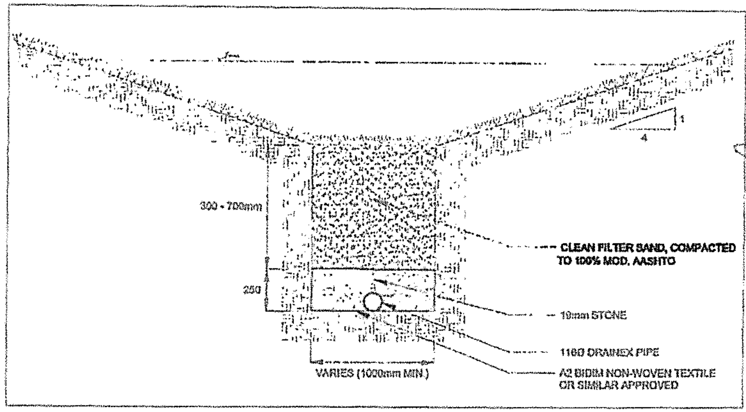

Figure 4.9
Proposed stormwater swale
Figure after Aurecon (2017b), with potential for extended detention if check dams placed along surface of swale

- <u>Sewage conveyance</u>: The following infrastructure, the alignment of which is shown in Figure 4.10) would be required to convey sewage and other waste water from the new development to an existing municipal discharge point in Station Road (Aurecon 2017b):
  - Two new pump stations, one in each Precinct – the pump stations would be located in plenum chambers in the basements, to contain spillage / leakage and minimise the chance of its passage into watercourses in the event of malfunction – the sump would have a 6 hour overflow capacity, after which sewage would pass into the plenum. Aurecon (2017b) outlines a reaction plan framework in the event of power or pump failure;
  - Two 160mm diameter HDPE rising mains – these would convey sewage from the pump stations to a break-pressure manhole outside of the site – they would run mainly in the basements of the built precincts, but would be trenched in for a short distance between the basements and the property boundary, with a single 160mm diameter HDPE rising main crossing Liesbeek Parkway to tie into the existing mains, and gravity feed from here. The east-west ecological corridor and the natural channel of the Liesbeek River / swale area would be crossed by these pipelines;
- <u>Sewage treatment</u>:
  - The City of Cape Town's Athlone Waste Water Treatment Works would treat effluent from the site (Aurecon 2017b).

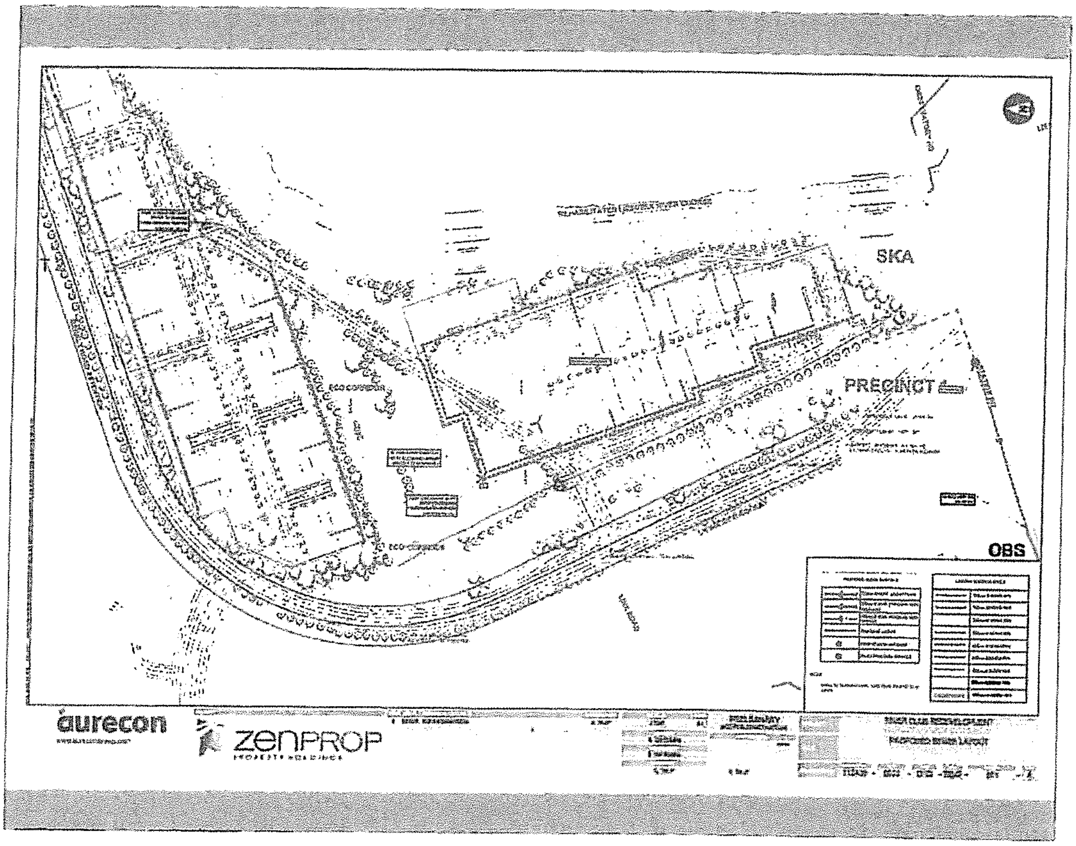

Figure 4.10
Layout of proposed sewer. Figure supplied by Aurecon

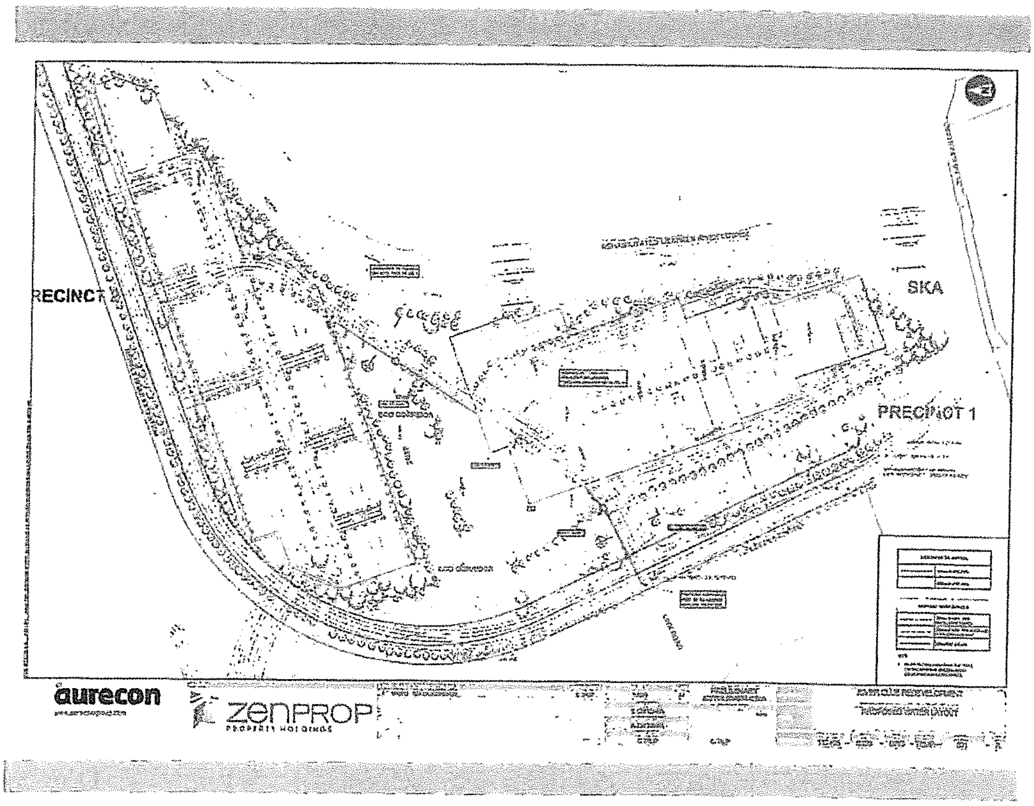

Figure 4.11
Layout of proposed water supply pipelines. Figure supplied by Aurecon

- Potable water supply:

PVC piping would be used to connect the development to an existing main that runs along the edge of Liesbeek Parkway (**Figure 4.11**). This pipeline would cross over the (Alternative 1) swale area abutting Liesbeek Parkway in the south eastern corner of the site, and would also cross through the ecological corridor, following the alignment of the proposed new road.

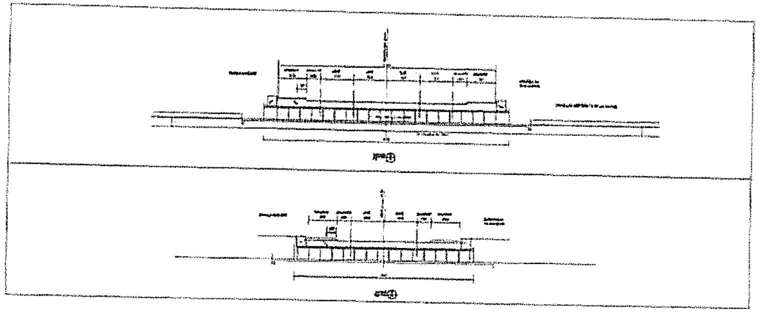

Figure 4.12
Treatment of roads and crossings to address Western Leoopard Toad safety concerns

- Internal road design to address concerns about Western Leopard Toads : Iterative discussions took place between the biodiversity specialists (Liz Day and Marius Burger) and the project engineer and landscape architect (Mr Carshif Talip (Aurecon) and Mr Jaco Jordaan (Planning Partners), respectively, regarding the need to use engineering and landscape design to discourage the movement of western leopard toads onto roads and the building platform as a whole. **Figure 4.12** presents the design response to such discussions, with vertical 0.5m gabion baskets edging the road, presenting a high, steep edge to the soft vegetated swale below within the open space corridor. This is intended to discourage scaling by these toads, while access back into the corridor would be facilitated by the lower step up to the top of the gabion from the pavement side. The swale that abuts the gabion has side slopes of 1:4 on either side of the swale.
- Bridge design: Major bridge / culvert structures would be constructed at four locations on the site, as shown in Figure 4.13, and at two minor locations along Berkley Road extension, namely:
  - A **bridge over the Black River (Berkley Road extension)**, constructed on piers as shown in **Figure 4.14** and including the following design elements (both alternatives):
    - Four piers support the bridge crossing over the river – one of the piers is located on the top of the river bank itself, with the fill platform extending to the edge of the pier;
    - Two 1500mm x 1500 mm box culverts would be constructed on either side of the crossing, to facilitate faunal passage along the top of the bank, through the infilled road structure. The culverts would be sited to include an area just above the 1:50 year floodline;

    - Gabion baskets would be used to line the road edge where the new road ties into the existing road;
    - Stormwater outlets channel water from the existing road into the Black River in unlined grassed channels;
  - Two culverts connecting the River Club development side of Berkley Road extension with the as-yet undeveloped land on the western (PRASA) side of the new road (see **Figure 4.1**);
  - A series of culverts under the Liesbeek Parkway connecting road (see Figure 4.13) where it crosses over the **ecological open space corridor.** These culverts are intended to allow the passage of both floodflows and small fauna including Western Leopards Toads under the road (**Figure 4.15**) and include, over an approximate 90m length of road:
    - Two sets of two 1500x600mm culverts;
    - One set of three 1500 x 1500mm culverts;
    - Shaping of the ecological corridor up towards the road surface;
  - A series of culverts over the northern end of the landscaped swale (Alternative 1) or the rehabilitated natural Liesbeek channel (Alternative 2), just upstream of where the channel swings east towards the Black River – these culverts (**"Culvert 1"** in **Figure 4.1 and 4.13**) would comprise (see Figure 4.16):
    - Four 1500 x 1500 mm box culverts, set in the current "low flow"section of the natural Liesbeek channel;
    - Edging of the road / pedestrian walkway along the length of the road with 500mm high gabion baskets to limit wetsren leopard toad passage up onto the road on either side;

It is assumed for purposes of this assessment that the structure would be the same for both Alternatives 1 and 2, with the dowbnstream end of the landscaped swale of Alternative 1 being completely accommodated by the width of the four culverts, but with only part of the downstream end of the rehabilitated channel of Alternative 2 being spanned by the culverts and the rest of the channel needing to be filled in at this pinch-point;

  - A series of culverts at the Liesbeek Parkway end of the new Liesbeek Parkway connecting road ("Culvert 2" in **Figure 4.1**) comprising (see Figure 4.17):
    - A total of five 1200x600 mm box culverts (three on the right hand side and two on the left hand side of the channel, facing downstream) and on the higher ground above the current channel level to allow terrestrial / flood time faunal connectivity along the landscaped swale (Alternative 1) or rehabilitated natural channel of the Liesbeek River (Alternative 2);
    - Three 1200 x 600mm box culverts located in the lower-lying landscaped swale (Alternative 1) or rehabilitated natural channel of the Liesbeek (Alternative 2) to convey flows;

It is again assumed for purposes of this assessment that the structure would be the same for both Alternatives 1 and 2.

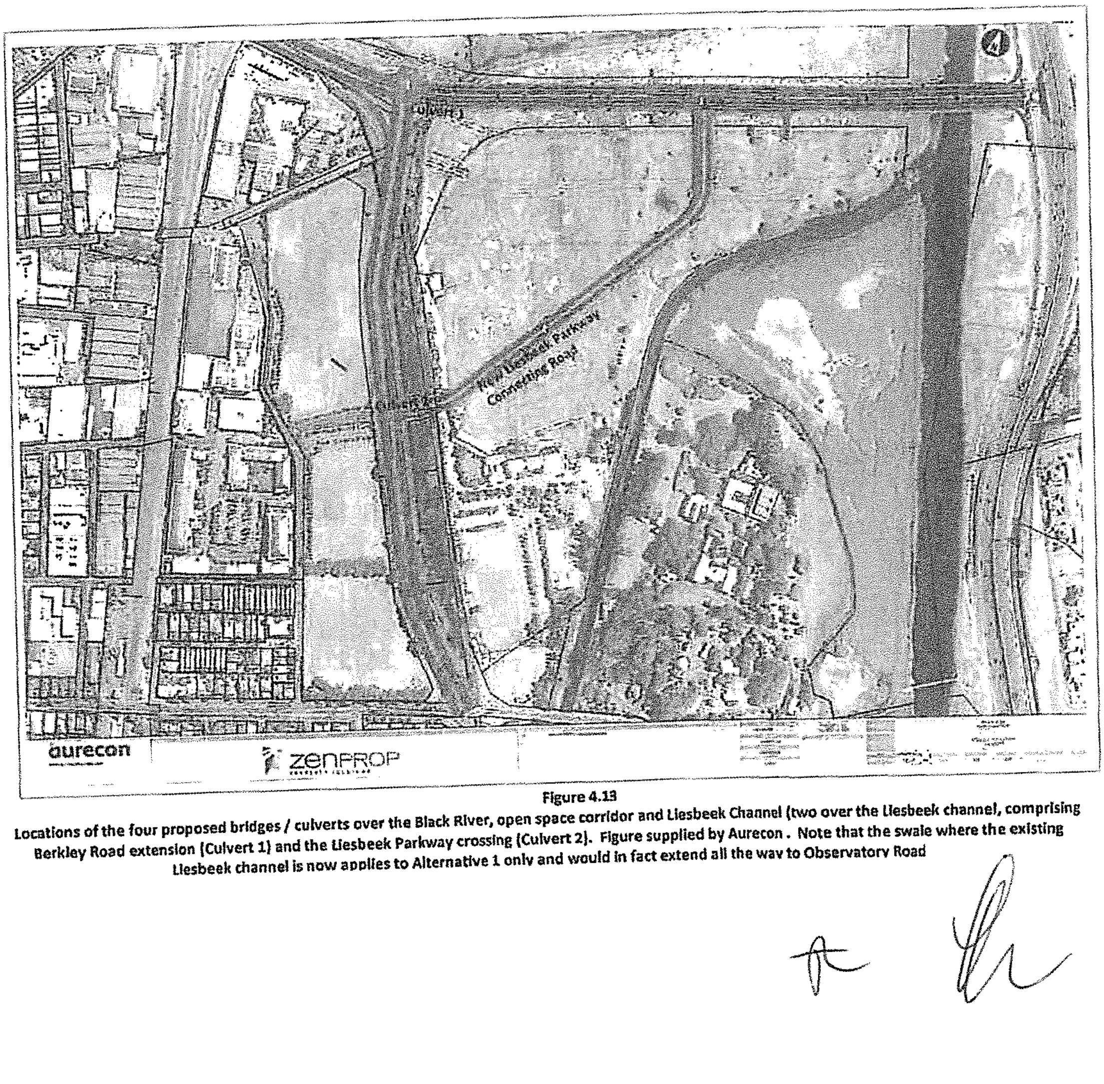

Figure 4.13
Locations of the four proposed bridges / culverts over the Black River, open space corridor and Liesbeek Channel (two over the Liesbeek channel, comprising Berkley Road extension (Culvert 1) and the Liesbeek Parkway crossing (Culvert 2). Figure supplied by Aurecon . Note that the swale where the existing Liesbeek channel is now applies to Alternative 1 only and would in fact extend all the way to Observatory Road

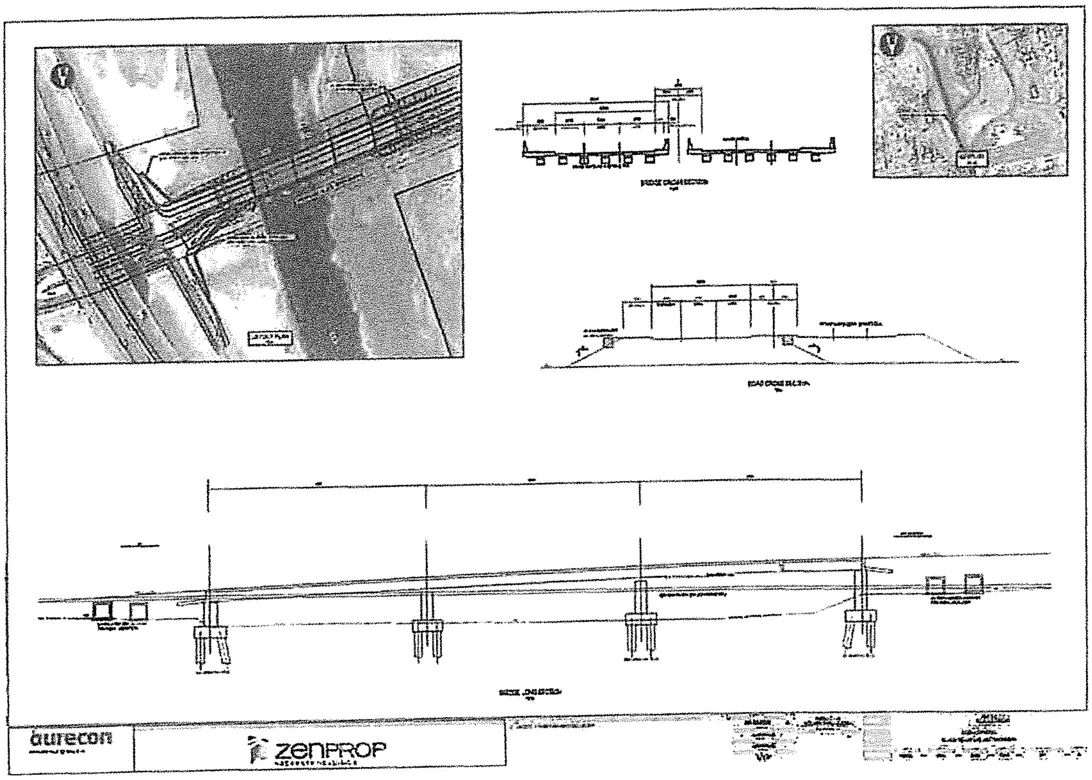

Figure 4.14
Design and Layout of proposed Berkley Road bridge over the Black River. Figure supplied by Aurecon

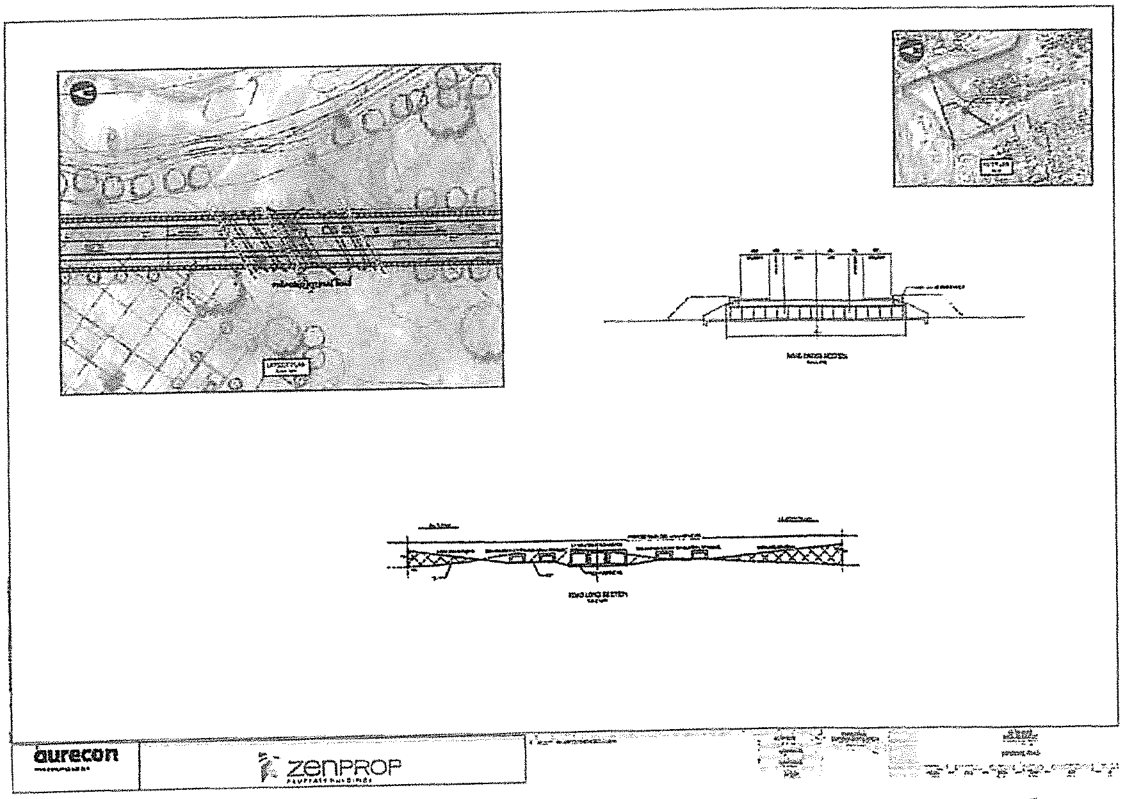

Figure 4.15
Design and Layout of proposed bridge / crossing over the open space / ecological corridor.
Figure supplied by Aurecon

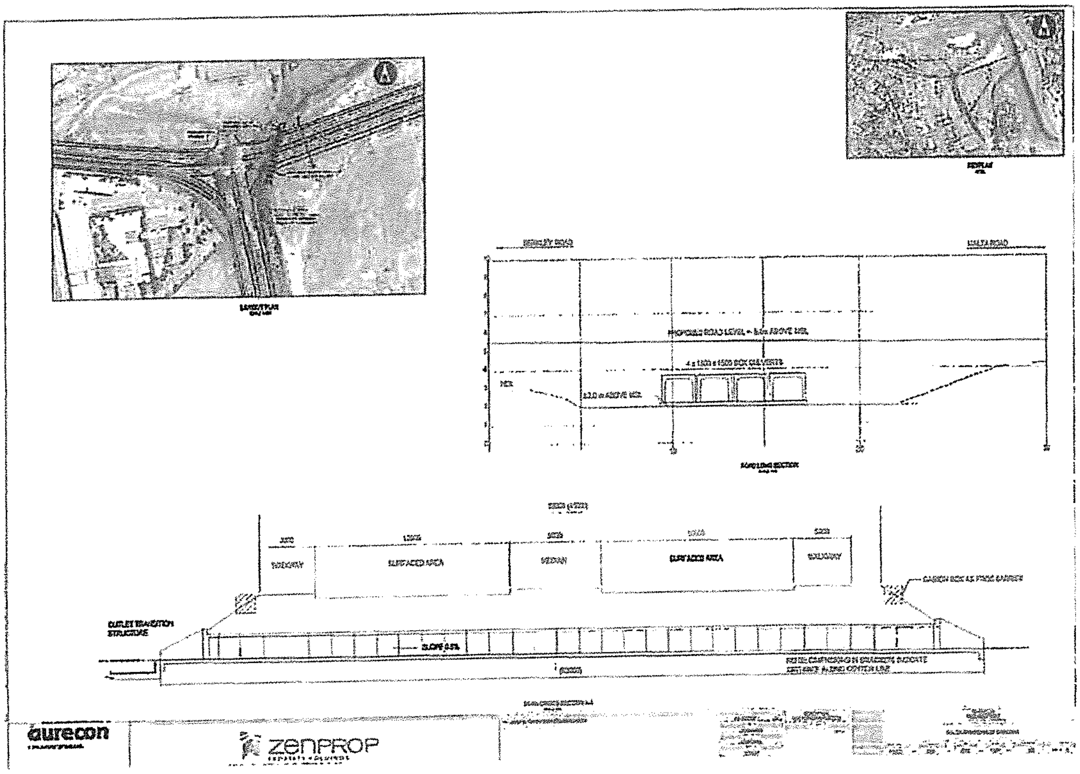

Figure 4.16
Design and Layout of proposed Culvert 1 over the natural channel of the Liesbeek River – same design for both alternatives, with the bridge at the downstream end of either the wetland swale (Alternative 1) or the rehabilitated natural channel of the Liesbeek River (Alternative 2)
Figure supplied by Aurecon: March 2018.

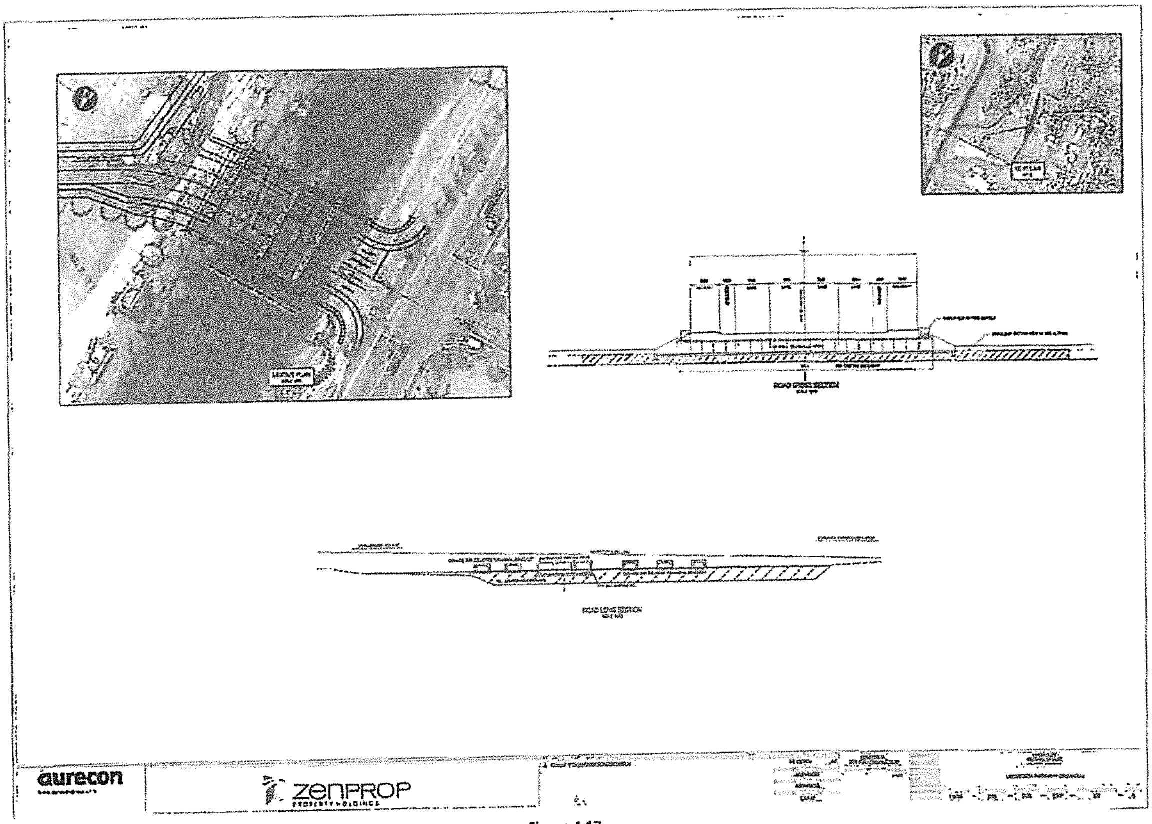

Figure 4.17
Design and Layout of proposed Culvert 2 over the (proposed -Alternative 1) swale area or (Alternative 2) over the rehabilitated natural channel of the Liesbeek River . Figure supplied by Aurecon: March 2018.

5 ASSESSSMENT OF IMPACTS ASSOCIATED WITH THE PROPOSED DEVELOPMENTS

This section describes the implications of the various components of the proposed River Club development for biodiversity as a whole, including the freshwater ecosystems, terrestrial and aquatic flora and fauna described in Section 3, using the assessment rating provided by SRK and included in Appendix F. The various alternatives are assessed formally in **Tables 5.1 to 5.15**.

During the course of FCG's involvement in this project, the proposed development footprint and layout of both development alternatives have undergone a number of changes, largely as a result of extensive, iterative feedback into the project, by biodiversity specialists and other-members of the design team. This process resulted in issues such as the avoidance of (ecologically) sensitive areas, the incorporation of ecological setback areas and faunal movement corridors in accordance with biodiversity specialist requirements and the strategic selection of opportunities that would enhance ecosystem function, quality or sustainability, while affording various development opportunities. To some extent, then, the development alternatives considered in this study already include a substantial level of mitigation, and the significance of the impacts considered in this section tend to be positive, or low to medium even without mitigation, despite the scale of development proposed.

Such an approach means that, if authorised, the selected development would, from a biodiversity perspective, potentially not require substantial revising to incorporate additional mitigation measures. However, the risk of such an approach is that some measures, assumed in assessment to be part of the planned development, are not explicitly included in the Authorisation. This author has experience of such projects, where subtle changes in development layout, design and implementation have significant implications for the end ecological outcome, but are not explicitly addressed in the mitigation measures, because they were included, but not overtly, in the assessed design.

Fundamental to the present assessment is thus the understanding that the design elements described in Section 4 and included in the figures of that section are assumed to be explicitly part of any future development authorisation for the relevant authorisation, unless mitigation measures outlined in this report require otherwise.

Since mitigation measures mostly revolve around improving the certainty of the positive aspects of the development outcomes, these are grouped together, as measures required for each phase.

5.1. Impacts of layout and design

The following 15 issues deriving from project layout and design are likely to result in impacts (both negative and positive) to aquatic ecosystems and/or overall biodiversity:

- Changes in the habitat quality and ecological functioning of the Liesbeek Canal (see section 5.1.1).
- Loss of terrestrial habitat for indigenous fauna (see section 5.1.2).
- Loss / degradation of indigenous floral communities / important floral populations (see section 5.1.3).
- Changes in faunal connectivity (see section 5.1.4).
- Increased western leopard toad mortalities (see section 5.1.5).

- Changes in flow regime into the Raapenberg wetlands (see section 5.1.6).
- Loss and degradation of riverine wetlands along the Black River margins (see section 5.1.7).
- Loss and/or changes in wetland habitat quality and availability in the areas of the natural Liesbeek River channel (see section 5.1.8).
- Faunal fatalities (particularly western leopard toads) as a result of construction activities (see section 5.2.1).
- Water quality and habitat deterioration as a result of diversion of river (Black River and Liesbeek Canal) and wetland (natural Liesbeek channel) flows during construction (see section 5.2.2).
- Degradation of downstream habitat in the Liesbeek Canal, lower natural Liesbeek channel and Black River (see section 5.2.3).
- Disturbance of watercourse bed and banks during infrastructure installation (see section 5.2.4).
- Degradation of habitat quality or failure to realise opportunities for improved habitat quality and biodiversity conservation / improvement as a result of inadequate or ill-advised channel and open space maintenance activities (see section 5.3.1).
- Contribution to deterioration of water quality in the Liesbeek and Black Rivers (see section 5.3.2).

5.1.1. *Changes in the habitat quality and ecological functioning of the Liesbeek Canal*

Impact description

- **Alternative 1:**

In this alternative, the Liesbeek Canal would be rehabilitated into a functional river channel. It would be edged with gabions on its right hand side, but effectively the canalisation effects (low biodiversity, low habitat heterogeneity, low ecosystem function) would be lost and the following attributes have been included in its design:

- A low flow channel with an earth bed, vegetated along its edges with *Phragmites australis* reedbed and other indigenous plant species typical of lowland rivers in this area – there is likely to be enough low flow in the channel all year round to maintain this as an open channel, although it is possible that reeds may at times close in the channel and periodic maintenance would be required – this is discussed in section 5.3;
- A vegetated high flow channel along the left hand bank – this would grade gently up from the low flow channel and be vegetated with a range of indigenous plant species, but it is likely that *Phragmites australis* reeds and possibly *Typha capensis* bulrush would dominate; it is also assumed that the low flow channel would meander across this area, making it a narrower on this side of the channel at times – note that the gabion baskets on the right hand side of the channel would probably be fairly sterile unless adjusted marginally to improve the likelihood of plant establishment. This area would be expected to be inundated during the wet season, with wet season baseflows. If vegetated with sedges and areas of higher spatial diversity than simple reedbed, it would be well-suited for colonisation during periods of inundation by fish larvae and the aquatic larvae and nymphs of various riverine insects, adding substantially to biodiversity;
- A flood channel, likely to be inundated by freshets and small (within-year) floods – this area (some 7m wide) would also be vegetated with indigenous vegetation and would

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provide floodplain habitat to adding birds and other river- associated fauna. It would also play a role in water quality amelioration;

- Less frequent flooding (up to 1:5 year RI) would be expected in the 15m wide (minimum) area extending as far as the gabion lining of the bottom cycle / pedestrian path. This area would provide a measure of ecologically diverse mostly terrestrial habitat, as well as a (similar) extent of lawned recreational area. In sections of the development where there is more open space along the riverine corridor, this area as well as the area above the pathway would be widened (See Figures 4.1 and 4.2);
- The area between the two pedestrian / cycle paths would provide recreational / amenity activities and would be of reduced biodiversity value – it would however provide refuge for mobile terrestrial fauna during periodic big floods, that overtopped the lower pedestrian footpath;

The above changes in river habitat quality are considered positive and would dramatically improve river habitat in this reach of river, from a PES Category F to at least a Category D and possibly a PES Category C. There is however only low to medium certainty that a Category C would be achieved – while no mitigation measures are included here, those outlined Section 5.1.10 aim at improving this certainty.

- **Alternative 2:**

Although Alternative 2 includes planting of the upper canal and possible introduction of gabion planters along the canal margins (assuming these can be accommodated in terms of flow velocities and flood capacity), such changes would have negligible impact on current (canalised) habitat quality and ecological functioning.

Table 5.1 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.1
Significance of changes in the habitat quality and ecological functioning of the Liesbeek Canal

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
ALT 1 Without Mitigation	1 Local	3 High	3 Long term Irreversible without major effort	7 High	Probable	High (Pos.)	Medium
ALT 2 Without Mitigation	1 Local	1 Low (negligible)	3 Long term Reversible	5 Low	Possible	Very Low (Pos.)	High

Essential mitigation measures:

An Environmental Control Officer (ECO) (or similar designation) with experience in construction work involving or in proximity to freshwater ecosystems must be on site on at least a weekly basis during all works involving canal rehabilitation and /or landscaping of adjacent areas.

5.1.2. *Loss of extent of terrestrial habitat for indigenous fauna*

Impact description

- **Both alternatives:**

Both development alternatives would entail the loss of substantial areas of terrestrial habitat which currently is understood to provide non-breeding habitat for western leopard toads. The faunal specialist also noted the possible use of the site as habitat for various indigenous small animals including the dwarf chameleons, noting however that the quality of such habitat is at present poor, given the dearth of remnant indigenous vegetation on the site and the dominance of mowed grass and parking areas on the site. While western leopard toads are able to utilise suburban gardens and other vegetated areas provided that they have adequate cover, the degree of present cover on the site (e.g. flower beds) is limited, and connectivity to areas with cover is fraught with risk (vehicles, lawn mowers, golf ball collection vehicles).

Compared to the present situation, and given that the proposed development alternatives would both include large areas of landscaped open space, with the design intention of the provision of high quality, safe faunal environments, the loss of degraded terrestrial habitat is considered of low negative significance, given the improvement in its quality and additional mitigation measures are not required.

The recommended Conditions of Development Authorisation outlined in Section 8 aim however to maximise the quality of the proposed terrestrial open spaces on the site, from a faunal habitat perspective.

Table 5.2 provides a more formal assessment of the impacts described above, with and without mitigation.

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Table 5.2
Significance of loss of terrestrial habitat area for indigenous fauna

Nature of impact	Extent of Impact	Intensity	Duration of Impact	Consequence	Probability of occurrence	Signif.	Confid.
Both alternatives Without Mitigation	1 Local	1 Low	3 Long term Irreversible	5 Low	Definite	Low (Neg.)	Medium
Essential mitigation measures:							
Not Applicable							
Additional measures to improve habitat quality							
Although not essential, open space terrestrial areas could be rehabilitated to include patches of renosterveld, by importing soils from disturbed renosterveld sites (e.g. quarries - see Appendix A). It is important that areas thus planted should be linked to form, as far as possible, continuous corridors linking to the east-west corridors, with recreational and other pathways meandering through both these and adjacent grassed areas. Ideally, grassed areas should be limited in this part of the site, which should aim to maximise quality toad habitat.							

5.1.3. *Loss / degradation of indigenous floral communities / important floral populations*

Impact description

- Both alternatives

  The botanical specialist (Appendix A) found no areas of any floral importance on the River Club site, and concluded moreover that the proposed development at this site would be highly unlikely to impact negatively on the dryland renosterveld vegetation at the adjacent SAAO site, including the Critically Endangered *Moraea aristata populations.*

The overall impact of the proposed development to indigenous flora is thus considered negligible. In the event that the mitigation measures around rehabilitation of terrestrial renosterveld habitat on the site are included (see Appendix A and Section 3.2), then the impact to indigenous flora would be considered positive.

Table 5.3 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.3
Significance of Loss / degradation of indigenous floral communities / important floral populations

Nature of impact	Extent of Impact	Intensity	Duration of Impact	Consequence	Probability of occurrence	Signif.	Confid.
Both alternatives Without Mitigation	Negligible impact						
Best practice measures:							
i. Actively rehabilitate renosterveld habitat on site by importing shale soil and overburden, perhaps from one of the Malmesbury shale aggregate mines in the Tygerberg, to provide potential additional renosterveld substrate							
Both alternatives With Mitigation	1 Local	2 Medium	3 Long term Reversible	6 Medium	Possible	Medium (Pos.)	Medium

5.1.4. *Changes in faunal connectivity*

Impact description

Although both alternatives entail development of large areas that currently afford connectivity / access across most of the site, the quality of such connectivity is poor and fraught with risk to small fauna (e.g. driving range activities). Both proposed alternatives allow for substantial faunal corridors, as outlined in Section 4.2, which allow

- Longitudinal links along the canal and natural Liesbeek channel areas,
- East-west links along the eastern and western boundaries and through the centre of the site
- Links under the bridges and roads that would otherwise fragment these corridors.

  The following aspects of connectivity are particular to different alternatives:

- Alternative 1:

  In addition to provision of the generic corridors outlined above, this alternative would improve existing faunal connectivity in the following manner:

  - Between the SAAO and the site and the Raapenberg wetlands and the site – at present, the canal affords limited to no connectivity for flightless fauna, as a result of its steep sides; the rehabilitated Liesbeek Canal would thus extend the zone of connectivity between the SAAO site and the River Club to the full length of the rehabilitated canal. This would be a positive outcome, particularly for the conservation of western leopard toads, the movement of which onto the site would be facilitated by removal of the canal;
  - Connectivity between the Raapenberg wetlands, the Black River and the remnant natural Liesbeek channel and associated stormwater swales would be facilitated by the proposed east-west corridor across the site – the quality of connectivity would be dependent on the landscaping details of the corridor;
  - Longitudinal connectivity along the lower portion of the rehabilitated canal, below the lower pathway, would be a significant improvement over current conditions - indigenous planted, non-lawned areas would be effective at facilitating faunal movement along the river corridor, linking with the major east-west corridor and providing high quality habitat for species such as western leopard toads in their non-breeding season in particular;

- Alternative 2:

  - The canal in this alternative would offer the same (poor) ecological connectivity as that in the present situation;
  - Connectivity between the Raapenberg wetlands, the Black River and the remnant natural Liesbeek channel and associated stormwater swales could be facilitated by the proposed east-west corridor across the site, although the retention of the canal itself would limit this connection to the unlined lower reaches towards the Black River. The quality of connectivity in all cases would be dependent on the landscaping details of the corridor.

While the above corridors are substantial and designed to mitigate against habitat fragmentation and the isolation of faunal populations, some aspects of their design are likely to have a substantial effect

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on their efficacy. Problems with the design of the above roads, bridges and open spaces from a faunal corridors perspective include:

- The position of culverts in the main (65-100m wide) east-west corridor (Figure 4.15): these are located in the central part of the corridor. This means that fauna moving along the sides of the corridor would not find connectivity, and unless the landscaping planting plan actively includes swathes of cover that guide fauna to zones of connectivity, these culverts might not play as strong a role in ensuring faunal connectivity as originally planned;
- Connectivity along the northern east-west corridor (along the property boundary abutting Berkley Road) would be reduced / possibly obstructed at the western end of the corridor, by a pinch-point at the access to development block 15 (see Figure 4.1) – this apparent "dead end" would make this corridor highly problematic from a faunal perspective, particularly given its length and overall narrowness. The corridor would also connect only in two places to the degraded open space and natural Liesbeek channel north of Berkley Road –given the length of this section of the road (some 550m estimated off GOOGLE imagery), the two connections would be unlikely to provide effective linkage between the northern and southern sides of the road. This means that the remnant section of the natural Liesbeek channel would be ecologically isolated between the railway line to its north and Berkley Road to the south;
- The width of Berkley Road in relation to the width of the culvert – the culverts under Berkley Road may be too dark to encourage the passage of western leopard toads through the culvert;
- The positioning of the culverts under the road connections that cut across the Berkley Road corridor appear to be advantageous, in that fauna would be "channelled" along the toe of either road, towards the culvert. However, where culverts pass under wide roads such as the Berkley Road extension, the provision of culverts alone may not be sufficient to persuade western leopard toads to pass through and such corridors might thus be ineffective – this would be a significant impact, as links north into the (as yet) undeveloped ground north of the River Club extending to the natural Liesbeek channel, in which the toads may breed, are considered important;
- The southern east-west corridor abutting the SKA boundary is relatively short, making its narrow width less problematic. The sustainability of this corridor is however likely to be threatened in the future by development of the SKA site, as it is assumed that the latter would require road access to the development, making crossing of the corridor inevitable;
- The design of the Berkley Road bridge over the Black River would effectively cut off longitudinal connectivity along the lower bank and top of bank, as a result of extension of the infilled portion of the road all the way to the first pier (**Figure 4.14**). This issue would be problematic to small fauna traversing this bank area, particularly as the area between the toe of the M5 and the river is already relatively sterile, with little vegetation cover on the upper bank / floodplain, through which culverts would afford connectivity;
- The Berkley Road bridge (Culvert 2 – see Figure 4.16) over the natural channel of the Liesbeek River is also problematic, in that it would allow only up- and downstream connectivity at the level of the channel itself – this means that aquatic fauna could pass through the culverts but that terrestrial fauna would be isolated on one side of the road.

  - In the case of Alternative 2 (rehabilitation of the channel) the four culverts as shown would also require constriction / infilling of the channel at this point, as the culverts do not extend across the whole channel.

- The ecological significance of the above issues would be greatest in the case of Alternative 2, in which the rehabilitated natural channel is intended as the focus for ecological improvement / rehabilitation. In the case of Alternative 1, the onus for rehabilitation and connectivity is mainly on the rehabilitated canal. The Liesbeek Parkway link bridge (Culvert 2 – Figure 4.17) would provide better levels of faunal connectivity than Culvert 1, as the former includes five culverts located above the low flow channel, which would allow terrestrial connectivity. Again, in the case of Alternative 2, the nevertheless moderate level of fragmentation that would occur in an area intended actively to promote rehabilitation is seen as an opportunity cost. The connectivity provided by the culverts in terms of Alternative 1, where the focus of ecological rehabilitation is in the canal, is considered quite adequate.

Essential mitigation measures
The following mitigation measures are considered essential.

Both alternatives

i. The main (65-100m wide) east-west corridor:
   a. This area must be landscaped so that it provides wide swathes of indigenous planted vegetation that ensure continuous vertical cover along the length of the corridor – preferably on both sides - as a guideline, at least 40% of the main ecological corridor should be managed as indigenous planted corridor habitat, without lawn or pathways;
   b. Efforts must be made to establish renosterveld vegetation in the corridor – ideally, using recommendations made in the botanical report for the import of soils from nearby quarries in renosterveld areas – a botanical specialist should be approached during the design phase for input into appropriate, practically obtainable plant species for this use;
   c. Ideally, an additional culvert should be located on either side of the corridor, so that these edges do not become closed off;
   d. The faunal specialist should have final sign-off on the detailed landscape plan for this corridor, and input during on-site implementation to ensure that it meets the required specifications;

ii. The northern east-west corridor:
   a. The Berkley Road toe / side slopes should be as steep as possible, in order to reduce faunal connectivity up to the road and increase open space along the edge of the road;
   b. The area between the development edge and the road must be landscaped with indigenous vegetation, laid out so as to provide a diversity of heights and densities of plants that will facilitate its role as a corridor;

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c. The pinch-point at the western end of the corridor (development block 15) must be addressed so that at least 5m open, vegetated space are provided at this point, widening thereafter to 10m;

d. An additional three culverts should be provided under Berkley Road – one between each of the access roads onto the site;

e. Consideration should be given to the provision of road grids over the culverts, to let in light and mitigate against the effects of the width of the road;

iii. The southern east-west corridor:

a. A condition of any <u>future</u> road crossings over this corridor (e.g. associated with SKA building access) must be the inclusion of bridging or adequately sized culverts to maintain faunal connectivity – this must be shown on the final layout plan;

b. The area between the development edge and the southern site boundary must be landscaped with indigenous vegetation, laid out so as to provide a diversity of heights and densities of plants that will facilitate its role as a corridor;

iv. Berkley Road bridge over the Black River:

a. On the M5 side of the channel (right hand bank):

i. The extent of the fill platform must be pulled back, so that an area of at least 5m from the top of the bank, as well as the river bank itself, is left open, before the pier;

ii. If required, reno mattresses may be used to stabilise the river bank and top of bank under the bridge itself, where vegetation might not establish readily. Such reno would need to be laid at a slope no greater than 1:4 and could if necessary be edged at the bottom by gabion mattresses provided that no step greater than 300mm vertical height was created;

iii. The river bank and open vegetated zone must be shaped (graded at 1:4 or flatter) and planted with appropriate indigenous vegetation along a bank length of at least 10m up- and downstream of the bridge, and extending to at least 5m over the top of the bank;

b. On the River Club side of the channel (left hand bank):

i. The extent of the fill platform must be pulled back, so that the bridge spans the full width of the Black River and its recommended ecological buffer / setback of 20m, measured from the top of the bank.

<u>Alternative 1</u>

v. The planted swathes through the main east-west corridor and the corridor as a whole must tie in to the landscaped rehabilitated river corridor, at the level below the lower pedestrian path – this can be achieved by creating boardwalk-type bridges in places in this section, so that the east-west and longitudinal corridors connect in as wide an area as possible, while maintaining human recreational use through these areas and preventing, as far as possible, faunal access to the development area itself;

vi. Proposed Berkley Road crossing over the Liesbeek channel (Culvert 1):

a. The crossing must be adjusted to allow for terrestrial faunal connectivity along the landscaped swale connecting into the remnant section of the natural Liesbeek channel downstream of the development, by adding at least three similarly sized (1500 x1500 mm) culverts to the design, located on the terrestrial margins of the swale. These culverts would need to be located only on the right hand channel margins (that is, culverts on the steep Liesbeek Parkway side of the channel would not be necessary or desirable). Inclusion of overhead grids for lighting of the culverts would be desirable and must be con sidered in final design;

vii. New (southern) culvert over the Liesbeek channel (Culvert 2):

a. The position of the main and minor culverts must be finalised when the location of the swale (closer or further from the development boundary, as shown in the options in **Figure 4.6**) is finalised;

<u>Alternative 2</u>

viii. The planted swathes through the main east-west corridor and the corridor as a whole must tie in to the landscaped edge / buffer area of the canal – habitat quality of this edge is likely to be low;

ix. The pathway shown in **Figure 4.6** cutting across the buffer area should be raised in places to allow a 300mm connecting space beneath the pathway, for faunal passage – this could be achieved by excavating out low points during construction of the pathway / boardwalk;

x. The pathways through the canal buffer area must be designed to prevent toad passage into the development - toad barriers should be included, and the top of the buffer area should be edged by a toad-barrier lined pedestrian pathway that is separated from the roadway and thus the main development, with toad barriers;

xi. Proposed Berkley Road crossing over the natural Liesbeek channel (Culvert 1):

In this alternative, it is particularly important that the rehabilitation potential of the channel is maximised. The design of the structure must be amended to allow spanning of the river channel, as has been included in the case of the Black River bridge, with the following essential design elements included:

i. The bridge must span the full rehabilitated channel and the full buffer width on the development side of the channel;

ii. Piers may be included in the design to facilitate the required length of span;

iii. Infilling of the buffer to accommodate the road would not be permitted;

Note that inclusion of a bridge rather than a culvert crossing was discussed in project planning meetings and agreed on in principle for this alternative.

xii. New (southern) Liesbeek Parkway link road over the Liesbeek channel (Culvert 2): Again, as in the case of Culvert 1, it is particularly important that the rehabilitation potential of the channel is maximised in this alternative. The proposed design of the structure must thus be

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amended to allow spanning of the river channel, with the following essential design elements included:

i. The bridge must span the full rehabilitated channel and the full buffer width on the development side of the channel;
ii. Piers may be included in the design to facilitate the required length of span;
iii. Infilling of the buffer to accommodate the road would not be permitted.

Note that inclusion of a bridge rather than a culvert crossing was discussed in project planning meetings and agreed on in principle for this alternative.

Table 5.4 provides a more formal assessment of the impacts described above, with and without mitigation, with relevant mitigation measures repeated in the table for ease of future reference. Note that the Regional rating for extent takes cognisance of the conservation status of western leopard toads. The difference in outcomes "with mitigation" between the two alternatives (Low positive in Alternative 1 and Very Low to Low negative in Alternative 2, really reflects the tremendous improvement in ecological connectivity that would result from removal of the canal in Alternative 1.

Table 5.4
Significance of changes in faunal connectivity

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
ALT 1 Without Mitigation	2 Regional	1 Low	3 Long term	6 Medium	Possible	Low (Neg.)	Medium
ALT 2 Without Mitigation	2 Regional	2 Medium	3 Long term	7 High	Probable	High (Neg.)	Medium

Both alternatives

i. The main (65-100m wide) east-west corridor:
   a. This area must be landscaped so that it provides wide swathes of indigenous planted vegetation that ensure continuous vertical cover along the length of the corridor – preferably on both sides;
   b. Efforts must be made to establish renosterveld vegetation in the corridor – ideally, using recommendations made in the botanical report for the import of soils from nearby quarries in renosterveld areas – a botanical specialist should be approached during the design phase for input into appropriate, practically obtainable plant species for this use;
   c. Ideally, an additional culvert should be located on either side of the corridor, so that these edges do not become closed off;
   d. The faunal specialist should have final sign-off on the detailed landscape plan for this corridor, and input during on-site implementation to ensure that it meets the required specifications;
ii. The northern east-west corridor:
   a. The Berkley Road toe / side slopes should be as steep as possible, in order to reduce faunal connectivity up to the road and increase open space along the edge of the road;
   b. The area between the development edge and the road must be landscaped with indigenous vegetation, laid out so as to provide a diversity of heights and densities of plants that will facilitate its role as a corridor;
   c. The pinch-point at the western end of the corridor (development block 15) must be addressed so that at least 5m open, vegetated space are provided at this point, widening thereafter to 10m;
   d. An additional three culverts should be provided under Berkley Road – one between each of the access roads onto the site;
   e. Consideration should be given to the provision of road grids over the culverts, to let in light and mitigate against the effects of the width of the road;
iii. The southern east-west corridor:
   a. A condition of any future road crossings over this corridor must be the inclusion of bridging or adequately sized culverts to maintain faunal connectivity – this must be shown on the final layout plan;
   b. The area between the development edge and the southern site boundary must be landscaped with indigenous vegetation, laid out so as to provide a diversity of heights and densities of plants that will facilitate its role as a corridor;
iv. Berkley Road bridge over the Black River:
   a. On the M5 side of the channel (right hand bank):
      i. The extent of the fill platform must be pulled back, so that an area of at least 5m from the top of the bank, and the river bank itself, is left open, before the pier;
      ii. If required, reno mattresses may be used to stabilise the river bank and top of bank under the bridge itself, where vegetation might not establish readily. Such reno would need to be laid at a slope no greater than 1:4 and could if necessary be edged at the bottom by gabion mattresses provided that no step greater than 300mm vertical height was created;
      iii. The river bank and open vegetated zone must be shaped (graded at 1:4 or flatter) and planted with appropriate indigenous vegetation along a bank length of at least 10m up- and downstream of the bridge, and extending to at least 5m over the top of the bank;
   b. On the River Club side of the channel (left hand bank):
      i. The extent of the fill platform must be pulled back, so that the bridge spans the full width of the Black River and its recommended ecological buffer / setback of 20m, measured from the top of the bank.

Alternative 1

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v. Proposed Berkley Road crossing over the Liesbeek channel (Culvert 1): The crossing must be adjusted to allow for terrestrial faunal connectivity along the landscaped swale connecting into the remnant section of the natural Liesbeek channel downstream of the development, by adding at least three similarly sized (1500 x1500 mm) culverts to the design, located on the terrestrial margins of the swale. These culverts would need to be located only on the right hand channel margins (that is, culverts on the steep Liesbeek Parkway side of the channel would not be necessary or desirable). Inclusion of overhead grids for lighting of the culverts would be desirable and must be con sidered in final design;

vi. New (southern) culvert over the Liesbeek channel (Culvert 2): The position of the main and minor culverts must be finalised when the location of the swale is finalised;

vii. The planted swathes through the main east-west corridor and the corridor as a whole must tie in to the landscaped rehabilitated river corridor, at the level below the lower pedestrian path – this can be achieved by creating boardwalk-type bridges in places in this section, so that the east-west and longitudinal corridors connect in as wide an area as possible, while maintaining human recreational use through these areas and preventing, as far as possible, faunal access to the development area itself;

Alternative 2

viii. Proposed Culvert 1 and Culvert 2 crossings over the natural channel of the Lesbeek River: The designs of these two crossings must be amended to allow spanning of the river channel, with the following essential design elements included:

a. The bridge must span the full rehabilitated channel and the full buffer width on the development side of the channel;

b. Piers may be included in the design to facilitate the required length of span;

c. Infilling of the buffer to accommodate the road would not be permitted;

ix. The planted swathes through the main east-west corridor and the corridor as a whole must tie in to the landscaped edge / buffer area of the canal – habitat quality of this edge is likely to be low;

x. The pathway shown in Figure 4.6 cutting across the buffer area should be raised in places to allow a 300mm connecting space beneath the pathway, for faunal passage – this could be achieved by excavating out low points during construction of the pathway / boardwalk;

xi. The pathways through the canal buffer area must be designed to prevent toad passage into the development - toad barriers should be included, and the top of the buffer area should be edged by a toad-barrier lined pedestrian pathway that is separated from the roadway and thus the main development, with toad barriers.

ALT 1 With Mitigation	2 Regional	1 Low	3 Long term	6 Medium	Possible	Low (Pos.)	High
ALT 2 With Mitigation	2 Regional	1 Low	3 Long term	6 Medium	Possible	Low (Neg.)	Medium

5.1.5. *Increased western leopard toad mortalities*

Impact description

The faunal specialist engaged in this project highlighted a number of potential negative impacts to western leopard toad longevity and thus the sustainability of the populations of this important species in the Observatory area (see Appendix B). These have been summarised as follows:

- Population fragmentation: this issue has been dealt with under the impact of changes in ecological connectivity (Section 5.1.4);
- Fatalities associated with roads/vehicles:

  The development design for Alternative 1 has been amended already to include measures that discourage western leopard toads from accessing the built-up components of the development, and seeks to direct them through and into the rehabilitated and other open spaces of the development. Provision of toad barriers on the downslope side of both sets of

pathways through the rehabilitated river corridor (Alternative 1) would prevent toads from climbing up onto the pathways from below and allow them to get off the pathways and re-enter the ecological areas from above.

Alternative 2 does not include toad barriers and the landscaped pathways shown in Figure 4.6 would allow ease of access to the busy development to toads. However, access to Liesbeek Parkway would be limited in Alternative 2, as the existing channel would retain its steep to vertical banks on the road side.

The following mitigation measures have already been included in the assessed landscaped plan for both alternatives:

- Provision of culverts beneath all roads passing through / across ecological corridors and terrestrial habitat;
- Provision of toad "barriers" along the edges of all roads (see Figure 4.12 and 4.154);

These design attributes would significantly lessen the impacts associated with the proposed development. However, the following risks / design weaknesses are still considered to pose threats to toads, namely:

- The embankment slopes up to the toad barrier at the top of the road, thus possibly drawing toads upwards towards the top of the slope and the road beyond – the risk is not therefore wholly negated;
- Alternative 1 – the interface between Liesbeek Parkway and the landscaped swale has been landscaped gently upwards towards Liesbeek Parkway, potentially allowing toads to move onto this dangerous zone across the full western boundary – this is likely to increase toad mortalities significantly along this section of roadway, when compared to the present, given that the current vertically banked natural Liesbeek channel is likely to act as a significant east-west barrier to movement off the site and onto Liesbeek Parkway;

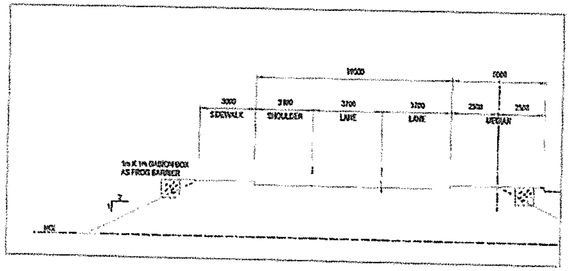

Figure 5.1
Detail of proposed toad barrier on roads (taken from Figure 4.15)

- Pitfall fatalities – these are possible in areas of the development where toads may be trapped – e.g. steep-sided channels, stormwater drains, water features, as well as infrastructure housing such as telecommunication cable access points / manholes. Falling into such structures may cause mortalities by means of starvation or dehydration or drowning and it is noted that even very small

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pitfalls can cause toad mortalities – for example, the faunal specialist noted that small plastic irrigation boxes that were present on the River Club golf course at the time of the 2016 survey were entrapping and killing toadlets;

- Mortalities associated with harsh terrain - large open (unsheltered) areas such as sports fields, grassed parks and parking areas could also cause substantial mortalities, as a result of dehydration and fatigue, for example when thousands of newly metamorphosed toadlets inadvertently arrive on such terrain. Greater visual exposure to predators such as crows may also be a contributing factor of toad mortalities under these circumstances.

  Such harsh terrain would potentially occur in the grassed expanses between the upper pathway and the lower pathway of the rehabilitated canal (Alternative 1) and along the ecological corridors (both alternatives), in the event that these are dominated by lawns rather than indigenous planting with cover and height;

- Obstructions - Solid brick or concrete walls, or fine mesh fencing and electric fences limit dispersal options for wandering toads – examples of such could occur in the constricted northern east-west corridor, already described in Section 5.1.4. In general, however, the proposed development layout does not include such obstructions in open space areas, other than where deliberately introduced to prevent western leopard toad access (e.g. toad barriers on road edges).

The above issues might result in negative impacts to western leopard toads. They have however largely already been considered in the existing design, and compared to the present situation, where toads are exposed to large areas of hostile space as well as traffic without any protective interventions, the negative significance of such risks are considered medium at most, and would have been rated as Low, without the consideration that the scale of development is likely to increase the frequency / risk of impact.

Essential additional mitigation measures

The following measures, some of which are implicitly if not explicitly already covered to some degree in the landscape plan, must form part of mitigation requirements:

i. Landscaping of open space areas and corridors must overtly aim to provide a high quality of cover and refuge for western leopard toads (as well as other indigenous fauna) – the planting plan must be approved by a botanical specialist and the layout / dimensions of planting areas in all corridors and open space areas must be approved by the faunal specialist prior to implementation;

   The required measure would need to include a substantial increase of low and medium height vegetation cover, with mixed plant species so that invertebrate (i.e. western leopard toad prey) diversity and abundance would be promoted. The more of this type of habitat available in the area, the greater the prospects for maintaining viable breeding stock in perpetuity. However, the areas immediately adjacent to toad exclusion barrier walls should not be vegetated with anything higher than lawn or a very low ground cover, because vegetation build-up right next to such barrier may allow toads to clamber over. Physical shelters for western leopard toads should furthermore be integrated within the landscaped/gardened open space area – the faunal report suggests approaches such as the use of natural logs, or artificial structures such as pieces of broken pots or ceramic piping cut lengthwise. The

improved moisture retention abilities of such shelters should be advantageous to western leopard toads, and their overall survival rate may thus be boosted;

ii. The side slopes of the road across the main ecological corridor should be designed to be as steep as possible (preferably vertical and stabilised with gabions, stone pitching or similar) and the open space area below the road should not be landscaped upwards to the road edge. Toad barriers should be used along the road edge as already included in design, but the base of the road should be edged by a stormwater drain that slopes gently outward onto the non-road side and is vertical on the road side edge; planting of the road side slopes should also aim for maximum sterility – mown grass or lining, to minimise its attractiveness to western leopard toads and other fauna;

iii. Pitfall-type structures (drains, stormwater canals, channels, water features and all manhole type structures must overtly be designed to allow toad escape options and limit access;

iv. Where fencing is required on the development or its boundaries, such that it would interfere with required faunal connectivity, such fencing should be designed such that it does not restrict the movement of small terrestrial animals – thus 300mm high x 200mm wide access holes must be created at least every 10m along a length of fence, which should not be electrified within 300mm of the ground;

v. During the operational phase of the development, extensive education and awareness campaigns must be launched to raise awareness around the life cycle and conservation status of western leopard toads, and the rationale behind the protection methods being employed on the site;

vi. Alternative 1:

   a. Connectivity across the landscaped swale to Liesbeek Parkway must be limited to relatively short areas towards the southern end of the development boundary, if at all, through the following measures:

      i. The existing steep to vertical earth bank, in the area extending from the proposed Berkley Road extension on the north western corner of the development (Culvert 1) to the southern side of where the new internal access road would eventually join up with Liesbeek Parkway (Culvert 2), should be retained as a steep to vertical sided earth bank – this will reduce access up this bank by western leopard toads, while retaining the earth bank, valued as a bird nesting area;

      ii. Where the above steep bank is not retained, toad barriers must be installed on the development side of the Liesbeek Parkway walking / cycling trail, to reduce toad access over the road but still allow access from the road side onto the site – such barriers are however shown in concept in Figure 4.16;

      iii. Where the walking trail transitions from its position above the vertical earth bank to its position at the top of the gently sloping banks down to the swale (i.e. the landscape shown in Figure 4.3), the pathway must remain edged with a toad barrier – Appendix 2 of the faunal report (see Appendix B of this report) provides illustrated options for creating such barriers;

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vii. Alternative 2:

a. Pathways / walkways along the canal area should be re-designed so as to prevent, as far as possible, the passage of western leopard toads into the main development area;

b. The toad barriers along the Liesbeek Parkway pedestrian walkways (Figures 4.16 and 4.17) must be included.

Table 5.5 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.5
Significance of increased western leopard toad mortalities

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
ALT 1 Without Mitigation	2 Regional	2 Medium	3 Long term Irreversible	7 High	Probable	High (Neg.)	Medium
ALT 2 Without Mitigation	2 Regional	2 Medium	3 Long term Irreversible	7 High	Probable	High (Neg.)	Medium

i. Landscaping of open space areas and corridors must overtly aim to provide a high quality of cover and refuge for western leopard toads (as well as other indigenous fauna) – the planting plan must be approved by a botanical specialist and the layout / dimensions of planting areas in all corridors and open space areas must be approved by the faunal specialist prior to implementation;
The required measure would need to include a substantial increase of low and medium height vegetation cover, with mixed plant species so that invertebrate (i.e. western leopard toad prey) diversity and abundance would be promoted. The more of this type of habitat available in the area, the greater the prospects for maintaining viable breeding stock in perpetuity. However, the areas immediately adjacent to toad exclusion barrier walls should not be vegetated with anything higher than lawn or a very low ground cover, because vegetation build-up right next to such barrier may allow toads to clamber over. Physical shelters for western leopard toads should furthermore be integrated within the landscaped/gardened open space area – the faunal report suggests approaches such as the use of natural logs, or artificial structures such as pieces of broken pots or ceramic piping cut lengthwise. The improved moisture retention abilities of such shelters should be advantageous to western leopard toads, and their overall survival rate may thus be boosted;

ii. The side slopes of the road across the main ecological corridor should be designed to be as steep as possible (preferably vertical and stabilised with gabions, stone pitching or similar) and the open space area below the road should not be landscaped upwards to the road edge. Toad barriers should be used on the road as already included in design, but the base of the road should be edged by a stormwater drain that slopes gently outward on the non-road side and is vertical on the road side edge; planting of the road side slopes should also aim for maximum sterility – mown grass or lining, to minimise its attractiveness to western leopard toads and other fauna;

iii. Pitfall-type structures (drains, stormwater canals, channels, water features and all manhole type structures must overtly be designed to allow toad escape options and limit access;

iv. Where fencing is required on the development or its boundaries, such that it would interfere with required faunal connectivity, such fencing should be designed such that it does not restrict the movement of small terrestrial animals – thus 300mm high x 100mm wide access holes must be created at least every 10m along a length of fence, which should not be electrified within 300mm of the ground;

v. During the operational phase of the development, extensive education and awareness campaigns must be initiated, to raise awareness around the life cycle and conservation status of western leopard toads, and the rationale behind the protection methods being employed on the site;

vi. Alternative 1:

a. Connectivity across the landscaped swale to Liesbeek Parkway must be limited to relatively short areas towards the southern end of the development boundary, if at all, through the following measures:

i. The existing steep to vertical earth bank, in the area extending from the proposed Berkley Road extension on the north western corner of the development to the southern side of where the new internal access road would eventually join up with Liesbeek Parkway, should be retained as a steep to vertical sided earth bank – this

will reduce access up this bank by western leopard toads, while retaining the earth bank, valued as a bird nesting area;

ii. Toad barriers must be installed on the development side of the Liesbeek Parkway walking / cycling trail, to reduce toad access over the road but allow access from the road side into the site;

iii. Where the walking trail transitions from its position above the vertical earth bank to its position at the top of the gently sloping banks down to the swale (i.e. the landscape shown in Figure 4.3), the pathway must remain edged with a toad barrier – Appendix 2 of the faunal report (see Appendix B of this report) provides illustrated options for creating such barriers;

vii. Alternative 2:

a. Pathways / walkways along the canal area should be re-designed so as to prevent, as far as possible, the passage of western leopard toads into the main development area;

b. The toad barriers along the Liesbeek Parkway pedestrian walkways (Figures 4.16 and 4.17) must be included.

ALT 1 With Mitigation	2 Regional	1.5 Low	3 Long term Irreversible	6.5 Medium	Possible	Low (Neg.)	Medium
ALT 2 With Mitigation	2 Regional	1 Low	3 Long term Irreversible	6 Medium	Possible	Low (Neg.)	Medium

5.1.6. *Changes in flow regime into the Raapenberg wetlands*

Impact description

The aquatic specialist Scoping Report for this project (Day 2016) raised concerns that if infilling of the River Club site as proposed resulted in even slight increases in the height, frequency or duration of floods passing into the Raapenberg wetlands, there might be significant ecological effects. The information presented in this report (see section 3.1.8 Aquatic ecosystems: Raapenberg Wetlands) confirmed the likely high sensitivity of these systems to changes in flow, particularly if coupled with increases in low salinity water (e.g. from the Liesbeek River). The likely effects of such changes would include expansion of low-importance *Phragmites australis* and even *Typha capensis* wetland at the expense of what are assumed to be more natural remnants of past seasonal Renosterveld wetlands, which have ironically been protected from changes in flow in the Black River through the construction of berms between it and the adjacent rivers.

While the above issues would be cause for serious concern, the hydrological study of Aurecon (2017a) found that:

- For [12]Alternative 1:
  - For the 0.5-year and 1-year recurrence interval storm events, only slight increases (1 to 2cm) if any, and in some cases decreases (1 to 2 cm) in water level in the Black and Liesbeek Rivers would occur, with decreases in flood level as a result of increased capacity in the rehabilitated Liesbeek canal. These findings are important, because (at least prior to opening up of a connecting channel into the wetland by the Friends of the Liesbeek River (see Section 3.1.8: Raapenberg Wetlands) the wetland was assumed to be hydrologically connected to the Liesbeek Canal at a surface elevation of 2.5m amsl, equating to a recurrence interval of between 0.5 and 1 year. The infilling of the River Club

[12] Note that the hydrological study focused only on Alternative 1 and did not model changes associated with Alternative 2

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site would thus exert a negligible effect on the hydrological regime of the Raapenberg wetlands, and is not considered a threat in this regard. This compares with the 125mm lowering of the level of inflows and outflows into the wetland as a result of the linking channel, which is likely to exert a significant negative effect on wetland function.

- Alternative 2:
  - It is assumed that flood changes would also be negligible, although the decrease in flood level would not occur.

Essential mitigation measures
No mitigation measures are applicable.

Infilling of the recently constructed linking channel between the Liesbeek Canal and the wetland would however be strongly recommended.

Table 5.6 provides a more formal assessment of the impacts described above.

Table 5.6
Significance of changes in flow regime into the Raapenberg wetlands

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
ALT 1 and 2 Without Mitigation	1 Local	0.5 Very low	3 Long term	4.5 Very low to Low	Improbable	Insignificant to very low (Neg.)	Medium
Mitigation: Not applicable							

5.1.7. *Loss and degradation of riverine wetlands along the Black River margins*

The proposed Berkley Road Extension bridge over the Black River would result in the definite loss of a section of fringing *Phragmites australis* wetlands along the river bank, as a result of the planned road that would be infilled to the bottom of the river bank (see Figures 4.13 and 5.2). This structure would result in the following kinds of wetland loss and degradation, namely:

- Loss of marginal wetland
- Disruption of longitudinal connectivity for terrestrial and semi-aquatic faunal along the river bank and margins (this impact has been dealt with already in Section 5.1.4);
- Disturbance to birds utilising the "palm island" habitat described by the avifaunal specialist as of particular habitat significance because of the roosting habitat it affords to birds, despite the alien nature of the palm itself (Appendix D). The specialist noted however that birds are likely to become rapidly accustomed to increased traffic on roads associated with the development, provided that they themselves were not targeted by any aspects of the development.

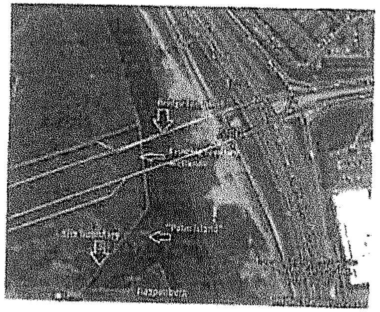

Figure 5.2
Encroachment of proposed briudge over riverine wetlands

The above impacts are considered of medium negative significance, largely as a result of the impacts to connectivity, which would affect ecological processes beyond the extent of the footprint of the bridge. The actual sensitivity of the affected wetlands is low.

Essential mitigation measures

The following mitigation measures must be implemented:

i. The extent of the fill platform must be pulled back, so that the bridge spans the full width of the recommended ecological buffer / setback of 20m, measured from the top of the bank (this measure has also been recommended for Impact 5.1.4) – note that it is assumed that piers, located outside of sensitive areas, and not on the bankS, may be required from an engineering perspective;

ii. Marginal wetlands disturbed during construction must be re-instated by regrading the disturbed bank to a slope of 1:4 or flatter and replanting it with appropriate indigenous wetland and riverine vegetation;

iii. Indigenous riverine / wetland trees should be planted at intervals along the river corridor to create roosting / nesting habitat for birds – species to consider could include Milkwoods, indigenous willows (*Salix capensis* and *Salix mucronata*) and other species as recommended by a botanical specialist.

Table 5.7 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.7
Significance of loss and degradation of riverine wetlands along the Black River margins

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
ALT 1 and 2 Without Mitigation	1 Local	2 Medium	3 Long term	6 Medium	Definite	Medium (Neg.)	Medium
Essential mitigation measures i. The extent of the fill platform must be pulled back, so that the bridge spans the full width of the recommended ecological buffer / setback of 20m, measured from the top of the bank (this measure has also been recommended for Impact 5.1.4); ii. Marginal wetlands disturbed during construction must be re-instated by regrading the disturbed bank to a slope of 1:4 or flatter and replanting it with appropriate indigenous wetland and riverine vegetation; iii. Indigenous riverine / wetland trees should be planted at intervals along the river corridor to create roosting / nesting habitat for birds – species to consider could include Milkwoods, indigenous willows (*Salix capensis* and *Salix mucronata*) and other species as recommended by a botanical specialist.							
ALT 1 and 2 With mitigation	1 Local	1 Low	2 Medium term	4 Very Low	Probable	Very Low (Neg.)	Medium

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5.1.8. *Loss and/or changes in wetland habitat quality and availability in the areas of the natural Liesbeek River channel*

Impact description

- **Alternative 1:**

The Liesbeek River channel would be filled in in this alternative, resulting in the following changes in wetland and terrestrial habitat quality and availability:

  - Loss of permanent standing water wetland habitat (some 623 m of channel length) associated with the current function of the natural Liesbeek River channel – this habitat may presently be used as a breeding area by western leopard toads and its loss without replacement is assessed as a significant impact;
  - The natural channelof the Liesbeek River might also support Cape Galaxias fish, and this alternative would entail some loss of this habitat – however, rehabiloitation of the main canal would in turn provide the vegetated margins required by this species, and loss of some habitat is not considered a severe impact;
  - Loss of steep earth river banks potentially used as bird nesting sites (e.g. kingfishers) on the left hand (Liesbeek Parkway side) river bank;
  - Loss of wetland amelioration function for stormwater currently discharged into the channel in its upper reaches, to be piped into the lower reaches in this option;
  - The creation of shallow swale wetlands (assumed to be <300mm deep) on the infilled area, with the swale discharging into the extant remaining channel downstream of the site. Thesewetlands would be likely to be seasonally inundated for short periods of time only, so allowance has been made for the creation of occasional weirs in the swales to allow longer term ponding of water to create western leopard toad breeding areas. This would also create improved wetland habitat for aquatic insects and other fauna compared to the swales without shallow weirs;

- **Alternative 2:**

In this alternative, the physical habitat quality and diversity of the channel would be improved substantially, by reshaping the channel banks and planting them as wide, indigenous vegetated wetland margins, with improved faunal accessibility in and out of the wetlands. The generous buffer area (see **Figures 4.4** and **4.6**) could provide terrestrial areas for Western Leopard toads outside of their breeding season – there would be less of such areas in this Alternative than in Alternative 1.

Essential mitigation measures

- Alternative 1:

  i. Additional artificial wetland ponds, suitable for breeding in by western leopard toads should be created – at least two such ponds are recommended, roughly sized with diameters of around 10m. They should be excavated to lie within the summer water table level or alternatively be lined to retain water, and should be landscaped with gently sloped sides (1:5 or less steep) and planted with indigenous wetland vegetation that is connected via planted landscaped swathes to the main east-west faunal corridors, with plants utilised being indigenous species with a range of textures, height and densities that can both provide cover and safe movement corridors. Note that these ponds might alternatively be adapted to tie in with the proposed stormwater attenuation ponds (**Figure 4.17**);

  ii. The faunal and wetland specialists should have input into the final sizing and design of these ponds;

  iii. A section of steep earth banks should be retained and developed to facilitate nesting areas for bank burrowing birds – the avifaunal specialist should be consulted in this regard – this recommendation has already been made to mitigate against risk of mortalities to western leopard toads as a result of passage up the otherwise easily accessible landscaped bank to the busy Liesbeek Parkway;

  iv. The swale areas should be planted with appropriate locally indigenous vegetation as recommended by the botanical and wetland specialists and ideally taking into account recommendations for the re-establishment of patches of renosterveld, by importing soils from disturbed renosterveld sites (e.g. quarries - see Appendix A). It is important that areas thus planted should be linked to form, as far as possible, continuous corridors linking to the east-west corridors, with recreational and other pathways meandering through both these and adjacent grassed areas. Ideally, grassed areas should be limited in this part of the site, which should aim to maximise quality toad habitat. Artificial shelters for toads (rocks, logs) could also be included to improve toad habitat;

- Alternative 2:

  v. The wetland margins and planted buffer areas for at least 15m from the wetland edge should be planted with appropriate locally indigenous vegetation as recommended by the botanical and wetland specialists. It is important that areas thus planted should be linked to form, as far as possible, continuous corridors linking to the east-west corridors, with recreational and other pathways meandering through both these and adjacent grassed areas.

Table 5.8 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.8
Significance of loss and/or changes in wetland habitat quality and availability in the areas of the natural Liesbeek River channel

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
ALT 1 Without Mitigation	1 Local	2 Medium	3 Long term Irreversible without effort	6 Medium	Definite	Medium (Neg.)	High
ALT 2 Without Mitigation	1 Local	1 Low	3 Long term	5 Low	Probable	Low (Pos.)	High

Essential mitigation measures

- Alternative 1:

  i. Additional artificial wetland ponds, suitable for breeding in by western leopard toads should be created – at least two such ponds are recommended, roughly sized with diameters of around 10m. They should be excavated to lie within the summer water table level or alternatively be lined to retain water, and should be landscaped with gently sloped sides (1:5 or less steep) and planted with indigenous wetland vegetation that is connected via planted landscaped swathes to the main east-west faunal corridors, with plants utilised being indigenous species with a range of textures, height and densities that can both provide cover and safe movement corridors. Note that these ponds might alternatively be adopted to tie in with the proposed stormwater attenuation ponds (Figure 4.17);

ii. The faunal and wetland specialists should have input into the final sizing and design of these ponds;

iii. A section of steep earth banks should be retained and developed to facilitate nesting areas for bank burrowing birds – the avifaunal specialist should be approached to give details in this regard – this recommendation as already been motivated for to mitigate against risk of mortalities to western leopard toads as a result of passage up the otherwise easily accessible landscaped bank to the busy Liesbeek Parkway;

iv. The terrestrial and swale areas should be planted with appropriate locally indigenous vegetation as recommended by the botanical and wetland specialists and ideally taking into account recommendations for the re-establishment of patches of renosterveld, by importing soils from disturbed renosterveld sites (e.g. quarries - see Appendix A). It is important that areas thus panted should be linked to form, as far as possible, continuous corridors linking to the east-west corridors, with recreational and other pathways meandering through both these and adjacent grassed areas. Ideally, grassed areas should be limited in this part of the site, which should aim to maximise quality toad habitat.

- Alternative 2:

v. The wetland margins and planted buffer areas for at least 15m from the wetland edge should be planted with appropriate locally indigenous vegetation as recommended by the botanical and wetland specialists. It is important that areas thus planted should be linked to form, as far as possible, continuous corridors linking to the east-west corridors, with recreational and other pathways meandering through both these and adjacent grassed areas.

ALT 1 With Mitigation	1 Local	1 Low	3 Long term Irreversible without effort	5 Low	Probable	Low (Neg.)	Medium
ALT 2 With Mitigation	1 Local	1 Low	3 Long term	5 Low	Probable	Low (Pos.)	Medium

5.2. Construction phase impacts

The construction phase of the proposed project is one where the risks of incurring significant damage that will prevent the realisation of the main biodiversity objectives of this project are highest. This section identifies and assesses the most relevant potential impacts accruing from the construction phase.

5.2.1. *Faunal fatalities (particularly western leopard toads) as a result of construction activities*

The construction phase would result in the construction on and the passage of vehicles through large areas of terrestrial habitat and in the vicinity of large areas of wetland and other watercourses. It is inevitable that such activities will result in faunal mortalities, which without any mitigation measures would be of medium to high negative significance, given the Endangered status of the affected western leopard toads and the size of the impacted area.

In the event that construction occurred during adult or toadlet migration stages (i.e. around July through to November / December respectively), the risks of mortalities (e.g. entrapment in excavations) would be substantially higher, even though most such migrations occur only at night, and thus after construction activity and vehicle movement would be likely to be vastly reduced.

The proposed construction approach would however be phased, which would afford opportunities to manage construction impacts such as these. The first phase would be the construction of Berkley Road and the road across the main ecological corridor, followed by phased construction of Precincts 1 and 2, but noting that development funding parameters might result in non sequential development of the phases shown in **Figure 4.7**.

Essential mitigation measures

While avoidance of any fatalities to on-site fauna including western leopard toads is not considered an achievable objective, minimising fatalities by a combination of search and removal and the creation of safe refugia during construction should be aimed for. The following measures apply (reference to phases as shown in **Figure 4.7**):

- **Both alternatives**

i. Faunal specialist to conduct search and rescue for western leopard toads (and any other small indigenous fauna encountered during this activity) prior to any on-site construction / clearing, with animals thus found being relocated temporarily to the infilled area to the north of the site, abutting the Liesbeek channel. This receiving area must be fenced off from the development site to prevent rescued toads wandering back to site – shade cloth, or windbreak fencing may be used for this purpose, provided that it is regularly inspected for damage / openings. Search and Rescue operations must be overseen by the faunal specialist, and should include record-keeping;

ii. Phase 1 road development:

   a. – temporary access roads across the corridor must be raised with pipe culverts so that they don't threaten faunal use of the corridor during construction;

   b. a construction access zone of 15m on either side of the proposed road across the corridor must also be fenced off, with the connecting pipes described above protruding on either side of this fenced off area;

iii. Phase 4 (as depicted in **Figure 4.7**) can commence simultaneously with Phase 1, if required, provided other mitigation requirements are met;

iv. Phase 3 construction may not commence until after rehabilitation of the Liesbeek Canal and its buffer area – this is because this zone connects to the Raapenberg wetland toad populations;

v. Commence rehabilitation of the Liesbeek Canal in the first summer after commencement and ensure landscaping is completed in March of the following year so that plants have time to establish before the start of the wet season when the river is vulnerable to erosion;

vi. After canal rehabilitation (defined by completion of initial planting at the end of the first summer after project implementation) the upper end of the planted canal zone (i.e. the top of the 1:100 year floodline) must be fenced, to prevent movement of leopard toads and other fauna into construction sites;

vii. Raapenberg wetland to be fenced off temporarily along the top of the river channel on the right hand bank prior to start of any construction on site, to prevent WLTs passing into the construction zone;

viii. Conduct bulk earthworks, installation of structures (e.g. gabion baskets) and landscaping / planting of the canal and the remnant natural Liesbeek River channel during the dry season only (between January (after Western Leopard Toadlet migration) and May (before major rains) – disturbed areas must be planted prior to the start of the wet season in each case;

ix. Landscape the main east-west recreational buffer area in direct consultation with a faunal specialist;

x. Development of Phase 3 may take place only after completion of the landscaping and planting of the north-south ecological corridor AND the "natural" channel of the Liesbeek River. At this point, the fenced off infill areas north of the site can be opened and connectivity of fauna secluded in these areas restored;

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xi. Infill and rehabilitate the original course of the Liesbeek River in summer, and after the establishment of the main east-west recreational buffer area and the rehabilitated canal corridor only;

xii. Landscape the ecological corridors on the northern and southern property boundaries once the respective development platforms are in place only;

xiii. The Raapenberg wetlands must be managed as a no-go area for all construction vehicles and personnel throughout the construction period, and should be fenced off at its northern boundary berm, with wire mesh fencing – such fencing must however include holes sized to allow faunal passage through the fences, unless otherwise required (e.g. during rehabilitation of the Liesbeek Canal) – holes 30cm high x 20cm wide at 5 – 10 m intervals should be created. Alternative approaches such as use of a simple temporary pole fence, with cross-beams could also be used, as these would allow faunal connectivity – they would however need adaptation during periods when faunal access needed to be prevented (e.g. during Liesbeek Canel rehabilitation works);

xiv. A detailed Construction Phase Environmental Management Programme (CEMPr) must be drawn up, outlining *inter alia* the required sequence of phased activities – the details of this plan would require careful input from the biodiversity as well as the civils and landscaping teams. The measures included in this report as Construction Phase mitigation should be included in such a document, which should also take cognisance of the additional measures outlined in Section 6.

- **Alternative 1:**

xv. During canal rehabilitation, safe faunal connectivity between the open space north of the site, and the natural Liesbeek channel must be maintained – this can be achieved if the areas are fenced off together. This measure is important because it means that search and rescued toads can at least access the natural channel of the Liesbeek River during breeding, and potentially migrate along the Black River corridor to reach the Raapenberg wetlands;

xvi. Rehabilitation of the Black River corridor (see mitigation in Section 5.1.8) in the vicinity of the new bridge would need to take place after rehabilitation of the canal, and after construction of the new proposed Berkley Road bridge, after which this important corridor would be functional;

xvii. The main east-west ecological corridor must be landscaped during summer (earthworks) into early winter (planting phase) – commencement of landscaping of this corridor should take place within one year of completion of landscaping of the rehabilitated Canal. The rehabilitated corridor must tie into the natural Liesbeek channel area, but should initially be fenced off from the area, during construction, and allowed rather to link into the rehabilitated canal corridor, leading to the Raapenberg wetlands. Links between the open space north of the site and the natural channel area on the site must be closed off with fencing to prohibit toad passage through this area, prior to the start of construction activities in the natural channel area;

xviii. Another toad search and rescue would need to take place prior to commencement of infilling and rehabilitation of the natural Liesbeek channel, with rescued toads being placed in the rehabilitated east-west corridor (assuming that it is adequately established) or other nearby suitable safe refugia;

xix. Infill and rehabilitation of the natural Liesbeek channel should take place in summer, once the main corridor and rehabilitated river course have been established;

xx. Western leopard toad search and rescues must be conducted prior to construction of any subsequent phases, with rescued animals placed in the main ecological corridor (assuming that it is adequately established) or other nearby suitable safe refugia;

xxi. Landscaping of the remaining two minor east-west corridors across the site must take place once the adjacent development platform is in place – again, the corridors would need search and rescue activities;

xxii. Both the aquatic specialist and the faunal specialist should have ongoing input into planning and implementation of the construction process, and particularly the phasing of activities and the rationale for connecting and disconnecting different parts of the open space areas to ensure both protection of western leopard toads and allow their safe breeding and migration through the site. The toads would require unrestricted migration and dispersal options between breeding wetlands and shelter/foraging habitats, and protection rom vehicular traffic during the breeding season – but as long as the latter is restricted to daylight hours, this aspect would generally not be an issue (M. Burger, pers. comm.);

xxiii. Canal rehabilitation and creation of the ecological corridor must take place within the first summer after construction commences;

xxiv. Infill and rehabilitation of the natural Liesbeek channel should take place in summer, once the main corridor and rehabilitated river course have been established, and no longer than one wet season after completion of the canal and corridor.

- **Alternative 2:**

In the event that this alternative is authorised, the same activities outlined above would be required, with the exception that rehabilitation of the natural channel should be prioritised over the minor beautification activities required for the canal.

Table 5.9 provides a more formal assessment of the impacts described above, with and without mitigation. The table shows that, without mitigation, both Alternatives are likely to result in fatalities to western leopard toad populations on the site (as well as other fauna). These impacts are unlikely to be large-scale and likely to be of medium intensity only, given the proposed phasing plans and the fact that western leopard toads emerge mainly at night.

With mitigation, the intensity of impact can be reduced, although some level of impact remains probable.

Table 5.9
Significance of faunal fatalities (particularly western leopard toads) as a result of construction disturbance

Nature of impact	Extent of impact	Intensity	Duration of impact	Consequence	Probability of occurrence	Signif.	Confid.
ALT 1 Without Mitigation	2 Regional (because of status of [13]WLTs)	2 Medium	2 Medium term – affecting Endangered species	6 Medium	Probable	Medium (Neg.)	Medium
ALT 2 Without Mitigation	2 Regional (because of status of WLTs)	2 Medium	2 Medium term – affecting Endangered species	6 Medium	Probable	Medium (Neg.)	Medium

Essential mitigation measures:
Both alternatives

i. Faunal specialist to conduct search and rescue for western leopard toads (and any other small indigenous fauna encountered during this activity) prior to any on-site construction / clearing, with animals thus found being relocated temporarily to the infilled area to the north of the site, abutting the Liesbeek channel. This receiving area must be fenced off from the development site to prevent rescued toads wandering back to site – shade cloth, or windbreak fencing may be used for this purpose, provided that it is regularly inspected for damage / openings. Search and Rescue operations must be overseen by the faunal specialist, and should include record-keeping;
ii. Phase 1 road development:
   a. – temporary access roads across the corridor must be raised with pipe culverts so that they don't threaten faunal use of the corridor during construction – a construction access zone of 15m on either side of the proposed road across the corridor must also be fenced off, with the connecting pipes described above protruding on either side of this fenced off area;
iii. Phase 4 (as depicted in Figure 4.7) can commence simultaneously with Phase 1, if required, provided other mitigation requirements are met;
iv. Phase 3 construction may not commence until after rehabilitation of the Liesbeek Canal and its buffer area – this is because this zone connects to the Raapenberg wetland toad populations;
v. Commence rehabilitation of the Liesbeek Canal in the first summer after commencement and ensure landscaping is completed in March of the following year so that plants have time to establish before the start of the wet season when the river is vulnerable to erosion
vi. After canal rehabilitation (defined by completion of initial planting at the end of the first summer after project implementation) the upper end of the planted canal zone (i.e. the top of the 1:100 year floodline) must be fenced, to prevent movement of leopard toads and other fauna into construction sites
vii. Raapenberg wetland to be fenced off temporarily along the top of the river channel on the right hand bank prior to start of any construction on site, to prevent WLTs passing into the construction zone
viii. Conduct bulk earthworks, installation of structures (e.g. gabion baskets) and landscaping / planting of the canal and the remnant natural Liesbeek River channel during the dry season only (between January (after Western Leopard Toadlet migration) and May (before major rains) – disturbed areas must be planted prior to the start of the wet season in each case;
ix. Landscape the main east-west recreational buffer area in direct consultation with a faunal specialist;
x. Development of Phase 3 may take place only after completion of the landscaping and planting of the north-south ecological corridor AND the "natural" channel of the Liesbeek River. At this point, the fenced off infill areas north of the site can be opened and connectivity of fauna secluded in these areas restored.
xi. Infill and rehabilitate the original course of the Liesbeek River in summer, and after the establishment of the main east-west recreational buffer area and the rehabilitated canal corridor only
xii. Landscape the ecological corridors on the northern and southern property boundaries once the respective development platforms are in place only
xiii. The Raapenberg wetlands must be managed as a no-go area for all construction vehicles and personnel throughout the construction period, and should be fenced off at its northern boundary berm, with wire

[13] WLT = Western leopard toad

mesh fencing – such fencing must however include holes sized to allow faunal passage through the fences, unless otherwise required (e.g. during rehabilitation of the Liesbeek Canal) – holes 30cm high x 20cm wide at 5 – 10 m intervals should be created. Alternative approaches such as use of a simple temporary pole fence, with cross-beams could also be used, as these would allow faunal connectivity – they would however need adaptation during periods when faunal access needed to be prevented (e.g. during Liesbeek Canel rehabilitation works);
xiv. A detailed Construction Phase Environmental Management Programme (CEMPr) must be drawn up, outlining *inter alia* the required sequence of phased activities – the details of this plan would require careful input from the biodiversity as well as the civils and landscaping teams. The measures included in this report as Construction Phase mitigation should be included in such a document, which should also take cognisance of the additional measures outlined in Section 6.

Alternative 1:

xv. During canal rehabilitation, safe faunal connectivity between the open space north of the site, and the natural Liesbeek channel must be maintained – this can be achieved if the areas are fenced off together. This measure is important because it means that search and rescued toads can at least access the natural channel of the Liesbeek River during breeding, and potentially migrate along the Black River corridor to reach the Raapenberg wetlands;
xvi. Rehabilitation of the Black River corridor (see mitigation in Section 5.1.8) in the vicinity of the new bridge would need to take place after rehabilitation of the canal, and after construction of the new proposed Berkley Road bridge, after which this important corridor would be functional;
xvii. The main east-west ecological corridor must be landscaped during summer (earthworks) into early winter (planting phase) – commencement of landscaping of this corridor should take place within one year of completion of landscaping of the rehabilitated Canal. The rehabilitated corridor must tie into the natural Liesbeek channel area, but should initially be fenced off from the area, during construction, and allowed rather to link into the rehabilitated canal corridor, leading to the Raapenberg wetlands. Links between the open space north of the site and the natural channel area on the site must be closed off with fencing to prohibit toad passage through this area, prior to the start of construction activities in the natural channel area;
xviii. Another toad search and rescue would need to take place prior to commencement of infilling and rehabilitation of the natural Liesbeek channel, with rescued toads being placed in the rehabilitated east-west corridor (assuming that it is adequately established) or other nearby suitable safe refugia;
xix. Infill and rehabilitation of the natural Liesbeek channel should take place in summer, once the main corridor and rehabilitated river course have been established;
xx. Western leopard toad search and rescues must be conducted prior to construction of any subsequent phases, with rescued animals placed in the main ecological corridor (assuming that it is adequately established) or other nearby suitable safe refugia;
xxi. Landscaping of the remaining two minor east-west corridors across the site must take place once the adjacent development platform is in place – again, the corridors would need search and rescue activities;
xxii. Both the aquatic specialist and the faunal specialist should have ongoing input into planning and implementation of the construction process, and particularly the phasing of activities and the rationale for connecting and disconnecting different parts of the open space areas to ensure both protection of western leopard toads and allow their safe breeding and migration through the site. The toads would require unrestricted migration and dispersal options between breeding wetlands and shelter/foraging habitats, and protection from vehicular traffic during the breeding season – but as long as the latter is restricted to daylight hours, this aspect would generally not be an issue (M. Burger, pers. comm.).
xxiii. Canal rehabilitation and creation of the ecological corridor must take place within the first summer after construction commences
xxiv. Infill and rehabilitation of the natural Liesbeek channel should take place in summer, once the main corridor and rehabilitated river course have been established, and no longer than one wet season after completion of the canal and corridor.

Alternative 2:

In the event that this alternative is authorised, the same activities outlined above would be required, with the exception that rehabilitation of the natural channel should be prioritised over the minor beautification activities required for the canal.

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ALT 1 With Mitigation	2 Regional (because of status of [14]WLTs)	1 Low	? Medium term – affecting Endangered species	5 Low	Probable	Low (Neg.)	Medium
ALT 2 With Mitigation	2 Regional (because of status of WLTs)	1 Low	? Medium term – affecting Endangered species	5 Low	Probable	Low (Neg.)	Medium

5.2.2. *Water quality and habitat deterioration as a result of diversion of river (Black River and Liesbeek Canal) and wetland (natural Liesbeek channel) flows during construction*

Impact description

Construction of bridges over the Black River and Liesbeek channel / landscaped swale area and rehabilitation of the Liesbeek Canal (Alternative 1) would all require full or partial diversion of river and (in the case of the Liesbeek channel) wetland flows. The results of flow diversion would be likely to include the following:

- **Black River impacts:** localised temporary loss of riverine habitat would be likely in sections of the river under active construction, where it is assumed that temporary coffer dams would be created to allow works in the river to proceed. Given the temporary nature of the impact and the degraded condition of the affected environment, the impact would be of low significance, although the system would be vulnerable to more extensive damage in the event of high flows;
- **Liesbeek Canal impacts:** wholesale diversion of flows from the Liesbeek canal is assumed to be required during canal rehabilitation works, and during this period (likely extending over a few weeks to months) river function in the canal area would be suspended. Given that river function in the canal is at best limited, this impact is not considered of great significance. In the event that construction overlaps with storm or floodflows, diversion might however be ineffective, resulting in damage to landscaped / shaped areas and the passage of volumes of sediment into the Black River downstream. If even medium sized flood events (0.5 - 1 year return interval) or greater occurred in the river, the transport of volumes of sediment into the adjacent Raapenberg wetlands could occur, resulting in degradation of this wetland as a result of receipt of volumes of sediment. Such events would also increase sedimentation into the Black River, increasing turbidity and increasing the extent of shallow sand bars (the latter encourage wading birds such flamingos but have the indirect effect of increasing dredging frequency in the channel;
- The mechanism of diversion of flows is currently undetermined, and could include diversion and pumping at the weir, into the former **Liesbeek channel**, and /or piping or trenching flows past the proposed rehabilitation course. Of these, the latter would increase flows into the natural channel on a short term basis, potentially flushing sediment and improving aeration –

[14] WLT = Western leopard toad

this would only be of benefit in the lower reaches, where infilling of the habitat is not already planned;

- Construction of the road across the open space corridor of the Liesbeek channel is currently planned for Phase 1 of construction. However, mitigation measures outlined in Section 5.2.1 recommend infilling of the channel (Alternative 1) only after construction of the main east west corridor and rehabilitation of the canal. Construction of the road crossing through the channel area is thus problematic and needs to be aligned with other activities (i.e. infilling) in the channel area.

Essential mitigation measures

The following impact mitigation measures are considered essential from an aquatic ecosystems perspective:

i. Construction activities involving excavation into any river or canal bed and banks must be carefully timed so as to take place in the dry season when there should be least risk of flooding, but ideally also outside of toad migration periods – this means the ideal window of opportunity is between December and May of any year. The timing of this could be less restrictive in terms of western leopard toads, provided that adequate measures are in place to 1) prevent/limit toad mortalities associated with construction activities and vehicular traffic, 2) maintain toad migration/dispersal corridor options. The details of such measures would need to be worked out with the faunal specialist, and could include the creation of toadlet collection traps upslope of the excavated Liesbeek canal, from where retrieval and relocation can take place;

ii. A comprehensive construction phasing plan must be drawn up, in collaboration with the faunal and aquatic (river and wetlands) specialists, the civil engineering team, the design engineers and the landscape team – this would need to be drawn up well in advance of the start of the project, and should take into account, or effectively mitigate against, the concerns of the biodiversity specialists;

iii. Detailed method plans for general watercourse construction and flow diversion approaches must be prepared as part of the detailed design phase of the development, and these should show how downstream sedimentation and/or turbidity would be avoided in design;

iv. Allowance must be made for emergency rehabilitation of any aquatic ecosystems that are accidentally (or otherwise) impacted as a result of flood flows – this would include the Raapenberg wetlands, in which careful manual removal of sediment may be required under circumstances where sedimentation from flood damage during construction is deemed problematic by the aquatic specialist;

v. Deliberate diversion of flow from the Liesbeek canal into the Raapenberg wetlands may not take place –[15]the existing channel excavated into the wetland from the canal should ideally be infilled prior to the start of any construction activities in the canal;

[15] Given that the channel lies outside of the proponent's property and was moreover not constructed by the proponent or the River Club, its removal cannot be a requirement of this project. It is however a strong recommendation that this channel be removed / infilled

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vi. Early establishment of a good quality of plant cover (80% cover by end of first year, with a high diversity of indigenous plant species, as selected in collaboration with the botanical and aquatic specialists) is essential in all landscaped open space areas, and particularly so for those prone to erosion (e.g. wet season channel and edge of low flow channel in the rehabilitated canal and landscaped swale (Alternative 1) or the remediated Liesbeek channel (Alternative 2);

vii. Construction of the culverted road crossing over the landscaped swale should be timed to synchronise with other landscape and construction activities in this area (see Section 5.2.1 mitigation).

Table 5.10 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.10
Significance of water quality and habitat deterioration as a result of diversion of river (Black River and Liesbeek Canal) and wetland (natural Liesbeek channel) flows during construction

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
ALT 1 Without Mitigation	1 Local	2 Medium	1 Short term	4 Very low	Probable	Very low (Neg.)	Medium
ALT 2 Without Mitigation	1 Local	1 Low	1 Short term	3 Very low	Probable	Very low (Neg.)	Medium

Essential mitigation measures

i. Construction activities involving excavation into any river or canal bed and banks must be carefully timed so as to take place in the dry season when there should be least risk of flooding, but ideally also outside of toad migration periods – this means the ideal window of opportunity is between December and May of any year. The timing of this could be less restrictive in terms of western leopard toads, provided that adequate measures are in place to 1) prevent/limit toad mortalities associated with construction activities and vehicular traffic and 2) maintain toad migration/dispersal corridor options. The details of such measures would need to be worked out with the faunal specialist, and could include the creation of toadlet collection traps upslope of the excavated Liesbeek canal, from where retrieval and relocation can take place;

ii. A comprehensive construction phasing plan must be drawn up, in collaboration with the faunal and aquatic (river and wetlands) specialists, the civil engineering team, the design engineers and the landscape team – this would need to be drawn up well in advance of the start of the project, and should take into account, or effectively mitigate against, the concerns of the biodiversity specialists;

iii. Detailed method plans for general watercourse construction and flow diversion approaches must be prepared as part of the detailed design phase of the development, and these should show how downstream sedimentation and/or turbidity would be avoided in design;

iv. Allowance must be made for emergency rehabilitation of any aquatic ecosystems that are accidentally (or otherwise) impacted as a result of flood flows – this would include the Raapenberg wetlands, in which careful manual removal of sediment may be required under circumstances where sedimentation from flood damage during construction is deemed problematic by the aquatic specialist;

v. Deliberate diversion of flow from the Liesbeek canal may not take place into the Raapenberg wetlands. The existing channel excavated into the wetland from the canal should ideally also be infilled prior to the start of any construction activities in the canal;

vi. Early establishment of a good quality of plant cover (80% cover by end of first year, with a high diversity of indigenous plant species, as selected in collaboration with the botanical and aquatic specialists) is essential in all landscaped open space areas, and particularly so for those prone to erosion (e.g. wet season channel and edge of low flow channel in the rehabilitated canal and landscaped swale (Alternative 1) or the remediated Liesbeek channel (Alternative 2);

vii. Construction of the culverted road crossing over the landscaped swale should be timed to synchronise with other landscape and construction activities in this area (see Section 5.2.1 mitigation).

ALT 1 With Mitigation	1 Local	1 Low	1 Short term	3 Very low	Probable	Very low (Neg.)	High
ALT 2 With Mitigation	1 Local	1 Low	1 Short term	3 Very low	Probable	Very low (Neg.)	High

5.2.3. *Degradation of downstream habitat in the Liesbeek Canal, lower natural Liesbeek channel and Black River resulting from activities other than flow diversion*

Impact description

Intensive construction activities involving the large-scale, medium term, intensive construction of the proposed River Club site is realistically likely to result, at least at times, in visible degradation of the adjacent Black River, Liesbeek canal and natural Liesbeek channel, including any of the following:

- Sedimentation of downstream areas – particularly during dewatering and site excavation activities;
- Passage of cementitious water / sediments into downstream areas – where this results in raising of river water pH, increased ammonia toxicity might occur, given that the Black River tends towards elevated total ammonia concentrations, the toxic (un-ionised ammonia) proportion of which increases with increasing pH, particularly in the pH range > pH=8;
- Other construction-related pollutants including spills of fuels, oils and other materials into the river;
- Physical disturbance of marginal bank habitat as a result of the passage of vehicles through or in proximity of these areas – the Black River wetlands would be vulnerable to such impacts, as would (possibly) the adjacent Raapenberg wetlands;
- Passage of litter and solid waste from the construction site into the river channels;
- Runoff from stockpiles and storage areas into adjacent aquatic ecosystems;
- Erosion of disturbed areas and loss of plants, affecting the intended outcomes of the project, as a result of floods and/or heavy rainfall events during construction phase activities involving earthworks, shaping, early planting or other construction in any of the watercourses.

Essential mitigation measures

i. The detailed Construction Phase Environmental Management Programme (CEMPr) (already recommended as mitigation) must include measures that:

   a. Limit the placement and management of stockpiles and storage areas to areas where it is not vulnerable to water- or wind-transport into aquatic ecosystems;

   b. Define areas for the storage of vehicles, fuel and other building materials within the development platforms – no stockpile or storage areas are to be allowed within 20m of the outer edge of any designated buffer area or ecological corridor – the only exception to the above would be the temporary stockpiling of topsoil, mulch and plants specifically required for the landscaping of these areas;

   c. Include requirements for bunding of fuel storage areas;

   d. Specify areas where concrete / cement can be safely stored and / or mixed, in phase with different development phases on the site;

   e. Include temporary sediment stilling ponds on flow pathways from the development platform;

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f. Outline construction platform access roads, so that ecological corridors and sensitive areas are not disturbed – access road should be clearly demarcated on site;

ii. Ecological corridors, designated buffer areas and other sensitive areas (e.g. the edge of the Raapenberg wetlands abutting the site) must be clearly demarcated as no go areas prior to the start of construction;

iii. The timing of all works involving active disturbance of river beds and /or banks should be such that the active works take place in the dry season months as far as possible. This will reduce but not avoid the possibility of damage from floods.

iv. Allowance must be made in project contingency planning for the high likelihood that planted / newly landscaped areas might require re-doing, in the event of significant flooding.

v. Allowance must be made for the rehabilitation of any disturbed areas that are part of the ecological buffers or corridors;

vi. An adequate waste management programme must be developed and implemented, allowing for regular collection of litter and other waste on site, the provision and management of adequate temporary toilets on site and the removal and legal disposal of building waste (e.g. removed sections of the Liesbeek Canal).

Table 5.11 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.11
Significance of Degradation of downstream habitat in the Liesbeek Canal, lower natural Liesbeek channel and Black River from activities other than flow diversion

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
Both Alternatives <u>Without Mitigation</u>	1 Local	3 High	2 Medium term	6 Medium	Probable	Medium (Neg.)	Medium

Essential mitigation measures:
Both Alternatives

i. The detailed Construction Phase Environmental Management Programme (CEMPr) (already recommended as mitigation) must include measures that:
   a. Limit the placement and management of stockpiles and storage areas to areas where it is not vulnerable to water- or wind-transport into aquatic ecosystems;
   b. Define areas for the storage of vehicles, fuel and other building materials within the development platforms – no stockpile or storage areas are to be allowed within 20m of the outer edge of any designated buffer area or ecological corridor – the only exception to the above would be the temporary stockpiling of topsoil, mulch and plants specifically required for the landscaping of these areas;
   c. Include requirements for bunding of fuel storage areas;
   d. Specify areas where concrete / cement can be safely stored and / or mixed, in phase with different development phases on the site;
   e. Include temporary sediment stilling ponds on flow pathways from the development platform;
   f. Outline construction platform access roads, so that ecological corridors and sensitive areas are not disturbed – access road should be clearly demarcated on site;

ii. Ecological corridors, designated buffer areas and other sensitive areas (e.g. the edge of the Raapenberg wetlands abutting the site) must be clearly demarcated as no go areas prior to the start of construction;

iii. The timing of all works involving active disturbance of river beds and /or banks should be such that the active works take place in the dry season months as far as possible. This will reduce but not avoid the possibility of damage from floods.

iv. Allowance must be made in project contingency planning for the high likelihood that planted / newly landscaped areas might require re-doing, in the event of significant flooding.

v. Allowance must be made for the rehabilitation of any disturbed areas that are part of the ecological buffers or corridors;

vi. An adequate waste management programme must be developed and implemented, allowing for regular collection of litter and other waste on site, the provision and management of adequate temporary toilets on site and the removal and legal disposal of building waste (e.g. removed sections of the Liesbeek Canal).

Both Alternatives <u>With Mitigation</u>	1 Local	1 Low	2 Medium term	4 Very Low	Probable	Very Low (Neg.)	Medium

5.2.4. *Disturbance of watercourse bed and banks during infrastructure installation*

The proposed development includes sewers, potable water pipelines and likely various telecommunication and electricity cabling etc. None of these would however be passed directly into the (rehabilitated) Liesbeek canal or the Black River, but some have been shown (see Section 4) as passing under or through the landscaped swale / natural Liesbeek channel area.

Passage of services through this area, assuming this happening after infilling and landscaping (Alternative 1) or after landscaping (Alternative 2) would result in localised, short term disturbance of aquatic and other habitats with low sensitivity to disturbance. The significance of these impacts would be low.

<u>*Mitigation measures*</u>

Best practice measures would need to include rehabilitation of areas disturbed by excavation and services installation, to pre-disturbance levels or better.

Table 5.12 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.12
Significance of Disturbance of watercourse bed and banks during infrastructure installation

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
Both Alternatives <u>Without Mitigation</u>	1 Local	2 Medium	1 Short term	4 Very Low	Probable	Very Low (Neg.)	Medium
Best practice measures **Both Alternatives** Best practice measures would need to include rehabilitation of areas disturbed by excavation and services installation, to pre-disturbance levels or better.							
Both Alternatives <u>Without Mitigation</u>	1 Local	1 Low	1 Short term	3 Very Low	Probable	Very Low (Neg.)	High

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5.3. Operational phase impacts

This section identifies and assesses key operational phase impacts on biodiversity and aquatic ecosystem functioning that could affect the capacity of the implemented alternative to meet its expected long-term biodiversity and/or aquatic ecosystem functional objectives.

5.3.1. *Degradation of habitat quality or failure to realise opportunities for improved habitat quality and biodiversity conservation / improvement as a result of inadequate or ill-advised channel and open space maintenance activities*

Problematic maintenance measures would include any of the following activities or outcomes:

- Long-term simplification of planted vegetation swathes through the main ecological corridor
- Grassing the minor (or major) ecological corridors, instead of planting with vertically diverse shrubs and other indigenous vegetation minor (or major)
- Allowing faunal culverts to block, over-grow or be cut off from their linking corridors by waste, vegetation or development edge expansion;
- Expansion of grassed areas into the riverine corridor at the expense of areas of indigenous riverine plantings;
- Re-landscaping / disruption to connecting landscaped swathes intended to provide longitudinal cover and habitat to western leopard toads and other indigenous fauna (e.g. chameleons) – as a guideline, at least 40% of the main ecological corridor should be managed as indigenous planted corridor habitat, without lawn or pathways (see Section 5.1.4 mitigation);
- Encroachment of development activities / impacts into the riverine and landscaped swale (Alternative 1) or remediated Liesbeek channel (Alternative 2) and/or the ecological corridors – examples of encroachment would include increased hardening of these areas, and the establishment of additional paved seating areas or the construction of fences within or through buffer areas;
- Incision and channelization of the low flow channel in the rehabilitated Liesbeek canal as a result of mechanical excavation / removal of reeds and/or sediments from the low flow channel
- Inadequate attention to the ongoing need for removal of alien and other weedy plant species, particularly from recently disturbed / newly established areas. Invasion of river margins by *Commelina benghalensis* and /or purple loose-strife is a significant risk to the long-term establishment of high quality riverine habitats, and there is a plethora of other alien plants (e.g. nasturtium, morning glory, various woody aliens), that would establish in these areas unless specifically managed. Invasion of the river channel by water hyacinth (*Eicchornia crassipes*) is also a reality that must be managed on an ongoing basis;
- Access to sensitive areas by increased numbers of people – e.g. Raapenberg wetlands. This impact is unlikely, as the wetland would be separated from the development by the rehabilitated canal (Alternative 1) or the canal (Alternative 2). In the former case, it is however possible that, during low flows, increased informal access to the wetlands could take place, in which case there would be an increase in disturbance of wetland birds, as well as increased trampling and general wetland disturbance;
- Increased disturbance to natural habitats and predation / disturbance of indigenous fauna as a result of increased numbers of domestic dogs and cats in residential and /or recreational areas of the development.

<u>*Essential mitigation measures*</u>

The following mitigation measures must be applied:

i. An Operational Phase Environmental Management Programme (OEMPr) must be compiled and used as the framework against which long-term management activities on the future development are planned and implemented;
ii. The OEMPr should draw information and specifications *inter alia* from the present report;
iii. The OEMPr must be compiled *inter alia* so as to reflect clearly:
    a. the ecological / biodiversity issues and objectives inherent in the design and layout of the development;
    b. the location, extent and role in the development of ecological corridors, ecological buffer areas and the Liesbeek canal, natural channel / landscaped swale;
    c. the sensitivities of these areas;
    d. the management objectives for all of the above areas;
    e. acceptable and unacceptable uses and activities in and around these areas;
iv. The OEMPr should include monitoring recommendations (see Section 8);
v. The OEMPr should be finalised on completion of the development, but its basis should be the ecological planning and layout inputs that have informed this assessment;
vi. The additional design and implementation measures outlined in Section 6 must be implemented;
vii. The OEMPr should include a detailed annotated plan of the development area, clearly indicating the position, dimensions and management objectives of the above listed areas;
viii. During the detailed design phase of the development, the OEMPr should be reformulated (with input from the aquatic ecologist and faunal specialist) into a detailed Property Owner Association (or similar designation) Management Guideline, that is legally compliant and that includes clear method statements regarding ecologically acceptable approaches to addressing the following issues, including timing, frequency, methods, and no-go approaches:
    a. Clearing of reeds from the low flow channel
        i. Such activities should always require clearance from an aquatic ecologist as to need and desirability
        ii. Reed clearing should be carried out manually in late summer / autumn and should entail only cutting of reeds close to the ground – just above water level;
        iii. Clearing of narrow longitudinal channels should not be permitted, as this would encourage channelization and incision – rather, reeds should be cut across the fill width of the channel – in 10m wide swathes, separated by river lengths of 20-30m if cutting the whole river channel is not feasible; such swathes could be alternated in different sections of the channel in subsequent years;
        iv. Cleared reeds should be removed from the channel
    b. Clearing of water hyacinth from the channel
        i. Ideally, removal of this weed should take place at a catchment level – this was achieved by the City in the Lotus River / Zeekovlei catchment with major success, and could be achieved with effort in the Black River / Liesbeek catchment;
        ii. Within the river reaches past the River Club site, clearing of hyacinth would need to be managed using manual labour and without intrusion by excavators or other machinery likely to disturb / destroy the landscaped gently graded river margins. Such measures would need to be undertaken in low flow conditions only, when there is safe access into the channel. Although there should be flexibility about the actual removal method, to allow for innovative approaches, water hyacinth could be

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floated up- or downstream in the channel to a single point where there is access from the side, for the collection and removal of the weed. Flotation into the Black River and collection from there could also be considered;

c. Clearing of sediment build-up in the channel
    i. Sediment removal should not take place more frequently than every five years, and then only when necessary because of significant loss of channel capacity;
    ii. If sediment is cleared, it could be removed mechanically, but the design profile of the channel must be restored, and cleared areas replanted with appropriate indigenous riverine and wetland vegetation, as per the original construction programme;
    iii. Sediment clearing may only take place with approval from a river specialist;
d. Maintenance requirements and management objectives for faunal culverts;
e. Rules and guidelines around the use and management of buffer areas and ecological corridors;
f. Design guidelines for open space areas, indicating clearly requirements for ecological connectivity to be created by indigenous planting templates, the extent of such areas required and appropriate access by humans into these areas;
g. Information regarding the design and function of toad barriers;
h. Guidelines for the removal of key invasive alien plant species – these would require updating as new species emerged and new control methods (e.g. biocontrols) are developed –approaches for the control of purple loose strife are outlined in **Box 3.1**, for information;
i. Access control guidelines should be included, and should consider the need for access to the Raapenberg wetlands to be controlled, while *ad hoc* access across the Liesbeek canal should ideally not be permitted. This said, the recommendations by the avifaunal specialist (Appendix D) regarding the social, educational and possible conservation benefits of linking urban developments to urban wildfowl areas should be considered. Opportunities to install bird hides and improve on-site bird habitat quality (e.g. perching trees) should be encouraged;
j. Requirements to increase the accessibility of the Raapenberg wetlands for an increased local human population / community would need to be carefully considered, and in the short term it is recommended that the wetland should be protected from such access by a permeable fence, that allowed for the passage of small wetland and wetland-associated fauna (toads, otters, porcupines) through gaps in the fencing, while limiting uncontrolled human access, as well as access by dogs;
k. Given the proximity of the development to a bird sanctuary and breeding areas for endangered fauna, the keeping and exercising of dogs in open spaces should be controlled, so that disturbance to natural fauna and habitats as a result of increased use of these open spaces does not occur. The keeping of cats should ideally be discouraged;

ix. Both the faunal specialist and the aquatic ecologist involved in the evolution of the development layouts assessed in this document should have input into the final OEMPr and the Property Owner Association Management Guideline, to ensure that the intention of the original design is carried through in long-term management;

x. Allowance must be made for adequate financial and human resources input into the long-term management of open spaces including ecological corridors and recreational and ecological buffer areas, as well as aquatic ecosystems, on a sustainable basis;

xi. The site should be audited at two to three year intervals, to determine the degree to which the design and management objectives of the development from an ecological perspective are being met. Data collected during ongoing monitoring (as recommended in Section 8) should inform these audits, and recommendations for changes in ongoing development management from an ecological perspective.

Table 5.13 provides a more formal assessment of the impacts described above, with and without mitigation. Arguably, the impacts with mitigation could be viewed as positive compared to present day levels of function – however, given the scale of development and the inherent risks associated with long term management, the impacts have been conservatively assessed rather as "Not Significant", with the positive aspects of development already rated in terms of Design (Section 5.1.1).

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Table 5.13

Degradation of habitat quality or failure to realise opportunities for improved habitat quality and biodiversity conservation / improvement as a result of inadequate or ill-advised channel and open space maintenance activities

Nature of Impact	*Extent of Impact*	*Intensity*	*Duration of Impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
Both Alternatives Without Mitigation	1 Local	2 Medium	3 Long term	6 Medium	Probable	Medium (Neg.)	Medium

Essential mitigation measures

The following mitigation measures must be applied:

xii. An Operational Phase Environmental Management Programme (OEMPr) must be compiled and used as the framework against which long-term management activities on the future development are planned and implemented;

xiii. The OEMPr should draw information and specifications *inter alia* from this report;

xiv. The OEMPr must be compiled *inter alia* so as to reflect clearly:

a. the ecological / biodiversity issues and objectives inherent in the design and layout of the development;

b. the location, extent and role in the development of ecological corridors, ecological buffer areas and the Liesbeek canal, natural channel / landscaped swale;

c. the sensitivities of these areas;

d. the management objectives for all of the above areas;

e. acceptable and unacceptable uses and activities in and around these areas;

xv. The OEMPr should include monitoring recommendations (see Section 8);

xvi. The OEMPr should be finalised on completion of the development, but its basis should be the ecological planning and layout inputs that have informed this assessment;

xvii. The additional design and implementation measures outlined in Section 6 must be implemented;

xviii. The OEMPr should include a detailed annotated plan of the development area, clearly indicating the position, dimensions and management objectives of the above listed areas;

xix. During the detailed design phase of the development, the OEMPr should be reformulated (with input from the aquatic ecologist and faunal specialist) into a detailed Property Owner Association (or similar designation) Management Guideline, that is legally compliant and that includes clear method statements regarding ecologically acceptable approaches to addressing the following issues, including timing, frequency, methods, and no-go approaches:

a. Clearing of reeds from the low flow channel

i. Such activities should always require clearance from an aquatic ecologist as to need and desirability

ii. Reed clearing should be carried out manually in late summer / autumn and should entail only cutting of reeds close to the ground – just above water level;

iii. Clearing of narrow longitudinal channels should not be permitted, as this would encourage channelization and incision – rather, reeds should be cut across the full width of the channel – in 10m wide swathes, separated by river lengths of 20-30m if cutting the whole river channel is not feasible; such swathes could be alternated in different sections of the channel in subsequent years;

iv. Cleared reeds should be removed from the channel

b. Clearing of sediment build-up in the channel

i. Sediment removal should not take place more frequently than every five years, and then only when necessary because of significant loss of channel capacity;

ii. If sediment is cleared, it could be removed mechanically, but the design profile of the channel must be restored, and cleared areas replanted with appropriate indigenous riverine and wetland vegetation, as per the original construction programme;

iii. Sediment clearing may only take place with approval from a river specialist;

c. Maintenance requirements and management objectives for faunal culverts;

d. Rules and guidelines around the use and management of buffer areas and ecological corridors;

e. Design guidelines for open space areas, indicating clearly requirements for ecological connectivity to be created by indigenous planting templates, the extent of such areas required and appropriate access by humans into these areas;

f. Information regarding the design and function of toad barriers;

g. Guidelines for the removal of key invasive alien plant species – these would require updating as new species emerged and new control methods (e.g. biocontrols) are developed –approaches for the control of purple loose strife are outlined in Box 3.1, for information;

h. Access control guidelines should be included, and should consider the need for access to the Raapenberg wetlands to be controlled, while *ad hoc* access across the Liesbeek canal should ideally not be permitted. This said, the recommendations by the avifaunal specialist (Appendix D) regarding the social, educational and possible conservation benefits of linking urban developments to urban wildfowl areas should be considered. Opportunities to install bird hides and improve on-site bird habitat quality (e.g. perching trees) should be encouraged;

i. Requirements to increase the accessibility of the Raapenberg wetlands for an increased local human population / community would need to be carefully considered, and in the short term it is recommended that the wetland should be protected from such access by a permeable fence, that allowed for the passage of small wetland and wetland-associated fauna (toads, otters, porcupines) through gaps in the fencing, while limiting uncontrolled human access, as well as access by dogs;

j. Given the proximity of the development to a bird sanctuary and breeding areas for endangered fauna, thekeeping and exercising of dogs in open spaces should be controlled, so that disturbance to natural fauna and habitats as a result of increased use of these open spaces does not occur;

xx. Both the faunal specialist and the aquatic ecologist involved in the evolution of the development layouts assessed in this document should have input into the final OEMPr and the Property Owner Association Management Guideline, to ensure that the intention of the original design is carried through in long-term management;

xxi. Allowance must be made for adequate financial and human resources input into the long-term management of open spaces including ecological corridors and recreational and ecological buffer areas, as well as aquatic ecosystems, on a sustainable basis;

a. The site should be audited at two to three year intervals, to determine the degree to which the design and management objectives of the development from an ecological perspective are being met. Data collected during ongoing monitoring (as recommended in Section 8) should inform these audits, and recommendations for changes in ongoing development management from an ecological perspective.

Both Alternatives With Mitigation	1 Local	0.5 Very Low	3 Long term	4.5 Low to Very Low	Possible	Insignificant to Very low (Neg.)	Medium

5.3.2. *Contribution to deterioration of water quality in the Liesbeek and Black Rivers*

Such impacts could be as a result of:

- Pollution of aquatic ecosystems as a result of sewage overflows / leakage: Either of the proposed developments would entail a large-scale increase in sewage loading from this area to the Athlone waste water treatment works, and the associated long-term risk that, at least at times, sewage spills / leakages into the adjacent aquatic ecosystems, either directly or via stormwater runoff, would occur. The development design has however attempted to minimise such risks, through the location of its pump stations in plenum chambers in the basements. Moreover, the new sewer mains from the development would cross through the landscaped swale (Alternative 1) or remediated Liesbeek channel, but not across the Liesbeek canal or Black River, other than in an existing pipeline. These measures should reduce the frequency of impact, as well as the sensitivity of the receiving environment. Nevertheless, when sewage spills do occur, they would be most likely to affect the low-lying main east-west ecological corridor and the swales and artificial wetland ponds in the landscaped swale area (Alternative 1) and the Liesbeek channel (Alternative 2), resulting in the following impacts:
  - Nutrient enrichment and organic loading, leading to high biological oxygen demands and potentially resulting in oxygen stress to sensitive aquatic organisms, particularly in hot weather conditions;
  - Bacterial contamination of open space areas with aesthetic and human health effects;
- Seepage or runoff from fertilised gardens / open space areas;

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- Stormwater runoff polluted with heavy metals and hydrocarbons from roads and parking areas, as well as from illegal waste discharges into stormwater systems – Aurecon (2017b) outlines however a stormwater management plan that includes the passing stormwater from low flows through stormwater swales and/or enhanced bioretention systems, and into a series of wet ponds located in open space areas;
- Irrigation of private and public open spaces with treated sewage effluent;
- Irrigation of private and public open spaces with domestic grey water;
- Discharges of chlorinated or salt water from swimming pools – chlorine from pool water discharges forms conservative, highly toxic chloramines in water with elevated ammonia concentrations (such as the Black River at times).

Sustained low-level pollution from the above sources would potentially contribute to ongoing eutrophication of the lower Liesbeek River and natural channel downstream of the development, encouraging the growth of aquatic weeds and other vegetation and indirectly increasing the need for maintenance measures associated with high levels of aquatic ecosystem disturbance. While the Black River would show low sensitivity to such impacts, given its current high levels of nutrient concentrations, the discharge of additional pollutants into the river runs counter to the urgent need to improve water quality in this system to more ecologically sustainable levels (i.e. PES Category D or better).

Periodic high flows of contaminated water that enter water courses could result in episodes of acute toxicity – such inflows would however be most likely to be associated with sewage leaks / overflows, unless they stemmed from illegal discharges of seriously contaminated water. IN the case of the former, preventative design mitigation measures have already been implemented as far as possible to address and contain pump failure impacts at source, and large scale overflows are considered possible but unlikely to occur at a level where they will cause ecosystem failure.

Essential mitigation measures

i. Treated sewage water should not be used as a source of irrigation water, unless additional treatment occurs to reduce phosphorus and total ammonia concentrations;
ii. Sewer manholes in all open space areas should be readily visible, so that overflows can be easily detected and reported.
iii. If greywater irrigation is used, it should not be used within any of the riverine corridor buffer areas, which are intended to actively protect adjacent watercourses form development-related impacts;
iv. Swimming pool effluent, if any, must be passed into the sewers and not discharged of overland, into the water table or into the greywater or stormwater systems;
v. Landscaping of all open space areas and private gardens must use indigenous, waterwise plants. The planted riverine corridor (Alternative 1) or remediated Liesbeek channel (Alternative 2) must be planted such that, after the initial establishment phase, irrigation of planted areas other than lawns is not required – the extent of lawns must be limited as far as possible to reduce water demand.

Table 5.14 provides a more formal assessment of the impacts described above, with and without mitigation.

Table 5.14
Significance of the contribution to the deterioration of water quality in the Liesbeek and Black Rivers

Nature of impact	*Extent of impact*	*Intensity*	*Duration of impact*	*Consequence*	*Probability of occurrence*	*Signif.*	*Confid.*
Both Alternatives Without Mitigation	1 Local	2 Medium	3 Long term	6 Medium	Probable	Medium (Neg.)	Medium
Essential mitigation measures i. Treated sewage water should not be used as a source of irrigation water, unless additional treatment occurs to reduce phosphorus and total ammonia concentrations; ii. Sewer manholes in all open space areas should be readily visible, so that overflows can be easily detected and reported. iii. If greywater irrigation is used, it should not be used within any of the riverine corridor buffer areas, which are intended to actively protect adjacent watercourses form development-related impacts; iv. Swimming pool effluent, if any, must be passed into the sewers and not discharged of overland, into the water table or into the greywater or stormwater systems; v. Landscaping of all open space areas and private gardens must use indigenous, waterwise plants. The planted riverine corridor (Alternative 1) or remediated Liesbeek channel (Alternative 2) must be planted such that, after the initial establishment phase, irrigation of planted areas other than lawns is not required – the extent of lawns must be limited as far as possible to reduce water demand.							
Both Alternatives With Mitigation	1 Local	1 Low	3 Long term	5 Low	Probable	Low (Neg.)	Medium

5.4. Cumulative Impacts

The cumulative effects of development of the River Club site are probably best assessed with regard to the proposed Two Rivers Urban Park (TRUP) development, which could potentially result in further loss of open space in the broader TRUP area. This could mean that impacts such as loss of terrestrial non breeding habitat for western leopard toads could increase in the future making the loss of terrestrial habitat on the current site more significant. Given the current low quality of such habitat from a faunal perspective, this point is however debatable, particularly in the context of the improvement in terrestrial habitat quality aimed at in the landscaping and management of the ecological corridors through the site. Moreover, in the context of ongoing development, from an aquatic ecosystems perspective, the proposed development of Alternative 1 would include a significant positive impact in the form of rehabilitation of a long-canalised river reach. Such improvements in aquatic ecosystem function and ecological connectivity could offset cumulative impacts of development in adjacent open space areas.

Increasing development of the surrounding area (e.g. increased traffic including from the planned SKA office) could arguably also increase pressures on western leopard toads by increasing mortalities on migrating toads southwards, across Observatory Road and into the open spaces associated with Valkenberg and the Liesbeek Lake area.

An important strategic means of mitigating such impacts would be for the installation of a wide pipeline to allow the movement of western leopard toads south, into the open space of Liesbeek Lake and Valkenberg. Authorities charged with authorising new developments in the area should also be

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cognisant of such cumulative impacts and ensure that such concerns are adequately addressed in adjacent site development conditions of authorisation, including provision of safe migratory corridors under roads, and in (ideally) the expansion of the rehabilitated Liesbeek Canal all the way past the SKA site, as far as Observatory Road.

Impacts associated with the no-development alternative

In the event that the development proposals considered in this report did not take place, it is assumed that the following factors would be in place:

- The Liesbeek Canal would remain *in situ* – but would be likely to require repair in the near future;
- The (natural) Liesbeek channel would remain *in situ*, and would continue to convey stormwater into the Black River. Ongoing removal of alien vegetation (e.g. water hyacinth) would be required, but the channel might provide breeding habitat to western leopard toads;
- The terrestrial open spaces of the River Club would remain undeveloped and potentially available as non-breeding habitat for Western Leopard toads – however, ongoing activities associated with the driving range (e.g. mechanical ball collection and mowing) would continue to hamper the ecological wellbeing of this species as would physical barriers to migration such as the Liesbeek Canal.

The main negative impact associated with the no-development alternative would be the lost opportunity to rehabilitate the Liesbeek Canal. Without development funding, it is extremely unlikely that this bold approach would ever be affordable.

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5.5. Summary of impacts from a biodiversity perspective

This section provides a brief overview of the changes / losses / impacts to natural ecosystems as a result of implementation of the proposed project alternatives. The information presented here is intended to inform specific aspects of the NEMA EIA information requirements.

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Table 5.15 provides coarse comparisons of changes in different open space / natural areas on the site in each of the development alternatives. Loss of terrestrial habitat is over-estimated, because it assumes that the site is currently undeveloped. This issue is not important, as the table clearly shows that no terrestrial habitat on the site has conservation value (i.e. not rated as terrestrial Critical Biodiversity Areas (CBAs) or Ecological Support Areas (ESAs)).

Table 5.15
Summary of impacts from a biodiversity perspective. Areas calculated from development layout polygons, overlaid into http://www.earthpoint.us/Shapes.aspx. Areas approximated from GOOGLE images only.

Impact	Alternative 1 (ha)	Alternative 2 (ha)	No development alternative (ha)
Loss of terrestrial habitat	8.8	8.8	0
Loss of terrestrial CBA	0	0	0
Loss of terrestrial ESAs	0	0	0
Loss of wetland habitat (TRUP Conservation area)	2.25	0	0
Coarse estimate of areas for rehabilitation of terrestrial, riverine and wetland areas (including some grassed areas)	6.6 (includes riverine corridor with wetland margins, main east west corridor and swale with artificial wetlands)	4.3 (mostly wetland and terrestrial areas; no riverine rehabilitation)	0
Loss of wetland CBAs	0	0	0
Loss of wetland ESAs	0.37	0	0

Table 5.16 summarises likely changes in the ecological condition of the aquatic ecosystems on and abutting the site, these being the only natural habitats identified of any ecological significance. The table assumes full implementation of the stated designs and their required mitigation measures, as well as implementation of additional requirements listed in the report that are intended to improve confidence that the development alternatives would inpractice achieve their anticipated outcomes.

Table 5.16
Summary of anticipated changes in aquatic ecosystem condition assuming full implementation of mitigation measures

System	Condition		
	Alternative 1	Alternative 2	Current state / No development alternative
Liesbeek River Canal	C	F	F
Natural channel of the Liesbeek River	Non-existent	D	E
Raapenberg wetland	C	C	C

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6 ADDITIONAL RECOMMENDATIONS TO INCLUDE IN DEVELOPMENT AUTHORISATION TO ADDRESS UNCERTAINTY OF DEVELOPMENT OUTCOMES

Assuming mitigation measures are applied as recommended in Section 5, the two alternatives both have the potential to provide an improved quality of aquatic ecosystem, either the rehabilitated canal (Alternative 1) or the remediated natural Liesbeek channel (Alternative 2). Both include enough space to provide highly functional faunal corridors and neither would impact negatively on areas of concern from a floral or faunal perspective, other than with regards to terrestrial, non-breeding habitat for endangered western leopard toads. Some of this habitat would be lost in both development alternatives, and a critical component of development design and enhancement mitigation is the creation of terrestrial habitat that is of a quality that will actively improve the longevity and resilience of western leopard toad populations on the site.

Allowing for the mitigation measures outlined in this report, both the alternatives would, overall, be assessed as having a net positive or at least negligible negative biodiversity impact, with alternative 1 being significantly preferred from a biodiversity perspective, because of the tremendous opportunities for river rehabilitation with which it is associated.

However, there remains a risk that, despite the theoretical evaluations of such positive impacts, the final outcomes might not in fact be as positive as envisaged. Reasons for this might include:

- Failure in landscaping implementation – many of the design details and some of the mitigation measures outlined in this section rely on the realisation of sometimes quite subtle landscape design aspects, some of which may be lost in translation between the compilation of this report with its design assumptions and mitigation requirements. Another important factor affecting the degree to which the landscape outcomes envisaged in this document can be achieved is the particular skillset and outlook of the final landscaping team utilised for project implementation would be a critical determinant of many of the required ecological outcomes being achieved (e.g. a landscaper proficient at creating park and garden landscapes might not be able to achieve the natural effects along the river channel and ecological corridors that would be required in a rehabilitation project;
- Under-estimating the scale of intervention – the proposed rehabilitation of the Liesbeek Canal and infilling of the natural channel (Alternative 1) would be significant interventions and their successful implementation would depend very much on the adequacy of design details such as provision of a flow corridor of adequate width to contain the river without the need for channel lining, and without creating an unstable eroding environment;
- Under-estimating the construction and long-term operational costs of creating and maintaining function of the planned landscape – without adequate sourcing, establishment and maintenance of sufficient plants in the ecological corridors and rehabilitated riverine or channel areas, these zones would not perform as high quality habitat types.

This issue, although somewhat philosophical, is an important consideration, as it highlights the likely difference between Alternative 1 achieving a river with a PES of Category D, versus its planned potential category C class, and between a real improvement in channel habitat quality in Alternative 2, versus superficial landscaping and amelioration.

The following measures have been recommended to improve the surety of outcomes of the two alternatives, and where practical, to raise opportunities for implementing more substantial measures that will improve final ecological function and ecosystem resilience. It is requested that, in addition to the mitigation measures outlined in Section 5, that these measures be incorporated into any DEADP Conditions of Authorisation associated with a positive decision for development of either Alternative.

Both alternatives

- In the event that one of the development alternatives is authorised for implementation, a final landscape plan must be drawn up that includes detailed annotations regarding the ecological landscaping requirements, with dimensions and minimum requirements stipulated as far as possible, so that this plan is easily auditable during and after project implementation, and includes all aspects and design assumptions considered important by the biodiversity team – the hydrological specialists should check this plan, to ensure it does not impact unwittingly on additional hydraulic and/or hydrological aspects;
- The appointed landscape team / landscape architects must have a proven ability to create landscapes that adequately mimic natural river and wetland environments, rather than garden / parkscapes;
- The implementing landscape architect / landscaping team must workshop the proposed project biodiversity outcomes, sensitivities and vision with the project design team, including the design landscape architect, the faunal specialist, the botanical specialist and the freshwater ecologist to ensure that there is full understanding of the intended project outcomes;
- A detailed costing must be drawn up prior to commencement of any construction activities, which estimates the likely implementation and operational management costs of the proposed open space areas, including allowance for acquisition and planting and /or nursery propagation of sufficient locally indigenous plants to achieve the required landscaping objectives in these zones – the landscape requirements of either alternative, but Alternative 1 in particular should not be under-estimated;
- Where detailed design phase or even implementation phase changes in authorised design are required in order better to meet the required ecological design objectives of the rehabilitated Liesbeek canal and landscaped stormwater swale (Alternative 1) or the remediated natural channel (Alternative 2) as well as any of the ecological corridors and toad management devices, these should be allowed. This measure is subject however to approval of such changes by the faunal and aquatic ecosystems specialists, noting that it is accepted that a project of this nature would require a degree of design plasticity going forward into, provided that the design objectives from a biodiversity and aquatic ecosystem functional perspective are not compromised by such changes.

- **Alternative 1:**

  Certainty that this alternative would be able to achieve the desirable PES Category C for the Liesbeek canal would be increased greatly by the following additional measures:

  I. Reshaping of the earth channel (left hand bank only) downstream of the existing canal must take place as part of the rehabilitation works, extending all the way to the Black River. The river bank must be stepped back / graded in line with the rehabilitated profile upstream, and planted accordingly. This will require removal of existing willow trees along the river bank, noted as important habitats by the avifaunal specialist (Appendix D) – these must be replaced with indigenous riverine trees that will supply roosting and /or nesting areas to riverine birds;

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ii. Reshaping of the Black River (left hand bank) to the aquatic specialist's specifications – where banks are considered too steep, allowance must be made for their regarding and appropriate planting;

iii. Installation of the lower gabion / 300mm reno mattress on the right hand canal wall at a lower level still, so that the top of the gabion is no higher than the wet season baseflow level and preferably slightly lower. Such a level would allow for the establishment of plants such as Palmiet (*Prionium serratum*) along the edge of the channel, providing a degree of velocity abatement along the edge of the channel and reducing the otherwise visual and ecological sterility of this side of the channel. Palmiet currently occurs in the river in its foothill reaches near Kirstenbosch and is likely to have occurred in the low salinity lower reaches of the river as well;

iv. Widening of the ecological component of the rehabilitated river profile where possible to provide a wider riverine corridor with likely greater resilience against flood impacts such as erosion and more space in which to address these – thus where the open space corridor opens out e.g. between the two precincts, in the vicinity of the east- west corridor link, the portion of the corridor vegetated as a natural riverine corridor should be expanded at least in proportion to the expansion of open space areas, and at least in places, the indigenous edge should be pulled out as far as the lower pathway. This would also simplify maintenance of these areas, as the line between the indigenous riverine edge and the recreational zone would be clearly defined by the pathway;

v. All river shaping and planting activities must have onsite input by the aquatic specialist /river ecologist and should include on-site inspections / discussions with the faunal specialist.

- **Alternative 2:**

Ideally, Alternative 1 should be selected, from a biodiversity and (in particular) the perspective of improving river function. However, the treatment of the canal in Alternative 2 is ecologically acceptable, in that it would not change the current *status quo* of the canal from a biodiversity perspective, and additional mitigation is not considered essential.

7 IMPLICATIONS OF THE PROPOSED DEVELOPMENT IN TERMS OF OTHER LEGISLATION

Development of the River Club would definitely require authorisation in terms of the National Water Act (NWA) (Act 36 of 1998), given that it would entail clear Section 21c and i water "uses", defined in the Act as (21c) impeding or diverting the flow of water in a watercourse and (21i) altering the bed, banks, course or characteristics of a watercourse. Given the scale of development and the significant watercourse interventions, it is likely that a full water use licence would be required by the Department of Water and Sanitation for these activities.

In addition to triggering aspects of the NWA and NEMA, it is noted that re-development of the River Club precinct would also be likely to trigger local government legislation, including the City of Cape Town's (2009) Management of Urban Stormwater Impacts Policy (City of Cape Town 2009a) and its policy regarding Floodplain and River Corridor Management (City of Cape Town 2009b), and relevant departments should be consulted in this regard.

Management of listed invasive alien vegetation on the site would also be required in terms of the National Environmental Management: Biodiversity Act (NEMBA) (Act 10 of 2004).

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8 MONITORING

In the event that the proposed development of the River Club site is approved, the following monitoring measures are recommended as essential, and the monitoring outcomes should be fed back into routine site audits, and used to adapt management approaches as necessary.

The monitoring programme should be kept as simple as possible, to reduce costs and ensure rapid turnover of data. The following aspects are recommended for inclusion:

- **Alternative 1:** Assessment of improvement in river condition / functioning based on SASS5 bio-assessment results – strictly speaking these assessments assess water quality, but they are influenced by habitat diversity and as such can provide a gauge of change in the latter – quarterly assessments are recommended over a period of five years, with pre-development monitoring required for comparative purposes;
- **Western leopard toad monitoring:** It is recommended (as per the faunal specialist's recommendations) that a western leopard toad management and monitoring programme be drawn up for the proposed development. Ideally the monitoring should start at least one breeding season prior to commencing with the construction phase, and continue up until five breeding seasons after construction has been completed. The main aims of this monitoring would be to evaluate the success and efficiency of faunal dispersal corridors, ecological shelter/foraging sectors, new breeding habitat, and the toad-friendly infrastructure. Monitoring details should be formulated in the detailed design phase of the project, taking cognisance of the authorised alternative. As part of this monitoring programme, the issue of salinity and breeding sites in the Raapenberg wetlands (as queried in Section 3.1.8) should also be investigated;
- **Avifaunal monitoring:**

  Monitoring of bird populations on and associated with the site has been recommended by the avifaunal specialist, in order to track planned improvement in habitat diversity and quality.

9 CONCLUSIONS

9.1. Discussion of development alternatives

This report has assessed two development alternatives, both of which would be acceptable from an ecological perspective, since they both address the key concerns potentially associated with development of the River Club site, namely:

- The potential risks of development to the resilience of important indigenous fauna – in this case, populations of endangered western leopard toads occurring on and adjacent to the site, and requiring safe migration routes through the site as well as access to both breeding and non-breeding habitats;
- The likelihood of impacting negatively on adjacent watercourses and/or wetlands;
- The need to improve ecosystem resilience through rehabilitation and /or remediation activities aimed at improving terrestrial and aquatic (river and wetland) habitat quality.

In the case of the River Club, both terrestrial and natural ecosystems are considered degraded, having suffered a long history of manipulation, including (in the case of aquatic ecosystems) variously, diversion, channelization, fragmentation and canalisation. Terrestrial ecosystems have been assessed by the faunal, avifaunal and botanical specialists as highly altered and affording very low levels of habitat quality. No indigenous flora of any concern was found on the site, although important renosterveld communities including red data species did occur on the adjacent SAAO site and Raapenberg wetlands. These communities were not however considered likely to be affected by development of the River Club site.

Despite the level of infilling that would be associated with development of the site, the adjacent Raapenberg wetlands were shown by the hydrological assessment of Aurecon (2017a) to be unlikely to be impacted by changes in flood height, frequency or duration. Ironically, recent interventions by local community groups aimed at "improving" Raapenberg wetland function by increasing flood frequency are likely to bring about greater negative effects in terms of decreased salinities and changes in hydroperiod than the proposed development.

Both development alternatives have addressed, through a long period of iterative design by the project team as a whole, issues such as ecological connectivity through the site, and both provide terrestrial habitat for western leopard toads, while including structural devices (toad barriers, culverts, landscaped refugia and connecting corridors) to reduce mortalities for this flagship species as well as other fauna on the site, which would be expected in theory to be positively affected by the proposed landscape rehabilitation and remediation activities.

Of the two alternatives, from an ecological perspective, there would however be a very clear preference for selection of **Alternative 1.** This alternative hinges on the rehabilitation of the currently canalised reaches of the lower Liesbeek River, and the planned creation of an unlined vegetated channel, that has sufficient space to function as a natural river within a broad connecting riverine corridor, to establish adequate longitudinal and lateral linkages into natural areas of the site and the adjacent Raapenberg wetlands, and which would significantly improve faunal connectivity and toad migration routes across the site. Implementation of this alternative would, from a biodiversity and

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general aquatic ecosystems perspective, be a positive impact, and its implementation is recommended.

This positive outcome has not however been rated as of high significance – this reflects the acknowledged risks of implementation, as well as the impacts to any sensitive natural ecosystems that would be associated with a development of the scale of the proposed River Club development. Against rehabilitation of the canal is also set the infilling and landscaping of the remnant (but historically fragmented and highly altered / diverted) "natural" channel of the Liesbeek River. This loss is considered ecologically acceptable in the context of substantial river rehabilitation, and the proposed development of vegetated swales in landscaped terrestrial areas suitable for colonisation by western leopard toads in their non-breeding season is considered an acceptable use of this space without significant negative biodiversity or other ecological costs.

Alternative 2 would nevertheless provide adequate mitigation against development-associated threats, and would improve the existing (degraded and fragmented) aquatic habitat on the site. Selection of this alternative would however, in this author's opinion, result in a significant biodiversity opportunity cost that could not be realised in the future once development had occurred. A similar opportunity cost applies to the No Development alternative - without significant development funding, it is extremely unlikely that rehabilitation of the canal would ever be feasible.

9.2. Increasing the certainty that anticipated outcomes would be achieved

One of the problems in compiling this assessment was, ironically, the degree to which the development layouts had already considered ecological impacts, and addressed and incorporated these in layout and design. While the resultant layouts are thus largely acceptable in their current form, two problems are presented with this approach:

3. Without medium or high negative significance being attached to particular layouts, it is difficult to motivate for the essential inclusion of additional subtle mitigation measures that would improve the final outcomes – this weakens the mitigation requirements;

4. If a layout is approved, there is a risk that some of the essential original mitigation thinking and approaches could be "lost", as it is not explicitly listed as mitigation.

In this report, these two issues have been addressed by:

- Including requirements for additional control measures aimed at improving uncertainty over the projected outcomes measures to be included in a potential development authorisation (Section 6);
- Including requirements for the development descriptions included in this report (Section 4) to be considered part of the approved design; and
- Including requirements for the authorised (if any) layout to be worked up as a detailed, annotated plan with written dimensions and ecological specifications, to be used as an auditable document going forward.

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APPENDICES

APPENDIX A

SPECIALIST BOTANICAL REPORT

Report provided by COASTEC

PROPOSED RIVER CLUB DEVELOPMENT: COMMENT ON POSSIBLE IMPACT ON THE BOTANY OF THE SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

A BARRIE LOW

DECEMBER 2016

COASTEC

COASTEC COASTAL AND ENVIRONMENTAL CONSULTANTS
BOTANICAL SPECIALISTS ECOLOGICAL ANALYSIS ENVIRONMENTAL MANAGEMENT IMPACT ASSESSMENT

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EXECUTIVE SUMMARY

A botanical assessment of the South African Astronomical Observatory sites confirmed the presence of Critically Threatened Peninsula Shale Renosterveld, although greatly disturbed. Soils analysis confirmed the presence of clay-rich soils, typical of renosterveld. The flora of the site supports some 96 indigenous species.

Mapping of the site showed that renosterveld occupies some 2.2 ha (23.9 %) of the site but that part of this (0.8 ha) is rare loam or shale wetlands. A simple comparison with the flora of Signal Hill suggest that this vegetation type is quite different from Peninsula Shale Renosterveld, particularly with the presence of clay wetlands.

The adjacent River Club site has no indigenous vegetation, being located on old fill material. Impacts arising from proposed development on River Club site on the dryland vegetation of the SAAO are deemed to be negligible. However, if local water level and inundation patterns are altered, them there is a possibility the wetlands along the edge of the SAAO site could become negatively impacted.

Both the River Club and SAAO sites can play a key role in renosterveld conservation, through rehabilitating presently disturbed sites on the SAAO property and/ or increasing the extent of renosterveld by bringing fill of a shale nature in the River Club development.

<u>Three conservation measures are proposed for augmenting renosterveld conservation in the area:</u>

Conservation action 1
Consolidate and revegetate the renosterveld on the SAAO site. Focus should be on the two broad renosterveld habitats here. Firstly, a specific conservation area needs to be identified on the SAAO site and protected as part of the SAAO landscape and management plan. In particular, the open vegetation will need the reintroduction of an emergent shrub layer as a basic minimum intervention, and which would grade into the existing thicket vegetation.

Conservation action 2
Establish and rehabilitate links to the north and south along the Black River, possibly as part of the current TRUP study.

Conservation action 3
I understand that the proposed River Club development, if approved, would require the input of much additional fill. Strategic selection of shale soil and overburden, perhaps from one of the Malmesbury shale aggregate mines in the Tygerberg, could provide potential additional renosterveld substrate on the River Club site and would enable the extension of these habitats along the Black River as well as within the River Club site. A linkage between the two sites should also be considered, even if the two dryland sites (SAAO and River Club) are connected by a wetland/ riverine habitat.

Conclusions

The proposed development at the River Club is highly unlikely to impact negatively on the dryland renosterveld vegetation at the SAAO site. The security of the Critically Endangered *Moraea aristata* is thus likely assured, provided acceptable conservation measures are introduced on the SAAO site.

However, impacts on the renosterveld wetlands might be significant if inundation patterns are altered by the proposed River Club development and present seasonality is compromised.

It is strongly recommended that all three conservation options are followed for the SAAO site and environs, but that efforts at extending the area of dryland renosterveld should be supported by a joint initiative between the River Club and the Observatory.

FIGURES

TABLES

PLATES

Plate 22. Uncanalised section of Liesbeek River

Plate 23. Polluted open channel along western boundary of River Club

Plate 24. Renosterveld in north-western part of the SAAO site, looking over the Liesbeek River from the River Club area

1. INTRODUCTION

Redevelopment of the River Club, Observatory, is being considered by the Liesbeek Leisure Club. The proposal is currently the subject of an environmental impact assessment (EIA) being facilitated by SRK Consulting.

To date one specialist study has been undertaken for the project, that of an opportunities and constraints study of freshwater ecosystems present on and adjacent to the property.

During the EIA process several individuals expressed concern about the botany of the River Club site and whether the proposed development would impact on the terrestrial (i.e. dryland) ecology of the neighbouring South African Astronomical Observatory grounds.

Coastec was appointed to undertake an assessment to establish whether there might be such impacts.

Site location is shown in Figure 1.

2. TERMS OF REFERENCE

(i) confirm the River Club has no indigenous botanical value;

(ii) establish the location, extent and quality of the renosterveld on the SAAO property; establish from the existing species list which are Red List species and which are still likely to occur on the site, notably *Moraea aristata;*

(iii) provide an annotated map of this indigenous vegetation and its proximity to the River Club development, in particular those areas abutting the wetland environment;

(iv) assess potential impacts, if any, on this vegetation based upon impacts articulated in Dr Liz Day's report. Impacts would include potential loss of species (notably *Moraea aristata*), indigenous vegetation and terrestrial (dryland) connectivity.

3. METHODS AND APPROACH

3.1 Literature review

Available reports on the River Club and SAAO were accessed as were GIS layers of the area

3.2 Field visit

The SAAO and River Club sites were visited on the 13 and 19 October 2016 respectively, where observations on the flora and vegetation (if present) were made, as well as recording photographic images; topsoil samples were collected from thicket and open renosterveld in the SAAO site. Soils were analysed for a suite of physical and chemical parameters at BemLab in Somerset West.

3.3 Annotated map

Annotated maps of the vegetation and landuse of the area were drawn up.

3.4 Report

An illustrated report encapsulating the above was prepared.

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Figure 1. Location of the South African Astronomical Observatory

4. FINDINGS & DISCUSSION

4.1 Geology & soils

Mustart (2010) provides details of the geology and soils of the site, and these aspects are summarised here.

Quoting Van der Walt & Strong (2010), she states that the site is underlain by sediments of the Malmesbury Group (see Theron, 1984), with a resistant ridge of greywacke and sandstone. Based upon the soil analysis below (Table 1), I would suggest that the parent material more closely resembles shale, owing to the moderate clay content and the chemical nature of the soils. Nevertheless the sandy loams analysed in her study did indicate moderate to slight acidity (pH 4.9 to 6.9), with fairly high levels of silt, and a range in clay from 7 to 9%.

In this study, analytical data from the seven topsoils sampled within the SAAO site are shown in Tables 1 (physical) and 2 (chemical). Both suites of soils indicate moderate acidity, a function of their shale origin. There is a difference in texture between the two sites, with the substrate under thicket more sandy, a probable function of its proximity to the alluvial deposits of the river and wetlands to the north. The high presence of reasonable amounts of clay is significant as this is a key characteristic of shale soils, in particular those supporting renosterveld. There is a clear difference between thicket and open communities, with the former displaying higher amounts of total and Bray no. 2 Phosphorus (a form of P available to plants), exchangeable cations, carbon and nitrogen. Cation exchange capacity (CEC) is also higher in the thicket site. Both carbon and nitrogen levels are generally closely correlated with CEC values, as are total cations. The soils are considered to be of moderate fertility, a key feature of renosterveld.

4.2 Flora

Indigenous plant species recorded from the SAAO site appear in Appendix 1. This list is due largely to the efforts of Mary Stobie, wife of one of the earlier Directors, but particularly those of Dr Penny Mustart, who produced the final compilation. The present studied contributed a further 12 records for the SAAO site.

Of the 96 indigenous species recorded, 87 are from dryland habitats, with nine endemic or near-endemic to wetlands. These are: *Agrostis lachnantha* var. *lachnantha* vinkagrostis, *Bolboschoenus maritimus* snygras, *Cotula coronopifolia* ganskos, *Lobelia erinus* wild lobelia, *Pauridia capensis* geelsterretjie, *Sarcocornia* cf. *capensis* seekoraal (new record), *Sparaxis bulbifera* fluweelblom, the semi-parasite *Thesium funale* and *Zantedeschia aethiopica* arum lily. Key dryland renosterveld species and indicators are: shrubs and climbers - *Searsia*

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Table 1. Results of topsoil physical analysis from selected habitats at the South African Astronomical Observatory. Sa = sand; Lm = loam

Habitat	Field label	Bulk density (kg/l)	Texture Clay (%)	Silt (%)	Sand (%)	Classification
Open renosterveld (Conservation Area B1)	SAAO RV1	1.11	13	20	67	SaLm
	SAAO RV2	1.12	13	16	71	SaLm
	SAAO RV3	1.08	17	18	65	SaLm
	SAAO RV4	1.05	15	20	65	SaLm
Mean		1.09	15	19	67	
Renosterveld thicket (Conservation Area B3)	SAAO RG1	0.72	9	8	83	LmSa
	SAAO RG2	1.03	7	12	81	LmSa
	SAAO RG3	0.98	9	8	83	LmSa
Mean		0.91	8	9	82	

tomentosa korentebos (new record), *Elytropappus rhinocerotis* renosterbos (extremely rare on the site, although dominant in most renosterveld habitats, especially where there is marked disturbance), *Eriocephalus africanus* kapokbos, *Otholobium hirtum* gryskeurtjie, *Olea europaea* subsp. *africana* wild olive, *Asparagus capensis* haakdoring; bulbs – *Lachenalia mediana*, *Ornithogalum thyrsoides* chincherinchee, *Babiana fragrans* bobbejaantjie, *Chasmanthe aethiopica* suurkanolpypie (new record), *Moraea aristata* blou-ooguintjie (endemic to the SAAO grounds – Mustart, 2010), *M.gawleri* renosteruintjie, *M.vegeta* bruintulp, *Sparaxis* cf. *grandiflora* subsp. *fimbriata* perskalkoentjie, *Watsonia meriana* var. *meriana* rooikanol (new record) and *W.spectabilis*. The original distribution of *M.aristata* was on clay flats and slopes in the Northern Cape Peninsula, between Cape Town and Rondebosch (Goldblatt, 1976 & 1986, in Mustart, 2010). Most of this habitat has been lost to farming and residential development. The role of the SAAO for the conservation of this species is therefore crucial; annuals – *Arctotheca calendula* gousblom, *Dimorphotheca pluvialis* witbotterblom and *Ursinia anthemoides* margriet; grasses – *Ehrharta calycina* rooigras and *Hyparrhenia hirta* thatch grass.

Red List species occurring on the site are: the peas, *Indigofera psoraloides* (Endangered) and *Podalyria sericea* (Near Threatened), the bulbs *Lachenalia mediana* var. *mediana* viooltjie (Vulnerable), *Babiana fragrans* bobbejaantjie (NT), *Xia maculata* geelkalossie (NT),

Table 2. Results of topsoil chemical analysis from selected habitats at the South African Astronomical Observatory. P = phosphorus; cations: Na = sodium; K = potassium; Ca = calcium; Mg = magnesium; T-value = total cations; C = carbon; N = nitrogen; CEC = cation exchange capacity

Habitat	Field label	pH	Resistance (ohms)	Total P (mg/kg)	Bray 2 P (mg/kg)	Exchangeable cations (cmol/kg) Na	K	Ca	Mg	T-value (cmol/kg)	Total C (%)	Total N (%)	CEC (cmol/kg)
Open renosterveld (Conservation Area B1)	SAAO RV1	5.0	1000	208	25	0.30	0.24	6.44	2.19	10.27	3.01	0.211	8.89
	SAAO RV2	5.4	1130	242	45	0.27	0.24	8.38	2.15	11.91	3.54	0.276	9.58
	SAAO RV3	5.2	740	228	20	0.35	0.31	7.09	2.04	11.02	3.03	0.243	9.69
	SAAO RV4	5.2	1020	270	46	0.28	0.39	8.01	2.24	11.85	3.06	0.216	9.94
Mean		5.2	973	237	34	0.30	0.30	7.48	2.16	11.26	3.16	0.237	9.53
Renosterveld thicket (Conservation Area B3)	SAAO RG1	5.2	1000	407	79	0.75	0.43	14.63	7.37	25.06	8.27	0.863	16.52
	SAAO RG2	4.8	1000	196	29	0.39	0.34	6.17	3.32	12.18	4.14	0.314	9.77
	SAAO RG3	5.2	890	215	33	0.52	0.21	10.74	5.29	17.92	4.78	0.350	11.61
Mean		5.1	963	273	47	0.55	0.33	10.51	5.33	18.39	5.73	0.509	12.63

Moraea aristata blou-ooguintjie (Critically Endangered, endemic to SAAO site), *Sparaxis grandiflora* cf. subsp. *fimbriata* fluweelblom.

As the renosterveld habitat at the SAAO is severely disturbed, there is a strong likelihood that species numbers would be far higher under natural conditions. Nevertheless several small shale renosterveld sites in the Tygerberg[16] such as Durbanville Nature Reserve (102), Groot Phesantekraal (101), Hoogekraal (112), Kliprug Farm (117) and Plattekloof Farm (96 species) have similar totals. But the latter can be as high as 234 (Joostenberg) and 211 species (Kanonberg Farm), presumably in less disturbed areas and with a more varied habitat.

In addition, there is a strong likelihood the renosterveld of the site is quite different from that of Signal Hill (the north-western limit of Peninsula Shale Renosterveld). A simple comparative analysis[17] of species occurrences between the SAAO and Signal Hill (Joubert & Moll, 1992) sites indicates 48 (i.e. half the SAAO total) are unique to the SAAO site, with the rest shared. Apart from the fact that several species are wetland endemics, most are dryland, suggesting that the SAAO site is floristically different from that of Signal Hill (quite likely – the latter is hilly and much drier).

4.3 Vegetation

The original vegetation of the SAAO site was Peninsula Shale Renosterveld (Rebelo et al., 2006), although most is heavily invaded by both annual and perennial exotic species. Mustart (2010) provides a summary of the history of vegetation on the site where strong historical emphasis has been placed on the presence of wild brushwood (i.e. renosterveld) growing on hard clay soils. There are also records of locals having shown an interest in the rich bulbous flora present on the site.

Figure 2 shows the distribution of vegetation across the SAAO site, mapped from the February 2015 CCT aerial photograph (8 cm resolution), with a summary of extent appearing in Table 3. Alien trees (3.97 ha) and developed areas (3.02 ha) comprise a total 6.99 ha of the 9.19 ha site, with 2.20 ha (23.9%) under dryland and wetland renosterveld. Most of the natural vegetation is located in the central west, northern and central eastern part of the site.

Of note, though, is that most of the renosterveld is in a poor condition, apart from locally, lacking a shrub layer which is so characteristic of this vegetation type (Low & Rebelo, 1996);

[16] Data taken from Wood & Low (1993); Low & Roberts (1998 – 2016)

[17] The SaSFlora database (Low & Roberts, 1998 – 2016) has a built-in function to compare selected site floras and to establish floristic uniqueness when comparing sites, in this case two renosterveld habitats

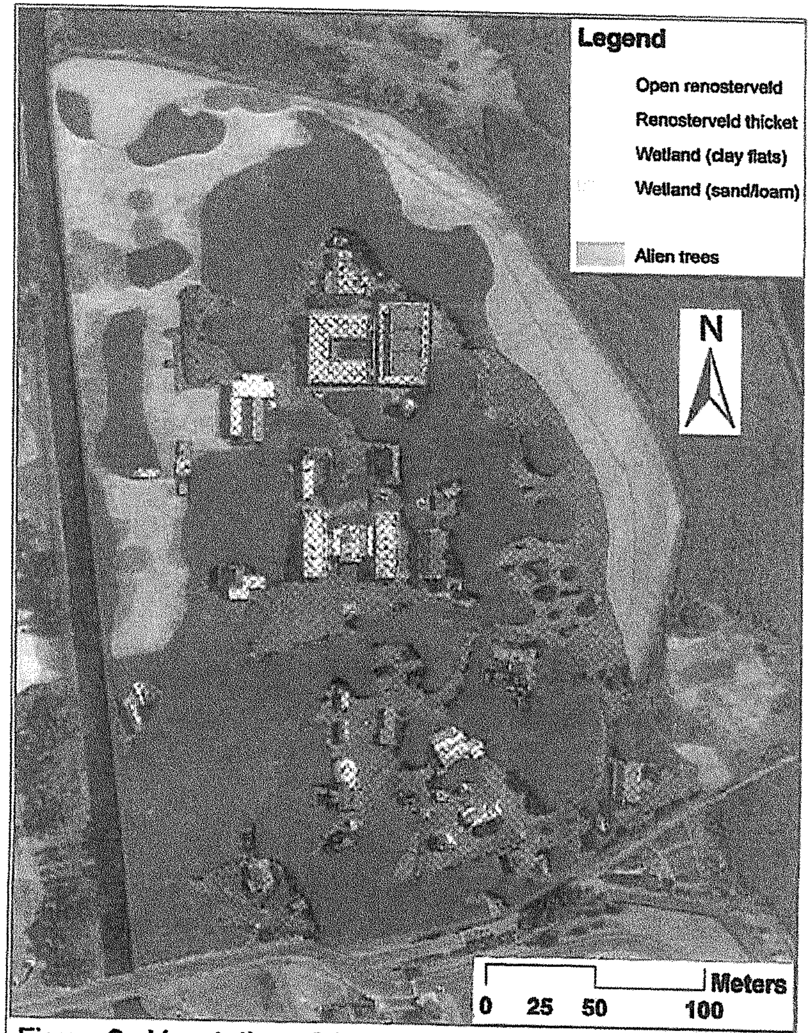

Figure 2. Vegetation of the SAAO site showing distribution of open and closed (thicket) renosterveld and wetlands, as well as the main clumps of introduced trees

Table 3. Extent of natural and alien (tree) vegetation at the South African Astronomical Observatory

Description	Area (ha)
Alien trees	3.97
Natural vegetation	
Open renosterveld	1.25
Renosterveld thicket	0.15
Clay wetland	0.55
Loam wetland	0.25
	2.20
Developed (buildings, roads, landscaped)	3.02
Total	9.19

grasses are locally prominent, particularly along the western boundary. Together with annuals and bulbs, grasses form a key component of renosterveld (Low & Rebelo, 1996).

The floristic differences when compared with Signal Hill suggest, perhaps, a different vegetation type on the SAAO site (why not Cape Flats Shale Renosterveld?!).

Images of the flora and vegetation of the SAAO site are shown in Plates 1 to 16.

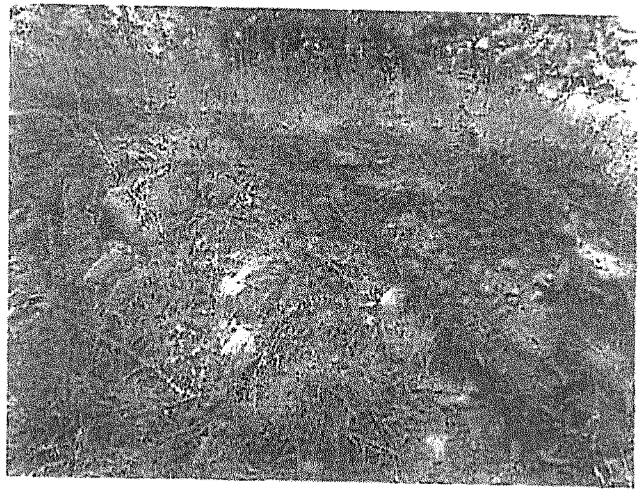

Plate 1. Cross section of the shale geology of the central ridge. Where shallow, this gives rise to a Mispah soil form, grading into probable Hutton soil forms where the soil becomes deeper. The brown colour is primarily due to the presence of clay

Plate 2. Topsoil under open (grassy) renosterveld. Note brown colour (clay) and marked stoniness

Plate 3. Open renosterveld in the western part of the SAAO site. Note the dominance of grasses and absence of emergent shrubs. This is one of the key locations for the Critically Endangered *Moraea aristata* blou-ooguintjie

Plate 4. Renosterveld thicket along western boundary of SAAO site, with *Searsia glauca* bloukoeniebos prominent

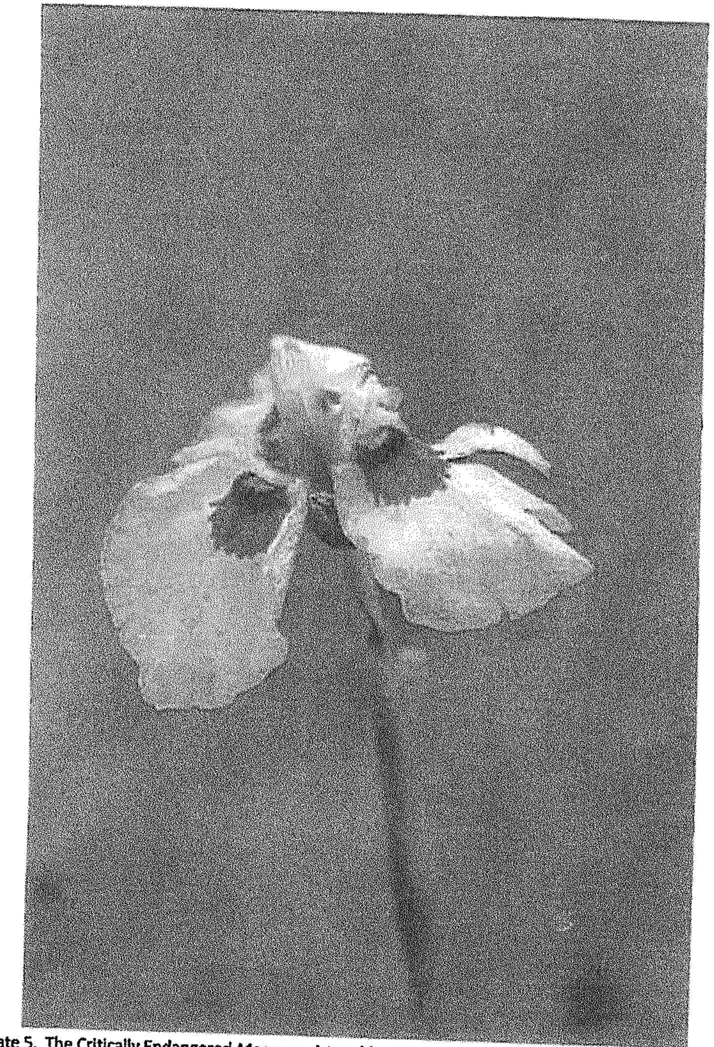

Plate 5. The Critically Endangered *Moraea aristata* blou-ooguintjie. This locally endemic species owes its high degree of rarity to loss of habitat under residential development between Cape Town and Rondebosch. The SAAO site is its last known locality. Image supplied by Caroline Voget

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Plate 6. *Watsonia meriana* var. *meriana* rooikanol, a new record for the site and found in the north-east, in likely damp soils

Plate 7. *Otholobium virgatum* agdaegeneesbossie in open renosterveld (new record)

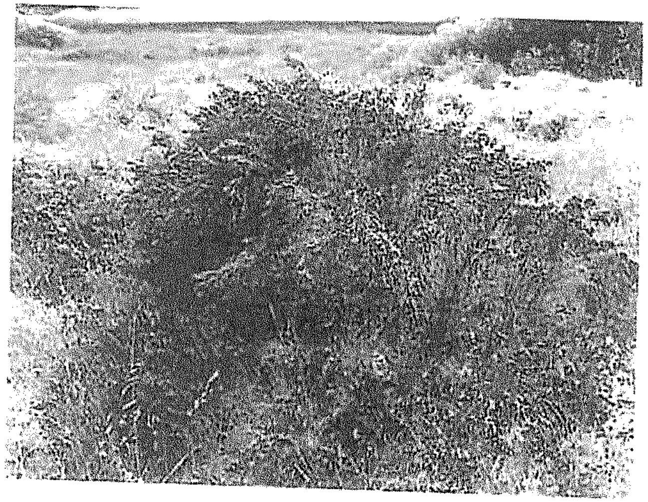

Plate 8. *Passerina corymbosa* gonnabas, found in moister renosterveld habitats, but also indicative of the slightly sandier soils found in the north of the SAAO site (new record)

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Plate 9. *Elytropappus rhinocerotis* renosterbos. The only specimen observed on the SAAO site, in front of the bird hide. This species should be far more common, particularly as it tends to favour disturbed sites

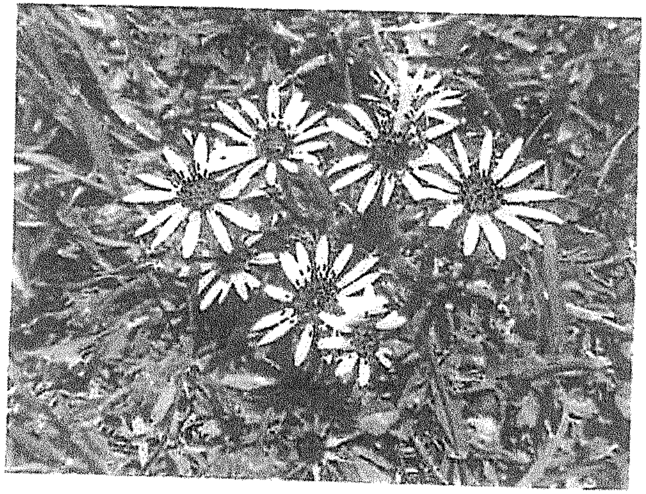

Plate 10. *Arctotheca calendula* gousblom, a common annual in renosterveld but not restricted to this vegetation type

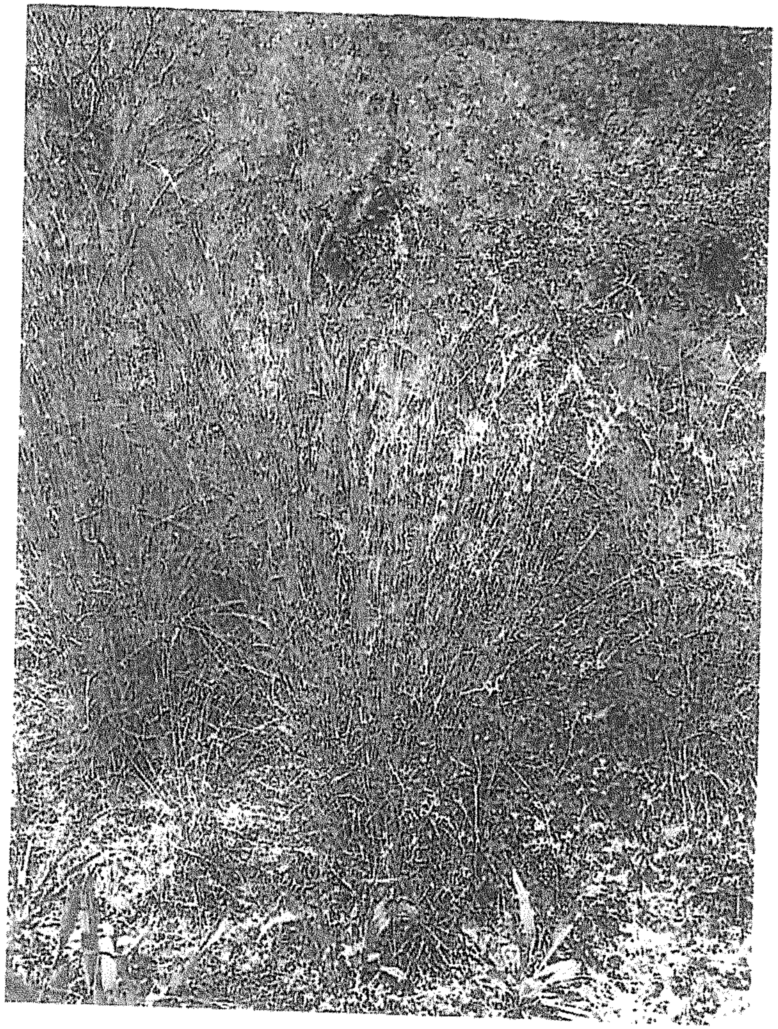

Plate 11. *Hyparrhenia hirta* thatch grass, a common component of renosterveld, particularly in open parts

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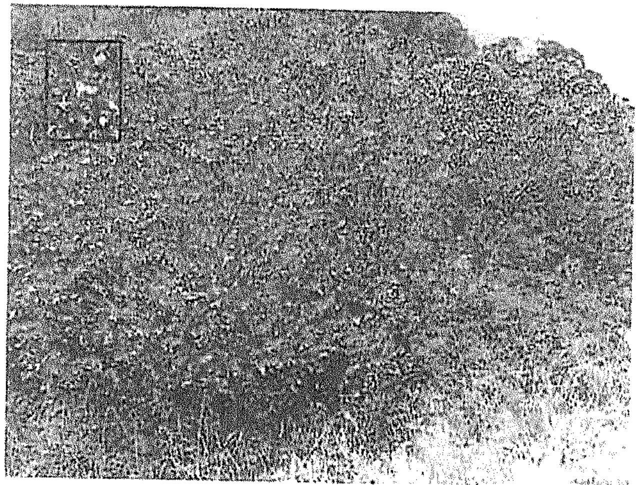

Plate 12. *Polygala myrtifolia* Septemberbos. Rare on the site but locally conspicuous as an emergent shrub in certain renosterveld sites

Plate 13. *Osteospermum moniliferum* bietou. This is a successful pioneering species in most vegetation types in the Cape and invades open renosterveld as well as forming part of thicket

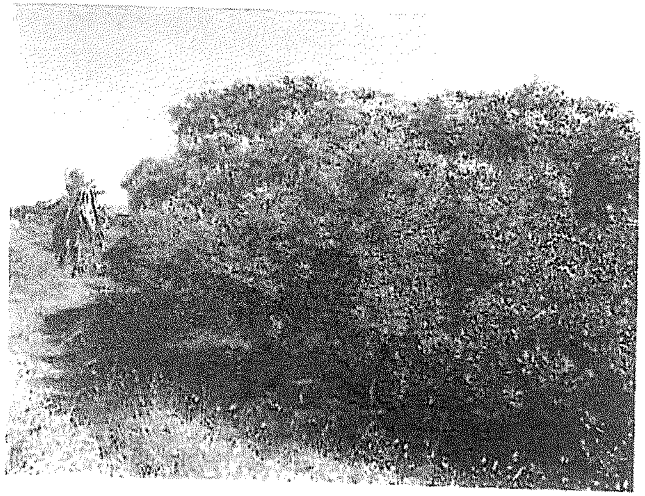

Plate 14. *Olea europaea* subsp. *africana* wild olive in the north of the SAAO site. This species forms a key component of renosterveld thicket and may attain heights of over 7 m in the Tygerberg

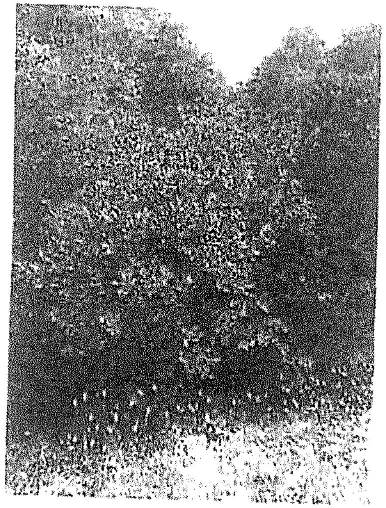

Plate 15. *Searsia tomentosa* korentebos, a common renosterveld thicket species (new record)

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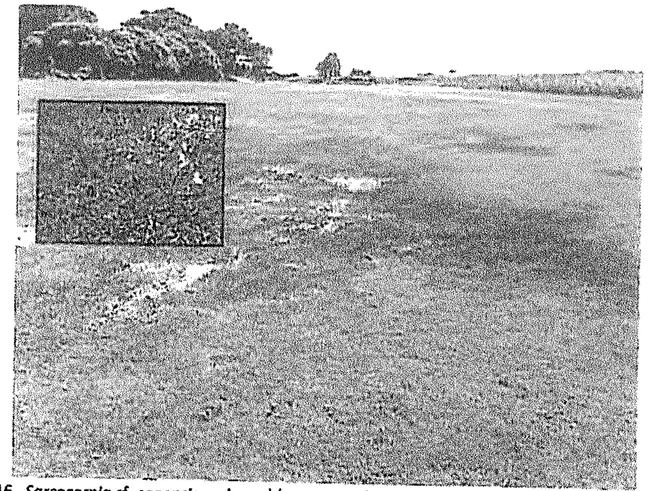

Plate 16. *Sarcocornia* cf. *capensis* seekoraal (new record) a wetland endemic on clay flats along the eastern boundary of the SAAO site. These renosterveld wetlands are extremely rare and require formal protection within a broader SAAO conservation area

Plate 17. *Cotula coronopifolia* ganskos, a wetland endemic on the eastern clay flats of the SAAO site. This species is often an indicator of slightly brackish conditions which can be triggered by the presence of clay-rich substrates

Plate 18. Wetland in north of site, with dominance by the sedge *Bolboschoenus maritimus* snyruigte. There appears to be a major difference in substrate between this wetland which is more sandy and its eastern counterpart (see Plate 16, above). Note fringe of introduced and invasive *Myoporum insulare* manitoka in distance

Plate 19. *Phragmites australis* fluitjiesriet dominated wetland on the northern and eastern edges of the SAAO site. This species reflects a habitat which is constantly inundated and in which there is very little seasonal variation in water table

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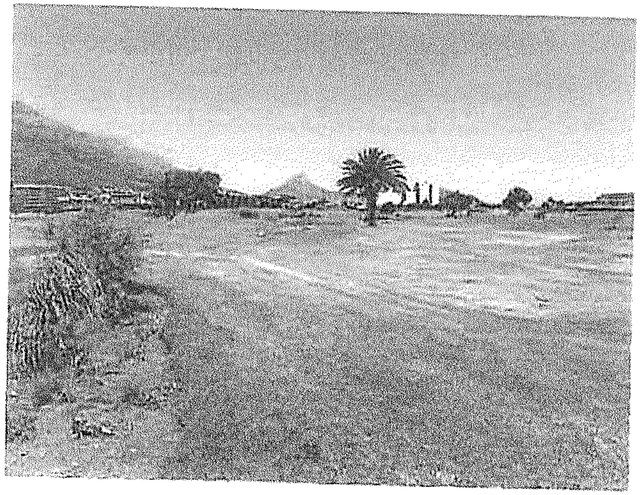

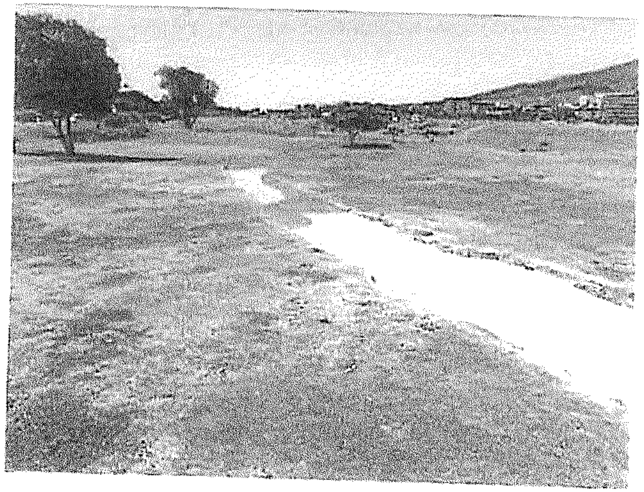

Plate 20 (top & bottom). Fill and golf course on the River Club site, showing landscape devoid of indigenous species and presence of exotic (introduced) trees

South African astronomical observatory: vegetation and conservation

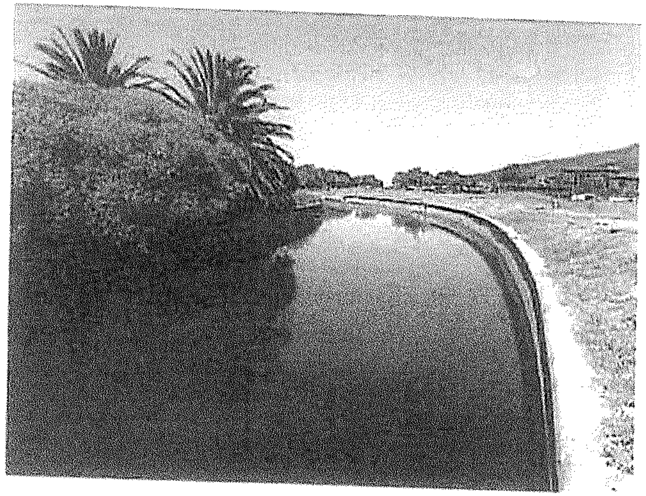

Plate 21. Canalised section of Liesbeek River, forming the eastern boundary of the River Club site. Canalisation offers very little rehabilitation potential for the river

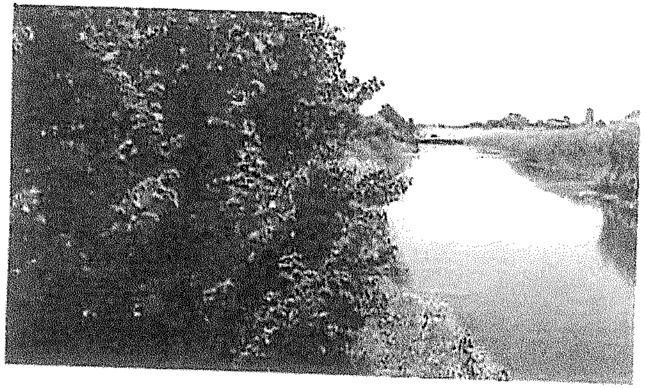

Plate 22. Uncanalised section of Liesbeek River running along the eastern boundary of the River Club site. The soft edges of the river provide great potential for rehabilitation to banks with gradual slopes which provide a better habitat for a suite of species on the river's edge

Plate 23. Polluted open channel along western boundary of the River Club site

Plate 24. Renosterveld in the north-western part of the SAAO site, looking over the Liesbeek River from the River Club area. A thicket clump in the middle of open renosterveld is clearly evident, as is the presence of invasive alien trees

4.4 Possible impacts of proposed River Club development on the renosterveld of the SAAO site

Dr Liz Day's report on the wetlands of the River Club (Day, 2015) says the following: "The Flood Report of Krige (2015) (in Day, 2015) suggests that infilling of the entire River Club site to the 1:50 year flood level would not affect flooding in adjacent properties. Subsequent discussions with Mr Krige clarified the fact that infilling of the floodline would have an (as yet) unquantified effect on floodplain capacity, resulting in likely more rapid inundation of areas below a specified floodline, during an event of such a magnitude (as a result of reduced storage capacity). It is assumed that, up to floods of a magnitude at which flows bypass the constricting Salt River bridge, described in Krige (2015), infilling of the floodplain would also result in increased inundation depth in areas that have not been infilled".

There would be no impacts on the dryland renosterveld vegetation at the SAAO site (the water levels would be constant). However, as articulated by Day (2015) there is possibility that certain wetlands would be more quickly inundated, along with an increase in inundation depth. This would likely affect the species composition of localised wetland habitats, where deeper water species such as *Typha capensis* bulrush are likely to invade at the expense of those species with a more ephemeral wetland character. By comparison, the artificial perennial inundation of the Kuils River wetlands has led to the decline and even loss of certain wetland species in the area (Ninham Shand, 1999; Low, 1998).

If inundation of the rare renosterveld wetlands, particularly along the SAAO eastern boundary, becomes more perennial, this would compromise this habitat in a major way and would also impact on efforts to rehabilitate and even augment this habitat.

4.5 Conservation

10.1.1. 4.5.1 The Observatory Landscape Framework (OLF)

The OLF (Van der Walt & Strong, 2010) has designated three conservation areas for the SAAO (Figure 3).

Area A[18]:

"Area A is mostly cultivated and includes the southwest area around the main entrance, the McClean Observatory and the old tennis court where different locally indigenous bulbs (e.g. *Sparaxis grandiflora* & *Lachenalia mediana* (Red data listed as Vulnerable), a few annuals (e.g. *Ursinia anthemoides*) and herbaceous herbs (e.g. *Pelargonium myrrhifolium*) flower in spring under the existing pine and eucalyptus trees. *Moraea aristata* does not occur here, but there are bulbs with speckled petals that Mary Stobie (wife of a previous Director at the SAAO) planted next to the small octagonal garden east of McClean.

[18] taken verbatim from Van der Walt & Strong (2010)

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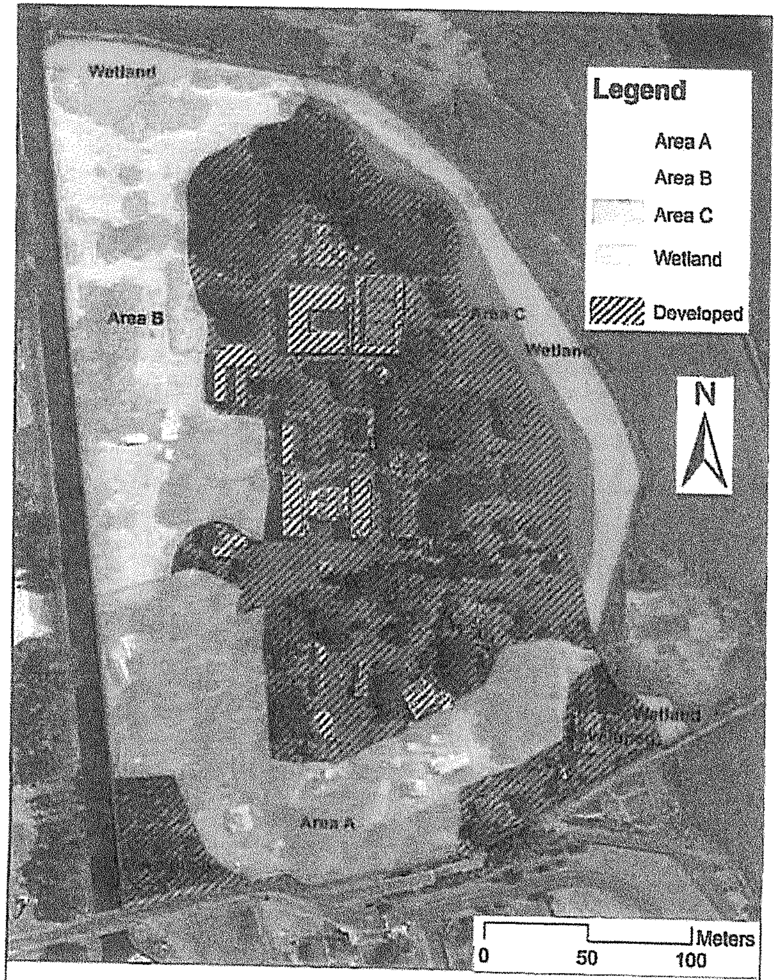

Figure 3. Conservation areas in the SAAO site (from Van der Walt & Strong, 2010). Area B has most of the remnant renosterveld with Area C largely a clay wetland

Area B:

"Area B is the most sensitive and important conservation area where the different populations of *Moraea aristata* occur in the unshaded areas. In general the area has a mixture of planted indigenous and exotic plants between the remaining remnants of the original Renosterveld. A variety of bulbs also occur under the pine and English elm (*Ulmus procera*) on the north of the Director's house. These bulbs could have escaped by seeding from the pots grown by Mary Stobie. The area around the bird hide overlooking the Black River wetlands has been altered by landfilling but still supports interesting plants such as *Moraea virgata* not found elsewhere on the property. One Renosterbos (Dicerothamnus (=

Elytropappus) rhinocerotis), the predominant shrub in Renosterveld, is growing just south of the bird hide but it is not clear if this shrub is natural or planted.

The only original *Moraea* population (M4 on their Conservation Areas map) is immediately west of the Director's house and garden. The other areas (M1-M3, M5-M7) have been planted.

Area C:

"The eastern boundary is very degraded and mostly covered with kikuyu grass. This low-lying area is flooded during the winter months and is valuable as part of the Black River system, but as no indigenous vegetation remains the area is not deemed conservation worthy at present".

As implied by Van der Walt & Strong (2010) these are not conservation areas in the true sense of the word, and, except for Area B and part* of Area C, do not necessarily relate to natural open (undeveloped) land or even indigenous vegetation, but rather to areas in which different indigenous species happen to occur. Wetlands should form part of Areas B and C, rather than being treated separately (thus Area C would have a combination of seasonally flooded flats and dryland habitat).

Area B has the best remnant of renosterveld thicket and open shrubland (medium height to tall shrubs of 2.5 m+, forming localised dense thicket). This is the most natural site in that there are patches of renosterveld which grade into the wetland in the north (Figure 2). Area B also has the greatest concentration of *Moraea aristata*. I address this Area in more detail when considering an over-arching conservation plan for the combined RC/ SAAO sites below.

10.1.2. 4.5.2 Context and possible future conservation action

Figure 4 shows the relationship of vegetation and landuse between the SAAO and River Club sites, with a summary of extent in Table 4. Unlike the SAAO site, the River Club has no natural vegetation, with only a scattering of indigenous species along the wetland fringe. This is mainly due to the fact that the bulk of the area is fill which has replaced what was likely to have been a wetland habitat.

The original extent of Peninsula Shale Renosterveld is shown in Figure 5. This enables us to establish which parts of the general area might have supported this vegetation type and what linkages there might have been or indeed still exist. Although no wetland vegetation is shown for the area in the SANBI map (Figure 5), there is a clear link along the Black River, stretching from the Mowbray/ Rondebosch Golf Courses, through the Oude Molen grounds as far as the SAAO site. Here the vegetation map is possibly inaccurate (shale and clay as opposed to sand vegetation seems to lie

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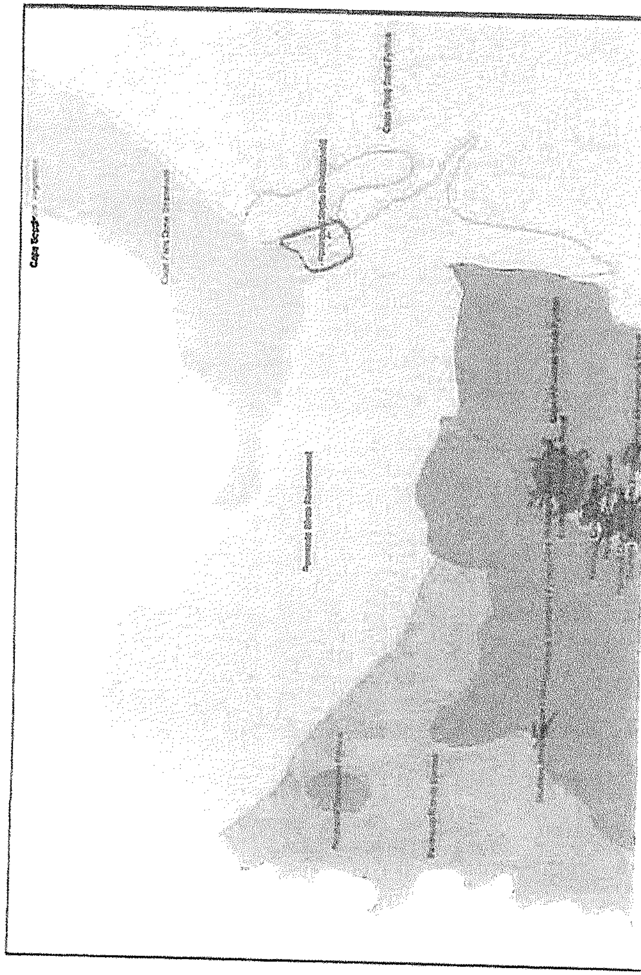

Figure 5. Original extent of Peninsula Shale Renosterveld, showing location of River Club and SAAO sites

Table 4. Extent of vegetation and landuse at the River Club and South African Astronomical Observatory (based upon study area shown in Figure 4)

Description	Area (ha)
Alien trees (SAAO only)	3.97
Natural dryland vegetation (renosterveld) (SAAO only)	1.40
Black & Liesbeek Rivers	5.31
River Club channel	3.38
Wetlands	10.47
Fill (River Club only)	16.82
Developed (buildings, roads, landscaped)	7.53
Total	48.88

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5. CONCLUSIONS

The proposed development at the River Club is highly unlikely to impact negatively on the dryland renosterveld vegetation at the SAAO site. The security of the Critically Endangered *Moraea aristata* is thus likely assured, provided acceptable conservation measures are introduced on the SAAO site.

However, impacts on the SAAO's renosterveld wetlands might be significant if inundation patterns are altered by the proposed River Club development and present seasonality is compromised.

It is strongly recommended that all three conservation options are followed for the SAAO site and environs, but that efforts at extending the area of dryland renosterveld should be supported by a joint initiative between the River Club and the Observatory.

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7. ACKNOWLEDGEMENTS

Louise Badenhorst kindly took me around the the SAAO site and provided useful discussion on the presence and conservation of renosterveld here; she also facilitated funding for the soil analysis

Jody Aufrichtig was helpful in showing me around the River Club site

Carline Voget provided the image of *Moraea aristata*.

APPENDIX 1. INDIGENOUS PLANT SPECIES RECORDED FROM THE SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

Report produced by the SaSFLORA database: data (C) Coastec; database design and structures (C) Reuben Roberts 1998-2016

EX = Extinct, EW = Extinct in the wild, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, R = Rare, NT = Near Threatened, DD = Data Deficient, LC = Least Concern, NE = Not Evaluated

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Division Anthophyta Class: Dicotyledones

AIZOACEAE
- Galenia
  - pubescens var. pubescens NE
- Tetragonia
  - herbacea LC

AMARANTHACEAE
- Sarcocornia
  - cf. capensis LC

ANACARDIACEAE
- Searsia
  - crenata LC
  - glauca LC
  - lucida LC
  - tomentosa LC

APIACEAE
- Arctopus
  - echinatus LC

APOCYNACEAE
- Gomphocarpus
  - fruticosus LC

ASTERACEAE
- Arctotheca
  - calendula LC
- Athanasia
  - trifurcata LC
- Cotula
  - coronopifolia LC
  - turbinata LC
- Dimorphotheca
  - pluvialis LC
- Elytropappus
  - rhinocerotis NE
- Eriocephalus
  - africanus LC
- Osteospermum
  - moniliferum LC
  - monstrosum LC
- Senecio
  - burchellii LC
- Stoebe
  - plumosa NE
- Ursinia
  - anthemoides LC

BRASSICACEAE

- Heliophila
  - coronopifolia LC

CARYOPHYLLACEAE
- Silene
  - burchellii var. angustifolia NE

CELASTRACEAE
- Gymnosporia
  - buxifolia LC

EBENACEAE
- Euclea
  - racemosa LC

FABACEAE
- Indigofera
  - incana LC
  - **psoraloides EN**
- Otholobium
  - hirtum LC
  - virgatum LC
- Podalyria
  - **sericea NT**

GERANIACEAE
- Pelargonium
  - elongatum LC
  - myrrhifolium var. myrrhifolium LC
  - triste LC

KIGGELARIACEAE
- Kiggelaria
  - africana LC

LOBELIACEAE
- Cyphia
  - bulbosa LC
- Lobelia
  - erinus LC

MALVACEAE
- Hermannia
  - hyssopifolia LC
  - multiflora LC

OLEACEAE
- Olea
  - europaea subsp. africana LC

OXALIDACEAE
- Oxalis
  - caprina LC

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compressa LC
hirta LC
obtusa LC
pes-caprae LC
purpurea LC
tomentosa LC
versicolor LC
POLYGALACEAE
Muraltia
demissa LC
Polygala
myrtifolia
SANTALACEAE
Thesium
funale LC
SCROPHULARIACEAE
Hemimeris
racemosa LC
THYMELAEACEAE
Gnidia
laxa LC
Passerina
corymbosa LC

Division: Anthophyta **Class:** Monocotyledones
AMARYLLIDACEAE
Amaryllis
belladonna LC
Crossyne
cf. guttata LC
ARACEAE
Zantedeschia
aethiopica LC
ASPARAGACEAE
Asparagus
asparagoides LC
capensis LC
declinatus LC
undulatus LC
ASPHODELACEAE
Bulbine
alooides LC
Trachyandra
ciliata LC
revoluta LC

COLCHICACEAE
Baeometra
uniflora LC
Colchicum
eucomoides LC
CYPERACEAE
Bolboschoenus
maritimus LC
HYACINTHACEAE
Albuca
canadensis LC
Lachenalia
mediana var. mediana VU
Ornithogalum
thyrsoides LC
HYPOXIDACEAE
Empodium
plicatum LC

Pauridia
capensis LC
IRIDACEAE
Babiana
fragrans NT
Chasmanthe
aethiopica LC
floribunda LC
Geissorhiza
aspera LC
juncea LC
Ixia
maculata NT
Moraea
aristata CR
flaccida LC
gawleri LC
miniata LC
setifolia LC
vegeta LC
cf. virgata subsp. virgata LC
Romulea
flava LC
hirsuta LC
obscura LC

rosea LC
Sparaxis
bulbifera LC
cf. grandiflora subsp. fimbriata NT
Watsonia
meriana var. meriana LC
spectabilis LC
POACEAE
Agrostis
lachnantha var. lachnantha LC
Ehrharta
calycina LC
Hyparrhenia
hirta LC
TECOPHILAEACEAE
Cyanella
hyacinthoides LC

Total named species:	**96**
Total genera:	**62**
Total families:	**32**
Total red list species:	**7**

APPENDIX B

SPECIALIST FAUNAL REPORT (EXCLUDING BIRDS)

8099

PROPOSED REDEVELOPMENT OF THE RIVER CLUB, OBSERVATORY: Baseline assessment of mammals, reptiles and amphibians at the confluence of the Liesbeek and Black rivers, with specific focus on the local Western Leopard Toad population

Report compiled for: The Freshwater Consulting Group (subcontracted to SRK Consulting

Client: Liesbeek Leisure Properties Trust

Report compiled by: Marius Burger, trading as *Sungazer Faunal Surveys*, 6 Putter Street, Lakeside 7945

Phone: 083 231 7452; Email: *sungazer@iafrica.com*

FINAL – December 2017

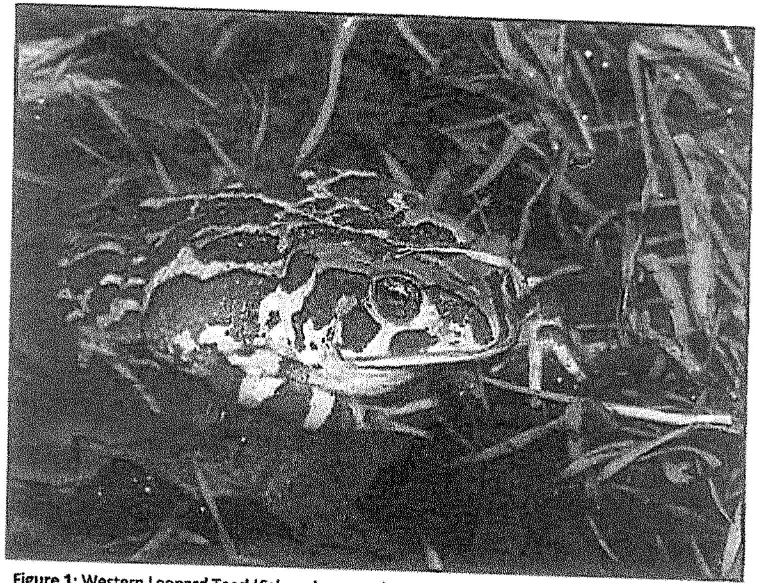

Figure 1: Western Leopard Toad (*Sclerophrys pantherina*) from the River Club grounds (Dec. 2016).

DECLARATION OF INDEPENDENCE

I hereby declare that I have no conflicts of interest related to the work of this report. Specifically, I declare that I have no personal financial interests in the property and/or development being assessed in this report, and that I have no personal or financial connections to the relevant property owners, developers, planners, financiers or consultants of the development. I declare that the opinions expressed in this report are my own and a true reflection of my professional expertise.

CV OF SPECIALIST CONSULTANT (abridged)

Mr **Marius Burger** holds a National Diploma in Nature Conservation with Cape Technicon, and worked as a research assistant with Eastern Cape Nature Conservation (1987-1997). Subsequently he took up employment with the Animal Demography Unit (ADU, University of Cape Town) as National Coordinator of the Southern African Frog Atlas Project (1997-2003) and as Project Herpetologist of the Southern African Reptile Conservation Assessment (2005-2009). Burger's EIA activities as a faunal specialist started in 1996, and since then he has participated in about 85 different projects in collaboration with a variety of EIA consultancies. In 1998, he established a sole-proprietor business *Sungazer Faunal Surveys*. His achievements as a faunal specialist are summarised below:

- Member of IUCN SSC Snake and Lizard Red List Authority 2017-2020: 2017 – present.
- Member of South African Frog Re-assessment Group (SA-FRoG): 2013 – present.

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- Extraordinary Lecturer with the Unit for Environmental Sciences and Management, North-West University: 2015 – present.
- Research collaborator with FLORA FAUNA & MAN, Ecological Services Ltd.: 2011 – present.
- Research Collaborator with the Smithsonian Institute: 2002 – 2004.
- Research Collaborator with the South African Museum: 2000 – 2002.
- Country liaison for the journal *Amphibian and Reptile Conservation*: 2000 – 2004.
- Chairman of the Port Elizabeth Herpetological Club: 1992 – 1996.
- Compiled about 100 specialist and EIA reports for various consultancies.
- Published about 105 scientific, semi-scientific and popular articles, and authored/edited three books and 34 chapters/accounts in books.
- Presented 41 papers/posters at national/international symposia.
- Directed/presented in about 100 natural history television documentaries for *National Geographic, BBC World, SABC, Kyknet* and others.

SUNGAZER
faunal surveys

M. Burger – trading as *Sungazer Faunal Surveys*
October 2017

<u>**CONTENTS**</u>

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Abbreviations

ADU	Animal Demography Unit
CBA	Critical Biodiversity Area
EN	Endangered
EIA	Environmental Impact Assessment
FCG	Freshwater Consulting Group
FIA	Faunal importance assessment
IUCN	International Union for Conservation of Nature
LC	Least Concern
NT	Near Threatened
PRASA	Passenger Rail Agency of South Africa
RBS	Raapenberg Bird Sanctuary
SA	South Africa, Lesotho and Swaziland
SAAO	South African Astronomical Observatory
SANBI	South African Biodiversity Institute
SCC	Species of conservation concern
SRK	SRK Consulting
ToR	Terms of Reference
TRUP	Two Rivers Urban Park
VU	Vulnerable
WC	Western Cape
WLT	Western Leopard Toad (*Sclerophrys pantherina*)

1 SUMMARY

Introduction

A baseline study was conducted for the mammal, amphibian and reptile faunas of the River Club study area, in the context of a proposed mixed retail/commercial/residential complex development. The main aims of this faunal study were to assess the area in terms of the local species richness of these various faunal groups, and to highlight environmental issues that may be of special concern in the light of the proposed development of the River Club property. Several site visits were conducted during the period October 2016 through to January 2017. Various data sources and persons were consulted to gain a reasonable impression of these faunal assemblages that are likely to be still present in the general region. In addition to the specific records obtained from the various sources, the local habitats were assessed in order to project the possible/probable species richness of these three faunal groups. A faunal importance assessment (FIA) score was calculated for the site for each of the three faunal groups, to obtain an approximate impression of the site's importance for each respective group at regional (CoCT Metropolitan Area) and national (South African; SA) scales. Various recommendations and mitigation measures were proposed to reduce impacts on the local faunal assemblages.

Faunal assessment

<u>MAMMALS</u>: A total of 29 indigenous mammal species may potentially occur on the River Club grounds and immediate surroundings, but the more realistic probable mammal richness here is about 19 or so species (Tale 4). Most of the larger mammal species that used to occur here historically have become locally extinct, leaving only a subset of small species that still manage to maintain meagre populations here. The conservation status of these mammals are almost all listed as being of Least Concern (LC), with only one species (African Clawless Otter) with a global (IUCN) and regional (Child *et al.* 2016) listing of Near Threatened (NT). The presence of otter activity have been confirmed from the general region. The River Club itself is unlikely to have a resident population of otters, but rather a few individuals probably move in and out of this area throughout the year. Although the River Club grounds and adjacent area are generally of MODERATE at regional and LOW to MODERATE at national scales (Table 1; FIA score = 4.5), any developments in this area should nevertheless be considerate about the associated environmental impacts. The most important consideration in respect of the local mammal assemblages would be to maintain or improve the ecological integrity of the Liesbeek and Black rivers, including a buffer region along the banks of these rivers and corridors between them.

<u>REPTILES</u>: A total of 32 indigenous reptile species may potentially occur on the River Club grounds and immediate surroundings, but the more realistic probable reptile richness here is about 20 or so species (Table 5). The conservation status of these reptiles are almost all listed as being of LC, except for the Cape Dwarf Chameleon which currently is listed as Vulnerable (VU). This particular species was recorded on the grounds of the adjacent South African Astronomical Observatory, and it may possibly also occur within the River Club grounds. The FIA score for reptiles (Table 2; score = 5) in the context of the River Club site is MODERATE at regional and LOW to MODERATE at national scales. However, it is advised to integrate a mosaic of green belts/nodes within the proposed development, in order to

maintain a degree of ecological resilience for the remaining faunal groups here. For species like the Cape Dwarf Chameleon for example, the habitats of such ecological nodes could be enhanced to better suite their needs and thus improve the overall conditions for maintaining a long-term population.

AMHIBIANS: A total of eight indigenous amphibian species may potentially occur on the River Club grounds and immediate surroundings, but the more realistic probable amphibian richness here is about six species (Table 6). The conservation status of these amphibians are almost all listed as being of LC, with the notable exception of the Western Leopard Toad (WLT) which is Endangered (EN). Even with the presence of a species of conservation concern (SCC), i.e. the WLT, the FIA score for amphibians (Table 3; score = 6.25) in the context of the River Club site is MODERATE at regional and LOW to MODERATE at national scales. Although this does not trigger a fatal flaw response in respect of the development intentions, the prevalence of WLTs in this area does call for special considerations to adequately accommodate this species here. The WLT represents the most significant faunal concern in respect of the proposed River Club development intentions, and the long-term viability of this species must not be compromised by this development. To achieve this, specific mitigating measures will have to be implemented. The following aspects are relevant in this regard:

WESTERN LEOPARD TOADS (WLT)

- The only known WLT breeding sites in the region of the River Club are wetlands of the Raapenberg Bird Sanctuary (RBS) and about 1.5 km south-east in the Oude Molen area.
- The WLT population of this specific area (Figures 2 and 3), i.e. Observatory and surroundings, appears to be somewhat disjunct and seemingly completely separated from the WLT breeding populations further south (see Figure 4) on the Cape Peninsula.
- Any proposed development of the River Club grounds and immediate surroundings must be mindful of the environmental constraints stemming from this WLT population. The following four components are critical for the viability of any WLT population:

1. Availability of suitable **breeding habitat**: In this case, the conservation and management of the RBS wetlands are thus of outmost importance. Additionally, the creation of supplementary WLT breeding habitat (e.g. along the western reaches of the site) is likely to improve the resilience of the localised Observatory WLT population.
2. Availability of habitat to provide **shelter and food (forage)**: Enough natural or semi-natural habitat must be available within at least a 2 km radius of breeding habitats to sustain WLT individuals for the non-breeding period (i.e. about 10 months of the year). Such sectors must provide the adequate shelter and foraging requirements to sustain the WLTs until the next breeding season. Thus substantial green belts must remain undeveloped, e.g. along the two rivers and especially in the areas near to the RBS wetlands and the northern sector near the confluence, and also within the east/west dispersal corridors.
3. Availability of **dispersal corridors**: Multiple dispersal options between breeding habitat and year-round occupancy habitat must be maintained, i.e. barriers must be limited. Connectivity must be

maintained between the RBS wetlands and the river regions to the west, including the area of the former Liesbeek flow, which must either be rehabilitated as an accessible high quality wetland habitat or converted into high quality terrestrial habitat with some pools/ponds that would retain water into the summer and could be used as WLT breeding grounds. One broad (>70 m wide) east/west belt must be established in the northern reaches of the property, and additional minor (>10m wide) east/west corridors must also be created along the northern and southern site boundaries.
4. Limiting the extent of **hazardous features** and **high-risk areas**: Toad exclusion barriers must be erected to prevent/limit toad access to high-risk zones such as roads, large unvegetated areas and various pitfall structures.

Main conclusions

- The importance value of the River Club site in respect of mammals, reptiles and amphibians is MODERATE at regional and LOW to MODERATE at national scales for all three faunal groups.
- From a faunal perspective, the prospects of developing the area is thus not fatally flawed.
- The main faunal consideration of the River Club project is the occurrence of an isolated population of WLTs, an EN species which breeds at the RBS wetlands.
- Significant mitigation is required to limit the impact of the proposed development, and to ensure the long-term viability of this WLT population.
- Mitigation measures implemented for WLTs will by default also serve to mitigate for the other faunal assemblages that are not of significant conservation concern.

Main recommendations and mitigations

Several general mitigation measures have been formulated during the course of the freshwater, botanical and faunal assessments (2015 – 217). The mitigation measures most relevant to the faunal considerations are summarised below:

1. **ECOLOGICAL SECTORS**: Several natural or semi-natural ecological sectors must be provided to serve as shelter/forage habitat for WLTs and other faunal species. Some of these ecological sectors may further function as WLT breeding habitat and/or faunal dispersal corridors. The most important ecological sectors are:

- LIESBEEK WEST SECTOR: The historical flow area of the Liesbeek River to the west of the River Club. This sector is earmarked to be converted and landscaped into being more of a vegetated terrestrial landscape, with seasonally flooded wetlands to serve as WLT breeding habitat.
- LIESBEEK EAST SECTOR: The canalised section of the Liesbeek River to the east of River Club. This ecological sector is earmarked to be converted and landscaped into a more natural (not canalised) watercourse with a substantial buffer area (at least 25m) of semi-natural vegetation including some lawned areas.
- EAST/WEST CORRIDOR: The east/west ecological (or faunal) corridor between the historic and canalised Liesbeek watercourses, as per the current development layout vision. This wide (65-100m) vegetated green belt will serve as the main linkage between the western Liesbeek sector

(and landscaped WLT breeding wetland habitat) and the eastern Liesbeek sector (including RBS and Black River). It will also serve as shelter/forage habitat for WLTs and certain other faunal species.

- NORTHERN SECTOR: the northern undeveloped section (owned by the Passenger Rail Agency of South Africa; PRASA) situated between the golf course and the railway line. This area does not form part of the proposed River Club development. It has good potential to serve as shelter/forage habitat and being an east/west faunal corridor. However, the terrain is currently suboptimal for these functions and would require a landscaping initiative to vegetate it adequately according to faunal (and WLT) requirements.

2. **TOAD-FRIENDLY INFRASTRUCTURE:** Toad-friendly structures (examples in Appendix 2) must be integrated with the proposed development, so that the negative impact on the WLT population can be minimise. The most important examples of such features are:

- EXCLUSION BARRIERS: Low barrier walls or fencing can be used to prevent WLTs from gaining access to hazardous terrain or high-risk areas such as parking lots and roads.
- UNDERPASSES: High-risk areas like roads can be made permeable for toads by means of a combination of exclusion barrier walls to keep toads off roads, and underpasses to allow safe movement of toads between different ecological sectors.

3. **WLT MANAGEMENT & MONITORING:** It is recommended that a WLT management and monitoring programme be drawn up for this proposed development. Ideally the monitoring should start at least one WLT breeding season prior to commencing with the construction phase, and continue up until five breeding seasons after construction has been completed. The main aims of this monitoring would be to evaluate the success and efficiency of faunal dispersal corridors, ecological shelter/foraging sectors, new WLT breeding habitat, and the toad-friendly infrastructure. Details to be formulated as part of the final design phase, if approved.

2 INTRODUCTION

The *Liesbeek Leisure Properties Trust* (LLPT) proposes to redevelop the River Club property situated within the Two Rivers Urban Park (TRUP) complex near Observatory, Cape Town. The proposal envisages retail, commercial and residential components. The scoping and Environmental Impact Assessment (EIA) studies for this proposed development are being conducted by *SRK Consulting (South Africa) Pty Ltd* (SRK), who in turn commissioned the *Freshwater Consulting Group* (FCG) to undertake the freshwater ecosystem studies. To date the FCG has compiled a preliminary scoping baseline report (Day 2015), which also included an avifaunal component. Additionally, a brief faunal assessment report was compiled by *Nick Helme Botanical Surveys* as part of the botanical assessment report that was prepared for the TRUB study area (Helme 2016). In both the freshwater/avifauna and botanical/faunal reports, the Western Leopard Toad (WLT) was highlighted as a species of conservation concern (SCC) in respect of the proposed developments here, and that a more detailed study was required to gain adequate insight in this regard. As such, a faunal consultant (M. Burger, trading as *Sungazer Faunal Surveys*) was subcontracted by the FCG (for SRK) to conduct a baseline assessment of the mammals and herpetofauna (i.e. reptiles and amphibians) of the TRUP study area.

2.1 Terms of Reference (ToR)

- Conduct a series of site visits/habitat assessments (day and night) and gather information and data sets from other resources to:
  1. Identify faunal species at and adjacent to the site;
  2. Estimate the population size of faunal species that utilise the site;
  3. Identify existing breeding locations for faunal species on the site; and
  4. Identify areas on the site used as faunal movement corridors.
- Compile a desktop baseline faunal assessment (informed by habitat assessment) based on known faunal distribution patterns and habitat associations, including:
  1. Identification of fauna that are known to or likely to use the site;
  2. Indication of whether these include red data species or other SCC;
  3. Description of habitat requirements and likely areas of the site that they would utilise;
  4. Identification of important off-site linkages;
  5. Broad comments on the sensitivity of the fauna to development – increased noise, buildings, traffic, construction phase disturbance; and
  6. Comments on appropriate development setbacks and design of corridors and buffer areas to address the habitat requirements of conservation worthy taxa/communities.

In addition to the above ToR, the specialist will comment on the connectivity between the Observatory WLT population and other populations in Cape Town e.g. the Cape Flats.

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3 STUDY AREA

The TRUP study area is situated in the Observatory region, near the confluence of the Black and Liesbeek rivers (Figure 2). Currently the main land-use nodes are: 1) The River Club venue, with a driving range and 9-hole golf course to the north of the River Club facility, 2) undeveloped terrain owned by Passenger Rail Agency of South Africa (PRASA) in the far north of TRUP, 3) the South African Astronomical Observatory (SAAO) to the east of River Club, 4) the Raapenberg Bird Sanctuary (RBS) to the north and east of the SAAO, and 5) a small area to the south of River Club which is earmarked for an office park and residential development by SKA South Africa. The Black River flows along the eastern limits of the faunal study, whereas the western and northern limits are along the historical flow of the Liesbeek River. The current flow of the Liesbeek River is along a canalised structure that separates the River Club development area from the RBS and SAAO.

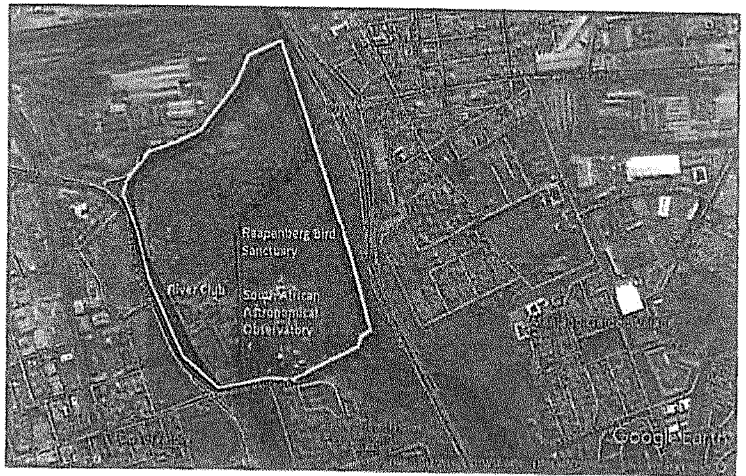

Figure 2: The location of the TRUP study area, with the approximate boundaries of the faunal study in yellow. The TRUP development footprint will be contained within the area demarcated with red boundaries, including the area currently occupied by the River Club. Two localities to the east of the River Club are noteworthy, i.e. the RBS and the SAAO. The Black River flows along the eastern limits of the faunal study, whereas the western and northern limits are along the historical flow of the Liesbeek River. The current flow of the Liesbeek River is along a canalised structure that separates the River Club and TRUP development area from the RBS and SAAO.

4 STUDY APPROACH AND METHODS

The faunal assessment was conducted in the following way:

- Several brief site visits were conducted during night and day during the period October 2016 through to January 2017. The main aim was to assess habitat diversity/quality (with specific attention to WLT habitats), and to search for some representatives of the three faunal groups.
- Some small mammal trapping was conducted in the PRASA and RBS sectors, and tadpole scoops were conducted on the periphery of the RBS wetlands.
- Other sources (e.g. online data sets, literature and persons) were consulted to gain deeper insights of the property. The main sources were:
  - iSpot Nature: https://www.ispotnature.org/
  - Animal Demography Unit (ADU) Virtual Museum: http://vmus.adu.org.za/
  - Dr Tony Rebelo: South African Biodiversity Institute (SANBI).
  - Dr John Measey: Centre for Invasion Biology, Stellenbosch University.
  - Mrs Jean Ramsay: Volunteer, recording annual WLT activities on the SAAO property.
  - Miss Peta Brom: Student of Urban Ecology.
- Faunal importance assessments (FIA) were conducted for the three faunal groups.

4.1 Study limitations

The relatively short field surveying period allows mainly to gauge habitat parameters of the study area, with insight on faunal assemblages having to be derived from other sources and inferences made from habitat availability. The extrapolations made from assessing the habitats and the habitat requirements of the species known from the general region, are sufficient for the compilation of reasonably accurate (>80% accurate/complete) faunal checklists. The WLT survey was conducted about one to two months after the 2016 WLT breeding survey, but sufficient information was obtained via other sources to gain an adequate understanding of WLT demographics in this region.

4.2 Faunal importance assessments (FIA)

The purpose of assessing the faunal importance of each of the three vertebrate faunal groups, i.e. mammals, reptiles and amphibians, is to obtain an approximate impression of each group's value at a regional (CoCT Metropolitan Area) and national (South African; SA) scale. This assessment incorporates a variety of components, i.e. the presence/absence of threatened species, the levels of conservation status of the threatened species, overall species richness, levels of endemism, ecological functioning potential of the site, the size and habitat quality of the site, habitat heterogeneity or homogeneity, and the site's value as an ecological corridor, a green zone, or source or sink for genetic exchange in respect of peripheral natural areas. The IUCN Red List of threatened species (IUCN 2017), together with the respective SA assessments of the three faunal groups, i.e. mammals (Child *et al.* 2016), reptiles (Bates *et al.* 2014) and amphibians (Minter *et al.* 2004; Measey 2011), served as the sources for the conservation status for fauna of the Observatory region. The following criteria were used to determine the relative importance of the River Club site in respect of these faunal groups, in

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the context of the CoCT Metropolitan Area (regional) and SA (national). A score of one point is given for each YES answer, excepting for Red List species where as many as two points can be awarded. A score of 0.5 is awarded if the answer is disputably YES or NO for questions 1 to 5. A score of 0.25, 0.5, 0.75 or 1 may be awarded for questions 6 to 12, depending on the subjective assessments of these questions. Thus a maximum possible score is 12 points.

- Score total 0 - 4 = LOW at regional and national scales.
- Score total 4.25 - 8 = MODERATE at regional and LOW to MODERATE at national scale.
- Score total 8.25 - 12 = HIGH at regional and MODERATE to HIGH at national scale.

Questions:

1. Are any threatened (Red List) species known to occur within the River Club site? Note that for the purpose of this evaluation, threatened species constitute those listed as ***Critically Endangered*** (2 points), ***Endangered*** (1.5 points), ***Vulnerable*** (1 point) and *Near Threatened* (0.5). If several threatened species are present, only the most threatened status of them all is applicable, thus a maximum of 2 points can be scored in this section. Note also that if a score is of YES (1) is made here, then no score can be presented in the next category (i.e. potential occurrence of threatened species). Thus the maximum total possible score for a particular faunal evaluation is 12.
2. If not, are any threatened species likely to occur within the River Club site?
3. Are any localised (CoCT) endemics known or likely to occur within the River Club site?
4. Are any provincial (WC) endemics known or likely to occur within the River Club site?
5. Are any national (SA) endemics known or likely to occur within the River Club site?
6. Is the site likely to support high species richness relative to the CoCT Metropolitan Area?
7. Are the existing faunal communities thought to be of importance in respect of the local ecological functioning of systems within the River Club site?
8. Is the total extent of the River Club site large enough to support the existing faunal communities in the long-term?
9. Is the habitat quality of the River Club site such that it is suitable for the long-term support of faunal communities?
10. Does the River Club site have great habitat heterogeneity that would favour overall high species richness?
11. Is the River Club site important in respect of peripheral natural areas, either as an ecological corridor or a significant suburban green zone?
12. Is the River Club site important in respect of peripheral natural areas as a source or sink for genetic exchange?

5 RESULTS

5.1 Habitat assessment

Habitat variation, habitat quality and the size of a particular site are significant determining factors in respect of the likely faunal species composition of that site. The assessment of these environmental parameters enables the faunal surveyor to make reasonable predictions concerning the likely presence or absence of specific species at a particular site. These unconfirmed species are incorporated in the respective checklists for the various faunal groups (Tables 4 to 6), together with known/confirmed species records that were obtained from other sources or by means of new faunal surveys and field observations. The relevant habitat parameters of the site are as follow (Figures 3 to 14):

The general terrain is substantially transformed and developed, most notably the SAAO grounds and the River Club property with associated buildings, parking lots and golf course/range fields. The belt of PRASA terrain beyond (north of) the golf course/range is also substantially degraded. The TRUP terrain is generally flat, without any rocky protrusions. A few small artificial ponds are present within the landscaped golf course section. Although also somewhat transformed, the Raapenberg Bird Sanctuary (RBS) wetlands are still of moderate ecological importance and of local conservation value. The Black River has undergone extreme changes from its natural condition (PES Category F according to Day 2015). The original flow of the Liesbeek River was diverted by means of a lined channel that short-cuts to the confluence with the Black River. The natural flow regime of the truncated section of the original Liesbeek along the west and north-west of the study has dwindled to a generally stagnant wetland system.

Vegetation types and quality: Vegetation descriptions of the TRUP study area were prepared in the botanical report (Helme 2016). In summary, the site falls mostly within the original extent of the Cape Flats Dune Strandveld Vegetation type, and a small portion falls within the original extent of the Peninsula Shale Renosterveld vegetation type. The Cape Flats Dune Strandveld Vegetation Type is classified as Endangered, with the Peninsula Shale Renosterveld vegetation being endemic to the CoCT and classified as Critically Endangered (Mucina and Rutherford, 2006). However, these vegetation types are no longer present within the TRUP study area, having been transformed into grassed (lawn) terrain with scattered trees. Essentially, >90% of the TRUP study area can be considered transformed habitats. According to the botanical assessment (Helme 2016), the only remaining terrestrial areas with traces of indigenous vegetation are on the SAAO grounds. However, these small remnants (<1 ha) are heavily transformed and currently support less than 10% of their likely original plant communities.

Geomorphological features: The River Club site is comprised of mostly flat terrain with a few low landscaped mounds incorporated within the golf range section. The area is devoid of any significant geomorphological features such as hills, rocky outcrops, valleys or major drainage zones. It is thus rather homogenous and consequently it is faunistically conservative. Substrate type is directly correlated with vegetation type. Additionally, substrate type is also a factor for fossorial (burrowing) species, e.g. golden moles, mole-rats, legless skinks, rain frogs, etc. But much of the terrain seems fairly compacted, thus offering only limited scope for varied fossorial faunal assemblages. A summary of substrate types were presented in the botanical report (Helme 2016):

- Alkaline marine sands derived from the Witzand formation (in north-western section).
- Acid sands from the Springfontein formation (east of modern day Alexandra Road, and also along parts of the Black River).
- Clay soils derived from the underlying Malmesbury group shales and ferricretes (in south-western section and a strip between the Black River and modern day Alexandra Road).

Wetland features: The most prominent River Club wetland features were assessed in the freshwater ecology baseline report (Day 2015). Briefly, these are as follow:

- OLD (WEST) LIESBEEK RIVER: The historic unlined reaches of the Liesbeek River, along western and north-western boundary of the TRUP study area (Figure 3). Due to the construction of a canalised shortcut to the confluence of the Black River (Figures 4 and 5), which currently constitutes the main flow of the Liesbeek River along the eastern boundaries of the River Club, the historic Liesbeek has lost most of its flow ability and has become a stagnant system for part of the year. It is not known if WLTs utilise this stretch of wetland (see Figure 17) for breeding, but it appears to be at least partially suited as WLT breeding habitat. For the purpose of this study, it is therefore presumed that WLTs do in fact breed here.
- NEW (EAST) LIESBEEK RIVER: The canalised portion of the Liesbeek River (Figure 4) that flows along the eastern boundary of the River Club property is not suitable as WLT breeding habitat, mostly because it is a flowing river system. WLTs generally prefer standing bodies of open water.
- BLACK RIVER: The Black River that forms the eastern boundary of the TRUP study area (Figure 16) is also a flowing river system that is not suitable as WLT breeding habitat.
- RAAPENBERG BIRD SANCTUARY (RBS) WETLANDS: Several bodies of standing water are present within the RBS (Figures 13 and 17). The RBS is currently the only confirmed WLT breeding site within the River Club study area, although it is not yet clear exactly which of the RBS wetlands are utilised. Another confirmed WLT breeding site is situated close by in the Oude Molen region.
- GOLF COURSE PONDS: Three small artificial wetlands (Figures 6 to 8, and 17) are present in the northern reaches of the golf course. Two of these (Figures 6 and 7) seem ideal as WLT breeding habitat, whereas the third (Figure 8) dries up too soon to allow for successful tadpole metamorphoses.
- SOUTH AFRICAN ASTRONOMICAL OBSERVATORY (SAAO) WETLAND: A small seasonal wetland is present in the north-western corner of the SAAO grounds (Figures 14 and 17). It has moderate to low potential to serve as WLT breeding habitat.

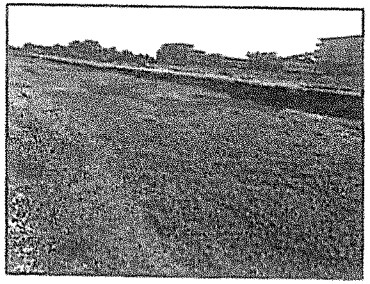

Figure 3: The historic unlined reaches of the Liesbeek River, along western and north-western boundary of the study area.

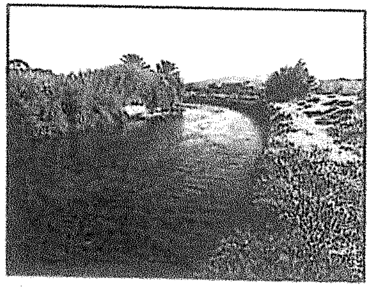

Figure 4: A canalised portion of the Liesbeek River that flows along the eastern boundary of the River Club property.

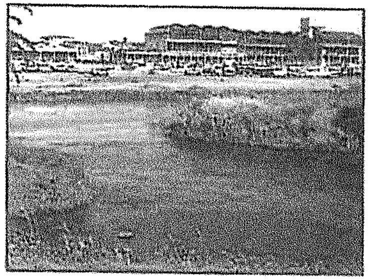

Figure 5: The current confluence of the Liesbeek and Black rivers at the north-eastern reaches of the River Club property.

Figure 6: Artificial wetland (1 of 3) on the River Club golf range may potentially be suitable breeding habitat for WLTs.

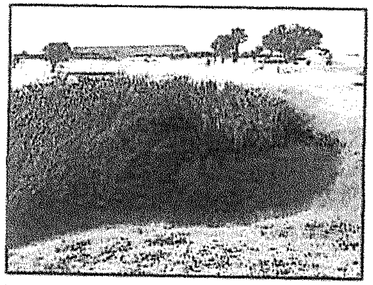

Figure 7: Artificial wetland (2 of 3) on the River Club golf range may potentially be suitable breeding habitat for WLTs.

Figure 8: Artificial wetland (3 of 3) on the River Club golf range, probably unsuitable as WLT breeding habitat.

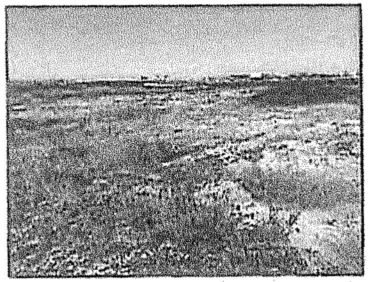

Figure 9: Degraded terrain of the PRASA sector in the north of the study site.

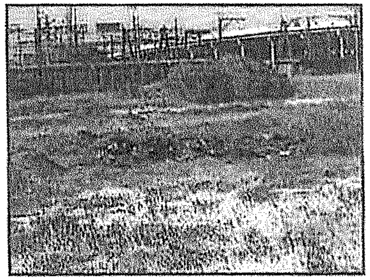

Figure 10: Some low intensity refuse dumping at the PRASA sector.

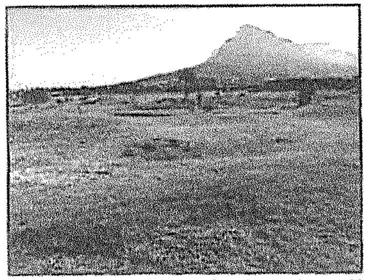

Figure 11: The northern limits of the 9-hole golf course.

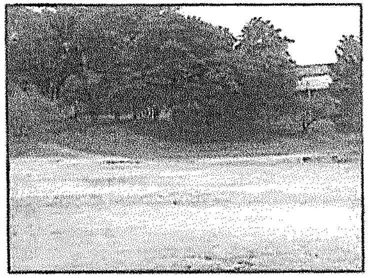

Figure 12: Transformed habitat within the SAAO grounds.

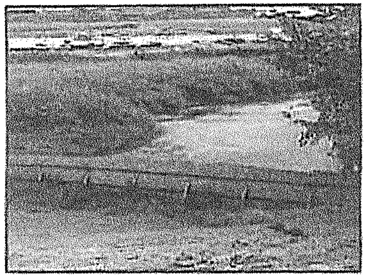

Figure 13: A wetland within the RBS that is utilised as WLT breeding habitat.

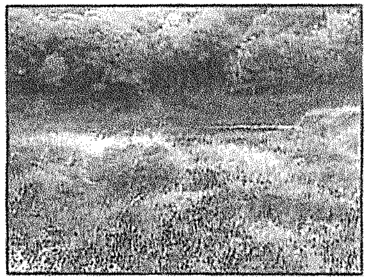

Figure 14: A small seasonal wetland on the SAAO property. No WLT breeding activities have been noted from this particular wetland.

5.2 Mammal FIA

The potential mammal species richness total of the River Club site is 29 (see checklist: Appendix 1, Table 4), but more realistically only about 19 (or less) mammal species are likely to inhabit or occasionally utilise the site. None of these are threatened species, but note that the global (IUCN) and regional (Child *et al.* 2016) status of the African Clawless Otter is NT. As is typical for present-day urban green zones, several mammal species that occurred here historically (e.g. ungulates and medium/large carnivores) have become locally extinct. The current remnant mammal fauna is comprised mostly of small species like rodents, insectivores and small carnivores. Although the rodent and insectivore species may be resident to the River Club site with breeding assemblages, the small carnivores are likely to be occasional visitors only.

The FIA for mammals (Table 1; score = 4.5) in the context of the River Club site is LOW at regional and national scales. The small size of the River Club site, combined with its low habitat heterogeneity and relatively degraded/transformed state, renders this site relatively unimportant in terms of mammal assemblages of the CoCT Metropolitan Area. From a mammal perspective, there are thus no reasonable or compelling grounds for the outright objection to the current development proposal for this site.

Table 1: Mammal FIA of the River Club site at regional and national scales.

Criterion	FIA score
Known presence of threatened species	0.5
Probable presence of threatened species	0
Presence of CoCT endemics	0
Presence of WC endemics	1
Presence of SA endemics	1
High species richness relative to the CoCT	0.25
Important ecological functioning	0.25
Size of the site	0.25
Habitat quality of the site	0.25
Extent of habitat heterogeneity	0.25
Importance as an ecological corridor or an urban green zone	0.5
Importance for genetic exchange	0.25
TOTAL	4.5

5.3 Reptile FIA

The potential reptile species richness total of the River Club site is 31 (see checklist: Appendix 1, Table 5), but more realistically only about 20 (or less) reptile species are likely to inhabit or occasionally utilise the site. One threatened reptile species occurs within TRUP boundaries, i.e. the Vulnerable (VU) Cape Dwarf Chameleon (*Bradypodion pumilum*). Note that the conservation status of this chameleon was recently downlisted to NT, but this revised status will only become official in 2018. For the purpose of this FIA, the current listing of VU still applies.

The FIA for reptiles (Table 2; score = 5) in the context of the River Club site is MODERATE at regional and LOW to MODERATE at national scales. The small size of the River Club site, combined with its low habitat heterogeneity and relatively degraded/transformed state, renders this site relatively unimportant in terms of reptile assemblages of the CoCT Metropolitan Area. From a reptile perspective, there are thus no reasonable or compelling grounds for the outright objection to the current development proposal for this site.

Table 2: Reptile FIA of the River Club site at regional and national scales.

Criterion	FIA score
Known presence of threatened species	1
Probable presence of threatened species	0
Presence of CoCT endemics	0
Presence of WC endemics	1
Presence of SA endemics	1
High species richness relative to the CoCT	0.25
Important ecological functioning	0.25
Size of the site	0.25
Habitat quality of the site	0.25
Extent of habitat heterogeneity	0.25
Importance as an ecological corridor or an urban green zone	0.5
Importance for genetic exchange	0.25
TOTAL	5

5.4 Amphibian FIA

The potential amphibian species richness total of the River Club site is eight frog species (see checklist: Appendix 1, Table 6), with probably only six species actually occurring here. The Endangered WLT is one of the species that utilises the River Club site. The Observatory region is an important strongholds for WLT, with the RBS serving as the nucleus for WLT breeding habitat.

Although the occurrence of this threatened frog and its associated habitats have upped the FIA score to substantially higher than that of the other two faunal groups (i.e. 6.25 vs 4, and 5 respectively), it is nevertheless still below the threshold for being of HIGH importance at a regional scale and MODERATE to HIGH importance at a national scale. This is mostly due to the small size and relatively degraded/transformed state of the River Club site, low habitat heterogeneity, and low species richness relative to the CoCT Metropolitan Area.

The FIA for amphibians (Table 3; score = 6.25) in the context of the River Club site is MODERATE at regional and LOW to MODERATE at national scales. At face value, this FIA score does not trigger a fatal flaw response in respect of the development intentions. However, due to the prevalence of WLTs in this area, special considerations and mitigation measures are nevertheless called for. These are outlined and discussed below in a section dealing specifically with the WLT in the context of the proposed development of the River Club site.

Table 3: Amphibian FIA of the River Club site at regional and national scales.

Criterion	FIA score
Known presence of threatened species	1.5
Probable presence of threatened species	0
Presence of CoCT endemics	0
Presence of WC endemics	1
Presence of SA endemics	1
High species richness relative to the CoCT	0.25
Important ecological functioning	0.25
Size of the site	0.25
Habitat quality of the site	0.5
Extent of habitat heterogeneity	0.25
Importance as an ecological corridor or an urban green zone	0.75
Importance for genetic exchange	0.5
TOTAL	6.25

5.5 The Observatory Western Leopard Toad population

The demographics of WLTs in the Observatory region is currently not fully understood. The population appears to be centred in the RBS environs, with most observations having been recorded from the SAAO grounds (Figures 15 and 16). WLT specimens were observed on the River Club grounds during the 2016 site visits, generally in the north-eastern reaches of the golf course, and in association with the original Liesbeek River on the west. Some scattered WLT records are known as far as 1.5 km away from the River Club region, to the south-west and south east in Observatory, Mowbray and south-western reaches of Pinelands (aka Oude Molen). Although the M5 must surely serve as a formidable dispersal barrier for WLTs moving between the RBS and south-western Pinelands (Oude Molen), it would appear as though some degree of connectivity still remains. This is presumably at the point where the M5 crosses the Swart River (Figure 17). Alternatively (or additionally), it may be that some of the wetlands just off the Black River are utilised as WLT breeding habitat (Figure 17). This needs to be investigated at some stage. The precise locations of RBS wetlands that serve as WLT breeding habitat are currently in dispute (due to salinity parameters), and should be investigated during forthcoming WLT breeding events. Currently, the only other known (confirmed) WLT breeding site in addition to the RBS is in this area is in the Oude Molen region.

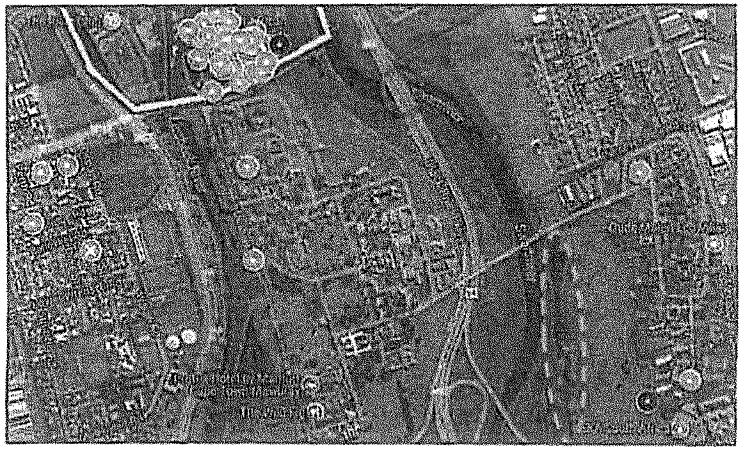

Figure 15: The two WLT records in the Oude Molen region are likely associated with a small wetland (black circle) in this area. The wetlands indicated by the stippled blue polygon may potentially serve as WLT breeding habitat (to be confirmed). Although the M5 is a significant dispersal barrier that hampers WLT movements between the River Club region and this western region, the bridge across the Black River (stippled red polygon) may potentially provide some degree of connectivity.

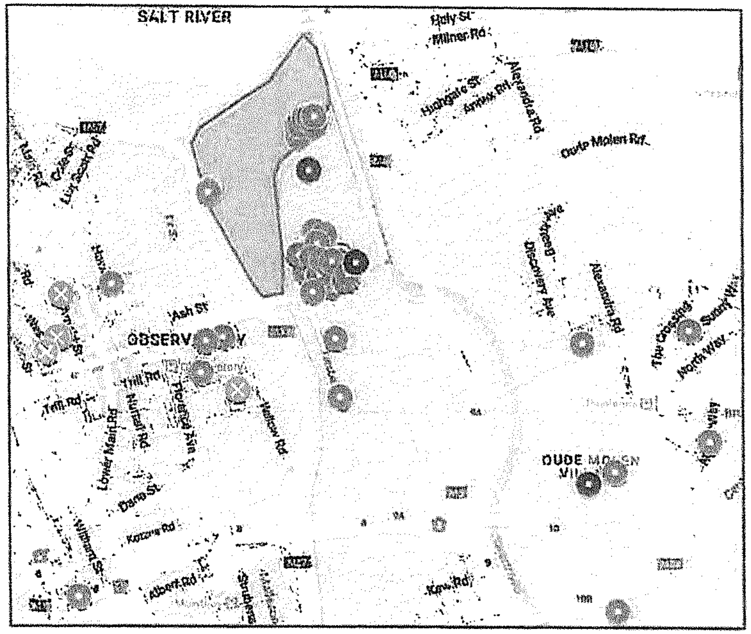

Figure 16: Confirmed records of Western Leopard Toads (WLT) in the general region of Observatory and the River Club (orange circles). A few unconfirmed records (blue circles) may either be that of WLTs or the recently established Raucous Toad (*Sclerophrys capensis*; green circle). The black circle denotes the two confirmed WLT breeding sites within the RBS, with a third confirmed WLT breeding site further south-east in the Oude Molen region.

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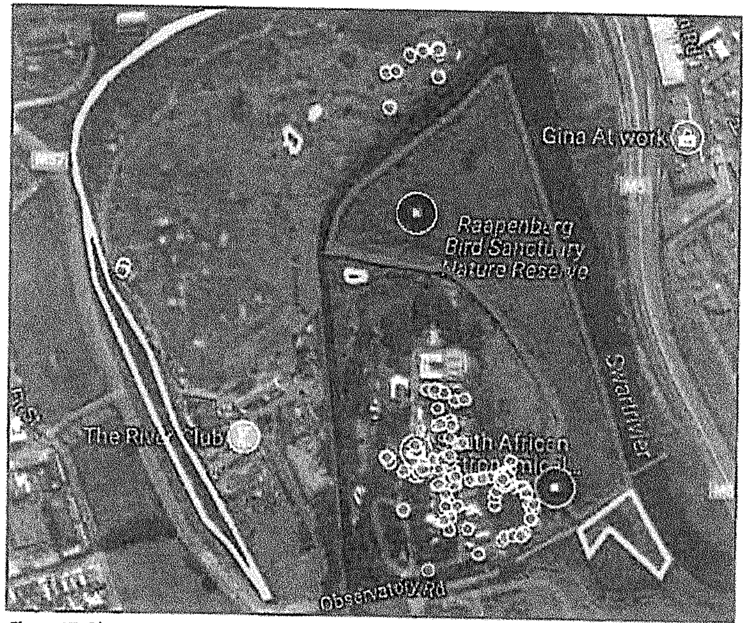

Figure 17: Observation records of WLT in the general region of the River Club (small orange circles), and the RBS (red boundaries) which is a known WLT breeding locality (large black circles). The yellow-lined polygons indicate wetlands that additionally may possibly be used as WLT breeding sites.

5.6 Connectivity between WLT populations

In the light of the proposed redevelopment plans for the River Club, an issue that was specifically highlighted is that the Observatory WLT population appears to be separated from other CoCT WLT populations. If indeed so, then it would likely be more susceptible to the associated negative development impacts as opposed to being more resilient if it was still functionally connected with other adjacent WLT populations. This issue was included in the faunal ToR, and is addressed here. The WLT is restricted to the south-western Cape region, ranging from the Cape Peninsula eastward to the western-most part of Agulhas National Park. Its total extent of occurrence (EOO) is 3824 km^2, with an area of occupancy (AOO) of 405 km^2 which is continually being reduced by ongoing development and habitat loss within the CoCT and Overstrand regions (IUCN 2017). The species breeds at low elevations

within 25 km of the sea, but adults have been recorded in the mountains up to 500 m asl. The WLT distribution is disjunct, with two distinct subpopulations separated by about 100 km. These are the CoCT Metropolitan Area and Overberg subpopulations. The eastern Overberg subpopulation is genetically distinct from those in the western CoCT region (Measey and Tolley 2011). For the purpose addressing the question of Observatory WLT population connectivity, the focus will be on the western CoCT WLT subpopulation (Figures 18 to 20). This subpopulation is distributed across four quaternary catchments, roughly according to the following regions:

- **Southern catchment**, including Noordhoek, Fish Hoek and Kommetjie regions. The Noordhoek and Fish Hoek regions is one of the most important strongholds for WLTs. The Kommetjie population was recently re-established, and is separated by about 5 km from the Noordhoek/Fish Hoek stronghold. This is the southern-most population on the Cape Peninsula.
- **Western catchment**, including Hout Bay region. This is also somewhat of an isolated population, separated by about 7.5 km from other CoCT WLT populations.
- **Eastern catchment**, including Lakeside, Kirstenhof, Bergvliet, Constantia, and onto the Cape Flats including Grassy Park, Ottery and Philippi regions. This is an important stronghold for CoCT WLTs.
- **Northern catchment**, including Observatory region. This is the northern-most population for the species, and it is seemingly well separated (9-10 km) from other CoCT WLT populations.

Although the two western and eastern subpopulations were shown to be genetically distinct (Measey and Tolley 2011), this study could not determine any simple patterns of isolation by distance within the populations of the CoCT WLT subpopulation. And although it is generally expected that the influences of different catchments would likely result in significant gene-flow partitioning, again this was not a finding of this study. Instead, distinct genetic group assemblages of haplotypes were found in association with breeding areas, and the influence of mountain barriers also shows grouped genetic structuring. These findings are inconclusive in terms of assessing the degree of connectivity of the Observatory WLT population. For the purpose of this faunal assessment, most of the evidence points to it being a distjunct (unconnected) population, and must thus be treated as being of special conservation significance. It is recommended that a genetic study be conducted to address this particular ambiguity.

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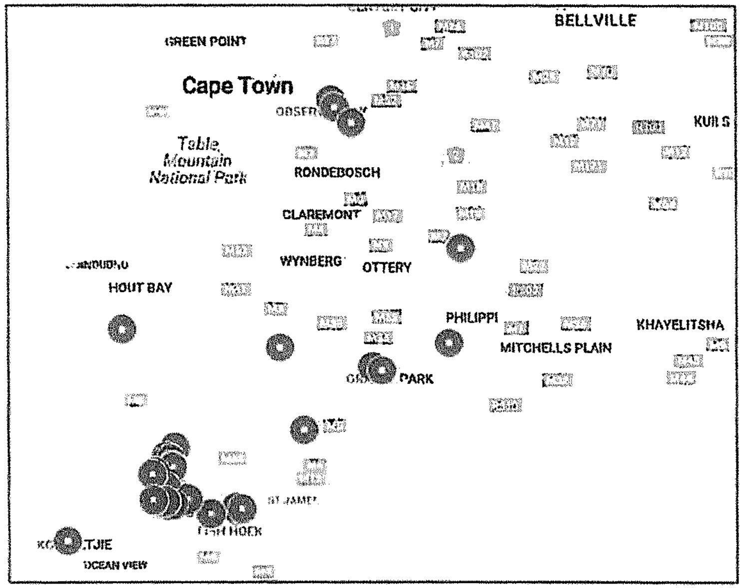

Figure 18: Known WLT breeding localities within the jurisdiction of CoCT (not complete). Note the relative isolation of the northern-most breeding population in the Observatory region.

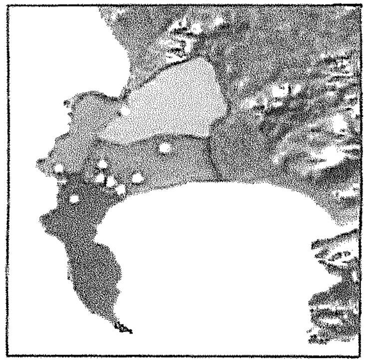

Figure 19: Quaternary catchments (4 polygons) with WLT sampling sites (white dots) within the CoCT Metropolitan Area (from Measey and Tolley 2011).

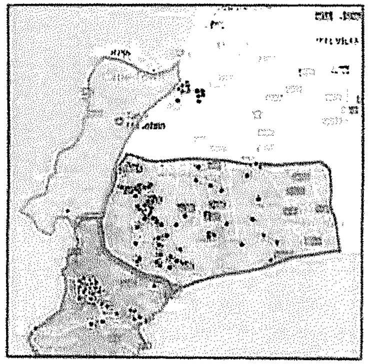

Figure 20: An updated schematic representation of the quaternary catchments (4 polygons), based on the study conducted by Measey and Tolley (2011). Black dots represent WLT records.

5.7 WLT ecological requirements

The following four components are critical for the viability of any WLT population:

__Breeding habitat:__ Availability of suitable breeding wetland habitat is a critical component in the life history of WLTs, and are utilised during the period from approximately late July to middle or late November and sometimes up until early December. Eggs are generally laid during August/September, with the remaining weeks being for the development of tadpoles into metamorphling toadlets. Several WLT breeding habitats within the CoCT Metropolitan Area have been destroyed or degraded in the course of suburban development over the past decades. Conversely, several artificial wetlands constructed here during the past decades have become seemingly suitable as substitute WLT breeding habitats. It is encouraging that the creation of artificial wetland habitats seems to be a viable practical option to increase the breeding potential of WLT populations. In the case of the proposed River Club development project, the RBS wetlands appears to be the primary WLT breeding site. However, the open pans in this area are saline, at least at times (Liz Day pers. comm.) and thus seemingly not suited for WLT breeding. The precise areas at the RBS that are used for WLT breeding need to be determined/investigated during forthcoming WLT breeding seasons. Some of the other existing wetland features (Figure 17) in this area are potential WLT breeding habitat. The proposal to transform the old (western) Liesbeek River into a terrestrial landscape with WLT breeding ponds is a positive development initiative, which may ultimately contribute to the resilience of the Observatory WLT population. However, the presence of breeding habitat alone is not sufficient to safeguard a WLT population.

__Shelter and foraging habitat:__ The availability of habitat to provide for WLT shelter and food requirements is another critical component for the viability of any WLT population. Most of the year adult and juvenile WLTs are not specifically associated with the breeding ponds. After breeding and/or metamorphosis have taken place, the toads disperse away from the wetlands and occupy suitable terrain in the general region. Most toads are likely to remain within about a 0.5 to 1 km radius of the breeding ponds, but it is well known that many will move over 2 km away. Much of the TRUP terrain in its current state consists of short-trimmed grass (lawn), most prominently on the driving range, golf course and SAAO grounds. This is generally suboptimal as WLT shelter/forage habitat, although toads will still visit such terrain. Likewise, the PRASA property in the northern reaches of the TRUP study area is also degraded and not well suited as WLT shelter/forage habitat. The proposal to create substantial sections of habitat to specifically improve shelter and foraging conditions for WLTs within the study area is also a positive development initiative that can increase the resilience of the Observatory WLT population. This would entail a substantial increase of low and medium height vegetation cover, with mixed plant species so that invertebrate (= WLT prey) diversity and abundance would be promoted. The more of this type of habitat available in the area, the greater the prospects for maintaining viable breeding stock in perpetuity. Physical shelters for WLTs can be integrated within

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the landscaped/gardened area. This can be in the form of natural logs, or artificial structures such as pieces of broken pots or ceramic piping cut lengthwise. The improved moisture retention abilities of such shelters should be advantageous to WLTs, and overall survival rate may be boosted. The rational is that by increase the proportion of WLT metamorphlings that mature to adulthood, the overall resilience of the local WLT population would be increased.

Dispersal corridors: With the expansion of urban/suburban communities, it sometimes happens that some faunal communities will become fragmented and isolated. A specific population may end up being split into several smaller subpopulations that can no longer come into contact with each other. This typically happens in species with limiting mobility, and may cause the genetic nonviability of subpopulations. This is certainly of relevance to current day WLT populations too (see for example Measey and Tolley 2011), and thus dispersal corridors are of great importance in maintaining the overall resilience of WLT subpopulations. Any development should also consider the larger scale ecological considerations, instead of only the on-site issues. In the case of the Observatory WLT subpopulation, it appears to be disjunct from other CoCT WLT subpopulations. This in itself is of conservation interest and value, and requires additional studying at the regional scale. In the context of the proposed River Club development, the on-site dispersal corridor needs are primarily to maintain connectivity for east/west migrations (i.e. between RBS and the western Liesbeek region). Details of the shelter/forage sectors and ecological dispersal corridors for this project are presented further below.

Hazardous features and high-risk areas: Over and above the need for habitats to cater for breeding, shelter and diet requirements, and dispersal corridors, it is also important to limit the hazardous components that may hinder WLT mobility or cause WLT mortalities. In a suburban setting, the prevalence of brick or concrete walls present WLTs with a maze of barriers which they can often not pass. Toads thus have to expend greater effort during their dispersal endeavours, and also the options for encountering suitable habitats are reduced. High-risk features include pitfall structures from which toads cannot escape (e.g. steep-sided canals, stormwater drains and swimming pools), and roads with vehicular traffic. These threats and high-risk features are discussed in greater detail below.

5.8 WLT threats

The hazardous features and high-risk areas that were referred to above, can cause significant WLT mortalities. These hazardous features can usually be grouped into one of the following four categories:

Roads/vehicles: WLTs are explosive breeders, which basically mean that they breed for a relatively short period of time each year. During this breeding event, adult toads move from their year-long shelter/food habitats to the breeding ponds. In an urban setting this means that these toads have to cross several roads to get to and fro these habitats. Mortality of the breeding stock caused by vehicular traffic is one of the most significant impacts on WLT populations, and one of the primary reasons why this species is currently listed as being EN. As such, the network of roads associated with the proposed

River Club development will have to incorporate various safeguarding measures to limit or prevent toad mortalities on these roads. Basically, the aim would be to prevent toads from being able to get onto roads, yet at the same time the roads must not restrict the movement of toads between the various ecological sectors. The placement of underpasses in combination with exclusion barrier walls (see Appendix 2) can be employed as an effective mitigation measure to achieve this aim.

Harsh terrain: The most hazardous areas in terms of WLTs are busy roads and pitfall features as outlined above. Additionally, large open (unsheltered) areas such as sports fields and parking areas can also cause substantial mortalities. This is usually caused by dehydration and fatigue, for example when thousands of newly metamorphosed toadlets would inadvertently arrive on such terrain. Greater visual exposure to predators such as crows may also be a contributing factor of toad mortalities under these circumstances. As proposed above for roads and pitfall zones, such inhospitable open terrain can be made off-limits by the strategic placement of exclusion barriers.

Pitfalls: In the course of adult and juvenile toads moving about in a suburban environment, they may encounter steep-sided features into which they can fall and not escape. The most common of these pitfall traps are swimming pools, steep-sided canals and stormwater drains. Falling into such structures may cause mortalities by means of starvation or dehydration or drowning. Developments should in general always be mindful of such hazards, and not only in cases where threatened frogs occur. Such hazards can be minimised by erecting exclusion barriers to prevent access to such features (see Appendix 2), and escaping devices (e.g. Toadsavers in swimming pools) can be installed in most cases. Even very small pitfalls can cause toad mortalities. For example, during the 2016 site visit it was discovered that the small plastic irrigation boxes that are currently present on the River Club golf course are entrapping and killing toadlets. The proposed River Club development must be mindful about the negative impacts of pitfall structures, and must provide escape options wherever these are installed (e.g. stormwater drains).

Obstructions: Solid brick or concrete walls limit the dispersal options of wandering toads. In some instances this may cause large-scale mortalities by dehydration when for example droves of newly metamorphosed toadlings would encounter such a dead-end structure. Where practical, developments should preferably use permeable fencing that does not restrict the movement of small terrestrial animals. Solid walls can also be modified to make it permeable, by providing of a series of pipes/holes through the wall at ground-level. It is of course important to distinguish between barrier walls where permeability is desired (i.e. so as not to hinder toad movements) and barrier walls that are explicitly placed to restrict entry to harsh terrain. The perimeter fencing of the proposed River Club must therefore be permeable at ground level so that WLTs and other small fauna species can move to and fro beyond the TRUP boundaries.

5.9 The River Club development in the context of WLTs

Several general mitigation measures have been formulated during the course of the freshwater, botanical and faunal assessments (2015 – 217), and are based on Alternative 1 (this being the preferred alternative for both the biodiversity team and the development team). The mitigation measures most relevant to the faunal considerations are summarised below:

2. **ECOLOGICAL SECTORS:** Several natural or semi-natural ecological sectors must be provided to serve as shelter/forage habitat for WLTs and other faunal species. These sectors will be landscaped and gardened specifically with the aim of optimizing the conditions for WLT habitation. Some of these ecological sectors may further function as WLT breeding habitat and/or faunal dispersal corridors. The most important ecological sectors are:

- LIESBEEK WEST SECTOR: The historical flow area of the Liesbeek River to the west of the River Club. This sector is earmarked to be converted and landscaped into being more of a vegetated terrestrial landscape, with seasonally flooded wetlands to serve as WLT breeding habitat.
- LIESBEEK EAST SECTOR: The canalised section of the Liesbeek River to the east of River Club. This ecological sector is earmarked to be converted and landscaped into a more natural (not canalised) watercourse with a substantial buffer area (the total river corridor to include an area of width at least 25 m) of lawn and semi-natural vegetation.
- EAST/WEST CORRIDOR: The east/west ecological (or faunal) corridor between the historic and canalised Liesbeek watercourses, as per the current development layout vision. This wide (65-100 m) vegetated green belt will serve as the main linkage between the western Liesbeek sector (and landscaped WLT breeding wetland habitat) and the eastern Liesbeek sector (including RBS and Black River). It will also serve as shelter/forage habitat for WLTs and certain other faunal species.
- NORTHERN SECTOR: the northern undeveloped section (owned by the Passenger Rail Agency of South Africa; PRASA) situated between the golf course and the railway line. This area does not form part of the proposed River Club development. It has good potential to serve as shelter/forage habitat and being an east/west faunal corridor. However, the terrain is currently suboptimal for these functions and would require a landscaping initiative to vegetate it adequately according to faunal (and WLT) requirements.

4. **TOAD-FRIENDLY INFRASTRUCTURE:** Toad-friendly structures (examples in Appendix 2) must be integrated with the proposed development, so that the negative impact on the WLT population can be minimise. The most important examples of such features are:

- EXCLUSION BARRIERS: Low barrier walls or fencing can be used to prevent WLTs from gaining access to hazardous terrain or high-risk areas such as parking lots and roads.
- UNDERPASSES: High-risk areas like roads can be made permeable for toads by means of a combination of exclusion barrier walls to keep toads off roads, and underpasses (e.g. culverts) to allow safe movement of toads between different ecological sectors.

5. **WLT MANAGEMENT & MONITORING:** It is recommended that a WLT management and monitoring programme be drawn up for this proposed development. Ideally the monitoring should start at least one WLT breeding season prior to commencing with the construction phase, and continue up until five breeding seasons after construction has been completed. The main aims

of this monitoring would be to evaluate the success and efficiency of faunal dispersal corridors, ecological shelter/foraging sectors, new WLT breeding habitat, and the toad-friendly infrastructure. Details to be formulated as part of the detailed design phase.

6 CONCLUSIONS

The general finding of this faunal baseline assessment in respect of the site of the proposed River Club development is that this property is not of particularly high conservation value for all three of the faunal groups that were assessed. However, the occurrence of EN WLTs in this area represents a significant exception to this finding. Thus, other than the presence of WLTs here, the development would not have been significantly constrained by faunal issues. Therefore this faunal baseline assessment focused specifically on the potential negative impacts on the Observatory WLT population. It assessed the environmental issues in respect of the River Club site and it provided general mitigation measures to reduce the overall environmental impact of this proposed development. Provided that proper attention is given to the implementation of WLT mitigation measures, it is deemed plausible to achieve the proposed River Club development intentions whilst at the same time adequately catering for WLT and other faunal ecological needs.

1. The existing WLT breeding habitats within the RBS may not be compromised. The creation of additional WLT breeding habitats within the western Liesbeek sector is likely to be a positive contribution in terms of improving WLT breeding success in this area.
2. Enough natural or semi-natural habitat must be available within a 2 km radius of breeding habitats to sustain WLT individuals for the non-breeding period (i.e. about 10 months of the year). Such sectors must provide the adequate shelter and food requirements to sustain the WLTs until the next breeding season. Thus substantial green belts must remain undeveloped, e.g. along the two rivers and especially in the areas near to the Raapenberg wetlands and the northern sector near the confluence.
3. Multiple dispersal options between breeding habitat and year-round occupancy habitat must be maintained, i.e. barriers must be limited. Connectivity must be maintained between the Raapenberg wetlands and the river regions to the west, including the area of the former Liesbeek flow.
4. One broad (>70 m wide) east/west belt must be established in the northern reaches of the property, and additional minor (>10m wide) east/west corridors must be created along the northern and southern site boundaries as well;
5. High-risk zones such as roads, large unvegetated areas and various pitfall structures must be modified to prevent/limit access by WLTs.
6. It is recommended that a WLT management and monitoring programme be drawn up for this proposed development. Ideally the monitoring should start at least one WLT breeding season prior to commencing with the construction phase, and continue up until five breeding seasons after construction has been completed. The main aims of this monitoring would be to evaluate the success and efficiency of faunal dispersal corridors, ecological shelter/foraging sectors, new

WLT breeding habitat, and the toad-friendly infrastructure. Details to be formulated as part of the detailed design phase, if approved.

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8 APPENDIX 1: SPECIES CHECKLISTS

Table 4: A checklist of mammals that are known from or likely to occur at the River Club grounds and immediate surroundings. Conservation status according to IUCN and local (SA; Child *et al.* 2016) listings include the following: Least Concern (LC) and Near Threatened (NT). Endemism is as follow: Endemic to South Africa, Lesotho and Swaziland (SA), endemic to Western Cape (WC). Scoring for likelihood of occurrence: Possible occurrence (1), probable occurrence (2) and confirmed occurrence (3). Confirmed records were provided by Burger (2017), Helme (2016) and Ramsay (2017).

Scientific name	English name	IUCN/SA	Endemism	Occur	Notes
Chrysochloridae	**Golden moles**				
Chrysochloris asiatica	Cape Golden Mole	LC/LC	SA	3	Ramsay (2017)
Leporidae	**Hares & rabbits**				
Lepus capensis	Cape Hare	LC/LC	0	1	
Muridae	**Old World rats, mice & gerbils**				
Otomys irroratus	Southern African Vlei Rat	LC/LC	SA	3	Burger (2017); Helme (2016)
Rhabdomys pumilio	Xeric Four-striped Mouse	LC/LC	SA	3	Burger (2017); Helme (2016); Ramsay (2017)
Mus minutoides	Pygmy Mouse	LC/LC	0	3	Burger (2017)
Desmodillus auricularis	Short-tailed Gerbil	LC/LC	0	1	
Gerbilliscus afra	Cape Gerbil	LC/LC	near WC	3	Burger (2017); Helme (2016)
Hystricidae	**Old World porcupines**				
Hystrix africaeaustralis	Cape Porcupine	LC/LC	0	3	Burger (2017); Helme (2016); Ramsay (2017)
Bathyergidae	**African mole-rats**				
Bathyergus suillus	Cape Dune Mole-rat	LC/LC	WC	3	Helme (2016); Ramsay (2017)
Georychus capensis	Cape Mole-rat	LC/LC	SA	3	Helme (2016); Ramsay (2017)
Cryptomys hottentotus	African Mole-rat	LC/LC	0	2	
Soricidae	Shrews				
Crocidura cyanea	Reddish-Grey Musk Shrew	LC/LC	0	2	
Crocidura flavescens	Greater Red Musk Shrew	LC/LC	near SA	3	Helme (2016)
Myosorex varius	Forest Shrew	LC/LC	SA	2	
Suncus varilla	Lesser Dwarf Shrew	LC/LC	0	2	

Table 4 (continued)

Scientific name	English name	IUCN/SA	Endemism	Occur	Notes
Pteropodidae	**Fruit bats**				
Rousettus aegyptiacus	Egyptian Fruit Bat	LC/LC	0	1	
Rhinolophidae	**Old World horseshoe & leaf-nosed bats**				
Rhinolophus capensis	Cape Horseshoe Bat	LC/LC	near SA	1	
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	LC/LC	0	1	
Nycteridae	**Slit-faced bats**				
Nycteris thebaica	Egyptian Slit-faced Bat	LC/LC	0	1	
Molossidae	**Free-tailed bats**				
Tadarida aegyptiaca	Egyptian Free-Tailed Bat	LC/LC	0	1	
Miniopteridae	Long-fingered bats				
Miniopterus natalensis	Natal Long-Fingered Bat	LC/LC	0	1	
Vespertilionidae	Plain-faced bats				
Eptesicus hottentotus	Long-Tailed Serotine Bat	LC/LC	0	2	
Myotis tricolor	Temmink's Myotis Bat	LC/LC	0	1	
Neoromicia capensis	Cape Serotine Bat	LC/LC	0	2	
Viverridae	Genets & civets				
Genetta genetta	Small-spotted Genet	LC/LC	0	3	Helme (2016)
Herpestidae	Mongooses				
Herpestes pulverulentus	Cape Grey Mongoose	LC/LC	0	3	Helme (2016); Ramsay (2017)
Atilax paludinosus	Water Mongoose	LC/LC	0	3	Burger (2017); Helme (2016); Ramsay (2017)
Mustelidae	Weasels, badgers, otters & relatives				
Ictonyx striatus	Striped Polecat	LC/LC	0	1	
Aonyx capensis	African Clawless Otter	NT/NT	0	3	Helme (2016); Ramsay (2017)

Table 6: A checklist of amphibians that are known from or likely to occur at the River Club grounds and immediate surroundings. Conservation status according to IUCN and local (SA) listings include the following: Least Concern (LC), and Endangered (EN). Endemism is as follow: Endemic to South Africa, Lesotho and Swaziland (SA), endemic to Western Cape (WC). Scoring for likelihood of occurrence: Possible occurrence (1), probable occurrence (2) and confirmed occurrence (3). Confirmed records were provided by Burger (2017) and Ramsay (2017).

Scientific name	English name	IUCN/SA	Endemism	Occur	Notes
Bufonidae	**Toads**				
Sclerophrys capensis	Raucous Toad	LC/LC	SA	1	Feral population known from Observatory
Sclerophrys pantherina	Western Leopard Toad	**EN/EN**	WC	3	Burger (2017); Ramsay (2017)
Vandijkophrynus angusticeps	Sand Toad	LC/LC	SA	3	Ramsay (2017)
Pyxicephalidae	**Pyxicephalid frogs**				
Amietia fuscigula	Cape River Frog	LC/LC	SA	2	
Cacosternum platys	Flat Caco	LC/LC	WC	1	
Strongylopus grayii	Clicking Stream Frog	LC/LC	0	3	Burger (2017); Ramsay (2017)
Tomopterna delalandii	Cape Sand Frog	LC/LC	SA	2	
Pipidae	**Pipid frogs**				
Xenopus laevis	Common Platanna	LC/LC	0	3	Burger (2017); Ramsay (2017)

9 APPENDIX 2: TOAD-FRIENDLY STRUCTURAL DEVICES

Underpasses: Safe-passing options for roads are available in the form of underpasses (Figures 22 to 26). For these to be most effective, roads would have to be somewhat raised to accommodate an underpass of about 30 cm (or more) in height. Additionally, the underpass roof should ideally be open to the surface, i.e. with a gridded top. However, gridded underpasses can be alternated with more simple structures such as under-road piping. Underpasses should be plentiful, preferably not less than at 15 to 20 m intervals. Underpasses should be used in conjunction with exclusion barriers (aka drift-fences) to maximise their functionality (see below).

Exclusion barriers: The main aim of exclusion barriers is to prevent access to harsh/hazardous terrain, e.g. roads and parking areas. Additionally, exclusion barriers may also serve as drift-fences to direct animals towards safe-crossing options such as underpasses (Figures 22 to 26). Some example of exclusion barrier designs are presented in Figure 21.

1. Straight wall with horizontal lip on right side, to deter access to the left area.
2. Straight wall with angled lip on right side, to deter access to the left area.
3. Wall angled to right, to deter access to the left area.
4. Straight wall with ramp on right and horizontal lip on right side, to deter access to the left area and allow access to the right area.
5. Fence structure curved to the right, to deter access to the left area.

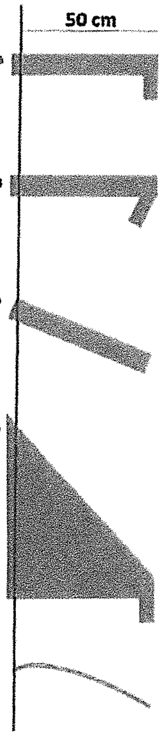

Figure 21: Profiles of barrier design options for the control of WLT movements: (1) Straight wall with horizontal lip on right side, to deter access to the left area. (2) Straight wall with angled lip on right side, to deter access to the left area. (3) Wall angled to right, to deter access to the left area. (4) Straight wall with ramp on right and horizontal lip on right side, to deter access to the left area and allow access to the right area. (5) Fence structure curved to the right, to deter access to the left area.

Cattle-grid structures: In certain situations (i.e. road entrance to parking areas), cattle-grid structures (Figure 29) can be used to prevent toads from accessing hazardous areas. The grid spaces must be wide enough for toads to drop through into a tunnel that will redirect to and open up in a safe area. These structures probably have greater application on roads for vehicular traffic, and would probably be undesirable (not practical) on paths/pavements with pedestrian traffic.

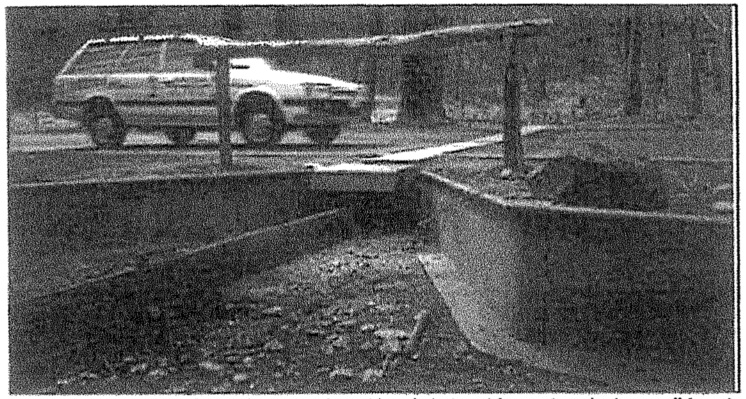

Figure 22: An example of an underpass with a grid roof, designed for toads and other small faunal species. The entrance/exit points are fringed with steep-sided walls to direct faunal movements.

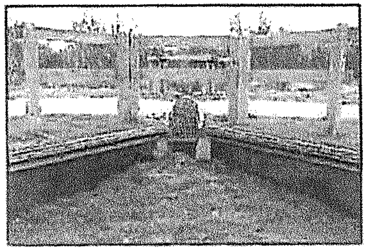

Figure 23: Underpass with a grid roof and directing walls.

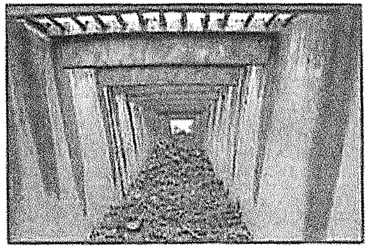

Figure 24: Underpass with a grid roof.

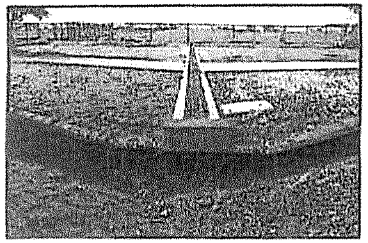

Figure 25: Underpass with a grid roof, designed for toads and other small faunal species.

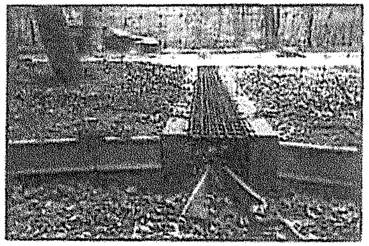

Figure 26: Underpass with a grid roof, designed for toads and other small faunal species.

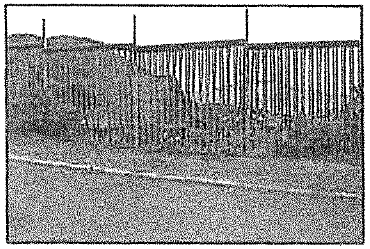

Figure 27: An example of permeable toad-friendly fencing in a residential setting.

Figure 28: Example of permeable toad-friendly fencing.

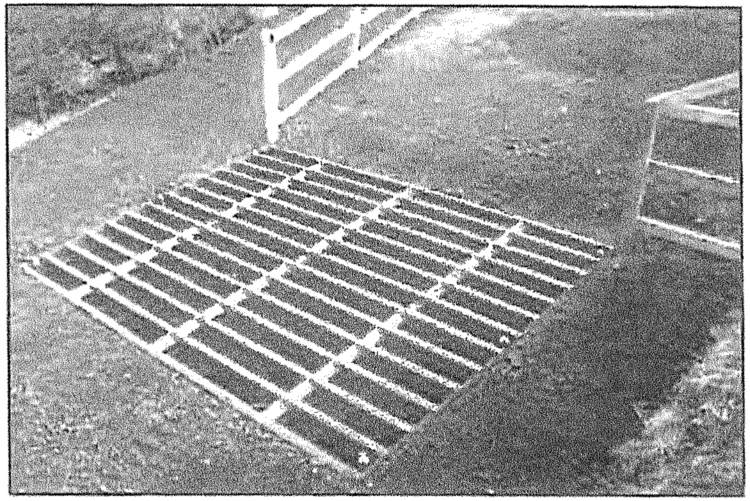

Figure 29: An example of a cattle-grid structure that can be used strategically to prevent toads from entering specific hazardous areas, and to redirect them by means of tunnels to safe terrain.

APPENDIX C

SPECIALIST GEOHYDROLOGICAL REPORT

srk consulting

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08 November 2017
478320- River Club EIA

Mr Matthew Law
SRK Consulting (South Africa) (Pty) Ltd
The Administrative Building
Albion Spring
183 Main Road
Rondebosch
7700

Attention: Mr Law

Dear Sir

Comments on Groundwater at the River Club

1 Introduction

SRK Consulting (South Africa) (Pty) Ltd (SRK) Groundwater Department was requested to comment on the underlying geohydrology at the River Club site, located on the banks of the Liesbeeck River, Cape Town.

The need for specialist comment was to address the following specific issues:

- Based on detailed survey information for the site and adjacent watercourses, as well as publically available desktop information, describe local groundwater hydrology at the site and in adjacent freshwater systems;
- Comment on the degree to which the Raapenburg wetlands are fed by the groundwater table versus floodflows; and
- Comment on potential changes to the groundwater flow regime from developing the River Club (noting that the current elevation of the site will generally be the ground level of a basement of the new proposed development).

2 Data

The following data sources were used to assess the groundwater at the River Club:

Geotechnical Report by Kanley and Templer: K&T PROJECT REFERENCE: 14887GG February 2016

The following data were used:

- Borehole and test pit logs; and
- Groundwater level measurements at the boreholes and test pits.

River Channel Survey by Biff Lewis Geomatics dated 23/01/2015.
Data used include:

- Water level heights (mamsl) survey of the Black River; and
- Water level heights (mamsl) survey of the Liesbeeck River.

Raapenburg Wetland Survey (2017).
Data used:

- Water level heights survey of the Black River;
- Water level heights survey of the Liesbeeck River;
- Water level heights survey of surface water in the Raapenburg Wetland; and
- Electrical Conductivity readings of the Black River and wetlands.

3 Discussions

Water Levels

Kantey and Templer drilled four boreholes at the River Club as part of the geotechnical investigation. The depth of the boreholes range between 7.8 m and 16.3 m. **Figure 1** shows the borehole positions (yellow squares), and the measured water levels are shown in MAMSL. The water levels range between 1.62 and 2.02 mamsl. The blue squares are the water level at the Liesbeek and Black Rivers and range between 1.28 and 1.65 mamsl. The groundwater levels at the River Club measured at the deeper boreholes are higher in elevation than the water level in the Rivers, indicating groundwater flow towards the Rivers. It should be noted that these boreholes were drilled into bedrock and could possibly represent some piezometric level influence of a deeper aquifer.

srk consulting	RIVER CLUB EIA Position of the deep boreholes with water level (mamsl)	Project No. 478320

Figure 1: Positions and water levels of boreholes

Figure 2 shows the positions of test pits where water levels were measured. The water levels range between 0.8 and 1.6 mamsl and are lower than the water levels in the Rivers, again suggesting groundwater flow towards the rivers.

Interesting to note is that the River Club has a fill layer of 1.5 to 2 m thickness, underlain by sediments, which are in turn underlain by bedrock (shale). The water levels measured are mainly at the contact between the fill and sediments. Before the diversion channel was build, the northern part of the River Club was part of the Raapenburg Wetland, which explains why the water table are at the contact with the fill material.

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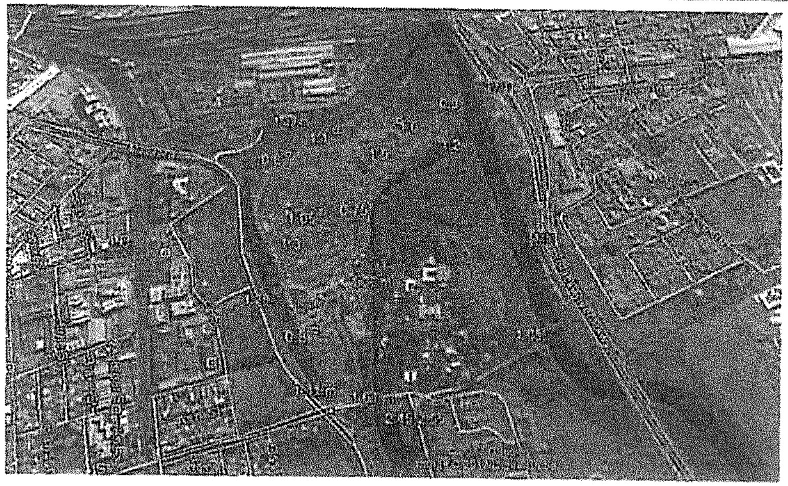
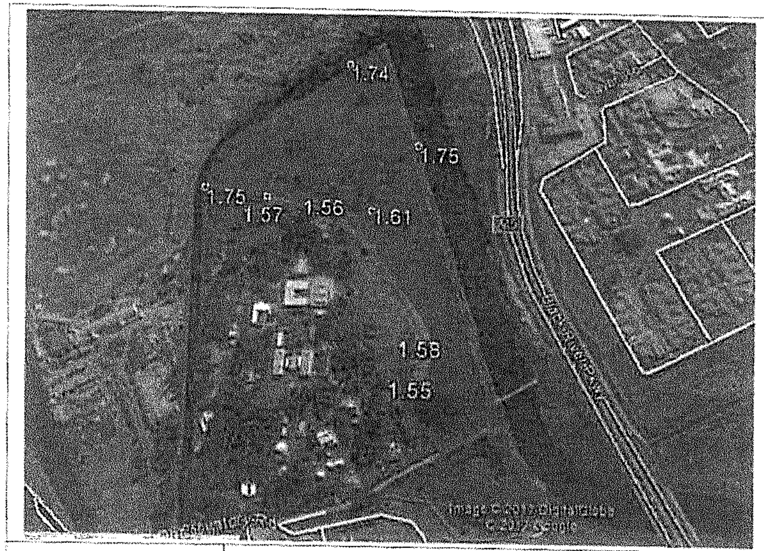


srk consulting	RIVER CLUB EIA Position of the test pits with water level (mamsl(	Project No. 478320

Figure 2: Positions of test pits and measured water levels (mamsl)

Figure 3 shows the surveyed water levels for the Raapenburg Wetlands and adjacent Rivers. The results indicate that flow is from the Black and Liesbeek Rivers to the Wetlands. It is also noted that the water levels measured in the wetlands are higher than the water levels measured at the test pits and are therefore considered to be upgradient from the River Club.



srk consulting	RIVER CLUB EIA Water level measurements at the Raapenburg Wetlnads	Project No. 478320

Figure 3: Water level measurements at the Raapenburg Wetlands

Electrical Conductivity

The Electrical Conductivity of the groundwater, wetlands, Liesbeek River and Black River were measured, and the data is presented in **Table 1**. The EC of groundwater and the Wetlands are substantially higher than the EC of the two rivers suggesting the water in the wetlands is mainly groundwater.

Table 1: Measured EC (mS/m)

Water Type	EC (mS/m)
BH1	2985
BH2	4099
BH4	851
Black River	110
Liesbeek River (canal)	35
Liesbeek (Back Water)	53-858
Raapenburg Wetland	2800

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4. Conclusion

The water level and EC data indicate that the water in the Raapenburg Wetlands is mainly groundwater, and that flow from the rivers towards the Wetlands is minor.

In the past, the River Club was part of the Raapenburg Wetlands. The building of the Liesbeek diversion channel changed the hydrology and has created two separate systems. This considered, it is likely that the diversion channel will act as a buffer to activities on the River Club side, and the Wetland is geohydrologically up gradient of the River Club Site. This demonstrates that extensive development at the River Club site will not affect groundwater flow to the Wetlands.

There is insufficient data to comment with confidence on the nature of surface/groundwater interaction, as the river water levels are higher than groundwater levels, but the EC of the rivers is considerably lower than the groundwater. It would therefore be expected that if there was inflow from the rivers to the wetlands that a much lower EC would have been recorded at the wetlands.

Yours faithfully,

SRK Consulting

SRK Consulting - Certified Electronic Signature
srk consulting

SRK Consulting - Certified Electronic Signature
srk consulting
478320/45036/Letter Report
4835-1557-7556-ENGE
This signature has been printed digitally. The Author has given permission for its use for this document. The details are stored in the SRK Signature Database

Leon Groenewald Pr. Sci. Nat. CPM

Principal Hydrogeologist

Bruce Engelsman Pr Eng Pr

Partner

APPENDIX D

SPECIALIST AVIFAUNAL (BIRD) REPORT

Report provided by Dr Tony Williams

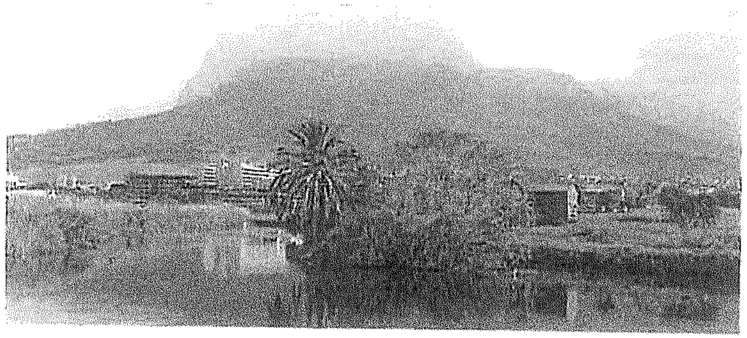
Note:

This report was based on a study area comprising the entire area as defined between Observatory Road, the natural channel of the Liesbeek River from Observatory Road to the Black River confluence and the Liesbeek River Cabal.

Following this input, the study area was redefined as excluding the SKA site and extending only to the Berkley Road road reserve.

Given the low sensitivity of the site from a bird perspective, the specialist was not asked to revise this report.

BIRD REPORT FOR THE RIVER CLUB



View towards the junction of the Liesbeek canal and the Black River with the River Club bird hide, roosting trees, and small mudbank

Prepared by Dr A.J. Williams

Dr Williams Bird Surveys

July 2015

EXECUTIVE SUMMARY

This report is in two sections. The first deals with the current situation regarding birds in the River Club area (hereafter RCA). The second section considers how provision of habitat for birds can enhance the value of the proposed new development and how such provision can compensate for any potential loss of development opportunity.

Section 1: The entire River Club area (hereafter RCA) has been transformed from its original state. About a third of it has been seriously degraded by the dumping of rubble and fill onto former floodplain. Apart from the open water there are now few habitat patches of value for birds. In contrast the immediately adjacent Raapenberg nature reserve, though of a far smaller area, has a higher value for birds. The birds of greatest interest, and conservation significance, are waterbirds. In both inspection visits two species of conservation significance were recorded. Situated at the juncture of the Liesbeek and Black Rivers the RCA has excellent wetland linkages across the centre-north of the Cape Town metropol.

Section 2: At present – without better understanding of the proposed commercial intentions – it is difficult to do other than suggest potential features that could enhance the terrestrial area for birds. Two principal approaches are recommended – 1) provision of a peripheral "Apron" with trails; and 2) creation of new managed wetland habitats on the outer part of the in-filled area along the bank of the Black River. The suggested features would primarily provide desirable green amenity features. It is indicated how these could have significant commercial benefits.

Apron and trails: It is not considered appropriate to construct buildings right beside the main water channels (rivers and canal) but set-back sufficiently to enable natural landscaping and the provisions of trails between the buildings and the waterbodies. It is recommended that this apron, managed by a property owners association, be broad enough to encompass two separate recreational trails. The "relaxation" trail would wind through naturally landscaped areas nearer the water. It would be suitable for strollers, wheelchairs etc. Offshoots would be provided at intervals to the water's edge where seats would provide seating for visitors or there might be screened viewing of wildlife. Clumps of bushes or trees would provide visual separation of the two trails and of human groups along the relaxation trail. These bush clumps would provide habitat for wildlife. Natural vegetation in the apron will improve outward views from the buildings and enhance property values. Closer to the buildings an "activity" trail would be provided for joggers or cyclists, activities that would otherwise disturb slower travellers and wildlife. These trails would provide circuits around the outer areas of the RCA whilst being routed to minimize disturbance to wildlife.

Wetland habitats: Removal of infill from part of the currently uncultivated, river junction, areas beyond the golf course could enable the creation of patches of managed wetland habitats. The fill removed could be used to reduce flood risk on the commercially developed area. Through judicious removal of fill a complex of wetland habitats can be created. This would be attractive to birds and other wildlife (e.g. otters and threatened Leopard Toads). Provision of suitable bird breeding features – e.g. breeding banks for kingfishers, breeding platforms for herons etc. - and of viewing facilities for visitors - e.g. hides and an observation tower - could make this area a considerable attraction for birders, photographers, eco-education purposes, and just for people to relax and enjoy.

These two broad suggestions would benefit the overall development by: 1) easing development approval - through appropriate provision of environmental and social amenities; and 2) increasing the value of properties.

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1 INTRODUCTION

The controlling company of the River Club Area (hereafter RCA), in the Observatory district of Cape Town, has the intention of undertaking the development of commercial buildings on part of the club area. Apparently the concept is for an office park. At this stage no information has been provided on the proposed layout and the parts of the overall area to be affected.

This bird report has been commissioned to document the current 1) status and importance of birds relative to local and regional contexts: and 2) habitats in the RCA of importance for birds. In addition to 3) indicate opportunities and constraints to guide the future planning of development and provide recommendations for the layout and footprint.

2 THE BASIC APPRAISAL

2.1. THE AREA

Riverine situation: The RCA lies between the channel and canal branches of the Liesbeek River and their conjunction with the Black River. These waterbodies, though peripheral to the RCA property, are the dominant environmental factors that have affected the past, and will have a substantial impact on potential future, development of the RCA, as well as being the key feature for birds in and around the RCA.

The waterbodies which border the RCA are subject to different flow regimes. The Black River results from high lowland ground water levels, now coupled with inflow from urban run-off and the upstream Athlone sewage treatment plant. It is a relatively stable system. The Liesbeek River is more volatile. It originates from mountain streams and now, especially, urban run-off and its flow changes radically in relation to rainfall events. Consequently the Liesbeek is subject to more irregular flows than the Black River. The lower Liesbeek is divided into two waterlines a short distance upstream of the RCA. Most flow is now in the canal which runs along the south-eastern side of the RCA. Flow through the original channel, that forms the north-east boundary of the RCA is now greatly reduced. One result of the reduced flow is shallowing of the channel which has facilitated invasion by, largely alien, aquatic plants that now block parts of the waterbody.

Flooding: The RCA lies just inland of regular tidal influence. The RC area must formerly have been a low floodplain about 1 m above normal flow (equivalent to the opposite bank of the Black River). Formerly the terrain and vegetation would have been bio-engineered by hippopotamuses. Downstream there would have been estuarine conditions where during high flow the river could spread over adjoining coastal lowland. The former estuarine environment has been constrained by infilling for the Culemberg rail yard and the industrialized area of Paarden Island. The situation has been exacerbated by the concrete canalization of the river from immediately downstream of the RCA. As a consequence flow backup has likely caused increased flooding in the RCA/M5 area which is the first downstream area where the river has an opportunity to overflow. As a result of continued global warming sea level will rise so there an increasing frequency of flooding can be expected in these lower reaches of the Black/Liesbeek Rivers. Floods particularly occur in September when, after winter rains, the water table is raised and equinoctial spring high tides block river flow into the sea.

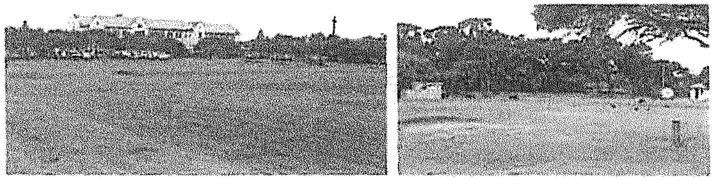
To reduce the threat of flooding the RC area has been progressively elevated over the years by infill. This has continued to recent times. Despite the infill the water table remains high across the RCA. Probably it is elevated in part by the clay substrate which underlies the infill. The heightened water table facilitates flooding when flow increases in the adjoining rivers. Consequently flood risk at 1-5 year intervals occurs across much of the RCA. Flood risk has been a major constraint on past development of the RCA hence the lack of former building development and the restriction to its use for a golf course. Alternatively, flooding can be seen as beneficial in that, with the improved economic potential of the site, an open field situation is now available for commercial development.

In ecological terms the Black River, which is broader and more stable offers the greatest potential for birds. The Liesbeek canal is sterilized by walls and is richest where the walls give way to "natural" banks near its confluence

with the Black River. Weak flow in the Liesbeek has resulted in shallowing and clogging aquatic plants. These plants inhibit most bird use of the clogged waterbody.

2.2. AREA DEMARCATION

For convenience and clarity this report is based on consideration of the RCA in terms of four areas. These areas are: 1) the "Entry" area south of the River Club buildings (Figs. 1 & 2); 2) the "Core" or manicured Golf Course area (Fig. 3) ; 3) the "Rough" the currently un-manicured area of infill between the Golf Course and the junction of the Liesbeek and Black Rivers (Figs. 4 & 5) and 4) the "Periphery" – a belt, approximately 8-10 m broad, beside the open water channels of the Liesbeek, canal, and Black River (Fig. 6) ;. There is overlap between the Peripheral and Rough areas.



Figs.1 & 2: The Entry area: This is effectively sterile for birds except where there are thickets though these are too small in area to support more than offshoots of birds from the better vegetated observatory area

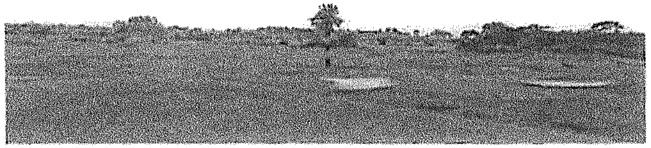


Fig. 3: The manicured Core area is also effectively sterile for most birds as it lacks plant diversity and structure, and is heavily disturbed

Fig.4: Part of the Rough area – currently unused, except for occasional dumping.

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Fig. 5: Another view of the Rough area. The low growth of the alien acacias suggests this area has only been available for plants for a short period i.e. infilling is quite recent'

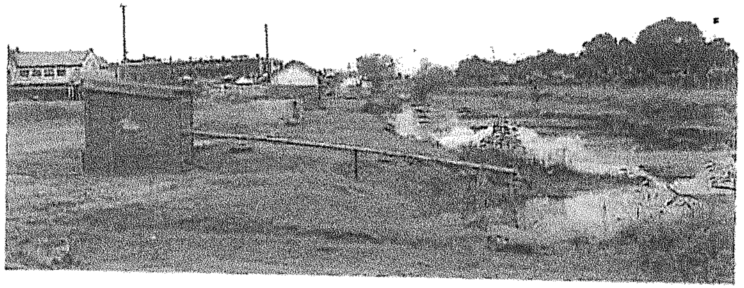

Fig. 6: The peripheral area abutting the Liesbeek channel. This area is currently used for maintenance and both banks are visually unappealing

Fig. 7. The Liesbeek Canal periphery: sterile edges an ugly corrugated "wall". Birds from the more naturally vegetated Observatory shore probably range into the few patches of appropriate habitat in the RCA

This report is primarily concerned with the Periphery and Rough areas on the assumption that commercial developments will be wholly or largely confined to the Entry and Core areas. Neither the Entry nor the Core areas are of current importance for birds. Without knowledge of the proposed commercial developments any comment on how these central areas might be made more attractive to birds is superfluous.

2.3. BIRD AND PHOTOGRAPHIC SURVEYS

To appreciate the RCA with its constraints and potential the area was visited with Dr Liz Day on 29th June 2015 from 09.30-12.30. A second visit was made from 11.00-12.30 on 8 July to reconsider bird presence and to re-assess concept proposals developed following the initial visit.

During the June visit 32 species of birds were recorded. Most of them were water-related. This total included two red-data (conservation priority) species both rated as near-threatened. These were a Great White Pelican in the Liesbeek channel (Fig. 8) and Greater Flamingos which were seen both in the adjacent Raapenberg reserve and in flight over the River Club. Two less often observed species recorded were Little Bittern and African Black Duck. In the July visit an additional 9 species of birds were recorded, most again were water related. On this visit a flock of 35 Greater Flamingos were near the RCA edge of the Black River just off the bird hide (Fig. 9), and a pelican was again in the Liesbeek channel.

Fig.8. A Great White Pelican (rated near –threatened in South Africa) seen on the Liesbeek in both June and July

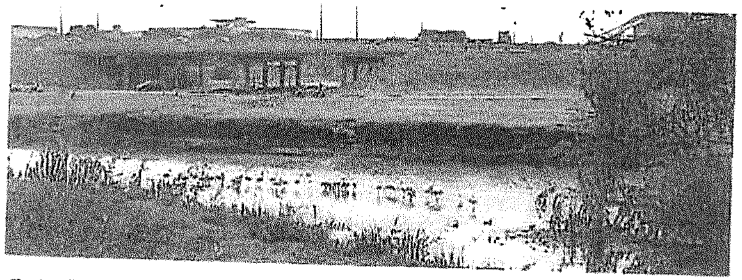

Fig. 9. A flock of 35 Greater Flamingos (rated near-threatened in South Africa), ducks, a moorhen and, in the trees, resting cormorants and a heron, seen from the bird hide. This is the most important area of bird habitat

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in the overall River Club area. Note the floodplain level of the opposite bank. This probably indicates the original level of the RCA. Note also the pipe which conveys urban run-off into the Black River.

In the Western Cape waterbirds tend to disperse to ephemeral wetlands as soon as winter rains cause temporary local flooding. Consequently the number and diversity of waterbirds seen during the two visits are likely to be lower than would occur in the summer when ephemeral wetlands have dried out and waterbirds are restricted to the use of permanent wetland areas such as the river channels around the RCA.

The current significance of the RCA for birds resides in the attraction of the peripheral waterbodies for waterbirds and their sometime use of the RCA banks for roosting. Waterbird use of the area is heavily influenced by the availability of wetland habitats in the Raapenberg Nature Reserve which is located on the opposite bank of the Liesbeek canal. The major drawback of the area for waterbirds, despite reasonable foraging areas and apparent food availability, is the lack of safe, undisturbed breeding habitat for the larger species. This situation applies along the greater part of the two rivers. The nearest significant breeding populations of larger waterbirds are at Intaka Island in Century City and at Rondevlei, near Grassy Park.

2.4. IMPORTANCE

The total area of wetlands remaining in the Western Cape is less than 0.5% of the province. The junction of the Liesbeek and Black River channels is a focal point in the wetland systems of central-north Cape Town. The conjoined Black-Liesbeek River is ecologically linked via Zoar Vlei to the Diep River system that extends northwards to beyond Malmesbury and includes the Rietvlei nature reserve, a registered Internationally Important Bird Area (IIBA). The only other significant wetlands in this centre-north area of Cape Town are at or near Century City: Intaka Island nature reserve wetlands; a large detention "pond"; and, just east of Century City, the pan between the N1 and the railway line. The wetland system of southern Cape Town – based on the False Bay Eco-park (Rondevlei- Seekoevlei-Strandfontein- Sandvlei and associated streams) is within ready flight distance for most waterbirds that use the northern Liesbeek-Black-Diep river wetlands.

The importance of the RCA for birds is in the open water and the abutting waters-edge habitats which together provide a range of micro-habitats for specialist foragers.

The majority, 21 of 33species, of the birds recorded in the two visits were related to wetland habitats, and these included several species of provincial conservation interest in addition to the two nationally rated conservation species.

The Cape Bird Club has an outing to the area planned for 18 August. This indicates established appreciation of birds in the riverine areas of the RCA. Members of the conservation committee of this bird club are likely to represent BirdLife South Africa as an I&AP for any pre- development EIA process.

2.5. HABITAT SENSITIVITIES

The greater River Club area has been both transformed and substantially degraded relative to the predicted natural situation prior to European-related regional developments. There is scarcely any habitat in the River Club area, other than the open water bodies, that can be currently considered important from a bird perspective although semi-sensitive habitats abut the area on the outer banks of the two defining water channels i.e. the Raapenberg Nature Reserve and the strip of land between the Culemberg rail-yard fence and the Liesbeek channel. The only patches of habitat currently within the RCA that merit preservation are the trees on the palm islet opposite the bird hide and the willows along the canal (see Figs. 10 and 113). Other isolated trees along the river bank are also of value as perches.

Figs. 10 &11: The two groups of trees used by Darters and Cormorants as day roosts. Palm Islet, on the left, is opposite the existing bird- hide. The willows, right hand picture, are a short way along the canal from the bird hide. These are the two habitat patches that most deserve preservation.

List of birds identified in the RCA – June 2015

Vernacular name	Scientific name
Little grebe	*Tachybaptus ruficollis*
White-breasted Cormorant	*Phalacrocorax carbo lucidus*
Grey Heron	*Ardea cinerea*
Purple Heron	*Ardea purpurea*
Little Egret	*Egretta garzetta*
Greater Flamingo	*Phoenicopterus ruber*
Sacred Ibis	*Threskiornis aethiopicus*
Hadeda Ibis	*Bostrychia hagedash*
Glossy Ibis	*Plegadis falcinellus*
Great White Pelican	*Pelecanus onocrotalus*
Egyptian Goose	*Alopochen aegyptiaca*
Black Duck	*Anas sparsa*
Yellow-billed Duck	*Anas undulata*
Cape Shoveler	*Anas smithii*
Moorhen	*Gallinula chloropus*
Red-knobbed Coot	*Fulica atra*
Blacksmith Lapwing	*Vanellus armatus*
Little Bittern	*Ixobrychus minutus*
African Black Duck	*Anas sparsa*
Three-banded Plover	*Charadrius tricollaris*
Red-eyed Dove	*Streptopelia semitorquata*
Laughing Dove	*Streptopelia senegalensis*
Speckled Pigeon	*Columba guinea*
Malachite Kingfisher	*Alcedo cristata*
Pied Kingfisher	*Ceryle rudis*
Giant Kingfisher	*Megaceryle maxima*
Hartlaub's Gull	*Larus hartlaubii*
Kelp Gull	*Larus dominicanus*
Cape Wagtail	*Motacilla capensis*
Cape Robin-Chat	*Cossypha caffra*
Cape Sparrow	*Passer melanurus*

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2.6. OPPORTUNITIES

Birds focus: Birds are the most easily appraised surrogate for the assessment of biodiversity. Based on the commissioning of this report it is assumed that the developers have an interest in increasing the attractiveness of the overall RCA for birds. Given the transformed nature of the entire area almost any action to improve the "natural" environment will be beneficial. To improve the area for birds (as a surrogate for the health of natural environments as well as for other wildlife) would, as a sole aim, not be cost effective nor worthwhile for the developer. Habitat for birds and wildlife will only be accommodated it they provide suitable value to the overall development. How birds can benefit from environmental and associated social values is considered in Section 2 of this report.

Habitat benefits for birds usually provide profit for other, less often appreciated, forms of wildlife. This report suggests how, by creating managed "natural" habitats that are attractive to birds the Periphery and Rough areas can be made more attractive as a green amenity.

3 COST COMPENSATING ENVIRONMENTAL OPPORTUNITES

3.1. THE PLANNING APPROVAL STAGE

Planning approval: Application to develop a green area beside wetlands and a nature reserve will require an EIA. Objections are likely from environmental I&APs: city conservation authorities; BirdLife South Africa through the Cape Bird Club conservation committee; and from the NGO Friends of the Liesbeek. Conservation groups tend to be anti-development. The objections relative to environment issues, and this "bird" report, are likely to fall under four categories.

1) The affects the proposed developments may have on the functioning of the existing waterbodies
2) Loss of potentially valuable wetland –associated habitat: through the footprint as well as associated negative impacts – e.g. disturbance, and loss of wildlife use of waters-edge areas
3) Possible negative carry-over effect on birds in the Raapenberg Nature Reserve which may lose foraging areas in or adjacent to the RCA
4) Perception that there will be loss of this urban "green lung", even though, for the non-golfing public. this is largely visual and mental feature.

Pre-emption of these likely objections can hasten planning approval - with accordingly reduced costs. Pre-emption requires pro-active planning to ameliorate or negate the objections. To do so some environmental compensation will have to be offered. Done appropriately such compensation can be potentially of considerable monetary value, to the proposed development, as well as, incidentally benefit birdlife. Hence the following.

Water functioning: This topic pertains to freshwater expert(s) & geo-engineers. Here it is assumed that there will be little change to the status quo and that any changes will be positive in terms of wetland functioning. Increased flow in the Liesbeek channel (not canal) will be beneficial to this outer boundary of the property.

Wildlife habitats & waterbirds: Responses strongly urged are for

i) Provision of an **apron of natural habitats** between buildings and riverine waterfronts

ii) Creation of a **mosaic of managed wetland habitats** in part of the existing "rough" area to reciprocate the Raapenberg Nature Reserve and especially to provide needed breeding places for waterbirds at this nodal location.

Social benefits: The aprons and wildlife habitats will provide improved aesthetics. Provision can be made within the apron for safe recreation, both active and passive, including for property occupiers as well as through controlled access for the local public, schools, and pensioners.

3.2. COST ISSUES

If sections of the RCA are to be set aside for environmental "compensation" the developer will seek legitimate recompense for the loss of potentially developable areas and for costs incurred in providing the indicated environmental and social features.

How funded: Compensation will be derived from:

a) Readier/ less contested, faster, planning approval which can save litigation, and retain investor interest
b) Higher sales/rental values from properties that overlook water and natural habitats (as known from Century City).
c) Vegetation masking of uglier external urban vistas – e.g. Culemberg rail-yard - will increase sales /rental values from properties that face such vistas. .
d) The positive image from demonstrated environmental and social responsibility will make it easier to market properties and rentals.
e) Property levies to a Property Owners Association which will fund management of the non-footprint areas.
f) A small entry fee charged for public access (to ensure an acceptable standard of visitor i.e. no undesirables, as well as to cover control/collection costs.

Relative to the multiple millions of rands required to fund re-sculpturing of the terrain to resolve flooding issues, as well as for new infrastructure and buildings, the cost for the proposed environmental/social features is miniscule. The social, environmental and monetary values added should more than compensate for the costs whether direct or through lost opportunity.

These suggestions imply a reversal from the current, central area focused, approach to management of the RCA for which the waterside areas are negative features to a management plan that recognizes the value, with considerable financial rewards, from provision of natural waterside habitats.

Promise an **Environmental Management Plan** – Create an independent advisory committee to pre-empt/ represent broad IAP interests. This should be formed before planning approval is sought. Experience is that such a committee, if taken into confidence by the developer, tends to act to positively support the developer. The committee need botanist/bird and freshwater specialists, and representatives from the city conservation/ biodiversity section and the Friends of the Liesbeek (how representative of the local concerned public?), with appropriate/suitably senior representatives of the developer. An independent chairperson is needed to give added credibility. The committee should meet at least quarterly but ideally monthly especially through construction phase when short-term changes need to be considered.

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Philosophy: Research has shown that, in a hospital of which one side faces greenery and the other side buildings, patients facing greenery recover quicker, and with less medication, than those in wards facing buildings. The manager of an office facing onto the Intaka Island nature reserve in Century City has stated that his staff now work longer, and more productively, than they did in their former city centre office, which looked onto adjoining buildings and where a 9.15-4.30 attitude held. Research overseas has demonstrated that the new generation of entrepreneurs has strong appreciation for environmental issues and of their social responsibility and, other things being equal this affects their consideration of where to locate their businesses. The ambience of the locale is an important aspect of this.

Changes in urban philosophy: There have been changes in preference from former "straight and sterile" and "concrete or kikuyu" landscapes to a more natural situation with more curves and greater use of indigenous plants. The rivers abutting the RCA have previously been seen as flood source and have been treated negatively. This attitude needs to switch to appreciation of the rivers as major benefactors of the proposed development, not least through provision of a "burglar barrier". This requires a shift in attitude from inward to outward consideration of the RCA. .

Re-sculpturing & landscaping: This will be necessary to reduce the flooding risk and to accommodate roads and buildings. In business parks, except for small private areas around the ground floor, most non-footprint ground is under corporate management through a Property Owners Association (POA). Landscaping of communal ground in the RCA must be seen as a continuum, from formal horticulture along roads and immediately around buildings, to "natural" vegetation near waterbodies. Indigenous plants have the benefit of using less fertiliser and water (except for the initial period after planting) and so reduction in maintenance costs.

Flood avoidance: The key to structural development on the RCA is reduction of the flood risk. This can be most readily achieved by raising the ground level of the area with buildings and their services to above the 1 in 5 year flood limit. A considerable amount of infill material will be required to achieve this. Transport of fill material from outside the RCA will be very expensive. This cost can be considerably offset by excavation of the infill already used in the "Rough" area and relocating it strategically to raise the area where buildings will be constructed. The resulting excavations can be re-sculptured to create a series of new peripheral wetlands (see suggestions below).

The flood risk is greatest next to the existing water channels. This risk can be reduced by setting buildings etc. some way back from the channels and creating a protective, anti-flood berm between the structures and the water-bodies. The berm and the area between it and the water channel is hereafter referred to as an Apron. The aprons can be most readily developed abutting the Black River and the Liesbeek channel.

Views: The water channels and flood avoidance apron will enforce spacing between buildings on the RCA and the neighbouring properties. This will create views of varying character. These views are potentially important selling factors. They offer quite different prospects from those of normal, tightly constrained, urban office developments. The prime views are to the west, towards Table Mountain. The southerly view will be onto the Observatory. To the east the view is across the Black River to the M5. The least desirable is view is towards the Culemborg railyard.

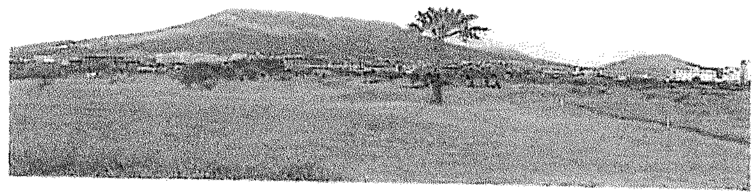

Fig. 12. View to southwest across the existing Golf Course. This is likely to be the view – towards Table Mountain - that will determine the orientation of buildings on the site with some adjustment to align along the prevailing southeast-northwest wind directions.

These views, especially that to the north and east can be considerably enhanced by natural landscaping – through the planting of indigenous bushes and trees.

To further improve views, it would be sensible to negotiate to take-over management of the opposing, non-RCA, banks of the water channels and to also landscape these. Any landscaping must avoid planting trees or bushes in isolation at some distance apart but rather aim for closer planting to create dense masses of foliage. Such dense masses are generally avoided in urban environments as they get used for undesirable practices. However, the river channels around the RCA facilitate exclusion of undesirables on the RCA. Bush development on the away banks would require appropriate fencing (this applies only to the west bank of the Liesbeek as the Culemberg sector is already fenced and the other nearby bank is that of the Raapenberg/Observatory.

Fig.13. The Raapenberg nature reserve contains varied wetland habitats with a reed screened central open water area highly attractive to waterbirds. Management collaboration with the Observatory administration could lead to improvements in the aesthetics of this view i.e. through replacement of the aging & deteriorating concrete canal wall by more naturally appearing gabions, and the removal of the rusted corrugated iron "wall that divides the Raapenberg wetland from the higher terrestrial area. .

Social values: The proposed peripheral flood protection/ view-enhancing aprons will provide social value to the overall development. To further enhance this value two systems of peripheral trails are proposed. An inner trail, i.e. closer to the buildings, for active recreation – jogging or cycling; and an outer, nearer the water, trail to suit more relaxed recreation – walking, sitting, and enjoyment of the views and nature. Further suggestions for these trails are made below.

Landscape Management: By managing the apron as a natural environment, with largely, if not entirely, indigenous plants will cost substantially less in terms of maintenance than if this were "horticulturally" landscaped. Natural vegetation has the benefit of periodic flowering, the provision of nectar, fruit and

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seeds for wildlife, as well as sheltering habitats for wildlife to breed. Irrigation would only be necessary in the first few years to ensure rapid development to the desired heights and appearance of the vegetation. Bushes and trees mute external traffic noise, and serve to give visual pleasure through greenery, flowers, butterflies, birds and bird song. .

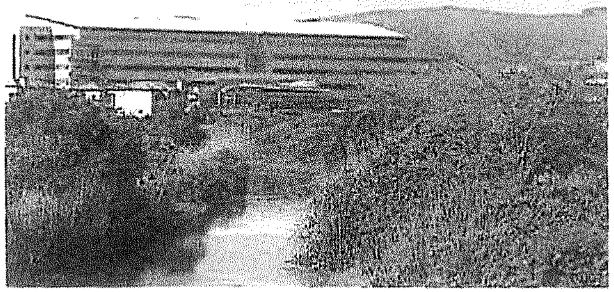


Fig. 14. What the peripheral area might resemble with appropriate planting – a good, near continuous bushy habitat for birds as well as being aesthetically pleasing to the public. Note the Liberty Life offices backed from, but overlooking, this area in Century City. Contrast this view with that of the current RCA peripheral pictures (Figs. 6 & 7). Gaps in the bush cover can be left for sitting, or watching nature.

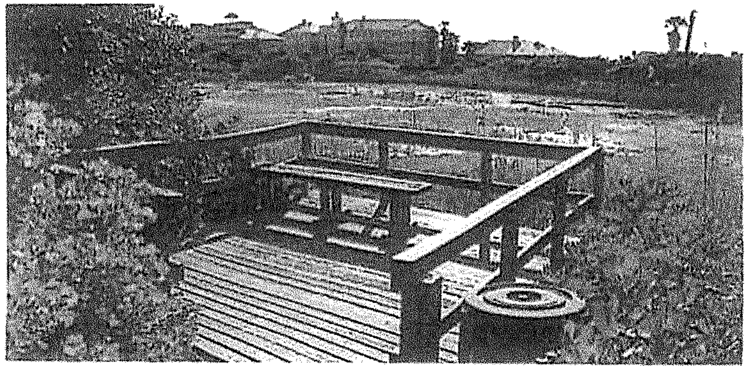
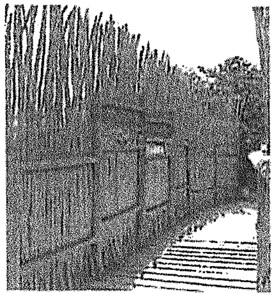
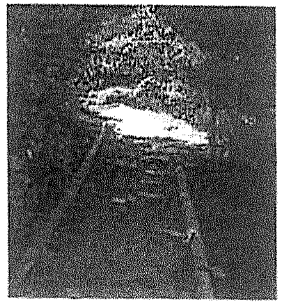


Fig. 15. A public viewing unit – constructed with "plastic wood". Not all viewing areas need be so fancy though decking is important in wet situations where heavy treading would soon result in a muddy mess.





Figs. 16 & 17: Examples of a) an inexpensive screen that enables viewing of wildlife with minimal risk of disturbance; and b) a wheelchair suitable walking trail through bush habitat. Note the passing bay and the sense of exploration created by the effect of the trail winding out of sight. Both these sorts of features would be appropriate for the outer, relaxed, trail in the apron.

Edutainment values: The social value of the apron environments would be substantially raised if, at intervals, attractive signage is installed that interprets occasional features of the natural environment. Further interpretation panels would be provided in the bird hides etc. within the new wetland habitats area (see below). An education/interpretation lapa, as well as walkthrough aviary to enable close up viewing of birds, might be considered.

New wetland habitats: Excavation of infill from the outer, waterside, part of the Rough area could create a series of new wetland habitats providing water of different depth in each of say three wetlands with water levels controlled by pumping from the Black River and using controlled culverts to manage water levels and seasonal level changes in each. These three habitats should be: one of open deeper water; a shallower reedy water; and a marsh. With peripheral reed/sedge beds these wetlands should provide an ideal group of habitats to attract a diverse range of wetland birds.

Provision should be made to enhance the likelihood of waterbirds breeding i.e. through 1) provision of open vertical embankments in which kingfishers and martins can burrow their nests; 2) a branch islet breeding platform to attract cormorants, darters and ibises; 3) and upright sticks set in the water on which kingfishers can perch. An open dryland area beside the deeper water habitat will attract birds to rest on during the day. Observation hides or screens can be located near these special features so that the public can obtain close looks, and photographs, without unduly disturbing the birds. See Figs. 18-20 for examples from Century City of how the new wetlands might look –all the Century City photos are of artificially created habitats developed mainly in the first five years after the start in 1996. A 4) wooden observation tower beside the Black River would please visitors. It would enable observations into both the new wetlands and Raapenberg nature reserve. This would also facilitate surveys of water bird numbers to demonstrate the degree to which development targets are met. Creation of an area of reciprocal habitat on the "point" area of the RCA would greatly increase the wildlife value of this area and simultaneously raise the value of Raapenberg nature reserve as part of a larger total area for wetland birds. These new habitats can be considered an offset against former loss of habitat through infilling of the floodplain. Even small areas of wetland habitat, as well as riparian vegetation have high biodiversity value. Rich aquatic insect life subsidises animals in appropriate immediately adjoining habitat.

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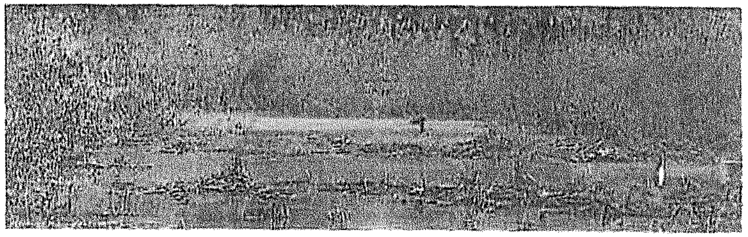

Fig. 18: The sort of relaxing view – from a bird hide or a viewing screen – that could be achieved in a restored, offset, section of the current Rough area

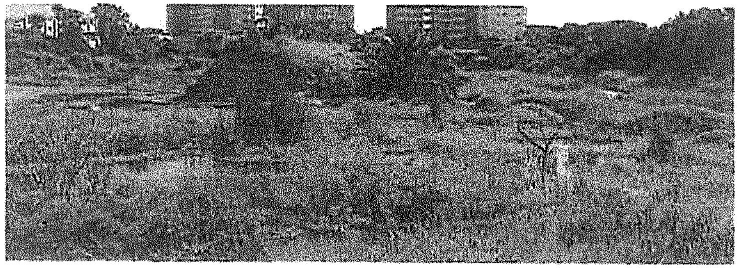

Fig. 19. Another view of what might be emulated through restoration of wetland habitats in the Rough area. Note the embankment in which kingfishers and martins excavated breeding burrows. This whole vista has been created artificially. Note the upright dead stick used by kingfishers for observing for fish in the water below.

Fig. 20. Branch islets set in permanent waterbodies are keenly valued by waterbirds as safe breeding sites. On such safe sites the birds readily tolerate humans watching from relatively close quarters. Experience has shown that the islets could have been erected considerably closer to the bird hide. This would have provided an even

better experience for visitors who lacked binoculars. Note the sandy open loafing area on the left bank much used by birds.

Timing and archives: A natural/ environmental area plan is required from before planning approval. Planting etc. in the apron should commence as soon as approval is granted. The plants can mature whilst construction is taking place so that the visual value is there when the properties are ready for sale or rental. It is important to take photos across the pre-construction phases and at regular intervals across and after development. Regular (ideally monthly) bird surveys are needed to document changes and see to what extent environmental targets, using birds as surrogates, are made.

Additional ideas for consideration: Planting thorn trees as these encourage terrestrial birds to breed in safety. The riverine borders constrain terrestrial non-volant predators but attention would have to be paid to aquatic predators, notably water mongooses. One aim should be to foster populations of wetlands species known to be under severe stress in and around Cape Town – Greater Painted Snipe, Leopard Toad etc.

Conclusion: Appropriate development of the RCA for an office park of 21st century environmentally conscious standards will cost multi-millions of rands. The costs of developing the proposed natural apron, new wetland habitats, and suggested recreational/ educational features would probably cost less than 1 million. This cost, and the cost of lost developable area, can be more than compensated from the: reduced flooding risk; raised ambience; and so value of the overall site for property sales or rentals; as well by pre-empting most, if not all, environmentally based objections that may be raised at the planning application phase. The suggested environmental developments will greatly enhance the RCA for birds and water-related wildlife in general.

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4 DR WILLIAMS' WATERBIRD AND WETLAND RELATED CV

After research into seabirds in the UK and Norway and qualifying as a Master of Science (Ornithology) from the University of Sheffield I joined the FitzPatrick Institute for African Ornithology at the University of Cape Town. Over nine years I was senior researcher responsible for the seabird programme at subantarctic Marion Island. I spent 2.5 years on the island during two visits. This led to publication of 21 per-reviewed scientific papers and the award of my Doctorate from the University of Cape Town. As the programme funding ceased in 1982 I transferred to the State Museum in Windhoek as curator of birds. Following the death of the former ornithologist for the then South West Africa (now Namibia) Department of Nature Conservation I took up that position which I held until in 1988.

In 1987 the (old and larger) Cape Province Department of Nature Conservation took over management of most of the former guano islands. Based on my seabird experience I was recruited and, though in charge of research at 16 islands spread from Algoa Bay to the Namib coast, I was stationed at Walvis Bay. In 1994 Walvis Bay and the Namib islands were transferred to Namibia and I was relocated to Stellenbosch as the senior ornithologist for the nature conservation department (now Cape Nature) of the newly created Western Cape Province.

My first task was to appraise the status of birds in the new province. It was immediately apparent that seabirds and water-related birds were those most at risk as coast and wetlands together form less than 1% of the total area of the province. Not only were these environments "rare" but they were also subject to greater human pressures than other provincial environments.

I focused largely on the wetlands and waterbirds. Accordingly I became Cape Nature's representative and on the management advisory committees for the: Paarl Bird Sanctuary (sewage works) from 1994-2004; Rietvlei Nature Reserve 1994-2014; and Intaka Island in Century City (from its initiation in 1995 to present). In addition I worked on surveys of waterbirds at Theewaterskloof, Bot River Lagoon, De Hoop Vlei, Rocher and Wadrif pans, and Paardevlei. This all in addition to my seabird , SANCCOB, and wider ornithological commitments.

In a pre-retirement period of secondment to the Avian Demography Unit (ADU) at UCT I used data from the Co-ordinated Waterbird Count (CWAC) data base at the ADU to assess the overall population and conservation status of the waterfowl, waders, shorebirds and see-birds in the entire province as well as using ecological knowledge to assess the global population status of four species of waterfowl endemic to southern Africa – Cape Teal, Karoo Shelduck, Cape Shoveler, and the southern African race of the Black-necked Grebe.

I considered it vital for the conservation of provincial waterbirds that public appreciation of the wetland habitats be raised. Hence I was a prime instigator of a proposed R 20 million wetland education eco-centre for Rietvlei. I motivated this with the (then) Blaauwberg Municipality. The municipality instigated a R 250,000 EIA report and also sent me on a fact-finding mission to the UK where over a three- week period. There I visited 13 major wetland eco-education centres collecting ideas for features that could be applied in Africa. Unfortunately, although most of the findings of the EIA were positive, it was decided that the project would not be not financially viable, and it lapsed. Subsequently, during attendance at international symposia, I was able to visit, and get ideas from, wetland eco-centres in north-eastern, south-eastern, and western USA as well as in Australia, New Zealand, and Malaysia.

Based on these international experiences I have provided information, advice, and development ideas for a number of proposed wetland developments or wetland impaction situations: the Matzikama Eco-park, Vredendal; developments at Somerset East; Paardevlei in Somerset West; Paarl Bird Sanctuary; Paarl Golf Estate; Drakenstein and Eden municipality landfill extensions; Safari-land near Franschoek; Vredenberg Golf Course; eco-estate residential proposals east and west of the Uilenkraal River; and within Cape Town - Intaka Island in Century City; Grand West Casino; and the Atlantic Hills development. I have also been consulted on the effect of proposed road developments at Wadrif Pan, and to provide information panels for the Rocher Pan nature reserve.

APPENDIX E

ENVIRONMENTAL IMPORTANCE AND SENSITIVITY (EIS) PROTOCOL FOR WETLANDS AND RIVERS

Appendix E Environmental Importance and Sensitivity (EIS) protocol for wetlands and rivers

The method used to assess the EIS of wetlands is a refinement of the DWAF Resource Directed Measures for Water Resources: Wetland Ecosystems method (DWAF, 1999b) and Rivers method (DWAF 199c). It includes an assessment of ecological (e.g. presence of rare and endangered fauna / flora), functional (e.g. groundwater storage / recharge) and socio-economic criteria (e.g. human use of the wetland).

Scoring of these criteria then places the wetland or river in an Importance Class (A-D) (see Tables E1 and E2).

Table E1
Wetland Importance Class integrating Ecological Importance and Sensitivity, and functional and socio-cultural importance modifiers.

Importance class (one or more attributes may apply)	Range of Median	Wetland Importance Class
Very high Representative of wetlands that: • support key populations of rare or endangered species; • have a high level of habitat and species richness; • have a high degree of taxonomic uniqueness and/or intolerant taxa; • provide unique habitat (e.g. salt marsh or ephemeral pan; physiognomic features, spawning or nursery environments); • is a crucial avifaunal migratory node (e.g. RAMSAR wetlands); • may provide hydraulic buffering and sediment retention for large to major rivers that originate largely outside of urban conurbations; • have groundwater recharge/discharge comprising a major component of the hydrological regime of the wetland; • are highly sensitive to changes in hydrology, patterns of inundation, discharge rates, water quality and/or disturbance; and • are of extreme importance for conservation, research or education.	>3 <=4	A
High Representative of wetlands that: • support populations of rare or endangered species, or fragments of such populations that are present in other similar and geographically-adjacent wetlands; • contain areas of habitat and species richness; • contain elements of taxonomic uniqueness and/or intolerant taxa; • contain habitat suitable for specific species (e.g. physiognomic features); • provide unique habitat (e.g. salt marsh or ephemeral pan; spawning or nursery environments, heronries); • may provide hydraulic buffering and sediment retention for rivers that originate largely outside of urban conurbations, or within residential fringes of urban areas; • have groundwater recharge/discharge comprising a component of the hydrological regime of the wetland;	>2 <= 3	B

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• may be sensitive to changes in hydrology, patterns of inundation, discharge rates, water quality and/or human disturbance; and • are important for conservation, research, education or eco-tourism.		
Moderate Representative of wetlands that: • contain small areas of habitat and species richness; • provide limited elements of habitat that has become fragmented by development (e.g. salt marsh, ephemeral pan; roosting sites and heronries); • provide hydraulic buffering for rivers that originate in urban areas; • are moderately sensitive to changes in hydrology, patterns of inundation, discharge rates and/or human disturbance; • perform a moderate degree of water quality enhancement, but are insensitive to sustained eutrophication and/or pollution; and • are of importance for active and passive recreational activities.	>1 <= 2	C
Low/marginal Representative of wetlands that: • contain large areas of coarse (reeds) wetland vegetation with minimal floral and faunal diversity; • have a high urban watershed:wetland area ratio; • are important for active and passive recreation; • provide moderate to high levels of hydraulic buffering; • may be eutrophic and generally insensitive to further nutrient loading; • are generally insensitive to changes in hydrology, patterns of inundation, discharge rates and/or human disturbance; • have regulated water; and • contain large quantities of accumulated organic and inorganic sediments.	>0 <= 1	D

Table E2
Wetland Importance Class Integrating Ecological Importance and Sensitivity, and functional and socio-cultural importance modifiers.

Determinant*	Guidelines And Description	Scoring Guidelines
Rare and@ endangered biota	Biota can be rare or endangered on a local, Provincial and National scale. Useful sources for this information include the South African Red Data Books that are suitable for assessment on a National scale. However, species (or taxa in the case of invertebrates) can be rare or endangered on a Provincial or local scale but not on a National scale. Professional judgement needs to be utilised in such cases.	Very High - rating=4; One or more species/taxon judged as rare or endangered on a National scale (i.e. SA Red Data Books). High - rating=3; One or more species/taxon judged to be rare or endangered on a Provincial/regional scale. Moderate - rating=2; More than one species/taxon judged to be rare or endangered on a local scale. Marginal - rating=1; One species/taxon judged as rare or endangered at a local scale. None - rating=0; No rare or endangered species/taxon at any scale
Unique biota@	Endemic or uniquely isolated species populations (or taxa, i.e. in the case of invertebrates) that are not rare or	Very High - rating=4; One or more population (or taxon) unique on a National scale. For the Western Cape - rated on a biome scale.

Determinant*	Guidelines And Description	Scoring Guidelines
	endangered should be included here. This assessment should also consider local, Provincial and National scales and should be treated separately from rare and endangered species (i.e. the same species should not be considered). The assessment should be based on professional knowledge. Fynbos biome: Within this biome all the biota would be unique. The rivers were therefore assessed within the context of the biome for the Western Cape (Luger 1999a).	High - rating=3; One or more population (or taxon) judged to be unique on a Provincial/regional scale. For the Western Cape - rated on a sub-regional scale (i.e. northern, western, southern and karroid). Moderate - rating=2; More than one population (or taxon) judged to be unique on a local scale. Marginal - rating=1; One population (or taxon) judged to be unique at a local scale. None - rating=0; No population (or taxon) judged to be unique at any scale.
Intolerant biota	Intolerant biota includes those species (or taxa in the case of invertebrates) that are known (or derived or suspected) to be intolerant to decreased or increased flow conditions as well as changed physical habitat and altered water quality conditions related to decreased or increased flows. As little experimental information is available on the intolerance of indigenous biota, assessment should be based on professional judgement. Kwazulu/Natal: There is no quaternary without flow and everywhere that there is flow an invertebrate community dependent on flow develops. This would mean that every quaternary should be rated highly with respect to this criterion. The solution to the problem was to use only fish (Chutter 1999).	Very High - rating=4; A very high proportion of the biota is expected to be dependent on permanently flowing water during all phases of their life cycle. High - rating=3; A high proportion of the biota is expected to be dependent on permanently flowing water during all phases of their life cycle. Moderate - rating=2; A small proportion of the biota is expected to be dependent on permanently flowing water during some phases of their life cycle. Marginal - rating=1; A very low proportion of the biota is expected to be only temporarily dependent on flowing water for the completion of their life cycle. Sporadic and seasonal flow events expected to be sufficient. None - rating=0; Rarely if any biota expected with any dependence on flowing water.
Species/taxon richness	Species/taxon richness can be assessed on a comparative basis according to a local, Provincial or National scale. Strictly, this kind of assessment should be based on the grouping of ecologically similar rivers. However, such a system is still under development and assessment will again to have to be based on professional judgement.	Very High - rating=4; Rated on a National scale. For the Western Cape - rated on a biome scale. High - rating=3; Rated on a Provincial/regional scale. For the Western Cape - rated on a sub-regional scale (i.e. northern, western, southern and karroid). Moderate - rating=2; Rated on a local scale. Marginal/low - rating=1; Not significant at any scale. (a rating of none is not appropriate in this context)

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APPENDIX F

SPECIALIST IMPACT ASSESSMENT METHODOLOGY

Methodology as provided by SRK Consulting

IMPACT ASSESSMENT METHODOLOGY FOR EIAS

The significance of all potential impacts that would result from the proposed Project is determined in order to assist decision-makers. The significance rating of impacts is considered by decision-makers, as shown below.

- **INSIGNIFICANT:** the potential impact is negligible and **will not** have an influence on the decision regarding the proposed activity.
- **VERY LOW:** the potential impact is very small and **should not** have any meaningful influence on the decision regarding the proposed activity.
- **LOW:** the potential impact **may not** have any meaningful influence on the decision regarding the proposed activity.
- **MEDIUM:** the potential impact **should** influence the decision regarding the proposed activity.
- **HIGH:** the potential impact **will** affect a decision regarding the proposed activity.
- **VERY HIGH:** The proposed activity should only be approved under special circumstances.

The **significance** of an impact is defined as a combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The significance of each identified impact[19] must be rated according to the methodology set out below:

Step 1 – Determine the **consequence** rating for the impact by determining the score for each of the three criteria (A-C) listed below and then adding them[20]. The rationale for assigning a specific rating, and comments on the degree to which the impact may cause irreplaceable loss of resources and be irreversible, must be included in the narrative accompanying the impact rating:

Rating	Definition of Rating	Score
A. *Extent*– *the area over which the impact will be experienced*		
Local	Confined to project or study area or part thereof (e.g. site)	1
Regional	The region, which may be defined in various ways, e.g. cadastral, catchment, topographic	2
(Inter) national	Nationally or beyond	3
B. *Intensity*– *the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources*		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. *Duration*– *the timeframe over which the impact will be experienced and its reversibility*		
Short-term	Up to 2 years (i.e. reversible impact)	1
Medium-term	2 to 15 years (i.e. reversible impact)	2
Long-term	More than 15 years (state whether impact is irreversible)	3

The combined score of these three criteria corresponds to a **Consequence Rating**, as follows:

Combined Score (A+B+C)	3 – 4	5	6	7	8 – 9
Consequence Rating	Very low	Low	Medium	High	Very high

[19] This does not apply to minor impacts which can be logically grouped into a single assessment.

[20] Please note that specialists are welcome to discuss the rating definitions as they apply to their study with the EIA team.

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Example 1:

Extent	Intensity	Duration	Consequence
Regional 2	Medium 2	Long-term 3	High 7

Step 2 – Assess the **probability** of the impact occurring according to the following definitions:

Probability– the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

Example 2:

Extent	Intensity	Duration	Consequence	Probability
Regional 2	Medium 2	Long-term 3	High 7	Probable

Step 3 – Determine the overall **significance** of the impact as a combination of the **consequence** and **probability** ratings, as set out below:

		Probability			
		Improbable	Possible	Probable	Definite
Consequence	Very Low	INSIGNIFICANT	INSIGNIFICANT	VERY LOW	VERY LOW
	Low	VERY LOW	VERY LOW	LOW	LOW
	Medium	LOW	LOW	MEDIUM	MEDIUM
	High	MEDIUM	MEDIUM	HIGH	HIGH
	Very High	HIGH	HIGH	VERY HIGH	VERY HIGH

Example 3:

Extent	*Intensity*	*Duration*	*Consequence*	*Probability*	*Significance*
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH

Step 4 – Note the **status** of the impact (i.e. will the effect of the impact be negative or positive?)

Example 4:

Extent	*Intensity*	*Duration*	*Consequence*	*Probability*	*Significance*	*Status*
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	–ve

Step 5 – State level of **confidence** in the assessment of the impact (high, medium or low).

Depending on the data available, you may feel more confident in the assessment of some impact than others. For example, if you are basing your assessment on extrapolated data, you may reduce the confidence level to low, noting that further ground-truthing is required to improve this.

Example 5:

Extent	*Intensity*	*Duration*	*Consequence*	*Probability*	*Significance*	*Status*	*Confidence*
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	–ve	High

Step 6 – Identify and describe practical **mitigation** and **optimisation** measures that can be implemented effectively to reduce or enhance the significance of the impact. Mitigation and optimisation measures must be described as either:

- **Essential:** best practice measures which must be implemented and are non-negotiable; and.
- **Best Practice:** recommended to comply with best practice, with adoption dependent on the proponent's risk profile and commitment to adhere to best practice, and which must be shown to have been considered and sound reasons provided by the proponent if not implemented.

Essential mitigation and optimisation measures must be inserted into the completed impact assessment table. The impact should be re-assessed with mitigation, by following Steps 1-5 again to demonstrate how the extent, intensity, duration and/or probability change after implementation of the proposed mitigation measures. *Best practice* measures must also be inserted into the impact assessment table, but not considered in the "with mitigation" impact significance rating.

Example 6: A completed impact assessment table

	Extent	*Intensity*	*Duration*	*Conseq.*	*Prob.*	*Signif.*	*Status*	*Confid.*
Without mitigation	Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	–ve	High
Essential mitigation measures: • Xxx1 • Xxx2 • Xxx3 **Best practice mitigation measures:** • Yyy1 • Yyy2								
With mitigation	Local 1	Low 1	Long-term 3	Low 5	Improbable	VERY LOW	–ve	High

Step 7 – Summarise all impact significance ratings as follows in executive summary:

Impact	*Consequence*	*Probability*	*Significance*	*Status*	*Confidence*
Impact 1: XXXX	Medium	Improbable	LOW	–ve	High
With Mitigation	Low	Improbable	VERY LOW		High
Impact 2: XXXX	Very Low	Definite	VERY LOW	–ve	Medium
With Mitigation:	*Not applicable*				

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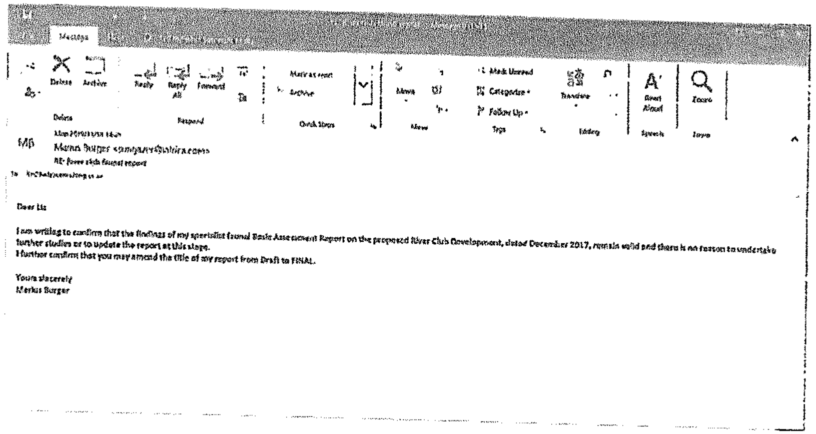
APPENDIX G

CONFIRMATION OF SPECIALIST FINDINGS

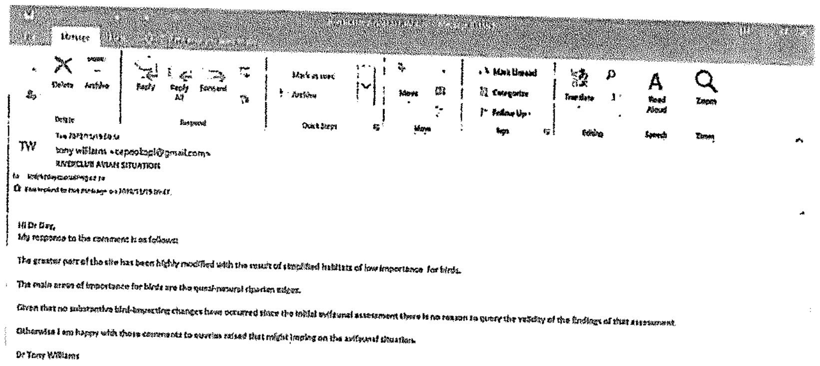


Marius Burger
RE: River club faunal report

Dear Liz

I am writing to confirm that the findings of my specialist faunal Basic Assessment Report on the proposed River Club Development, dated December 2017, remain valid and there is no reason to undertake further studies or to update the report at this stage.
I further confirm that you may amend the title of my report from Draft to FINAL.

Yours sincerely
Marius Burger



tony williams <cepookapl@gmail.com>
RIVERCLUB AVIAN SITUATION

Hi Dr Day,
My response to the comment is as follows:

The greater part of the site has been highly modified with the result of simplified habitats of low importance for birds.

The main areas of importance for birds are the quasi-natural riparian edges.

Given that no substantive bird-impacting changes have occurred since the initial avifaunal assessment there is no reason to query the validity of the findings of that assessment.

Otherwise I am happy with those comments to queries raised that might impinge on the avifaunal situation.

Dr Tony Williams

8136

From: tony williams
To: liz@lizdayconsulting.co.za
Subject: RIVERCLUB AVIAN SITUATION
Date: Tuesday, 19 November 2019 09:34:44

Hi Dr Day,
My response to the comment is as follows:

The greater part of the site has been highly modified with the result of simplified habitats of low importance for birds.

The main areas of importance for birds are the quasi-natural riparian edges.

Given that no substantive bird-impacting changes have occurred since the initial avifaunal assessment there is no reason to query the validity of the findings of that assessment.

Otherwise I am happy with those comments to queries raised that might imping on the avifaunal situation.

Dr Tony Williams

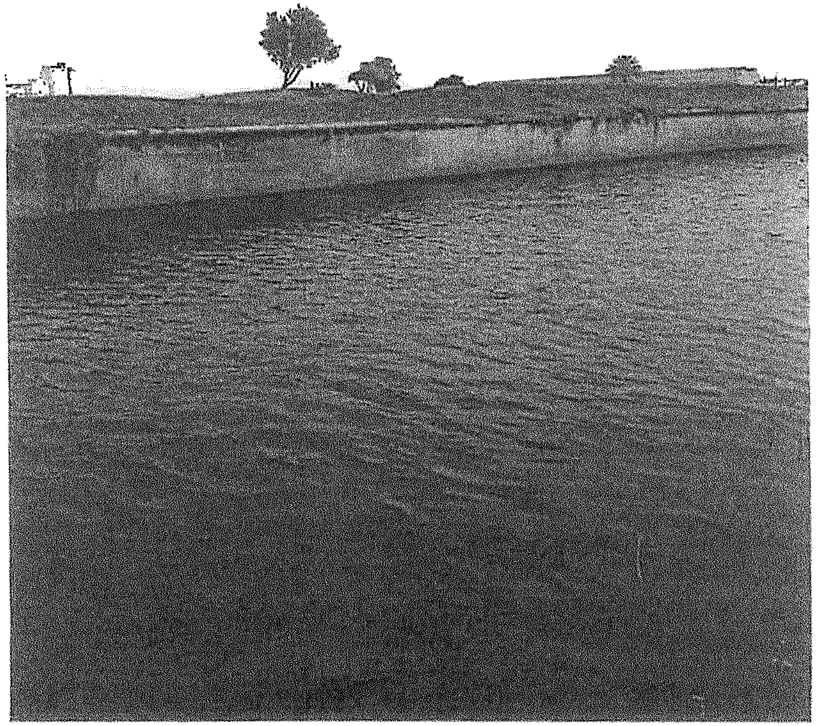
From: Marius Burger
To: liz@lizdayconsulting.co.za
Subject: RE: River club faunal report
Date: Monday, 18 November 2019 14:40:26

Dear Liz

I am writing to confirm that the findings of my specialist faunal Basic Assessment Report on the proposed River Club Development, dated December 2017, remain valid and there is no reason to undertake further studies or to update the report at this stage.
I further confirm that you may amend the title of my report from Draft to FINAL.

Yours sincerely
Marius Burger

Appendix G3:
Surface Water Hydrology Impact Assessment



aurecon

Proposed River Club Redevelopment

Investigation into the impact of the proposed redevelopment of the River Club on flooding and flood abatement in the Salt River Catchment

Liesbeek Leisure Properties Trust

12 March 2018
Revision: 3
Reference: 112405

Bringing ideas to life

Document control record

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Client contact	Stuart Walls	Client reference		Surface Water Hydrology		
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0	20 October 2017	Draft 0	Lloyd Fisher-Jeffes	Mike Shand		
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2	23 November 2017	Draft 2	Lloyd Fisher-Jeffes	Mike Shand		
3	12 March 2018	Final Draft	Lloyd Fisher-Jeffes	Mike Shand		Fareed Nagdi
Current revision	3					

Approval			
Author signature		Approver signature	
Name	Lloyd Fisher-Jeffes	Name	Fareed Nagdi
Title	Graduate Engineer	Title	Technical Director

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Disclaimer

This study was commissioned by Liesbeek Leisure Properties Trust (LLPT) to investigate the impact that their proposed development might have on flooding in the vicinity, downstream and upstream of their property. The City of Cape Town and other affected parties made a number of requests for the modelling to consider a range of alternatives. Aurecon has modelled these with the best available information at the time. The findings of this report should only be used to assess the impact of the River Club Proposal, and cannot / should not be used when considering alternative proposals (e.g. TRUP, NRF, PRASA etc.).

Executive Summary

Introduction

Aurecon South Africa (Pty) Ltd was appointed to undertake a definitive, detailed study of the impact of the proposed River Club development on the potential flooding. This study is intended to be used to guide the decision-making process with respect to the approval, and if successful, the design of the proposed redevelopment of the River Club site. The objectives of this investigation were therefore to determine the following:

- The effect that developing the River Club site would have on the extent of flooding along the Salt and Liesbeek Rivers;
- The implications that any changes to the surface water hydrology might have on flood levels which would affect infrastructure and private property in the vicinity of the Salt and Liesbeek Rivers;
- The cumulative impacts of the River Club development and all other likely / planned developments in the surrounding area; and
- The potential ecological impacts of developing the River Club site – particularly on the Raapenberg wetlands.

The City of Cape Town (City) agreed that reference to other accepted studies would be necessary as these address some of the above-mentioned objectives.

Literature Review

A review of the relevant literature details the following: the history of the site which once formed part of an extensive wetland; the changes to the City's policies; the effects of urban development, climate change and sea level rise; seven recent studies relating to flooding in the Liesbeek / Salt River Catchments; and which currently conceptualised developments are likely to take place in the vicinity of the River Club site. The literature review found that:

- The River Club site is prone to flooding by events with a frequency of recurrence of about once in every 2 to 5 years.
- There are a significant number of recent studies that incorporate the River Club site - some of these studies provide contradictory results.
- There is significant interest in the future development of the River Club site:
  - There are a wide range of stakeholders.
  - There are a variety of contradictory 'visions' of what should, and should not be done.
- There have been changes to the City's policies relating to developing within the floodplain.
- There is concern that infilling of the River Club site will result in significant increases in flood levels.
  - Some stakeholders have openly rejected any study that indicates a negligible or insignificant impact on flood levels.
- There was a need for a detailed analysis of the potential for flooding in the vicinity of the River Club site.

Method of Investigation

To assess the potential impacts of the proposed development on flooding in the vicinity of the site, Aurecon developed a series of PCSWMM and HEC-RAS two-dimensional models. These models were used to determine the existing (status-quo) flooding and the extent of flooding if the proposed development were to be allowed – and thus any changes as a result of the proposed development. A range of development and mitigation scenarios were considered. These include: pre- and post-development flood models; the effect of widening the Salt River Canal; the effect of sediment build up in the channel; the effect of different storm surges; the change in the hazard associated with the flooding; and the sensitivity of the models to different input parameters. As far as possible this analysis has been conservative. Furthermore, it has taken account of the full range of development proposals for the area.

Results and Conclusions

This study has reviewed seven relevant studies, and has undertaken extensive modelling with both HEC-RAS and PCSWMM 2D. The report presents (Chapter 4) the results for each scenario that was considered, without making definitive findings or conclusions due to the complexity of the site. Therefore, it is necessary to consider all the separate findings from the different scenarios together before drawing any definitive conclusions. Considering any 'question' or 'issue' raised in isolation may lead to a misinterpretation of the results. Furthermore, hydrology and hydraulic modelling should be considered as a tool for analysing potential impacts and scenarios, and as this is not an 'exact science', rather engineering judgement and experience is important in interpreting the results. Therefore, Aurecon involved three of its staff who have extensive experience of the circumstances at this site in order to ensure that the analyses were undertaken and interpreted in the most reasonable and appropriate manner.

Based on a review of all the available studies, the extensive modelling, and engineering judgement, it is Aurecon's opinion (as stated in Chapter 5) that:

- The results (magnitude of impact) appear to be relatively consistent for each study, even where study methods and elevations may differ slightly.
- The development of the River Club, along with the TRUP, PRASA and NRF sites is likely to have an impact on flood levels, in the order of 0.01m – 0.15m depending on the storm recurrence interval and location. The greatest differences in flood levels occur in the vicinity of the South African Astronomical Observatory. The impacts of these changes were deemed to be insignificant.
- Were the River Club to be developed in isolation (i.e. TRUP, NRF, PRASA were not to be developed), then the impacts on flood levels would be of a similar magnitude for all recurrence intervals, but less by approximately 0.00m – 0.03m, than the levels for the scenario where all the proposed developments went ahead. These impacts were also considered to be insignificant.
  - The differences between the post development scenarios are also well within the uncertainties of the modelling tools.
  - It is important to note that if any of the proposed TRUP, NRF and PRASA developments were to be undertaken in isolation, then the results must not be interpreted to mean that they would only have an impact equal to the differences between the post development scenarios for the River Club, TRUP, PRASA, and the NRF sites together, and the post development scenario for the River Club alone– as indicated in the RHDHV Study. This is because of the complexities of the hydrology and hydraulics in the vicinity of the River Club site.
- The design of changes to the Liesbeek Canal should aim to maintain the existing hydraulic functioning of the wetland during smaller recurrence interval events. The current proposal would have little to no effect, but further detailed design refinements – during detailed design – should be reanalysed.
- It would be advisable, in consultation with the Fresh Water Consultant, to consider reversing the intervention undertaken by the TRUPA, Friends of the Liesbeek and the South African Astronomical Observatory (SAAO) – as this is likely to increase flows into the wetland.

- The site is unlikely to be developed by the City as an attenuation facility.
- PRASA should not be allowed to close the existing overland flood route that extends across its property, as this is important for mitigating flood risk – regardless of whether the proposed River Club development proceeds.
- The extension to Berkley Road should be designed in such a manner as to not impact on the water levels determined by this study and any changes to the preliminary design would need to be re-evaluated. The detailed design of the extension of Berkley Road should consider raising the portion of the road that is within the floodplain.
- There is a need to address the localised change in risk along Liesbeek Parkway. This could be done through raising the road locally (as discussed in the report) to eliminate the potential flooding by the 1 in 100-year event, however ponding due to local stormwater is also likely to occur at this location for which the provision of warning signs would probably suffice.
- The impact of the proposed development on flood levels and the areal extent of the additional flooding are considered to be negligible.
- The combined impacts on flood levels of the proposed development together with the proposed development of the Two Rivers Urban Park and their extent are considered to be negligible.
- Widening the Salt River would reduce the flood levels for all scenarios, but as the capital cost would be very high and the benefits very small this is unlikely to be viable in the foreseeable future.

The main conclusion of this study is that the proposed development would have an insignificant effect on flooding in the vicinity of the existing River Club site. Although the development would have some limited localised effects on flows and water levels in the Liesbeek and Black Rivers, the modelled impacts in terms of increased hazard and potential damage to properties are insignificant and can be considered to be negligible – provided that the above-mentioned findings are adhered to.

Although the proposed development would not have a significant impact on flooding, it would none the less require the following deviations in terms of the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a):

- Section 9.2: Flood Management and Public Safety
  - Permission to develop / obstruct the free flow of water within the 20-year flood line area would need to be granted.
- Section 10.5: Table 1: Framework for the assessment of Proposals
  - The current assessment framework forbids development (including filling) within the 50-year flood plain. It notes: "*In exceptional circumstances minor "smoothing" of the 50 / 100-year flood line may be considered, provided equivalent compensatory stage storage volume is provided within the development precinct*".
  - As the proposed development falls under the 50-year flood line, a deviation from the policy, allowing the developer to fill (considered development) would need to be granted.

Although the two development layouts (Section 3.2) would both have similar impacts, Layout Option 1 (focus of this study) would be the preferable option as it aligns with the vision of the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) in that, in comparison to Layout 2) it provides an improved ecological corridor, and the potential for improved amenity and biodiversity in accordance with the principles of Water Sensitive Urban Design (WSUD) principles.

It is recommended that the City should take account of the findings of this study to determine whether in terms of the policy and based on consideration of the "*geomorphological, maintenance, social and economic aspects*" (presented by other specialists) the proposed development of the River Club Site should be approved.

Contents

Figures

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Tables

Abbreviations

1D	One Dimensional
2D	Two Dimensional
AED	African Environmental Development
CC	Climate Change
CMC	Cape Metropolitan Council
CSRM	Catchment, Stormwater, and River Management Branch
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
EGL	Energy Grade Line
EL	Energy Level
GIS	Geographical Information Systems
LiDAR	Light Detection and Ranging
LLPT	Liesbeek Leisure Properties Trust
NRF	National Research Foundation
PRASA	Passenger Rail Agency of South Africa
PRDW	Prestedge Relief Dresner Wijnberg
RH-DHV	Royal HaskoningDHV
RI	Recurrence Interval
RSA	Republic of South Africa
SAAO	South African Astronomical Observatory
TRUP	Two Rivers Urban Park
TRUPA	Two Rivers Urban Park Association
WCG	Western Cape Government
WS	Water Surface Level

Symbols

C	Runoff Coefficient
ha	Hectares
km	Kilometre
km^2	Square kilometres
m	Metre
m^3	Cubic metres
m^3/s	Cubic metres per second
N	Manning's Roughness

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1 Introduction

1.1 Background

The Liesbeek Leisure Properties Trust (LLPT) currently owns and operates the River Club in Observatory, Cape Town (Figure 1-1). LLPT proposes to develop the site as a mixed commercial, institutional, residential site and therefore as part of the scoping study for the proposed development it acquired the services of African Environmental Development (AED) to undertake a flood line determination study and to assess the impacts of the proposed development on the River Club site and surrounding properties. This study considered the flooding in the vicinity of the River Club site as a result of flows in the Salt River Catchment (Figure 1-1) – which drains by the Elsieskraal, Black and Liesbeek Rivers that discharge into the Salt River.

Concurrently, while LLPT's scoping studies were being undertaken, the Western Cape Government (WCG) were undertaking similar studies aimed at developing a spatial development framework for an area known as the Two Rivers Urban Park (TRUP) – shown in Figure 1-1. The TRUP area is predominantly owned by government (City of Cape Town (City) and Western Cape Government) but also includes some privately-owned erven, such as the River Club site.

Following the release of the Draft Scoping Report for LLPT's proposed development a number of queries were raised with regard to AED's study titled "*Flood Line Determination for the Salt and Liesbeek Rivers at the Cape Town River Club, Cape Town, Western Cape Province, RSA*". It was also noted that there were differences in flood levels determined by the studies commissioned by LLPT and by the WCG as well as in the results of previous studies commissioned by CCT – undertaken by Ninham Shand (2003; 2004) and SRK (2013).

In 2016 Aurecon South Africa (Pty) Ltd was appointed by LLPT to undertake a peer review of the AED study. This necessitated a review of the WCG study and of the previous 2003, 2004 and 2013 studies in order to investigate the identified discrepancies. As a result of the review of these studies it was decided, in consultation with LLPT, that it was necessary to undertake further investigations to confirm the extent, if any, of the impact of the proposed development of the River Club site on the flooding of properties in the areas surrounding this site. This study indicated that the proposed River Club development, in isolation, would have an insignificant impact on flood levels and that there were a number of significant differences between these results and the results of both the AED and WCG studies.

In 2017 Aurecon South Africa (Pty) Ltd was appointed to undertake a definitive, detailed study of the implications on flood levels of the proposed River Club development together with the proposed TRUP development.

This report documents the process and findings of the review of the previous flood studies and of the further investigations carried out by Aurecon. The report also describes the additional investigations and provides comment and conclusions about the potential impacts of the proposed development on flooding and inundation of the River Club site and surrounding properties.

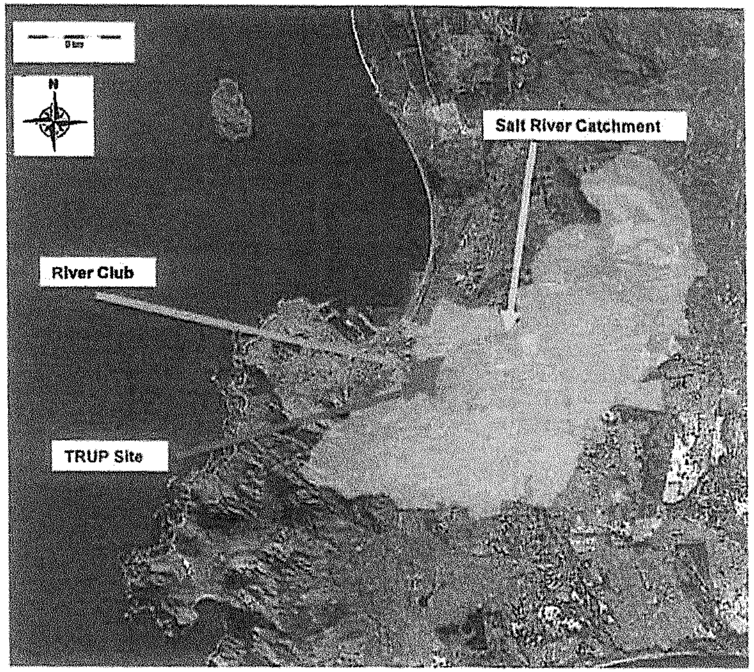

Figure 1-1 Location, and size of the River Club site, within the TRUP area and greater Salt River Catchment

1.2 Objectives

The objectives of this investigation are, *inter alia*, to determine:

- The effect that developing the River Club site would have on the extent of flooding along the Salt and Liesbeek Rivers;
- The implications that any changes to the surface water hydrology might have on flood levels which would affect infrastructure and both public and private property in the vicinity of the Salt and Liesbeek Rivers;
- The cumulative impacts of the River Club development and all other likely / planned developments in the surrounding area; and
- The potential ecological impacts of developing the River Club site – particularly on the Raapenberg wetlands and bird sanctuary.

As agreed with the City, reference to other accepted studies would be necessary to address some of the above-mentioned objectives.

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1.3 Limitations

It is important to note that this investigation is based on the City's latest hydrologic models – SRK (2012). Aurecon has previously highlighted concerns about the correctness of this hydrological modelling of various sub-catchments within the catchment area of the Salt River and has made proposals for addressing potential shortcomings. Never the less Aurecon is of the opinion that the Two-Dimensional (2D) models that have been configured for this study provide a reasonable basis for making informed judgements regarding the flood levels for both the pre- and post-development of the River Club site flooding and adjacent areas. This is because the water levels and flow paths determined from the modelling correspond closely with observations by experienced Aurecon employees who visited the sites during major flooding events over the last 15+ years.

2 Literature review

2.1 General background

2.1.1 History of the Salt River Catchment

The histories of the rivers and wetlands in Cape Town are comprehensively documented in Brown & Magoba (2009) and therefore are not repeated in detail here. The histories include the impacts that urbanisation has had on the 'rivers and wetlands' in Cape Town. A literature and internet search of historic images highlighted the changes, over the last century, to the environment in the vicinity of the confluence of the Liesbeek, Black and Salt Rivers. These changes are highlighted in Figure 2-1, Figure 2-2, Figure 2-3 and Figure 2-4, to provide context for this report.

Figure 2-1 shows that historically the Liesbeek and Black Rivers flowed into an extensive wetland. By 1958 this had had changed with the initial canalisation of the rivers as evident from Figure 2-3. In 1960 the (re)canalisation of the Black River took place as well as the creation and canalisation of the Liesbeek Canal along the Eastern boundary of the River Club Site (Whittemore & Gorgens, 2007). By 1968 (Figure 2-3) the impact of urbanisation is clearly evident including a number of changes that impacted on what was previously a more extensive wetland. The last remnants of this once extensive wetland are now known as the 'Raapenberg Wetlands'. The historic presence of an extensive wetland in this area is not surprising, as the area is relatively flat and low lying.

Of interest for this study, is that it is apparent that the course of Liesbeek River changed a number of times between 1937 and the present. Today the abandoned river course is fed by limited runoff from the adjacent urban area, and the majority of the Liesbeek River Catchment's flow is channelled down the Liesbeek River Canal as shown in Figure 2-3 and as evident in Figure 2-4.

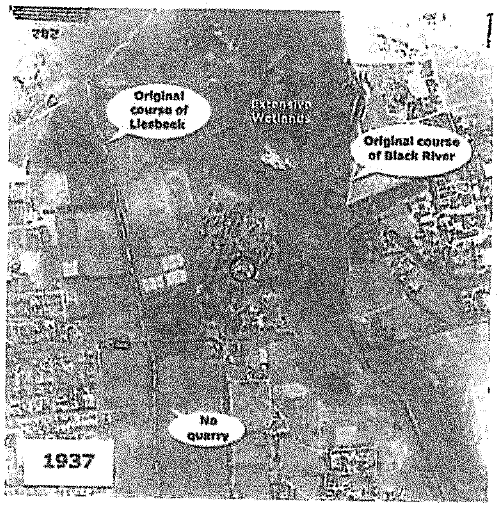

Figure 2-1 Aerial footage from 1937 indicating the 'original' course of the Black and Liesbeek Rivers (Richard.F, 2016)

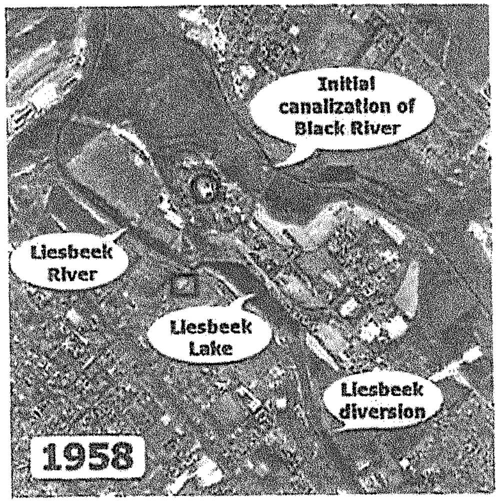

Figure 2-2 Aerial footage indicating the changes between 1937 – 1958 to the course and structure of the Liesbeek and Black Rivers (Richard.F, 2016)

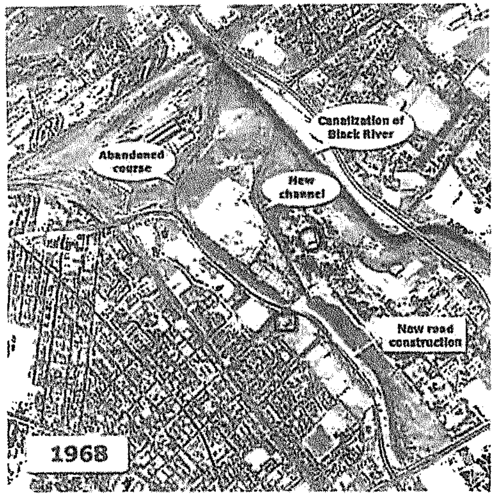

Figure 2-3 Aerial footage indicating the changes between 1958 – 1968 to the course and structure of the Liesbeek and Black Rivers (Richard.F, 2016)

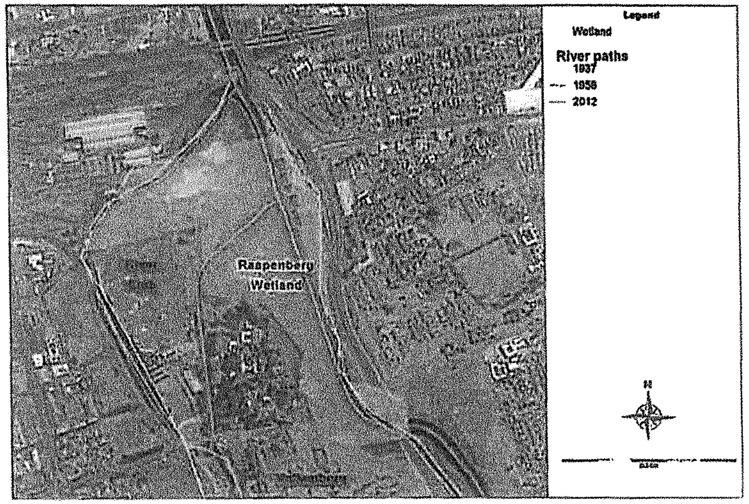

Figure 2-4 Map overlaying the changes between 1937 and the present to the course of the Liesbeek and Black Rivers.

2.1.2 Potential Ecological impacts

The ecological value of the lower reaches of the Liesbeek and Black Rivers is dealt with in a separate report compiled by Dr Liz Day (Freshwater Consulting Group). Dr Day highlighted that the Raapenberg Wetlands (Figure 2-4) are of particular importance and that the change in water depths, particularly for intra-year storm events, was of concern as it may impact on the local fauna and flora. The approach to assessing the impact of the proposed development on the Raapenberg Wetlands is described in Section 3.5.

2.1.3 Policy changes

It is important to recognise that over the last 20 years there have been significant shifts in policy relating to the management of stormwater and flooding in the City. Prior to 2000 general practise was to limit development to above the 50-year flood line (CMC, 2000). ARCUS GIBB (2000) noted that there was no legislation which stipulated whether it was permissible to develop and fill within the 100, 50 or 20-year flood plains; and that the City had no by-laws preventing filling of the 50 year flood plain. Subsequently the City made significant changes to its policies which are presented in the following documents:

- In 2000
  - *'Development Control Guidelines in Flood Prone Areas'*(CMC, 2000)
- In 2003
  - *'Floodplain Management Guidelines'* (CSRM, 2003)

- In 2009
  - *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a)
  - *'Management of urban stormwater impacts policy'* (CSRM, 2009b)

The latest two policy documents, published in 2009, provide the basis for the assessment of development plans in regard to stormwater management and flooding, in the City. Together these require the following:

- Development such as that proposed for the River Club site is required to be elevated above the 1 in 100-year flood line.
- Future upstream developments are required to ensure that properties downstream of any such development are not affected, and if downstream properties are affected then the upstream development would not be permitted in terms of the "Framework for assessment of proposals".
- Future developments are also required to manage their runoff so as to not to increase and preferably to reduce peak flows.

2.1.4 Construction of a berms along the banks of the Liesbeek River

The construction, in September 2013, of berms and infilling along the banks of the Liesbeek Canal by the, then tenant, of the River Club property has been a contentious issue. Cape Argus (2017) reported that "*Friends of the Liesbeek secretary, Francine Becker, said they saw large Ross Demolition trucks dumping soil on the river banks. This activity continued over the weekend and up to 10 large tks loaded with soil were observed driving into the River Club in the space of an hour. It seems the River Club, desperate to deal with flooding, has illegally dumped material in and along the Liesbeek.*" In the same article it is noted that "*Becker said she spoke to a River Club representative, Nick Ferguson, who said it had been decided to cover the bank to make it 'neat and tidy'...'He said he could not wait for authorisation as the soil was available and too expensive to truck in later. The dumped soil would be compacted mechanically and planted with grass.'*"

During the scoping phase of the project it became evident that the construction of the berm in 2013 remains a contentious issue. The extent of infilling for the berm is shown in Figure 2-5. A process with City's legal section is currently underway concerning the construction of berms along the Liesbeek Canal without authorisation (Construction of a Berm Along the Liesbeek Canal by the River Club, Ref: 16/1/1/11/243).

According to the proponent of the current development proposal, the berm was built by the previous tenant and is not connected to the current ownership. A notice concerning the removal of the berm was issued by the City to the Liesbeek Leisure Club (Pty) Ltd of which the current owners were not directors or shareholders.

It is Aurecon's understanding that the process is currently ongoing and the results of the development application will be considered in determining the course of any further action.

During the course of this investigation it became apparent that the South African Astronomical Observatory (SAAO) had constructed a berm on the opposite bank to that of the River Club as indicated in Figure 2-6. The construction of this berm appears to have been undertaken without the permission of the City of Cape Town.

For the assessment of the impact of the infilling on the River Club property the status of both berms presents a difficulty in determining the "predevelopment" status quo. Therefore, for this impact assessment it was decided that the worst-case scenario would be considered – i.e. the "status quo" for

which the largest impact on the SAAO would be realised. This is considered to be the case where neither the River Club, nor the SAAO would have constructed berms (i.e. the status quo in 2012).

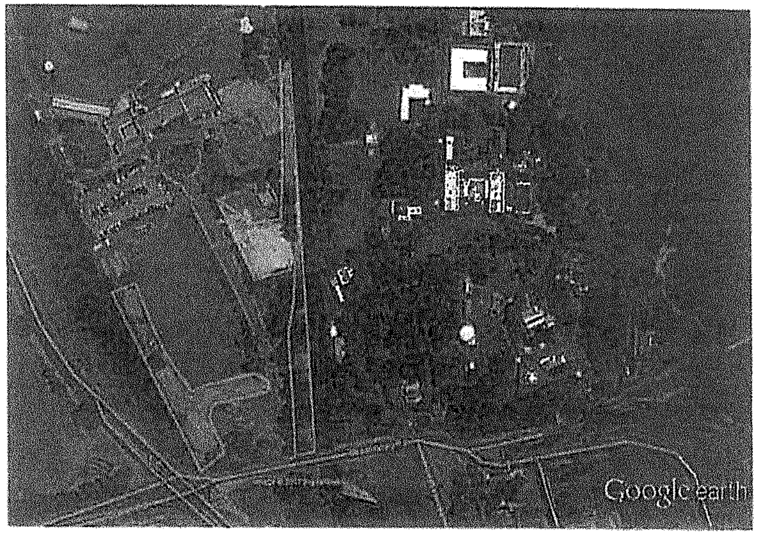

Figure 2-5 Extent of infilling on site (outlined in green) (Source: Google earth (11/01/2014))

Figure 2-6 Berm on the South African Astronomical Observatory (SAAO) side of the Liesbeek Canal – constructed sometime between 2013 – 2015

2.1.5 Climate Change considerations

'Human interference with the climate system is occurring, and climate change poses risks for human and natural systems' (IPCC, 2014b). Within urban areas, it is generally predicted that the increase in global temperatures associated with climate change will be exacerbated as a result of the urban heat island effect (IPCC, 2014a). Willems et al. (2012) indicate that rainfall intensities are typically expected to be increase by the end of this century (2100) at small urban hydrology scales by between 10% and 60% from historic levels recorded between 1961 and 1990. A recent stormwater master planning report for the City, SRK (2012) indicated that it was necessary to increase the modelled rainfall depth for design storms by 15% to account for changes in the intensity of extreme events. This was based on an analysis of the potential impact that climate change might have on rainfall intensities in Cape Town, and incorporated into this study.

Other expected impacts of climate change are a rise in the global sea level and increased storm intensities. PRDW (2010) undertook a study to provide estimates of the expected storm surge and wave setup corresponding 1:20 year, 1:50 year and 1:100-year frequencies and provided best and upper estimates of sea level rise in 2035 and in 2060. It was agreed with the City that the levels provided by PRDW (2010), and used for Royal Haskoning DHV's (RH-DHV's) (2017) investigation of the TRUP site, should be used for the current investigation.

2.1.6 The effect of further urbanisation / changes in land-use within the greater Salt River Catchment

Urbanisation typically results in an increase in the impervious surface area, which has significant impacts on a watershed's hydrology (Shuster et al., 2005; CSIR, 2005; Leopold, 1968; Walsh, 2000). Leopold (1968) noted that the volume of runoff is primarily determined by the soil's infiltration characteristics. The increase in the impervious area associated with urbanisation results in greater volumes of runoff and higher peak flows. Urbanisation can also result in significant changes in how runoff is conveyed in most urban areas (Marsalek et al., 2006). Historically, natural channels have often been replaced with hydraulically highly efficient concreted channels. While the increase in impervious areas results in increased runoff volumes, Fletcher et al. (2008) highlighted that 80% to 90% of the increase in peak flows can be attributed to the nature of the conveyance network. The impacts of possible uncontrolled and unmanaged urbanisation are also important.

Long-term catchment planning and management is the responsibility of the City, and not the developers of individual sites within a catchment that is significantly larger than the individual sites. In the case of the River Club the area of the site is less than 0.1% of the area of the Salt River Catchment. The City has, fortunately, been progressive in implementing two critical policies to manage the impact of urbanisation and densification on flooding within the City. These are the City's *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a) and *'Management of urban stormwater impacts policy'* (CSRM, 2009b) – as discussed above.

This report describes the determination of the impacts that the proposed development is expected to have on properties in its vicinity – in accordance with the policies discussed in Section 2.1.3.

2.1.7 Flooding in urban areas

It is important to recognise that not all flooding in an urban area is necessarily related to the flows in a nearby river. The piped underground stormwater system is typically sized for smaller recurrence interval events (typically for flood magnitudes smaller that than the 1 in 2-year, 1 in 5-year and 1 in 10-year events – depending on the design criteria) (CSIR, 2005). It is usually planned that during larger storm events (with flood magnitudes greater than the 1 in 2-year, 1 in 5-year or 1 in 10-year events –

depending on design criteria) the excess flows will discharge overland via the road network which is intentionally designed to serve as part of the surface drainage system (CSIR, 2005). While this may be considered as 'flooding', it is intentional and not related to the flooding caused by flows in a nearby river – in this case the Liesbeek and the Black/Salt Rivers.

Additionally, for small storm events, should the stormwater infrastructure (inlets and/or pipes) become blocked it is expected that stormwater will be conveyed via the road network – which may appear to be flooding but is often unrelated to the flow in the river.

2.1.8 Perceptions about flooding

In the public discourse – both in media articles and comments submitted as part of the EIA process – there appears to be a perception that the River Club site frequently floods and that the development of the site "will" have an impact on the flooding of properties in the surrounding area – with some interested and affected parties 'rejecting' any studies that do not indicate this. While it is correct that the site has flooded relatively frequently (every few years) in recent history – as discussed in Section 2.3 – it is important to differentiate flooding as a result of high runoff, and flooding that results due to the capacity of the drainage system being limited due to inadequate maintenance and or structural failure.

One specific question that will not be answered by the modelling and analysis is "Why it is necessary for the River Club to raise itself out of the floodplain, whilst it is not necessary for the surrounding areas to be raised above the floodplain (TRUP Assoc, 2017)." This is an important question as it implicitly suggests that if the River Club's proposed development takes place this will worsen the flooding affecting properties that have already been developed, and that if the River Club is not developed these properties will not be affected by flooding. Furthermore, it has been suggested that if the proposed development of the River Club is unaffected by flooding this will increase the impact of flooding of the surrounding properties. It is therefore important to note:

- The reason that there are properties developed on land lower than the existing flood lines is that historically (see Section 2.1.3) properties were allowed to be developed within the 100-year flood plain. Therefore, properties such as those identified as being below the 100-year flood line would, if developed today, be required to elevate themselves out of the floodplain – as is being required for the proposed development on the River Club site.
- The purpose of this report is to assess the impact that the proposed development will have on surrounding properties, in accordance with the provisions of the City's *'Floodplain and River Corridor Management Policy'* (CSRM, 2009a).

2.2 Previous investigations

The River Club and surrounding areas have been the focus of a number of hydrological and hydraulic studies over the last 20 years. These include the following studies: ARCUS GIBB (2000), Ninham Shand (2003 and 2004); SRK (2012); AED (2016) and RH-DHV (2016). Table 2-1 shows the flood levels determined by these studies at the various locations in the vicinity of the River Club shown in Figure 2-7.

There has been a lack of consistency in the modelling methods and in the resolution at which the upstream catchment area has been modelled. In addition, the more recent models have incorporated climate change considerations. Therefore, undertaking comparisons between the different results is not directly possible. On the other hand, it is evident from Table 2-1 that there are inconsistencies in the results of the various studies. An overview of each of these flood line determinations and other relevant investigations is provided below.

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There have also been a number of academic research projects that have considered aspects related to flooding of the River Club Site. These include Lurie (1954), Giermek (2015) and Fisher-Jeffes (2015).

All the above-mentioned studies are briefly described below.

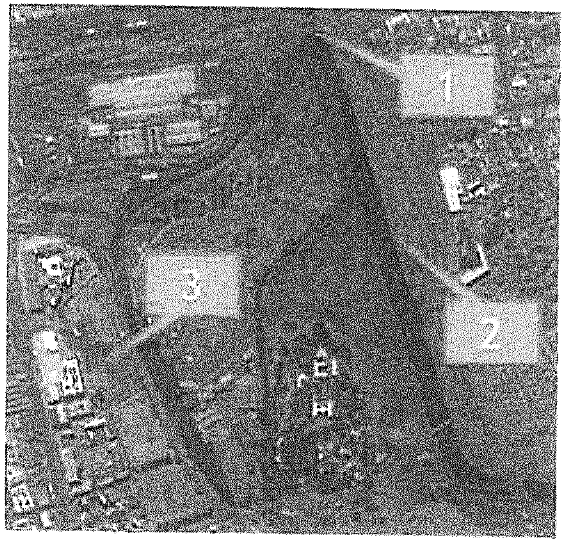

Figure 2-7 Locations at which flood levels are compared in the table below

Table 2-1 Flood levels determined / used in different studies

Report	Year	Climate Change		1:100 Year Storm Event – Water Surface Elevation (mamsl)		
		Increased Rainfall	Increased Sea Level	Location 1	Location 2	Location 3
ARCUS GIBB[1]	2000			Approximately 5.45-5.55m (50 year)		
Ninham Shand[2]	2003/2004			4.26	4.45	Flooded
SRK[2]	2012	✓	✓[5]	4.54	4.95	Flooded
AED[3]	2016	✓		5.40	5.40	Flooded
Royal HaskoningDHV[4]	2017	✓	✓	4.45	4.55	'Limited'

[1]ARCUS GIBB refers to the City as having provided these levels, the source of the levels are not clear. [2]Hec-Ras Model, [3]Spreadsheet based model developed by AED, [4]PCSWMM 2D Model,
[5] The study considered both current sea level and sea level rise due to climate change. The model made available by CCT for this investigation did not include sea level rise.

2.2.1 ARCUS GIBB (2000)

In 2000 ARCUS GIBB was appointed by the then tenant of the 'River Club' to prepare a report '*giving details relating to flood levels, options for detention ponding and mitigating measures to reduce the impact of the proposed development on the flood conditions.*' ARCUS GIBB determined 1 in 50-year flood levels of between 5.4 mamsl and 5.5 mamsl. While the more recent studies do not show significant differences in the flood levels between the 1 in 50-year and 1 in 100-year events, it is evident that the flood levels determined by the ARCUS GIBB (2000) study are significantly higher than those determined all other studies except the AED (2016) study. Unlike the AED (2016) study it is not possible to determine how these flood levels were determined by ARCUS GIBB.

2.2.2 Ninham Shand (2003)

As part of a study commissioned by the City and undertaken with input from a number of consulting engineering companies, Ninham Shand developed flood lines for the Black and Salt Rivers (including the area surrounding the River Club site). This was done with input from BKS who undertook the hydrological modelling and the determination of flood lines for the Liesbeek River Catchment. Ninham Shand's flood line determination indicated that:

- For large recurrence interval storm events (i.e. greater than the 1:20 year event) flooding would occur over the PRASA site.
- The fields adjacent to the old Liesbeek River would be flooded.
- The peak flow in the Liesbeek River (as determined by BKS) is approximately 160 m^3/s for the 1:100 year recurrence interval flood event.
- The peak flow from the Salt River Catchment, including the Liesbeek River Catchment is approximately 240 m^3/s for a 1:100 year recurrence interval storm event.

2.2.3 SRK (2012)

As part of a study commissioned by the City, titled "Stormwater Infrastructure Asset Management Plan (Phase 2A) Rainfall Analysis and High-Level Master Planning", SRK developed both hydrological and hydraulic models for the Salt River Catchment (including the Liesbeek River Catchment). It is worth noting the following:

- The models considered the impact of climate change on rainfall and sea level rise.
- The modelling was undertaken in one dimension (1D) making use of PCSWMM (hydrology and basic hydraulics) and HEC-RAS (hydraulics for flood line determination).
- It is unclear whether Energy Levels or Water Surface Levels were used in determining the flood lines. Communication with the City and a review of the HEC-RAS models indicated the likelihood that Energy Levels were used. This is significant as PCSWMM, the City's choice for modelling the site in 2D does not report Energy Levels directly.

Flood lines determined in this study have been adopted by the City's Stormwater and Sustainability Branch as those to be used for planning purposes. As such, the 2012 SRK study supersedes the 2003 and 2004 Ninham Shand studies.

2.2.4 Giermek (2015)

As part of a Master Degree research project Giermek (2015) undertook an investigation of the benefits of the attenuation provided by the Valkenberg wetlands immediately upstream of the River Club site. The study found that the wetland (+- 2 hectares) was most effective at attenuating rainfall events with "*sudden spikes in peak flow, where a 42 per cent reduction of peak flow was observed. For a scenario with lower flow rates yet a prolonged peak flow rate, the wetland was less effective, with a 20 per cent reduction observed.*" It is important to note that the model for this study was not calibrated and only considered three rainfall events, all in 2013.

2.2.5 Fisher-Jeffes (2015)

Fisher-Jeffes (2015) undertook an investigation of the viability of rainwater and stormwater harvesting in the residential areas of the Liesbeek River Catchment, City of Cape Town. The study focused exclusively on the Liesbeek River Catchment and did not consider the effect of the greater Salt River catchment on the River Club Site. While the study indicates that stormwater harvesting (SWH) throughout the catchment (in a decentralised manner) may have the potential to significantly attenuate peak flows and flooding in the catchment, this does not necessarily equate to the same benefits being experienced if stormwater harvesting / attenuation were to take place on the River Club Site. The study only assessed storms with recurrence intervals of less than 1 in 20 years. Furthermore, the study noted that a decentralised approach to attenuating stormwater would not be practical (to retrofit the catchment at this point) as, apart from the open space at the River Club (which would require a centralised approach) it was shown that the majority of the remaining open space is either not situated in areas where it could be used for SWH – i.e. at the edge of the catchment – or is used for other purposes such as school sports fields. Thus, the study recommended SWH be considered at the planning stage of any future settlement.

2.2.6 AED (2016)

LLPT appointed African Environmental Development (AED) to undertake a flood line determination study as part of the scoping study for the proposed development. LLPT subsequently appointed Aurecon to review the AED study. The review indicated the following:

- The results of AED's hydrological analyses were significantly more conservative than any of the other studies with the 1:100-year storm event having a peak flow of 336 m^3/s. The other studies indicated a 1:100-year peak flow of approximately 250 m^3/s. AED's peak flows for lower recurrence interval storm events are also higher than those of the other studies. The difference in flow rates between the AED study and other studies is a result of the methods used for runoff determination and routing of the runoff through the catchment.
- AED used an in-house developed spreadsheet based model for determining flood levels. The spreadsheet utilised seven river channel / floodplain cross-sections and took account of bridge backwater effects by increasing channel roughness coefficients at bridge locations. The spreadsheet did not take tidal effects or sea level rise due to climate change into account. The higher AED flow rates and the coarser spreadsheet based determination of flood levels resulted in higher flood levels for all recurrence interval events. In the case of the 1:100-year event, the AED flood levels are between 0.5m and 1.0 m higher than those of the other studies.
- The configuration of AED's hydrological and hydraulic models made it difficult for AED to respond to queries regarding the impact of the proposed development on surrounding areas during lower order flood events (i.e. the annual, 2 year and 5-year events). Also, the effects of tides and sea level rise on flood levels at the River Club site could not be accurately assessed in the spreadsheet model.
- AED identified, as did previous studies, a need to maintain the overland flow route through the PRASA owned land.

2.2.7 RH-DHV (2017)

As a part of the planning for the development of the TRUP area by the Western Cape Government (WCG), Nisa Mammon & Associates (NM&A) was appointed to provide professional services as part of this project. RH-DHV were appointed by NM&A to provide various specialist services, which included the assessment of flooding and flood mitigation measures in the TRUP area. A review of their analysis models and study reports indicated that RH-DHV:

- Made use of the City's existing SWMM stormwater models (i.e. the SRK 2012 models) to provide the hydrology for the investigation.
- Modelled potential flooding in the TRUP area using a 1D-2D approach.
- Had expressly indicated their preference for the use of the HEC-RAS model for undertaking the work, however the City had indicated their preference for the use of PCSWMM.
- Did not identify any flooding over the PRASA site, nor flooding of the fields adjacent to the old Liesbeek River using their base line models.

Aurecon reviewed the RH-DHV models, and identified possible improvements. Following a request from Mr Gerhard Gerber (WCG's TRUP Project Manager), these concerns were conveyed to the TRUP project team. Aurecon and RH-DHV then engaged on the approaches and technical aspects of the RH-DHV models. RH-DHV subsequently revised their model (Model D1). The engagement and results are detailed in Hirschowitz (2017). The results indicated that the revisions to the models increased the 1:100-year flood level by approximately 0.5 m near the River Club, indicating that flooding would occur over the PRASA site, and that flooding of the fields adjacent to the old Liesbeek River would occur. This brought the flood levels determined by RH-DHV in line with those of the other studies.

The TRUP study as a whole has not yet been finalised, however for the purpose of this report the focus is on the RH-DHV: Task 2 Final Report - Modelling of Flood Mitigation Options on the Salt River.

2.2.8 Conclusions based on the review of recent studies

The review of the above studies revealed that the Ninham Shand (2003) study predicted the lowest 1:100 flood levels in the vicinity of the River Club site. This is expected as the study predated the availability of climate change data for rainfall and sea level rise and thus did not consider these circumstances. Considering that the impact of sea level rise on flood levels at the River Club was not found to be significant, and that the effect of climate change on rainfall is an approximate 15% increase in total storm volume, the difference in flood levels between the Ninham Shand (2003) study and the subsequent SRK (2012) study is considered to be reasonable.

Given the differences in hydraulic modelling methods between the SRK (2012) and the RH-DHV (2017) studies (i.e. 1D modelling in the SRK study and 2D in the RH-DHV study), the differences in the predicted flood levels are also reasonable.

The AED study (2016) predicts the most conservative flood levels which are between 0.5 m and 1 m higher than those of the other studies for the same recurrence interval floods. The methodologies and software used for the AED study are considered to be too simplistic for the complexities of a system of this nature which makes justification of the results difficult. It was also difficult for AED to respond to the more detailed modelling requirements of City (i.e. assessment of lower order flood events, tidal effects and seal level rise).

2.3 Recorded flood events

The available records for the last 17 years shown in Figure 2-8 indicate that there have been approximately 7 occasions when the River Club Site was inundated with water – generally considered 'flooded'. This is not surprising as most modelling indicates that any event greater than about the 1 in 2-year flood event is likely to result in flooding – depending on the spatial and temporal distribution of the storm event in the catchment. Therefore 'roughly' it is not unreasonable to expect a number of storm events to have resulted in flooding on the site in the past 17 years. It is worth highlighting that:

- Four of these events take place in a five-year period between 2007 and 2012. During this period the lower reaches of the Liesbeek River shown in Figure 2-9 were partially obstructed due to a structural failure in the canal wall and a lack of maintenance. These partial obstructions resulted in a reduced capacity in the canal and likely increased the depths of flooding during this period. While the frequency of these events highlights the need to maintain / rehabilitate the canal when failures occur, it would be misleading to incorporate them into a frequency analysis.
- The recurrence interval of a storm event does not imply that it occurs on a regular basis. A five-year storm does not take place once every five years – it could happen 5 years in a row and then not again for the next 20 years.

Therefore, it is Aurecon's opinion that the flooding on the site is consistent with the modelling to date of floods with a frequency of recurrence of about once in every 2 to 5 years.

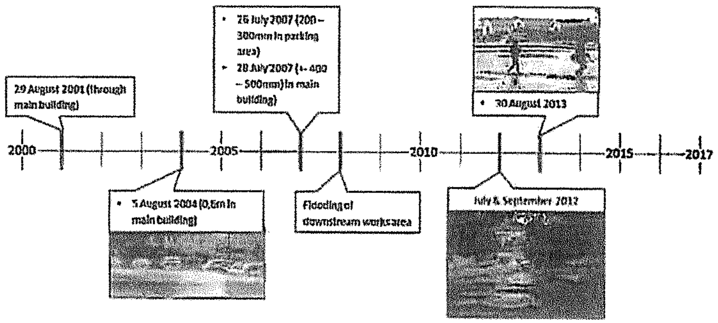

Figure 2-8 Timeline of recorded floods in the vicinity of the River Club

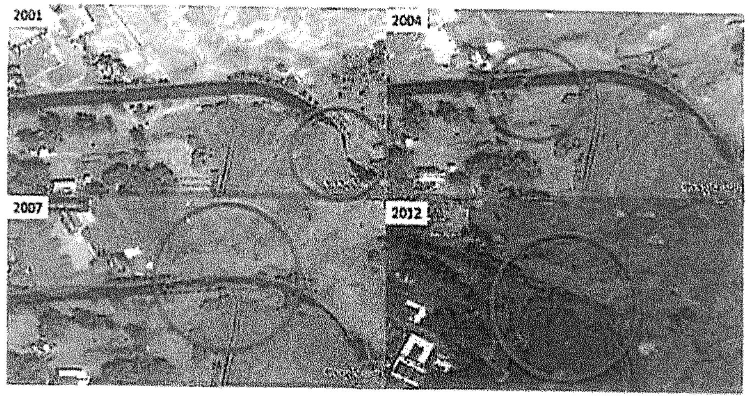

Figure 2-9 Partial obstructions in the Lower Liesbeek River between 2007-2012

2.4 Future development scenario's

2.4.1 TRUP

The Two Rivers Urban Park (TRUP) Programme is an initiative resulting from a partnership between the City and the Western Cape Government (WCG). The intention is to enhance the area's natural and cultural resources while concurrently developing the TRUP area for residential, commercial, institutional, manufacturing and recreational activities, aimed at generating a wide range of housing, recreation, business and employment opportunities, with the aim of creating an *'open opportunity society for all'* so that people can live lives that they value.

Following extensive work undertaken primarily by NM&A, a concept for future development of the TRUP was developed in order to make a preliminary assessment of the capacity of services in the area as indicated in Figure 2-10. Although the TRUP development proposals are not yet available, this conceptual layout provides a good indication of the potential spatial extent of TRUP. It should be noted that the developable area (on the River Club site) according to the TRUP 'vision' is significantly less than that proposed by LLPT for the development of this site.

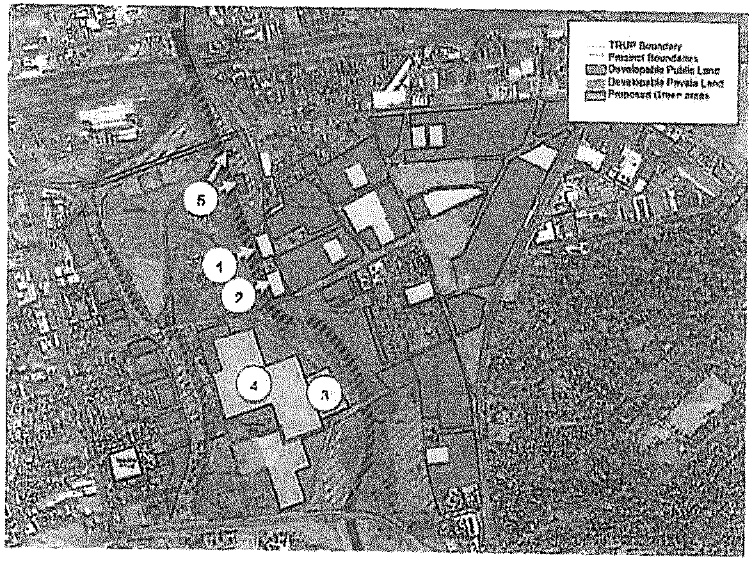

Figure 2-10 Proposed TRUP Layout indicating developable area's

2.4.1.1 Comments on the concept design

Aurecon raised a few queries with regard to the existing concept design and the impact it may have on the flood plain. These questions, and answers, included:

- Whether the proposed open space (No. 1 & 2 in Figure 2-10) will go ahead as they overlay the existing M5?
  - Mammon (2017) noted that these areas are part of a long term landscape scenario to deck over the M5. Mammon (2017) further noted that it is highly unlikely to be implemented in the short to medium term but potentially could be considered in the next 50 + years. Mammon (2017) concluded that *"It is an idea and not a realistic proposal for where we are at as a government and city."*
  - Aurecon would agree it is unrealistic and therefore has not incorporated it into the modelling.
- Whether the developable land (No. 3 in Figure 2-10) will be limited to the South West and not cross the road as it currently does / the road will not be moved nearer to the river?
  - Mammon (2017) noted that the response here is similar to that above.
  - Aurecon allowed for this development, assuming the road could move – even if it is unlikely – as this would potentially affect the floodplain.
- Whether there is an intention to develop areas such as No.4 in Figure 2-10?
  - Mammon (2017) noted that the intention is to develop the Valkenberg Hospital Site in the long term notwithstanding the fact that this site has upgrade plans in place. The dark grey corner portion can be considered for development in the medium term.

- What it is the intention regarding the development of the two pieces of land labelled as No.5 in Figure 2-10, as depending on how these are to be developed and linked to the surrounding areas, they could have a significant impact on the floodplain?
  - Mammon (2017) noted that these areas have been identified for the proposed docking feature associated with an information centre and a small-scale restaurant/coffee shop. These areas are dealt with comprehensively in the TRUP Specialist Study: Watercourse Management & Creating a Docking / Waterfront Feature.

2.4.1.2 Conclusions of the RH-DHV Report

The following comments are made with regard to the RH-DHV: Task 2 Final Report - Modelling of Flood Mitigation Options on the Salt River:

- During January 2017 Aurecon had the opportunity to review and comment on the RH-DHV model. The comments made, and responses, are documented in Hirschowitz (2017). Importantly, the subsequent adjustments had a significant impact on the results of the analyses and as such it is worth noting the following:
  - Not all the models were rerun.
  - Not all the suggested changes were made.
  - Aurecon did not review the models prior to their finalisation.
- The City views the RH-DHV study as a high-level planning study that sought to address the key challenges and to identify options for possibly reducing / attenuating peak flows. While the study provided some insight into the potential flood levels, both the report and the City recognised that more detailed studies – such as the current study described in Section 3 – would be required to address local / specific questions.
- RH-DHV had a number of concerns relating to the use of PCSWMM2D and advised the City not to use PCSWMM for any further 2D Hydraulic Modelling.
  - It is Aurecon's view that PCSWMM2D provides a useful tool for assessing flooding in an urbanised area. While HEC-RAS may be better suited for modelling the river hydraulics, it is unable to model the greater stormwater network, surcharging and runoff trapped at low points.
  - PCSWMM 2D has been tested by CHI using the, now standardised, 'Benchmarking the latest generation of 2D hydraulic modelling packages (Neelz & Pender, 2013)' tests. The results indicated that PCSWMM2D performed relatively well in comparison with fully 2D models for other catchments.
  - PCSWMM2D has been utilised for 2D modelling in a range of catchments around the world.

On account of RH-DHV's concerns regarding PCSWMM2D, the 'Status Quo' has been modelled both with both PCSWMM2D and HEC-RAS 2D. The results are discussed in Section 4.

2.4.2 PRASA

The Passenger Rail Agency of South Africa (PRASA) currently intends to further develop its site to the North of the 'Old' Liesbeek River – Figure 2-11. Although significant additional development is proposed, this is not expected to have any effect on the flooding of the Liesbeek/Salt Rivers. It is important to note that there is an overland flood route over the PRASA land, which might be blocked by the proposed PRASA development and result in ponding. This would be the case regardless of any development on the River Club site.

AED (2016) and RH-DHV (2016) discussed the proposed closing by PRASA of the flood route. In this regard the following should be noted:

- It is generally agreed that this would cause flooding upstream; and
- The City would not knowingly allow PRASA to close the flood route. The City has already prevented this happening on one occasion, and an extensive study would be required before a departure from the City's policy would be granted.

The impact of closing this flood route is none the less assessed as part of this study.

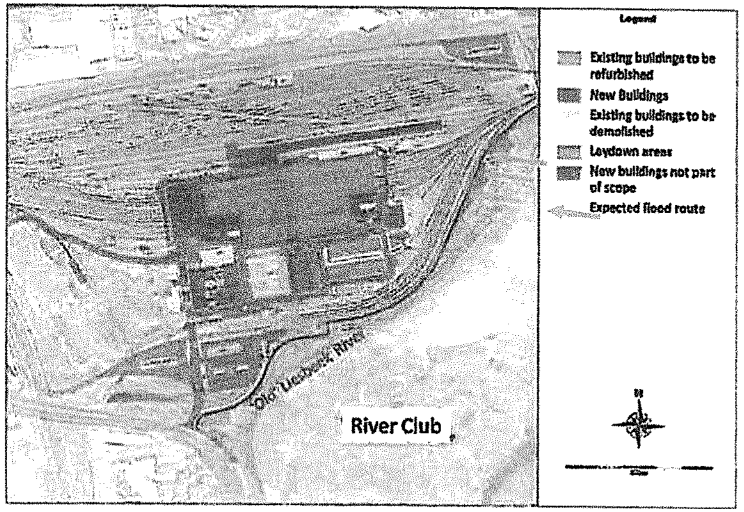

Figure 2-11 Existing PRASA development proposal

2.4.3 NRF

The National Research Foundation (NRF) owns the land at the South African Astronomy Observatory and at the entrance to the River Club (Erf 26423 RE, 26426 and 151833 (26423)) shown in Figure 2-12. The NRF currently intends to develop ERF 151833. As for the proposed River Club site, any development would need to consider the potential impacts on flooding both upstream and downstream. The NRF is also an important stakeholder as there is concern that the proposed development would affect flooding of the Observatory site (ERF 26423 RE). For this analysis, it has been assumed that an office building for the SKA will be constructed on Erf 151833 and a parking area on Erf 26426 as indicated in Figure 2-13.

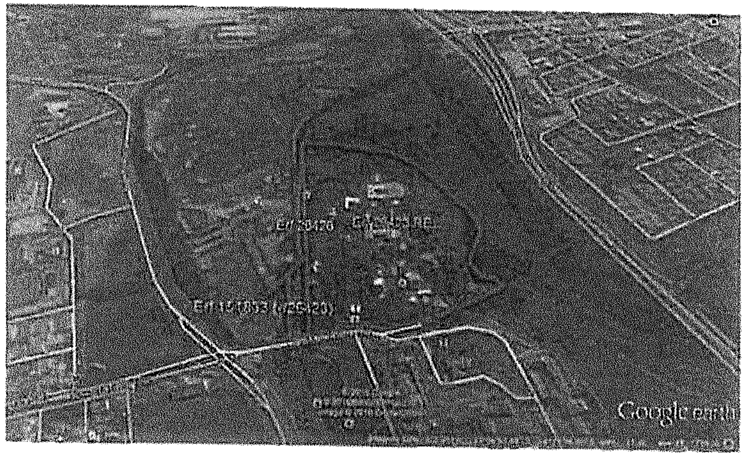

Figure 2-12 NRF owned land in the vicinity of the River Club

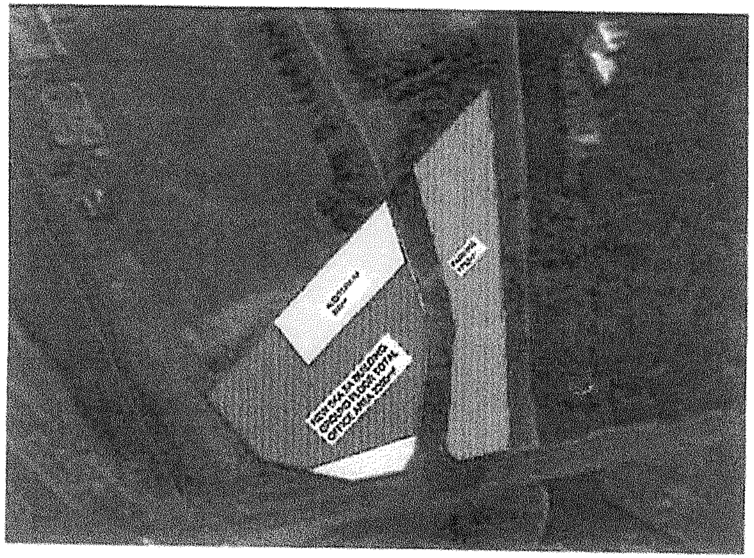

Figure 2-13 Existing NRF development proposal

2.5 Summary of literature review

The above review of the available literature indicates that:

- The River Club site is prone to flooding by events with a frequency of recurrence of about once in every 2 to 5 years (however as noted above it was not possible to undertake a statistical analysis with the available data).
- There are a significant number of studies that incorporate the River Club site.
  - Some of these studies provide contradictory results.
- There is a significant interest in the future development of the River Club site.
  - There are a wide range of stakeholders.
  - There are a variety of contradictory 'visions' of what should, and should not be done.
- There have been changes to the City's policies relating to developing within the floodplain
- There is concern that infilling of the River Club site will result in significant increases in flood levels.
  - Some stakeholders have openly rejected any study that indicates a negligible impact on flood levels.
- There is a need for a detailed analysis of the potential for flooding in the vicinity of the River Club site.

3 Methods of Investigation

3.1 Hydrology & Hydraulic parameters

For the purposes of this investigation it was assumed that the currently accepted hydrological and hydraulic data for the greater Salt River catchment, as incorporated in the SRK (2012) PCSWMM and HEC-RAS models, and provided to Aurecon by the City, are correct. Within the detailed modelling area (the study area), the SRK/City models were interrogated and where inconsistencies and/or inaccuracies were identified these were rectified based on the available data. Although considerable effort was taken to improve the data it is possible that all the errors were not identified.

3.1.1 Hydrological parameters

It is important to note that the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) refers to the '1:100 year flood'. While it is generally assumed that the 1:100-year flood event is synonymous with the 1:100-year rainfall event, this is not always the case. Several factors affect the relationship between rainfall and runoff, including: the extent of rainfall in a catchment, antecedent soil moisture conditions and the size and shape of the catchment. For the purposes of this study and in accordance with City's requirements, the 24-hour 1:100-year SA SCS Type 1 design rainfall event, adjusted to allow for climate change in accordance with SRK (2012), was used to simulate events with recurrence intervals of between 1 in 2 years and 1 in 100 years.

As noted above, all the remaining catchment / hydrologic parameters used in the SRK (2012) models were adopted.

3.1.2 Manning's roughness

The increased resolution of modelling of the hydraulic system (rivers and stormwater network) for the current study necessitated the reassessment of the roughness parameters assumed for the area that was modelled. The roughness coefficients used for modelling in this study were based on the following: a site inspection; a review of relevant literature shown in Table 3-1; a review of SRK (2012); and a review of the roughness coefficients used in the RH-DHV (2017) study. It was decided to use a Manning's coefficient of 0.015 for all stormwater pipes. The Manning roughness coefficients used for channels and for flood plains are shown in Figure 3-1.

The selection of Manning's Roughness coefficients was further checked against those advised by the Kruger & Gomes (2007).

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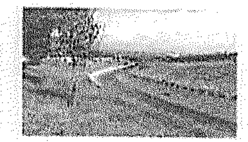
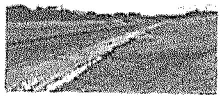
Table 3-1 Typical Manning's Roughness used in modelling

Component	Suggested Manning's roughness range	Typical condition
Storm water pipes & Culverts	0.010-0.014 (Brunner, 2010) 0.010-0.015 (Brown et al., 2013) 0.011-0.015 (Rossman, 2008) Laboratory tests 0.010-0.011 (Brown et al., 2013)	The use of 0.01 was deemed too low and more representative of laboratory conditions. It is likely that the effective roughness in the stormwater pipes is higher than the selected value. This would have the effect of attenuating peak flows. As such an "average value" was selected.
Overbank roughness (1D Modelling)	Earth channel straight and uniform covered with grass some weeds: 0.022-0.033 Earth channel winding and sluggish covered with grass some weeds: 0.025-0.033 Short grass: 0.025-0.035 High grass 0.03-0.05 (Brunner, 2010)	
Floodplains (2D Modelling)	Short grass: 0.025-0.035 High grass 0.03-0.05 (Brunner, 2010; Hamill, 1995)	
Concrete channels (1D and 2D modelling)	Concrete float finished: 0.013-0.016 (Brunner, 2010) Concrete channel: 0.011-0.02 (Rossman, 2008)	
Grassed Channels / Channel formed by Levees (1D and 2D Modelling)	Earth channel straight and uniform covered with grass some weeds: 0.022-0.033 (Brunner, 2010) Earth channel winding and sluggish covered with grass some weeds: 0.025-0.033	

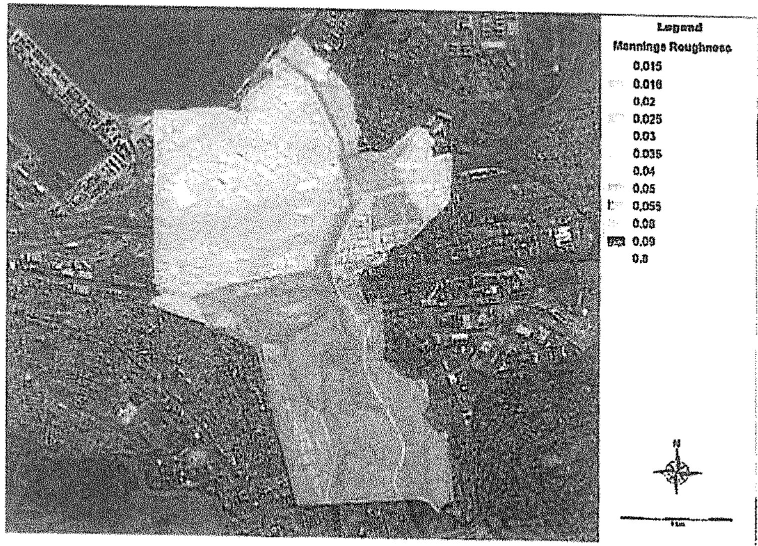


Figure 3-1 Manning's Roughness used for modelling

3.1.3 Digital Terrain Model (DTM)

To undertake 2D modelling – as required by the City – it was necessary to make use of an accurate Digital Terrain Model (DTM). This DTM was generated as follows:

- A 0.15 m DTM was created from the LiDAR ground points provided by the City.
  - These LiDAR points did not represent the river bed profiles (as LiDAR does not penetrate the water surface).
  - RH-DHV (2017) identified that a comparison between the various topographical surveys undertaken for the River Club and the original LiDAR data indicated that the LiDAR levels were generally lower than the corresponding ground surveys. Therefore, the levels of all the LiDAR points were raised by 0.25 m.
  - RH-DHV (2017) further noted that *"it was later confirmed by the City of Cape Town surveyor that a correction in the order of 0.25m was deemed necessary in other studies in the TRUP area as well."*
  - Aurecon requested a topographical dataset from the City which had already been corrected. As this is the most recent topographical data, and appeared to best represent the site, it was used by Aurecon for all modelling.
- The underwater profiles of the river channels were generated as follows:
  - The 1D HEC-RAS Model created from a bathymetric survey undertaken as part of the RH-DHV (2017) study was provided by the City.

- RAS Mapper was used to interpolate and "export" 0.15 m DTMs of the various river channels.
- DTMs of the bridges were generated, based on the levels of the top of the railings (conservative assumption) surveyed for the RH-DHV (2017) study.
- These three DTMs were then merged to create a single representative DTM as indicated in Figure 3-2.

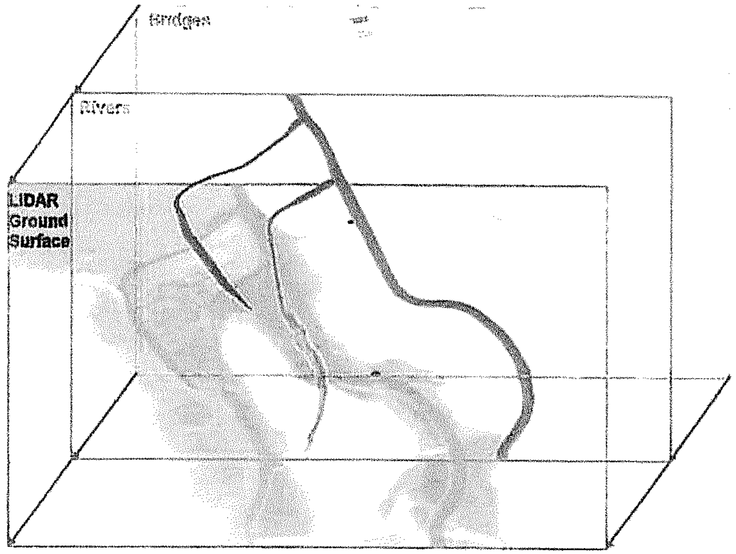


Figure 3-2 Merging of LIDAR, River and Bridge DTM's

3.1.4 Modelling of bridges / culverts

PCSWMM/PCSWMM2D does not contain a "Bridge modelling tool". To ensure that the HEC_RAS model and the PCSWMM models could be compared, PCSWMM's tool for importing hydraulic structures (e.g. bridges, culverts, weirs) from HEC-RAS was utilised. PCSWMM automatically converts bridges / culverts into a series of parallel conduits: one to convey bridge overtopping flow (high chord), and one or more to represent the opening(s) underneath the bridge deck. The high chord may be best represented by an irregular cross-section (transect), and each opening below the bridge deck by a custom cross section. The conversion from HEC-RAS to PCSWMM is illustrated in Figure 3-3.

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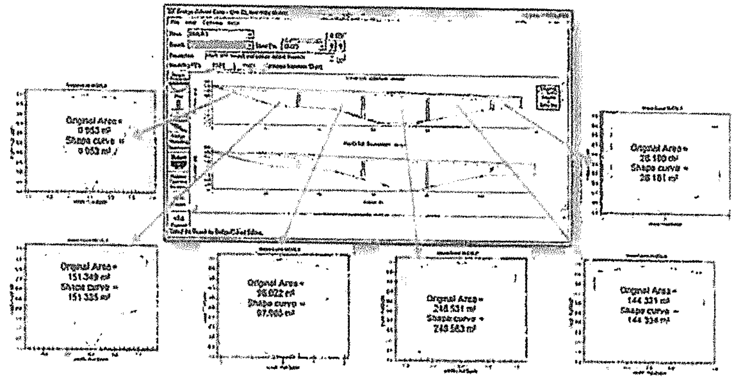

Figure 3-3 Importing of bridges from HEC-RAS into PCSWMM

For the PCSWMM model, energy loss coefficients were determined for bridges to account for the contraction and expansion of the flows under bridges (which are modelled by HEC-RAS in accordance with normal procedures). Loss coefficients were determined for the different bridges in accordance with James et al. (2012) to be as follows:

- Entrance Loss Coefficients (ELC) equivalent to the contraction coefficient used in HEC-RAS, and
- Average Loss Coefficient (ALC) equivalent to the expansion coefficients used in HEC-RAS.

The coefficients utilised for the SRK (2012) PCSWMM models were, typically, ELC 0.1, and ALC 0.3.

3.1.5 Boundary conditions

For both the PCSWMM2D and the HEC-RAS modelling the boundary conditions were as follows:

- The SRK (2012) hydrographs for the Black River and the Liesbeek Rivers were used as upstream boundary conditions.
- Within the modelling area, for the PCSWMM2D model only, the minor stormwater system was modelled.
- The boundary conditions at the outer edges of the floodplain assumed normal flow depth.
- The downstream boundary conditions for the Salt River Canal at the coast are shown Table 3-2. These conditions are based on the PRDW (2010) estimates which in turn were based on the SA Navy (2010). The peak tidal level was assumed to coincide with the peak flow in the Salt River which is a very conservative assumption as the tidal cycle is approximately 12.5 hours. PRDW (2010) also stated that *"It is also understood that the maximum flows expected in the Salt River Canal, and by implication the flood causing events, are expected approximately 12 hours after the maximum rainfall events in the catchment. This effect will further be complicated with varying local precipitation within the catchment."*

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Table 3-2 Tidal levels used in modelling

Recurrence Interval	High (mamsl)	Low (mamsl)	Explanation
100	2.53	0.9	PRDW (2010) 90th percentile tidal ranges and tidal levels – 50-year RI as used in RH-DHV (2017)
50	2.53	0.9	PRDW (2010) 90th percentile tidal ranges and tidal levels – 50-year RI as used in RH-DHV (2017)
20	2.45	0.83	PRDW (2010) – 20-year RI as used in RH-DHV (2017)
10	1.99	0.5	Current MHWS/MLWS allowing for: • 0.45m storm surge • 0.55m for sea level rise as a result of climate change
<5	1.76	0.27	Current MHWS/MLWS allowing for: • 0.25m storm surge • 0.55m for sea level rise as a result of climate change

Note: These are the Still Water Levels excluding individual wave crest and excluding wave run up. These latter processes are not relevant here since the levels here are used for the downstream water level boundary in the SWWM model which will not resolve individual wind-waves.

It is important to recognise that a 1 in 100-year recurrence rainfall (which is assumed to cause the 1 in 100-year flood) and a 1 in 100-year tidal event do not necessarily coincide. In principle, the probability of each occurring separately is 1% and occurring simultaneously is 0.01% or equivalent to a 1 in 10 000-year event. However, there is likely to be some relationship between storm events at sea, and flood events on land – but not necessarily of equal magnitude and recurrence interval.

PRDW (2010) investigated the correlation of storm surge and rainfall events using 24 years of data at the South African Weather Service's Observatory rainfall station. Their investigation found that "*Preliminary results show limited correlation of extreme rainfall and storm surge. The maximum rainfall from the correlated data set (~90 mm representing a return period between 1:20 and 1:50 years) occurred with small positive storm surge (~0.1 m representing a return period less than 1:10). While the maximum storm surge from the correlated data set (~0.75 m for a return period > 1:100) occurred with a relatively small rainfall (~30 mm for a return period < 1:10).*"

PRDW (2010) concluded that "*based on the level of uncertainty of the response of the catchment hydrograph to precipitation events, specifically with respect to the time delay in peak flow, it is recommended that the calculations for return period floods are calculated with the equivalent return periods for rainfall (i.e. 1:100-year flood and 1:100-year rainfall) and a lower return period for storm surge for the sea interface (i.e. 1:10 year storm surge for example).*"

As noted by PRDW (2010) the correlation between storm surge and rainfall is complicated due to a range of factors including timing, rainfall distribution across the Salt River Catchment and tidal cycle (Spring high or Spring low). Therefore, a simple analysis was undertaken using 10 years of rainfall data at the Newlands rainfall station which provides an indication of high rainfalls in the Liesbeek River Catchment as a result of the orographic effect caused by Table Mountain. This analysis indicated that approximately 30% of rainfall events occurred on a day when the peak sea level exceeded the Mean High-Water Spring (MHWS) tidal level. An analysis of the 10 largest rainfall events with precipitation of between 90 mm and 130 mm (per day), roughly equivalent to 1-5-year Recurrence Interval events, indicated that 4 of the 10 events occurred when tidal levels exceeded the MHWS level.

Based on the above findings, particularly those of PRDW (2010), it is considered that the assumptions used for the RH-DHV (2017) study are reasonable and have been adopted for the analyses described below.

3.1.6 Accounting for intra year events

The City has developed standard design storms and hydrological models for 1 in 2-year, 5-year, 10-year, 20-year, 50-year, and 100-year recurrence interval events. These storm rainfalls and flood discharges were analysed and both were found to have linear relationships when plotted with a log normal distribution. Using this relationship, it was possible to estimate the flows at the boundary of the modelling area, as well as the precipitation parameters for the 0.5-year and 1-year storm events.

Providing the parameters for a 1-year or smaller storm event is, statistically speaking, not possible as it implies that every year, without fail, an event of that magnitude or greater will take place. As was evident in 2017, it is possible that such an event does not take place. However, for the purposes of this analysis it was felt that such an approach was reasonable and would provide the required insights.

3.2 Development Layouts

The layouts for the proposed development have evolved through a number of iterations with the proposals increasingly gaining a focus towards transforming the Liesbeek River Canal into a more natural river channel that provides habitat for a variety of fauna and flora. This would link with the Raapenberg wetlands and is seen as improving the overall functioning of the ecological systems in the area. The changes have resulted in two primary development options:

- Option 1 (Figure 3-4) – which envisions the transformation of the Liesbeek canal and the partial filling of the 'old' Liesbeek River; and
- Option 2 (Figure 3-5) – which leaves the Liesbeek canal and 'old' Liesbeek River largely untouched.

On account of the backwater effects of the downstream railway bridges – essentially causing a damming effect that impacts on the River Club site – the differences between Options 1 and 2 are inconsequential. Therefore, this study has been based on the Option 1 layout which is also perceived to be the preferred layout.

It should be noted that the proposed development is not explicitly in accordance with the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) and would require the City to make exceptions for the following provisions:

- Section 9.2: Flood Management and Public Safety
  - Permission to develop / obstruct the free flow of water within the 20-year flood line area would need to be granted.
- Section 10.5: Table 1: Framework for the assessment of Proposals
  - The current assessment framework forbids development (including filling) within the 50-year flood plain. It notes: "*In exceptional circumstances minor "smoothing" of the 50 / 100-year flood line may be considered, provided equivalent compensatory stage storage volume is provided within the development precinct*".
  - As the proposed development falls under the 50-year flood line, a deviation from the policy, allowing the developer to fill (considered development) would need to be granted.

Notwithstanding the above, the City could approve the development based on the "*geomorphological, maintenance, social and economic aspects*" (presented by other specialists), and on the findings of this study.

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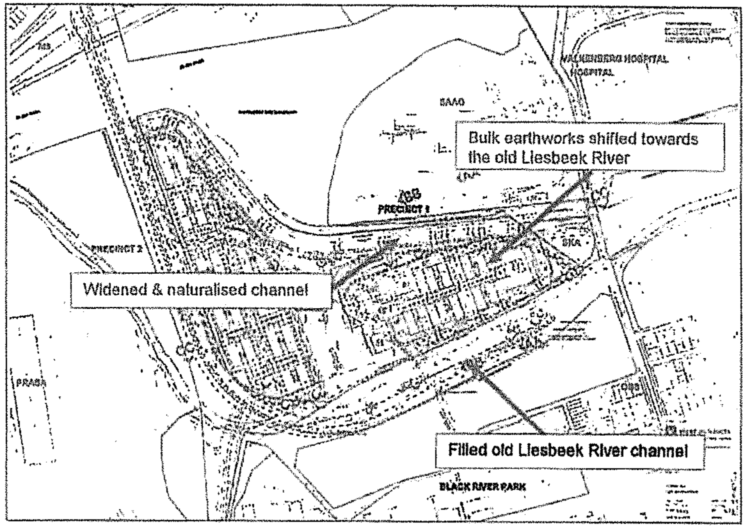

Figure 3-4 Layout option 1, showing the most significant difference with Option 2

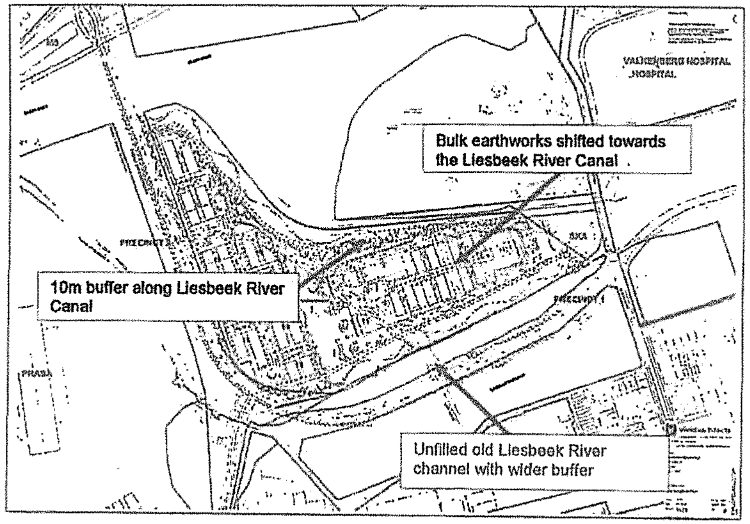

Figure 3-5 Layout option 2, showing the most significant difference with Option 1

3.3 PCSWMM-2D

PCSWMM-2D was used as the primary tool for analysing the impact of the proposed River Club development on the surrounding areas. PCSWMM was selected because:

- The City had recently used PCSWMM for a similar study of the area and therefore the use of PCSWMM for the current study would facilitate comparisons;
- PCSWMM incorporates the minor stormwater system into the model – which is important within an urban area; and
- The background models – previous studies prepared for the City – were SWMM based.

For the current study the PCSWMM models were set up as 1D-2D models. This models the minor stormwater system and the river channel as 1D conduits and the floodplain as a 2D mesh. The selection of the mesh resolution was important as higher resolution meshes result in longer model run times, whereas lower resolution meshes might affect the reliability of the results. The selected mesh resolution used within the modelling area is shown in Figure 3-6. As is evident from Figure 3-6, the mesh in the vicinity of the River Club was generated with a significantly higher resolution than the mesh for areas of less interest – e.g. Paarden Eiland.

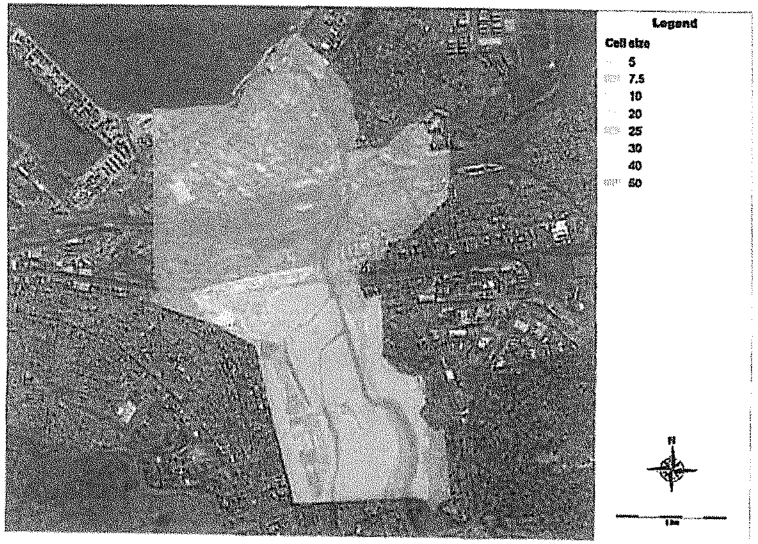

Figure 3-6 Area modelled in 2D showing the resolution of mesh in each area

3.4 HEC-RAS

HEC-RAS 5.0.3 was used in this study to model the site in 2D. This was in response to comments made in RH-DHV (2017) which questioned the use and appropriateness of PCSWMM. Both PCSWMM and HEC-RAS have their own strengths and weaknesses for modelling and therefore it was decided to undertake the additional HEC-RAS modelling as a confirmatory check – not to replace the PCSWMM model.

The 2D mesh for the HEC-RAS model was developed using QGIS and the 'RiverGIS' plugin. For the HECRAS mesh (Figure 3-7), the same break lines that were used for the PCSWMM model were used and supplemented by break lines along the centres and edges of the respective rivers. The addition of the break lines representing the centres and edges of the respective rivers in the HEC-RAS model was utilised due to the HEC-RAS model being a fully 2D model, and because of HEC-RAS's computational methods. It was also necessary to ensure that the edges of the river (sometimes elevated above the surrounding area) were clearly defined to prevent 'leakage' within the modelling.

HEC-RAS is currently unable to model bridges in the fully 2D modelling environment, and as noted in Neelz & Pender (2013) there is a degree of uncertainty concerning the linking of 1D channels and the 2D flood plain. Therefore, it was decided to use HEC-RAS in a fully 2D modelling environment (rather than the 1D-2D modelling environment) and to overcome the existing restriction with regard to modelling of the bridges within the 2D environment, two approaches were followed:

- Both approaches make use of open source software, and therefore once the 2D mesh was generated it was imported into HEC-RAS where the Mesh was edited, finalised and the relevant 2D modelling parameters were generated.
- HEC-RAS made use of the same DTM's and land-use / roughness parameters as SWMM.

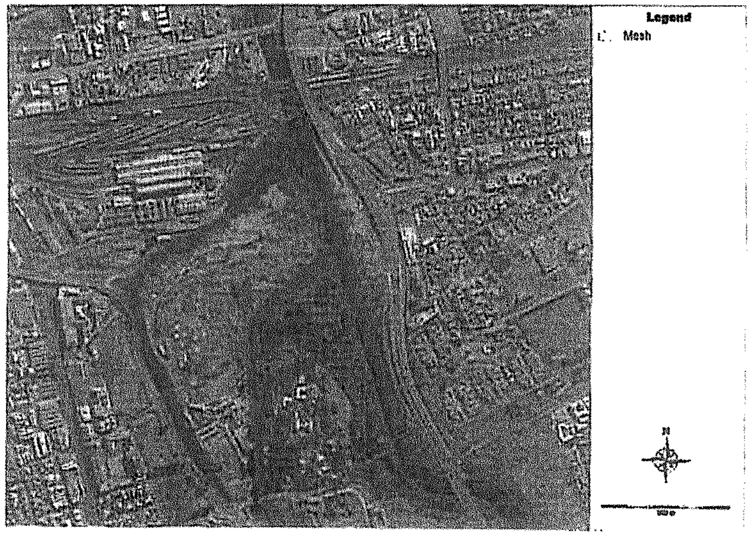

Figure 3-7 HEC-RAS 2D Mesh – showing varying resolutions

3.5 Accuracy of Models

The City has, historically, preferred two models for hydraulic and hydrological modelling. The hydrological determinations have typically been undertaken with PCSWMM; and the hydraulic modelling with HEC-RAS. It is worth noting that the PCSWMM routes the runoff from multiple sub catchments by performing hydraulic calculations, and therefore that it is not purely a hydrological model. PCSWMM's routing can therefore have an impact on the HEC-RAS outputs. More recently the City has preferred PCSWMM 2D for its 2D modelling. It should be noted that modelling hydraulic and hydrological systems is not an exact deterministic science – different models and modellers may obtain different results. This is further complicated by the selection of modelling approach. PCSWMM 2D Modelling approach – sometimes called 'quasi-2D – is equivalent to the 'diffuse wave solution' in that it does not incorporate the full 2D momentum equation. On the other hand, HEC-RAS uses the 'diffuse wave solution' – as opposed to the 'full momentum solution' – which runs faster and is more stable. While the full momentum solution is considered more accurate it does require calibration – as do all models – and HECRAS also contains more parameters for which values are uncertain – especially when calibration is not possible.

The variation in modelling results is evident in the recent 2D bench marking studies – based on the original benchmarking study by Neelz & Pender (2013) – where the results varied for a variety of reasons between the different models as shown in Figure 3-8. It is worth noting that when PCSWMM modelled the scenario the results (overlaid on top of the original study) appeared to be reasonable. HEC-RAS also modelled the same scenario and its results were also reasonable. There were differences between the full momentum and diffuse wave solutions of about 300mm – as shown in Figure 3-9.

Essentially, a review of both the PCSWMM and the HEC-RAS models indicated that both provide reasonable 2D modelling results.

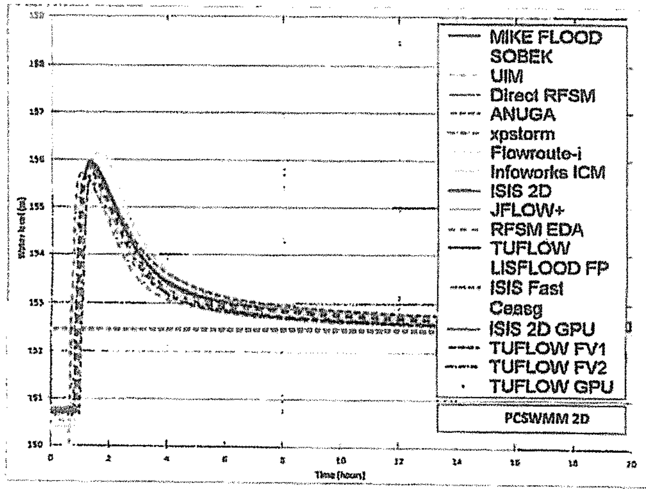

Figure 3-8 Comparison of the 2D modelling results for a valley flooding scenario (Test 5, Point 3) (Neelz & Pender, 2013)

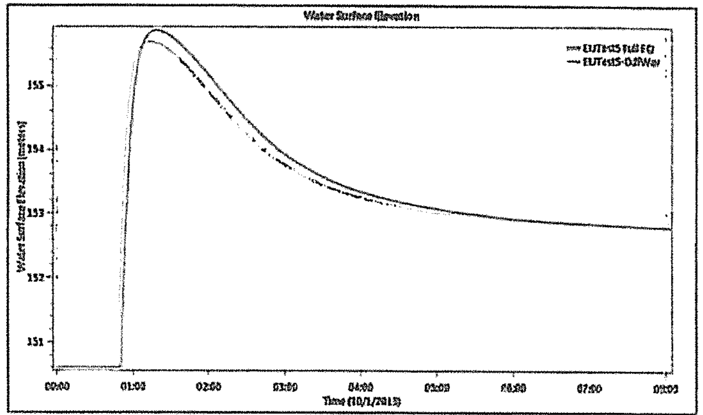

Figure 50. Test Point 3 - Water Level (depth) for Full Equations and Diffusion Wave.

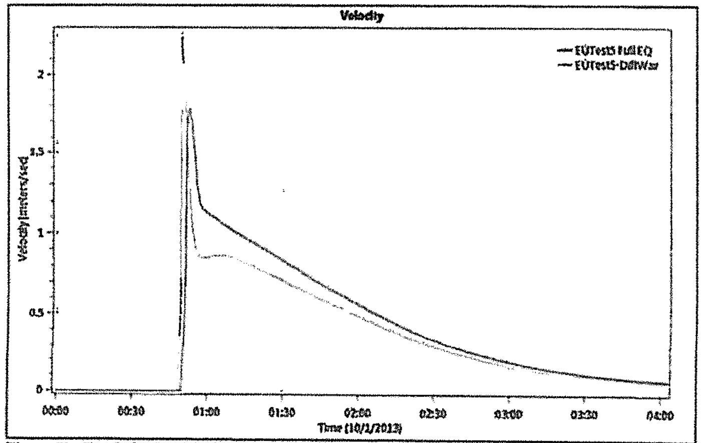

Figure 51. Test Point 3 - Velocity Time Series for Full Equations and Diffusion Wave.

Figure 3-9 Comparison of the 2D modelling results for a valley flooding scenario (Test 5 , Point 3) (Brunner, 2016)

3.5.1 Model complexity

It is important to recognise the context, especially with regard to data availability, within which these models have been developed. Wainwright & Mulligan (2013) state that an *'optimal model is one that contains sufficient complexity to explain phenomena, but no more'*. James (2005) suggests that it is sometimes assumed that the reliability of a model will increase with its complexity to a certain point, and that beyond this, the reliability will decrease (Figure 3-10). James (2005) notes that this has never been proven for surface water models. Therefore taking a parsimonious approach to modelling – developing a model with the greatest explanatory power and the fewest parameters or complexity – *is a particularly important principle in modelling since our ability to model complexity is much greater than our ability to provide the data to parameterize, calibrate and validate those same models'*(Wainwright & Mulligan, 2013).

It is difficult to determine the required level of complexity, as there is no accepted measure of this (James, 2005). However, experience and intuition will assist in the development of good models (Wainwright & Mulligan, 2013).

Data are crucial for the development and calibration of reliable models. In theory, the more data available, the more reliable the model should be (James, 2005). There is a relationship between complexity and the amount of data that is available as shown in Figure 3-11 which suggests that a more complex model will be more uncertain than a less complex model with minimal data, but less uncertain than a less-complex model with a lot of data.

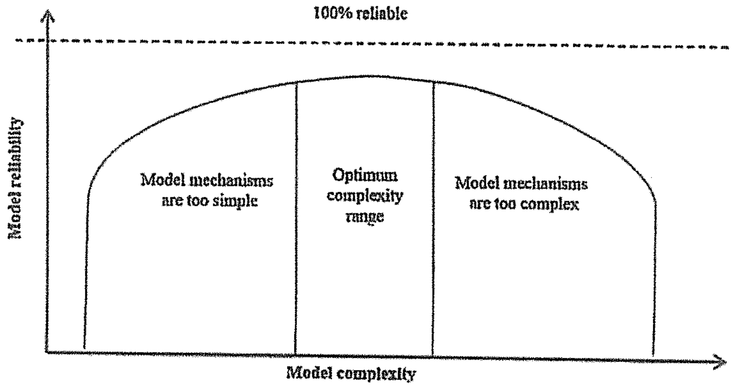

Figure 3-10: Relationship between complexity and reliability (After James, 2005)

In essence, choosing the correct level of complexity is a difficult but important part of modelling. Models should be neither overly complex nor too simple. Overly complex models will consume more time and money and potentially offer less reliable results. On the other hand, a model that is too simplistic may not offer adequate reliability (Wainwright & Mulligan, 2013; James, 2005; van Waveren et al., 1999). Ideally it is preferable to select *'no more complex a model or representation of reality than is absolutely necessary'* (Wainwright & Mulligan, 2013).

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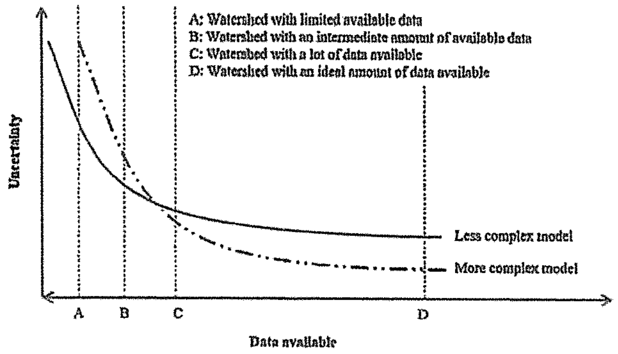

Figure 3-11: Relationship between data, uncertainty and complexity (After James, 2005)

Considering that this catchment has limited functional and reliable flow or depth gauges, it is not reasonable to expect a very complex model (i.e. full momentum 2D model) to be of much additional value as there is too much uncertainty – especially concerning the modelling of bridges.

3.5.2 Advantages and disadvantages of the different models

Both HEC-RAS and PCSWMM provide reasonable results. Each model has its own advantages and disadvantages as follows:

- HEC-RAS is generally better for modelling large river systems:
  - HEC-RAS 1D is better at modelling bridges and inline structure
  - HEC-RAS 1D provides a more accurate Energy Grade Line (see Section 3.7)
  - HEC-RAS 2D is currently not capable of modelling bridges and instead assumptions – much as for SWMM – need to be made.
  - HEC-RAS 2D can implement the full momentum 2D modelling equations, but without calibration this adds further uncertain parameters which may affect the results.
- PCSWMM is generally better for modelling in urban areas:
  - Models the stormwater system – both major and minor – which allows it to highlight potential trapped low points and back flooding through the stormwater system
  - Does not discretely model bridges, but approaches have been developed and tested that account for the energy losses at the bridges in the SWMM model (e.g. James et al., 2012).
  - SWMM 2D – a 'quasi' 2D model – allows for the incorporation of the minor stormwater system with surface flows.

While the Black River is a 'large river' for Cape Town, it is not particularly large when compared to other rivers in South Africa and across the world. The surrounding urban areas are relatively low lying and thus being able to incorporate the minor stormwater systems in the modelling is important and useful as there is evidence that some of the flooding is due to the minor systems surcharging. Therefore, while

both HEC-RAS and PCSWMM could be used, it is considered that because of the urban nature and various types of flooding (e.g. surcharging of minor systems) PCSWMM is likely to provide the best representation of the flooding for the various flood recurrence intervals. On the other hand, HEC-RAS was used to confirm that the PCSWMM results were reasonable.

3.6 Quantifying the Risk to the Raapenberg Wetlands

Dr Day – the appointed Fresh Water Ecologist – identified the need to quantify the risk of changes to the hydrological and hydraulic regime in the Raapenberg wetlands as a critical component of her study. Initially, this was to be achieved by utilising flow data collected by the City. Of the two gauging stations, only the downstream station (Glamis Close) was in operation. After an analysis, and cleaning of the data it was determined that the data was not reliable. This meant that any analysis undertaken by Dr Day would have a low level of confidence, and so would not be of use in assessing the impact on the Raapenberg Wetlands. It was therefore decided that it would be necessary to approach this aspect of the surface water study differently. This was done by surveying the Raapenberg wetlands, and using biological indicators (e.g. reed and other plant zonation) to deduce what were the critical potential hydrological and hydraulic impacts. The survey identified a number of important features of the area:

- The water level in the Raapenberg wetlands is approximately 250mm lower than that in the surrounding Rivers.
- There is evidence of wetland vegetation that grows in brackish water.
- There was an informal intervention shown in Figure 3-12 which was to excavate with the intention of increasing / allowing flows into the wetland. This intervention was performed by a "Friends of the Liesbeek" maintenance team following concerns raised by SAAO and members of TRUPA regarding the lack of water in the Raapenberg wetland. The intention was to try and divert water into the wetland.
- There is an artificial channel that seems to have been created along the boundary of the SAAO property. This is not linked to the Liesbeek or Black River Systems.

Figure 3-12 Intervention that encourages flows into the wetlands

The findings of the site visit suggested:

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- An increase in the recurrence interval of flooding would have a negative effect on the functioning of the wetland. Therefore, the pre- and post (proposed) development scenarios were modelled to determine when the wetland would fill with water.
- The increase in volume flowing into the wetland would have a negative impact on the functioning of the wetland as the wetland is not primarily a freshwater system, and because increased water depths would result in a change in the distribution of different plant species (Flow into the wetland cannot drain out due to the differential in the water levels in the wetland and in the nearby rivers). As such the pre- and post (proposed) development scenarios were modelled to determine when the wetland would fill with water.

3.7 Widening the Salt River Channel

In 2004 Ninham Shand undertook a study on behalf of City which investigated the possible widening of the Salt River Canal. This emanated from a review of a 1957 Council proposal for flood relief which involved widening, and in some areas, concrete lining of the river channel. This scheme would entail the widening of the Salt River Canal from the original current width of 46 m to 61 m (an increase of 15 m). In 1974, the City's Executive Committee approved a recommendation by the Utilities and Works Committee that the Salt River Canal (canal downstream of the Railway Bridges) be widened (by 15m) and that land adjacent to the canal, that was required to effect the widening, be acquired by the City. To date, some of the required land is still not owned by the City and the widening of the canal has not been implemented.

In the 2004 Ninham Shand study, and in line with the 1974 scheme approved by the Executive Committee, all existing road and rail bridges over the Salt River Canal were evaluated in terms of requirements for widening of the canal.

The results indicated some significant changes in the elevation of the flood line. When these elevations are plotted on the latest DTM, the benefits of this scheme are only realised in the vicinity of the PRASA site – Figure 3-13. It is important to note that the Ninham Shand report of 2004 was produced prior to the adoption of climate change and sea level rise factors.

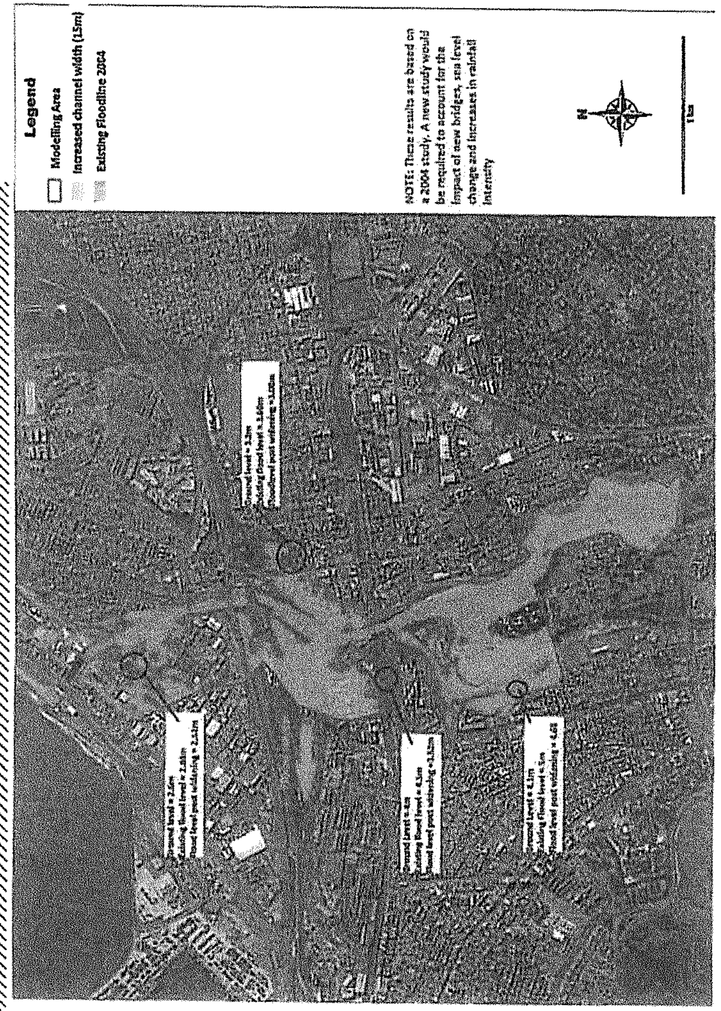

Figure 3-13 The effect of widening the Salt River Canal and associated bridges based on Ninham Shand 2004

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The TRUP study (RH-DHV, 2017) also considered widening of the Salt River Canal. The study examined the potential benefit of widening the canal by modelling an additional 25 m wide rectangular canal in parallel with the Black River channel and the existing Salt River Canal, together with widening of the bridges crossings. It is uncertain why 25m was selected, and it is unlikely that it would be possible to widen more than the 15m originally proposed. RH-DHV found that immediately downstream of the N2, there would be a predicted reduction of 0.83 m in the water level due to the 15 m widening. The RH-DHV report noted that canal enlargement would involve significant capital costs.

The City, none the less requested that this study also consider the possible effect of widening the canal and removing any restrictions (e.g. bridges). The following assumptions were made:

- The bridges could be engineered / re-engineered to not affect the flow in the Salt River – i.e. span the river.
- The canal was assumed to be a 61m rectangular cross-section – with the same invert levels as the existing canal.

Such a scenario would represent the 'absolute best case' scenario and is, in Aurecon's view, unlikely to ever be realised. The City, however requested, that no option / possibility should be excluded.

3.8 Sediment build up at the canal outfall

It was noted that the survey showed that sediment had built-up at the Salt River Canal outfall into the ocean. A review of historic images – on Google Earth – indicated that since 2000 there was only one year (Figure 3-14) in which the canal was clear – i.e. no sediment build up – meaning it had 100% of its capacity. Aurecon believes that during any significant flood this sediment would erode effectively leaving the canal with its full capacity. This may not happen for smaller floods. Therefore, all recurrence intervals were modelled assuming the sediment would not erode (worst case scenario), except the 100-year event which was modelled twice assuming that the sediment would / would not erode.

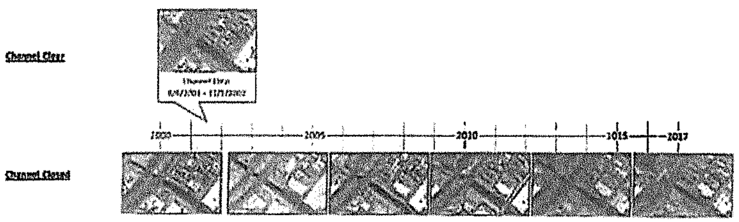

Figure 3-14 Evidence of sediment at the mouth of the Salt River for 16 of the last 17 years.

3.9 Closing the 'PRASA' overland escape

As highlighted in Section 2.2, all the previous studies have identified a major storm event flood route across the PRASA site. There has been concern about what would happen if this flood route were to be closed. While doing so would be illegal and counter to the City's policies, the City nonetheless requested that this scenario be modelled. In order to do so it was assumed that PRASA would berm the 'old'

Liesbeek so that flood waters would not flow onto its property. This scenario was tested for both the status quo and the post development scenarios.

3.10 Water Surface vs Energy Level

It is important to note that all results in this report, and all conclusions drawn from the reported results are based on simulated Water Surface Elevations (WS) and not on Energy Levels (EL). This is contrary to the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) (developed prior to the widespread use of 2D modelling) which requires that "*all flood lines must be based on the theoretical energy level as opposed to the water surface level*". These requirements are most appropriate for 1D models, whereas on this site the City has indicated a preference for 2D modelling. The use of energy levels is not appropriate for 2D modelling as for 2D models the extent of flooding is determined by the boundary between "wet" and "dry" cells. At the edge of the flood extent flow velocities are typically minimal / non-existent and therefore the Energy Level is, approximately, the same as the Water Surface level.

Where the energy level has been provided, this has been done by adding the energy head ($V^2/2g$) to the water level.

3.11 Hazard Analysis

The City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) considers, as part of its flood plain management, the hazard that flooding may pose to life and property. The hazard posed by flood waters (excluding water quality) is based on the ability to wade or gain vehicular access as well as the stability of structures such as dwellings or boundary walls. If these are likely to be seriously compromised, the area is considered to be in the High Hazard Zone. In terms of the City's '*Floodplain and River Corridor Management Policy*' "*No new or additional rights or the exercising of existing development rights will be granted to properties located within the high hazard zone*" as determined in accordance with Figure 3-15 (CSRM, 2009a).

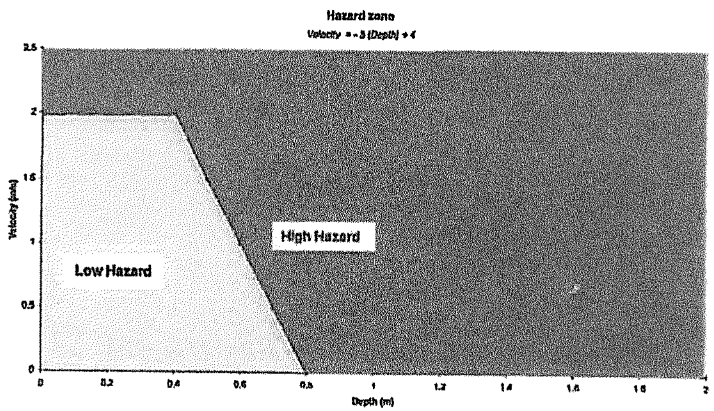

Figure 3-16 Flood Hazard Zones

Furthermore, the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) notes that: *"The permissible extent and nature of land use, development or activities within floodplains must be subject to stringent evaluation and control in the interests of public safety. In particular, obstruction to the free flow of water within the 20-year flood line area shall not be permitted. However, between the 50 and 100-year flood lines, some developments or activities may be permitted, subject to such conditions as the City may in its discretion impose, while developments with particular evacuation or emergency response issues and high risk developments will only be permitted above the 100-year flood line"*

3.12 Sensitivity Analysis

In order to ensure that any queries relating to the accuracy / reliability of the City's hydrologic models for the greater Salt River catchment could be quantified, a sensitivity analysis was undertaken by modelling a storm with a 1 in 200-year Recurrence Interval using the same approach as discussed in Section 3.1.6 for the scaling of intra-year events.

4 Modelling Results

This study assessed 35 Scenario's with a total of 39 model runs utilising two 2-Dimensional hydraulic modelling software packages (PCSWMM and HEC-RAS) as summarised in Table 4-1 – making it the most comprehensive study of the site to date. It is not possible to present all output data in this report, and therefore only relevant information from the over 900GB of output data which was generated is presented.

Table 4-1 Overview of the scenarios that were modelled and the model runs undertaken as part of this study.

Scenario	PCSWMM	HEC-RAS
Status Quo: 0.5-year	✓	✓
Status Quo: 1-year	✓	✓
Status Quo: 2-year	✓	
Status Quo: 5-year	✓	
Status Quo: 10-year	✓	
Status Quo: 20-year	✓	
Status Quo: 50-year	✓	
Status Quo: 100-year	✓	✓
Status Quo: 100-year (with widened Salt River canal)	✓	
Status Quo: 100-year (with 10-year sea level)	✓	
Status Quo: 100-year (PRASA overland route closed)	✓	
Status Quo: 100-year (PRASA overland route closed, Bridges obstructed)	✓	
Status Quo: 200-year	✓	
Post-development (River Club only): 0.5-year	✓	
Post-development (River Club only): 1-year	✓	
Post-development (River Club only): 2-year	✓	
Post-development (River Club only): 5-year	✓	
Post-development (River Club only): 10-year	✓	
Post-development (River Club only): 20-year	✓	
Post-development (River Club only): 50-year	✓	
Post-development (River Club only): 100-year	✓	
Post-development (River Club only): 200-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 0.5-year	✓	✓
Post-development (River Club, TRUP, NRF, PRASA): 1-year	✓	✓
Post-development (River Club, TRUP, NRF, PRASA): 2-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 5-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 10-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 20-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 50-year	✓	
Post-development (River Club, TRUP, NRF, PRASA): 100-year	✓	✓
Post-development (River Club, TRUP, NRF, PRASA): 100-year (with widened Salt River canal)	✓	
Post-development (River Club, TRUP, NRF, PRASA): 100-year (with PRASA overland route closed)	✓	
Post-development (River Club, TRUP, NRF, PRASA): 100-year (with PRASA overland route closed and bridges obstructed)	✓	
Post-development (River Club, TRUP, NRF, PRASA): 100-year (with 10-year sea level)	✓	
Post-development (River Club, TRUP, NRF, PRASA): 200-year	✓	
Total model runs:	35	6

For the purposes of this report the twelve key 'monitoring points' indicated in Figure 4-1 were selected for comparison purposes throughout Section 4 in this report. These points were selected to represent areas where any impacts of the proposed developments are most likely to be realised / be of concern. If necessary, the models can be used for comparisons at any point within the modelling area.

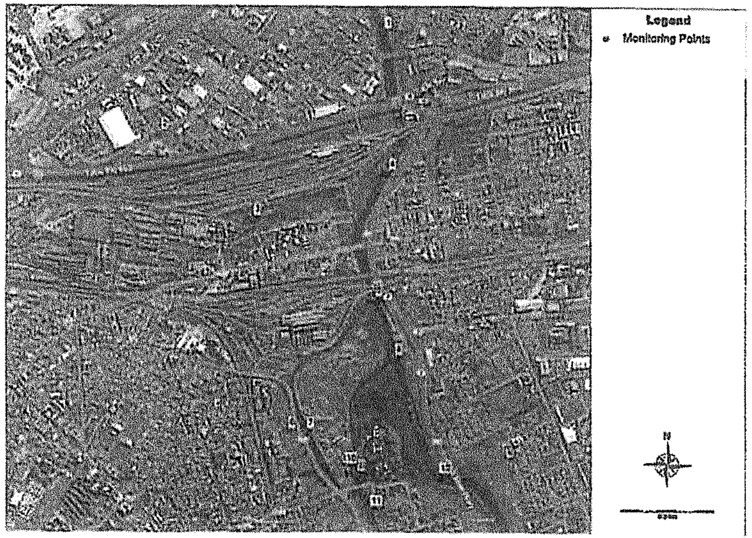

Figure 4-1 'Monitoring points' used for comparison between the different scenario's

4.1 Accuracy of the models

The PCSWMM models performed well, as all the models had 'routing continuity' and 'runoff continuity' errors of less than 1% which is considered acceptable (Rossman, 2008; CHI, 2017).

A comparison of the PCSWMM and HEC-RAS models showed the following:

- The HEC-RAS (Diffusion Wave model with the bridges modelled as 1D gates) and the PCSWMM models provided results that were within 0.01m of each other. Such differences were considered to be very good, especially considering the differences in ways that each of these programs models the flow.
- When HEC-RAS (Full Momentum equation with the bridges modelled as 1D gates) was used there appeared to be an increase in the backwater effect of the bridges immediately downstream of the River Club site. This appears to be as a result of a combination of adding the momentum component of the 2D equation and the manner in which the bridges were modelled (1D) within the 2D mesh. The results were compared with the results of previous models (especially Ninham Shand, 2004) and it seemed that the use of the full momentum equation with 1D elements within the 2D mesh (Bridges) resulted in some modelling instability.
- For both models the comparative increases in water levels between pre- and post-development were effectively the same.

- When modelling the lower recurrence intervals it was possible to model the Bridges in 2D (by adding the piers into the model). For this scenario the results of the PCSWMM model and the HEC-RAS model were again within less than 0.1m. Unfortunately, as a result of the bridges all acting as controls, and the water levels potentially overtopping the bridges it was not possible to analyse the 1 in 100-year events.

All models have their limitations, however (with reference to Section 3.5) Aurecon is of the opinion that the models used for this investigation balance the complexity, uncertainties and data availability. PCSWMM and HEC-RAS both provided reasonable results in the 2D benchmark tests, and therefore the results presented herein, provide a reasonable basis for assessing the impacts of the proposed developments.

It is important to note that configuring the models was based on engineering judgement, and experience (Aurecon has more than 15-years' experience in this specific area), as there is no reliable data to calibrate the models.

4.2 Impact of the proposed development on flooding in the surrounding urban area

This section of the report presents and discusses the results of the modelling undertaken in order to determine the potential impacts that the proposed development might have on the adjacent properties.

4.2.1 Runoff from the site

The runoff from the site would have no impact on the flood level for a number of reasons:

- The conceptual design envisages a system of swales to attenuate and treat the flow – in accordance with the City's '*Management of urban stormwater impacts policy*' (CSRM, 2009b); and
- For larger storm events (e.g. 1 in 100-year recurrence interval flood events) the peak runoff from the site would occur approximately 1 to 3 hours before the peak flow in the adjacent rivers, and therefore the site's local runoff has an insignificant impact on the flows in the adjacent rivers

4.2.2 Flooding as a result of overland flow / minor system surcharging

Figure 4-2 highlights what is discussed in Section 2.1.7, concerning the flooding that occurs within the adjacent urban area and affects a number of houses. This flooding is the result of local overland flows that occur within the adjacent urban area when the local stormwater runoff exceeds the capacity of the local minor (piped) stormwater system. Figure 4-2 indicates that for storms equal to or smaller than the 1 in 20-year recurrence interval event local flooding in the highlighted area is a result of the stormwater system surcharging and resulting in overland flow.

As evident in Appendix B there is an increase in the extent of flooding extent of the Valkenberg wetland and the sports fields. It is Aurecon's view that the change in extent is exaggerated due to the computational and design of the model. As noted throughout this document the increase in water surface elevation that has been modelled is insignificant. It is more likely that during a storm event these areas will be inundated in any case.

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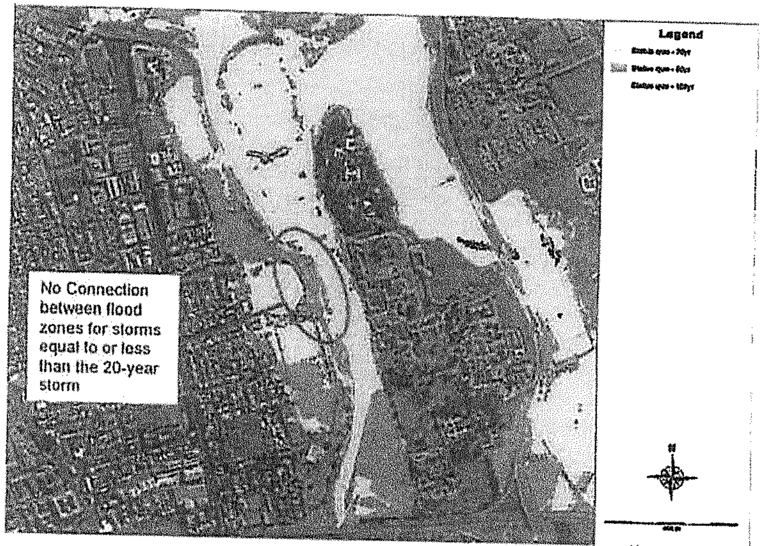

Figure 4-2 Flooding as a result of overland flow / minor system surcharging

4.2.3 Impact on water surface elevations

As expected, the most significant changes in water surface elevations would occur for the post-development scenario that includes the River Club, TRUP, PRASA and NRF developments. Table 4-2 provides a high-level overview of the differences in modelled water surface levels, based on the PCSWMM models, at 10 of the 12 monitoring points shown in Figure 4-1 – the results for all scenarios are provided in Appendix A. The TRUP development proposes that the sports fields along Liesbeek Parkway (Monitoring Point 6) are partially developed – resulting in no comparison between these two scenarios. Monitoring Point 2 consistently showed differences of between 0.01 m and 0.03 m for all recurrence intervals.

Table 4-2 indicates the following:

- For the 0.5-year and 1-year recurrence interval storm events the combined impacts of the developments would be small, possibly even reducing the water levels slightly. This is due to the small flows during these storms and the additional capacity, and perhaps the local attenuation volume that would be provided by the proposed new Liesbeek Canal design.
- The proposed developments would have minimal impact along the Salt River Canal. This is due to the canal overtopping and then flooding the neighbouring areas (Monitoring Points 1-4) except at Point 3 (appears to be in a wetland) at a low point where the level would increase by 0.08 m during the 1 in 5-year flood event.
- The greatest increases in water levels would be in the immediate vicinity of the River Club – Monitoring Points 5 through 12 – with the maximum expected increase in water level of up to 0.13 m (13 cm) for all flood events between the 1:5 year and 1:100-year return intervals.

- The impact of discharging runoff from the suburb of Observatory into the Liesbeek Canal (Post development scenario) rather than into the 'Old' Liesbeek, as well as cutting off the overland flow route over the River Club site connecting the Liesbeek Canal and the 'Old' Liesbeek appears to increase flow down the Liesbeek Canal and contributes to the increased water levels.

Aurecon would suggest consideration might be given to investigating ways of connecting the 'Old' Liesbeek and the Liesbeek Canal – this would aid in alleviating the above, negligible, effects.

Appendix A provides the results for the scenario where only the River Club is developed. While it is noted that the changes in water level are of a similar magnitude (differences typically +- 0.00m – 0.03m) to Table 4-2. It is important to note that if each of the TRUP, NRF and PRASA sites were to be developed in isolation, these results do not mean that they would only have an impact equal to the difference (typically +- 0.00m – 0.03m) between the post development scenarios including River Club, TRUP, PRASA, and the NRF sites and the post development scenario only including the River Club – as indicated in the RHDHV Study. This is due to the complexities of the hydrology and hydraulics in the vicinity of the River Club site.

Table 4-2 Summary of differences (m) in Water Surface elevation at the different monitoring points (Figure 4-1) between the existing status quo and the post development scenario (including TRUP, PRASA and NRF).

Recurrence Interval (Description)	Monitoring Point									
	1	3	4	5	7	8	9	10	11	12
0.5-year	-0.04	0	0.01	0.01	Filled 'old' Liesbeek	-0.01	0.02	0	0.02	-0.02
1-year	-0.03	Has surface water	0	0.01		-0.03	-0.02	0	0	-0.01
2-year	0.02		0.02	0.04		0.01	0.04	0.03	0.04	0.01
5-year	0.02	0.08	0.02	0.04	-0.01	0.04	0.11	0.11	0.12	0.04
10-year	0.01	0.01	0.02	0.05	0	0.06	0.12	0.12	0.14	0.06
20-year	0.02	0.01	0.02	0.05	0.01	0.07	0.11	0.11	0.12	0.07
50-year	0.02	0.01	0.02	0.08	0.04	0.1	0.13	0.13	0.12	0.1
100-year	0.02	0.02	0.01	0.07	0.07	0.09	0.11	0.11	0.11	0.09
200-year	0.01	0.01	0	0.07	0.1	0.1	0.13	0.13	0.13	0.1
100-year (PRASA overland route closed)	0.02	0.01	0.01	0.08	0.1	0.1	0.12	0.12	0.12	0.1
100-year (Opened Salt River mouth)	0.02	0.01	0.01	0.07	0.07	0.09	0.11	0.11	0.11	0.09

The increases in water surface elevations shown in Table 4-2 need to be seen in the context of the uncertainties associated with modelling, the effects of wave action, the size of the storm event and the extent of inundation (as discussed in Section 4.2.4). In the light of all these considerations the increase in the modelled water surface elevations is relatively insignificant.

4.2.4 Impact on the extent of inundation

The increases in water level shown in Table 4-2 would result in limited changes in the extent of inundation for all recurrence intervals as is evident from Appendix B and discussed below. The relatively minor local changes in the depths of inundation shown in Table 4-2 has little impact on the extent of flooding, and it requires a detailed inspection of the modelling results to identify differences in the extents of flooding – except for the 20-year where the extent increases into the Valkenberg wetland and into public open space. While the results for all the different scenarios are available – Appendix B – the only scenarios that would, potentially cause flooding of already developed properties are the 1 in 50-year flood event (Figure 4-3 and Figure 4-4) and the 1 in 100-year flood event (Figure 4-5 and Figure 4-6). These properties would be affected by flooding, to some extent whether the additional developments take place or not.

There are two minor exceptions where additional flooding would occur on account of overland flow. These are the properties discussed in Section 4.2.2 and the SAAO building which is discussed in Section 4.3. Therefore, the remainder of this section focuses on the main differences in flood extents for the 1 in 50-year and the 1 in 100-year recurrence interval storm events.

Figure 4-3 to Figure 4-6 show insignificant changes to the extent of flooding i.e. the area that would be flooded. The most noticeable changes are highlighted (Red Circles) and mainly comprise very shallow flooding on the PRASA site. The very small increases in the extent of flooding do not appear to compromise any infrastructure that is not already affected – most of the additional areas that would be flooded being railway lines. The other noticeable change is to the south of the modelling area as indicated in Figure 4-6, which would not have a significant impact on the existing flooding situation.

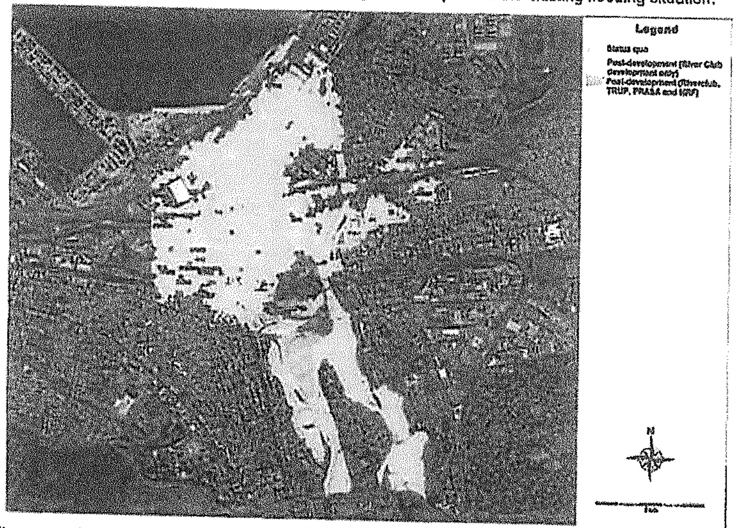

Figure 4-3 Maximum extent of inundation for the 50-year flood (whole model)

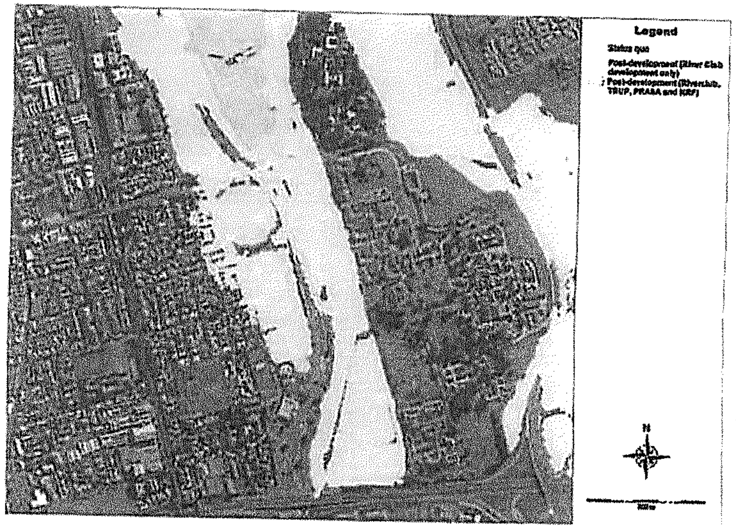

Figure 4-4 Maximum extent of inundation for the 50-year flood (Vicinity of River Club)

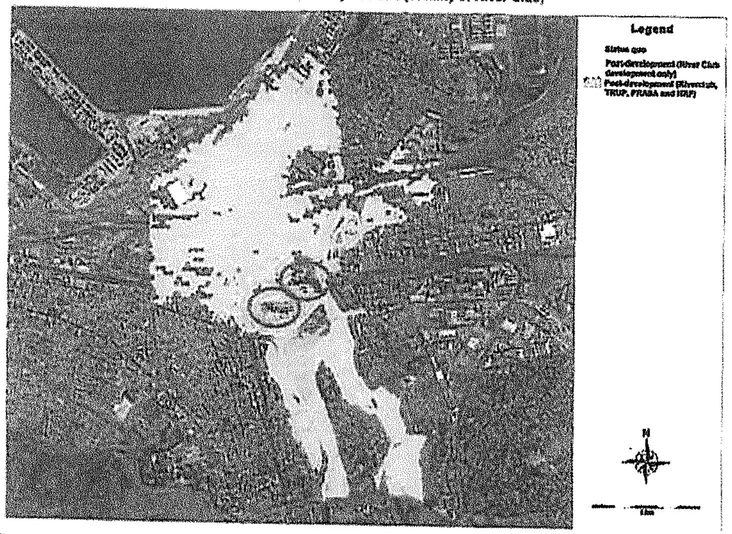

Figure 4-5 Maximum extent of inundation for the 100-year flood (whole model)

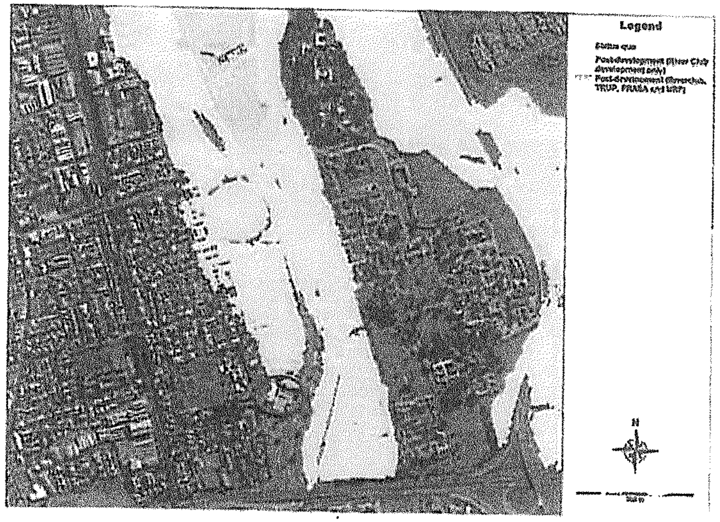

Figure 4-6 Maximum extent of inundation for the 100-year flood (Vicinity of River Club)

4.2.5 Changes in flow

The flows were assessed at the seven locations shown in Figure 4-7, and Table 4-3 provide a high-level overview of changes in the flow characteristics as a result of the proposed development/s.

Table 4-3 indicates the changes in the characteristics of the 1 in 100-year flood that would occur at various locations on account of the proposed developments. The main increases in flows would occur at the Salt Left and at the Black@River_Club. These increases are also evident from the hydrographs shown in Figure 4-8. The total volume of the flood at the Salt Left would increase by 4% as a result of the 7% increase in the peak flow. As discussed in Section 4.2.4, this change would have little effect on the aerial extent of flooding, as it would have little impact on the depth of flooding as discussed in Section 4.2.3. The additional flooding would also have little impact on the extent of the high hazard zone further downstream as discussed in Section 4.2.6. As the flood peak would occur marginally earlier as indicated in Figure 4-8 – which equates to a few minutes earlier rather than hours earlier and is thus of little significance.

The flow at Black@River_Club shows a significant, 24% increase in the peak flow that would occur for a couple hours. This increase in peak flow would occur because the proposed River Club development would effectively block the existing flow route that would have connected to the 'Old' Liesbeek River. This would force all the flow down the Liesbeek Canal route. This increased flow results in the slightly greater increases in flood levels in the vicinity of SAAO (Section 4.2.3). The effect though is localised along the course of the Liesbeek Canal (alongside the River Club site as is evidenced by the flow characteristics upstream (Black_River and Liesbeek) and downstream (Salt@Railway) in Table 4-3 and Figure 4-8. Figure 4-8 clearly demonstrates that the flow, and timing of the peak, under the railway bridges immediately downstream (Salt@Railway) is largely unaffected. As such, the effect is localised,

does not significantly affect any properties other than the River Club and SAAO, the impact of potential in the damage to property and the loss of human life is considered small. It is worth noting that the detailed design of the 'new' Liesbeek Canal, and extension to Berkley Road Bridge would need to account for the above changes in flow.

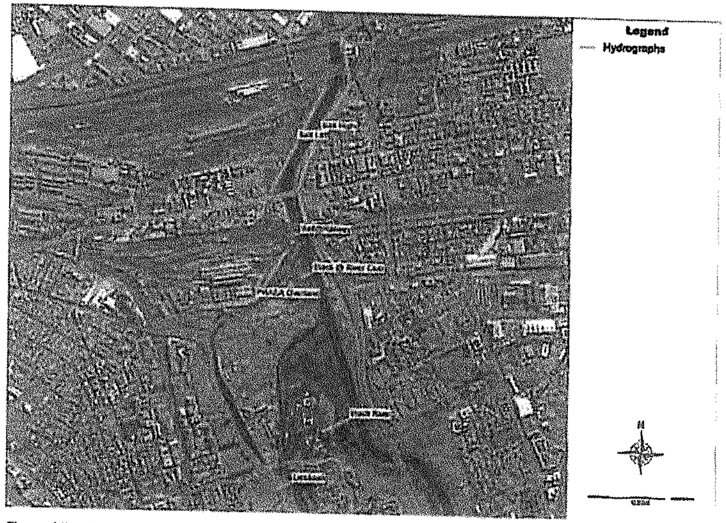

Figure 4-7 Locations at which flow was analysed

Table 4-3 High level overview of changes in the 1 in 100-year flood characteristics as a result of the proposed developments

Objective Function	Black @ River Club Status Quo	Black @ River Club Post-development	Black River Status Quo	Black River Post-development	Liesbeek Status Quo	Liesbeek Post-development	PRASA Overland Status Quo	PRASA Overland Post-development	Salt Left Status Quo	Salt Left Post-development	Salt Right Status Quo	Salt Right Post-development	Salt@Railway Status Quo	Salt@Railway Post-development
Maximum Flow(m^3/s):	202.2	249.1	212	215.1	96.29	96.38	6.045	9.319	125.4	134.2		*	242.5	249.9
Minimum Flow(m^3/s):	13.86	15.57	11.13	12.3	-1.428	-1.034	-0.1065	-0.1359	-0.02391	-0.01814			16.05	16.51
Mean Flow(m^3/s):	106.4	121.7	97.28	97.26	24.81	24.59	0.5272	0.8095	35.72	37.11			123.4	123
Total Flood Volume($1000m^3$):	10930	12490	9990	9988	2548	2525	54.14	83.14	3559	3811	-462.3	-486.3	12680	12640

*Due to a significant stormwater culvert crossing the flow path the estimation of peak discharges is distorted

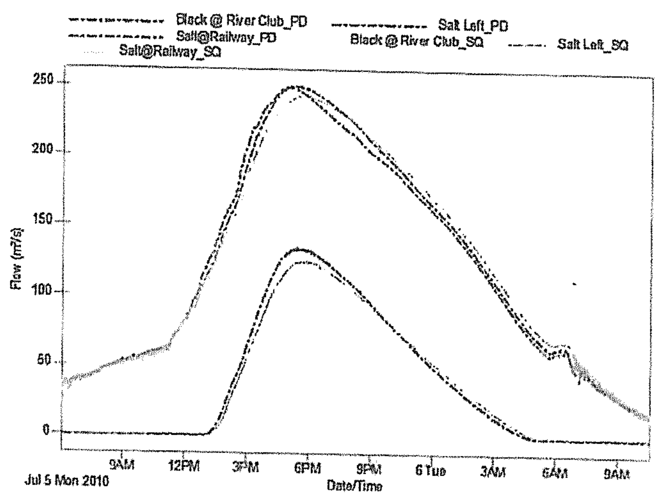

Figure 4-8 Hydrographs at locations where noticeable changes in flow were detected (SQ = Status quo; PD = Post development with NRF, TRUP, PRASA, River Club)

4.2.6 Environmental and Proposed Development Considerations and Constraints

The increased water levels at Monitoring Point 5 shown in Table 4-2 and in Figure 4-1 arise mainly from the additional losses at the railway bridges on account of the higher flows. The additional increases in water levels further upstream appear to arise from the following:

- The increased flow in the channel between Points 5 and 8 with no improvements to the channel.
- The proposed configuration of the channel from Points 9 and 10 which was determined in accordance of the environmental constraints which include the approximately 25 m wide buffer strip to be provided within the boundary of the proposed River Club development.

4.2.7 Hazard Analysis

The hazard analysis indicates that currently a significant portion of the River Club Site falls within the High Hazard zone. In terms of the City's 'Floodplain and River Corridor Management Policy' (CSRM, 2009a) development would not be allowed. Should the development be elevated out of the flood plain – as is proposed – and there be adequate, safe access the development would no longer fall within the High Hazard Zone. This would however require a deviation from Section 9.2 of the City's 'Floodplain and River Corridor Management Policy' (CSRM, 2009a) which prohibits new or existing rights within the High Hazard zone – and considers 'Filling' as development.

The analysis indicates rather limited changes to the type and extent of flood hazards – highlighted in Figure 4-9 and Figure 4-10. The impacts at the locations of the numbered circles in Figure 4-10 are described below:

- Circles 1& 2: The affected area on the PRASA site is discussed in Section 4.2.4. This increase would have little or no impact.
- Circle 3 highlights a potential change in hazard that appears to border / incorporate one lane of Liesbeek Parkway. This could have a significant impact. It is necessary to raise the road locally – where the hazard changes and for a short distance (e.g. 50m either side), as agreed with the City, to eliminate the potential high hazard caused by flooding in the 1 in 100-year. There would also be value providing warning signs.
- Circle 4 highlights the increase hazard evident in the vicinity of the Hartleyvale sports complex. This increase hazard is very localised and unlikely to have any impact – the area would normally be flooded and is unlikely to be used during extreme events such as the 1 in 100-year storm event.
- Circle 5 highlights that the existing Berkley Road is within the 100-year flood line and low hazard zone. This is section of road is also affected in storm events greater that the 1 in 20-year event. This should be considered and analysed in the final design

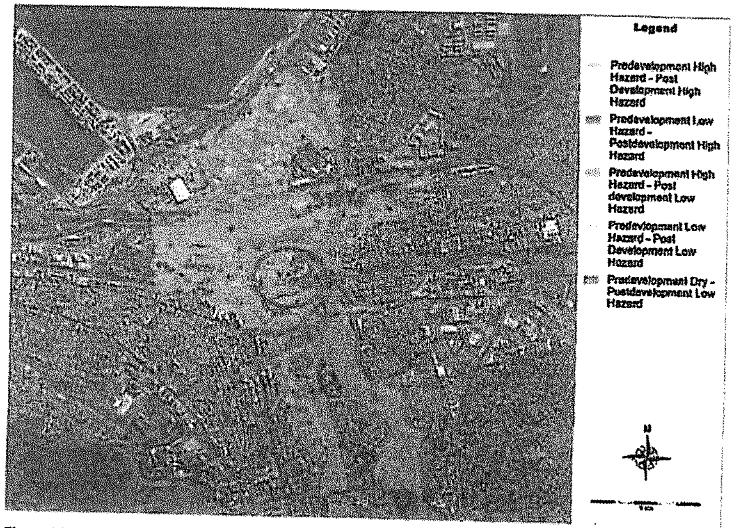

Figure 4-9 Impact of the development of the hazard of flooding (Whole model)

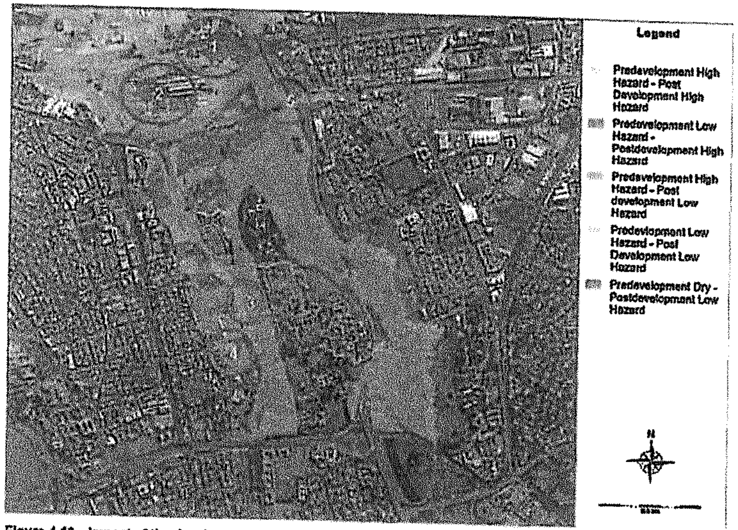

Figure 4-10 Impact of the development of the hazard of flooding (in the vicinity of the River Club)

4.2.8 Impact of the closure of the PRASA overland escape

The analysis of the impact of closing the PRASA overland escape route indicated, surprisingly, that it would have an insignificant impact on the extent of inundation during a storm event – as indicated in Figure 4-11 – assuming the flow through the bridges downstream of the site remained unobstructed. The change in water surface level for the 1 in 100-year flood event remains small at the monitoring points as highlighted in Appendix A.

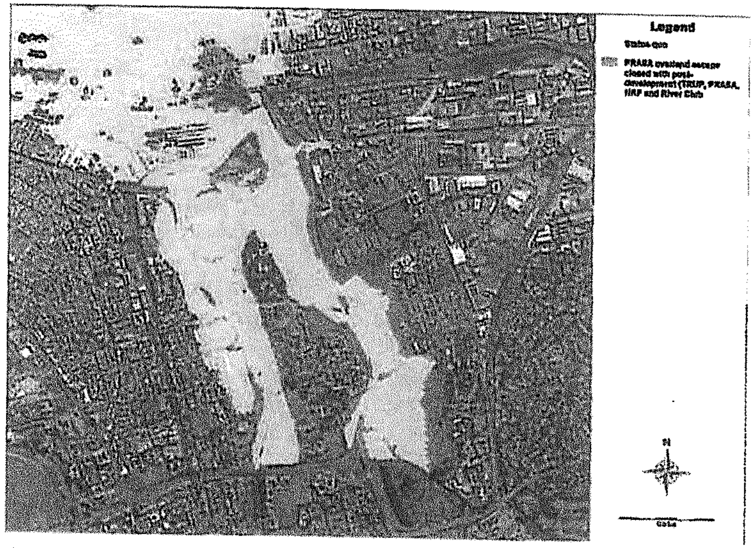

Figure 4-11 Impact on flooding of possible PRASA escape route during the 100-year Storm event

Should the flow through the bridges become obstructed (e.g. by debris flowing down the river) the importance of the PRASA escape flow route would increase. Therefore, is would be preferable for the City to ensure that this escape route is maintained for the following reasons:

- Should, for any reason, the railway bridges immediately downstream of the River Club site become blocked, the PRASA escape route would become critical – as shown in Figure 4-12.
- Once such a flood route is closed it is unlikely that it would be possible to re-establish it.

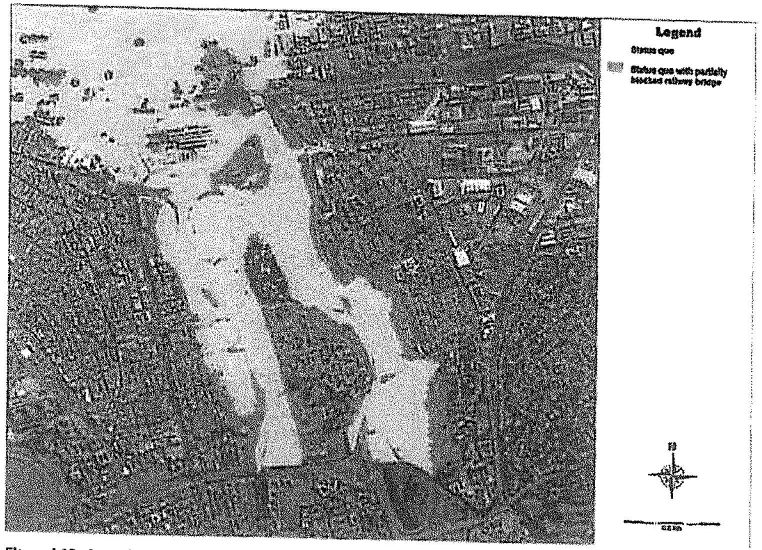

Figure 4-12 Impact of partially blocking the railway bridge immediately downstream of the River Club site

4.2.9 Impact of Sea Level rise

For the TRUP study conducted by RH-DHV (2017), which is discussed in Section 3.1.5, the City and RH-DHV agreed on certain boundary conditions based on the recommendations of PRDW which are discussed in Section 3.1.5 and summarised in Table 3-2 (PRDW, 2010). PRDW (2010) noted that preliminary results indicate that extreme rainfall events should be considered with storm surge events of a lower return period (i.e. 1 in 10 year storm surge – for which they did not offer an estimate in their study – with a 1 in 100 year flood event). As the City and RH-DHV had already agreed to using the 1 in 50 year storm surge with a 1 in 100 year flood event for the TRUP study and the surface water hydrology study is particularly contentious, Aurecon decided to use what RH-DHV had agreed with the City – 50 year storm surge. However for completeness, Aurecon also modelled the 10 year storm surge with a 100 year flood event. The results of the modelling are shown in Figure 4-13 which indicates very little difference in the extent of flooding. Aside from the area around Paarden Eiland, the water surface elevations remain within 1 cm (0.01 m) of each other – well within acceptable modelling error. There is a slight greater difference in modelled water surface elevations in the vicinity of Paarden Eiland – approximately 0.08 m – which is likely due to slightly less flooding from the canal and lower estimated tidal levels, but this is independent of the proposed developments and rather the selection of boundary conditions

These results are not entirely surprising as the tidal levels in Section 3.1.5 make provision for 0.55 m to account for sea level rise as a result of climate change and a storm surge which together add more than 0.8 meters to the Mean High Water Spring tidal level – which was used for previous studies. This larger sea level rise would seriously constrain the capacity at the outfall, likely contributing to the flooding. An investigation of the impacts of sea level rise is beyond the scope of this study, however it would be in the City's interest to undertake further modelling to assess how climate change and sea level rise impacts could be mitigated.

Another reason for the limited differences, regardless of the tidal levels, is that a significant portion of the flooding is as a result of the Salt River exceeding its capacity. However, as discussed in Section4.2.10, even if the Salt River Canal were to be widened, the benefit would be relatively minor.

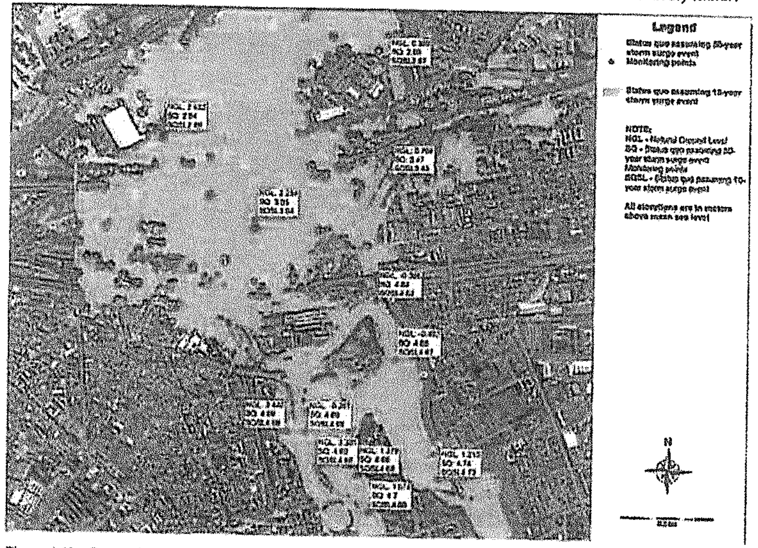

Figure 4-13 Comparison of the inundation considering the 100-year flood event in combination with the 50-year and 10-year storm surge events

Effectively this study indicated that due to the projected sea level rise, resulting from climate change, there would be flooding in the lower parts of the catchment – regardless of whether the development went ahead or not, and that the development is unlikely to have any effect on the extent of flooding.

4.2.10 Impact of widening the Salt River Canal

The City requested that this study should also consider the possible effect of widening the Salt River Canal and removing any restrictions (e.g. bridges). As discussed in Section 3.7, the modelling of this scenario would represent the 'absolute best case'. In Aurecon's view, such improvements are unlikely to ever be realised for a number of reasons, including both practical and economic considerations. The modelling considered the 1 in 100-year storm event and the following scenarios:

- Existing status quo (existing channel and development) – SQ;
- The status quo (existing development) with a widened channel (Section 3.7) – SQW; and
- The proposed River Club development together with the proposed TRUP, PRASA and NRF developments and a widened channel – PDTW.

The results which are summarised in Figure 4-14 indicate that widening the channel and removing the hydraulic effects of the bridges would reduce the maximum water surface level by between 0.1m and 0.8m. Interestingly this would have little impact on the extent of inundation, except as follows:

- The sports fields would not be inundated as the 'old' Liesbeek would not over top, although the fields would be lower than the water level in the canal and thus would be considered to be within the floodplain; and
- The PRASA land, also because the 'old' Liesbeek would not overtop.

There are some other minor differences between the status quo and the post-development scenarios with the Salt River Widened. These are most marked near the existing entrance to the River Club site about 0.35m. This effect is localised. For both scenarios with the widened Salt River channel, the extent of flood inundation would be reduced – but not significantly.

Widening of the canal would potentially have a negative environmental impact on the Raapenberg Wetland due to the lower water levels which would result in the wetland being flooded less frequently. Therefore, unless the value of development on the PRASA site were significant or critical as part of long-term city/town planning and the City were to undertake further modelling of the design of any widened channel, it is unlikely that widening the Salt River would be an economic or practical solution to flooding in the Salt River Catchment – whether the River Club development goes ahead or not.

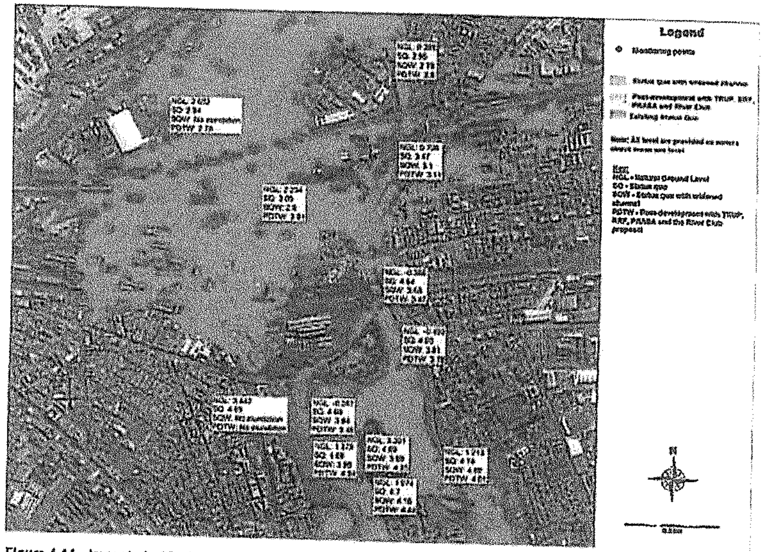

Figure 4-14 Impact of widening the Salt River on the extent of inundation of the 100-year flood

4.2.11 Sensitivity analysis

The sensitivity analysis, discussed in Section 3.12, indicated that although the proposed River Club and other developments would cause small increases in flood levels (as expected due to the increases in flow), the maximum differences between pre- and post-development flood levels would only be about 0.01 m (10 cm). Even if future models indicate increased or decreased flows in the Black and Liesbeek Rivers, it is likely that these would show similar differences in the pre- and post-development flood levels.

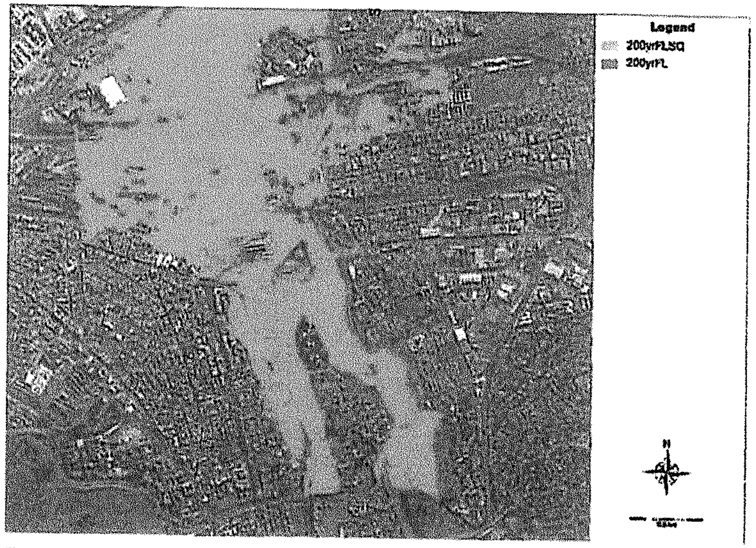

Figure 4-15 Maximum extent of inundation for the 200-year flood (whole model)

4.2.12 Summary of the analysis

It is evident that the modelling results show that "no matter what" is done, the impact is "insignificant". This is borne out by the following:

- The development of the River Club, along with the TRUP, PRASA and NRF sites is likely to have an impact on flood levels, in the order of, 0.01m – 0.15m depending on the storm recurrence interval and location. With the greatest differences expected in the vicinity of the SAAO.
- The insignificant changes in the extent of inundation whether the River Club proposal is taken forward in isolation or in combination with the TRUP, PRASA and NRF proposals;
- The insignificant changes in the extent of inundation when the PRASA overland escape route is closed;
- The insignificant changes in the extent of inundation for minor storm events that may have an impact on the functioning of the Raapenberg Wetlands; and

- The insignificant change to the extent of inundation, when the 10-year or 50-year storm surge is used as a boundary condition.

This is not entirely surprising as the River Club site is located in what historically was an extensive wetland which likely drained to the ocean as discussed in Section 2.1. As discussed in (Brown & Magoba, 2009) the site itself is in places only 2 m above mean sea level and the slope of the canal to the ocean is very flat, in some areas it is completely flat, and there are a number of hydraulic obstructions along its route (e.g. bridges).

4.3 Impact of the proposed River Club development on the SAAO buildings

4.3.1 Impact of developing the River Club and surrounding sites

Assessing the impact of flooding on the SAAO buildings is complicated as the SAAO has constructed its own berm (Section 2.1.4). As noted in Section 2.1.4, these berms were not considered as part of this analysis. The analysis was further complicated as some of the buildings indicated in Figure 4-16, some which might also have heritage value, were developed in what is clearly the flood plain and are therefore are prone to flooding.

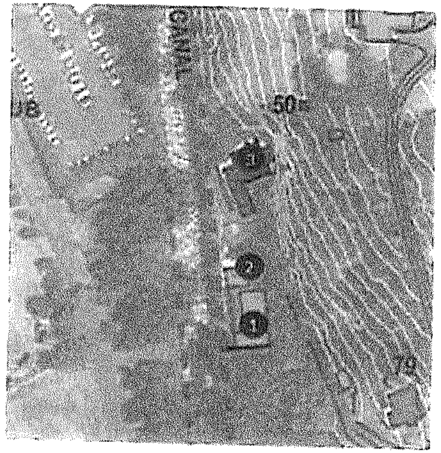

Figure 4-16 SAAO buildings on the edge of the Liesbeek River canal. Dark blue – 3 – buildings are considered to have possible heritage value

The modelling indicated that for the 1-year recurrence interval storm event, none of the buildings would be flooded under any development scenario and that there would be no flooding onto the SAAO property. The modelling indicates that for the 1 in 2-year recurrence interval storm event the land surrounding the buildings would be inundated and that there is a high likelihood that water would enter Building 1 as evident from Figure 4-16. For the Status Quo scenario the water level around the building (3.36 mamsl) would be just below floor level (3.33 mamsl) during the 1 in 2-year flood whereas for the

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post development scenarios (River Club Including / Excluding TRUP PRASA, NRF) the modelled water surface elevation would be 3.6 mamsl and 3.7 mamsl.

As mentioned throughout this report, the modelled results should be carefully considered, especially considering small differences in water levels of less than 0.1 m. However, for the post development scenario Building 1 (not identified as having heritage value) would be flooded slightly more frequently and its floor is likely to be damaged by the 1 in 2-year flood and by all larger flood events. Therefore, for the post development scenario the frequency of damage may be increased. Quantifying the differences in damage is not possible – except to indicate that this would be marginal.

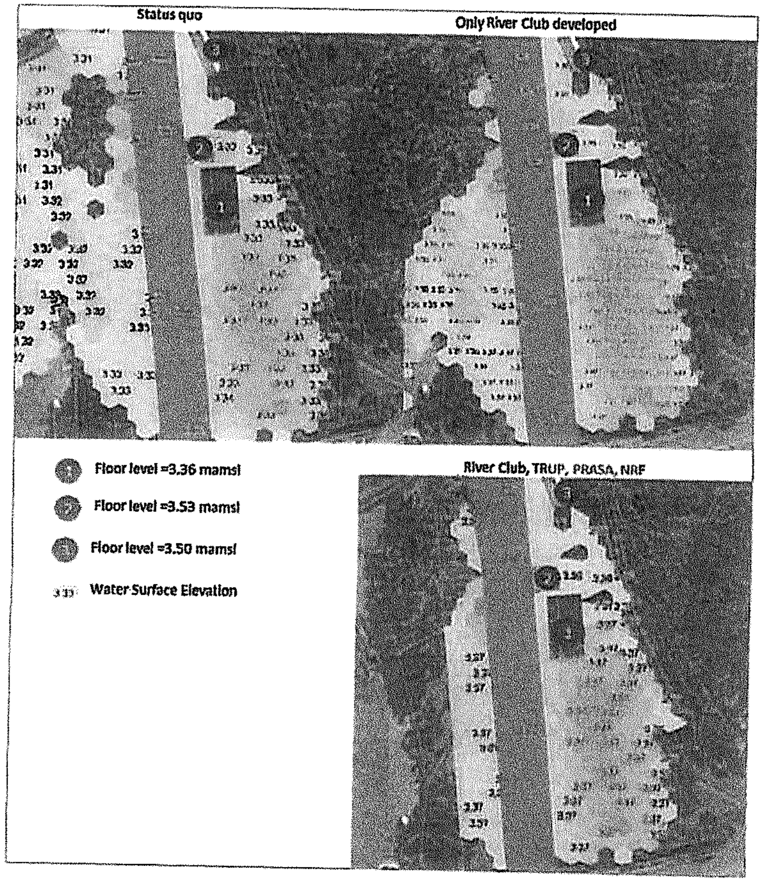

Figure 4-17 Impact on flooding during the 2-year recurrence interval storm event for various development scenarios

For the 5-year recurrence interval storm events, all the buildings of concern would be inundated by flood water. The differences between the status quo and the post-development scenarios are evident from Figure 4-18 – an increase in depth of 0.12 m (12cm). It is worth noting that the floor level of Building 3 (which has heritage value) is 3.50 mamsl and therefore the building would be inundated about once in 5 years to a depth of about 0.15 m deep. Although the increased depth would have an impact, this would not have a significant impact on the cost of repairs as the 1 in 5-year water depth in the building would be less than 0.3 m.

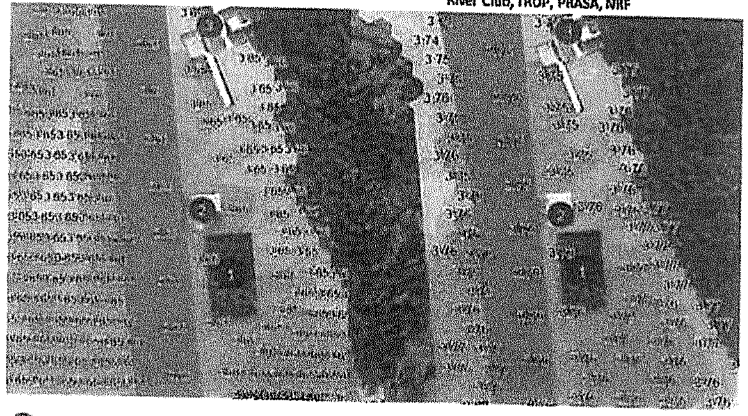

Figure 4-18 Water surface elevations during the 5-year recurrence interval storm event for different development scenarios

For larger storm events the pre- and post-development impacts would be similar with very slightly higher flood levels for the post development scenarios.

4.3.2 Mitigation options

It is important to recognise that these properties were built within the 1 in 2 to 1 in 5-year flood plain and therefore are prone to flooding. The only real option to protect these buildings would be to construct a protective berm. As mentioned in Section 2.1.4, without the knowledge of the City's stormwater department the SAAO constructed a berm along the boundary of their property. The top of the berm varies between 3.6 mamsl and 4.14 mamsl. It is likely that this will only protect the SAAO buildings from the 1 in 2-year recurrence interval storm events. This berm could be raised to protect these properties, from larger storm events. Raising the crest the berm to about 4.8 mamsl would provide protection for the 100-year recurrence interval event although this would pose a significant risk to the occupants of the buildings if the berm failed. The berm would probably not have any significant impact on flooding elsewhere.

4.4 Impact of the proposed development on flooding in the surrounding ecosystems

In Section 3 it was mentioned that estimating the rainfall for a storm with a recurrence interval of less than about 1 in 2 years is statistically problematic. Based on the modelling undertaken as part of this study – both in PCSWMM and HEC-RAS modelling - it would appear that the wetlands would receive inflows from the Liesbeek Canal when the water surface elevation is in the region of about 2.5 mamsl as indicated in Figure 4-19. This would equate to the wetland filling in a storm with a recurrence interval of between ½-year and 1-year. Once water enters the wetland, and the wetland is filled to +-2.5 mamsl the wetland becomes part of the flood plain area offering limited offline storage. The wetland does not appear to drain below a level of +-2.5 mamsl (the level at which flow enters the wetland). This would equate to approximately 1 m of standing water at the deepest points in the wetland. It seems that this water evaporates over time. Evaporation at Observatory is estimated to be approximately 1.5 m/annum, and rainfall about 0.6 m/annum. This would suggest that over a typical / average year the water levels would fluctuate in the wetland. If there were successive droughts – as in 2015, 2016, 2017 – it is possible that the wetland could dry out should there not be a storm of sufficient magnitude to result in flooding into the wetland.

Figure 4-19 Overview of how flow enters and then leaves the Raapenberg wetland

The intervention undertaken by the Friends of the Liesbeek, TRUPA and SAAO which is shown in Figure 3-12 has effectively reduced the level at which the wetlands are likely to fill and empty, to about 2.25 mamsl. While Dr Day (Freshwater Consultant) will address the potential impacts of the increased frequency of inundation on the ecology, the intervention effectively has the impact of adjusting the level to which the wetlands would drain after flooding to about 2.25 mamsl (instead of about 2.5 mamsl). This equates to 250 mm lower. Assuming an evaporation rate of about 4 mm/day, the reduced water level would equate to a reduction of about 60 days before the water volume stored in the wetland is evaporated away. This could be compensated by more frequent flooding, but it is Aurecon's understanding from Dr Day, that an increase in flood frequency may have a negative impact on the wetlands performance as it could decrease the salt levels in the wetland.

An interesting observation on site which is confirmed by the survey, is that the water levels in the Black and Liesbeek Rivers are higher than the water level in the wetland by approximately 100-150 mm – Figure 4-20. This indicates that the wetlands are not, typically, filled with water from the surrounding rivers – although the hydraulic gradient would indicate a flow direction into the wetlands. In fact, it would appear that the hydraulic conductivity of the soil / peat that makes up the wetland is equal to or lower

than the evaporation rate. The part of the wetland South of the footpath extending from Observatory Road towards the M5 appears to be connected to the river System at some point upstream and also has a higher surface water level that the primary wetland that borders the SAAO.

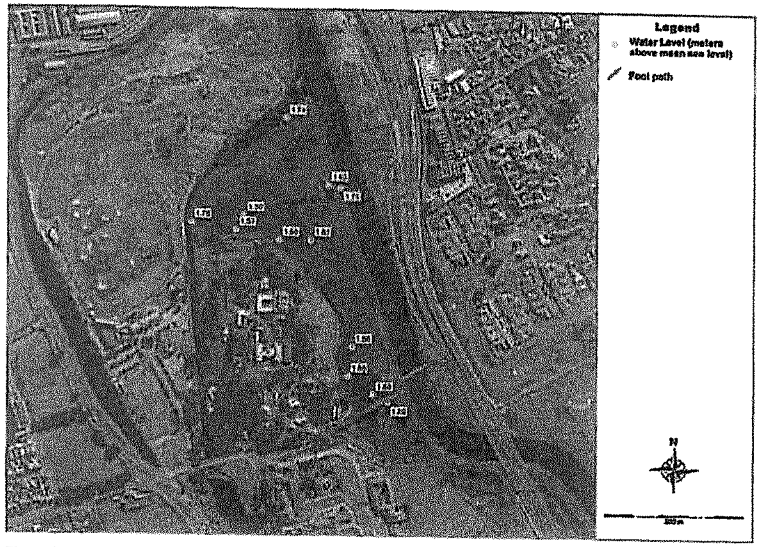

Figure 4-20 Surveyed water levels in, and surrounding, the Raapenberg wetlands

While not explicitly tested, the attenuation benefits of the wetland are clearly limited. Prior to canalisation of the rivers, the wetlands would have been far more extensive and offered significantly more attenuation capacity – unfortunately this situation is not reversible.

An interesting outcome of the analysis is that the current post development scenario would suggest that the water level would drop – albeit by 0.03 m – for the 1-year storm event. Therefore, it is possible that the proposed wider channel would offer some attenuation benefits over the existing situation for this event although this is within the margin of error and relatively insignificant. For larger storm events (greater than 1-year recurrence interval) there would be no attenuation benefit.

Effectively, the analysis indicates little to no significant change in the performance of the wetland, as long as the recent intervention is reversed.

4.5 Opportunity cost of not using the River Club for attenuation of runoff

In order to assess the opportunity cost of developing the site – instead of using it for attenuation – the City agreed previous studies could be referred to. The results of each of these is reviewed below and the implications summarised thereafter.

4.5.1 Ninham Shand (2004)

Ninham Shand (2004) investigated the idea of creating a attenuation pond by excavating high ground between the "Canalised" and "Old" Liesbeek River channels (i.e. The River Club) and along the side of Black River Parkway to provide additional flood attenuation in this area. Their analysis revealed that the 1:50 and 1:100-year flood volumes were simply too large for a pond in this area to have any attenuating effect on the downstream flow rates. It was also evident that, to be effective, significant throttling of the river flow would be required at the confluence of the Black and Liesbeek Rivers rather than just provision of additional attenuation capacity. Throttling of the river would in turn result in an unacceptable rise in flood levels in the vicinity of the River Club as well as increases in flood levels further upstream along the Liesbeek and Black Rivers. As a result, the idea of a retention pond was abandoned.

Subsequent to this study the City incorporated Climate Change and Sea Level rise into their modelling. These changes are likely to further reduce any benefits offered by an attenuation system.

4.5.2 Fisher-Jeffes (2015)

Fisher-Jeffes (2015) undertook a PhD study to assess the viability of rainwater and stormwater harvesting in South Africa. The study made use of the Liesbeek River Catchment as a case study to test the viability of rainwater and stormwater harvesting.

Fisher-Jeffes (2015) also indicated, as did Ninham Shand (2004), that providing attenuation in the region of the confluence of the Black and Salt Rivers could provide additional benefits in the form of flood attenuation. Fisher-Jeffes (2015) however only looked at records of events between 2003 and 2012 – due to the lack of data before that period. The largest recurrence interval event during this period was estimated to have been a 1:20 year event.

Fisher-Jeffes (2015) study was focused on utilising the Liesbeek River Catchment as a 'typical' catchment and did not model the greater Salt River Catchment as was done in Ninham Shand (2004).

4.5.3 RH-DHV (2017)

As part of the RH_DHV study two alternatives were considered for the River Club Island: either flood storage or infill and development. RH-DHV concluded that flood storage should only be considered in combination with storage at the Rondebosch and King David Mowbray golf courses or other upstream measures, as on its own it would not have a significant effect on flooding within TRUP. The effect of the combined flood storage above would have to be evaluated using a hydraulic model extending further upstream, with additional surveys of the upstream Black River cross-sections.

4.5.4 Conclusions

Based on a review of the above studies, it was apparent that the potential benefits of using the site for flood attenuation purposes would be negligible. It was also evident that the construction of an attenuation

facility would require the City to invest significant resources in design, operation and maintenance with limited benefit in terms of reduced impacts of flooding. If an alternative to flood attenuation is required it would likely be more appropriate to implement the original long-term plan of widening the channel. However, were the City to consider the potential for utilising the site to attenuate storm events, it would need to consider the following:

- The site would need to be excavated to provide additional storage.
- Additional storage / attenuation capacity would probably also have to be provided at the Rondebosch and King David Mowbray Golf Courses.
- The City would have to have the resources, to actively manage the site as either a Real-Time Control attenuation facility or a Stormwater Harvesting facility.
- The Owners of the River Club would need to be willing to sell their land, which would likely be at a high price and from which the City would not receive the financial benefits of the property rates.

Considering the above, it is unlikely, that the River Club site will be developed as an attenuation facility. Based on the available literature the benefits are unlikely to be significant - in terms of reduced flood damage.

5 Impact Assessment

Section 4 provides a detailed discussion of the potential hydrological and hydraulic impacts of the proposed development. This discussion is summarised in Section 6. The assessment of the impact was completed as shown in Table 5-1. The impact for the proposed development (any alternative) without mitigation is assessed to be insignificant, and with the proposed mitigation the impact is assessed to be low (+ve) significance. This impact is manageable to a limited extent, but once the site is develop will not be reversible.

Table 5-1 Significance of increased flood hazard

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Both Alternatives								
Without mitigation	Local	Medium	Long-term	Medium	Possible	LOW	-ve	Medium
	1	2	3	6				
Essential mitigation measures:								
• Raise the Liesbeek Parkway locally (as discussed in Section 4.2.7) to eliminate potential High Hazard flooding at this location (at 33°56'14.80" S, 18°28'34.13" E).								
With mitigation	Local	Low	Long-term	Low	Improbable	VERY LOW	+ve	Medium
	1	1	3	5				

In the case of the No-Go alternative, the site will continue to be used as a commercial, recreational and conference facility. There would be no change to the flood risks – except those as a result of climate change, or development on surrounding / upstream properties.

6 Conclusions

This study has reviewed seven relevant studies, and undertaken extensive modelling with both HEC-RAS and PCSWMM 2D. The site is extremely complicated, and it is necessary to consider all the separate findings together before drawing any definitive conclusions. Considering any 'question' or 'issue' raised in isolation may lead to a misinterpretation of the results. Furthermore, hydrology and hydraulic modelling should be considered as a tool for analysing potential impacts and scenarios and as this is not an 'exact science', engineering judgement and experience in interpreting the results are important. As such the findings based on the complete analysis are presented and interpreted using Aurecon's knowledge of the site. For these reasons, Aurecon involved three of its staff who have extensive experience of this site in order to ensure the analyses were undertaken and interpreted in the most appropriate manner.

Therefore, based on a review of all the available studies, the extensive modelling, and engineering judgement, it is Aurecon's opinion that:

- The results (magnitude of impact) appear to be relatively consistent for each study, even where study methods and elevations may differ slightly.
- The development of the River Club as well as the TRUP, PRASA and NRF sites is likely to have an impact on flood levels, in the order of between 0.01 m and 0.15 m depending on the storm recurrence interval and the location. The greatest differences between the results are in the vicinity of the SAAO. The impacts of these differences are insignificant.
- If the River Club is developed in isolation (i.e. TRUP, NRF, PRASA were not developed), the impacts would be of similar magnitude for all recurrence intervals, but less by approximately 0.00m – 0.03m, to the scenario where all the proposed developments went ahead. This difference is considered to be insignificant because the differences between the post development scenario's are well within the uncertainties of the modelling tools.
- It is important to note that if the TRUP, NRF, PRASA were to be developed in isolation, then the results must not be interpreted to mean that they would only have an impact equal to the difference (typically +- 0.00m – 0.03m) between the post development scenarios including River Club, TRUP, PRASA, and the NRF sites and the post development scenario for the River Club alone – as indicated in the RHDHV Study. This is because of the complexities of the hydrology and hydraulics in the vicinity of the River Club site.
- The design of changes to the Liesbeek Canal should aim to maintain the existing hydraulic functioning of the wetland during smaller recurrence interval events. The current proposals would have little to no effect, but further detailed design refinements – during detailed design – should be reanalysed.
- It would be advisable, in consultation with the Fresh Water Consultant, to consider reversing the intervention undertaken by the TRUPA, Friends of the Liesbeek and SAAO – as this is likely to increase flows into the wetland.
- The site is unlikely to be developed by the City as an attenuation facility.
- PRASA should not be allowed to close the existing overland flood route that extends across its property, as it is important for mitigating flood risk – regardless of whether or not the proposed River Club development proceeds.
- The extension to Berkley Road should be designed in such a manner as to not impact on the water levels determined by this study and any changes to the preliminary design would need to be re-evaluated. The detailed design of the extension of Berkley Road should consider raising the portion of the road that is within the floodplain.
- There is a need to address the localised change in risk along Liesbeek Parkway. This could be done through raising the road locally (as discussed in the report) to eliminate the potential flooding by the

1 in 100 year event, however ponding due to local stormwater is also likely to occur at this location for which the provision of warning signs would probably suffice.

- The impact of the proposed development on flood levels and their extent are considered to be negligible.
- The impacts of the proposed River Club development and of the proposed Two Rivers Urban Park development on flood levels and their extent are considered to be negligible.
- Widening the Salt River Canal would reduce the flood levels for all scenarios, but that this would come at a significant cost with very little benefit and is unlikely to be in the foreseeable future.

The main conclusion of this study is that the proposed development would have an insignificant effect on flooding in the vicinity of the existing River Club site. Although the development would have some limited and localised effects on the flows and water levels in the Liesbeek and Black Rivers, the modelled impacts in terms of increased hazard and damage to properties are insignificant and can be considered negligible – as long as the above findings are appropriately dealt with.

Although the proposed development might not appear to have a significant impact on flooding, it would none the less require the following deviations in terms of the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a):

- Section 9.2: Flood Management and Public Safety
  - Permission to develop / obstruct the free flow of water within the 20-year flood line area would need to be granted.
- Section 10.5: Table 1: Framework for the assessment of Proposals
  - The current assessment framework forbids development (including filling) within the 50 year flood plain. It notes: "*In exceptional circumstances minor "smoothing" of the 50 / 100-year flood line may be considered, provided equivalent compensatory stage storage volume is provided within the development precinct*".
  - As the proposed development falls under the 50-year flood line, a deviation from the policy, allowing the developer to fill (considered development) would need to be granted.

With regard to the two development layouts (Section 3.2), both would have similar impacts, although Layout Option 1 (focus of this study) would appear to be the preferable option as it aligns with the vision of the City's '*Floodplain and River Corridor Management Policy*' (CSRM, 2009a) in that, in comparison to Layout 2) it provides an improved ecological corridor, provides the potential for improved amenity and biodiversity in line with the principles of Water Sensitive Urban Design (WSUD) principles.

It is recommended that the City should take account of the findings of this study to determine whether in terms of the policy and based on consideration of the "*geomorphological, maintenance, social and economic aspects*" (presented by other specialists) the proposed development of the River Club Site should be approved.

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Appendix A

Table A1 Water Surface Elevations (mamsl) at Point 1 (Natural Ground Level = 0.389 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	1.98	1.94	1.94
1-year	2.19	2.16	2.16
2-year	2.37	2.39	2.39
5-year	2.52	2.54	2.54
10-year	2.63	2.64	2.64
20-year	2.81	2.82	2.83
50-year	2.91	2.93	2.93
100-year	2.95	2.96	2.97
200-year	3.00		3.01
100-year (Widened Channel)	2.79	Not modelled	2.8
100-year (PRASA overland route closed)	2.95		2.97
100-year (Opened Salt River mouth)	2.95		2.97

Table A2 Water Surface Elevations (mamsl) at Point 2 (Natural Ground Level = 2.651 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	No water on the surface		
1-year			
2-year			
5-year			
10-year			
20-year	2.79	2.81	2.81
50-year	2.9	2.91	2.92
100-year	2.94	2.95	2.97
200-year	3.01		3.01
100-year (Widened Channel)	No water on the surface	Not modelled	2.76
100-year (PRASA overland route closed)	2.94		2.96
100-year (Opened Salt River mouth)	2.94		2.96

Table A3 Water Surface Elevations (mamsl) at Point 3 (Natural Ground Level = 2.238 mamsl)

Recurrence interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	No water on the surface	No water on the surface	No water on the surface
1-year			2.27
2-year			2.41
5-year	2.76	2.79	2.84
10-year	2.90	2.9	2.91
20-year	2.97	2.97	2.98
50-year	3.02	3.03	3.03
100-year	3.05	3.06	3.07
200-year	3.05	Not modelled	3.10
100-year (Widened Channel)	2.90		2.91
100-year (PRASA overland route closed)	3.05		3.06
100-year (Opened Salt River mouth)	3.05		3.06

Table A4 Water Surface Elevations (mamsl) at Point 4 (Natural Ground Level = 0.709 mamsl)

Recurrence interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.16	2.17	2.17
1-year	2.51	2.52	2.51
2-year	2.77	2.79	2.79
5-year	3.04	3.06	3.06
10-year	3.18	3.19	3.2
20-year	3.31	3.33	3.33
50-year	3.42	3.43	3.44
100-year	3.47	3.48	3.48
200-year	3.52	Not modelled	3.52
100-year (Widened Channel)	3.11		3.12
100-year (PRASA overland route closed)	3.48		3.49
100-year (Opened Salt River mouth)	3.47		3.48

Table A5 Water Surface Elevations (mamsl) at Point 5 (Natural Ground Level = -0.374 mamsl)

Recurrence interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.48	2.49	2.49
1-year	2.84	2.85	2.85
2-year	3.2	3.24	3.24
5-year	3.58	3.61	3.62
10-year	3.83	3.86	3.88
20-year	4.11	4.14	4.16
50-year	4.44	4.49	4.52
100-year	4.64	4.68	4.71
200-year	4.81	Not modelled	4.88
100-year (Widened Channel)	3.58		3.49
100-year (PRASA overland route closed)	4.67		4.75
100-year (Opened Salt River mouth)	4.64		4.71

Table A6 Water Surface Elevations (mamsl) at Point 6 (Natural Ground Level = 3.443 mamsl)

Recurrence interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	No water on the surface	No water on the surface	Developed as part of TRUP Proposal
1-year			
2-year			
5-year			
10-year			
20-year	3.84	3.72	
50-year	4.49	4.52	
100-year	4.69	4.75	
200-year	4.85	Not modelled	
100-year (Widened Channel)	No water on the surface		
100-year (PRASA overland route closed)	4.71		
100-year (Opened Salt River mouth)	4.69		

Table A7 Water Surface Elevations (mamsl) at Point 7 (Natural Ground Level = -0.23 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.48	Section of 'Old' Liesbeek filled	
1-year	2.84		
2-year	3.21		
5-year	3.63	3.61	3.62
10-year	3.88	3.86	3.88
20-year	4.16	4.14	4.17
50-year	4.49	4.52	4.53
100-year	4.69	4.75	4.76
200-year	4.85		4.95
100-year (Widened Channel)	3.84		3.49
100-year (PRASA overland route closed)	4.71	Not modelled	4.81
100-year (Opened Salt River mouth)	4.69		4.76

Table A8 Water Surface Elevations (mamsl) at Point 8 (Natural Ground Level = -0.402mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.53	2.52	2.52
1-year	2.92	2.89	2.89
2-year	3.28	3.29	3.29
5-year	3.63	3.66	3.67
10-year	3.88	3.92	3.94
20-year	4.15	4.20	4.22
50-year	4.48	4.55	4.58
100-year	4.68	4.74	4.77
200-year	4.85		4.95
100-year (Widened Channel)	3.81		3.78
100-year (PRASA overland route closed)	4.71	Not modelled	4.81
100-year (Opened Salt River mouth)	4.68		4.77

Table A9 Water Surface Elevations (mamsl) at Point 9 (Natural Ground Level = 1.379 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.54	2.56	2.56
1-year	2.97	2.95	2.95
2-year	3.33	3.36	3.37
5-year	3.65	3.75	3.76
10-year	3.89	3.99	4.01
20-year	4.17	4.26	4.28
50-year	4.49	4.58	4.62
100-year	4.69	4.77	4.80
200-year	4.85		4.98
100-year (Widened Channel)	3.90		4.24
100-year (PRASA overland route closed)	4.72	Not modelled	4.84
100-year (Opened Salt River mouth)	4.69		4.80

Table A10 Water Surface Elevations (mamsl) at Point 10 (Natural Ground Level = 3.299mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	No water on the surface		
1-year			
2-year	3.33	3.36	3.36
5-year	3.65	3.75	3.76
10-year	3.89	3.99	4.01
20-year	4.17	4.26	4.28
50-year	4.49	4.58	4.62
100-year	4.69	4.77	4.8
200-year	4.69		4.98
100-year (Widened Channel)	4.85		4.23
100-year (PRASA overland route closed)	4.72	Not modelled	4.84
100-year (Opened Salt River mouth)	4.69		4.80

Table A11 Water Surface Elevations (mamsl) at Point 11 (Natural Ground Level = 1.974 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.55	2.57	2.57
1-year	2.96	2.96	2.96
2-year	3.35	3.38	3.39
5-year	3.69	3.81	3.81
10-year	3.93	4.05	4.07
20-year	4.20	4.29	4.32
50-year	4.51	4.59	4.63
100-year	4.70	4.77	4.81
200-year	4.86		4.99
100-year (Widened Channel)	4.17		4.44
100-year (PRASA overland route closed)	4.72	Not modelled	4.84
100-year (Opened Salt River mouth)	4.70		4.81

Table A12 Water Surface Elevations (mamsl) at Point 12 (Natural Ground Level = 1.206 mamsl)

Recurrence Interval (Description)	Development Scenario		
	Status Quo	Post-development (River Club only)	Post-development (River Club, TRUP, NRF, PRASA)
0.5-year	2.69	2.67	2.67
1-year	3.11	3.10	3.10
2-year	3.41	3.42	3.42
5-year	3.71	3.74	3.75
10-year	3.95	3.99	4.01
20-year	4.22	4.27	4.29
50-year	4.54	4.60	4.64
100-year	4.74	4.80	4.83
200-year	4.90		5.00
100-year (Widened Channel)	4.05		4.04
100-year (PRASA overland route closed)	4.76	Not modelled	4.86
100-year (Opened Salt River mouth)	4.74		4.83

Appendix B

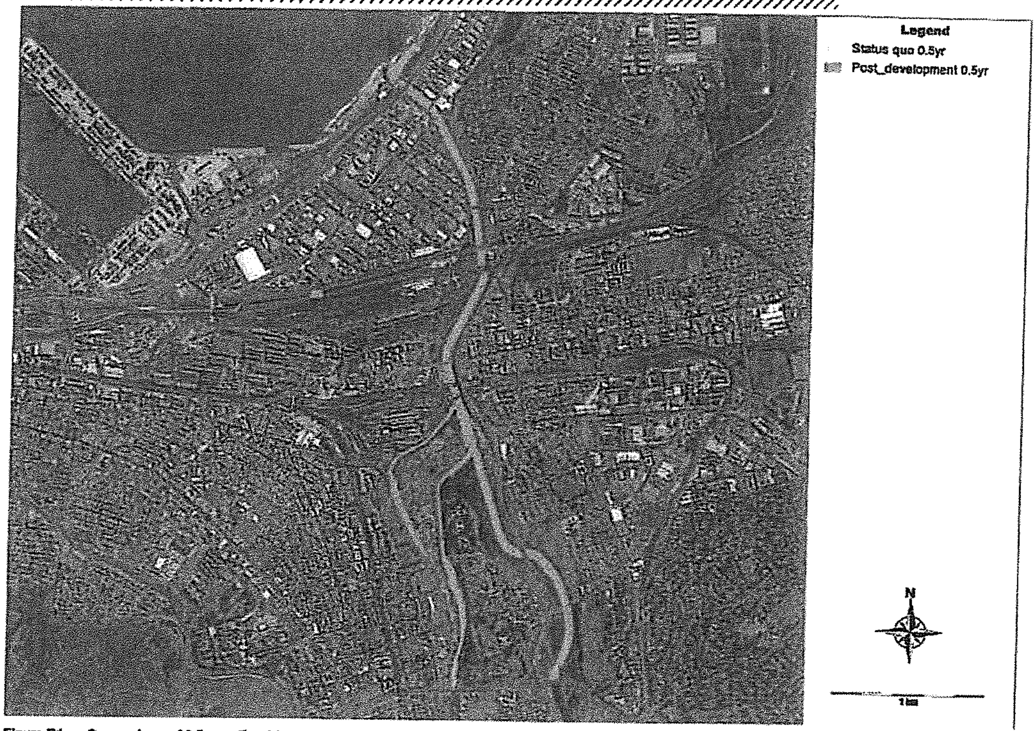

Figure B1 Comparison of 0.5-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, PRASA)

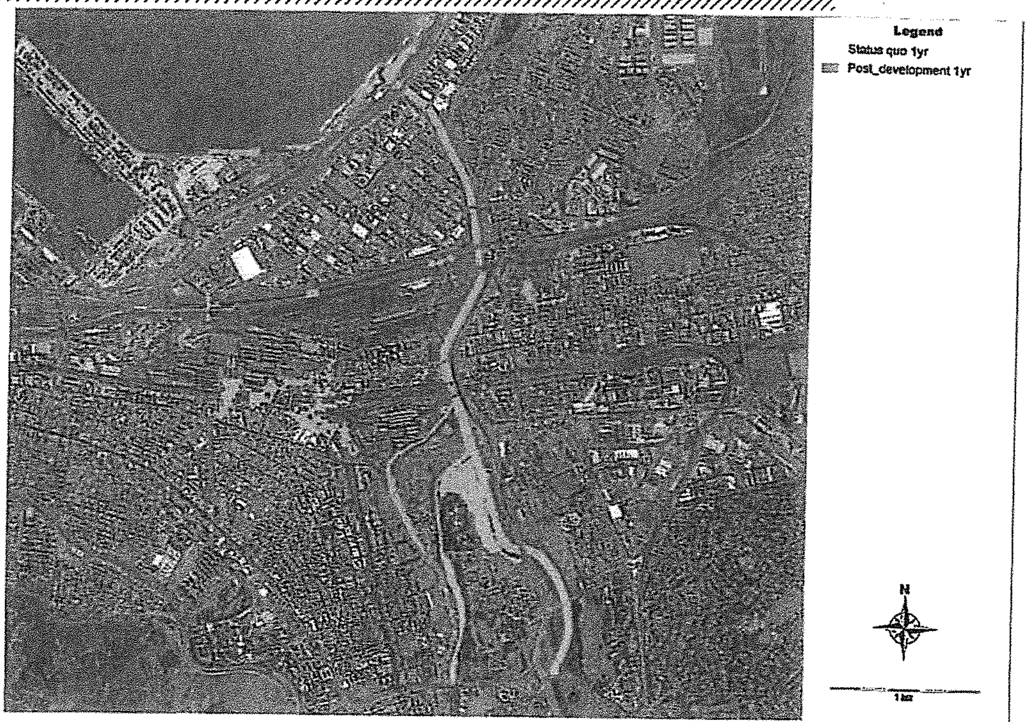

Figure B2 Comparison of 1-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, PRASA)

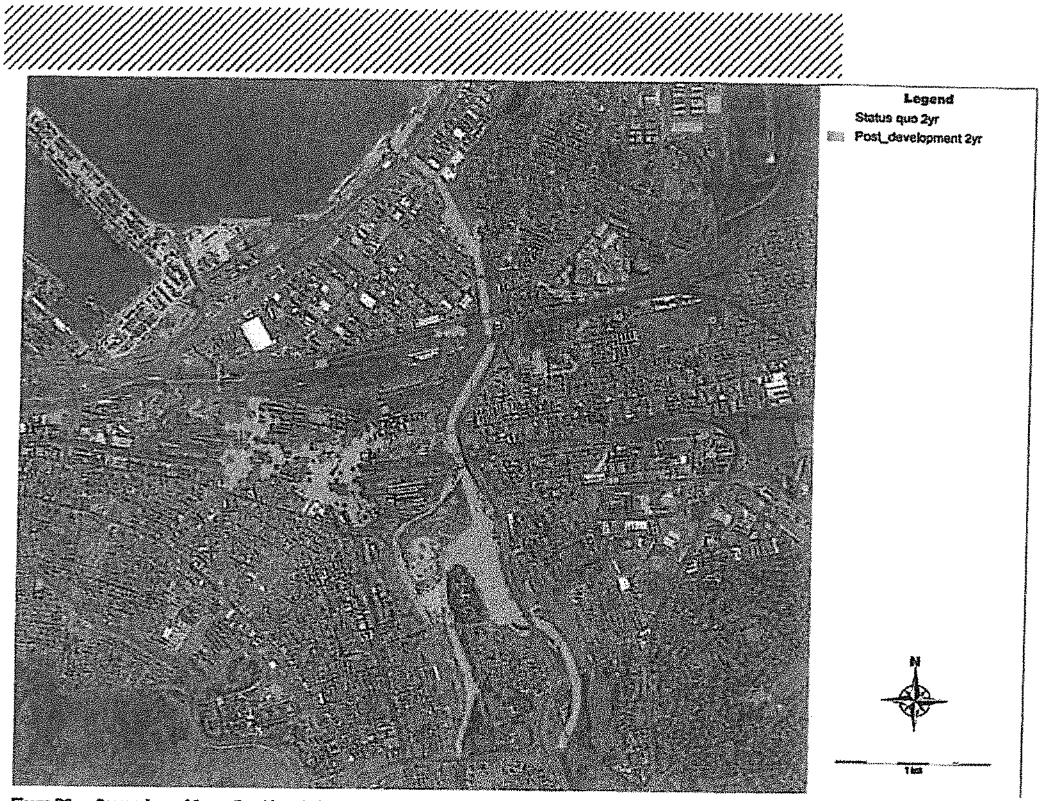

Figure B3 Comparison of 2-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

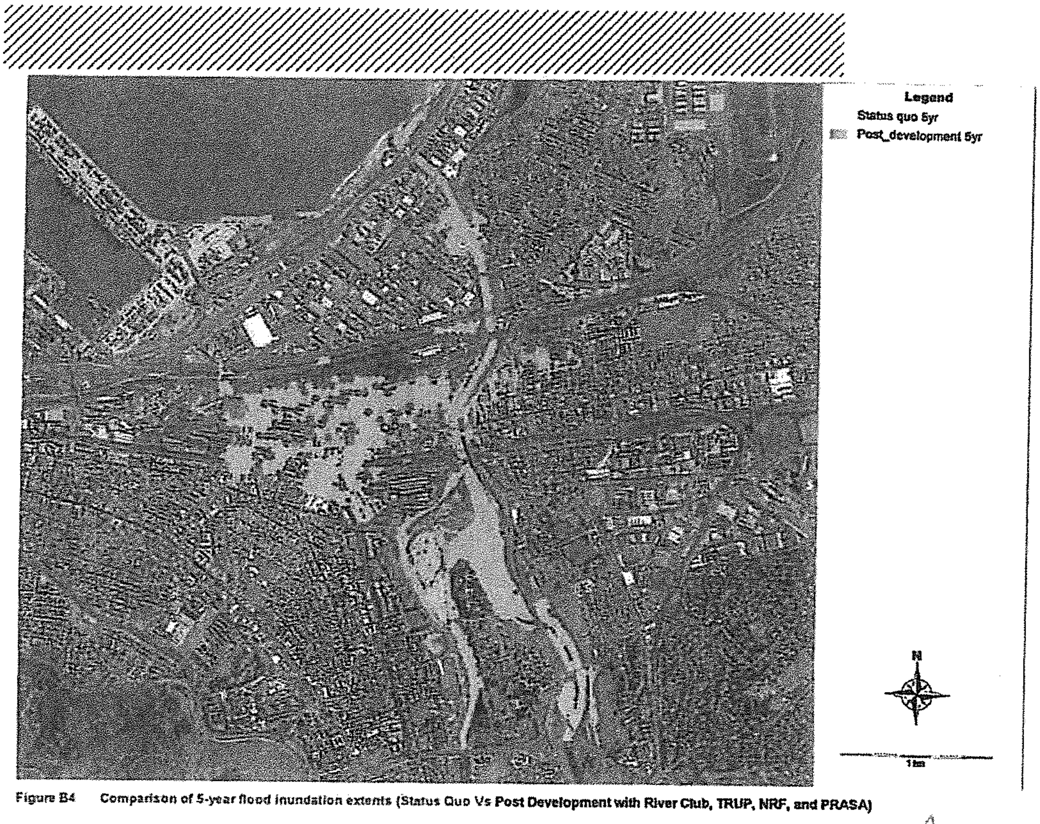

Figure B4 Comparison of 5-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

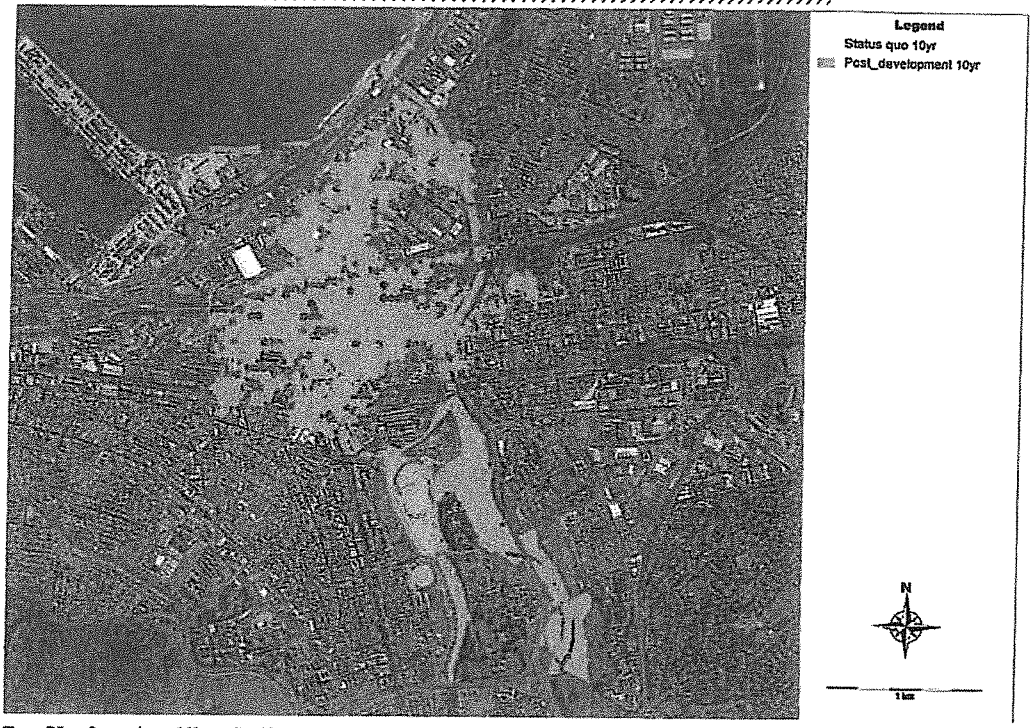

Figure B5 Comparison of 10-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

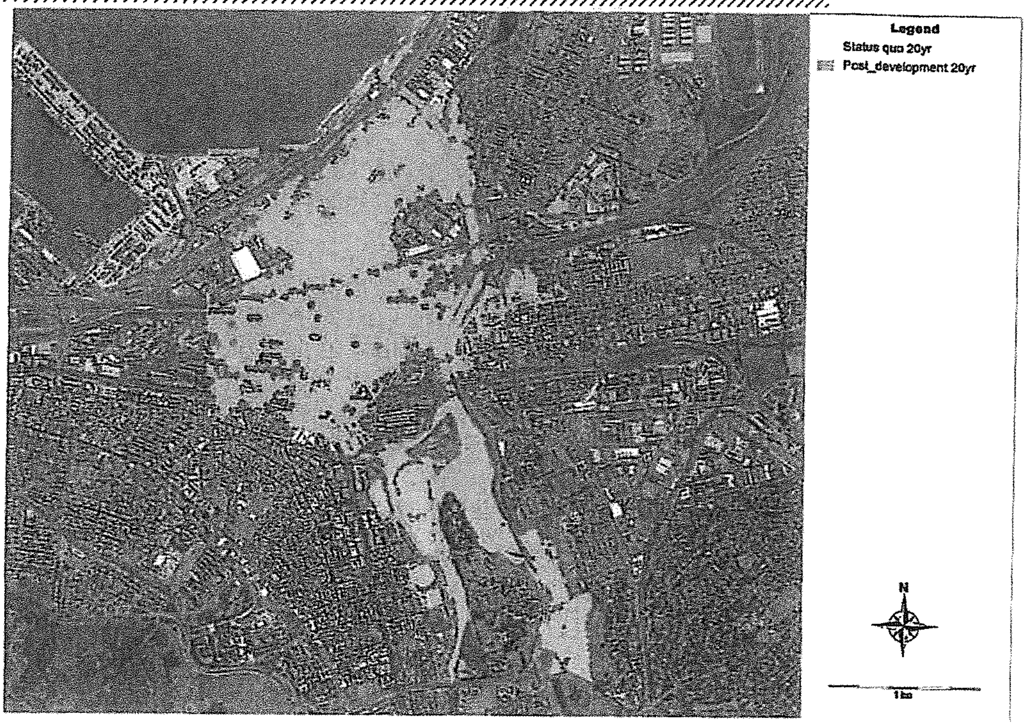

Figure B6 Comparison of 20-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

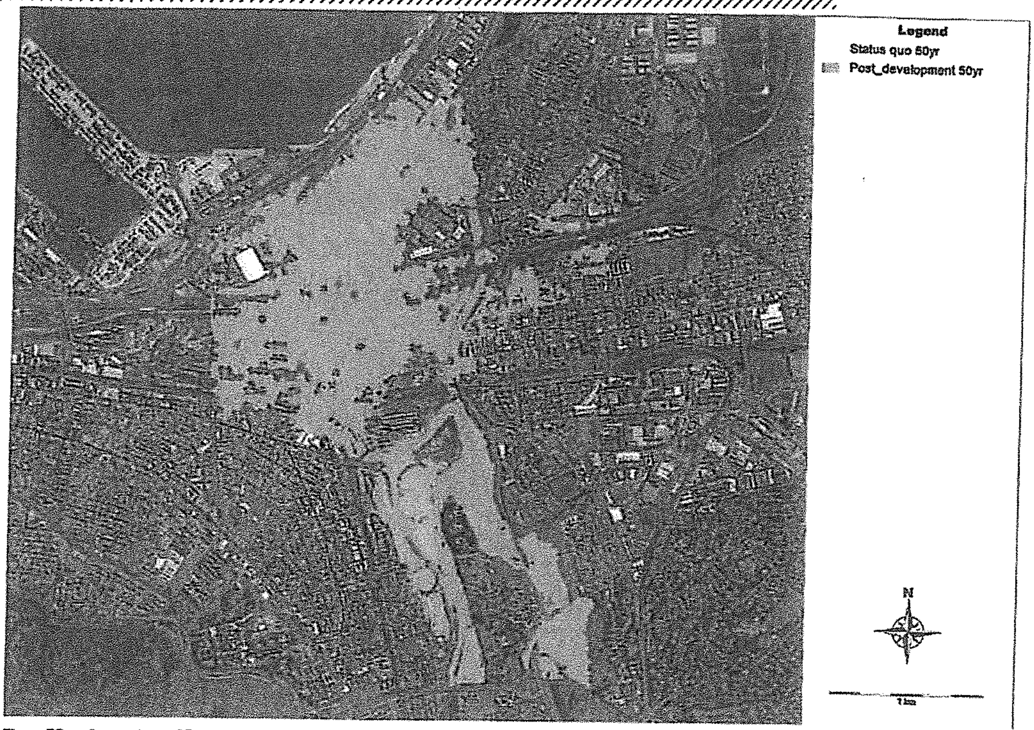

Figure B7 Comparison of 50-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

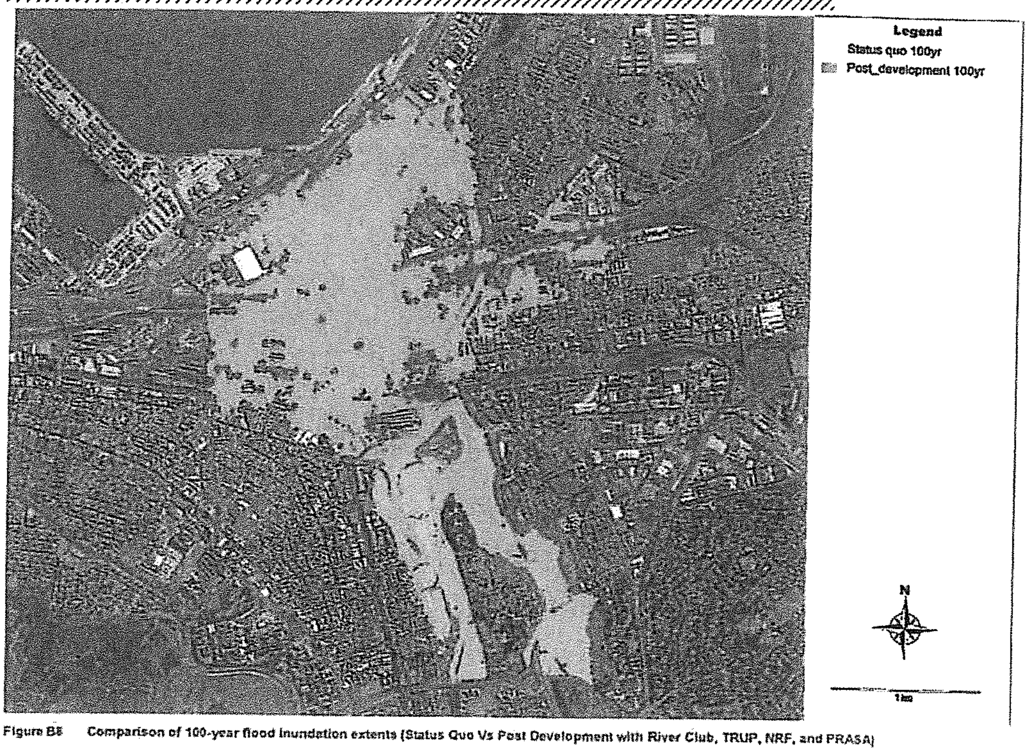

Figure B8 Comparison of 100-year flood inundation extents (Status Quo Vs Post Development with River Club, TRUP, NRF, and PRASA)

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To: Tim Florence; "geoff@planpart.co.za"
Bcc: "abicase@gmail.com"; "aimee@unicorncafe.co.za"; "dayson@mweb.co.za"; "venteralex@gmail.com"; "alexdmueller@gmail.com"; "alexr@edgegrowth.com"; "alison.paulin@gmail.com"; "amienadavids@gmail.com"; "andrea.couvert@gmail.com"; "asbowden@gmail.com"; "anielabb@gmail.com"; "annakajam@gmail.com"; "annalisa.za@gmail.com"; "tgreenwood@oldmutual.com"; "Ariane.delannoy@gmail.com"; "arnie.rkfc@gmail.com"; "auke@psychohistorian.org"; "auke@cfah.org.za"; "rodrigues.belisa@gmail.com"; "bdivey@gmail.com"; "caitlin.sole@alumni.uct.ac.za"; "cebarnes@gmail.com"; "carinezaayman@icloud.com"; "czaayman@gmail.com"; "carol@nocturnalaffair.co.za"; "edgyhart@polka.co.za"; "charlotte@ccnia.co.za"; "littlesong1645@gmail.com"; "chris@magics.co.za"; "hettlage@saao.ac.za"; "cirajrassool@gmail.com"; "terreblanche.christelle@gmail.com"; "everatts@gmail.com"; "colleen.edgyhart@gmail.com"; "cor@tommybrummer.co.za"; "davesue@mweb.co.za"; "dtrow@oldmutual.com"; "dibnob@saao.ac.za"; "wackeyza@gmail.com"; "deon.erasmus@optinet.net"; "duncan@smallbones.com"; "dylanbarsby@gmail.com"; "ejffoster@gmail.com"; "edwin@obsid.org.za"; "emma.e.buckley@gmail.com"; "emstockden@gmail.com"; "ester.mikaela@gmail.com"; "tjaila@iafrica.com"; "farzaneh.behroozi@gmail.com"; "fbgreene@mweb.co.za"; "frances@communitree.in"; "leyman@jaywalk.co.za"; "pianohammer.gh@gmail.com"; "capeblueliving@gmail.com"; "katunduw@telkomsa.net"; "guynicol@worldonline.co.za"; "g.dereymaeker@gmail.com"; "lampen@mweb.co.za"; "hermschle@gmail.com"; "hilary.albutt@gmail.com"; "hollyfilday@gmail.com"; "howard@obz.capetown"; "hvdmerwe@csvr.org.za"; "Glass.ian@gmail.com"; "ivan@ivansams.com"; "chambersj@rghs.org.za"; "jacqui.klarenbeek@gmail.com"; "johanbeaurain@gmail.com"; "123jmbissett@gmail.com"; "jan@windowline.co.za"; "jvorster@media24.com"; "Ms.j.j.matthews@gmail.com"; "janetcronje@gmail.com"; "Jean.s.ramsay@gmail.com"; "jen-bader@mweb.co.za"; "outlook_BB02B66BA2B4A285@outlook.com"; "jlwyeth@gmail.com"; "joubertjill@gmail.com"; "jodiallemeier@gmail.com"; "Terreblanche.christelle@gmail.com"; "drjoyrobinson@starshine.co.za"; "jheerden@mweb.co.za"; "jvandervlugt@mweb.co.za"; "Justin.floor@gmail.com"; "karawendylevy@gmail.com"; "karen@flipper.co.za"; "Katharinem7@gmail.com"; "michael@sundevelopment.co.za"; "kechilk@hotmail.com"; "lara.pietersen@gmail.com"; "youngberry48@gmail.com"; "Lauraschultz8@gmail.com"; "Leighlamb14@gmail.com"; "leigh.lambrechts@webberwentzel.com"; "leebenjafield@gmail.com"; "lenita.duplessis@gmail.com"; "leslie.london@uct.ac.za"; "lianne@stbb.co.za"; "louis.stanford@gmail.com"; "louisetudorjones@gmail.com"; "luciamenicanti@gmail.com"; "lynetteamunro@gmail.com"; "marcel@marcel.co.za"; "margaret@fagan.co.za"; "malblas@iafrica.com"; "Marine.leblond@gmail.com"; "marion@smallbones.com"; "marius@visuals.tv"; "mark@neville.za.net"; "mark@jacksonfilm.co.za"; "markj@redefine.co.za"; "mark@derrickcapetown.com"; "mark@derrickcapetown.com"; "mark@derrickcapetown.com"; "marthinaj@oculusinnovations.co.za"; "mijssi@gmail.com"; "marykeolivier@gmail.com"; "melani.alp@gmail.com"; "mvs@mvs.za.org"; "michellecollis@gmail.com"; "minnajv69@gmail.com"; "mirandadutoit@gmail.com"; "miriam.breytenbach@gmail.com"; "nasimacoovadia@gmail.com"; "natalie.leon@mrc.ac.za"; "nodi@oia.co.za"; "oliviaandrews@yahoo.co.uk"; "pam.britt@wol.co.za"; "anaikala@gmail.com"; "visualhistoryuwc@gmail.com"; "peter.coates@telkomsa.net"; "peterwilliamsashman@gmail.com"; "manager@fol.org.za"; "info@fol.org.za"; "philippahiggins5789@gmail.com"; "richard.andrew@yahoo.co.uk"; "rstanbridge@gmail.com"; "robket@gmail.com"; "rol.hunter@gmail.com"; "ros@saao.ac.za"; "ros.skelton@gmail.com"; "royashton@gmail.com"; "russell196@hotmail.com"; "rhall@uwc.ac.za"; "sandraduplessis96@gmail.com"; "driver_jowitt@hotmail.com"; "sarah@tique.co.za"; "sarah@sarahrice.co.za"; "sheilapi@icon.co.za"; "shonah@mac.com"; "simon@visser.archi"; "simon@visserarchitects.co.za"; "sh@saao.ac.za"; "Vanderspuy38@gmail.com"; "susangredley@gmail.com"; "moses.sue@gmail.com"; "taliameer@gmail.com"; "tania.mackenzie@gmail.com"; "tarquin@imago-visual.com"; "terence.visagie@gmail.com"; "tessatoerien@gmail.com"; "hijacx@toms-surfboards.com"; "tracybarclay04@gmail.com"; "hedmekanik@gmail.com"; "tghughes@gmail.com"; "treevora@gmail.com"; "chair@trup.org.za"; "secretary@trup.org.za"; "virginia.mackenny@uct.ac.za"; "wdm@astro4dev.org"; "iwerner@mweb.co.za"; "willem@willembuhrmann.co.za"; "william@frater.co.za"; "wolfgang@campaignforeducation.org"; "yoavandi@gmail.com"; "sabina.favaro@gmail.com"; "nschwartz@waterfront.co.za"; "tame@telkomsa.net"; "camelacious@gmail.com"; "dolmike1@gmail.com"; "vining.emily@gmail.com"; "emma.vandervliet@gmail.com"; "esmegoldblatt9@gmail.com"; "eugenie.skelton@gmail.com"; "underhayh@gmail.com"; "jakemorris01@gmail.com"; "projects@spiritofafrica.co.za"; "jonty@nu.org.za"; "bex87davies@gmail.com"; "jvandervlugt@mweb.co.za"; "rick.white16@hotmail.com"; "Seth.til@gmail.com"; "soniadv@live.co.uk"; "traceyleighlawson@gmail.com"; "treve@incite.co.za"; "alexdmueller@gmail.com"; "amienadavids@gmail.com"
Subject: PROPOSED APPLICATION FOR REZONING, APPROVAL OF COUNCIL AND DEVIATIONS FROM CITY POLICIES IN RESPECT OF ERF 151832, 6 LIESBEECK PARKWAY (BOUNDED BY LIESBEECK PARKWAY AND OBSERVATORY ROADS), OBSEVATORY
Date: 01 October 2020 16:05:00
Attachments: image001.png
image002.jpg
Appeal DECISION LETTER ERF 151832.pdf

Good Day

Please see attachment for your attention.

This letter is addressed to the applicant or to an objector in the case where there has been an objection to the above application.

My department has now issued the notification of the decision of the MPT and related appeal rights by registered mail. While the reasons for this are explained in the registered letter, all parties did also not agree to being notified via e-mail. Also note: not all parties provided their physical/postal addresses to enable notification via post.

As a courtesy, I have attached a copy of the letter.

For your information, since the letters were registered at the post office on the 01 October 2020 (i.e. today), please note the contents in the attached letter relating to the due date for any appeals.

You are welcome to reply via e-mail.

Kind Regards / Vriendelike Groete/ Ozithobile
Letitia Ohlson-Isaacs
Table Bay District: Customer Interface
Development Management
Spatial Planning and Environment Directorate

WORKING FROM HOME DURING COVID 19

T + 27 21 400 6407
E Letitia.Ohlson-Isaacs@capetown.gov.za

Development Management Information Hubs: Table Bay

CCT Contacts | CCT Media and News | Report a fault | Account Queries | COVID-19

0860 103 089 (free call 24/7)

cid:image001.jpg@01D66BCE.317F2720

Please note that the Municipal Planning Bylaw has been amended, see the link below.
2020 Amended MPBL
Land use and building applications may only be submitted via the City's e-Services portal.
Register as a business partner to submit your application via e-Services and track its progress.

DEVELOPMENT MANAGEMENT

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

JOY SAN GIORGIO
SENIOR PROFESSIONAL OFFICER

T: 021 400 6444 F: 021 400 5830 / 086 202 9981
E: appeals.tablebay@capetown.gov.za
Case ID: 70396369

BLUM017

30 SEPTEMBER 2020

Applicant and Objectors

Dear Sir / Madam

PROPOSED APPLICATION FOR REZONING, APPROVAL OF COUNCIL AND DEVIATIONS FROM CITY POLICIES IN TERMS OF THE CITY OF CAPE TOWN MUNICIPAL PLANNING BYLAW IN RESPECT OF ERF 151832, 6 LIESBEECK PARKWAY (BOUNDED BY LIESBEECK PARKWAY AND OBSERVATORY ROADS), OBSEVATORY, CAPE TOWN

This letter is addressed to the applicant or to an objector in the case where there has been an objection to the above application.

The application with reference in the above regard, refers.

The Municipal Planning Tribunal (MPT) on 18 September 2020 **approved** in terms of section 98(b) of the City of Cape Town Municipal Planning By-Law, 2015 (MPBL), the application for rezoning, approval of council and deviations from city policies, as per the attached Annexure A.

Kindly also note where applicable, the above approval does not guarantee approval of any related building plan application in terms of the National Building Regulations and Building Standards Act, No 103 of 1977 and that building work may therefore only commence once such plans are formally passed.

Reasons for the above decision are set out in the **attached** extract of the minutes of the meeting concerned, dated 18 September 2020.

Should the reasons for the above decision not be contained in this notification you are advised in terms of section 104(2)(c) of the MPBL and section 5 of the Promotion of Administrative Justice Act, No 3 of 2000 that you are entitled to request in writing reasons for the above decision.

In terms of section 108(1) of the City of Cape Town Municipal Planning By-Law, 2015, you may appeal to the Appeal Authority against the above decision by giving written notice of the appeal and grounds of appeal and by completing and signing the prescribed form.

In terms of section 108(1) of the City of Cape Town Municipal Planning By-Law, 2015, you may appeal to the Appeal Authority against the above decision by giving written notice of such appeal and the grounds of appeal.

An appeal, including the written notice and the grounds of appeal (and not only the intention to appeal), must be lodged on the prescribed form (the form can be **downloaded here:** (http://www.capetown.gov.za/LandUseAppeals) with the City Manager, c/o the Table Bay District Manager, at the following email address: appeals.tablebay@capetown.gov.za within **21 days of the**

date of notification of the decision. If the appeal cannot be lodged by email it may be hand delivered to the 2nd floor, Media City Building, Cnr of Hertzog and Heerengracht Boulevard, Cape Town or faxed to 021 400 5830 / 086 202 9981 **within 21 days of the date of notification of the decision.** See definition of notification date to be read together with the provisions of the Interpretation Act 1957 in footnote below to determine the closing date for submission. If this letter has been sent to you by registered mail, then it is your responsibility to establish the date stamped upon the receipt for registration issued by the post office when accepting this notice from the City of Cape Town. You will need to contact the post office and use the tracker number on the envelope for this purpose.

Failure to comply with the above requirements and provisions within section 108 of the MPBL will result in the appeal being ruled invalid.

Kindly note that the operation of the approval of this application is suspended and may therefore not be acted on until such time as the City gives notice that no appeal has been lodged and the decision is effective or the date that the appeal is decided by the appeal authority. If an appeal is lodged against a condition of approval the City may determine that the operation of the approval of the application is not suspended.

Yours faithfully

for **DIRECTOR: DEVELOPMENT MANAGEMENT**

Notes and extracts from sections of the City of Cape Town Municipal Planning By-Law, 2015

105 Effective date of decision

(2) The effective date of a decision in terms of this By-Law is –
- (a) the date that the City gives notice that no appeal has been timeously lodged and that the decision is accordingly effective; or
- (b) subject to subsection (3), if an appeal is timeously lodged, the date that the appeal is decided by the appeal authority.

(3) If an appeal is lodged only against a condition imposed in terms of section 100, the City may determine that the operation of the approval of the application is not suspended

Method and date of notification

The date of notification is determined as follows:
if the notification is provided –
- (a) orally, it is the date of oral communication;
- (b) by hand ,it is the date of delivery or collection;
- (c) by registered post, it is regarded as the fourth day after the date stamped upon the receipt for registration issued by the post office which accepted the notice; or
- (d) by email or fax, it is the date that the email or fax is sent,

Interpretation Act No 33 of 1957 section 4

(4) Reckoning of number of days. – When any particular number of days is prescribed for the doing of any act, or for any other purpose, the same shall be reckoned exclusive of the first and inclusive of the last day, unless the last day happens to fall on a Sunday or on any public holiday, in which case the time shall be reckoned exclusive of the first day and exclusive also of every such Sunday or public holiday.

As an example, if the date of notification is 1 October, then the first day of calculation of the 21day appeal period will be 2 October and the 21st day would be 22 October. If 22 October is either a Sunday or a public holiday, then the closing date will the next following day that is not either a Sunday or a public holiday.

INTERVIEW

SMPTNW 06/09/20 **WARD 57: APPLICATION FOR REZONING, APPROVAL OF COUNCIL AND DEVIATIONS FROM CITY POLICIES IN TERMS OF THE MUNICIPAL PLANNING BY-LAW, 2015: ERF 151832, 6 LIESBEECK PARKWAY (BOUNDED BY LIEBEECK PARKWAY AND OBSERVATORY ROADS), OBSERVATORY**

Ms San Giorgio introduced the application

Messrs Florence, Arendse and Hugo spoke in support of the application. Mr Hugo made a PowerPoint presentation (Annexure 1)

Ms Mgedezi made a powerpoint presentation (Annexure 2). Mr Jenkins, Prof London and Mr Cogger addressed the Tribunal and spoke against the application. Mr Cogger's written submission is attached (Annexure 3)

The applicant was given an opportunity to rebut

The MPT asked several questions to the applicant, the objectors and the case officer. The individual MPT members gave extensive input in support of the application

UNANIMOUSLY RESOLVED that:

a. The application for the rezoning of the property from an Open Space Zoning 3: OS3 to a Subdivisional Area Overlay Zone in respect of Erf 151832, 6 Liesbeek Parkway Observatory **BE APPROVED** in terms of Section 98(b) of the Municipal Planning By-Law subject to conditions contained in Annexure A attached.

b. The application for the approval of Council to permit retaining structures to be 5.7m high in Precinct 1 and 5.9m high in Precinct 2 in lieu of 2.0m high above ground level in respect of Erf 151832, 6 Liesbeek Parkway Observatory **BE APPROVED** in terms of Section 98(b) of the Municipal Planning By-Law subject to conditions contained in Annexure A1 attached.

c. The application for:

- the deviation from the Table Bay District Plan
- Deviation from the Floodplain and River Corridor Management Policy (2009) seeking permission to:

i. develop/obstruct the free flow of water within the 20-year and 50-year floodplain *and to seek the in-filling below the 1:50 year floodplain.*

ii. Deviation from the Management of Urban Stormwater Impacts Policy (2009) seeking permission to:

- Deviate from the annexure table requiring 24-hour extended detention of the 1-year Recurrence Interval, 24-hour storm event in a greenfield development greater than 50 000m²; *to deviate from the annexure table* *requiring up to 10 year recurrence interval peak flow to be reduced to pre-development level in a greenfield development greater than 50 000m² and to deviate from the annexure table requiring up to 50 year recurrence interval peak flow to be reduced to existing development levels in a greenfield development greater than 50 000m².*

in respect of Erf 151832, 6 Liesbeek Parkway Observatory **BE APPROVED** in terms of Section 98(b) of the Municipal Planning By-Law subject to conditions contained in Annexure A attached.

REASONS FOR DECISION
The applications for the rezoning from an Open Space 3 to a Subdivisional Area Overlay Zone, approval of Council and deviation from policy comply with the requirements of Sections 99(1)(2)(3) of the MPBL and are approved for the following amended and summarized reasons:

1. All the applications required in terms of the MPBL have been applied for and relevant public participation processes followed.
2. The applications are consistent with the requirements of the MSDF as the property is located within the Urban Inner Core and integration zone where development of this nature is encouraged. To this extent, the deviation from the District Plan is warranted
3. The proposal will result in intensification and densification of the land which is supported by City policy.
4. A diverse range of land uses will be accommodated on the property.
5. Densification and intensification of land contributes toward the spatial restructuring of the City and ensures better utilization of the service infrastructure.
6. Short and long term employment opportunities will be created.
7. The mixed use development is suitably located being surrounded by residential, business and industrial uses.
8. The property provides access to opportunities being located close to, and providing access to, places of employment and various services and amenities.
9. Reduced parking provision ensures improved thresholds for public transport use.
10. The reduced parking ratio is considered rational as the site is located within a public transport corridor.
11. It will result in road improvements that will offer wider connections to various parts of the city.
12. There will be no adverse impact on the service infrastructure as either sufficient capacity exists or improvements to the services infrastructure will be implemented to accommodate the proposal. In some instances, on-site provision will be made to accommodate services.
13. Heritage impacts have been carefully considered and heritage components will be incorporated into the development.
14. Certain landscaping and other measures are proposed to mitigate against impacts on the receiving environment.
15. Specialist studies sufficiently demonstrate that measures proposed will mitigate against impact of development within the floodplain. This is agreed to by the competent Department.

MEDIA CITY BUILDING, 2ND FLOOR,
CNR ADDERLEY STREET AND HERTZOG BOULEVARD CAPE TOWN, 8001

16. The proposal supports the principles contained in both the LUPA and SPLUMA – the developer also offered to provide inclusionary housing in support of the spatial justice principle
17. The permitting of GB7 with a height limitation in Precinct 2 enables flexibility to be achieved at SDP Precinct level
18. The elevated height in Precinct 2 enables a sensitive bulk distribution where it is deemed most appropriate
19. In order to develop a viable solution for potential flooding and storm water management, deviation from Council policy in this regard is required and merited in order to facilitate a sustainable flood/stormwater management system for the development

<u>Annexure A1</u>
Delete paragraph 4 and 5

<u>Conditions imposed in terms of Section 100 of the MPBL</u>
Note: These conditions refer to the original conditions in the report and not the amended conditions tabled at the meeting

6.1 The property shall accommodate two Precincts (Precinct 1 and Precinct 2) comprising areas designated for General Business purposes and the overall combined floor space for the two Precincts shall not exceed 150 000m²

6.1.1 Precinct 1 shall not exceed a floor space of 60 000m2 and Precinct 2 shall not exceed a floor space of 90 000m²

6.1.2 The maximum height that will be permissible in the GB7 zone must not exceed 44.7m above base level.

Delete the heading 'Subdivision'

6.2 The subdivision plan required pursuant to in 6.1 above, shall –
6.2.1 Accompany the *site development* plan submissions, and
6.2.2 Be in accordance with the indicative subdivision plan (Concept subdivisional area plan) attached in Annexure D1 attached

6.3 The submission of a subdivision plan clearly identifying the
a. Cadastral boundary of the site and each portion
b. Extent of each portion
c. Zone of each portion including the sub-zone as approved herein
d. Servitude rights of way registered in favour of the general public
e Services.

Delete paragraph 6.3.1

6.3.1.1 Portion 3 of the subdivision shall be zoned for Open Space Zoning 3: Special Open Space purposes and shall be a minimum of 49835m² in extent.
6.3.1.2 Portion 3 shall comprise servitude rights of way registered in favour of the general public and shall be to the satisfaction of the authorized official (Development Management).

Amend paragraph 6.3.2 as follows:

6.3.2 A servitude right of way to permit the general public access across internal private roads shall be registered prior to the first occupancy to the satisfaction of the authorized official

Delete paragraph 6.3.3

Replace the heading 'Development Framework' with 'Site Development Plan'

Amend paragraph 6.4 as follows:

6.4 Prior to any development, the owner/developer shall submit an SDP for approval by the authorized official

Amend 6.4.1 as follows:

6.4.1 The SDP mentioned in 6.4 above shall be informed by the HIA/EIA and principles established in the Urban Design Study, Visual Impact Assessment, Hydrology Study (which may be amended to meet further requirements of relevant City departments).

Amend paragraph heading 6.4.2 as follows:

6.4.2 The SDP shall, furthermore, include –

- Overall site design;
- Spatial distribution of land uses within each Precinct;
- Phasing of development across the site;
- Vehicular movement and access arrangements;
- NMT movement and linkages to NMT routes external to the development
- Areas of historic significance with specific regard to areas on the property where the history of the property will be memorialised;
- Public and private spaces;
- Open spaces with associated linkages external to the development;
- Edges of the site.
- Character Precincts identified in the HIA/EIA, Visual Impact Study and Urban Design Study.

Delete paragraph 6.4.3

6.5 Each character Precinct referred to in 6.4.2 above shall

6.5.1 Ensure that buildings located along Berkley Road extension shall be higher than those located along the southern edge of the eco-corridor identified in the EIA.

6.5.2 Have regard for the heights of buildings and display a hierarchy of spaces, demonstrate the treatment of corners and edges, internal roads and building being stepped to accommodate light penetration.

6.5.3 Identify appropriate locations where foreground and background buildings are to be situated.

Delete paragraph 6.6

Delete paragraph 6.6.1

6.6.2 The design of each Precinct shall show –
- The extent of each Precinct;
- Character areas;
- Appropriately located bulk, including for example: - hierarchy of spaces; - light penetration; and - foreground and background buildings;
- Visual/view corridors;
- Road / built form interfaces;
- Any boundary treatments
- Floor space ratio per Precinct,
- Land use mix,
- Number of parking bays,
- Gateway buildings;
- Landscaping interventions.
- NMT;
- Maximum heights building heights measured from base level;
- Floor space per Precinct;
- Ranges of uses having regard to the permissible floor space;
- The number of parking bays provided;
- Public, semi-public and private spaces
- Interface conditions with the public realm having specific regard to the Urban Design policy demonstrating compliance with the principles contained therein and;
- Holding areas for public transport stops.

Delete paragraph 6.6.3

6.7 <u>In respect of Precinct 1:</u>

6.7.1 Building heights shall ensure that the lowest buildings observe the heritage indicators in relation to the SAAO (Erf 26493 – to the east of the property).

6.7.2 East/west pedestrian access into the retail component shall be open-to-the-sky and shall permit public access that links to the wider NMT network and surrounds.

6.7.3 Gateway buildings shall be reflected in height and architectural treatment.

6.7.4 Buildings shall be designed to ensure an appropriate interface with the surroundings.

6.8 <u>In respect of Precinct 2:</u>

6.8.1 The built form shall be separated to a greater degree than that proposed with greater levels of articulation to break up the monolithic form still experienced.

6.8.2 Highest buildings are to respond to the higher order Berkley Road. The height, mass, and bulk of buildings needs to be carefully considered to avoid conditions that may cause a 'walled development response'.

Amend paragraph 6.9 as follows:

6.9 Each Precinct plan and all subsequent Site Development Plan shall be accompanied by a bulk register detailing:

- Floor space per land use within each Precinct utilised and residual available;

• Overall floor space for the property utilised and residual available;
• Parking provision per Precinct required and that constructed.

6.10 The floor space allocated per Precinct shall not be transferable between Precincts.

Delete paragraph 6.11

6.12 The proposed link road alignment and form shall be designed to further reduce the negative visual impact on the "sense of place" experienced so as not to detract from the public and NMT users' experience, especially within and adjacent to, the ecological corridors.

6.13 Traffic circles provided on the property shall endeavour to accommodate a NMT prioritised environment which will facilitate the accessibility of the OS3 as part of the NMT route.

6.14 Detailed design of any vehicular or pedestrian control measures introduced on the property shall accompany the SDP for each phase.

Delete paragraph 6.15
Delete paragraph 6.16

6.17 The base level indicated for buildings and structures shown on each SDP shall accord with that indicated in Annexure C17.

Amend heading 'Land Uses' to 'Zoning and Land Uses'
Amend paragraph 6.18 as follows:

6.18 The land uses accommodated on-site in use zones GB3, GB6 and GB7 shall be limited to:
• Business Premises (Shops, Offices, Restaurants)
• Flats (including a minimum of 6000m2 of inclusionary housing or 20% of the residential component – whichever is the greatest)
• Hotel
• Place of entertainment (gym, conference facility, events pavilion)
• Place of Instruction
• Parking appurtenant to the abovementioned uses
• Ancillary uses appurtenant to uses accommodated on the property.

Delete 6.19

<u>Amend paragraph 6.20 as follows:</u>

6.20 The provision of inclusionary housing shall be interspersed with the open market dwelling units and other activities. At least 6000m² (or 20% of the residential component – whichever is the greater) shall be provided for affordable housing, as defined in the MSDF and must be indicated on the SDP and at building plan submission stage. The developer shall submit the plan for implementation of rental units in perpetuity, which shall be to the satisfaction of the authorized official

6.21 Housing typologies within the River Club shall be varied in typology and nature.

<u>Replace paragraph 6.22 with the following:</u>

6.22 An Owners' Association shall be established, as provided for in the By-Law, to be responsible for maintenance and management of the private roads and private open spaces

Landscape plan

6.23 A master landscape plan, drafted by a suitably qualified landscape architect, shall be included in the development framework referred to above. Furthermore, the master landscape plan shall –

6.23.1 Conform to the associated guidelines and principles set out in the landscape guidelines accompanying this application and shall be generally in accordance with the landscape concept plan submitted.

6.23.2 The master landscape plan shall detail

- Planting, terrestrial and riverine amongst others that will be removed, retained, transplanted and new planting;
- The provision of buffer areas along the river/canal edges;
- Servitude rights of way;
- Hard and soft landscaping
- Areas of historic significance and the memorialising the history of the site
- Street furniture
- Lighting and light fixtures across the site
- Provision of attenuation measures (including vegetated swales, bioretention areas, source control, etc.) which shall have regard to the stormwater flood management plan referred to below
- NMT routes comprising pedestrian and cycle paths, amongst others and links to existing NMT routes and networks;
- NMT routes shall have connections with existing,
- A plan for the phased development of the site and
- Flood attenuation measures

6.23.3 The master landscape plan referred to in above shall be to the satisfaction of the authorized official (Development Management).

6.23.4 A detailed landscape plan shall accompany each SDP which shall be generally in accordance with the master landscape plan and shall be to the satisfaction of the authorized official (Development Management).

6.23.5 All corresponding and adjacent open spaces details of the development area shall correspond, and be integrated, with the City of Cape Town's open spaces, having regard to the streets, pedestrian walkways, amongst others and shall be to the satisfaction of the authorized official (Development Management).

6.23.6 An open space register shall be submitted with each application submitted with each Precinct plan showing

6.23.6.1 Hard and soft landscaping

6.23.6.2 Ecological areas

6.23.6.3 Space of active play and

6.23.6.4 Heritage spaces.

6.24 The developer/owner shall be responsible for implementation of the approved master landscape plan and landscape plans (including all costs) in accordance with the landscape phasing plan.

6.25 The Owners' Association shall ensure the maintenance and upkeep of the riverine habitat in respect of portions of the Liesbeek River canal that has been decanalised.

6.26 The developer shall be responsible for all costs associated with implementation of landscaping.

6.27 The owner/developer shall submit a Construction Phase Environmental Management Plan prior to commencement of construction demonstrating how habitats will be protected during the construction phase of the development to the approval of the delegated authority (Development Management) in consultation with the Directors: Environment and Heritage Resources Management and Catchment Stormwater and River Management.

6.28 All habitable spaces shall be provided above the 1:100-year floodplain in accordance with various City policies. Catchment and Stormwater Management

<u>Catchment and Stormwater Management</u>

6.29 A Stormwater Management Plan for the property shall be submitted for the approval of the delegated authority (Development Management) in consultation with the Director: Catchment Stormwater and River Management in accordance with their requirements which may include further studies or modelling to be undertaken.

6.30 The developer/owner shall ensure that the necessary measures in mitigation of impacts as a consequence of flood level rise, including any necessary insurances, to safeguard properties affected by flood level rise as a consequence of this submission.

6.30.1 Any measures proposed in mitigation of the submission, shall be to the approval of the authorized official (Development Management) in consultation with the Director: Catchment, Stormwater and River Management.

Delete paragraph 6.31
Delete paragraph 6.31.1

6.32 The owner/developer shall provide a detailed river corridor management plan (as per requirements of Catchment Stormwater and River Management).

6.32.1 The plan referred to in 6.32 above, shall show measures to enhance water quality and restoration of water flows to the natural Liesbeek River, in addition to the management of the quality of the stormwater discharging into the Liesbeek River.

6.32.2 The plan shall be submitted simultaneously with the submission of the Stormwater Management Plan.

6.32.3 Any implementation measures referred to in 6.32.1 and 6.32.2 shall be to the account of the owner/developer.

6.33 The proposed upgrade of the Liesbeek River Canal on the eastern side of the property shall be subject to detailed Construction and Operational Environmental Management Plans (including plans, elevations and sections) for the design and management of the future rehabilitated environment to the approval of the delegated authority (Development Management) in consultation with the Director: Catchment Stormwater and River Management.

6.34 The rehabilitation of the canalised section of the eastern Liesbeek River shall accord with international best practice trends and is not to be regarded as a substitution of habitat for filling in the historic Liesbeek River channel.

6.35 A report drafted by a suitably qualified professionally registered engineer shall accompany the first SDP submission and shall demonstrate that all (proposed) new and existing structures on the property, on the unsubdivided remainder Erf 151832, can withstand the forces and effects of floodwaters to the satisfaction of the delegated authority (Development Management) in consultation with the Director: Water and Waste (Catchment Stormwater and River Management).

6.36 The determination of the buffer width along each river and riparian landscape shall be to the satisfaction of the Director: Development Management in consultation with the Director: Water and Waste (Catchment, Stormwater River Management).

<u>Amend paragraph 6.37 as follows:</u>

6.37 Flood attenuation measures for the development as proposed and contained in the Hydrologic Study or any revision or amendment thereof that may be required resulting from this approval shall be approved by the Catchment Stormwater and River Management Department.

6.38 Upon the advice of the Director: Catchment, Stormwater and River Management, should it be so deemed necessary by said department, flood warning systems shall be installed and to the developer/owner/ home owner's association's account.

<u>Transport</u>

6.39 The proposed road infrastructure and intersections as recommended in the TIA be implemented and that Malta/ Berkley / Liesbeeck intersection shall be design option 2 as indicated in the TIA drafted by Aurecon.

6.40 Improvements to Liesbeek Parkway to prevent flooding of the Liesbeek Parkway shall be implemented to the owner/developer's account and shall be to the approval of the Director: Road Infrastructure and Management and Director: Transport Forward Planning (Transport Planning).

6.41 Detailed civil engineering plans shall provide for the road upgrades along with the associated costs which shall be to the developer/owners account.

6.42 The proposed Public Transport routes and infrastructure facilities shall be provided to the satisfaction of the Director: Transport Forward Planning (Transport Planning).

6.43 No trapped low points be created with the geometric design of all roads, parking areas and overland escape routes.

6.44 The developer shall be responsible for the reinstatement of all damaged municipal infrastructure after completion of the construction work to the full municipal standards.

6.45 At least 4801 parking bays shall be provided on the property where Precinct 1 shall accommodate 1829 parking bays and Precinct 2 shall accommodate 2972 parking bays.

6.46 Shared parking shall be encouraged.

6.47 In the event that parking is provided above the 1:100-year floodplain provision shall be made for future conversion thereof to enable the conversions to habitable space in the future.

6.48 Signage shall be displayed along Liesbeek Parkway and any other road identified by Director: Catchment, Stormwater and River Management and/or Director: Transport Forward Planning (Transport Planning) warning motorists of the likelihood of flooding.

6.49 Provision shall be made internal to the development for shared parking to occur between businesses and residential uses to prevent the underutilisation of parking.

Amend paragraph 6.50 as follows:
Provision shall be made internal to the development for a holding area to accommodate stop and drop facilities to the approval of the Director: Transport Forward Planning (Transport Planning).

6.51 Prior to the approval of a Site Development Plan, any further permissions and approvals of Heritage Western Cape and/or the Department of Environment and Development Planning shall be obtained.

Note:

1. In accordance with the Item 136 of the development management scheme, the submission of any further land use applications whether as a consequence of MPT Report Template – 8 June 2017 Page 263 of 277 conditions imposed or not shall be subject to further comment and may be subject to further conditions to ensure the appropriate development of the property.
2. The conditions of the Provincial Administration: Western Cape (Department of Transport) shall be adhered to.
3. The requirements of the Director: Asset Management and Maintenance.
4. Various requirements of the National Water Act must be complied with in order to provide for certain water uses.
5. The requirements of various service branches in respect of water and sanitation, water and sewer, solid waste and electrical connections to the site.
6. These conditions shall be read in conjunction with the Record of Decision as submitted by the Heritage Western Cape dated January 2012 attached as Annexure I.
7. In respect of the subdivision: The conditions referred to be shall relate only to the subdivision of the consolidated property into portions 1 and 2. The

further subdivision of portions 1 and 2 shall necessitate circulation to branches for comment and further service related conditions in respect of the subdivisions to be imposed.

8. A home owners' association constitution shall be submitted after the further subdivision of each superblock for approval of the authorized official

<u>Add a 'Note' as follows:</u>

9. Pursuant to this approval, further development of the property shall consider the subdivision conditions referred to in the report under consideration

FOR INFORMATION: SAN GIORGIO / SEPTEMBER

SMPTNW 07/09/20 MEETING CLOSING

The Chairperson thanked the Councillors, SMPTNW Panel members and Officials for their input and for logistical arrangements of the meeting.

REASONS FOR DECISION

The applications for the rezoning from an Open Space 3 to a Subdivisional Area Overlay Zone, approval of Council and deviation from policy comply with the requirements of Sections 99(1)(2)(3) of the MPBL and are approved for the following amended and summarized reasons:

20. All the applications required in terms of the MPBL have been applied for and relevant public participation processes followed.
21. The applications are consistent with the requirements of the MSDF as the property is located within the Urban Inner Core and integration zone where development of this nature is encouraged. To this extent, the deviation from the District Plan is warranted
22. The proposal will result in intensification and densification of the land which is supported by City policy.
23. A diverse range of land uses will be accommodated on the property.
24. Densification and intensification of land contributes toward the spatial restructuring of the City and ensures better utilization of the service infrastructure.
25. Short and long term employment opportunities will be created.
26. The mixed use development is suitably located being surrounded by residential, business and industrial uses.
27. The property provides access to opportunities being located close to, and providing access to, places of employment and various services and amenities.
28. Reduced parking provision ensures improved thresholds for public transport use.
29. The reduced parking ratio is considered rational as the site is located within a public transport corridor.
30. It will result in road improvements that will offer wider connections to various parts of the city.
31. There will be no adverse impact on the service infrastructure as either sufficient capacity exists or improvements to the services infrastructure will be implemented to accommodate the proposal. In some instances, on-site provision will be made to accommodate services.
32. Heritage impacts have been carefully considered and heritage components will be incorporated into the development.
33. Certain landscaping and other measures are proposed to mitigate against impacts on the receiving environment.
34. Specialist studies sufficiently demonstrate that measures proposed will mitigate against impact of development within the floodplain. This is agreed to by the competent Department.
35. The proposal supports the principles contained in both the LUPA and SPLUMA – the developer also offered to provide inclusionary housing in support of the spatial justice principle
36. The permitting of GB7 with a height limitation in Precinct 2 enables flexibility to be achieved at SDP Precinct level
37. The elevated height in Precinct 2 enables a sensitive bulk distribution where it is deemed most appropriate
38. In order to develop a viable solution for potential flooding and storm water management, deviation from Council policy in this regard is required and merited in order to facilitate a sustainable flood/stormwater management system for the development

ANNEXURE A~~1~~

(Conditions amended by the MPT 18-09-2020)
[Words indicated in italics have been added, words struck through must be omitted]

REF: Case ID: 70396369

In this annexure:
"City" means the City of Cape Town
"The owner" means the registered owner of the property
"The property" means **Erf 151832, 6 Liesbeek Parkway Observatory**
"By-law" and "Development Management Scheme" has the meaning assigned thereto by the City of Cape Town Municipal Planning Bylaw, 2015
"Item" refers to the relevant section in the Development Management Scheme
"Commissioner: TDA" means Commissioner: Transport and Urban Development Authority or his/her delegatee.
"Director: DM" means Director: Development Management or his/her delegatee.

1. REZONING GRANTED IN TERMS OF SECTION 98(b) OF THE MUNICIPAL PLANNING BY-LAW:

1.1. Rezoning of the property from Open Space 3: Private Open Space zone to a Subdivisional Area (i.e. general business and open space zones).

2. APPROVAL GRANTED IN TERMS OF SECTION 98(b) OF THE MUNICIPAL PLANNING BY-LAW:

2.1. To permit the Approval of Council in terms of Item 126 of the DMS to enable retaining structures to be constructed to a height of more than the permitted 2.0m above the existing level of the ground in lieu of 2.0m.

3. DEVIATIONS FROM THE FOLLOWING CITY POLICIES SUPPORTED IN TERMS OF SECTION 98(d) OF THE MUNICIPAL PLANNING BY-LAW:

3.1. With respect to the Table Bay District Plan in order to permit urban development on land designated as "open space", "core 2" and "buffer 1".

3.2. With respect to the Floodplain and River Corridor Management Policy (2009) to develop/ obstruct the free of water within the 20-year and 50-year floodplain *and to seek the in-filling below the 1:50 year floodplain* ~~(excluding the in-filling of the ::Liesbeek River)~~.

3.3. With respect to the Management of Urban Stormwater Impacts Policy (2009) to enable deviation from the annexure table requiring

- 24hr extended detention of the 1-year Recurrence Interval, 24hr storm event in a greenfield development greater than 50 000m²
- *up to 10 year recurrence interval peak flow to be reduced to pre-development level in a greenfield development greater than 50 000m² and*
- *up to 50 year recurrence interval peak flow to be reduced to existing development levels in a greenfield development greater than 50 000m²*. ~~meet policy standards in respect of the ½ year stormwater recurrence/return intervals for a 24hr storm event.*~~

4. ~~REZONING~~ ~~<u>REFUSED</u>~~ ~~IN TERMS OF SECTION 98(c) OF THE MUNICIPAL PLANNING BY-LAW:~~

~~4.1. Rezoning of the property from Open Space 3: Private Open Space zone to a Subdivisional Area (General Business, Sub-zone GB7).~~

~~5. DEVIATIONS FROM CITY POLICY IS NOT SUPPORTED IN TERMS OF SECTION 98(d) OF THE MUNICIPAL PLANNING BY-LAW RELATING TO:~~

~~5.1 The Floodplain and River Corridor Management Policy (2009) the in-filling of the portion of the Liesbeek River on the western side of property.~~

~~5.2 The Management of Urban Stormwater Impacts Policy (2009) seeking deviations from *the requirement to meet the policies pollutant removal targets.**~~

~~5.2.1 To annexure table requiring 24hour extended detention of the 1-year Recurrence Interval, 24h storm event in a greenfield development greater than 50 000m² and~~

~~5.2.2 The requirement to improve the quality of run-off relating to the annexure table requiring pollutant removal targets to be met.~~

~~6.~~ *4.* CONDITIONS IMPOSED IN TERM OF SECTION 100 OF THE MUNICIPAL PLANNING BY-LAW:

~~6.1~~ *4.1* The property shall accommodate two precincts (Precinct 1 and Precinct 2) comprising areas designated for General Business purposes and the overall combined floor space for the two precincts shall not exceed 150 000m².

~~6~~.*4*.1.1 Precinct 1 shall not exceed a floor space of 60 000m² and Precinct 2 shall not exceed a floor space of 90 000m².

4.1.2 The maximum height that will be permissible in the GB7 zone must not exceed 44.7m above base level.

~~Subdivision~~

~~6~~ *4*.2 The subdivision plan required pursuant to in ~~6~~ *4*.1 above, shall –

~~6~~ *4*.2.1 Accompany the ~~precinct~~ *site development* plan submissions,

~~6~~ *4*.2.2 Be in accordance with the indicative subdivision plan attached in Annexure D1 attached.~~, and~~

~~6.2.3 Be to the prior approval of the delegated authority (Development Management).~~

~~6~~ 4.3 The submission of a subdivision plan clearly identifying the

- a. Cadastral boundary of the site and each portion
- b. Extent if each portion
- c. Zone of each portion including the sub-zone as approved herein
- d. Servitude right of ways registered in favour of the general public
- e. Services.

~~6.3.1. The subdivision plan shall show the subdivision of the property into three portions comprising:~~

- ~~Portion 1 being 48361m² in extent,~~
- ~~Portion 2 being 49148m² in extent, and~~
- ~~Portion 3 being 49835m² in extent.~~

~~6~~4.3.1.1 *Portion 3 of subdivision shall be zoned for Open Space 3: Special Open Space purposes and shall be a minimum of 49835m² in extent.*

~~6~~ 4.3.1.2 Portion 3 shall comprise servitude rights of way registered in favour the general public and shall be to the satisfaction of the ~~delegated~~ *authorized official* (Development Management).

~~6~~ 4.3.2 A servitude right of way to permit the general public access across ~~any~~ internal private roads shall be registered prior to the first occupancy ~~certificate being issued for the portion 2 in accordance with the Annexure D1~~ *to the satisfaction of the authorized official*.

~~6.3.3 Subject to the prior approval of the delegated authority (Development Management), servitude rights of way to permit the general public access across any internal private roads shall be registered for portions 1 and 3.~~

~~6.3.4~~

~~Development Framework~~ *Site development Plan*

~~6~~4 4 Prior to any development, the ~~applicant/~~owner/developer shall ~~prepare and~~ submit a *SDP* ~~development framework~~ for ~~the property detailing the development of the site~~ *approval by the authorized official*.

~~6~~ 4.4.1 The *SDP* ~~framework~~ mentioned in ~~6~~4.4 above shall be informed by the HIA/EIA and principles established in the Urban Design Study, Visual Impact Assessment, Hydrology Study (which may be amended to meet further requirements of relevant City departments).

~~6~~ 4.4.2 The *SDP* ~~framework~~ shall, furthermore, include –

- The two precincts mentioned in condition ~~6~~5.2.
- Overall site design;
- Spatial distribution of land uses within each precinct;
- Phasing of development across the site;
- Vehicular movement and access arrangements;
- NMT movement and linkages to NMT routes external to the development
- Areas of historic significance with specific regard to areas on the property where the history of the property will be memorialised;
- Public and private spaces;
- Open spaces with associated linkages external to the development;
- Edges of the site.
- Character precincts identified in the HIA/EIA, Visual Impact Study and Urban Design Study.

~~6.4.3 The framework shall be to the approval of the delegated authority (Development Management).~~

~~Precinct Plans~~

~~6~~ 4.5 Each character precinct referred to in ~~6~~ 4.4.2 above shall

~~6~~ 4.5.1 Ensure that buildings located along Berkley Road extension shall be higher than those located along the southern edge of the eco-corridor identified in the EIA.

~~6~~ 4.5.2 Have regard for the heights of buildings and display a hierarchy of spaces, demonstrate the treatment of corners and edges, internal roads and building being stepped to accommodate light penetration.

~~6~~ 4.5.3 Identify appropriate locations where foreground and background buildings are to be situated.

~~6.6 Prior to the submission of site development plans, Precinct plans shall be submitted for each precinct and shall include –~~

~~6.6.1 Urban design and development guidelines for the entire development in general accordance with 6.4 above.~~

~~6.6.2~~ 4.6 The design of each precinct shall show –

- The extent of each precinct;
- Character areas;
- Appropriately located bulk, including for example: - hierarchy of spaces; - light penetration; and - foreground and background buildings;
- Visual/view corridors;
- Road / built form interfaces;
- Any boundary treatments
- Floor space ratio per precinct,
- Land use mix,
- Number of parking bays,
- Gateway buildings;
- Landscaping interventions.
- NMT;
- Maximum heights building heights measured from base level;
- Floor space per precinct;
- Ranges of uses having regard to the permissible floor space;
- The number of parking bays provided;
- Public, semi-public and private spaces
- Interface conditions with the public realm having specific regard to the Urban Design policy demonstrating compliance with the principles contained therein;
- Holding areas for public transport stops.

~~6.6.3 The Precinct plans shall be to the approval by the delegated authority (Development Management).~~

~~6~~ 4.7 In respect of Precinct 1:

~~6~~ 4.7.1 Building heights shall ensure that the lowest buildings observe the heritage indicators in relation to the SAAO (Erf 26493 – to the east of the property).

~~6~~ 4.7.2 East/west pedestrian access into the retail component shall be open-to-the-sky and shall permit public access that links to the wider NMT network and surrounds.

~~6~~ 4.7.3 Gateway buildings shall be reflected in height and architectural treatment.

~~6~~ *4.7.4* Buildings shall be designed to *ensure an appropriate* interface with the surroundings.

~~6~~ *4.8* In respect of Precinct 2:
~~6~~ *4.8.1* The built form shall be separated to a greater degree than that proposed with greater levels of articulation to break up the monolithic form still experienced.

~~6~~ *4.8.2* Highest buildings are to respond to the higher order Berkley Road. The height, mass, and bulk of buildings needs to be carefully considered to avoid conditions that may cause a 'walled development response'.

~~6~~ *4.9* Each precinct plan and all subsequent site development plans shall be accompanied by a bulk registered detailing

- Floor space per land use within each precinct utilised and residual available;
- Overall floor space for the property utilised and residual available;
- Parking provision per precinct required and that constructed.

~~6~~ *4.10* The floor space allocated per precinct shall not be transferable between precincts.

~~6.11 The area proposed as OS3 on Erf151832, and the remaining full development area shall be registered as a public right of way servitude in perpetuity.~~

~~6.12~~ *4.11* The proposed link road alignment and form shall be designed to further reduce the negative visual impact on the "sense of place" experienced so as not to detract from the public and NMT users' experience, especially within and adjacent to, the ecological corridors.

~~6.13~~ *4.12* Traffic circles provided on the property shall endeavour to accommodate a NMT prioritised environment which will facilitate the accessibility of the OS3 as part of the NMT route.

~~6.14~~ *4.13* Detailed design of any vehicular or pedestrian control measures introduced on the property shall accompany the SDP for each phase.

~~6.15 Site Development Plans (SDP) shall be submitted for each individual development within the Precinct Plans and Character Areas and with the corresponding Landscape SDP Plans.~~

~~6.16 All SDP's shall be accordance with the development framework and precinct plans.~~

~~6.17~~ *4.14* The base level indicated for buildings and structures shown on each SDP shall accord with that indicated in Annexure C17.

<u>*Zoning and* Land uses</u>
~~6.18~~ *4.15* The land uses accommodated on-site *in use zones GB3, GB6 and GB7* shall be limited to

- Business Premises (Shops, Offices, Restaurants)
- Flats (including a minimum of 6000m² of inclusionary house)
- Hotel
- Place of entertainment (gym, conference facility, events pavilion)
- Place of Instruction
- Parking appurtenant to the abovementioned uses and

- Ancillary uses appurtenant to uses accommodated on the property.

~~6.19 Notwithstanding the provisions of the DMS, coverage on the property (after subdivision) shall not exceed 35%.~~

~~6.20~~4*.16* The provision of inclusionary housing shall be interspersed with the open market dwelling units and other activities. *At least 6000m² (or 20% of the residential component – whichever is greater) shall be provided for affordable housing, as defined in the MSDF and must be indicated on the SDP and at building plan submission stage. The developer shall submit the plan for implementation of rental units in perpetuity, which shall be to the satisfaction of the authorized official.*

~~6.21~~4*.17* Housing typologies within the River Club shall be varied in typology and nature.

~~6.22 With respect to the overall maintenance and management responsibilities for the property, the applicant/owner/developer shall enter into any necessary agreements with the City prior to issuance of any occupancy certificate/s.~~

4.18 An Owners' Association shall be established, as provided for in the By-Law, to be responsible for maintenance and management of the private roads and private open spaces.

<u>Landscape plan</u>

~~6.23~~ *4.19* A master landscape plan, drafted by a suitably qualified landscape architect, shall be included in the development framework referred to above. Furthermore, the master landscape plan shall -

~~6.23.1~~4*.19.1* Conform to the associated guidelines and principles set out in the landscape guidelines accompanying this application and shall be generally in accordance with the landscape concept plan submitted.

~~6.23.2~~ *4.19.2* The master landscape plan shall detail

- Planting, terrestrial and riverine amongst others that will be removed, retained, transplanted and new planting;
- The provision of buffer areas along the river/canal edges;
- Servitude rights of way;
- Hard and soft landscaping;
- Areas of historic significance and the memorialising the history of the site;
- Street furniture;
- Lighting and light fixtures across the site;
- Provision of attenuation measures (including vegetated swales, bioretention areas, source control, etc.) which shall have regard to the stormwater flood management plan referred to below;
- NMT routes comprising pedestrian and cycle paths, amongst others and links to existing NMT routes and networks;
- NMT routes shall have connections with existing, and
- A plan for the phased development of the site.
- Flood attenuation measures

~~6.23.3~~4*.19.3* The master landscape plan referred to in above shall be to the satisfaction of the ~~delegated authority~~ *authorized official* (Development Management).

~~6.23.4~~ *4.19.4* A detailed landscape plan shall accompany each ~~precinct plan~~ *SDP* which shall be generally in accordance with the master landscape plan and shall be to the satisfaction of the delegated authority (Development Management).

~~6.23.5~~ *4.19.5* All corresponding and adjacent open spaces details of the development area shall correspond, and be integrated, with the City of Cape Town's open space in addition to having regard to the streets, pedestrian walkways, amongst others and shall be to the satisfaction of the delegated authority (Development Management).

~~6.23.6~~ *4.19.6* An open space register shall be submitted with each application submitted with each precinct plan showing

~~6.23.6.1~~*4.19.6.1* Hard and soft landscaping
~~6.23.6.2~~ *4.19.6.2* Ecological areas
~~6.23.6.3~~ *4.19.6.3* Space of active play and
~~6.23.6.4~~ *4.19.6.4* Heritage spaces.

~~6.24~~ *4.20* The developer/owner shall be responsible for implementation of the approved master landscape plan and landscape plans (including all costs) in accordance with the landscape phasing plan.

~~6.25~~ 4.21 The ~~applicant~~ Owner's Association shall ensure the maintenance and upkeep of the riverine habitat in respect of portions of the Liesbeek River canal that has been decanalised.

~~6.26~~ *4.22* The developer shall be responsible for all costs associated with implementation of landscaping.

~~6.27~~ *4.23* The ~~applicant/~~owner/developer shall submit a Construction Phase Environmental Management Plan prior to commencement of construction demonstrating how habitats will be protected during the construction phase of the development to the approval of the delegated authority (Development Management) in consultation with the Directors: Environment and Heritage Resources Management and Catchment Stormwater and River Management.

~~6.28~~ *4.24* All habitable spaces shall be provided above the 1:100 year floodplain in accordance with various City policies.

<u>Catchment and Stormwater Management</u>

~~6.29~~ *4.25* A Stormwater Management Plan for the property shall be submitted for the approval of the delegated authority (Development Management) in consultation with the Director: Catchment Stormwater and River Management in accordance with their requirements which may include further studies or modelling to be undertaken.

~~6.30~~ *4.26* The developer/owner shall ensure that the necessary measures in mitigation of impacts as a consequence of flood level rise, including any necessary insurances, to safeguard properties affected by flood level rise as a consequence of this submission.

~~6.30.1~~*4.26.1* Any measures proposed in mitigation of the submission, shall be to the approval of the delegated authority (Development Management) in consultation with the Director: Catchment, Stormwater and River Management.

~~6.31 Buildings on the South African Astronomical Observatory shall be flood proofed where necessary and in consultation with that land owner and shall be to the approval of the delegated authority (Development Management) in consultation with the Director: Catchment Stormwater and River Management.~~

~~6.31.1 Unless determined otherwise by the delegated authority (Development Management), the flood proofing mentioned inn 6.31 above shall be implemented prior to the issuing of the first occupancy certificate for the development proposed and shall be to the owner/developers account.~~

~~6.32~~*4.27* The ~~applicant/~~owner/developer shall provide a detailed river corridor management plan (as per requirements of Catchment Stormwater and River Management).

~~6.32.1~~*4.27.1* The plan referred to in ~~6.32~~ *4.27* above, shall show measures to enhance water quality and restoration of water flows to the natural Liesbeek River, in addition to the management of the quality of the stormwater discharging into the Liesbeek River.

~~6.32.2~~ *4.27.2* The plan shall be submitted simultaneously with the submission of the Stormwater Management Plan.

~~6.32.3~~ *4.27.3* Any implementation measures referred to in ~~6.32.1~~ *4.27.1* and ~~6.32.2~~ *4.27.2* shall be to the account of the owner/developer.

~~6.33~~ *4.28* The proposed upgrade of the Liesbeek River Canal on the eastern side of the property shall be subject to detailed Construction and Operational Environmental Management Plans (including plans, elevations and sections) for the design and management of the future rehabilitated environment to the approval of the delegated authority (Development Management) in consultation with the Director: Catchment Stormwater and River Management.

~~6.34~~*4.29* The rehabilitation of the canalised section of the eastern Liesbeek River shall accord with international best practice trends and is not to be regarded as a substitution of habitat for filling in the historic Liesbeek River channel.

~~6.35~~ *4.30* A report drafted by a suitably qualified professionally registered engineer shall accompany the first SDP submission and shall demonstrate that all (proposed) new and existing structures on the property, on the unsubdivided remainder Erf 151832, can withstand the forces and effects of floodwaters to the satisfaction of the delegated authority (Development Management) in consultation with the Director: Water and Waste (Catchment Stormwater and River Management).

~~6.36~~ *4.31* The determination of the buffer width along each river and riparian landscape shall be to the satisfaction of the Director: Development Management in consultation with the Director: Water and Waste (Catchment, Stormwater River Management).

~~6.37~~ *4.32* Flood attenuation measures for the development as proposed and contained in the Hydrologic Study or any revision or amendment thereof that may be required resulting from this approval, ~~including but not limited to alternate measures to filing in of the Liesbeek River~~, shall be approved by the Catchment Stormwater and River Management.

~~6.38~~ *4.33* Upon the advice of the Director: Catchment, Stormwater and River Management, should it be so deemed necessary by said department, flood warning systems shall be installed and to the developer/owner/ home owner's association's account.

Transport

~~6.39~~ *4.34* The proposed road infrastructure and intersections as recommended in the TIA is implemented and that Malta/ Berkley / Liesbeeck intersection shall be design option 2 as indicated in the TIA drafted by Aurecon.

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~~6.43~~ *4.38* No trapped low points are created with the geometric design of all roads, parking areas and overland escape routes.

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~~6.45~~ *4.40* At least 4801 parking bays shall be provided on the property where precinct 1 shall accommodate 1829 parking bays and precinct 2 shall accommodate 2972 parking bays.

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~~6.49~~ *4.44* Provision shall be made internal to the development for shared parking to occur between businesses and residential uses to prevent the underutilisation of parking.

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~~6.51~~ *4.46* Prior to the approval of a site development plan, any further permissions and approvals of Heritage Western Cape and/or the Department of Environment and Development Planning shall be obtained.

Note:

1. In accordance with the Item 136 of the development management scheme, the submission of any further land use applications whether as a consequence of conditions imposed or not shall be subject to further comment and may be subject further conditions to ensure the appropriate development of the property.
2. The conditions of the Provincial Administration: Western Cape (Department of Transport) shall be adhered to.
3. The requirements of the Director: Asset Management and Maintenance.
4. Various requirements of the National Water Act must be complied with in order to provide for certain water uses.
5. The requirements of various service branches in respect of water and sanitation, water and sewer, solid waste and electrical connections to the site.
6. These conditions shall be read in conjunction with the Record of Decision as submitted by the Heritage Western Cape dated January 2012 attached as Annexure I.
7. In respect of the subdivision: The conditions referred to be shall relate only to the subdivision of the consolidated property into portions 2 and 3. The further subdivision of portions 2 and 3 shall necessitate circulation to branches for comment and further service related conditions in respect of the subdivisions to be imposed.
8. A home owners' association constitution shall be submitted after the further subdivision of each superblock for approval the approval of the Director: Development Management.
9. *Pursuant to this approval further development of the property shall consider the subdivision conditions referred to in the report under consideration.*

2597 LL60

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

SPATIAL PLANNING
AND ENVIRONMENT

Internal Memorandum

To : Director: Development Managment
Att : Joy San Giorgio, Land Use Management Branch (LUM)

From : Acting Manager: Environmental & Heritage Management

Subject : DAMS Case 70396369, Cape Town, erf 151832, No. 6 Liesbeek Way, Observatory (River Club): Rezoning, Consent, Deviation from policies.

Date : 23 January 2020

APPLICATION FOR DEVIATION FROM THE TABLE BAY DISTRICT PLAN, REZONING TO SUBDIVISIONAL AREA OVERLAY ZONE, APPROVAL TO CONSTRUCT RETAINING STRUCTURES, & DEVIATION FROM THE CITY'S FLOODPLAIN AND RIVER CORRIDOR MANAGEMENT POLICY (2009) AND MANAGEMENT OF URBAN STORMWATER IMPACTS POLICY (2009), ERF 151832 CAPE TOWN (RIVER CLUB, OBSERVATORY)

Reference is made to Environmental Management comments dated 15 October 2018, as well as to the Revised Submission (Revision 4) Erf 151832 Cape Town Ref. 4342, Motivation Report (of 216 pages in length), and the Supplementary Information Report (undated) (of about 70 pages in length).

The City of Cape Town's Environmental Management Department was requested at a meeting between the applicant, Development Management Department officials and officials from other departments, on 1 November 2019, to submit revised comments based on supplementary information showing how certain buildings, landscapes and other elements of the development respond to concerns raised to this application.

This comments address the following:

1) The Development Proposal and the Application
2) Heritage Assessment
3) Environmental Assessment
4) Conclusion and Recommendations

1 THE DEVELOPMENT PROPOSAL AND THE APPLICATION

1.1 The Development proposal

This application will allow the following development:

- mixed use development of 150 000 m²
- Retail, offices, dwelling units
- Approximately 20% of the total floor space for residential development
- Approximately 20% of the residential component will be allotted to inclusionary housing
- Hotel
- Places of Instruction
- Building heights ± 16m to ±46m (3 to 10 storeys) above base level (which will be 5.7 – 5.9m above existing ground level), i.e. up to 52m above existing ground level.
- Construction of retaining structures so that roads and habitable spaces are raised above the 1:100year flood plain
- Partial construction of the Berkley Road extension from mid-site to Ndabeni
- The Liesbeek Canal on the eastern boundary of the site will be rehabilitated into a river course
- The 'old' historic Liesbeek River course on the western boundary of the site will largely be filled in with earth, and landscaped to accommodate a vegetated stormwater swale, while the river would be piped below ground.
- An ecological corridor and open space will extend across the site in an east-west direction connecting the stormwater swale with the rehabilitated riverine canal.
- Pedestrian and cycle paths, viewing and seating areas along the rehabilitated canal east of the River Club.

1.2 The Application

1.2.1. The application is for approval of the following:

- **A deviation from the Table Bay District Plan** to permit urban development on land designated as "open space", "core 2" and "buffer 1", in accordance with section 16 of the MPBL.
- **rezoning** from Open Space Zoning 3: Special Open Space (OS3) to Subdivisional Area Overlay Zone (SAO)
- **approval to construct retaining structures**, in terms of Section 42(i) of the MPBL and in accordance with item 126 of the DMS, to be constructed to a height of more than the permitted 2.0m above the existing level of the ground (to heights of 5.7m and 5.9m above existing ground level)
- **deviations from the following city policies**:
  - Floodplain and River Corridor Management Policy (2009):
    i) Section 9.2: Flood management and public safety
    Permission to develop / obstruct the free flow of water within the 20year flood plain
    ii) Section 10.5 Table 1: Framework for the assessment of proposals
    Permission to infill within the 50year floodplain.
  - Management of Urban Stormwater Impacts Policy (2009)
    i) Annexure table: 24hour extended detention of the 1year RI, 24hour storm even in a greenfield development >50000m². Permission to deviate from this requirement.
    ii) Annexure table Up to 10-year RI peak flow reduced to pre-development level in a greenfield development >50000m². Permission to deviate from this requirement.
    iii) Annexure table up to 50year RI peak flow reduced to existing development levels in a greenfield development >50000m². Permission to deviate from this requirement.

1.2.2. The applicant states that this application is the initial step in a series of land use related applications for this site, such as subdivision and departures. He states that the preliminary Development Framework, indicated as Figure 1of the River Club Supplementary Information, (see below) is submitted as part of the Motivation Report only, and not for approval.

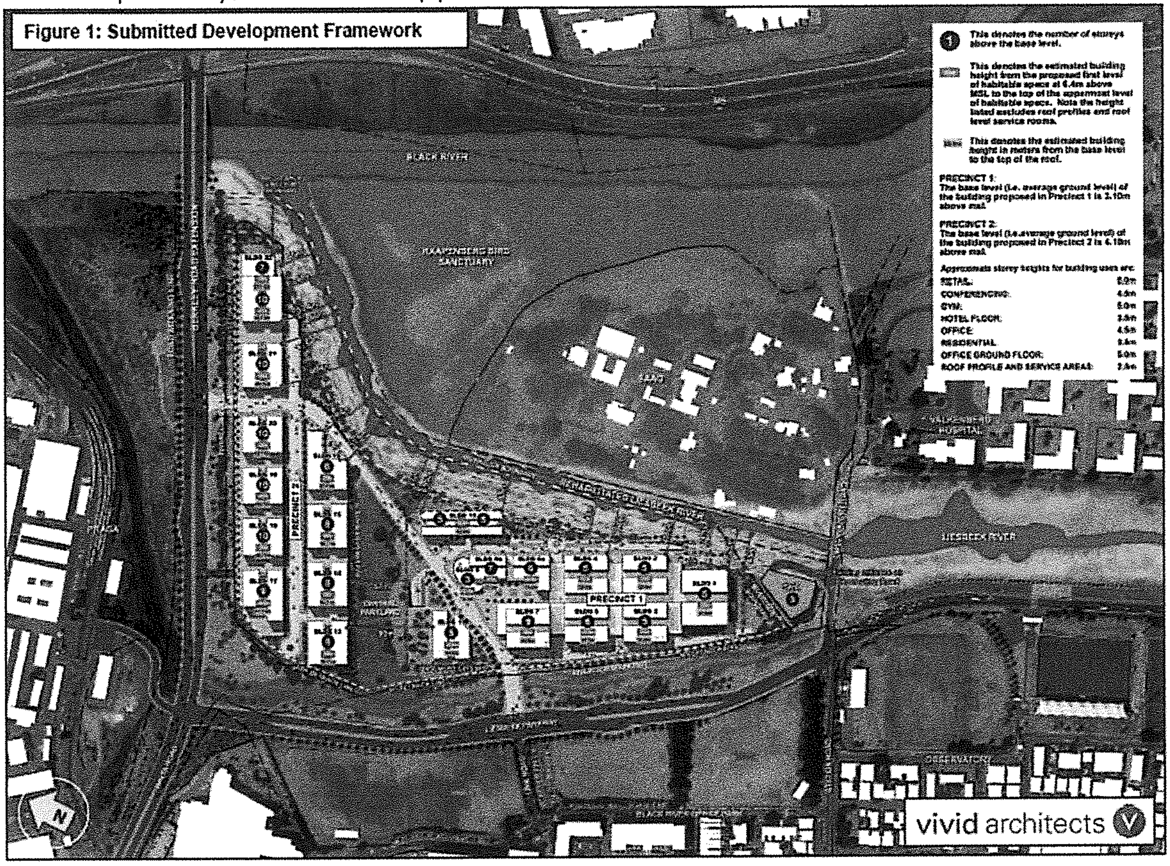


Figure 1: Submitted Development Framework

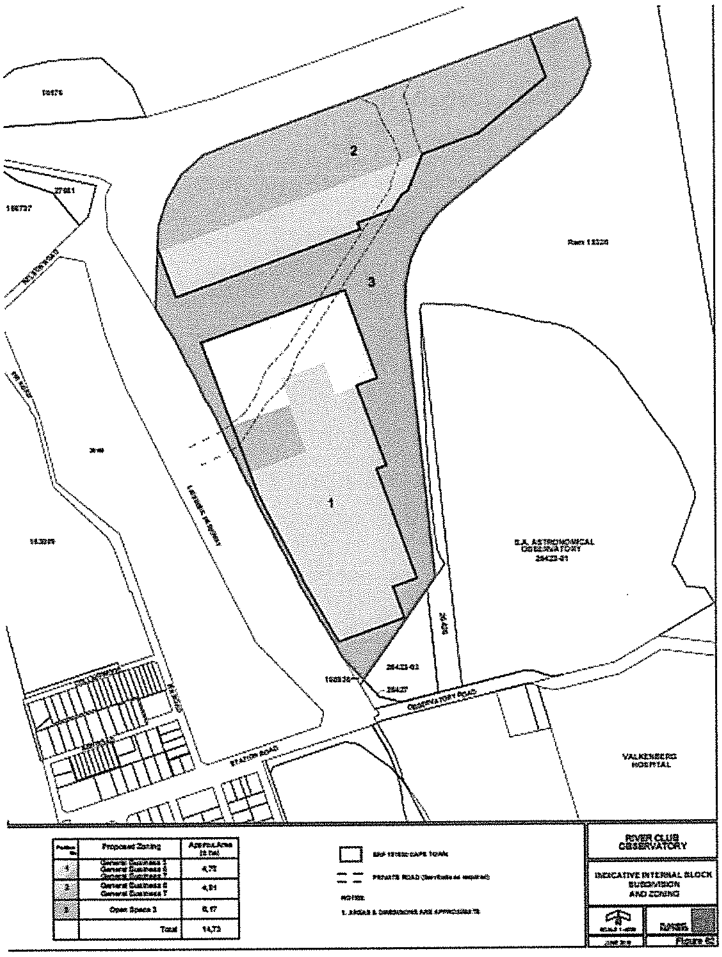
1.2.3. Further, "the statutory planning application remains unchanged and after rezoning to subdivisional area, future formal submissions will be made relating to Precinct Plans, internal Subdivision pans and Site Development Plans." The application does not include submission of a Site Development Plan (SDP)

1.2.4. The applicant indicated that the site will be divided into two development precincts, with a central open space precinct (Motivation Report, Figure 62, page 181). However, this is not included in the land use management application.

1.2.5. The applicant is offering to submit a subdivision plan, phasing plan, precinct plans and site development plans in future, once this application to rezone and allocated bulk is approved (Motivation Report, Section 11.1, page 181).

1.2.6. The supplementary information is submitted in motivation of the land use rights sought, but the applicant indicates that this information is not enforceable and merely provided to illustrate future intent.

1.2.7. The Motivation Report (pg182) includes a basic Site Development Plan which indicates proposed land uses / zonings on the site. However, this plan is not included for approval, and is indicative only of what may or may not be submitted in the future.



1.2.8. The diagram above indicates areas proposed for General Business 6 & 7, which zones permit heights of up to 60m above existing ground level, and it shows areas to retain the current Open Space 3 zoning. Nevertheless, this diagram is not submitted for approval and is only indicative of what may be submitted in future applications.

1.2.9. The applicant includes a diagram indicating the proposed retaining wall heights relative to existing ground levels. However, it is not clear if this diagram is to be included for approval or not. Nevertheless, it indicates, in conjunction with other supporting information, that the applicant has a clear idea of building footprints, and would likely be able to supply a Site Development Plan if requested to do so.

1.2.10. The City is empowered to request a Site Development Plan in terms of Item 123 of the Municipal Planning By-law, for this type of development: Item 123(1) "In addition to the zonings that specifically require a site development plan, the City may require a site development plan in respect of the following development types:

(a) Shopping centres and shopping complexes
(b) Business and office park developments
(c) ...

(d) Developments in conservation areas
(e) Developments that will be sectionalised
(f) Incremental residential developments; and
(g) Major developments where there are concerns relating to urban form, heritage, traffic or spatial planning in general."

1.2.11. This proposed development falls within a proposed Heritage Protection Overlay Zone (HPOZ), a provisional protection area in terms of Section 29 of the National Heritage Resources Act (no. 25 of 1999), and within the biodiversity conservation area of the historic Liesbeek River which forms part of the broader Biodiversity Network, which the applicant wishes to infill. The proposed development includes a shopping complex, business and office park development, and constitutes a major development where there are concerns relating to urban form, heritage, traffic and spatial planning. Hence it would not have been unreasonable to expect the applicant to submit more detailed planning at the outset, or for the City to request such plan.

1.2.12. The City is empowered by the Municipal Planning By-law to request all the information relating to the preparation of a Site Development Plan, in terms of Item 123(2)(a) through to (t), including:

- existing bio-physical characteristics of the property;
- existing and proposed cadastral boundaries;
- the layout of the property, indicating the use of different portions thereof;
- the massing, position, use and extent of buildings;
- sketch plans and elevations of proposed structures, including information about external finishes;
- cross-sections of the site and buildings on site;
- the alignment and general specification of vehicle access, roads, parking areas, loading areas, pedestrian flow and footpaths;
- the position and extent of private, public and communal space; typical details of fencing or walls around the perimeter;
- management of stormwater and disposals of sewage and refuse;
- general landscaping proposals, including vegetation to be preserved, removed or to be planted;
- the phasing of development;
- the proposed development in relation to existing and finished ground levels, including excavation, cut and fill;
- statistical information about the extent of the proposed development, floor space allocations and parking supply;
- relationship of the proposed development to the quality, safety and amenity of the surrounding public environment;
- relationship of the proposed development to adjacent sites, especially with respect to access, overshadowing and scale;
- illustrations in a three-dimensional form depicting visual impacts of the proposed development on the site and in relation to surrounding buildings; and
- any other details as may reasonably be required by the City.

1.2.13. The supplementary information indicates, for example, the new road linkage between Salt River and Ndabeni, but the actual application in front of the decision maker at this time is only for the eastern link to provide freeway access for the benefit of the proposed development. In fact, there is no site development plan submitted for approval of a road in this application.

1.2.14. A second such example is the setbacks and height limitations shown at various places in the precinct, to respond to the heritage impact and indicators.

1.2.15. The proposal seeks to authorise the infilling of the western Liesbeek River course in exchange for de-canalising one side of the western section, but also seeks to dispose of stormwater on City property, against current stormwater Policy (Post development run-off would exceed pre-development run-off, and the water would be discharged off the private property into the surrounding rivers on City land). The Environmental Impact Assessment, in terms of Act 107 of 1998 (and its regulations), for these two aspects of the development, has not yet been finalised. This matter cannot reasonably be decided upon by the Municipal Planning Tribunal without the environmental impact assessment process having been finalised first.

1.2.16. The following extract from the motivation report for this application (Section 10.1.1 on page 179) refers to the rezoning being sought:

> Application is submitted in terms of section 44(1) of the MPBL to rezone the property from *Open Space 3: Special Open Space (OS3)* to *Subdivisional Area Overlay Zone*.
>
> The reason behind the rezoning to Subdivisional Area is to allow for a degree of flexibility with regard to the future subdivision and deemed zoning(s) on the site. For example, it will allow for different General Business sub-zones to be utilized in different portions of the site, as well as more precise determination of the environmental and open space areas, which zoning will be deemed as Open Space 3.
>
> Preliminary deemed zonings for the site following future subdivision are *General Business (Sub-zones 4 – 7)* and *Open Space Zoning 3*.

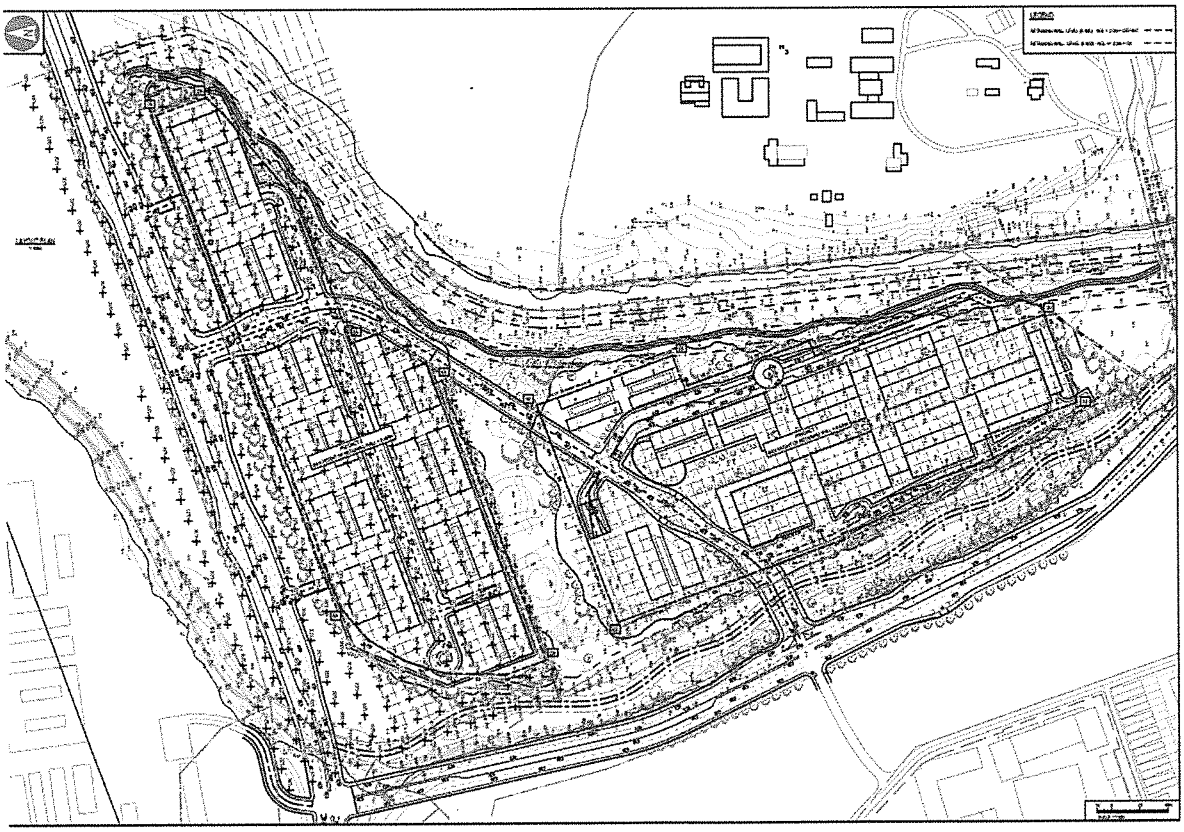
1.2.17. The applicant is asking the City, in the motivation report, to consider allocating 150 000m^2 floor area of mixed use land use rights, building heights of up to 46 metres above existing ground level, and the possibility of subdividing the site into precincts, but does not want to commit to any development framework plan or conceptual framework plan at this stage and has not submitted such spatial plans as for approval as part of the land use management application.

1.2.18. The lack of SDP/some form of plan makes even the most basic evaluation and mitigation of environmental and heritage impacts (and therefore assessment of desirability; or the ability of the site to accommodate the proposed land use) impossible to do in a meaningful way, if the applicant cannot be held to the illustrations and ideas contained in the motivating memorandum and supplementary information. Conversely, certain ideas contained in the motivation report are not the subject of a formal application process and need not be included for approval, as they cannot be considered as integral to the planning application submission. If included on a Site Development Plan, or within a Development Framework, they could have been considered as part of the overall land use management application and approval.

1.2.19. The applicant alluded to following a package of plans process, but instead of doing that, chose to pursue rezoning to Subdivisional Area Overlay Zone, meant for homogenous developments with a uniform nature and repetitive subdivisions, to release the land in future. This may be the incorrect planning mechanism to apply in the case of this development that could alternatively have followed a package of plans process, with a high level plan for the site right from the start.

1.2.20. According to the MPBL, Chpt 18, "The Subdivisional Area Overlay (SAO) Zone designates land for future subdivision with development rights by providing development directives through specific conditions as approved in terms of the MPBL. The SAO zoning confirms the principle of development and acceptance of future subdivision of land; but not the detailed layout, which will be determined when an actual application for subdivision is approved. .... The SAO zoning may or may not be used in conjunction with the Special Planning area mechanism." Hence, the submission of the diagrams for retaining structures on two large development footprints, uploaded to the DAMS case, are premature because without having submitted SDPs for the site, building footprints for structures are already indicated relative to the biodiversity conservation area of the historic Liesbeck River (west of the River Club), and without showing the requisite setback for an ecological buffer from the Liesbeek River.

1.2.21. Furthermore, the diagram (see below) included for the retaining structures up to 5.9m in height, in lieu of 2m in height, indicates development on City land, outside the private property site boundaries, for which power of attorney from the City's Property Management Branch is not uploaded to the case on DAMS, for part of the development proposals to extend onto City land, such as a roads and swales.



1.2.22. Furthermore, a trail crosses over land owned by the SA Astronomical Observatory and owned by the City on the retaining structures diagram. Proposed roads extend over City land. It would be problematic to approve such a diagram in the absence of an approved spatial development framework.

1.3 Deviations from approved City Policies and reference to draft Two Rivers Local Spatial Development Framework

1.3.1. The applicant includes reference in the River Club Supplementary Information, Section 1.2, to the Draft Two Rivers Local Spatial Development Framework as supporting the proposed River Club development. This draft LSDF is problematic and unlikely to be approved in its current form, due to it being in conflict with several approved City policies. The plans in the Draft TRLSDF are of poor quality, are unclear, and are not endorsed by the City as they disregard the existence of a high faunal sensitivity Conservation Area, which is part of the City's Biodiversity Network. A draft policy that is still out for public comment cannot be used to motivate a land use application.

1.3.2. Further, in Section 1.3 of the Supplementary Information Report, the applicant disparages the status of the Council approved Two Rivers Urban Park Contextual Framework (2003). Although not a spatial planning instrument, it is nevertheless an approved policy and has status, such as the Floodplain and River Corridor Management Policy, for which application is being made to deviate. As approved policy, the principles must be used to guide decision-makers regarding any future development within the area. Recently (January 2020) a Memorandum of Advice on the Two Rivers Urban Park Contextual Framework and Phase 1 Environmental Management Plan, 2003 and intended Local Spatial Development Framework for the Two Rivers Urban Park Area", the City's legal advisor to the Water Department advised as per section 12 of her MoA, "in the absence of formal structure plan status, the CF must be regarded as a policy or a guideline. The City is obliged to apply policy and if there an application entails a substantive departure from policy we would have to seek a council decision (there is no delegation for this)." Furthermore, "There isn't a formal process for a developer to apply for a policy deviation. It's up to City decision-makers to apply policy. If asked for a substantive policy deviation they would have to approach council for approval, citing all relevant considerations."

1.3.3. The areas of conflict / deviation from the approved Two Rivers Urban Park Contextual Framework are highlighted in section 3 of these comments, The Environmental Assessment.

1.4 Concern

1.4.1. The applicant is asking the City to consider the supplementary information provided in support of the application without binding or committing themselves to its content or submitting it for approval as a formal application.

1.4.2. The applicant is offering to submit a subdivision plan, phasing plan, precinct plans and site development plans in future, after this application to rezone has been approved. However, it is critical for the applicant to include, as part of this land use management application, a high level conceptual framework or development framework plan to provide a spatial representation of how the development will materialise, and to enable the proper evaluation of impacts on the environmental and heritage resources, by the Municipal Planning Tribunal.

1.4.3. The further requirement for a river corridor management plan (as per requirements of the City's Catchment Management Branch) must be dealt with in the current application, because the rights sought, relate directly to the storm water management impact and deviations from Policy and also relate to impacts on biodiversity within a high faunal sensitivity Conservation Area.

1.4.4. The Landscape Master Plan requested in the branch comment can form part of the high level conceptual framework or development framework plan mentioned, and should be submitted for evaluation during this current application, prior to any development rights being granted.

1.4.5. The proposals to landscape and rehabilitate the existing Liesbeek Canal should be included as part of the submission, and shown on detailed spatial plans, with elevations and cross-sections, as part of the Site Development Plan submission, otherwise the rehabilitation may not necessarily materialise if not shown on detailed spatial plans, nor indicated on a phasing plan.

1.4.6. Although not legally obliged to wait, the City needs to carefully consider the fact that there are two legislative impact assessment processes underway that still seek to understand the sensitivity of the receiving environment. At the time of writing this comment, the environmental evaluation was just released and has not been subject to scrutiny. Equally, the heritage impact report has still to serve before the competent authority. It may be advisable to wait for these processes to reach some stage of progress and certainty before recommendations are made to the Municipal Planning Tribunal.

2 HERITAGE ASSESSMENT

For reference to our previous Heritage Assessment of October 2018, please see our comments in Appendix A. These heritage comments remain valid. These additional Heritage comments are in response to the supplementary information submitted.

2.1. Purpose of the Application

2.1.1. It is proposed to redevelop the property (known as the River Club). In summary it is proposed to accommodate a mixed use development of 150 000 m² comprising retail Shops and Restaurants (retail uses), Offices, Dwelling units, a Hotel and Places of Instruction (and associated uses).

2.1.2. The proposal will entail the construction of retaining structures so that roads and habitable space are raised above the 1:100 year flood plain. The initial phase of the development proposal will see the partial construction of the Berkley Road extension, which in future phases will be further extended to provide access from Berkley Road to Malta Road/Leisbeek Parkway. Additionally, the Liesbeek Canal on the eastern boundary of the site will be rehabilitated into a river course, while the 'old' Liesbeek River Channel on the western boundary of the site will largely be filled and landscaped to accommodate a vegetated stormwater swale.

2.1.3. The intention is to consider this new information and to issue a supplementary comment, flowing from which the Land Use Management report can be completed and tabled before the Municipal Planning Tribunal (MPT).

FIGURE 1: Previously submitted Development Framework

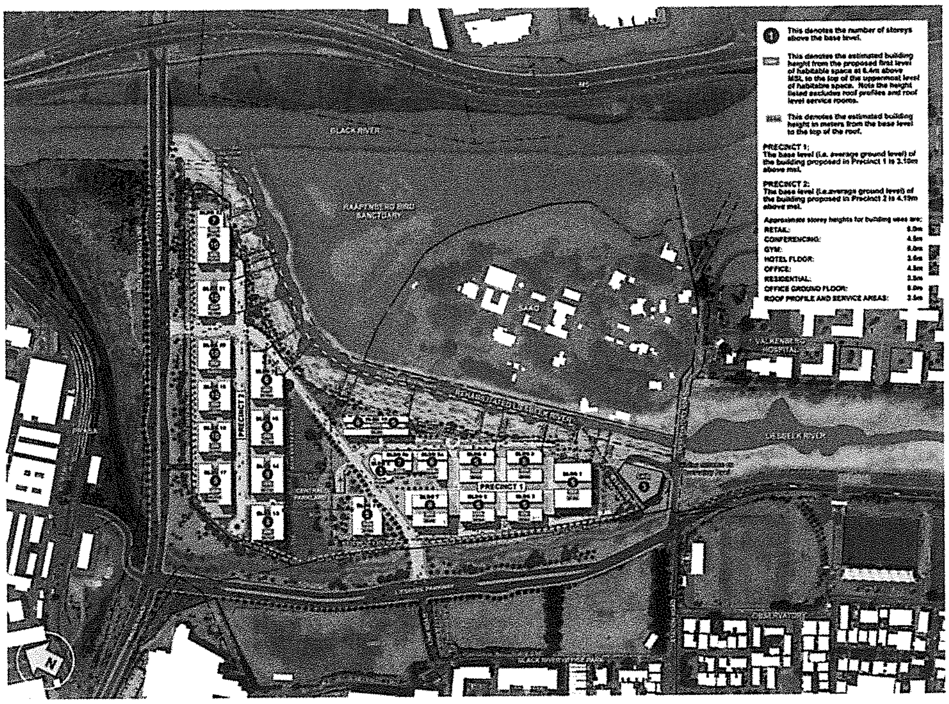
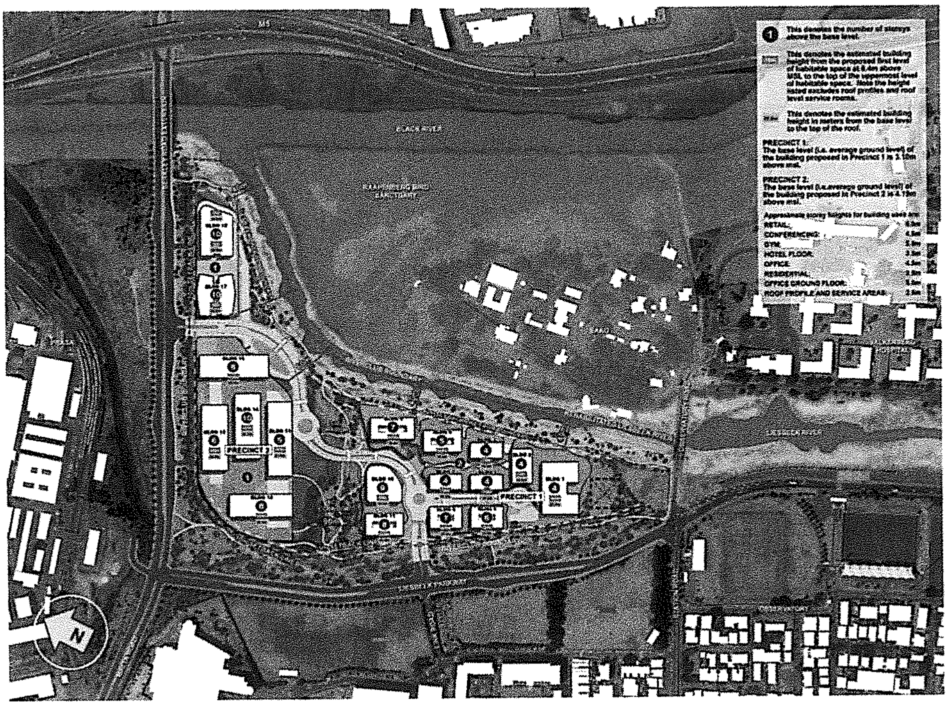


FIGURE 2: Currently submitted "Refined Development Framework"



2.2. Supplementary Heritage Consideration

2.2.1. Additional information provided in the Supplementary Information, that relates to our previous comment and specific heritage issues are:

- Figure 2 "Refined Development Framework" (page 9)
- 2.3 First Nations Heritage as a Design Informant (page 21)
- 2.6 Hard & Soft Landscaping (page 47)
- 2.6.3 Ecological/Heritage Trail (page52)

2.2.2. Figure 2 "Refined Development Framework" (page 9)
As per the Supplementary Information the refined development framework, as shown in the FIGURE 2 above, "Noteworthy changes from the original development framework are:"

a) The diagonal road dissecting the central 'ecological corridor' has been replaced by a road that crosses the green open space in a more orthogonal orientation, with the intention to mimic the orientation of the buildings, as well as reduce the impact on the amenity and functioning of the 'ecological corridor' space.
b) The setback of the buildings from the rehabilitated Liesbeek Canal is now a minimum of 40 metres (this setback previously ranged between 24 – 40 m).
c) The buildings directly adjacent to the SA Astronomical Observatory to the west have been lowered in height to reduce the impact on this historical precinct.
d) The access roads in Precinct 1 are no longer positioned on the 'outside' of the precinct adjacent to the rehabilitated Liesbeek Canal and vegetated swale. Instead, there is now a central road servicing the precinct, and the buildings overlook landscaped areas providing a better interface with these areas.
e) The western half of Precinct 2 has been earmarked as the Amazon campus. Amazon is a global company that has very specific requirements for their buildings (e.g. standard floor plates, which in turn result in very specific building footprints). This campus is located next to Berkley Road extension where greater heights are appropriate, although the heights of buildings in the Amazon campus have been staggered as a means to articulate the massing.

f) The inclusion of First Nations heritage as a design informant which now includes the following:
- establishing an indigenous garden for medicinal plants used by the First Nations;
- establishing a cultural centre;
- establishing a heritage-eco trail;
- establishing an amphitheatre for use by both the First Nations and the general public;
- commemorating the history of the First Nations by: establishing a Gateway Feature inspired by symbols central to the First Nations narrative at the road crossing the eco-corridor; incorporating symbols central to the First Nations narrative in detailed design of buildings; and naming internal roads inspired by people or symbols central to the First Nations narrative;
- the implementation of these mechanisms is to be assured through an institutional arrangement which establishes within the Property Owners Association (or similar) an autonomous legal entity led by the Gorinhaiqua Cultural Council that will be responsible for the governance, planning, management, operations, maintenance and sustainability of the indigenous place-making mechanisms.

2.2.3. Furthermore, (page 25)

"A number of refinements and amendments have been made to the development proposal (listed on p21 above). All of these are, we argue improvements to what was discussed in the *HIA* dated 2 July 2019. Many of these changes are refinements and will, we presume, not satisfy all commentators; however, we suggest that several of the changes are significant from a 'heritage point of view'. These latter changes include, most importantly:

- reducing the height of the buildings in Precinct 1 opposite the SAAO in order that their presence, already minimised by the distance is further reduced and so that Lions Head and Signal Hill can be seen from the roof of the old Royal Observatory building;
- improving the vehicular-bridge-crossing of the eco-corridor; and
- introducing the several strategies discussed for "indigenizing the site through place-making mechanisms" as outlined on pages 8 and 21 above."

2.2.4. In the document titled "**HWC Issues on River Club HIA (a component of the BAR) and Project Team Responses**", several points must be noted:

- On page 3 under point 8. "Regarding the visual impact on sense of place, it is acknowledged that although ~65% of the site will be retained as open space, due to its location at the confluence of the Liesbeek River and Black River, and long-term status of the site as a green open space, the change in character may be experienced as a strong visual contrast for surrounding (urban) receptors, and the (negative) impact of a change in sense of place will be significant."

- On page 3 under point 12. "impacts on the sense of place, and historical character of the site have been assessed in the HIA and found to be significant."

2.2.5. On page 6 under point 31. "Regarding **open space** specifically, it should be noted that:

- The heritage specialists argue that while the development may lead to significant visual impacts, transformation of the site's character is of relatively low heritage significance."

2.2.6. Environmental Management Department believes that the site's character and the sense of place to be interlinked through the site's history, intangible as well as tangible heritage and agree with point 8. above that the negative impact of a change in the sense of place and visual impacts will be significantly negative.

2.2.7. On page 6 under point 35. "The HIA recommends that the heights of buildings in the portion of the site closest to the SAAO are kept lower than that of the bank of trees on the SAAO ridge (and that these buildings must include a range of building heights, variation in building form, and an avenue of trees lining the development along the edge of the riverine corridor)."

2.2.8. Although the revised proposal has reduced proposed building heights in proximity to the SAAO, Environmental Management Department still has concerns with the overall heights of the proposed development and how this will impact negatively on the cultural landscape, sense of place as well as the SAAO itself.

2.2.9. On page 9 under point 49. "the "River Club First Nations Report" (AFMAS, 2019a – attached as River Club First Nations Report) was informed by:

- Primary research, including key informant interviews with various First Nations representatives for the "TRUP First Nations Report" (AFMAS Solutions, 2019);
  - Key informant interviews with First Nation knowledge keepers and traditional custodians of the Goringhaiqua, Gorachouqua, Cochoqua, Griqua Royal Council and the San House of N||n‡e to understand First Nation intangible heritage significance and indigenous "sense of place and meaning" of the River Club site; and
  - Deconstruction of the Two Rivers local area cultural landscape through multi-layered and multi-dimensional contextualizing to locate the indigenous narrative of the River Club within this area."

2.2.10. With specific reference to the First Nations grouping and respective parties involved, a Cape Times article, December 2019, quotes Goringhaicona Khoena Council High Commissioner Tauriq Jenkins as saying, "**We as the Goringhaicona do not accept this development as, in its current form, it is an act of spiritual and heritage genocide.**" Notwithstanding the highly commended work on the First Nations narrative, this statement is of concern and raises the question of how inclusionary the process of participation with the First Nations has been.

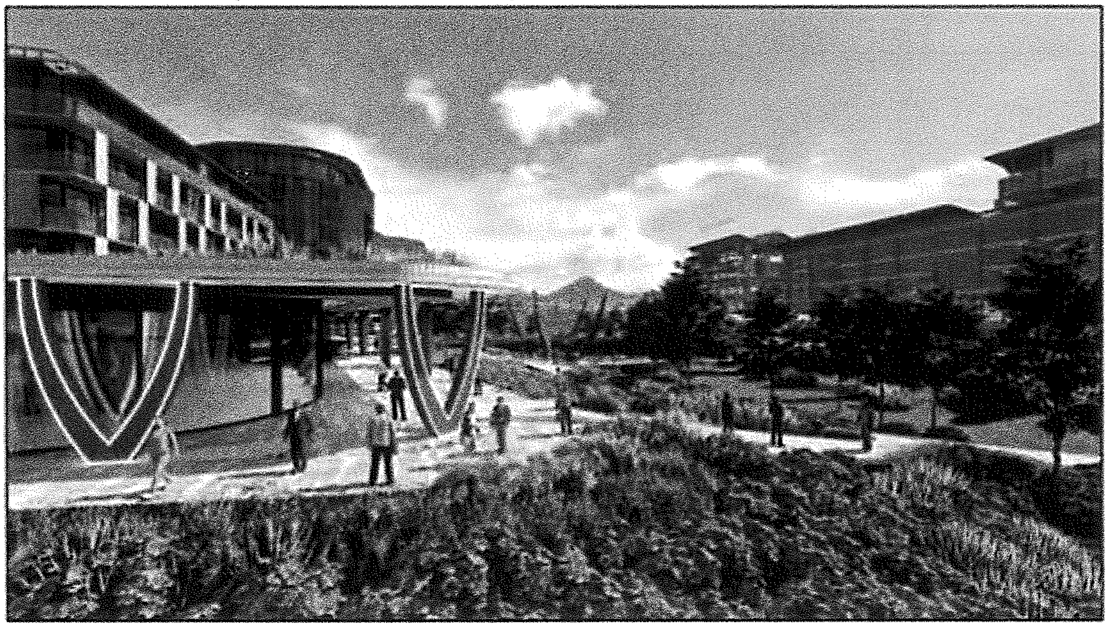
2.2.11. The TRUP landscape has been identified as the site of the skirmish between D'Almeida and the Goringhaiqua in 1509. Legacy Projects established in 1994 included Khoisan heritage: outcomes of the 2015 baseline study and feedback from Dept Arts Culture were that the 'unique relationship of the Khoi-San with the environment' could be presented as a park and that the intention of the Khoi-San legacy Project "**is not to create a memorial comprised of buildings and/or traditional sculpture**".

2.2.12. On page 13 under point 74. "With regard to the visual impact, the VIA finds that the scale of the development will have visual impacts, and it is the location/context of the site - the surrounding built fabric and topography, visual absorption capacity, visibility, and landscape integrity - which effectively reduces such impacts to the assigned medium rating after mitigation."

2.2.13. Environmental Management Department is of the belief that the visual impact of the current proposal to be highly negative due to the scale of the proposed buildings, footprint of the development and heights of the proposed buildings. See Figures 3 & 4 below.

FIGURE 3: Currently submitted Visual Impact Views

FIGURE 4: Currently submitted Visual Impact Views



2.2.14. "This cultural landscape is a legacy for the whole of society and reveals aspects of our country's origins and developments as well as our evolving relationships with the natural world. The ongoing care and interpretation of these sites improves our quality of life and deepens a sense of place and identity for future generations." – The Cultural Landscape Foundation.

2.2.15. The cultural landscape, of which the pre-1952 river course is an integral part, as well as the SAAO site, are of a very high level of heritage significance and the proposed development's heights, scale and density would certainly also impact negatively on these relative levels of heritage significance.

2.2.16. The impact on the level of significance of the cultural landscape will be highly negative in terms of the level of physical and visual change on the environmental/topographical/ecological and historical significance of the area and by the proposed heights, scale, and density of the current proposal. This negative impact on the significance of the heritage resources will also carry over to the SAAO site for the same reasons of the suggested heights, scale and density. Further mitigation should be in the form of reducing the proposed build heights and density.

2.2.17. Infilling of the old Liesbeek River channel and remodelling of this channel into a vegetated stormwater swale will also impact negatively on the high level of significance of the cultural landscape.

2.2.18. The old Liesbeek River channel forms an integral part of the environmental/ topographical/ ecological and historical significance and current status of the area which can clearly be seen from Figures 2 and 21 of EMD previous comment, as well as from the cover photograph of The River Club: Development Alternatives, prepared by Planning Partners dated November 2017. Removing the old Liesbeek River channel's ability to be perceived as a historical watercourse and thereby severing its role in the story line of the cultural landscape will impact negatively on the significance of that resource. This might be mitigated by the inclusion of a watercourse of sorts within the proposed 'park-like' pedestrian and cycle path 'transformed riverine corridor'.

2.3. Conclusion to the Heritage Impact Assessment:

2.3.1. Environmental Management Department is not opposed to the redevelopment of the River Club site. The heritage resources identified to be impacted on by the proposed development have varying degrees of proximity to the site and heritage levels of significance but, this Department believes that the levels of significance of, in particular, the cultural landscape and the SAAO site will still be compromised or reduced by the current proposal and that, although mitigation measures have been applied in the form of the First Nations narrative, setting back proposed buildings further from the SAAO and promoting a 'park like' eco corridor, the overall impact on the heritage resources identified, sense of place and cultural landscape is still perceived to be negative.

2.3.2. "the site functions as an important urban threshold, characterised by the openness of the area and the network of watercourses crossing it. This character sets it in contrast to the urban fabric that surrounds it, and makes, along with the extended context, a unique place within the city. Many of the buildings and uses that are already located "between the rivers" are located here precisely because of the threshold quality the area offers.

2.3.3. The proposed development does not acknowledge the unique and symbolic "threshold role" that the site plays, both in its formal layout, scale, and in the uses that are being proposed. Having to raise the site by 3m or more to achieve an acceptable height above the flood water level further exacerbates the concern that the development would be an invasion of this significance." Cape Institute of Architects, 8 Feb 2018.

2.3.4. Environmental Management Department agrees with the development consultants that the visual impact is pronounced but is not supportive of the visual impact conclusion which describes the proposal as being "not inconsistent with a cityscape". The cityscape of Cape Town as depicted in the before and after figures clearly shows a significant and pronounced change and impact from a visual perspective. This impact can be mitigated by reducing bulk, development footprint and building heights.

2.3.5. Of relevance within the **Environmental Strategy for the City of Cape Town (Policy 46612)** which was approved by Council on 24 August 2017 (C05/08/17) are the following:

2.3.6. Directive points 6.11.1 through 6.11.4 are not fully complied with by the proposal in that the full significance of the unique sense of place and cultural landscape is not acknowledged sufficiently by the current development proposal which impacts overly negatively on these values. Mitigation is by means of reconfiguring the Liesbeek Canal and landscaping green open areas but the currently suggested bulk and heights of the proposed structures and resultant built forms should be reduced further in order to present a more sensitive alignment with the significance of the cultural landscape and sense of place.

2.3.7. The social issues revolving around cultural appropriation and social impact have not been expounded on sufficiently, the First Nations narrative appears to not be totally inclusive of all relative groups. Inclusionary housing from a socio-economic perspective relating to historic communities that may be impacted on, requires investigation. This should not only address accessibility but include factors revolving around inclusionary housing. The idea of inclusionary housing needs to be elaborated on further relative to its historic context? The typologies of homes are very important to look at critically. Can a micro apartment or one-bedroomed apartment such as may be included in this development, accommodate a family within this area between Woodstock and Maitland, areas characterised by the so-called working class who may function within extended family structures? Will the market forces of such a development, unintentionally further exclude and drive out working class communities in historically working class neighbourhoods, close to opportunity and the City?

2.3.8. The current proposed development does not conserve sufficiently the historical and cultural value and significance of the cultural landscape of the area. The importance of historic and existing spatial context is not adequately recognised in the proposed development in its current form which could be mitigated by a further reduction in bulk and heights.

2.3.9. Furthermore, the No-go option and development within the parameters of the current Open Space Zone have not been explored adequately other than for reasons of economic viability to the developer. These alternatives require further investigation in order to establish if the ensuing negative impacts would be less than those perceived from the current proposal.

2.3.10. The application in its current form is not supported, as it does not align with current approved City Policy and Strategies in terms of the City's Tall Building Policy, Environmental Strategy and Cultural Heritage Strategy.

2.3.11. Environmental Management further do not support the evaluation of this application without a high level precinct or concept plan.

3 ENVIRONMENTAL ASSESSMENT

The environmental assessment comprises:

- Assessment of the application in terms of approved City policies, spatial plans, and principles in legislation
- Assessment of the environmental impacts of the development application and motivation report, Contextual and site analysis
- Further requirements

3.1 Environmental Assessment of the Application in terms of approved City policies, spatial plans, and principles in legislation

The following applications are submitted for approval:

3.1.1. Deviation from the Table Bay District Plan to permit urban development on land designated as "open space", "core 2" and "buffer 1", in accordance with section 16 of the MPBL.

3.1.1.1. The proposed deviation from the Table Bay District Plan regarding development within the areas identified as Core 2, Open Space and Buffer 1 is a concern, as these were identified for open space and conservation purposes. These areas are located within the 1:10year floodline at the confluence of two rivers, and containing valuable wetlands and fish habitat, currently sustaining the endangered Western Leopard Toad breeding areas, plus the indigenous Galaxia fish, which fish provide food for several bird species in the area, as well as the Cape clawless otter.

3.1.1.2. Despite the applicant's assertion on pg178 of their Motivation Report, that the Table Bay District Plan must concur with the MSDF at a higher level, it must be noted that the recently approved MSDF does not comply with the requirements of the Western Cape Land Use Planning Ordinance (WCLUPA) whereby structuring elements in municipal spatial development frameworks must include the identification of ecological corridors and open space systems. Such ecological corridors and open space systems are correctly identified at the District Plan level, in compliance with the requirements of WCLUPA for spatial plans. It is hoped that the MuniSDF will be corrected to accommodate this omission in the next iteration. The City is also currently working on a Green Infrastructure Plan (which includes river corridors and open space systems) which is intended to feature spatially in the next MuniSDF.

3.1.2. **Rezoning from Open Space Zoning 3: Special Open Space (OS3) to Subdivisional Area Overlay Zone (SAO)**

3.1.2.1. Although intensification and densification is promoted in the City's spatial planning, this site is poorly services and not located in any future catalytic growth and investment area. It does not align with the City's TOD Strategy or initiatives to revitalise and invest in Belville's declining CBD.

This land use application seeks to amend policy, solicit massive bulk infrastructure investment from public coffers and substantially change a sensitive receiving environment, while there are many other areas in decline that urgently require investment.

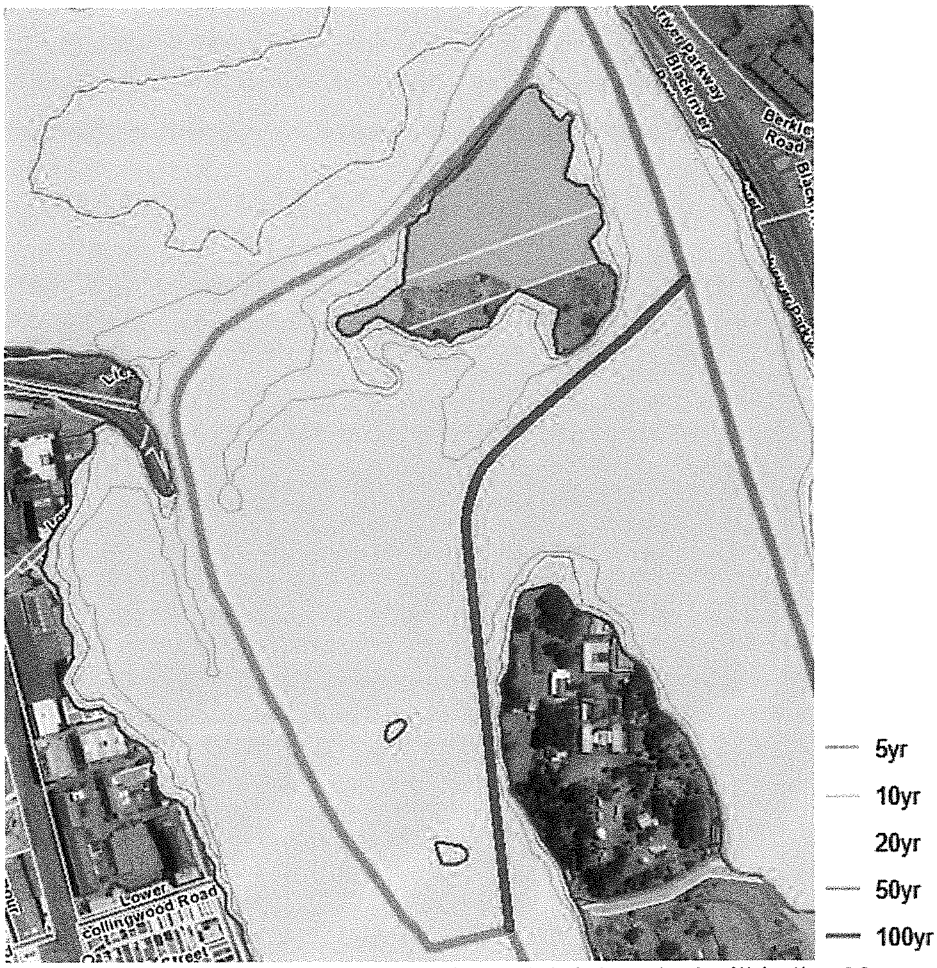
There is no convincing desirability motivation that can succeed when compared to alternatives. This development on this site is simply not desirable and has too many uncertainties to allow for a rezoning of this nature.

3.1.3. Approval to construct retaining structures, in terms of Section 42(i) of the MPBL and in accordance with item 126 of the DMS, to be constructed to a height of more than the permitted 2.0m above the existing level of the ground (to heights of 5.7m and 5.9m above existing ground level)

3.1.3.1. Environmental Management Department has concerns regarding the proposed retaining structures extending up to 5.9m above the existing ground level. This is not an appropriate development in the floodplain and riverine open space context where the linear open space is a major structuring element linking Table Bay to False Bay, and providing visual and recreational amenity to all the high density developments adjacent to it. This long term impact is complex and the risk of a decision around this based on localised modelling is a serious risk for a City that is already looking at spending billions to remedy poor planning practices of the past, where the complexity of environmentally sensitive receiving environments was ignored.

3.1.4. **Deviations from the following city policies:**
Floodplain and River Corridor Management Policy (2009):
i) Section 9.2: Flood management and public safety
Permission to develop / obstruct the free flow of water within the 20year flood plain

3.1.4.1. Environmental Management Department does not support the proposed deviation from this policy to develop within the 20year floodplain. To be more accurate, the development is within the 1:10year floodplain, according to the City Map Viewer's floodlines, and based on local knowledge of flooding at the River Club.



3.1.4.2. Floodlines showing the River Club is located within the 10year floodline, but over the last 10years it has flooded more than once.

3.1.4.3. Page 7 of the Floodplain and River Corridor Management policy states that The permissible extent and nature of land use, development or activities within floodplains must be subject to stringent evaluation and control in the interests of public safety. In particular, obstruction to the free flow of water within the 20-year floodline area shall not be permitted. In the case of the River Club, the obstruction to the free flow of water is actually within the 10-year floodline, although there is little difference between the 10 and 100year floodlines in this area.

3.1.4.4. However, between the 50 and 100-year floodlines, some developments or activities may be permitted, subject to such conditions as the City may in its discretion impose, while developments with particular evacuation or emergency response issues and high risk developments will only be permitted above the 100-year floodline (refer to Table 1).

3.1.4.5. At the River Club, there have already been instances of trying to evacuate the area during high rainfall flooding events, and some people were unable to get their cars out of the area. Furthermore, the water levels reached 1m in height (hip height) within half an hour and it was difficult to walk in the water we have heard from people who were at the River Club during a flood event.

The short term financial gain from development and transient tenants cannot be allowed to out-weight the potential long term risk to the City and surrounding areas.

ii) Section 10.5 Table 1: Framework for the assessment of proposals Permission to infill within the 50year floodplain.

3.1.4.6. Environmental Management Department does not support filling in floodplains in general, as river floodplains are important ecological buffers to river corridors that sustain fauna and flora, and they provide important green lungs, carbon sinks, visual amenities, cultural landscapes, and recreation areas that enhance the quality of life for the City's residents. The infilling is not equally offset by the proposed rehabilitation of the Liesbeek Canal.

3.1.4.7. The Floodplain and River Corridor Management Policy acknowledges that within the confines of the Cape Town Metropolitan Area, the pressure to develop is significant and requires careful management to avoid developing in high flood risk areas, to protect the environmental integrity of aquatic resources and to ensure that permitted development enhances the aesthetics and character of the adjacent watercourses / wetlands. In order to achieve this, a new approach is required where engineering, environmental and socio-economic elements are assessed and integrated as the vision for a particular watercourse / wetland system. The River Club development proposal is not an example of such an integrated vision that achieves the above mentioned objectives.

3.1.4.8. The application to Land Use Management should also include **to fill in a river, within the river bed**. The historic Liesbeek River, according to the drawings in the Motivation Report, is proposed to be infilled, in addition to filling in the floodplain. Only the floodplain infilling is applied for in the Application.

3.1.4.9. Further, application should also be made to Land Use Management **to deviate from the principle of retaining an ecological buffer which should be between 30 – 40m from the historic Liesbeek River,** and should also be applied for from the canalised section of the river, and from the linear wetland edges on the eastern edge of the River Club site on its north-eastern edge, near Raapenberg Bird Sanctuary.

3.1.4.10. The Floodplain and River Corridor Management Policy, Section 9.3 Ecological Buffers, provides as follows:

3.1.4.11. Watercourses and wetlands with their adjacent riparian areas and associated fauna and flora must be protected or "buffered" from the impacts of adjacent development or activity. Often referred to as ecological buffers, these protected zones / setbacks provide continuous corridors and habitat for flora and fauna. Buffers also provide other benefits such as water quality improvement of point or diffuse sources of pollution, stream bank and erosion protection from the hydrological impacts associated with hardened catchments in urban areas, and space for implementation of appropriate water sensitive urban design elements. In addition, buffer areas can provide socio-economic benefits in the form public open space, opportunities for recreation and environmental education / awareness, and enhancement of waterway, visual and property values. In instances where watercourses have been canalized, buffers are still required to aid maintenance and, in some instances, to allow adequate space for possible future restoration activities.

3.1.4.12. In the case of the River Club development, Environmental Management Department does not support having no ecological buffer to the historic Liesbeek River, filling it in, and filling in the 1:10year floodplain (although application is only made to fill in the 1:50year floodplain.

3.1.4.13. Filling in the river also compromises its potential for groundwater recharge, and recharge of the Cape Flats aquifer, which is not in line with the climate resilience principles for water security. Filling in a major waterbody is also not in line with best practice water sensitive spatial planning principles.

3.1.4.14. Environmental Management Department would wish to see the cumulative impact should other properties within the floodplain also wish to fill in the floodplain.

3.1.4.15. Hard-surfacing and built footprints within the floodplain should be kept to a minimum so as to allow water percolation within the floodplain area. The purpose of floodplain management is to protect human life and health, minimize property damage, to encourage appropriate construction practices to minimize future damage, to protect individuals from unwittingly buying land subject to flood hazards, and to protect water supply, sanitary sewage disposal, and natural drainage.

3.1.4.16. The prevention of unwise development in areas subject to flooding will reduce financial burdens to the community and to the Government, and will prevent future displacement and suffering of its residents. Hence, the precautionary principle should be applied to discourage development within the floodplain, and infilling of the floodplain.

3.1.4.17. Alternative development designs, such as on stilts, above the 1:100year floodline could be considered, which would likely be smaller in scale and more in keeping with the sense of place and character of the riverine environment.

Management of Urban Stormwater Impacts Policy (2009)

i) Annexure table: 24hour extended detention of the 1year RI, 24hour storm even in a greenfield development >50000m². Permission to deviate from this requirement.

ii) Annexure table Up to 10-year RI peak flow reduced to pre-development level in a greenfield development >50000m². Permission to deviate from this requirement.

iii) Annexure table up to 50year RI peak flow reduced to existing development levels in a greenfield development >50000m². Permission to deviate from this requirement.

3.1.4.18. Deviation from the Urban Stormwater Impacts Policy is not advisable.

3.1.4.19. Page 5 of the Urban Stormwater Impacts Policy notes the deleterious impacts of urbanisation on receiving waters, that is rivers, streams, wetlands, groundwater and coastal waters, are a worldwide phenomenon. Such impacts include:

· Declining water quality;
· Diminishing groundwater recharge and quality;
· Degradation of stream channels;
· Increased overbank flooding;
· Floodplain expansion;

· Loss of ecosystem integrity and function;
· Loss of biodiversity.

3.1.4.20. One of the functions of this policy, in addition to safeguarding human health, is to protect natural aquatic environments, and improve and maintain recreational water quality. The proposed River Club development is also deviating from this objective.

3.1.4.21. A fundamental principle of this policy is that the person or body, whether private enterprise or an organ of state, who creates a development should do so responsibly and should ensure that such development does not adversely impact on present and future communities and on natural ecosystems. In the case of the River Club development, it is acknowledged that there will be some likely increase in flooding and potentially some homes will be flooded slightly more than before. This is a deviation from the policy.

3.1.4.22. In order to reduce impacts of urban stormwater systems on receiving waters, all stormwater management systems shall be planned and designed in accordance with best practice criteria and guidelines laid down by Council, to support Water Sensitive Urban Design principles and the following specific sustainable urban drainage system objectives:
· Improve quality of stormwater runoff;
· Control quantity and rate of stormwater runoff;
· Encourage natural groundwater recharge.

3.1.4.23. The proposed River Club development is not designed so as to support Water Sensitive Urban Design principles, and does not achieve the sustainable urban drainage system objectives listed above. Filling in a river corridor is the most inappropriate course of action in this regard. This also constitutes a deviation from the policy.

3.1.4.24. The planning process of the City identified the river course for protection in previous iterations of the Municipal Spatial Development Framework, and within the latest Table Bay District Plan (2012), as required by WCLUPA. Sustainable use of water resources should consider water as an asset and within the context of the total urban water cycle. Stormwater drainage, nutrient management, WSUD, protection of water resources, water efficiency, recycling and re-use thus must form elements of holistic and integrated planning for the City.

3.1.4.25. The proposed River Club development is not an example of best management practices promoting urban biodiversity, and enhancing the amenity and aesthetics of the River Club site and its surrounds.

3.1.4.26. Identification of other City policies from which the proposed development deviates:
Specific sections of these policies need to be referenced. This will take further work.

- Climate Change Policy: the City's Climate Change Policy promotes the protection, maintenance, rehabilitation and restoration of natural systems and resources. Infilling a river and developing within the floodplain is not consistent with the stated objectives of the Climate Change Policy.

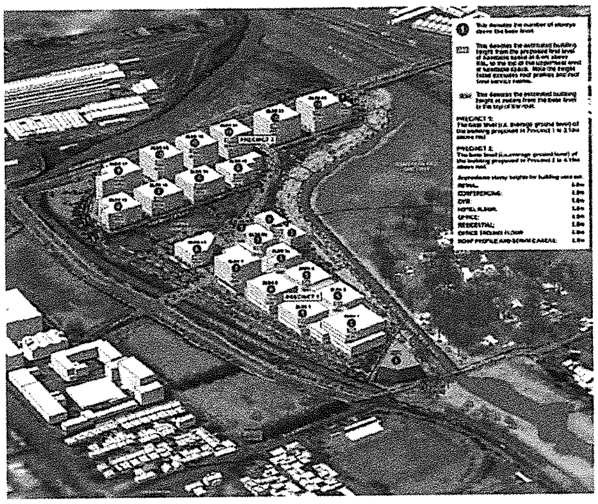
- The Environmental Strategy for the City of Cape Town (Policy No:46612) maintains that in order to realise the City's vision, it needs to put measures in place to ensure that "*Cape Town's rivers and wetlands are well managed and where possible planned as cohesive corridors that are well-used recreational spaces and community assets that provide ongoing ecological service*". Taking this into account, this Department questions whether the approval of this development proposal as is, will ensure that these principles are met as the development proposal will not ensure ecological diversity of this natural open space is preserved, nor will it ensure social inclusivity where all citizens will have reasonable access to this ecologically diverse natural open space. The development proposed would also not promote the protection of river corridors and mountain-to-sea linkages which provide habitat protection for recreational opportunities while ensuring visual and physical access to the water's edge.

- The Two Rivers Urban Park Contextual Framework (2003): As demonstrated above, this development proposal completely deviates from the vision of the Two Rivers Urban Park Contextual Framework and Phase 1 Environmental Management Plan (2003) ..." *To rehabilitate, protect, secure and enhance the intrinsic ecological qualities of this area, to conserve the unique cultural and landscape, to encourage environmental education, to maximise opportunities for all people and to promote sustainable development*". The Two Rivers Urban Park Contextual Framework and Phase 1 Environmental Management Plan (2003) can be used a yardstick against which to measure and future development proposals. However, it is evident that consideration of the provisions of this policy has been minimal.

- In terms of the future development and management of this area (TRUP,2003), development proposals for this area should not result in any significant ecological impacts. This policy details that development within this area should be kept outside the 50-year floodplain provision. The development proposal is a direct deviation from the TRUP Contextual Framework (2003). Furthermore, no infilling of the floodplain should be considered until more detailed hydrological data becomes available. These provisions in the policy has been given very little regard.

3.1.4.27. It must be noted that the proposed development is deviating from approved spatial plans and policy, in addition to those specifically listed in the application.

3.2 Assessment of the environmental impacts of the development application and motivation report, Contextual and site analysis



3.2.1. The applicant's stated vision for the site is to create a lasting legacy, create job opportunities, commercial enterprises and a space for people of all cultures to live and work and which is open to the community for safe, recreational activities through the creation of a financially sustainable development. However, according to the artist's impression included in the Motivation Report, a large scale, high rise, commercial development is proposed, within the low-lying floodplain at the convergence of two significant rivers in Cape Town, and the historic Liesbeek River faunal habitat is replaced with a vegetated swale, while new freeways are planned over significant riverine landscapes, rather than maximising the opportunities of a riverine park with buildings in it.

3.2.2. Our point of departure is that this site should be developed in a way that provides for the work, play, live concept as envisaged by the applicant while at the same time, enhances the site's opportunities that are currently underutilised for both recreational benefit alongside rivers and swales within the River Club site (rather than in the Liesbeek River itself) and to enhance the ecology of the site and adjacent rivers and canal. Towards this goal we envisage the creation of a park-like environment with buildings in it, rather than the creation of a building complex and the provision of remaining park /open spaces around it. i.e. the creation of an urban village not an office park. Given that the entire site (apart from a small portion in the north-eastern corner) falls within a floodplain (within the High Hazard Zone and the 1:20 and 1:10year flood line), is a strategic green open space linkage and a sensitive cultural landscape with a unique sense of place, and that the existing Special Open Space zoning (OS3) only permits very limited but suitable development rights, we suggest that this point of departure be pursued as guidance for future development.

3.2.3. Environmental Management Department is of the opinion that these abovementioned urban development opportunities should only be supported where a good balance is reached between the extra development rights given and the benefits accrued to the total receiving environment w.r.t ecology, heritage and social benefits (housing and recreation). Taking this further, therefore, while we support the benefits w.r.t upgrading and landscaping of the open spaces, rehabilitation and /or remediation aimed at improving terrestrial and aquatic (river and wetland) habitat quality, the improvement and maintenance of ecosystem resilience and sustainability and the provision of publicly accessible formalised recreational areas, we are concerned that the scale, bulk and footprints proposed for the building component of the development are excessive within the receiving context when considering the fact that the site is zoned Special Open Space and is entirely within a floodplain.

3.2.4. Furthermore, we are opposed to the infilling of the prime biodiversity high sensitivity faunal conservation area located within the historic Liesbeek River, and therefore reject this component of the proposal. A reduced footprint of the development, set back 30 – 40m from the Liesbeek River, to enable an ecological riverine buffer for faunal habitat and for recreational and visual amenity, should be investigated.

3.2.5. Freshwater Ecology: The interface between the site and the Liesbeek Canal, Liesbeek River and the Black River and the confluence area of these two rivers has ecological value and provides opportunities to rehabilitate and enhance these ecological areas and incorporate some new swales for Western Leopard Toads, in the east-west corridor of the development.

3.2.6. Botanical value: The majority of the River Club site offers no botanical value but nevertheless provides habitat to breeding Western Leopard Toads, and also provides some wetland habitat on its north-eastern river embankment for a length of roughly 80m. The bank of the Liesbeek River along the western edge of the River Club provides valuable bird and frog habitat, for waterfowl and fish-dependent bird species, such as the kingfishers.

3.2.7. Traffic: The construction of Berkley Road extension to Malta Road bridge, is being promoted as essential in the motivation report. However, the applicant is only intending to build the link from their development to Ndabeni at this point to provide freeway access to the M5 for the development. The supplementary information incorrectly shows the Malta Road link. There is no commitment to build this section.

3.2.8. Context of the River Club within the Two Rivers Urban Parks The site is located within the larger Two Rivers Urban Park (TRUP), as a Precinct within the broader 300ha TRUP study area and this context must inform the spatial and environmental context w.r.t the sites' proposed uses and intensity and scale of these uses, use of infrastructure, transport and parking etc.

3.2.8. Discussion on environmental authorisation process : As part of the Environmental Authorisation process, the River Club Consultants (using the Specialised Reports) prepared a Draft Environmental Scoping Report (2017) and after public participation prepared a Scoping Report, as part of a full EIA process. The NEMA Regulations were subsequently amended in April 2017 and the activities proposed no longer trigger the need for a full EIA, but rather a BAR (Basic Assessment Report). A BAR has been drafted by SRK and has recently been advertised for comments from Interested and Affected Parties, due 14 February 2020, where after a Final BAR will be available for further comment, and this BAR together with any additional comments will be submitted to DEADP. The BAR includes the HIA which HWC is required to comment on (which will be addressed at their meeting of 28 January 2020). SRK has not received comment on the revised HIA and Supplementary First Nations Report from HWC yet. Without finality on the heritage indicators and environmental constraints and opportunities, it is premature to consider the Land Use application.

3.2.9. The City needs to take cognisance of the findings and recommendations on the environmental and heritage impact process that seeks to understand the sensitivity of the receiving environment, prior to making recommendations for this land use application, with insufficient information available.

3.2.10. Impacts on the Receiving Environment

3.2.10.1. Botanical significance: The River Club site is highly disturbed with no indigenous terrestrial vegetation, being located on old fill material and there are no areas of floral importance. The proposed development at this site would be highly unlikely to impact negatively on the dryland renosterveld vegetation at the adjacent SAAO site, including the Critically Endangered *Moraea aristata* populations. The overall impact of the proposed development to indigenous flora is accepted as negligible. We suggest mitigation measures for rehabilitation of terrestrial renosterveld habitat on the site (including along Berkeley Road extension).

3.2.11.2. Raapenberg wetlands and other ponds: The Raapenberg Bird Sanctuary wetlands (mostly adjacent to the site – refer figure 1) host a mosaic of wetland plant communities and are important from an avifaunal perspective, supporting waterfowl. They providing breeding habitat to the endangered Western Leopard Toad (WLT). The maintenance of this habitat must be carefully maintained i.t.o of seasonal flows, inundation patterns, salinity and water quality. The wetlands are highly sensitive to the following: increased flood velocity, frequency, duration and magnitude; drainage of water from the wetlands; diversion of water into the wetland; removal of existing berms or structures.

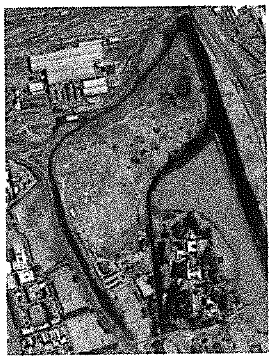


Figure 1: Raapenberg wetlands and associated ponding areas

- A number of seasonally to perennially inundated ponds have been created on the golf course. These artificial water features may provide suitable breeding sites for western Leopard Toads (WLT) and other amphibians, but are easily replaceable habitats, and of low current habitat quality. Nevertheless, the principle of providing continued WLT breeding sites on the River Club site is expected.

- Despite the level of infilling that would be associated with development of the site, the Raapenberg wetlands have been shown to be unlikely to be impacted by changes in flood height, frequency or duration, according to the Motivation Report. Nevertheless, given that the flood waters would no longer be able to spread out across the existing floodplain, but would be 'channelled in a more confined area, it is possible that the velocity of floods, and their magnitude, may be increased. This should be further investigated.

3.2.11.3. The natural Liesbeek River course / channel on the west: (natural earth-lined), which lies on land owned by the City of Cape Town between Liesbeek Parkway and the

River Club boundary. This section of the Liesbeek Rivercourse channel is largely disconnected from the Liesbeek River above due to an engineered diversion of most of its flow into the canal, and it now functions as a permanent backwater waterbody, receiving additional fresher water during rainfall events as the Observatory catchment stormwater discharges into it, and as flooding of the Liesbeek River overtops the road flowing into the historic river course in big rainfall events. Owing to its depth, it is a permanent waterbody. Its water depth is deeper than the Liesbeek Canal on the eastern side during low-flow days. It provides habitat and breeding areas to important bird species to the endangered Western leopard toads.

Figure 2: Liesbeek Natural Channel

3.2.11.4. The historic Liesbeek River, as it skirts the River Club Site on the west, remains on the same alignment as it was, dating back to the 1800s. Historic aerial photographs attest to this. The historic Liesbeek River is an important fish river and supports an abundance of bird life. The adverse water quality impacts from urban and suburban run-off from the Observatory catchment, changes in natural flow regime with the introduction of the canal, loss of some indigenous vegetation and invasion of the river channel by invasive alien plants, provide opportunities for improvement in the management and rehabilitation of the Liesbeek River (it's flows, water quality and habitat). The historic Liesbeek River and its vegetated margins are used by several species of waterfowl, particularly the Red knobbed coot, as breeding grounds for their young. They build floating nests on the river, safe from predators such as cats, dogs and humans. This section of the historic Liesbeek River is also home to Pied Kingfishers, Malachite Kingfishers and Giant Kingfishers. Endemic Cape Galaxia fish occur in this stretch of the river. Fish-eating birds seen catching fish in this particular area, include cormorants, reed cormorants, the snake bird, and herons. Further, the river provides suitable habitat for the Cape Clawless Otter which also eats fish. The steep embankments are important for the Kingfishers, and possibly for otters' holts (lairs / dens).

3.2.11.5. The Liesbeek River also contains some indigenous reed species typical of wetlands, such as Typha capensis and Phragmites australis, along the banks of the river. These provide linear wetlands and valuable habitat to birds and frogs along the edges of the river. It is for these reasons, that the historic Liesbeek River, as part of the broader Two Rivers Urban Park, has been identified as a Biodiversity Conservation Area. The City has entered into an agreement with CapeNature to ensure the long-term sustainable management of the rivers and wetlands of the Two Rivers Urban Park.

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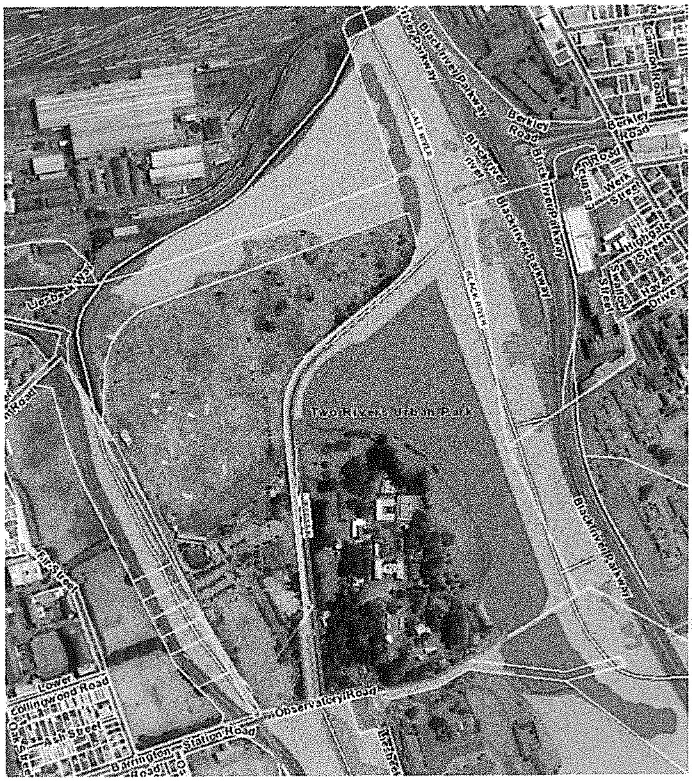


Protected Areas

Protected: In Perpetuity

Protected: Not In Perpetuity

Conservation Area

3.2.11.6. The Environmental Management Department does not support the infilling and landscaping the Liesbeek River. This loss is considered ecologically unacceptable notwithstanding the substantial canal rehabilitation proposed on the eastern edge of the River Club, and the proposed development of vegetated swales in landscaped terrestrial areas for use by the western leopard toads in their non-breeding season (and possibly breeding season habitat). The Department does not consider the canal rehabilitation as an acceptable biodiversity offset for the loss of a well-functioning natural ecosystem. The canal rehabilitation is an obvious upgrade that should be implemented for many canalised rivers in the City to enhance their ecological functioning, water percolation and aquifer recharge potential, but is not a substitute for filling in this part of the river. Filling in the historic Liesbeek River, with its numerous fish, bird and frog populations, would have significant high negative biodiversity / ecological impacts and would compromise the functionality of the Raapenberg Wetland, and hence the overall functioning of the TRUP Conservation Area, according to Dr Charmaine Oxtoby, the City's Biodiversity Specialist.

3.2.11.7. Measures should be developed for removing litter from the Observatory catchment stormwater discharging into the natural Liesbeek River channel, and for water polishing, to be implemented in the historic Liesbeek River, in consultation with the City's Biodiversity Management Branch, and Stormwater and Catchment Management Branch. It is recommended that a 30m setback be applied to any development footprints along the edge of the historic Liesbeek River, in order to provide a vegetated open space area which will have both amenity and stormwater polishing functions.

Mitigation measures (gabions and barriers) to discourage western leopard toad passage into the development should be implemented, except where it is reasonable for toads to cross the east-west corridor from the historic Liesbeek River breeding area to the Raapenberg Bird Sanctuary. These proposals need to be shown spatially on plans, and included in Construction & Operational River Corridor and Wetland Habitat Environmental Management Plans. It should be noted that the rationale for an east west WLT corridor was to enable movement from their breeding area within the Liesbeek River to the Raapenberg Wetlands. Removal of the Liesbeek River course would negate the need for any such movement corridor. Hence we do not support infilling the WLT breeding site in the historic Liesbeek River.

3.2.11.8. A pedestrian route with bird-watching opportunities within the 30m setback vegetated buffer to the historic Liesbeek River on the side of the Liesbeek River.

3.2.11.9. Environmental Management Department does not support the proposed widening of the Liesbeek Parkway road into the historic Liesbeek River area due to the loss of the high faunal sensitivity Conservation Area that would occur within the river itself.

3.2.11.10. The proposed infilling of the Liesbeek River as indicated in the Motivation Report, is not supported by the Environmental Management Department, because it is not consistent with Water Sensitive Spatial planning and urban design principles; Further filling in a natural river course is not consistent with Climate change resilience principles, nor the biodiversity strategy - to destroy a high faunal sensitivity conservation area by infilling a WLT breeding area.

3.2.11.11. In future land use applications, provide details of the East-West Corridor planting for WLT habitat versus recreational use, and First Nation Parameters.

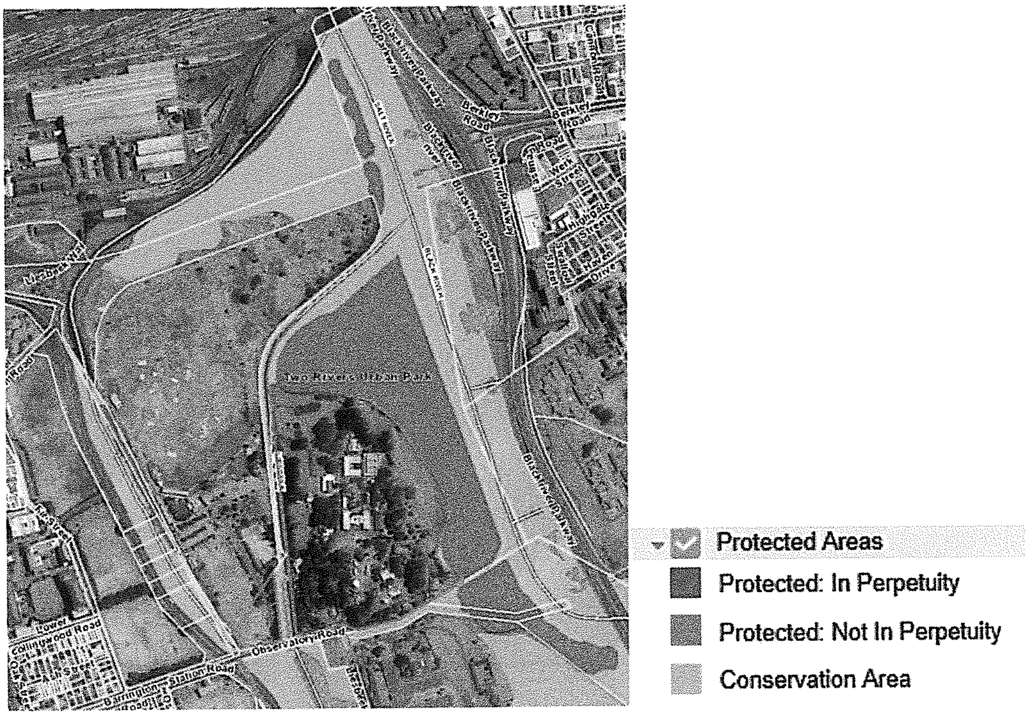
3.2.11.12. The Liesbeek Canal on the east: between the river club and South African Astronomical Observatory, separating the site along its south eastern boundary from the Raapenberg wetlands:

Figure 3: Liesbeek canal

The Liesbeek Canal also constitutes part of the above-mentioned Conservation Area and provides an important link from the historic Liesbeek River above, to the linear wetland areas lining the eastern side of the River Club site, and to the Raapenberg Bird Sanctuary. See illustration of Conservation Areas in green in the diagram below. The canal is not optimal as a riverine habitat in its current form. It is not canalised for the full length of the River Club site, and has a natural wetland edge along roughly 80m of the length of the site.

This linear wetland area of the River Club site would be sensitive to any construction impacts and any future development impacts, particularly where it abuts the Raapenberg Bird Sanctuary.

3.2.11.13. The Department recommends a setback of 30m from the edge of the eastern Liesbeek River, to enable a viable ecological buffer, in line with the City's Floodplain and River Corridor Management Policy, particularly where the river becomes a natural wetland embankment, opposite the Raapenberg Bird Sanctuary.



3.2.11.14. Environmental Management Department supports the intention to create a largely unlined (except for the right hand river bank) river channel to recreate the natural river corridor (where this is not already in existence along the eastern edge of the River Club site). This river should have a minimum building setback space of 30m to allow for natural flooding and riverine functions. This includes the removal of the existing left hand (western) wall of the Liesbeek Canal and the removal of its floor and the use of stepped gabion baskets to stabilise the right hand canal wall next to the SAAO. Sufficient space must be provided for a vegetated buffer with appropriate low-growing vegetation and trees, plus retention of the existing wetlands where these are preferable.

3.2.11.15. Environmental Management Department supports the creation of a cycling / pedestrian pathway alongside the river wall with a lawned buffer at least 15m wide that serves as a recreational space to accommodate social activities uses such as playing and picnicking. A second pedestrian pathway / cycle lane on the other side of this recreational space is also supported.

3.2.11.16. Western Leopard Toad (WLT): The only known WLT breeding sites in the region of the River Club are on the River Club site itself, according a member of the WLT Conservation Committee, within the historic course of the Liesbeek River, and within the wetlands of the Raapenberg Wetlands and about 1.5 km southeast in the Oude Molen area. The WLT represents the most significant faunal concern in respect of the proposed River Club development.

3.2.11.17. The conservation and management of the Raapenberg Wetlands, and the historic Liesbeek River course, plus the allocation of certain River Club open space areas for WLT breeding habitat, is of outmost importance. These areas must provide shelter and food. A natural habitat must be available within at least a 2 km radius of the breeding habitat to sustain WLT individuals for the non-breeding period (breeding is between July and October). Environmental Management Department supports the creation of a high quality terrestrial habitat (swale area) on the River Club property only, in the east-west open space corridor, providing safe passage for the movement of WLTs between the historic Liesbeek River to the linear wetlands on the eastern Liesbeek River banks of the River Club, and to the Raapenberg wetlands. However, the infilling of WLT breeding areas such as the Liesbeek River, is not supported. WLT Breeding areas on the River Club site itself can be offset by the rehabilitation of the eastern Liesbeek River canal.

3.2.11.18. Such swale area (in the east west corridor area of the River Club property) must have sufficient ponding areas which retain water into the summer to support the WLT breeding grounds. There should be a minimum of two such ponds with diameters of minimum of 10m. They should be excavated to lie within the summer water table level or alternatively be lined to retain water, and should be landscaped with gently sloped sides (1:5 or less steep) and planted with appropriate (i.e. to provide cover and safe movement of WLT) indigenous wetland vegetation that is connected via planted landscaped swathes to the main east west eco corridor. These banks will also provide nesting areas for bank burrowing birds.

3.2.11.19. Note these ponds might alternatively be adapted to tie in with the proposed stormwater attenuation ponds.

3.2.11.20. Environmental Management Department supports the development of an eco-corridor to allow for connectivity east-west across the site from the Raapenberg wetlands east of the River Club site, to the WLT breeding areas of the natural western Liesbeek River channel (west of the River Club). This will allow for movement of wetland fauna – in particular western leopard toads. This eco-corridor should be a minimum width of 100 m wide (varying in width). If there is to be a road traversing the east west bio-corridor, this must be planned to allow for movement of the WLT, and potentially the otters, below the grade of the road. This space is to remain undeveloped and will allow for flood attenuation during periods of high rainfall, as well as provide visual amenity as a landscaped public space on the site.

3.2.11.21. Environmental Management Department support the creation of additional green open buffer areas along the northern and southern site boundaries. These terrestrial areas should be a minimum of 10m wide and should be rehabilitated to include patches of renosterveld, by importing soils from disturbed renosterveld sites elsewhere. These planted areas must be linked to create a continuous network of open space / corridor linking to the east-west bio corridor.

This area currently forms a buffer to the existing wetlands north of the River Club site which line the northern extent of the natural Liesbeek River, as it rounds the northern extent of the 'island.' This northern area is also home to various other birds, not necessarily wetland species only, including seed-eating species, such as cape canaries, and also the Cape Spurfowl / Francolin.

3.2.11.22. Recreational and other pathways throughout this swale and open space network must be separated from the ecological spaces so to provide safe WLT habitat. Grassed areas should be limited in this part of the site, which should aim to maximise quality toad habitat. Bird habitat should also be addressed.

3.2.11.23. Toad exclusion barriers must be erected to prevent toad access to high-risk zones such as the roads and the raised platform.

3.2.11.24. Environmental Management Department support the Provision for at least two culverts under Berkley Road extension to allow for faunal passage of a range of fauna into the presently undeveloped open space to the north, between the natural Liesbeek River channel and Berkley Road.

3.2.11.25. All roads and the development platform abutting ecological corridors / rehabilitated areas must be designed to prevent accessibility by WLTs (to prevent road kills).

3.2.11.26. The stormwater system must allow for the creation of WLT breeding ponds.

3.2.11.27. Artificial shelters including rocks and logs could also be included to improve WLT habitat.

3.2.11.28. Supply of adequate Open Space:

3.2.11.29. Consideration must be given to the site's role in the larger open space and river system and the need for quality future open spaces given the expected increase in population into the area. The City of Cape Town's population is expected to expand rapidly over the next 5 years, growing from 4 055 580 people in 2018 to 4 232 276 in 2023 (Cape Town Socio Economic Profile, Western Cape Provincial Government, 26 January 2018).

3.2.11.30. Also noteworthy is that for the period 2016 to 2021, the Western Cape is estimated to have an inflow of migrants totalling 311 004 (second highest in the country). The City anticipates densification within the Voortrekker Road Corridor area and the CBD. As such, the need for public open space will be even greater. Is a rezoning from open space 3 is in the best interest of the City and the broader public? The City first and foremost needs to make a call on the role of the site in a future, denser City. Options to develop and upgrade the site for uses other than open space exist within the ambit of the Bylaw such as land uses permitted with consent.

3.2.11.31. The River Club site should be seen as a future public park destination within the City's open space network. This future Park should allow for access for the general public to enhanced recreation and biodiversity areas.

3.2.11.32. Whilst the site is greatly transformed and currently offers little ecological value, the potential to rehabilitate the river corridor's ecology and create meaningful open spaces and recreational areas as breathing space for this future increase of people in the larger TRUP area and beyond, must not be undervalued. Opportunities for a substantive park in the City are limited and if this area is re-zoned and development allowed across the entire site, a rare opportunity will be lost. The rationale for utilising the full site for urban development must therefore be queried. One cannot ignore provisions of the Table Bay District Plan (2012) where the role of this site for open space and buffers is acknowledged. The cumulative loss of POS in the wider context of TRUP must be addressed and quantified. The opportunity loss of POS for the broader population must be addressed.

3.2.11.33. Water bodies, rivers and canals, rehabilitated open spaces and buffers need to be accommodated in the open space web for the site, and sufficient setbacks from hard surfacing and buildings to these areas are required. Detail of areas of soft and hard landscaping and built upon needs to be shown (as referred to by Urban Design Branch). The interface of development with these areas and the opportunities that arise from these spaces need to be carefully spelled out.

3.2.11.34. It is stated that 46 percent of the site is earmarked for POS. It is important that the POS reads as green / soft open space for recreational and ecological processes. If the site is to be filled to 7m amsl with parking below at existing ground level how will the green landscaping and tree planting be implemented (as shown on the Illustrative Landscape Master Plan -"tree planting"?). Some initial concepts for greening and landscaping and how the open spaces will be operated and maintained should be outlined.

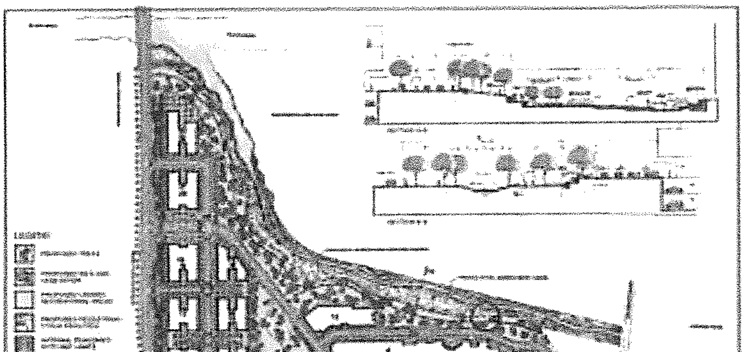


Figure 4: Illustrative Landscape Master Plan as included in supporting documentation

3.2.11.35. A better balance between the natural environment and the built form itself also needs to be shown (i.e. how to enhance and integrate the green web throughout the two precinct themselves as a structuring element).

3.2.11.36. The open space web on this site should furthermore be planned showing how it links into TRUP and surrounding open spaces, to demonstrate the network / continuous system of hard and soft spaces, functional continuity and visual legibility.

3.2.11.37. The infilling of the historic Liesbeek River as shown on this Landscape Master Plan, is not supported.

3.2.11.38. Hydrology and Flooding: Environmental Management Department understands that, according to the hydrological modelling, the current site level can be raised above the 1:100year flood line without significantly increasing local flood risks and without impacting on surrounding properties flood levels (apart from only about 4 residential properties). The cumulative impacts of water flows and possible flooding stemming from future developments within the entire TRUP (that includes PRASA and NRF proposals) should be addressed in further hydrological modelling prior to granting additional rights on the River Club site. The NEMA precautionary principle be applied where there are some elements of uncertainty.

3.2.11.39. Sustainable provision of services and buildings and ensuring a resilient development in light of climate change implications: The applicant should outline how the services that are to be provided are sustainable. This should include Construction materials, Energy – solar power, Water - grey water re use, SUDS (sustainable urban drainage systems and how Waste is dealt with (reduction, recycling and re-use of waste). A water and energy saving plan will be required to be submitted for approval at a later stage. The City's Management of Urban Stormwater Impacts Policy requires new developments above a certain size to use SUDS principles in their design to manage their stormwater run-off on-site.

3.2.11.40. The applicant should outline how the stormwater will be managed to be integrated with other spatial elements such as parks, playing fields, green roofs and public open space (hard and soft) and landscaped areas (In line with current international thinking).

3.2.11.41. Regarding implementation of green technologies and creating a sustainable development, plus employing principles of water sensitive spatial planning and design, the current proposal does not respond appropriately to principles of international best practice.

3.2.11.42. The proposal contained in the Motivation Report, by developing within the floodplain and filling in a high-faunal sensitivity riverine conservation area, and by piping a natural river underground, does not contribute towards the development of a resilient city capable of withstanding the effects of climate change. This is because the water percolation and aquifer recharge potential of the river is negated by piping the water out to sea. The loss of such a large waterbody and its service of cooling the environment through evaporation, and to provide water during low-flow seasons to fish and bird-life during drought periods, cannot be supported.

3.3. FURTHER REQUIREMENTS

- Environmental Management Department requires detailed Precinct Plans as part of this current application, showing the open space web and network throughout the entire site and interface with buildings and circulation areas and linkages to surrounding sites.

- A detailed river corridor management plan (as per requirements of Catchment Planning) is required. Such plan must show the enhancement of water quality, and restoration of water flows to the natural Liesbeek River, in addition to the management of the quality of the stormwater discharging into the Liesbeek River.

- A Landscape Master Plan and Guideline (as per requirements of Urban Design) is are required.

- The assessment of the receiving environment must be completed before recommendations can be made for this application.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Despite the additional information submitted, Environmental Management Department does not support the proposed development proposal in its current form, for the reasons outlined above.

4.2. The Environmental Management Department believes that the land use management application is incomplete in its current state, because it omits any spatial component for approval, such as a Development Framework, Precinct Plans, Site Development Plan(s), or Landscape Master Plan. The application seeks rights to rezone from OS3 zone that is currently appropriate for a site located at the confluence of two rivers set within the 1:10year floodplain (Special Open Space 3) which is subject to frequent inundation and currently is an important Biodiversity Conservation Area. While seeking additional rights, the applicant makes no commitment, in terms of the land use approvals or deviations from policies sought, to seek approval for spatial plans indicating for example the upgrading and rehabilitation of the Liesbeek Canal (on the eastern bank of the River Club).

4.3. The proposed River Club mixed use office, commercial and residential development, including construction of roads across sensitive riverine and wetland enviornments, and infilling of the Liesbeek River bed and floodplains, is not in keeping with the Table Bay District Plan, nor the Biodiversity Objectives of the Municipal SDF, the approved Two Rivers Urban Park Contextual Framework, and various other City policies, and provincial and national legislation.

4.4. Environmental Management Department supports the proposed upgrade of the Liesbeek Canal on the eastern side of the River Club site, subject to detailed Construction and Operational Environmental Management Plans (including plans, elevations and sections) for the design, and management of the future rehabilitated environment.

4.5. The rehabilitation of the canalised section of the eastern Liesbeek River is in line with international best practice trends, and is not to be regarded as a substitution of habitat for filling in the historic Liesbeek River channel.

4.6. Infilling of the historic Liesbeek River (and converting it to a landscaped stormwater swale) is strongly opposed because this is one of the City's high faunal sensitivity Biodiversity Conservation Areas that has to be conserved and managed as such in perpetuity. The infilling of the Liesbeek River would compromise the functionality of the Raapenberg wetlands and associated fauna.

4.7. Environmental Management Department has no objection to some development on the site for uses possibly other than those allowed under Open Space 3, as long as they don't detract from the conservation functioning of the adjacent Conservation Areas within the historic Liesbeek River, part of the Black River (on the north-eastern boundary), the eastern wetlands on the River Club site, and the Raapenberg Bird Sanctuary, or detract from the cultural landscape and sense of place identified as important heritage factors. Such application would need to include the submission of a Site Development Plan as described in item 123 of the Municipal Planning By-law.

4.8. Floor area should only be determined following the submission of detailed spatial plans, including a Development Framework, Precinct Plans, and Site Development Plan in order to determine suitable parameters for the spatial distribution of such floor area. It is premature to award floor area of 150000m^2 (as a condition of rezoning to Subdivisional Area) prior to a simultaneous submission of a spatial plan indicating the location of such floor area, along with elevations and cross-sections and architectural treatment of such area.

4.9. Notwithstanding information contained in the Motivation Report ansd Supplementary Report, it is noted that none of this material can be enforced and is purely illustrative.

4.10. It is recommended that the various components of City policies, guidelines and strategies, from which the proposal deviates, be identified. This was requested by the applicant in correspondence, yet it has not yet been done comprehensively. It will require inputs from all the various departments to list the relevant sections of all the policies from which the development proposal deviates.

D. Georgeades
Environment Management Department
23 January 2020

Appendix A: Heritage Assessment - October 2018

Environmental Management Department is inputting into the Revised Submission (Revision 4)" Application for the Deviation from the Table Bay District Plan, Rezoning to Subdivisional Area and Approval to Construct Retaining Structures in Accordance with Item 126 of the DMS" including the Heritage Impact Assessment (HIA) and Visual Impact Assessment (VIA).

For your information our earlier comment in terms of the applicant's submission to Heritage Western Cape, the Environmental and Heritage Management Branch in EMD's comment was as follows:

The Heritage Impact Assessment document identifies several heritage resources to be impacted on by the proposed development and provides a detailed analysis of the level of significance of those resources. The resources identified are subsequently filtered into "High-order cultural significances" and Low-order cultural significances". EMD is in agreement with which heritage resources have been identified and determined to be impacted on by the proposed development.

2.1 Purpose of the application:
It is proposed to redevelop the property (known as the River Club). In summary it is proposed to accommodate a mixed use development of 150 000 m² comprising retail Shops and Restaurants (retail uses), Offices, Dwelling units (approximately 20% of the total floor space will be residential and of that approximately 20% will be allotted to inclusionary housing), a Hotel and Places of Instruction (and associated uses). Building heights will range from ± 16m to ±46m (3 to 10 storeys) above base level. The proposal will entail the construction of retaining structures so that roads and habitable space are raised above the 1:100 year flood plain. The initial phase of the development proposal will see the partial construction of the Berkley Road extension, which in future phases will be further extended to provide access from Berkley Road to Malta Road/Leisbeek Parkway. Additionally the Liesbeek Canal on the eastern boundary of the site will be rehabilitated into a river course, while the 'old' Liesbeek River Channel on the western boundary of the site will largely be filled and landscaped to accommodate a vegetated stormwater swale.

EMD believes that additional emphasis should be placed on the levels of significance of the following two subject areas:

1. **The Cultural Landscape:** Under 7.3 Conclusions on pages 50 and 51 regarding significances, the document states that, "We regard the River Club site and its surrounds to be of very high environmental/topographical/ecological and historical significance both as a flood plain of the Liesbeek River and as the site of the early confrontations between indigenous peoples and settlers."
   This in essence is the cultural landscape which encompasses the River Club site and surrounds. The 'old river course', albeit altered and currently disjointed over time, forms an integral part of the environmental, topographical, ecological and historical significance of this cultural landscape.

   EMD agrees with the statement regarding these very high levels of significances and will similarly use it to measure the potential impacts thereon by the proposed development and related alternatives.
   This cultural landscape is a legacy for the whole of society and reveals aspects of our country's origins and developments as well as our evolving relationships with the natural world. The ongoing care and interpretation of these sites improves our quality

of life and deepens a sense of place and identity for future generations. – The Cultural Landscape Foundation.

2. **"The South African Astronomical Observatory (SAAO)** campus or site, comprised of heritage buildings and spaces associated with the early nineteenth century establishment of the Royal Observatory, has been graded a Grade I site by South African Heritage Resources Agency (SAHRA). The entire SAAO site is of the highest (National) importance in terms of its heritage significance. This is a site of outstanding cultural and scientific significance and has contributed in international terms to the science of astronomy. It is an outstanding example of a layered heritage landscape, comprising buildings of architectural significance and activities of scientific significance set within a treed campus. The campus is of international scientific significance and has been the subject of a UNESCO World Heritage Site report." – Melanie Attwell and Associates and Arcon Heritage and Design: Two Rivers Urban Park Baseline Heritage Study October 2016.

Further to the document's **proposed heritage-related design indicators** – criteria for decision making, EMD would add more emphasis on the three 'bullet points' which relate to, the "pre-1952 river course", design indicators intending to guide development in more prescriptive detail including heights, scale, and density, and the SAAO Site.
As described above, the cultural landscape, of which the pre-1952 river course is an integral part, as well as the SAAO site, are of a very high level of heritage significance and a proposed development's heights, scale and density would certainly also impact on any relative levels of heritage significance.

Alternative 1: The Riverine Corridor Alternative.

Approximately 150 000sq.m of floor space will be developed.

The impact on the level of significance of the cultural landscape will be very high in terms of the level of physical and visual change on the environmental/topographical/ecological and historical significance of the area and by the proposed heights, scale, and density of this alternative. This negative impact on the significance of a heritage resource will also carry over to the SAAO site for the same reasons of the suggested heights, scale and density, as can be seen from the Masterplan Massing – Preferred Alternative 3D image provided in the Architectural Report, dated 2018-01-15 by Vivid Architects which is contained in Appendix B of the Urban Design Report.
Mitigation might be in the form of reducing the proposed build heights and density as well as a reduction of hard surface areas. Stepping back and away from the SAAO site in terms of height and relative proximity with the aim of creating a more sensitive relationship between the two sites and establishing of historic view lines might also be implemented through development layout adaption.

Infilling of the old Liesbeek River channel and remodelling of this channel into a vegetated stormwater swale will also impact negatively on the high level of significance of the cultural landscape.
The old Liesbeek River channel forms an integral part of the environmental/ topographical/ ecological and historical significance and current status of the area which can clearly be seen from Figures 2 and 21 of the document as well as from the cover photograph of The River Club: Development Alternatives, prepared by Planning Partners dated November 2017. Removing the old Liesbeek River channel's ability to be perceived as a historical watercourse and thereby severing its role in the story line of the cultural landscape will surely impact negatively on the significance of that resource. This might be mitigated by the inclusion of a watercourse of sorts within the proposed 'park-like' pedestrian and cycle path 'transformed riverine corridor'.

Alternative 2: Island Concept Alternative.

Approximately 150 000sq.m of floor space will be developed.

Alternative 1 and 2 will have a similar level of impact except that Alternative 2 will impact less on the cultural landscape. This will be as a result of the proposed upgrading of the old Liesbeek River channel and retention of the canal as a manmade structure. The existing watercourses will remain largely unchanged.

Alternative 3: Mixed Use Affordable Alternative.

Approximately 110 000sq.m of floor space will be developed.

This reduction in proposed floor area impacts less on the cultural landscape and to a lesser degree on SAAO than do Alternatives 1 and 2.

Alternative 4: Reduced Floor Space Alternative.

Approximately 102 000sq.m of floor space will be developed. Similar impacts on levels of heritage significance as Alternative 3.

Conclusion to the Heritage Impact Assessment:

The level and intensity of these impacts might be understood better through the availability of appropriate studies in the form of, or similar to, visual and traffic impact assessments for example and, in addition, a peer review of the document, if not undertaken already, could also add value to the process as well as to the development as a whole.

EMD is not opposed to the redevelopment of the River Club site. The heritage resources identified to be impacted on by the proposed development have varying degrees of proximity to the site and heritage levels of significance but, EMD believes that the levels of significance of, in particular, the cultural landscape and the SAAO site will be compromised or reduced by the proposal, that mitigating measures should be considered in order to reduce the negative impact.

With specific reference to the **rezoning of the property from Open Space 3: Private Open Space zone to Subdivisional Area**, comprising General Business and Open Space Zones, Part 3: Open Space Zoning 3: Special open space (OS3), Item 105 Development Rules states that, The following development rules apply:

(a) The City may require a site development plan for a primary use, and shall require a site development plan for a consent use application.
(b) The site development plan as approved by the City shall constitute the development rules for a primary use if applicable, and a consent use.
(c) The provisions for a site development plan in item 123 shall apply.

Please provide clarity as to the meaning and implications of a Subdivisional Area and how such relates to when a site development plan will be required by the City and the resultant request for comment by EMD.
Does the current Revised Submission (Revision 4) document constitute more of a conceptual layout which speaks to bulk, building heights and general layout or is the document fixing the bulk and layout as depicted in Precinct 1 and Precinct 2?

Contained in the Visual Impact Assessment Report Prepared by Srk consulting Report Number 78320/42A/2 November 2017, the following points are noted:

4.2 Visual Character
Although most of the area surrounding the site can be described as a substantially developed landscape (*highly transformed landscape*), the site and the immediate surrounds can be defined as an *"isolated" transition landscape* associated with the interface between highly developed urban areas and modified natural elements.

EMD are not in agreement with the above statement regarding the visual character of the site and immediate area and believe a more appropriate description to be as written by the Cape Institute for Architects, dated 8February 2018, in a response to Dr Townsend's presentation which reads,

"the site functions as an important urban threshold, characterised by the openness of the area and the network of watercourses crossing it. This character sets it in contrast to the urban fabric that surrounds it, and makes, along with the extended context, a unique place within the city. Many of the buildings and uses that are already located "between the rivers" are located here precisely because of the threshold quality the area offers.
The proposed development does not acknowledge the unique and symbolic "threshold role" that the site plays, both in its formal layout, scale, and in the uses that are being proposed. Having to raise the site by 3m or more to achieve an acceptable height above the flood water level further exacerbates the concern that the development would be an invasion of this significance."

In addition, the VIA describes impact further under,

6.2 Operational Phase

6.2.1 Altered Sense of Place caused by the Change in Character of the Site

The proposed development is located in the midst of a wholly transformed urban environment, but has remained underdeveloped, conferring a more "natural" sense of place to surrounding (urban) receptors.

The development will change the character of the site from an underdeveloped green open space to a highly developed site. Although the River Club site is surrounded by urban development, due to the size of the proposed development, its location at the confluence of the Liesbeek River and Black River, and long-term status as a green open space, the change in character to a highly developed site may be experienced as a strong visual contrast for surrounding (urban) receptors and frequent visitors to the area.

Loss of sense of place is expected since the development and the change in the state of the site is mostly incongruent with the current nature of the site *viz.* green open space and use of the site *viz.* recreation.

The impact for **both alternatives** is assessed to be of **high** significance and with the implementation of mitigation, is reduced to **medium** (Table 6-2).

EMD is in agreement that impact of the proposal will be of high significance but believe that due to the proposed bulk and heights, and implementation of mitigation, the impact will not be reduced to medium but will remain as high. Similarly, EMD believe that Visual Intrusion as per 6.2.2 below will also remain as high significance. See figures 29b and 29j below.

6.2.2 Visual Intrusion caused by the Development

The impact for **both alternatives** is assessed to be of **high** significance and with the implementation of mitigation, is reduced to **medium** (Table 6-3).

7.2 Conclusion of Visual Impact Assessment

In many respects, the visual impact is pronounced, but not inconsistent with a cityscape. However, the sense of place impact is more significant and difficult to mitigate. Receptor perceptions are also important: for some, retention of the open space might be critical to retaining the sense of place; for others, urban development, especially if celebrated by iconic structures, may be valued. The development could both alter sense of place and, at the same time, deliver a functional development with interesting structures with their own visual appeal.

EMD agrees that the visual impact is pronounced but is not supportive of the above visual impact conclusion which describes the proposal as being "not inconsistent with a cityscape". The cityscape of Cape Town as depicted in the before and after figures below clearly shows a significant and pronounced change and impact from a visual perspective. This impact can be mitigated by reducing bulk and building heights.

Similarly with points 4.3.3 and 4.3.5 below EMD believes that the cumulative impact is of high significance and not of medium as concluded by the assessment.

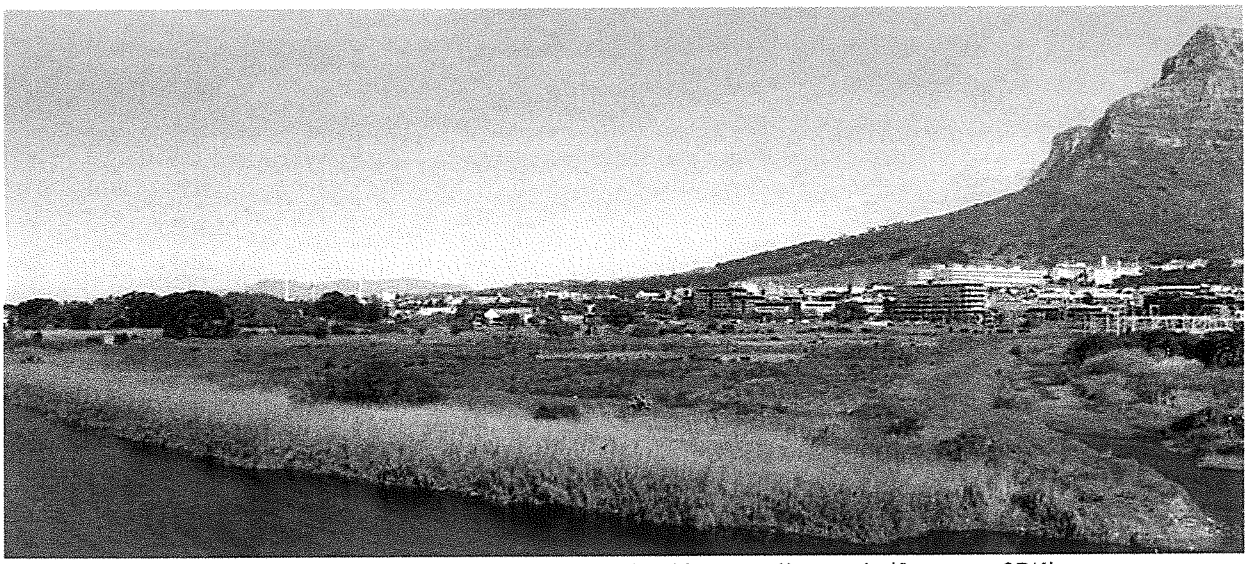


Figure 29a: Viewpoint 1 – view from M5 freeway looking southwards (Source: SRK)

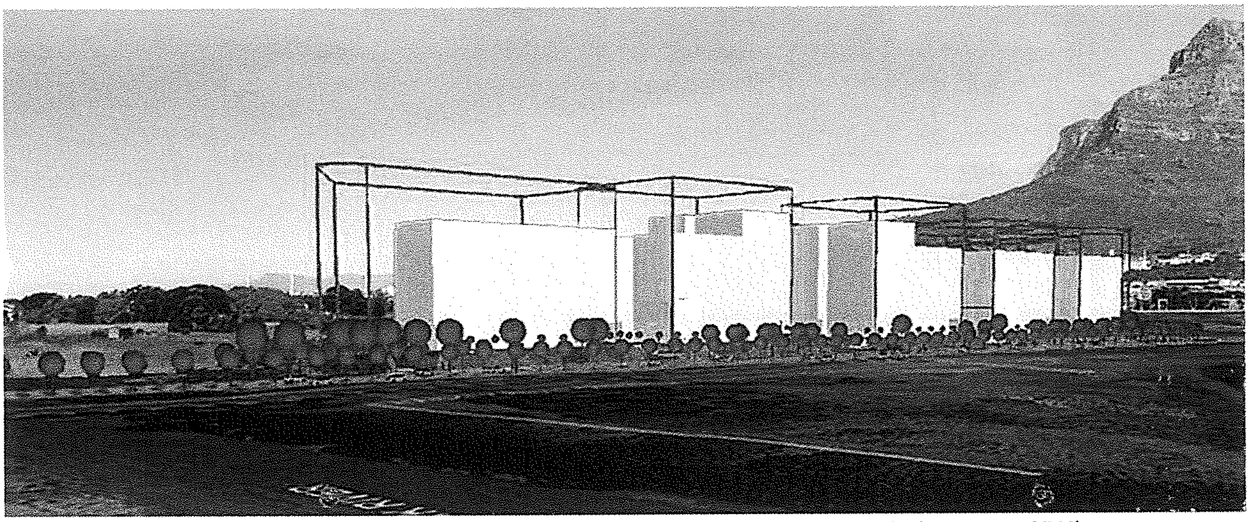


Figure 29b: Viewpoint 1 – photomontage from M5 looking southwards (Source: SRK)

Figure 29i: Viewpoint 7 – view from Malta Road looking southeast (Source: SRK)

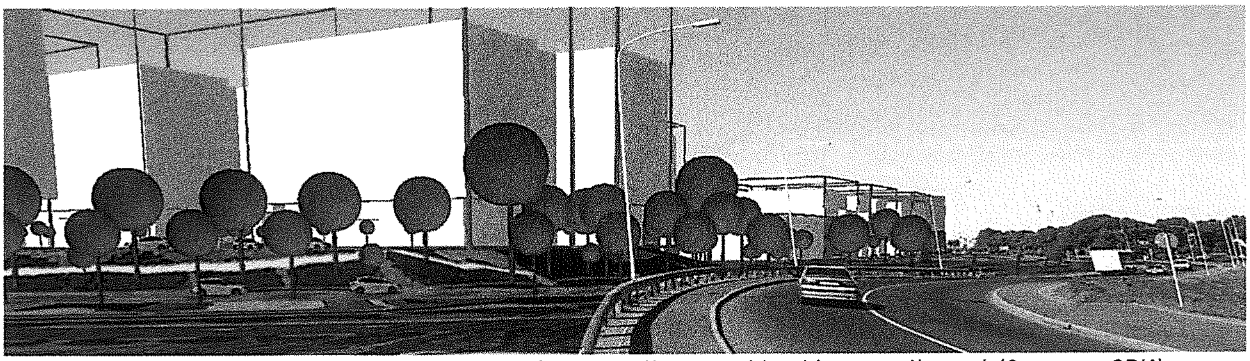


Figure 29j: Viewpoint 7 – photomontage from Malta Road looking southeast (Source: SRK)

4.3.3 Impact Assessment
Cumulative impact
The severity of the impact on the visual landscape and sense of place is rated as *moderate*, and
is assessed to be of a medium extent. The cumulative impact is thus assessed to be of *medium*
significance.

4.3.5 Conclusion of the Impact Assessment

The Draft VIA concludes with following statement:
"Though tools are available to more scientifically and dispassionately assess visual and sense of place impacts, VIAs require a large degree of professional, subjective judgment. This is more difficult for a project such as the River Club development, which is located in the midst of a wholly transformed urban environment on land very well located for development, but which has remained undeveloped and conferred a natural sense of place to surrounding (urban) receptors.
In many respects, the visual impact is pronounced, but not inconsistent with a cityscape. However, the sense of place impact is more significant and difficult to mitigate. Receptor perceptions are also important: for some, retention of the open space might be critical to retaining the sense of place; for others, urban development, especially if celebrated by iconic structures, may be valued. The development could both alter sense of place and, at the same time, deliver a functional development with interesting structures with their own visual appeal."

3.12 City of Cape Town Tall Building Policy (2013)
The City of Cape Town Tall Building Policy was adopted with the aim of controlling and guiding the development of tall buildings in the city. It is essentially a guide for the location and design of tall buildings that require height related departures, as well as an assessment tool that allows the City to ensure responsible growth that makes a positive contribution to placemaking and the public realm.
The main principles of the Tall Building Policy are to:
Ensure that taller buildings fit into the context of the surrounding cityscape, without negative impacts;

P7: *"Area character analysis will inform the design of tall buildings"*
Urban Concepts undertook a contextual analysis in the urban design indicators and recommendations report (refer to **Annexure M**). The analysis includes an assessment of surrounding building height and form. **Figure 14** overleaf provides an illustrative analysis of the surrounding buildings. The following has been deduced by Urban Concepts:

• Heights of the buildings at the Black River Park development to the west of the site vary between 4 – 9 storeys (i.e. 15m – 32m).
• The PRASA buildings to the north are relatively low at approx. 20m – 25m in height. However, these appear monolithic on the landscape, particularly when experienced from the site.
• The premier foods buildings and silos, located to the north-west of the site, range between (approximately) 20m – 50m in height. The silos, in particular, dominate the skyline in this part of the city.
• The M5 office park (located adjacent to the M5 to the east of the site) are 3 – 4 storeys in height (i.e. approximately 15m).
• Buildings on Observatory hill are relatively low (i.e. approximately 10m).

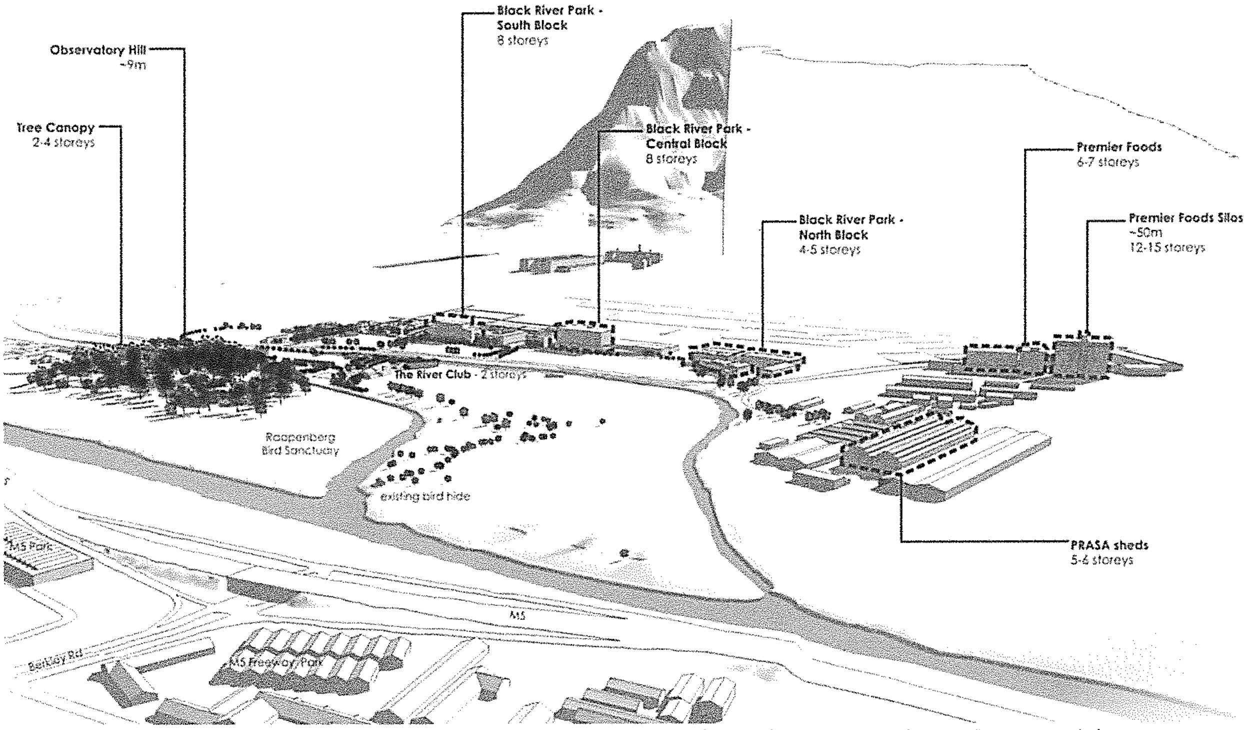


Figure 14: Analysis of surrounding building height and form (Source: Urban Concepts)

EMD's further analysis of the proposal reads directly to P6 of the City's Tall Building Policy – Assessment on merit within the building's unique context which states that, "Approval of the height of a tall building should not be seen as a precedent for other applications in the same area. The final height that is approved will depend on the tall building's motivation towards an appropriate location, response to the context and its compliance with the Tall Buildings Policy assessment criteria."
Specifically, criteria 2 and 3, Relationship to physical context and relationship to historic and cultural context are not met by the proposal. EMD considers the proposed heights to be incongruent with the significance of the historical and cultural context and that mitigation would be in the form of reducing proposed heights.

Of relevance within the **Environmental Strategy For the City of Cape Town (Policy 46612)** which was approved by Council on 24 August 2017 (C05/08/17) are the following:

6.11. Protected Cultural Heritage

Cape Town's cultural heritage as it relates to the built environment is a significant economic and social asset, and contributes significantly to the unique sense of place, strong global identity, and community spirit that is characteristic of the city.

<u>Principle</u>
In taking decisions, operating, and planning for the future, the City will ensure that the value of the city's cultural heritage is recognised, protected and promoted, and that the benefits and opportunities it provides to communities are realised.

<u>Directive</u>
In this regard, the City will:

6.11.1. consider all developments, including municipal infrastructural development, and land-use changes in terms of their potential impact on the city's cultural heritage, and ensure that negative impacts are prevented, or where they cannot be prevented, minimised or mitigated, and ensure that positive impacts are identified, maximised, and enhanced;
6.11.2. ensure that the city's scenic drives and cultural landscapes are protected in order to maintain the scenic sense of place and tourism value and potential that these provide;
6.11.3. ensure that the city's cultural heritage, including the built environment and sites of cultural and historical significance that promote Cape Town's unique sense of place and celebrate

the city's diverse cultures, are appropriately protected and managed, while promoting sensitive new development and adaptive re-use in line with the City's densification policy;
6.11.4. identify, assess, conserve, manage and enhance the heritage resources, structures and landscapes of all the people of Cape Town and ensure that the memories and values associated such resources are appropriately represented; and
6.11.5. ensure that cemeteries and memorial gardens that meet the full range of religious, spiritual, and cultural needs, are adequately incorporated into the City's open space planning processes.

EMD believes that the Directive points 6.11.1 through 6.11.4 are not fully complied with by the proposal in that the full significance of the unique sense of place and cultural landscape is not acknowledged sufficiently by the current development proposal which impacts overly negatively on these values. Mitigation is by means of reconfiguring the Liesbeek Canal and landscaping green open areas but the suggested bulk and heights of the proposed structures and resultant built forms should be reduced in order to present a more sensitive alignment with cultural landscape and sense of place.

Section 8.4 of the **Environmental Strategy For the City of Cape Town** endorses the City's **Cultural Heritage Strategy (2005)** as being the guide for heritage decision-making.

Within the **Cultural Heritage Strategy**, the following should be noted:

2.1 Conceptual framework
The following Cultural Heritage Strategy describes the principles and objectives required for effective heritage management. The policies must be applied according to the City's legislative
mandate, and through the appropriate management structures.

2.2 Vision
Cape Town is a unique historic city. It derives its character from evidence of a layered and multifaceted history, its dramatic scenic setting, its historical townscapes and cultural landscapes, its cultural and heritage diversity and the traditions and memories that arise from its past.
The role of the City is to co-ordinate the protection and enhancement of this unique character.
The protection of heritage sites and the traditions and memories associated with them, are an important part of City management.
The City's vision is of a unique historic city where the heritage of its past and present inhabitants is respected, protected and enhanced through appropriate heritage management practices;
adherence to sensitive, socially aware and appropriate heritage concepts; and integration with other City responsibilities and policy objectives

In addition, **2.5 Policies of principle** states:

Policy 3: Authenticity
Each heritage resource reflects a unique expression resulting from a particular historical process.
The original fabric and character and use of the heritage resource determines its value and can be read as an historical record reflecting its historical significance and cultural value.
The City will ensure that heritage resources are conserved as much as possible in their authentic state and function, to reflect their historical and cultural value.
The City will ensure that a distinction be made between the authentic fabric of a resource and later and contemporary interventions.

Policy 5: Context and Scale
The social and landscape context of heritage sites is critical in the understanding and conserving of their significance. The significance of a heritage resource is partly determined by its context and scale.
The context can be both social and spatial, taking into account both historical and contemporary perceptions of their significance. A heritage landscape may be significant by providing a context for a heritage element, while also representing a valuable heritage resource in itself.
Heritage resources can be interpreted and understood at a variety of scales, from an object to an entire landscape.
An understanding of the nature of significance at different scales is fundamental to a holistic approach to heritage management.
The City will consider the relevance of social and landscape contexts when making decisions affecting heritage resources.

The City will acknowledge the significance of scale in making appropriate conservation-related decisions and in evaluating heritage resources within broader contexts.
The City will ensure that the character of places based on their context and scale, (rather than individual sites and objects) is protected, wherever appropriate.
The City will ensure where possible that new developments in historic precincts acknowledge an appropriate scale as well as an appropriate architectural language. Scale, massing, articulation and texture will be regarded as critical considerations in determining a response to a development proposal.

Policy 7: Cultural landscapes
The City of Cape Town and surrounding areas represent a unique and dramatic natural and cultural landscape. Within this landscape a wide variety of cultural landscapes can be identified which differ in scale and nature. They provide evidence of the City's history over time and contribute to a sense of place and identity. They provide dynamic reference points and positive instruments for growth and change.
The City will conserve the unique cultural landscape and scenic qualities of the region for the benefit of its inhabitants and for tourism. The City will ensure the identification and appropriate management of such cultural landscapes as fundamental to the economy and well-being of the City.
The City will ensure that the cultural landscape is protected and managed as an integral part of development and environmental planning.
The City will ensure that the protection of the cultural landscape is enhanced by recognising and giving value to the many layers of cultural significance resulting from the area's long history and prehistory.

Cultural landscape can be described as a physical area with natural features and elements modified due to human activity and resulting in patterns of evidence layered over time in the landscape, which give a place its distinctive spatial historical aesthetic symbolic and memorable character.
EMD believes that the proposed development does not conserve sufficiently the historical and cultural value and significance of the cultural landscape of the area. The importance of historic and existing spatial context is not recognised in the proposed development in its current form which could be mitigated by a reduction in bulk and heights.

Heritage Impact Conclusion:

The application for the Deviation from the Table Bay District Plan, Rezoning to Subdivisional Area and Approval to Construct Retaining Structures in Accordance with Item 126 of the DMS which includes the Revised Submission (Revision 4) is NOT SUPPORTED in totality by EMD (Heritage) as the proposal does not align with current approved City policy and Strategies in terms of the City's Tall Building Policy, Environmental Strategy and Cultural Heritage Strategy.

EMD is not opposed to the deviation, rezoning, redevelopment of the River Club site and proposed layout, but NOT SUPPORTIVE OF THE PROPOSED BULK OR HEIGHTS OF THE DEVELOPMENT which should be reduced significantly in order for synthesis with and recognition of the areas recognised and valued heritage resources, cultural landscape and unique sense of place to be achieved.

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FLOODPLAIN AND RIVER CORRIDOR MANAGEMENT POLICY

APPROVED BY COUNCIL : 27 MAY 2009

C 58/05/09

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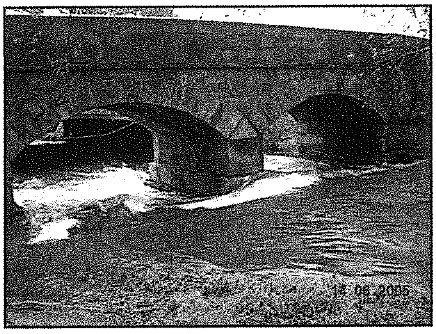
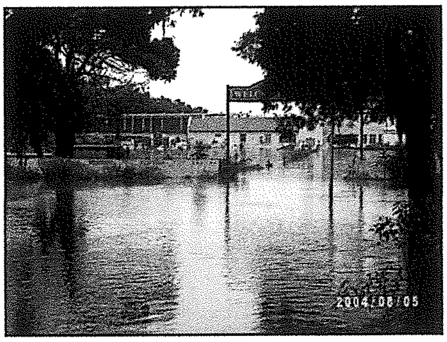


ROADS & STORMWATER DEPARTMENT

Catchment, Stormwater and River Management Branch

Floodplain and River Corridor Management Policy

Balancing flood risk, ecological and socio-economic considerations in developments near watercourses and wetlands



Version 2.1

Approved by Council
27 May 2009
C 58/05/09

CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD

(Previously entitled: Floodplain Management Guidelines)

Table of Contents

1 Preamble

There is a developing worldwide view in many cities that watercourses and wetlands, whether natural or constructed, form an integral component of urban stormwater management systems, are important for sustaining the aquatic ecology of the city, and are an essential element in restoring the urban fabric of the city by providing both recreational and socio-economic opportunities to all citizens.

A well managed watercourse / wetland is a valuable resource for improving the quality of life and aesthetic nature of an urban area and provides benefits for public health, recreation and economic growth. This is particularly important in the context of changing weather patterns and the associated local, national and international strategies targeting sustainability issues.

This policy document is an enhancement of the former Floodplain Management Guidelines (Version 1.0) published in September 2003. Various improvements have been effected to align the policy principles to corporate strategic objectives. It outlines the procedure for managing development adjacent to watercourses and wetlands taking cognisance of the flood regime, aquatic and riparian ecology as well as socio-economic factors.

2 Definitions

In this policy, unless inconsistent with the context:–

"Council" means the City of Cape Town;

"development" means any man-made change to property, including but not limited to construction or upgrading of buildings or other structures, filling, paving, municipal services, or the associated preparation of land;

"ecological buffer" means a strip of land adjacent to a watercourse, wetland or vlei required for the protection and enhancement of these ecosystems;

"fill" means the placement of fill material such as natural sands, dirt, soil or rock and may include concrete, cement or other waste materials at a specified location to bring the ground surface up to a desired elevation;

"floodlines" mean lines on a map or drawing depicting water levels likely to be reached by a flood having a specified recurrence interval;

"floodplain" means the land adjoining a watercourse which is susceptible to inundation by floods up to the one hundred year recurrence interval;

"floor" means the inner, lower surface of a room, garage or basement to which the occupants of a building have access;

"recurrence interval" means the average interval between rainfall or flood events equaling or exceeding a specified severity;

"river corridor" means a mixed-use corridor comprising a watercourse and/or associated wetlands, the floodplain, the ecological buffer and the area required for specific aesthetic, recreational and/or socio-economic needs. This combined area must be managed in an integrated manner which balances the flooding, environmental, social and economic issues;

"stormwater" means water resulting from natural precipitation and/or the accumulation thereof and includes groundwater and spring water ordinarily conveyed by the stormwater system, as well as sea water within estuaries, but excludes water in a drinking water or waste water reticulation system;

"stormwater system" means both the constructed and natural facilities, including pipes, culverts, watercourses and their associated floodplains, whether over or under public or privately owned land, used or required for the management, collection, conveyance, temporary storage, control, monitoring, treatment, use and disposal of stormwater;

"structure" means any man-made feature affixed to the ground or attached to something located on the ground, including but not limited to fences, walls, berms, levees, fill, storage tanks, shelters or buildings;

"top of bank" of a watercourse means a position identifiable by scour lines, vegetation limits, changes in bed and bank materials, the presence of flood deposited silt, or abrupt changes in slope;

"water sensitive urban design" is an approach which seeks to ensure that development in urban areas is holistically planned, designed, constructed and maintained so as to reduce negative impacts on the natural water cycle and protect aquatic ecosystems.

"watercourse" means a river, stream, channel, canal, vlei, wetland, dam or lake in or into which water flows regularly or intermittently. Reference to a watercourse includes, where relevant, its bed and banks;

"wetland" means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil. This definition thus includes, but is not necessarily limited to, water bodies such as lakes, salt marshes, coastal lakes, estuaries, marshes, swamps, vleis, pools, ponds, pans and artificial impoundments.

"wetland delineation" means the determination and marking of the boundary of a wetland using nationally accepted guidelines / methodologies.

3 Introduction

Watercourses and wetlands are integral to the stormwater management system, are an important component of the City's biodiversity network, and represent an essential element in restoring the urban fabric of the City by providing both recreational and economic opportunities.

This policy supports the Roads and Stormwater Department objectives incorporated in the Integrated Development Plan for the City of Cape Town, namely to;

- Reduce the impact of flooding on community livelihoods and regional economies
- Safeguard human health, protect natural aquatic environments, and improve and maintain recreational water quality

The management of land use, development or activity adjacent to watercourses and wetlands is important for the following reasons:

- It is far more cost effective, in the long term, to develop in areas where the threat of flooding is infrequent and the severity of flooding is minimal as opposed to the retrospective implementation of flood mitigation works which would generally be extremely costly and sometimes prone to catastrophic failure when flood flows exceed the design capacity of infrastructure

- Climate change predictions indicate greater variability in the intensity and magnitude of storm events coupled with accelerated sea level rise. These uncertainties pose significant challenges for the management of major drainage systems.
- Encroachments result in ecological degradation, often reducing water quality and precipitating loss of ecological resources irreversibly.
- Since modifications to natural systems may disrupt natural aquatic and geomorphological processes they require a long term maintenance commitment. Therefore urban activity must be managed in such a way that maintenance activities can be adequately conducted.
- To promote a sense of place and recreational enjoyment for communities.

This policy describes a merit based approach for dealing with land use, development or activity proposals near watercourses and wetlands.

4 Legislative Context and Legal Mandate

Land use, development and associated activities influenced by this policy are dealt with in terms of the statutes and planning frameworks highlighted in the following sections.

4.1 National

- National Building Regulations & Building Standards Act, 1997 (Act 103 of 1977)
- Conservation of Agricultural Resources Act (Act 43 of 1983)
- National Water Act (Act 36 of 1998)
- National Environmental Management Act (Act 107 of 1998)
- Disaster Management Act (Act 57 of 2002)
- National Environmental Management: Biodiversity Act (Act 10 of 2004)
- National Environmental Management: Protected Areas Act (Act 57 of 2004)

4.2 Provincial

- Western Cape Planning & Development Act (Act 7 of 1999) (This Act will apply upon its coming into operation).
- Land Use Planning Ordinance, 1985 (Ordinance 15 of 1985)

4.3 City of Cape Town

- Integrated Development Plan (2007/8 to 2011/12)

  The Roads and Stormwater Department objectives are incorporated in the Integrated Development Plan for the City of Cape Town:

  - Reduce the impact of flooding on community livelihoods and regional economies
  - Safeguard human health, protect natural aquatic environments, and improve and maintain recreational water quality

- By-law relating to Stormwater Management (Promulgated September 2005 – PG 6300) together with which this policy is to be read and interpreted.

The City's By-law relating to Stormwater Management defines the stormwater system to mean "both the constructed and natural facilities, including pipes, culverts, watercourses and their associated floodplains, whether over or under public or privately owned land, used or required for the management, collection, conveyance, temporary storage, control, monitoring, treatment, use and disposal of stormwater".

Clauses 4 and 5 of the By-law deal with the protection of the stormwater system (which includes the natural and built systems and associated floodplain) and the prevention of flood risk.

It is in terms of this By-law therefore that Council may prohibit or conditionally permit development in areas adjacent to watercourses and wetlands.

In addition, a number of other documents have been produced over the years which have referred to the management of development adjacent to watercourses and wetlands, either directly or by implication, and considered how these areas should be managed. Some of the more pertinent are listed below.

- Greening the City: Open Space and Recreation Plan for Cape Town (1982)
- Roads and Stormwater Department: Catchment, Stormwater and River Management Strategy (2002)
- Biodiversity Strategy (2003) and Biodiversity Report (2008)
- Coastal Zone Strategy (2003) and Coastal Zone Management Review and State of the Coast Report Year 3 (2006)
- CMOSS – An Open Space Strategy (2005)
- Planning for Future Cape Town (2006)

5 Policy Rationale

Within the confines of the Cape Town Metropolitan Area the pressure to develop is significant and requires careful management to avoid developing in high flood risk areas, to protect the environmental integrity of aquatic resources and to ensure that permitted development enhances the aesthetics and character of the adjacent watercourses / wetlands.

In order to achieve this, a new approach is required where engineering, environmental and socio-economic elements are assessed and integrated as the vision for a particular watercourse / wetland system.

In this Policy a merit based approach is advocated for dealing with proposals within and adjacent to floodprone areas and environmental buffers. In addition, socio-economic considerations are also introduced whereby any permitted development will take cognizance of the presence of the watercourse / wetland and thereby holistically enhance the urban fabric of the area.

This Policy is important in achieving the service outcomes (refer to Section 3) namely; reducing the impact of flooding on people and properties, and of safeguarding human health, aquatic environments and improving and maintaining recreational water quality.

6 Policy Statement

"In order to ensure sustainable development and associated activities within or adjacent to natural and built stormwater systems, and that there is a balanced consideration of potential flood risk, environmental impacts and socio-economic needs, all developments within these areas shall be planned and designed in accordance with best practice and the requirements and conditions laid down in this policy."

This policy supports the service outcomes as highlighted in Section 3 above. It furthermore ensures administrative actions with respect to land use planning applications that are lawful, reasonable and procedurally fair.

7 Scope and Application

This policy is applicable to land use, development or building or activity proposals adjacent to watercourses or wetlands. The principles regarding flood management can also be applied to development in the vicinity of formal stormwater management systems.

8 Objectives

The objectives of this policy are to manage development in a manner that;

- Limits or reduces exposure to flood risk by avoiding hazardous, uneconomic or unwise use of floodplains, thereby protecting life, property and community infrastructure.
- Protects the natural flood carrying capacity of watercourses and wetlands.
- Protects and enhances the intrinsic value and the environmental goods and services provided by watercourses, wetlands and associated riparian areas and floodplains.
- Facilitates the beneficial integration of watercourses into the urban landscape by creating an aesthetically pleasing public resource which will ultimately allow for the social and economic up-liftment of communities adjacent to watercourses and wetlands.
- Provides an effective decision making tool for officials, developers and consultants by introducing an element of predictability with regard to applications for development along watercourses / river corridors and adjacent to wetlands.
- Promotes sustainable development from engineering, environmental and socio-economic perspectives.

9 Planning, Safety, Environmental and Socio-economic Considerations

Land use, development or activities near watercourses and wetlands must be appropriate for the anticipated degree of flood risk whilst minimising concomitant environmental impacts and sustaining a sense of place and urban form. The following sections outline the planning, safety, environmental and socio-economic aspects to be considered when evaluating applications as envisaged in Section 7 above.

9.1 Plans / Sectoral plans

Cognisance must be taken of applicable requirements and recommendations contained in various plans / related documents. Various categories of plans that should be consulted where available are listed below. Sound engineering and environmental judgment should be applied in the absence of these guide plans.

- Roads and Stormwater Department: Catchment, Stormwater and River Management Strategy 2002 – 2007
- Catchment & River Management Plan
- Stormwater Master Plan

9.2 Flood Management and Public Safety

Watercourses and their associated floodplains can convey significant volumes of water under flood conditions. For the purposes of this policy, a floodplain is defined as the area susceptible to inundation by the 100-year flood, as indicated in Figure 1 below.

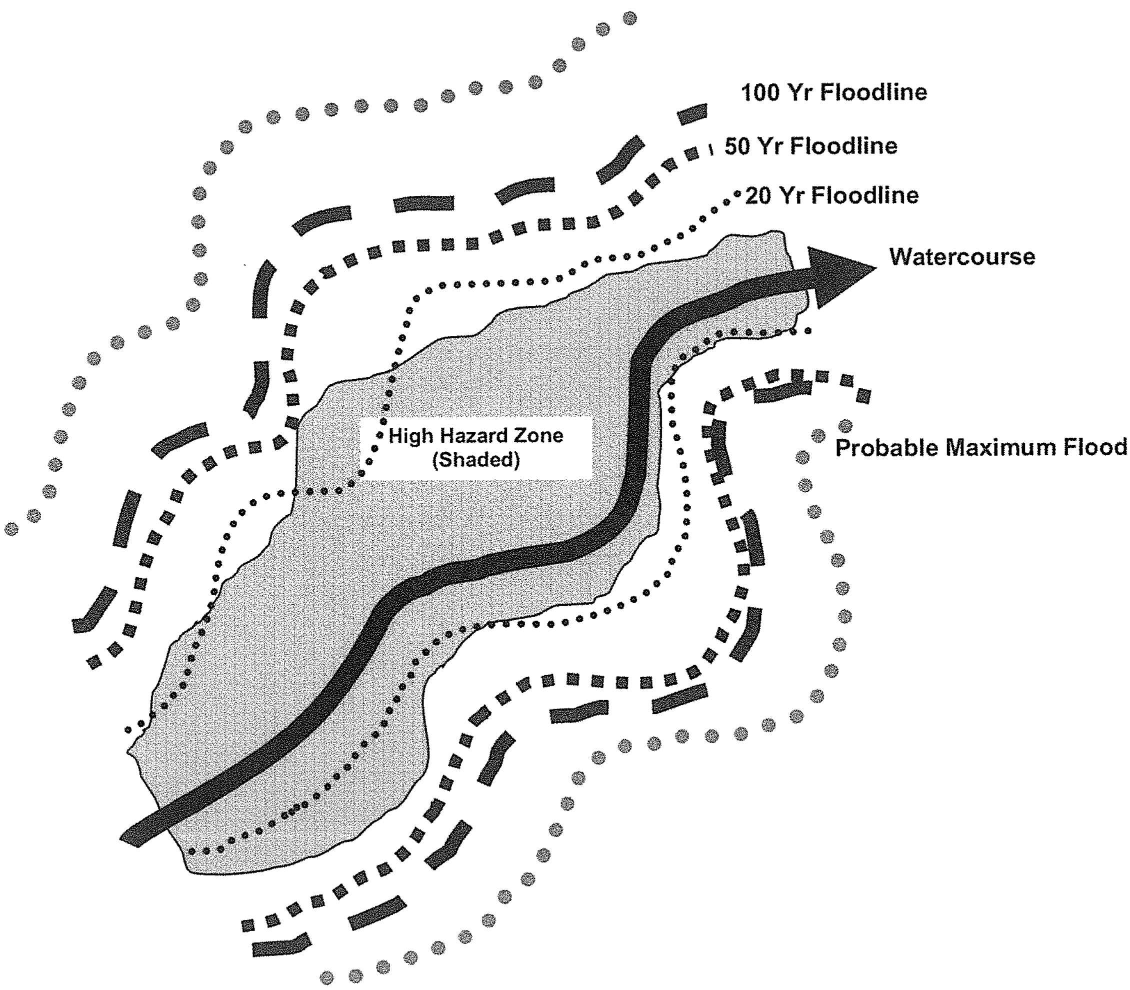


Figure 1: Schematic representation of floodplain depicting watercourse and significant floodlines

The high hazard zone within a floodplain, based on an analysis of the expected flow characteristics of the 100-year flood, is graphically indicated in Figure 2 below. The ability to wade or gain vehicular access as well as the stability of structures such as dwellings or boundary walls are deemed seriously compromised under these conditions. No new or additional rights or the exercising of existing development rights will be granted to properties located within the high hazard zone.

The permissible extent and nature of land use, development or activities within floodplains must be subject to stringent evaluation and control in the interests of public safety. In particular, obstruction to the free flow of water within the 20-year floodline area shall not be permitted. However, between the 50 and 100-year floodlines, some developments or activities may be permitted, subject to such conditions as the City may in its discretion impose, while developments with particular evacuation or emergency response issues and high risk developments will only be permitted above the 100-year floodline (refer to Table 1).

Any proposed development or redevelopment within the floodplain must be supported by a report by a registered professional engineer to ensure that any new or existing structure can withstand the forces and effects of floodwaters (refer to requirement R1 in Table 1). If building plans are submitted in respect of proposed buildings within the floodplain and such a report has not previously been submitted, it must be included with the building plans.

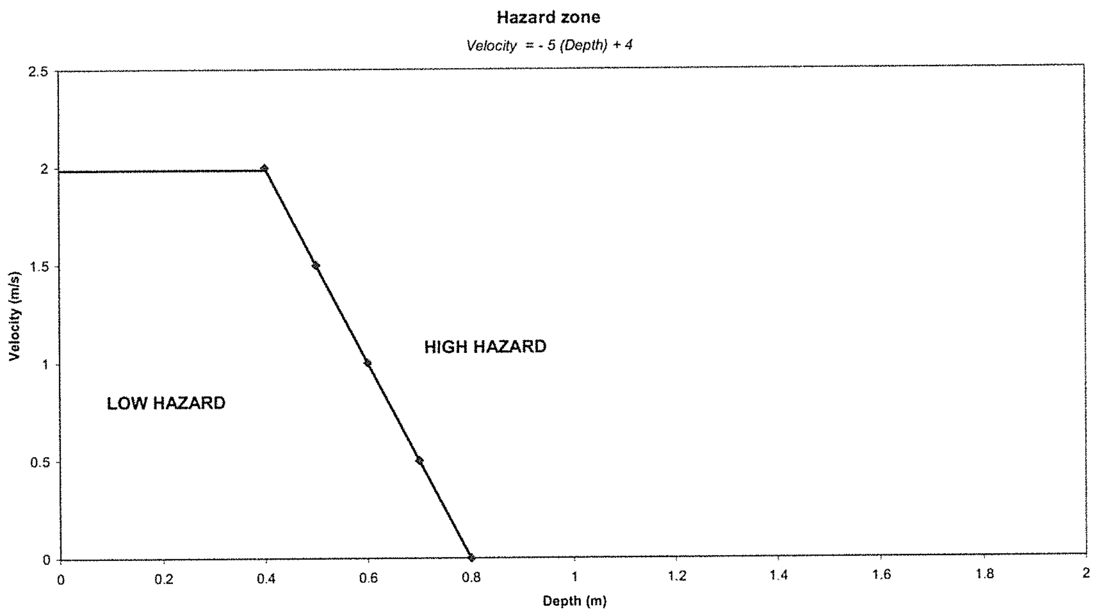


Figure 2: Flood hazard zones

9.2.1 Floodline Determination

Where floodlines have not previously been determined for a particular location, the developer will be required to procure the services of a suitably qualified registered engineering professional to undertake such determinations at own cost and to submit a report in connection therewith together with such planning or building plan approval applications he or she may lodge with the City. This should take place prior to any detailed planning being undertaken and must be in accordance with generally accepted practice.

In determining catchment runoff, the foreseeable ultimate development scenario for the catchment must be considered. All floodlines must be based on the theoretical energy level as opposed to the water surface level.

Permissible landuse / development / activity and applicable conditions within the floodplain are indicated in Table 1: Framework for the assessment of proposals (section 10). Depending on the type of application a range of floodlines must be determined as indicated below:

Floodline (Annual Probability)	Rationale
2 year (50%)	Determine if required (see Table 1)

Floodline (Annual Probability)	Rationale
20 Year (5 %)	Required for parking and other activities
50 Year (2%)	Controls a number of development activities
100 Year (1%)	Controls floor levels and high risk development activities

Note: Other legislation (e.g. NEMA) may require additional floodline determinations and therefore further restrictions may apply.

9.3 Ecological Buffers

Watercourses and wetlands with their adjacent riparian areas and associated fauna and flora must be protected or "buffered" from the impacts of adjacent development or activity. Often referred to as ecological buffers, these protected zones / set backs provide continuous corridors and habitat for flora and fauna. Buffers also provide other benefits such as water quality improvement of point or diffuse sources of pollution, stream bank and erosion protection from the hydrological impacts associated with hardened catchments in urban areas, and space for implementation of appropriate water sensitive urban design elements. In addition buffer areas can provide socio-economic benefits in the form public open space, opportunities for recreation and environmental education / awareness, and enhancement of waterway, visual and property values. In instances where watercourses have been canalized, buffers are still required to aid maintenance and, in some instances, to allow adequate space for possible future restoration activities.

Determination of ecological buffer widths is based on classification of the watercourse or wetland in terms of a recognized national classification system followed by an assessment of the ecological condition and importance of the system (using nationally recognized methods). Watercourses and wetlands with high ecological condition and importance require a wider buffer than those which have been exposed to considerable modification. For watercourses, buffer width may also be adjusted on the basis of the width of the active channel. The buffer is measured from watercourse "top of bank" or outer edge of the wetland (which must be delineated according to nationally accepted guidelines / methodologies e.g. DWAF 1999 and 2005). They have been determined for several of the significant watercourses and certain wetlands within the metropolitan area and vary in width between 10 m and 40 m for watercourses, and up to 75 m for wetlands. A minimum buffer of 10 m is required for concrete canals. Buffers must be adjusted to accommodate wetlands in close association with a watercourse as indicated schematically in Figure 3.

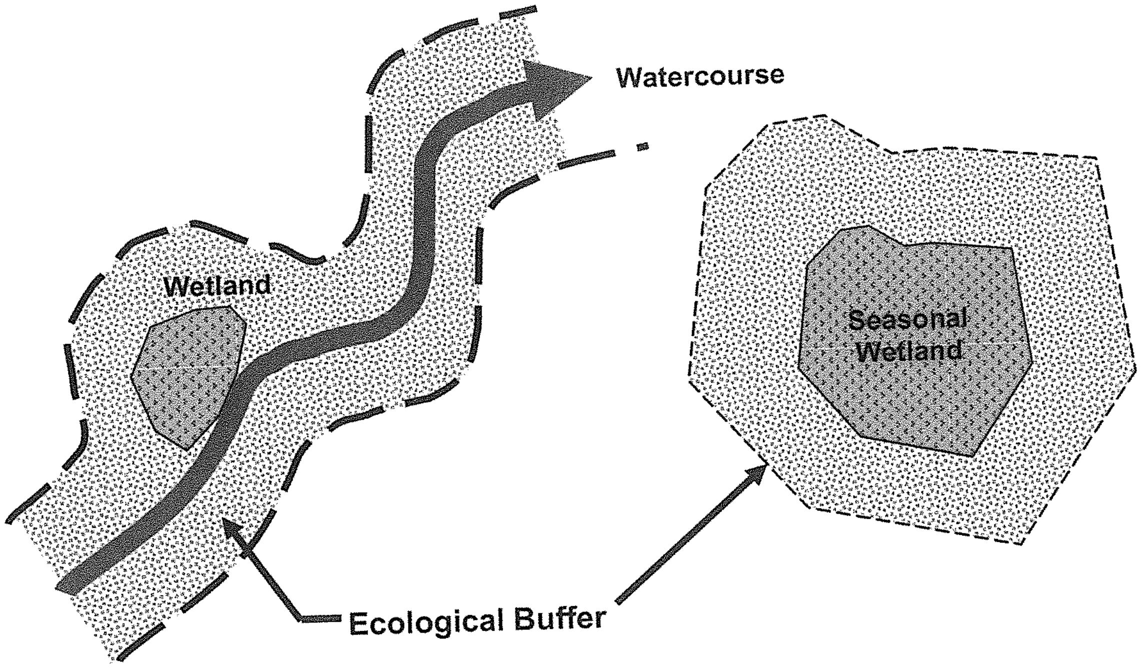


Figure 3: Schematic representation of ecological buffers

Where ecological buffers have not yet been determined for a particular watercourse or wetland, either the City may determine a buffer width by extrapolation if calculated buffer widths are available for similar situations elsewhere, or the developer is required to procure the services of a suitably qualified freshwater ecologist to recommend buffer widths in terms of Council guidelines or approved best practice at own cost and to submit a report in connection therewith together with such planning and building plan approval applications as he or she may submit to the City. This must take place prior to any detailed planning being undertaken.

Site / case specific adjustment of the recommended minimum buffer width may be necessary to allow for exceptional circumstances such as the presence of sensitive habitats, fauna or flora which may require wider buffers for adequate protection; the intensity of adjacent landuse and the nature of anticipated impacts; and the physico-chemical and/or botanical characteristics of the buffer area which may alter the efficacy of the buffer to mitigate against identified impacts.

Permissible landuse / development / activity and applicable conditions within the ecological buffer are indicated in Table 1: Framework for the assessment of proposals (section 10).

9.4 Geomorphological Processes

Cognisance must also be taken of the fact that the beds of many watercourses, particularly on the Cape Flats, are dynamic and prone to erosion, sedimentation and meandering. Where the ecological buffer width and/or floodplain setback requirement is considered an inadequate allowance for these natural processes, additional site-specific studies and setback width may be required in the discretion of the City prior to planning and building plan approval. In these instances, the developer will be required to procure the services of a suitably qualified geomorphologist to determine setback widths at own cost and to submit a report in connection therewith upon request.

9.5 Socio-economic Considerations

Watercourses and wetlands are public resources which have the remarkable potential to stimulate local economies and to break down political, social and economic barriers if managed and used with this goal in mind. Assessment of developments adjacent to watercourses and wetlands must therefore take cognizance of this potential and promote developments which actively incorporate these systems into the urban fabric of the area.

Without derogating from the general nature of what is stated in this clause, the following specific issues must be considered:

- Water Sensitive Urban Design principles
- Layout / configuration and nature of adjacent development and/or associated activities
- Watercourse / wetland frontage with adjacent development
- Areas of passive and active open space
- Areas for walkways, cycle tracks, picnic facilities
- Aesthetic improvement of degraded systems with appropriate indigenous landscaping
- Public access
- Safety and security
- Economic upliftment
- Environmental education and awareness
- Environmental standards and best practice

Socio-economic considerations such as those listed may be taken into consideration by the City when evaluating planning and building plan approval applications, in its discretion.

9.6 River Corridor

The "River Corridor" comprises the watercourse and/or associated wetlands (as applicable), the floodplain, the ecological buffer and the area required for specific aesthetic, recreational and/or socio-economic needs. This combined area must be managed in an integrated manner which balances the flooding, environmental, social and economic issues (as outlined in the preceding sections 9.2 to 9.5) . The City shall strive to develop river corridor plans for all river corridor areas within its jurisdiction, in order to give effect ultimately to this holisitic vision.

An allowance of up to 10 m (measured from the top of bank or outer edge of the wetland) dependent on the current or future maintenance strategy for the watercourse / wetland must be made for maintenance access.

10 Assessment of Proposals and Applications

This policy advocates a merit-based approach to the assessment of proposals and applications pertaining to property near watercourses and wetlands. Any new land use, development, activity or building must be appropriate for the anticipated flood risk and geomorphological process requirements and compatible with the ecological buffer and socio-economic requirements, whilst allowing access for maintenance. Table 1 provides acceptable land use for the various floodplain zones and buffer, as well as specific requirements in instances where conditional approval is considered.

Proposed land-use / development / activities / buildings must be set back beyond the greater of the applicable floodplain, geomorphological and ecological buffer requirements.

Typical proposals requiring input and approval may be divided into three broad categories as described in the following sections.

10.1 Zoning Schemes, Structure Plans and Related Policies

Only land uses considered appropriate within the applicable floodplain and ecological buffer (Refer Table 1) can be contemplated. In addition geomorphological, maintenance as well as social and economic aspects must be considered.

10.2 Land Use Planning Applications

10.2.1 New Development Rights

Developments or activities falling within this category typically require additional and/or amended land use rights to proceed, such as:

- Rezoning
- Sub-division
- Land use departures
- Consent use
- Amendment of plans or conditions of approval

Only land uses, developments or activities considered appropriate within the applicable floodplain and ecological buffer (Refer to Table 1) can be contemplated. In addition geomorphological, maintenance, social and economic aspects must be considered where appropriate.

10.2.2 New Development Rights on Existing Building Footprint

Where no increase in existing building footprint or usage is proposed, as in the case of the redevelopment of an existing building, deviation from this could be considered, where the development or activity is located outside the high hazard zone, subject to compliance with the following:

- Fulfillment of requirements R1 and R2 on Table 1.
- Implementation of appropriate flood protection and mitigation works, including but not limited to the flood proofing of buildings and flood evacuation plans if appropriate. The developer must make adequate provision for future maintenance or operation.
- The registration of a Notarial Deed of Restraint against alienation, which provides that the registered owner shall not be entitled to alienate his/her property without the consent of the City. Such consent shall be withheld until such time as the new owner/purchaser signs an indemnity on terms and conditions acceptable to council. The issuing of a clearance certificate in terms of section 118(1) of the Municipal Systems Act No. 32 of 2000 shall not constitute consent for the abovementioned purpose.
- Endorsement of all Building Plans to the effect that the owner is aware of the consequences of developing within a floodplain and floodlines to be depicted on all applicable building plans.

10.3 Building Plan Applications (Exercising of Existing Development Rights)

Consideration of building plans for structures, submitted in terms of existing development rights, will be conditional on the following:

- Location of buildings on the higher lying portions of the property with floors above the 100-year flood level where practically possible, the flood proofing of buildings and flood evacuation plans where necessary.
- No buildings will be permitted within the high hazard zone.
- Limitation of all construction / development activity within the ecological buffer.
- Consideration of measures to mitigate potential maintenance impacts as appropriate.
- The registration of a Notarial Deed of Restraint against alienation, which provides that the registered owner shall not be entitled to alienate his/her property without the consent of the

City. Such consent shall be withheld until such time as the new owner/purchaser signs an indemnity on terms and conditions acceptable to council. The issuing of a clearance certificate in terms of section 118(1) of the Municipal Systems Act No. 32 of 2000 shall not constitute consent for the abovementioned purpose.

- Endorsement of all Building Plans to the effect that the owner is aware of the consequences of developing within a floodplain and floodlines to be depicted on all applicable building plans.

10.4 Development Layouts

In preparing development layouts cognisance must be taken of the various considerations outlined in the previous sections (10.2 and 10.3) as well as Council's Stormwater Management Planning and Design Guidelines for New Developments. Where appropriate, a servitude protecting the floodplain and / or ecological buffer from alteration or obstruction on completion of the development must be registered in favour of Council by the developer at own cost. Where maintenance access is required, this must also be incorporated in the conditions of servitude.

Buildings must be located above the appropriate flood level or buffer zone, or on the upper extremities of the property if the site is entirely located within the relevant floodline, and must front or provide views onto the watercourse or wetland to ensure adequate visual surveillance and integration of the system into the fabric of the development and the City as a whole. Perimeter fencing below the 50-year floodline must be visually permeable from ground level and not adversely affect the free flow of water and movement of aquatic fauna (e.g. palisade fencing).

10.5 Table 1: Framework for the Assessment of Proposals

Table Shading Key	
Colour Coding	**Description**
Clear	Permitted
	Conditionally Permitted
	Not Permitted

Additional Requirement Key	
Code	**Requirement**
R1	A registered Engineering Professional must be engaged by the developer to satisfactorily demonstrate and certify that: ▪ The activity / development will not materially increase flood hazards for other property owners or adversely affect flood behavior or the stability of river channels. ▪ Any structure can withstand the forces and effects of flowing floodwaters, including scour of foundations, debris forces and buoyancy forces.
R2	Floors above 1:100 year flood level. Basements (non-habitable purposes) to be flood-proofed to 1:50-year flood level.
R3	Floors above 1:50 year flood level.
R4	A registered Environmental Professional (Aquatic Ecologist) must be engaged by the developer to determine the ecological buffer (if not available) and to satisfactorily demonstrate and certify that: • The activity / development will not negatively impact on the present condition of the watercourse or wetland OR • The activity or development will improve the condition of the watercourse or wetland from its present state

The land use / development / activity must be set back beyond the *greater* of the applicable floodplain zone / geomorphological or ecological buffer requirements

Land use / Development / Activity		Requirements and Conditions							
		Floodplain Zone (Flood Recurrence Interval in Years)						Ecological Buffer (Width in meters)	
Category	**Typical Examples**	**< 2**	**2–20**	**20–50**	**50-100**	**>100 (Note 1)**	***Explanatory Notes***	**Up to 75m (Note 2,3)**	***Explanatory Notes***
Industrial Development	Light, General, High Risk								
	Extractive (Mining)		R1	R1	R1				
Business Development	General				R2				
	Commercial (CBD)								
	Service Stations								
Residential Development	Formal				R2				
	Informal								
Community & Public Facilities	Hospitals, Clinics, Nursing Homes, Old Age Home								

Land use / Development / Activity		Requirements and Conditions							
		Floodplain Zone (Flood Recurrence Interval in Years)						Ecological Buffer (Width in meters)	
Category	**Typical Examples**	**< 2**	**2–20**	**20–50**	**50-100**	**>100 (Note 1)**	***Explanatory Notes***	**Up to 75m (Note 2,3)**	***Explanatory Notes***
	Prisons, Military Bases, Police Stations, Fire Stations								
	Cemeteries								
	Educational Facilities								
	Public Halls, Places of Worship								
Utility / Infrastructure Services (incl. Private)	Stormwater Management Facilities	R1	R1					R4	
	Underground Sewers, Services						Manhole cover levels above 1:50 year flood level. Structure to be suitably protected and integrated into surrounds		
	On Site Sewage Treatment								
	Water & Wastewater Works, Pump Stations								
	Solid Waste Disposal Sites								
	Power Generation, Electrical Substations								
	Telecommunication Exchanges & Transmitters.								
Environment, Open Space & Recreation	Nature Reserves and Conservancies						All structures/earthworks to be subject to conditional approval		All structures/earthworks to be subject to conditional approval
	Sports Fields, Golf Courses, Picnic Areas		R1	R3			All club houses and similar structures to be above the 50 year floodline	R4	
	Public & Private Open Space						All structures/earthworks to be subject to conditional approval		All structures/earthworks to be subject to conditional approval
Agriculture	Cultivation, Free-range animal husbandry		R1	R1			Subject to Conservation of Agricultural Resources Act (CARA) Regulations		

Land use / Development / Activity		Requirements and Conditions							
		Floodplain Zone (Flood Recurrence Interval in Years)						Ecological Buffer (Width in meters)	
Category	**Typical Examples**	**< 2**	**2–20**	**20–50**	**50-100**	**>100 (Note 1)**	***Explanatory Notes***	**Up to 75m (Note 2,3)**	***Explanatory Notes***
	Agricultural Processing / Industry				R1,R2				
	Feedlots, Piggeries and Battery Farming			R1	R1		Subject to Conservation of Agricultural Resources Act (CARA) Regulations		
Resorts	Hotels, Holiday Resorts and Bungalows,				R2				
	Caravan and Camping Sites		R1	R3			All ablution facilities to be located above the 20 year floodline	R4	
Transport Systems	Roads and Railways elevated above NGL		R1	R1	R1				
	Modal Interchanges, Bus Depots, Railway Stations								
	Parking Areas			R1					
Bank Protection Works, Flow Diversion Structures, & Earthworks	Revetments, Training Walls, Levees	R1	R1	R1				R4	
	Dams, Weirs, Bridges	R1	R1	R1	R1	R1	Dam-break analysis to be performed where required in terms of National Water Act	R4	
	Filling				R1	R1	In exceptional circumstances minor "smoothing" of the 50 / 100 year floodline may be considered, provided equivalent compensatory stage storage volume is provided within the development precinct		

Note 1: The effects of the 100-year storm event on all developments and infrastructure, including adjacent and downstream properties, must be evaluated to comply with the above requirements.

Note 2: Watercourses: 10 to 40 m; Wetlands: up to 75 m

Note 3: Conditional approval may be granted for certain low impact social needs / activities, appropriate landscaping, indigenous planting, pathways

11 Commencement and Implementation

11.1 Commencement Date

Unless otherwise specified, the commencement date for this policy will be the date of adoption by Council

11.2 Existing Policies / Guidelines Repealed

The following existing policies / guidelines are repealed:

Title	Commencement Date	Resolution
Floodplain Management Guidelines: Version 1.0	September 2003	MC37/11/03

12 General

12.1 Statutory Permits and Approvals

Certain developments or activities may be subject to approvals in terms of national legislation by Provincial and National Government Departments.

Examples include, but are not limited to:

- Storing water
- Impeding or diverting the flow of water in a watercourse
- Altering the bed, banks, course or characteristics of a watercourse
- Using water for recreational purposes
- Abstraction
- Land reclamation
- Agricultural cultivation in close proximity to watercourses.

12.2 Indemnity

The degree of flood and/or environmental protection recommended by this policy is considered reasonable for regulatory purposes and is based on engineering and scientific methods of study. Mere compliance with its provisions cannot ensure complete protection from flooding particularly from high order events or reduced environmental impact and must therefore not be construed as a warranty.

This policy shall not create liability on the part of the City of Cape Town or any officer thereof, for any damage that may result from reliance thereon.

12.3 Copyright

12.4 References

Flood Risk Reduction Measures, Alexander WJR, Department of Civil Engineering, University of Pretoria, April 2000

Development Control Guidelines in Floodprone Areas (Prepared for the former Cape Metropolitan Council), VKE Consulting Engineers (Pty) Ltd in association with Barker and Louw Town and Regional Planners, Dr J. Neethling (Environmental Specialist), Prof A. Rooseboom (Hydraulics and Hydrology Specialist) Du Plessis and Hofmeyer Attorneys, Dr C. Brown (Freshwater Ecologist), June 2000

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Resource Directed Measures for Protection of Water Resources: Wetland Ecosystems. Appendix W6: Guidelines for the delineation of wetland boundary and wetland zones. Editor: H. Mackay. Department of Water Affairs and Forestry. 1999.

A practical field procedure for identification and delineation of wetlands and riparian areas. Department of Water Affairs and Forestry 2005.

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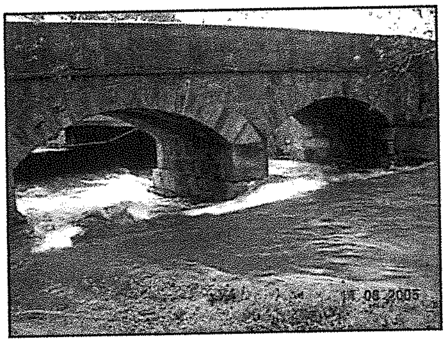
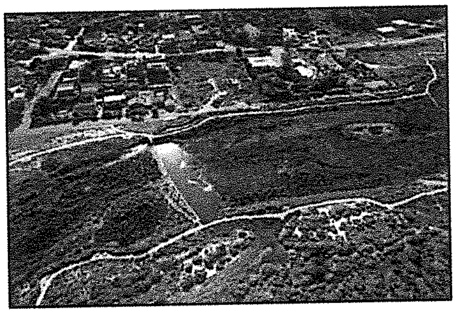
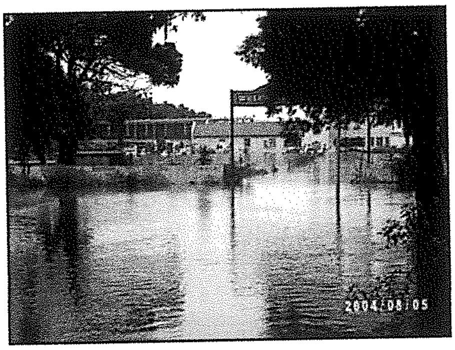


DEPARTEMENT PAAIE & STORMWATER

Opvangsgebied-, stormwater-en-rivierbestuurstak



Beleid oor vloedvlakte- en rivierkorridorbestuur



Die balansering van vloedgevaar, ekologiese en sosio-ekonomiese oorwegings by ontwikkelings naby waterlope en vleilande

Weergawe 2.1

Goedgekeur deur die raad
27 Mei 2009
C 58/05/09

(Voorheen getiteld: Riglyne vir vloedvlaktebestuur)

CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD

Inhoudsopgawe

1 Aanhef

Dit is toenemend 'n wêreldsiening dat waterlope en vleilande, hetsy natuurlik of mensgemaak, 'n integrerende deel van stormwaterbestuurstelsels uitmaak, belangrik is vir die volhoubaarheid van stede se waterekologie, en 'n noodsaaklike element is by die herstel van stedelike weefsel deur die voorsiening van sowel ontspannings- as sosio-ekonomiese geleenthede aan alle inwoners.

'n Goed bestuurde waterloop/vleiland is 'n waardevolle hulpbron vir die verbetering van die lewensgehalte in en skoonheid van 'n stedelike gebied, en hou voordele vir openbare gesondheid, ontspanning en ekonomiese groei in. Dit is veral belangrik in die lig van veranderende weerpatrone en die verwante plaaslike, nasionale en internasionale strategieë gemik op volhoubaarheidskwessies.

Hierdie beleidsdokument is 'n versterking van die vorige riglyne vir vloedvlaktebestuur (weergawe 1.0) van September 2003. Verskeie verbeteringe is aangebring om die beleidsbeginsels met korporatiewe strategiese doelwitte te versoen. Met inagneming van die vloedregime, water- en oewer-ekologie sowel as sosio-ekonomiese faktore, sit dit die prosedure vir ontwikkelingsbestuur langs waterlope en vleilande uiteen.

2 Omskrywings

In hierdie beleid, tensy uit die samehang anders blyk, beteken:–

"ekologiese buffer" 'n strook grond aanliggend aan 'n waterloop of vleiland, wat vir die beskerming en versterking van dié ekosisteme nodig is;

"grond" die laagste binnevlak van 'n vertrek, motorhuis of kelder waartoe diegene in 'n gebou toegang het;

"herhalingsinterval" of **"HI"** die gemiddelde interval in jaar tussen reënval- en oorstromingsvoorvalle wat dieselfde of erger is as 'n bepaalde hewigheidsgraad;

"ontwikkeling" enige mensgemaakte verandering aan eiendom, wat insluit, maar nie beperk is nie tot die oprigting of opknapping van geboue of ander strukture, opvulling, plaveiwerk, munisipale dienste, ensovoorts, of die verwante grondvoorbereidingswerk;

"oorskryding" 'n indringing of skending;

"opvul(ling)" die plasing van opvulmateriaal, soos natuurlike sand, slyk, grond of klip, wat beton, sement of ander afvalmateriaal kan insluit, op 'n bepaalde plek om die grondvlak tot 'n gewenste hoogte te lig;

"raad" die Stad Kaapstad;

"rivierkorridor" 'n gemengdegebruik-korridor wat bestaan uit 'n waterloop en/of verwante vleiland, die vloedvlakte, die ekologiese buffer en die gebied wat vir bepaalde estetiese, ontspannings- en/of sosio-ekonomiese behoeftes vereis word. Hierdie gebied moet in sy geheel geïntegreerd bestuur word ten einde oorstromings-, omgewings-, maatskaplike en ekonomiese kwessies te balanseer;

"stormwater" water uit natuurlike neerslag en/of die opgaring daarvan, wat grondwater en fonteinwater wat gewoonlik deur die stormwaterstelsel afgevoer word, sowel as seewater in 'n riviermonding insluit, maar wat water in 'n drink- of afvalwaterverspreidingsnetwerk uitsluit;

"stormwaterstelsel" sowel geboude as natuurlike fasiliteite, wat pype, duikslote en waterlope met hulle gepaardgaande vloedvlaktes insluit, hetsy oor of onder openbare of privaat grond, wat vir die bestuur, opgaar, vervoer, tydelike berging, beheer, monitering, behandeling, gebruik en wegvoer van stormwater gebruik of vereis word;

"struktuur" enige mensgemaakte kenmerk wat aan die grond of aan iets op die grond geheg is, wat insluit, maar nie beperk is nie tot omheinings, mure, berms, oewerwalle, opvulling, opgaartenks, skuilings of geboue;

"vleiland" grond wat tussen aard- en watersisteme geleë is, en waar die watertafel gewoonlik op of na aan die oppervlak is, of waar die grond van tyd tot tyd met vlak water bedek is, welke grond normaalweg plantegroei (sou) onderhou wat tipies in deurweekte grond gedy. Hierdie omskrywing sluit dus in, maar is nie noodwendig beperk nie tot watermassas soos mere, brak vleie, kusmere, riviermondinge, moerasse, kuile, poele, panne en kunsmatig opgedamde water;

"vleilandkartering" die bepaling en merk van die grens van 'n vleiland deur nasionaal aanvaarde riglyne/metodologieë te gebruik;

"vloedlyne" lyne op 'n kaart of skets wat die watervlakke aandui wat 'n vloed met 'n bepaalde herhalingsinterval waarskynlik sal bereik;

"vloedvlakte" die grond wat aan 'n waterloop grens en tot en met die honderdjaar-herhalingsinterval vir oorstroming vatbaar is;

"walbopunt" van 'n waterloop, 'n punt wat deur skuurlyne, plantegroeigrense, veranderinge in bedding- en walmateriaal, die teenwoordigheid van slykafsetting weens oorstroming, of skielike hellingveranderinge gekenmerk word;

"waterloop" 'n rivier, stroom, kanaal, sloot, vlei, vleiland, dam of meer waarin of waarheen water gereeld of met tussenposes vloei. 'n Verwysing na 'n waterloop sluit waar van toepassing ook sy bedding en walle in; en

"watersensitiewe stedelike ontwerp" 'n benadering wat dit ten doel stel om te verseker dat ontwikkeling in stedelike gebiede holisties beplan, ontwerp, gebou en in stand gehou word ten einde die negatiewe uitwerking op die natuurlike watersiklus te verminder en waterekosisteme te beskerm.

3 Inleiding

Waterlope en vleilande is 'n integrerende deel van die stormwaterbestuurstelsel, maak 'n belangrike onderdeel van die Stad se biodiversiteitsnetwerk uit, en verteenwoordig 'n noodsaaklike element in die herstel van die Stad se stedelike weefsel deur die voorsiening van sowel ontspannings- as ekonomiese geleenthede.

Hierdie beleid ondersteun die Departement: Paaie en Stormwater se doelwitte wat in die Stad Kaapstad se geïntegreerde-ontwikkelingsplan opgeneem is, naamlik:

- Om die impak van oorstroming op die bestaan van gemeenskappe en streeksekonomieë te verminder

- Om mensegesondheid en natuurlike wateromgewings te beskerm, en ontspanningswatergehalte te verbeter en in stand te hou

Die bestuur van grondgebruik, ontwikkeling of aktiwiteit langs waterlope en vleilande is om die volgende redes belangrik:

- Dit is op lang termyn by verre meer kostedoeltreffend om in gebiede te ontwikkel waar die vloedgevaar ongereeld en die hewigheid van oorstromingsvoorvalle minimaal is, in vergelyking met terugwerkende vloedskadetempering wat gewoonlik uiters duur is en soms rampspoedige gevolge kan hê wanneer vloede die ontwerpvermoë van infrastruktuur oorskry.

- Klimaatsvoorspellings dui op al hoe meer wisseling in die intensiteit en krag van stormvoorvalle, saam met 'n snelle styging in die seevlak. Hierdie onsekerhede hou groot uitdagings vir die bestuur van groot dreineerstelsels in.

- Oorskrydings lei tot ekologiese agteruitgang, verswak dikwels watergehalte, en verhaas die onherroeplike verlies aan ekologiese hulpbronne.

- Aangesien die wysiging van natuursisteme natuurlike water- en geomorfologiese prosesse kan ontwrig, is langtermyntoewyding nodig wat instandhouding betref. Daarom moet stedelike aktiwiteit op so 'n manier bestuur word dat voldoende instandhoudingsaktiwiteite steeds onderneem kan word.

- Dit ondersteun 'n plekgeheue, en werk ontspanningsgenot vir gemeenskappe in die hand.

Hierdie beleid beskryf 'n merietegegronde benadering tot voorstelle vir grondgebruik, ontwikkeling of aktiwiteit naby waterlope en vleilande.

4 Wetgewende raamwerk en mandaat

Grondgebruik, ontwikkeling en verwante aktiwiteite wat deur hierdie beleid geraak word, word ingevolge onderstaande statute en beplanningsraamwerke hanteer.

4.1 Nasionaal

- Wet op Nasionale Bouregulasies & Boustandaarde, 1997 (Wet 103 van 1977)
- Wet op Bewaring van Landbouhulpbronne (Wet 43 van 1983)
- Nasionale Waterwet (Wet 36 van 1998)
- Wet op Nasionale Omgewingsbestuur (Wet 107 van 1998)
- Rampbestuurwet (Wet 57 van 2002)
- Wet op Nasionale Omgewingsbestuur: Biodiversiteit (Wet 10 van 2004)
- Wet op Nasionale Omgewingsbestuur: Beskermde Gebiede (Wet 57 van 2004)

4.2 Provinsiaal

- Wes-Kaapse Wet op Beplanning & Ontwikkeling (Wet 7 van 1999) (Dié wet sal van toepassing wees wanneer dit in werking tree.)
- Ordonnansie op Grondgebruikbeplanning (Ordonnansie 15 van 1985)

4.3 Stad Kaapstad

- Geïntegreerde-ontwikkelingsplan (2007/8 tot 2011/12)

Onderstaande doelwitte van die Departement: Paaie en Stormwater is in die Stad Kaapstad se geïntegreerde-ontwikkelingsplan opgeneem:

- Verminder die uitwerking van oorstroming op die bestaan van gemeenskappe en streeksekonomieë
- Beskerm mensegesondheid en natuurlike wateromgewings, en verbeter en hou ontspanningswatergehalte in stand

- Verordening op Stormwaterbestuur (uitgevaardig in September 2005 – PK 6300), waarmee saam dié beleid gelees en geïnterpreteer moet word.

  Die Stad se Verordening op Stormwaterbestuur omskryf die stormwaterstelsel as "die opgerigte en natuurlike geriewe, waaronder pype, duikslote, waterlope en hulle meegaande vloedpleine, hetsy oor of onder grond in openbare of private besit, wat vir die bestuur, versameling, vervoer, tydelike berging, beheer, monitor, behandeling, gebruik en wegvoer van vloedwater gebruik of vereis word".

  Klousule 4 en 5 handel oor die beskerming van die stormwaterstelsel (wat natuurlike en geboude sisteme en die verwante vloedvlaktes insluit) en die voorkoming van vloedgevaar.

  Die raad kan dus ingevolge hierdie verordening ontwikkeling in gebiede langs waterlope en vleilande verbied of voorwaardelik toelaat.

Voorts is 'n aantal ander dokumente wat hetsy regstreeks of by implikasie na ontwikkelings- en gebiedsbestuur langs waterlope en vleilande verwys, oor die jare ontwikkel. 'n Paar van die belangrikste dokumente is:

- *"Greening the City: Open Sapce and Recreation Plan for Cape Town" (1982),* die Stad Kaapstad se plan vir die vergroening van oop en ontspanningsruimtes.
- Die Departement: Paaie en Stormwater se strategie oor opvangsgebied-, stormwater- en rivierbestuur (2002).
- *"Biodiversity Strategy" (2003)* and *"Biodiversity Report" (2008),* die Biodiversiteitstrategie en Biodiversiteitsverslag.
- *"Coastal Zone Strategy" (2003)* and *"Coastal Zone Management Review and State of the Coast Report Year 3" (2006), die* Kussonestrategie en die Kussonebestuursoorsig en verslag oor die stand van die kus jaar 3.
- *"CMOSS – An Open Space Strategy" (2005)*, CMOSS – 'n oopruimtestrategie.
- *"Planning for Future Cape Town" (2006)*, 'n beplanningsraming vir die Kaapstad van die toekoms.

5 Beleidsgronde

Binne die grense van die Kaapstad- metropolitaanse gebied is die druk om te ontwikkel groot, en dit verg dus omsigtige bestuur om ontwikkeling in gebiede met 'n hoë vloedgevaar te voorkom, die omgewingsintegriteit van waterhulpbronne te beskerm, en te verseker dat toegelate ontwikkeling die skoonheid en karakter van die aanliggende waterlope/vleilande versterk.

Om dit te bereik, is 'n nuwe benadering nodig waardeur ontwerp-, omgewings- en sosio-ekonomiese elemente as die visie vir 'n bepaalde waterloop-/vleilandsisteem beoordeel en geïntegreer word.

Hierdie beleid beveel 'n merietegegronde benadering tot voorstelle binne en langs vloedgeteisterde gebiede en omgewingsbuffers aan. Voorts word sosio-ekonomiese oorwegings ook in ag geneem, en behoort enige toegelate ontwikkeling dus aandag te skenk aan die teenwoordigheid van die waterloop/vleiland, en daardeur die stedelike weefsel van die gebied holisties te versterk.

Hierdie beleid is belangrik vir die verwesenliking van die diensuitkomste soos in afdeling 3 hier bo uitgelig, naamlik om die impak van oorstroming op mense en eiendomme te verminder, en mensegesondheid en wateromgewings te beskerm en ontspanningswatergehalte te verbeter en in stand te hou.

6 Beleidstelling

'Om volhoubare ontwikkeling en verwante aktiwiteite binne of langs natuurlike en geboude stormwaterstelsels te verseker, en voorts te verseker dat die moontlike vloedgevaar, omgewingsimpakte én sosio-ekonomiese behoeftes gebalanseerd oorweeg word, sal alle ontwikkelings in hierdie gebiede ooreenkomstig beste praktyk en die vereistes en voorwaardes in hierdie beleid neergelê, beplan en ontwerp word.'

Hierdie beleid ondersteun die diensuitkomste soos in afdeling 3 hier bo uiteengesit, en verseker voorts dat die administratiewe optrede met betrekking tot grondgebruikbeplanningsaansoeke wettig, redelik en prosessueel billik is.

7 Bestek en toepassing

Hierdie beleid is van toepassing op grondgebruik-, ontwikkelings- of bou- of aktiwiteitsvoorstelle langs waterlope of vleilande. Die beginsels met betrekking tot vloedbestuur kan ook op ontwikkeling in die omgewing van formele stormwaterbestuurstelsels toegepas word.

8 Oogmerke

Die oogmerke van hierdie beleid is om ontwikkeling op 'n manier te bestuur wat:

- blootstelling aan vloedgevaar beperk of verminder deur gevaarlike, onekonomiese of onwyse gebruik van vloedvlaktes te verhoed, en daardeur lewens, eiendom en gemeenskapinfrastruktuur te beskerm;
- die natuurlike vloeddravermoë van waterlope en vleilande beskerm;
- die intrinsieke waarde en die omgewingsgoedere en -dienste wat waterlope, vleilande en verwante oewergebiede en vloedvlaktes bied, te beskerm en te versterk;
- die voordelige integrasie van waterlope by die stedelike landskap in die hand werk deur 'n esteties bevredigende openbare hulpbron te skep, wat uiteindelik die maatskaplike en ekonomiese opheffing van gemeenskappe langs waterlope en vleilande moontlik sal maak;
- 'n doeltreffende besluitnemingsinstrument vir amptenare, ontwikkelaars en konsultante bied deur 'n mate van voorspelbaarheid met betrekking tot ontwikkelingsaansoeke langs waterlope/rivierkorridors en vleilande te skep; en
- volhoubare ontwikkeling uit 'n ontwerp-, omgewings- en sosio-ekonomiese perspektief ondersteun.

9 Beplannings-, veiligheids-, omgewings- en sosio-ekonomiese oorwegings

Grondgebruik, ontwikkeling of aktiwiteite naby waterlope en vleilande moet geskik wees vir die verwagte graad van vloedgevaar, terwyl dit ook die gepaardgaande omgewingsimpak beperk en 'n plekgeheue en stedelike vorm behou. Die afdelings hieronder sit die beplannings-, veiligheids-, omgewings- en sosio-ekonomiese aspekte uiteen wat in die beoordeling van aansoeke oorweeg moet word, soos daar in afdeling 7 hierbo bedoel word.

9.1 Planne / sektorale planne

Toepaslike vereistes en aanbevelings in verskeie planne/verwante dokumente moet in ag geneem word. Die verskillende kategorieë planne wat, waar beskikbaar, geraadpleeg behoort te word, word hier onder gelys. Gesonde ontwerp- en omgewingsoordeel behoort in die afwesigheid van hierdie gidsplanne gebruik te word.

- Die Departement: Paaie en Stormwater se strategie oor opvangsgebied-, stormwater- en rivierbestuur 2002–2007
- Opvangsgebied- & rivierbestuursplan
- Stormwatermeesterplan

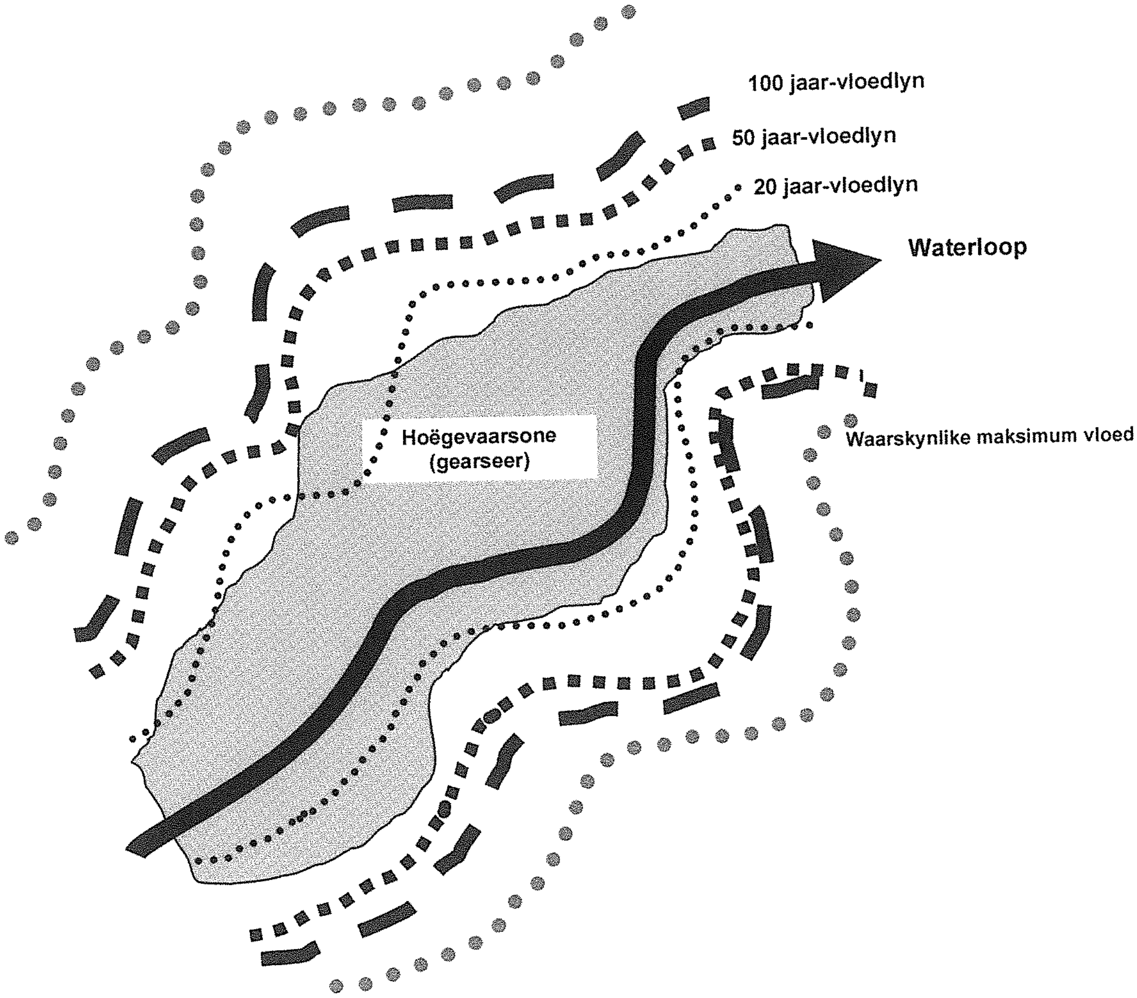
9.2 Vloedbestuur en openbare veiligheid

Waterlope en hulle verwante vloedvlaktes kan onder vloedomstandighede groot volumes water dra. Vir die doeleindes van hierdie riglynbeleid, word 'n vloedvlakte omskryf as die area wat vatbaar is vir oorstroming tot en met die 100 jaar-vloed, soos in Figuur 1 hieronder aangedui.

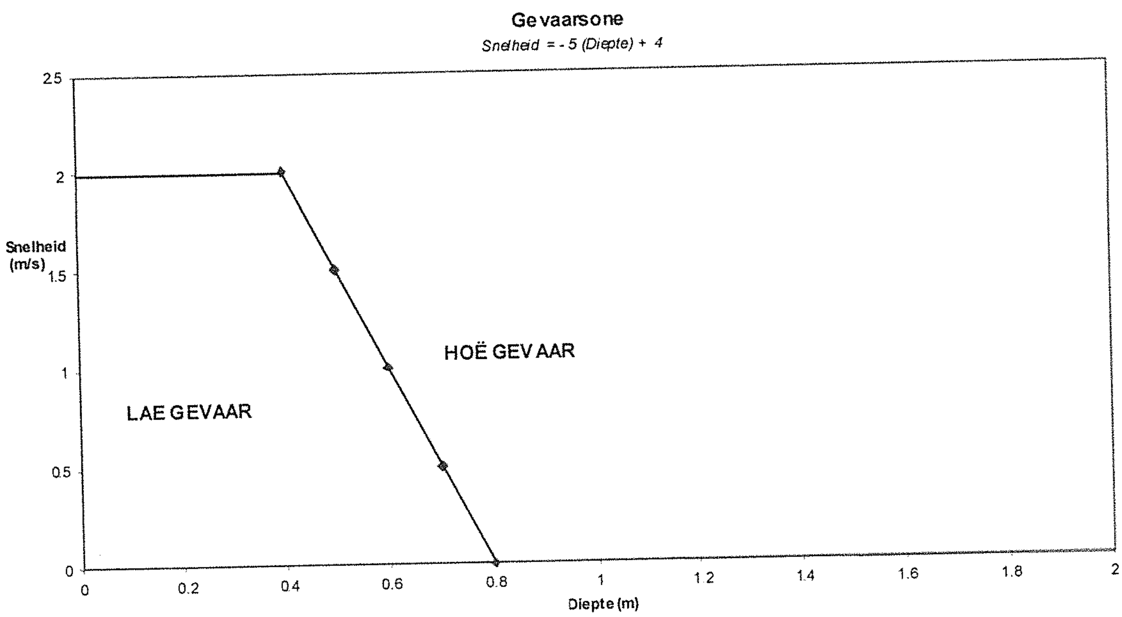
Die hoëgevaarsone binne 'n vloedvlakte, gegrond op die ontleding van die verwagte vloei-eienskappe van die 100 jaar-vloed, word grafies in Figuur 2 hieronder aangedui. Die vermoë om deur die water te loop of voertuigtoegang te verkry, sowel as die stabiliteit van strukture soos wonings of grensmure word onder hierdie omstandighede as ernstig gekompromitteer beskou. Geen nuwe of bykomente regte of die uitoefening van bestaande ontwikkelingsregte sal toegestaan word vir eiendomme wat in die hoëgevaarsone geleë is nie.

Die toegelate omvang en aard van grondgebruik, ontwikkeling of aktiwiteite in vloedvlaktes moet in die belang van openbare veiligheid aan streng beoordeling en beheer onderwerp word. In die besonder word die versperring van vrye watervloei binne die 20 jaar-vloedlyngebied hoegenaamd nie toegelaat nie. Tussen die 50 jaar- en 100 jaar-vloedlyne kan die meeste ontwikkelings of aktiwiteite toegelaat word, onderhewig aan sodanige voorwaardes na gelang die Stad na eie goeddunke kan oplê, terwyl ontwikkelings met bepaalde ontruimings- of noodreaksiekwessies sowel as hoërisiko-ontwikkelings slegs bo die 100 jaar-vloedlyn toegelaat sal word (sien Tabel 1).

Enige voorgestelde ontwikkeling of herontwikkeling binne die vloedvlakte moet deur 'n verslag deur 'n geregistreerde ingenieur gesteun word om te verseker dat enige nuwe of bestaande struktuur die kragte en effekte van vloedwater kan weerstaan (sien vereiste R1 in Tabel 1). As bouplanne ten opsigte van voorgestelde geboue binne die vloedvlakte voorgelê word, en sodanige verslag nie voorheen voorgelê is nie, moet die laasgenoemde by die bouplanne ingesluit word.



Figuur 1: Skematiese voorstelling van vloedvlakte, met waterloop en belangrike vloedlyne daarop uitgebeeld.



Figuur 2: Vloedgevaarsones

9.2.1 Vloedlynvasstelling

Waar vloedlyne nog nie voorheen vir 'n bepaalde plek vasgestel is nie, sal daar van die ontwikkelaar verwag word om op eie koste die dienste van 'n toepaslik gekwalifiseerde en geregistreerde ingenieur te verkry om sodanige vasstelling te doen, en om 'n verslag daaroor in te dien tesame met sodanige aansoeke om goedkeuring van beplanning of bouplanne wat hy/sy by die Stad kan indien. Dít behoort te geskied voordat enige uitvoerige beplanning 'n aanvang neem, en moet ooreenkomstig algemeen aanvaarde praktyk gebeur.

In die bepaling van die afloop in die opvangsgebied, moet die voorsienbare maksimum-ontwikkelingscenario vir die opvangsgebied in ag geneem word. Alle vloedlyne moet gegrond word op die teoretiese energievlak teenoor die vlak van die wateroppervlakte.

Toelaatbare grondgebruike/ontwikkeling/aktiwiteite en toepaslike voorwaardes in die vloedvlakte word in Tabel 1, "Raamwerk vir die beoordeling van voorstelle" (afdeling 10), aangedui. Afhangende van die soort aansoek, moet 'n reeks vloedlyne soos hier onder aangedui, vasgestel word:

Vloedlyn (jaarlikse waarskynlikheid)	Motivering
2 jaar (50%)	Bepaal, indien vereis (sien tabel 1)
20 jaar (5 %)	Vereis vir parkering en ander aktiwiteite
50 jaar (2%)	Beheer 'n aantal ontwikkelingsaktiwiteite
100 jaar (1%)	Beheer grondvlakke en hoërisiko-ontwikkelingsaktiwiteite

Let wel: ander wetgewing (bv. die Wet op Nasionale Omgewingsbestuur) kan dalk bykomende vloedlynbepalings vereis, en bykomende beperkings kan dus van toepassing wees.

9.3 Ekologiese buffers

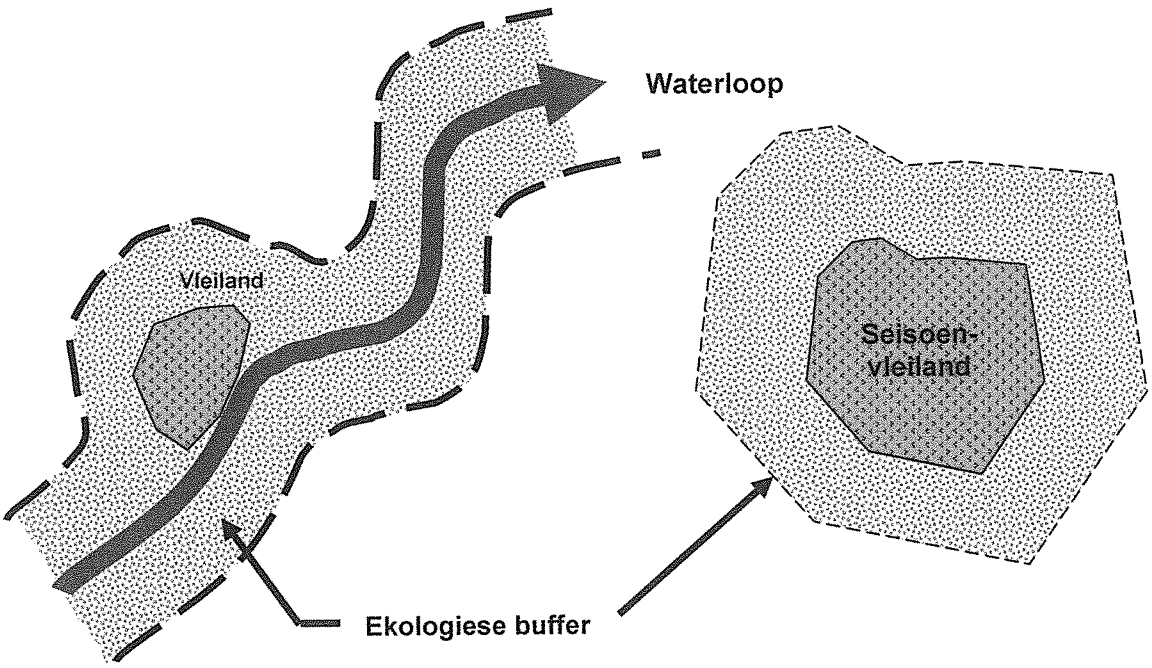
Waterlope en vleilande met hulle aanliggende oewergebiede en verwante diere- en plantelewe het 'n 'buffer' teen die impak van aanliggende ontwikkeling of aktiwiteit nodig. Hierdie beskermde sones/inspringings, wat dikwels ekologiese buffers genoem word, verteenwoordig ononderbroke korridors en habitat vir plante en diere. Buffers hou ook ander voordele in, soos watergehalteverbetering by punt- of verspreide besoedelingsbronne, stroombank- en erosiebeskerming teen die hidrologiese effek wat met geharde opvangsgebiede in stedelike omgewings gepaardgaan, en ruimte vir die inwerkingstelling van toepaslike watersensitiewe-stedelikeontwerpelemente. Voorts kan buffergebiede ook sosio-ekonomiese voordele in die vorm van openbare oop ruimtes, geleenthede vir ontspanning en omgewingsopvoeding/-bewusmaking, en die verhoging van waterlope se visuele en eiendomswaardes inhou. In gevalle waar waterlope gekanaliseer is, word buffers steeds vereis om instandhouding moontlik te maak en om, in sommige gevalle, voldoende ruimte vir moontlike toekomstige herstelaktiwiteite te laat.

Die vasstelling van ekologiese-bufferbreedtes berus op die klassifikasie van die waterloop of vleiland ingevolge 'n erkende nasionale klassifikasiestelsel, gevolg deur 'n beoordeling van die ekologiese toestand en belang van die sisteem (deur van nasionaal erkende metodes gebruik te maak). Waterlope en vleilande in 'n goeie ekologiese toestand en van groot belang vereis 'n breër buffer as dié wat aan beduidende wysigings blootgestel is. Vir waterlope word bufferbreedtes ook op grond van die breedte van die aktiewe kanaal aangepas. Die buffer word van die waterloop se walbopunt, of die buiterand van die vleiland gemeet (wat ooreenkomstig nasionaal aanvaarde riglyne/metodologieë gekarteer moet wees, bv. "DWAF" 1999 en 2005. Hierdie punte en rande is vir verskeie van die belangrike waterlope en sekere vleilandgebiede in die metropolitaanse gebied vasgestel, en wissel in breedte tussen 10 m en 40 m vir waterlope, en tot en met 75 m vir vleilande. 'n Minimum buffer van 10 m word vir betonkanale vereis. Buffers kan ook aangepas word om voorsiening te maak vir gevalle waar vleiland en 'n waterloop in tandem is, soos skematies in Figuur 3 aangedui.

Waar ekologiese buffers nog nie voorheen vir 'n bepaalde waterloop of vleiland vasgestel is nie, kan òf die Stad 'n bufferbreedte deur middel van ekstrapolering bepaal as berekende bufferbreedtes vir soortgelyke situasies elders beskikbaar is, òf daar sal van die ontwikkelaar verwag word om op eie koste die dienste van 'n toepaslik gekwalifiseerde varswater-ekoloog te verkry om bufferbreedtes ingevolge raadsriglyne of goedgekeurde beste praktyk aan te beveel, en om 'n verslag daaroor in te dien tesame met sodanige aansoeke om goedkeuring van beplanning of bouplanne wat hy/sy by die Stad kan indien. Dít moet geskied voordat enige uitvoerige beplanning 'n aanvang neem.

Terrein-/gevalspesifieke aanpassing van die aanbevole minimum bufferbreedte kan nodig wees om vir uitsonderlike omstandighede voorsiening te maak, soos die teenwoordigheid van sensitiewe habitat; diere- of plantelewe wat breër buffers vir voldoende beskerming vereis; die intensiteit van aanliggende grondgebruik, en die aard van die verwagte impak daarvan; en die fisiko-chemiese en/of botaniese kenmerke van die buffergebied wat die doeltreffendheid van die buffer teen 'n bepaalde impak kan beïnvloed.

Toelaatbare grondgebruike/ontwikkeling/aktiwiteite en toepaslike voorwaardes in die ekologiese buffer word in Tabel 1, "Raamwerk vir die beoordeling van voorstelle" (afdeling 10) aangedui.



Figuur 3: Skematiese voorstelling van ekologiese buffers

9.4 Geomorfologiese prosesse

Dit is ook belangrik om daarop te let dat die beddings van baie waterlope, veral op die Kaapse Vlakte, dinamies is en geneig is tot erosie, afsetting en kronkeling. Waar die vereiste ekologiese-bufferbreedte en/of vloedvlakte-inspringing as ontoereikend vir hierdie natuurlike prosesse beskou word, kan bykomende terreinspesifieke studies en inspringingsbreedte dalk na goeddunke van die Stad vereis word voordat beplanning en bouplanne goedgekeur word. In so 'n geval sal daar van die ontwikkelaar vereis word om op eie koste die dienste van 'n toepaslik gekwalifiseerde geomorfoloog te verkry om inspringingsbreedtes te bepaal en op versoek 'n verslag daaroor voor te lê.

9.5 Sosio-ekonomiese oorwegings

Waterlope en vleilande is openbare hulpbronne met die merkwaardige potensiaal om plaaslike ekonomieë te stimuleer en om politieke, maatskaplike en ekonomiese versperrings uit die weg te ruim indien dit met dié doel voor oë bestuur en gebruik word. Die beoordeling van ontwikkelings langs waterlope en vleilande moet dus hierdie potensiaal in ag neem en ontwikkelings ondersteun wat hierdie sisteme daadwerklik by die stedelike weefsel van die gebied insluit.

Sonder om afbreuk te doen aan die algemene aard van dit wat in dié klousule gemeld word, moet die volgende spesifieke kwessies oorweeg word:

- Watersensitiewe-stedelikeontwerpbeginsels
- Uitleg/struktuur en aard van aanliggende ontwikkeling en/of verwante aktiwiteite
- Uitsig oor waterloop/vleiland vanaf aanliggende ontwikkeling
- Areas met passiewe en aktiewe oop ruimte
- Areas met wandelpaaie, fietspaaie, piekniekfasiliteite
- Estetiese verbetering van verswakte sisteme met toepaslike inheemse terreinverfraaiing
- Openbare toegang
- Veiligheid en sekuriteit
- Ekonomiese opheffing
- Omgewingsopvoeding en –bewusmaking
- Omgewingstandaarde en beste praktyk

Sosio-ekonomiese oorwegings soos dié wat gelys is, kan deur die Stad na eie goeddunke in aanmerking geneem word wanneer aansoeke om goedkeuring van beplanning en bouplanne geëvalueer word.

9.6 Rivierkorridor

Die rivierkorridor bestaan uit die waterloop en/of verwante vleiland (waar van toepassing), die vloedvlakte, die ekologiese buffer en die gebied wat vir bepaalde estetiese, ontspannings- en/of sosio-ekonomiese behoeftes benodig word. Hierdie gebied moet in sy geheel geïntegreerd bestuur word ten einde vloed-, omgewings-, maatskaplike en ekonomiese kwessies te balanseer (soos in die voorafgaande afdelings 9.2 tot 9.5 uiteengesit is). Die Stad streef daarna om rivierkorridorplanne vir alle rivierkorridorgebiede binne sy regsgebied te ontwikkel ten einde uiteindelik aan hierdie holistiese visie uitvoering te gee.

Afhangende van die huidige of toekomstige instandhoudingstrategie vir die waterloop/vleiland, moet tot en met 10 m (gemeet van bo-op die oewer of die buitenste rand van die vleigebied), waar vereis, vir instandhoudingstoegang toegelaat word.

10 Beoordeling van voorstelle en aansoeke

Hierdie beleid beveel 'n merietegegronde benadering tot die beoordeling van voorstelle en aansoeke met betrekking tot eiendomme naby waterlope en vleilande aan. Enige nuwe grondgebruik, ontwikkeling of aktiwiteit moet egter met die verwagte vloedgevaar- en geomorfologiese-prosesvereistes strook en aan die ekologiese-buffer- en sosio-ekonomiese vereistes voldoen, terwyl voldoende toegang vir instandhouding ook, waar vereis, toegelaat moet word. Tabel 1 sit aanvaarbare grondgebruike vir die verskillende vloedvlaktesones en -buffers uiteen, sowel as bepaalde vereistes in gevalle waar voorwaardelike goedkeuring oorweeg word.

Voorgestelde grondgebruike/ontwikkeling/aktiwiteite/geboue moet verder inspring as die *grootste* van hetsy die toepaslike vloedvlakte-, geomorfologiese of ekologiese-buffervereiste.

Tipiese voorstelle wat kommentaar en goedkeuring verg, kan in drie breë kategorieë, soos in onderstaande afdelings beskryf, verdeel word.

10.1 Soneringskemas, struktuurpanne en verwante beleid

Slegs grondgebruike wat as geskik vir die toepaslike vloedvlakte en ekologiese buffer beskou word (sien Tabel 1) kan oorweeg word. Voorts moet geomorfologiese, instandhoudings- sowel as maatskaplike en ekonomiese aspekte in ag geneem word.

10.2 Grondgebruikbeplanningsaansoeke

10.2.1 Nuwe ontwikkelingsregte

Ontwikkeling of aktiwiteite in hierdie kategorie vereis tipies bykomende en/of gewysigde grondgebruikregte om voort te gaan, byvoorbeeld

- hersonering;
- onderverdeling;
- grondgebruikafwykings;
- toestemmingsgebruik; en
- wysiging van planne of goedkeuringsvoorwaardes.

Slegs grondgebruike wat as geskik vir die toepaslike vloedvlakte en ekologiese buffer beskou word (sien Tabel 1) kan oorweeg word. Voorts moet geomorfologiese, instandhoudings- sowel as maatskaplike en ekonomiese aspekte in ag geneem word.

10.2.2 Nuwe ontwikkelingsregte op bestaande gebouvoetspoor

Waar geen toename in die bestaande gebouvoetspoor of -gebruik voorgestel word nie, soos in die geval van die herontwikkeling van 'n bestaande gebou, kan afwyking oorweeg word waar die ontwikkeling of aktiwiteit buite die hoëgevaarsone geleë is, onderworpe aan voldoening aan die volgende:

- Voldoening aan vereistes R1 en R2 in Tabel 1.
- Inwerkingstelling van toepaslike vloedbeskermings- en -temperingswerk, wat insluit, maar nie beperk is nie tot die waterdigting van geboue, kompenserende grondwerk, en vloedontruimingsplanne, na gelang van omstandighede. Die ontwikkelaar moet voldoende voorsiening vir toekomstige instandhoudings- of bedryfswerk maak.
- Die registrasie van 'n notariële beperkingsakte teen vervreemding, wat bepaal dat die geregistreerde eienaar nie daarop geregtig sal wees om sy/haar eiendom sonder die Stad se toestemming te verkoop nie. Sodanige toestemming sal weerhou word tot tyd en wyl die nuwe eienaar/koper 'n vrywaring onderteken volgens bepalings en voorwaardes wat vir die Stad aanvaarbaar is. Die uitreiking van 'n klaringsertifikaat ingevolge artikel 118(1) van die Wet op Munisipale Stelsels, Wet 32 van 2000, geld nie as toestemming vir bogenoemde doel nie.
- Endossering van alle bouplanne ten effekte dat die eienaar bewus is van die gevolge van ontwikkeling in 'n vloedvlakte, en vloedlyne moet op alle toepaslike bouplanne aangedui word.

10.3 Bouplanaansoeke (uitoefening van bestaande ontwikkelingsregte)

Oorweging van struktuurbouplanne wat ingevolge bestaande ontwikkelingsregte ingedien word, geskied voorwaardelik op grond van die volgende:

- Ligging van geboue op die hoërliggende gedeeltes van die eiendom, met vloere bo die 100 jaar-vloedvlak, waar prakties moontlik, die vloedwaterdigting van geboue en vloedontruimingsplanne waar nodig.
- Geen geboue word binne die hoëgevaarsone toegelaat nie.
- Beperking van alle bou-/ontwikkelingsaktiwiteit binne die ekologiese buffer.
- Oorweging van maatreëls om, waar toepaslik, potensiële instandhoudingsimpak te temper.
- Die registrasie van 'n notariële beperkingsakte teen vervreemding, wat bepaal dat die geregistreerde eienaar nie daarop geregtig sal wees om sy/haar eiendom sonder die Stad se toestemming te verkoop nie. Sodanige toestemming sal weerhou word tot tyd en wyl die nuwe eienaar/koper 'n vrywaring onderteken volgens bepalings en voorwaardes wat vir die Stad aanvaarbaar is. Die uitreiking van 'n klaringsertifikaat ingevolge artikel 118(1) van die Wet op Munisipale Stelsels, Wet 32 van 2000, geld nie as toestemming vir bogenoemde doel nie.
- Endossering van alle bouplanne ten effekte dat die eienaar bewus is van die gevolge van ontwikkeling in 'n vloedvlakte, en vloedlyne moet op alle toepaslike bouplanne aangedui word.

10.4 Ontwikkelingsuitlegte

In die voorbereiding van ontwikkelingsuitlegte, behoort die verskillende kwessies in die vorige afdelings (10.2 en 10.3), sowel as die raad se beplannings- en ontwerpriglyne vir stormwaterbestuur by nuwe ontwikkelings in ag geneem te word. Waar toepaslik, moet die ontwikkelaar op eie koste 'n serwituut, wat die vloedvlakte en/of ekologiese buffer teen wysiging of versperring by voltooiing van die ontwikkeling beskerm, ten gunste van die raad registreer. Waar instandhoudingstoegang vereis word, behoort dit by die voorwaardes van die serwituut ingesluit te word.

Geboue moet bo die toepaslike vloedvlak of buffersone of op die hoogste gedeeltes van die eiendom geleë wees, as die perseel in sy geheel binne die toepaslike vloedlyn geleë is, en moet uitkyk of 'n uitsig bied oor die waterloop of vleiland om voldoende visuele waarneming en integrasie van die sisteem by die weefsel van die ontwikkeling en die Stad in sy geheel te verseker. Grensomheining onder die 50 jaar-vloedlyn moet visueel deurdringbaar wees van grondvlak, en mag nie die vrye vloei van water en beweging van waterfauna negatief beïnvloed nie (byvoorbeeld 'n spitspaalheining).

10.5 Tabel 1: Raamwerk vir die beoordeling van voorstelle

Arseringsleutel	
Kleurkode	**Beskrywing**
Ongearseer	Toegelaat
	Voorwaardelik toegelaat
	Nie toegelaat nie

Bykomende-vereistesleutel	
Kode	**Vereiste**
R1	Die ontwikkelaar moet die dienste van 'n geregistreerde ingenieur verkry om tot almal se bevrediging te toon en te sertifiseer dat ▪ die aktiwiteit/ontwikkeling nie die vloedgevaar vir ander eiendomseienaars beduidend verhoog of vloedgedrag of die stabiliteit van rivierkanale negatief raak nie; en ▪ enige struktuur die kragte en uitwerking van 'n stroom vloedwater kan weerstaan, wat wrywing teen fondasies, puinkragte en hefvermoë insluit.
R2	Vloere bo 1:100 jaar-vloedvlak. Kelders (vir nie-bewoonbare doeleindes) moet tot by die 1:50 jaar-vloedvlak waterdig gemaak word.
R3	Vloere bo 1:50 jaar-vloedvlak.
R4	Die ontwikkelaar moet die dienste van 'n geregistreerde omgewingskundige (waterekoloog) verkry om die ekologiese buffer te bepaal (as dit nie beskikbaar is nie) en om tot almal se bevrediging te toon en te sertifiseer dat: • die aktiwiteit/ontwikkeling nie 'n negatiewe impak op die huidige toestand van die waterloop of vleiland sal hê nie; OF • die aktiwiteit/ontwikkeling die huidige toestand van die waterloop of vleiland sal verbeter.

Die grondgebruik/ontwikkeling/aktiwiteit moet verder inspring as die *grootste* van hetsy die toepaslike vloedvlaktesone-, geomorfologiese of ekologiese-buffervereistes

Grondgebruik/ontwikkeling/aktiwiteit		Vereistes en voorwaardes							
		Vloedvlaktesone (vloedherhalingsinterval in jaar)						Ekologiese buffer (breedte in meter)	
Kategorie	**Tipiese voorbeelde**	**<2**	**2–20**	**20–50**	**50-100**	**>100 (Nota 1)**	***Verduidelikende notas***	**Tot 75 m (Nota 2, 3)**	***Verduidelikende notas***
Nywerheids-ontwikkeling	Lig, algemeen, hoë risiko								
	Ekstraktief (mynwese)		R1	R1	R1				
Sake-ontwikkeling	Algemeen				R2				
	Kommersieel (sentrale sakekern)								
	Diensstasies								
Residensiële ontwikkeling	Formeel				R2				
	Informeel								
Gemeenskaps- en openbare fasiliteite	Hospitale, klinieke, verpleeginrigtings, ouetehuise								

Grondgebruik/ontwikkeling/aktiwiteit		Vereistes en voorwaardes							
		Vloedvlaktesone (vloedherhalingsinterval in jaar)						Ekologiese buffer (breedte in meter)	
Kategorie	**Tipiese voorbeelde**	**<2**	**2–20**	**20–50**	**50-100**	**>100 (Nota 1)**	***Verduidelikende notas***	**Tot 75 m (Nota 2, 3)**	***Verduidelikende notas***
	Tronke, militêre basisse, polisiestasies, brandweerstasies								
	Begraafplase								
	Opvoedkundige fasiliteite								
	Openbare sale, plekke van aanbidding								
Nuts-/infrastruktuur-dienste (wat privaat insluit)	Stormwaterbestuurs-fasiliteite	R1	R1					R4	
	Ondergrondse rioolpype, dienste						Mangatdekselvlakke bo 1:50 jaar-vloedvlak. Struktuur moet toepaslik beskerm en by omgewing geïntegreer word.		
	Rioolwatersuiwering op die terrein (byvoorbeeld 'n verteerput)								
	Water- en afvalwateraanlegte, pompstasies								
	Wegdoeningsterreine vir vaste afval								
	Kragopwekking, elektrisiteitsubstasies								
	Telekommunikasie-sentrales & -senders								
Omgewing, oop ruimte en ontspanning	Natuurreservate & -bewaringsgebiede						Alle strukture/grondwerk onderworpe aan voorwaardelike goedkeuring.		Alle strukture/grondwerk onderworpe aan voorwaardelike goedkeuring.
	Sportvelde, gholfbane, piekniekplekke		R1	R3			Alle lubgeboue en soortgelyke strukture moet bo die 50 jaar-vloedlyn wees	R4	
	Openbare en privaat oop ruimte						Alle strukture/grondwerk onderworpe aan voorwaardelike goedkeuring.		Alle strukture/grondwerk onderworpe aan voorwaardelike goedkeuring.

Grondgebruik/ontwikkeling/aktiwiteit		Vereistes en voorwaardes							
		Vloedvlaktesone (vloedherhalingsinterval in jaar)						Ekologiese buffer (breedte in meter)	
Kategorie	**Tipiese voorbeelde**	**<2**	**2–20**	**20–50**	**50-100**	**>100 (Nota 1)**	***Verduidelikende notas***	**Tot 75 m (Nota 2, 3)**	***Verduidelikende notas***
Landbou	Grondbewerking, vrywei-veeteelt		R1	R1			Onderworpe aan regulasies van Wet op Bewaring van Landbouhulpbronne ("CARA")		
	Landbouverwerking/-nywerheid				R1, R2				
	Voerkampe, varkboerdery en batteryboerery			R1	R1		Onderworpe aan regulasies van Wet op Bewaring van Landbouhulpbronne ("CARA")		
Oorde	Hotelle, vakansie-oorde en strandhuise				R2				
	Karavaan- en kampeerterreine		R1	R3			Alle ablusiefasiliteite moet bo die 20 jaar-vloedlyn geleë wees	R4	
Vervoerstelsels	Paaie en spoorweë bo natuurlike grondvlak		R1	R1	R1				
	Modale wisselaars, busdepots, spoorwegstasies								
	Parkeerterreine			R1					
Walbe-skermingswerk, stroomomlei-dingstrukture en grondwerk	Keermure, rigmure, oewerwalle	R1	R1	R1					
	Damme, keerwalle, brûe	R1	R1	R1	R1	R1	Dambreekontleding waar vereis ingevolge Nasionale Waterwet	R4	
	Opvulling				R1	R1	In uitsonderlike omstandighede kan geringe 'afvlakking' van die 50 jaar/100 jaar-vloedlyn oorweeg word, mits gelykstaande kompensasiestadium-bergingsvolume binne die ontwikkelingsgebied voorsien word.		

Nota 1: Die uitwerking van die 100 jaar-stormvoorval op alle ontwikkelings en infrastruktuur, wat aanliggende kenmerke én kenmerke laer af insluit, moet beoordeel word om aan bostaande vereistes te voldoen.
Nota 2: Waterlope: 10 tot 40 m; vleiland: tot en met 75 m.
Nota 3: Voorwaardelike goedkeuring kan vir sekere lae-impak maatskaplike behoeftes/aktiwiteite, toepaslike terreinverfraaiingg, inheemse aanplanting, voetpaaie, ensovoorts toegestaan word.

11 Inwerkingtreding en -stelling

11.1 Datum van inwerkingtreding

Tensy anders aangedui, sal die datum van inwerkingtreding vir hierdie beleid die datum wees waarop die raad die beleid aanvaar.

11.2 Bestaande beleid/riglyne herroep

Onderstaande bestaande beleid/riglyne word hiermee herroep:

Titel	Datum van inwerkingtreding	Resolusie
Riglyne vir vloedvlaktebestuur, weergawe 1.0	September 2003	MC37/11/03

12 Algemeen

12.1 Statutêre permitte en goedkeurings

Sekere ontwikkelings of aktiwiteite kan onderworpe wees aan goedkeuring deur provinsiale en nasionale staatsdepartemente ingevolge nasionale wetgewing.

Voorbeelde sluit in, maar is nie beperk daartoe beperk nie

- Die berging van water
- Die belemmering of omleiding van watervloei in 'n waterloop
- Wysiging van die bedding, walle, loop of kenmerke van 'n waterloop
- Watergebruik vir ontspanningsdoeleindes
- Onttrekking
- Grondherwinning
- Landboubewerking naby waterlope

12.2 Vrywaring

Die graad van vloed- en/of omgewingsbeskerming wat deur hierdie beleid aanbeveel word, word as redelik vir reguleringsdoeleindes beskou en is op ingenieurs- en wetenskaplike studiemetodes gegrond. Blote nakoming van die bepalings van die beleid kan egter nie volkome beskerming teen oorstroming verseker nie, veral nie teen hoë-ordevoorvalle of 'n verminderde omgewingsimpak nie, en die beleid behoort daarom op geen manier as 'n waarborg beskou te word nie.

Nóg die Stad Kaapstad nóg enige Stad-amptenaar sal vir enige skade wat uit die toepassing of navolging van hierdie beleid kan spruit, aanspreeklik wees.

12.3 Kopiereg

Die Stad Kaapstad, Suid-Afrika, behou alle regte voor. Geen deel van hierdie dokument mag in enige formaat sonder die skriftelike toestemming van die Stad Kaapstad gereproduseer word nie, met die uitsondering van afskrifte vir opvoedkundige doeleindes.

12.4 Verwysings

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