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DRAINAGE STRATEGY PEER REVIEW

Lincoln Heath South PSP1207.1

June 2015

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Abbreviations

Alluvium	Alluvium Consulting Australia Pty Ltd
ARI	Average recurrence interval
BPEM	Best practice environmental management
EVC	Ecological vegetation class
Ha	Hectare
kL	kilolitre
MPA	Metropolitan Planning Authority
PSP	Precinct Structure Plan
WOWC	Whole of water cycle management

1 Introduction

The Metropolitan Planning Authority (MPA) requires a peer review of the drainage strategy for the Lincoln Heath South precinct structure plan (PSP) 1207.1. The original strategy was prepared by N. Craigie on behalf of the site's developer Australand. The aim of the review is to confirm a drainage strategy that allows all parties to proceed with a shared understanding and agreed approach to surface water management and stormwater quality requirements within the PSP. The scope of the peer review also considers whole of water cycle (WOWC) management opportunities including the provision of recycled water to the PSP's open space.

1.1 Location and context

PSP 1207.1 covers an area of 45ha and is ultimately expected to house approximately 600 dwellings. The PSP is to the east of the existing Alamanda Estate and north of the proposed future Point Cook South PSP. The Point Cook South PSP is not expected to be developed for some time, and therefore considerations as to how surface water from PSP1207.1 may interact with that PSP are longer term in nature.

Conversely, the Alamanda Estate and its associated wetlands (seen along the western border of PSP 1207.1) are existing. Ensuring that the surface water elements within PSP 1207.1 interact successfully with the Alamanda estate's wetlands is a critical project objective. A development services scheme has not yet been prepared for this PSP.

Figure 1. *PSP1207.1 location map*

1.2 Sub-catchments

Figure 2 illustrates the sub-catchments within the Lincoln Heath South PSP. Of note is the ecological vegetation class (EVC) wetland area that is intended to be preserved as part of the PSP in the south west corner. Proposed locations for sediment basins and wetlands are along the PSPs southern boundary. Figure 2 also highlights the location of Alamanda wetlands to the west of PSP1207.1.

Figure 2. *PSP1207.1 sub-catchment plan*

2 Objectives and issues

The overarching objective of the review is to confirm or amend the existing strategy to ensure that there is an agreed way forward regarding surface water and flood management and stormwater quality requirements. The peer review will consider how the drainage strategy integrates with the existing Alamanda Estate wetlands and the future Point Cook South PSP.

The peer review extends to consider opportunities for whole of water cycle (WOWC) management within the PSP. Given the relatively small area covered by the PSP, WOWC considerations will focus on the capacity of the nearby recycled water network to irrigate the proposed open space within the PSP rather than consider a stormwater harvesting .

As well as addressing these broader objectives, issues addressed within the Craigie strategy and raised during consultation with project stakeholders (including Melbourne Water, City West Water and Wyndham City Council) include:

- *Flood management*: required flood storage and transfer of flows during a 1 in 100 year rainfall event.
- *The drainage layout*: function of the proposed linked pipe system connecting the PSP's wetlands and the existing Alamanda Wetlands.
- *EVC area*: the management and preservation of the EVC wetland area that occupies the south western corner of the PSP.
- *Stormwater quality requirements*: confirming the proposed wetland and sediment basin areas required to achieve best practice environmental management (BPEM) requirements.
- *Integration with surrounding PSPs*: including consideration of the long term strategy for integration with the Point Cook South PSP to the south and the Alamanda Wetlands.
- *Whole of water cycle management*: identifying opportunities to identify an alternative water supply to improve the liveability values within the PSP.

3 Modelling method

While this investigation was primarily a review of existing work and models, including MUSIC and RORB, some alternative modelling tools were used to add to the analysis within the Craigie strategy. In summary the following modelling platforms and tasks were undertaken:

- Development of a digital terrain model with levels updated based upon 'Design' and 'As Constructed' drawing, plans of the Alamanda Estate and associated wetlands (provided by Melbourne Water) and the Craigie strategy (updated September 2014)
- Hydrologic and hydraulic modelling including:
  - A review of the existing RORB models that produce hydrographs and runoff volumes for average recurrence interval (ARI) rainfall events and durations
  - TUFLOW modelling: TUFLOW is a two dimensional hydraulic modelling package that can dynamically illustrate the varying tailwater levels within and between PSP 1207.1 and the Alamanda Estate's linked wetlands and retarding basins.
- MUSIC models prepared as part of the Craigie strategy were reviewed to confirm the sediment basin and wetland areas required to meet best practice environmental management requirements for total suspended solids (80% load reduction), total nitrogen (45% reduction) and total phosphorus (45% reduction)

4 Hydrology

The RORB model prepared as part of the Craigie strategy contained only two sub catchments covering the whole of the Lincoln Heath South PSP and Alamanda Estates respectively. The focus of the Craigie modelling was to use RORB to generate volumetric runoff for a variety of storm events rather than to estimate peak flow. This explains why the Craigie model only contained two sub catchments upstream of the point of interest rather than the traditional four sub catchments to define the hydrograph shape for peak flows.

One of the objectives of the Alluvium review was to check the hydraulic capacity of the linking pipes and to consider the dynamic variation in water levels within the basins. In order to do this the two dimensional hydraulic model TUFLOW was used and multiple hydrograph inputs were required to represent the spatial variation in flow across the basin system.

Alluvium therefore prepared a revised RORB hydrological model for the Lincoln Heath and Alamanda Estate catchments. The model was updated to reflect a greater number of sub catchments and the following scenarios were modelled:

1. A pre-development scenario: A RORB model was developed and calibrated to the 100 year ARI flow estimated via the rational method.
2. Developed catchment scenario: the pre-developed scenario was modified to reflect post development conditions.

4.1 Catchment plan

Using contour data and plans of the surrounding drainage network, sub catchments were delineated as per Figure 3. This shows the PSPs eastern sub catchments draining to the two main sediment basin and wetland cells along the PSPs southern boundary. The north western sub catchment is modelled to drain to the sediment basin and wetland cell running north-south along the eastern boundary of the Alamanda Estate. As a result wetlands within PSP1207.1 were increased in size to compensate for the stormwater flows that are diverted to and treated within the Alamanda Estate.

The key elements of the RORB model include:

- 12 sub catchments ranging from 1.8 to 9.4 ha that were defined for PSP1207.1 and for the east of the Alamanda Estate; and
- Six sub catchments ranging from 1.6 to 9.8 ha defined for the west of the Alamanda Estate.

Figure 3. *PSP1207.1 RORB modelling sub-catchment plan*

4.2 Modelling Parameters

Since the structure of this RORB model differs considerably from that completed as part of the original Craigie strategy, the RORB modelling parameters (i.e. "kc") required re-derivation. "Calibration" of the models was based on matching the peak flows estimated from the rational method and using the Intensity Frequency Duration (IFD) curves sourced from Bureau of Meteorology (BOM). The RORB parameters that provide the best fit were:

- m = 0.8
- kc = 3.0

The outcomes of this "calibration" are summarised within Table 1 showing the estimated 1 in 100 year ARI peak flows for both a) Lincoln Heath South and the Alamanda Estate's eastern catchments and b) the Alamanda Estate's western catchments.

Table 1 Calculated peak 100 year ARI flows for Pre-Development Conditions

Catchment name	Catchment area (ha)	Rational Method 100 year peak flow (m3/s)	RORB Model 100 year peak flow (m3/s)
Lincoln Heath and east Alamanda	35.7	1.4	1.27
West Alamanda	75.4	2.7	2.76

4.3 Developed Conditions Modelling

The calibrated model (pre-developed conditions) was then modified to reflect future developed conditions. The model structure remained the same however the reach types and fraction impervious values were altered to represent an urbanised catchment. The volumetric runoff coefficients adopted for the modelling was consistent with the values adopted in the Craigie strategy. These values are summarised in Table 2.

Table 2 Runoff coefficients calculated in previous study

Return period	2 year ARI	5 year ARI	10 year ARI	20 year ARI	50 year ARI	100 year ARI
Runoff coefficient	0.25	0.3	0.4	0.5	0.55	0.6

Based upon the proposed drainage system for Lincoln Heath South as described in the Craigie Strategy and the existing drainage network in Alamanda Estate, a hydrograph was calculated for each catchment inflow point to the basin system. The location of these inflows into the 2D hydraulic model is shown in Figure 4.

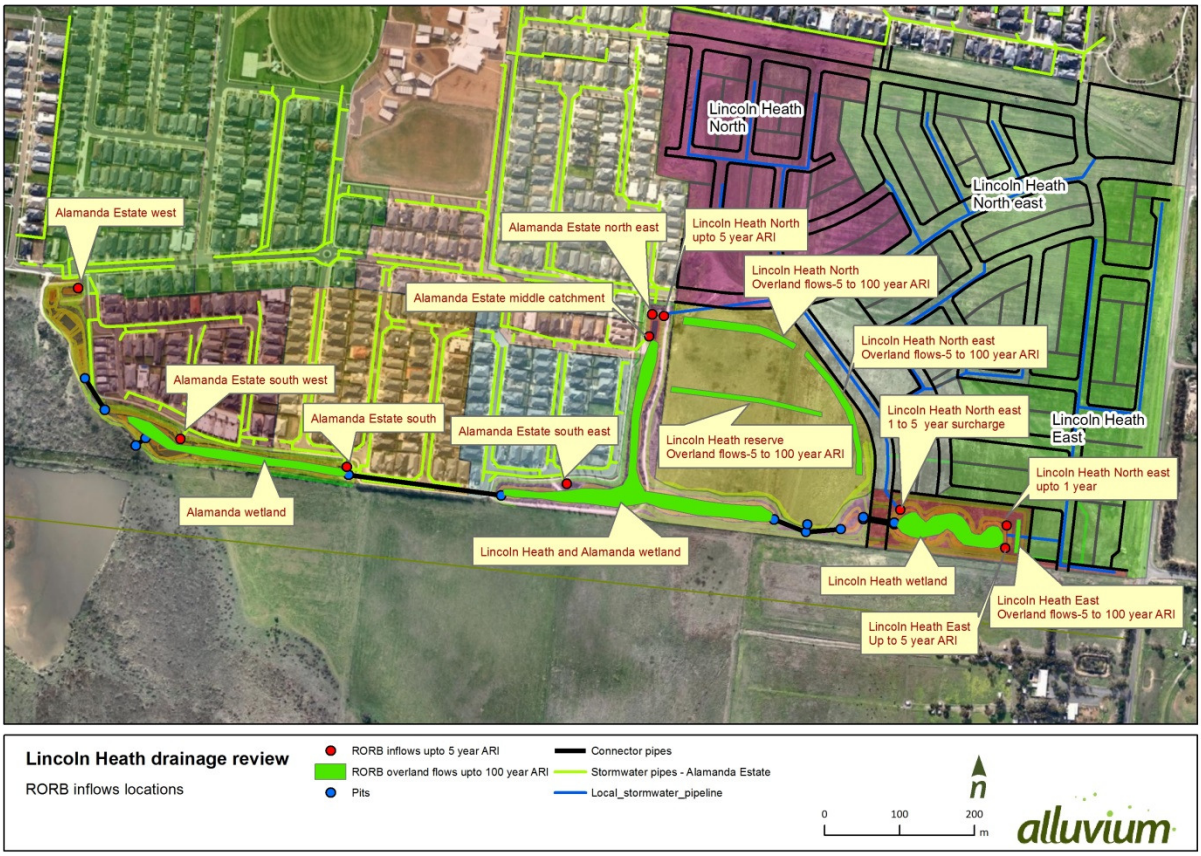

Figure 4. *RORB inflow locations*

5 Hydraulic elements

To evaluate the efficiency of the proposed retarding basin / wetland system, a two-dimensional hydraulic model was developed using the TUFLOW software. TUFLOW is an advanced software package for dynamic modelling of one and two dimensional river systems and can be used to simulate the hydraulic conditions of wetland systems under different flow conditions. TUFLOW was used to get a better understanding of:

- the hydraulic performance of the linked pipe system,
- the likely sequence of spills during a 1 in 100 year flood event based on the crest heights of various bunds across the system, and
- the performance of the EVC wetland area as a storage.

The hydrodynamic model was run for different flows include 1, 2, 5, 20 and 100 year ARI.

5.1 Modelling hydraulic elements

The hydraulic elements that were modelled include bund elevations, existing and designed pits and drainage lines, and the pipelines proposed to connect the systems wetlands. The location of each of these elements is summarised within Figure 5.

Figure 5 *System hydraulic elements*

Land surface

The geometry adopted for the wetland system was created using contour lines received from the MPA, which was based on LIDAR information. This survey information enabled the existing Alamanda Estate wetland system to be represented and was supplemented with the original design plans and "as constructed survey" information. Concept design levels and contours from the Craigie strategy was also used to define the proposed the PSP1207.1 wetlands.

Assumed land uses adopted for TUFLOW modelling are contained in Figure 6.

Figure 6 *Assumed landuses for input into 2D hydraulic modelling*

5.2 Scenarios

The following scenarios were modelled within TUFLOW to evaluate the hydraulic performance of the wetland system. Each scenario is described below and illustrated within Figure 7:

1. "As designed": where bund elevations were set at levels described within the design drawings provided for the proposed PSP1207.1 wetlands and the existing Alamanda Estate wetlands
2. "As constructed": that adopts a bund elevation to the western extent of the existing Alamanda wetland of 7.2 m AHD
3. Lowered EVC bund: that adopts a design level of 7.4m for the bund between the Lincoln Heath South wetland and the EVC wetland area to its north to understand the storage potential of the wetland.

Figure 7 *Modelling elements that differentiate each scenario*

5.3 Hydraulic modelling results

"As designed" scenario

Figure 8 shows the TUFLOW modelling results where bund levels have been set as per the design intent (i.e. as per the updated levels provided within the September 2014 update of the Craigie strategy). What is evident is that the designed retarding basins and wetlands contain the 1 in 100 year flood event, with flows exiting the system via 4 x 300mm discharge pipes at the south western corner of the Alamanda wetlands. This is how the original system was designed to function and the TUFLOW modelling demonstrates that the peak 100 year design flow is less than the design threshold value (i.e. less than 0.4 m^3/s).

Therefore Craigie's proposed strategy for Lincoln Heath South provides sufficient additional flood storage within the extended wetland system to mitigate the additional runoff from urban development. When compared to the peak 100 year ARI flows that were potentially conveyed across the southern boundary under pre-developed conditions (i.e. 1.4 m^3/s for the western catchment and 2.7 m^3/s for the eastern catchment) the proposed strategy is conservative and provides significant flexibility for the future.

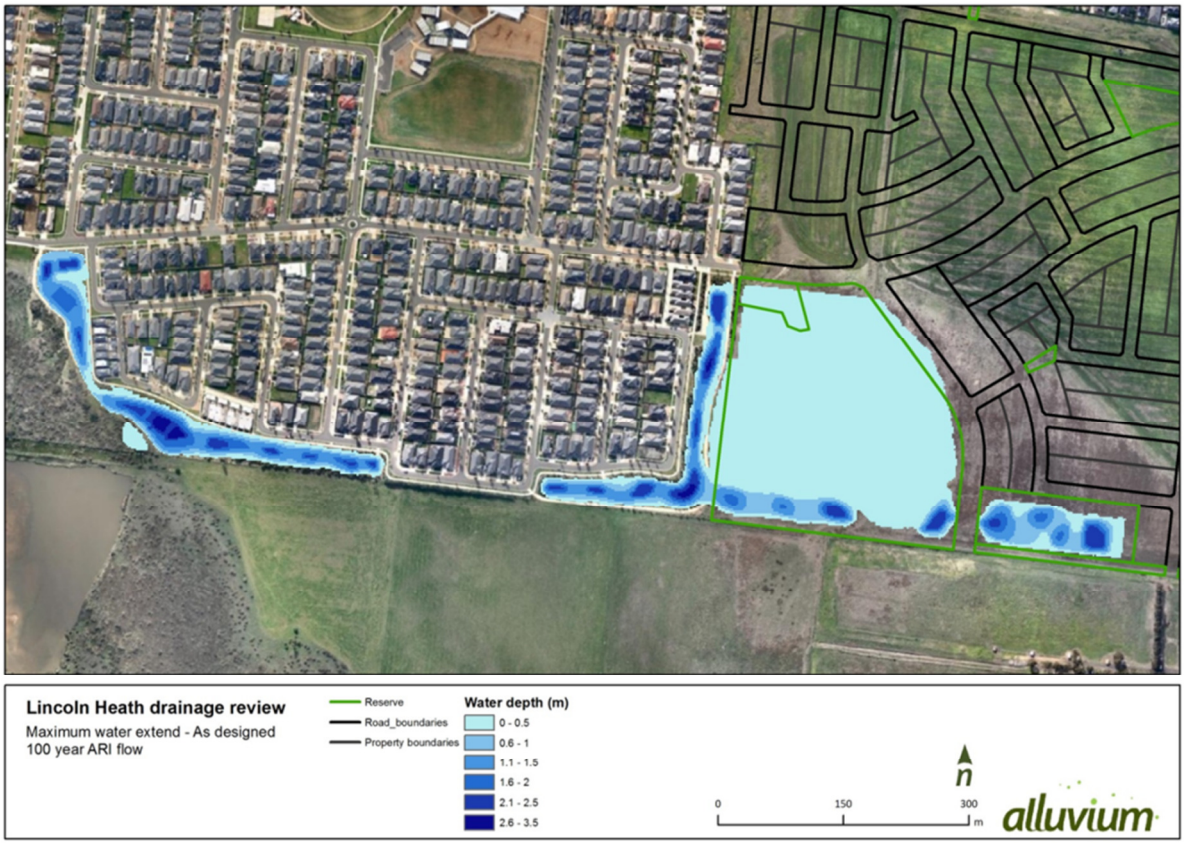

Figure 8. *Tuflow results: Design intent levels*

The updated Craigie strategy (Sept 2014) reduced the number of new linked pipe systems in the Lincoln Heath South system from three to one. The number of "linked pipes" had previously been flagged by Melbourne Water as a potential concern both hydraulically and from a maintenance perspective. However from a hydraulic perspective the TUFLOW modelling demonstrates that the proposed linked pipe system between the wetlands has sufficient capacity and enables the storage basins to essentially operate "as one". From a conservation perspective, the retention of the EVC area limits the options for connecting the wetland/basins together. The available space between the EVC area and the southern boundary appears to rule out a channel or waterway link between the basins and therefore a linking pipe system is the most feasible option from a vegetation disturbance perspective.

The hydraulic modelling also shows the wetlands within PSP1207.1 overtopping and engaging the EVC area and providing approximately 5,000m^3 of 100 year flood storage and a wetland system storage of around 17,000m^3 at a peak flood level of RL 7.62m. The peak 100 year flood level in the EVC area is lower than RL 7.62m; therefore an additional 10,000m^3 of storage is available in the EVC area. This potential storage provides redundancy and flexibility in the flood storage system.

From an ecological perspective a key issue will be ensuring that the inundation frequency of the EVC area and its extent is sustainable for the existing vegetation community. With the proposed bund between the new wetland and the EVC proposed at RL 7.5m, the EVC area engages for storm events with an Average Recurrence Interval (ARI) above 2 years. Once the storm event has passed, the inundated EVC storage area will take time to drain before it becomes dry again. It will therefore be important from a detailed design perspective to review and optimise the outlet arrangement behind the EVC bund following input from an ecologist.

"As constructed" scenario

Melbourne Water provided "as constructed" design plans for the existing Alamanda wetland system. This information was incorporated into the digital terrain model for hydraulic analysis using the TUFLOW model. Figure 9 below represents the TUFLOW results for this scenario which show a significant spill at the north-western extent of the Alamanda wetlands. Based upon these as-constructed levels the model indicates that during a 100 year event flows will spill from the wetland system at the north western extent of Alamanda before the EVC bund within Lincoln Heath South is overtopped (i.e. at RL 7.2m). Therefore flood water's escape the basin system before the EVC flood storage area is utilised.

Obviously this is not the design intent as proposed by Craigie. Alluvium therefore recommends that the following is undertaken:

- A check as to whether the as-constructed information supplied to Alluvium includes all of the available information for the bund asset within Alamanda. If additional information is available, check that the minimum bund height at the north western end is as per the design intent.
- If the bund at the north western end of Alamanda is shown to be at a level that is lower than the design intent, undertake rectification works on site.

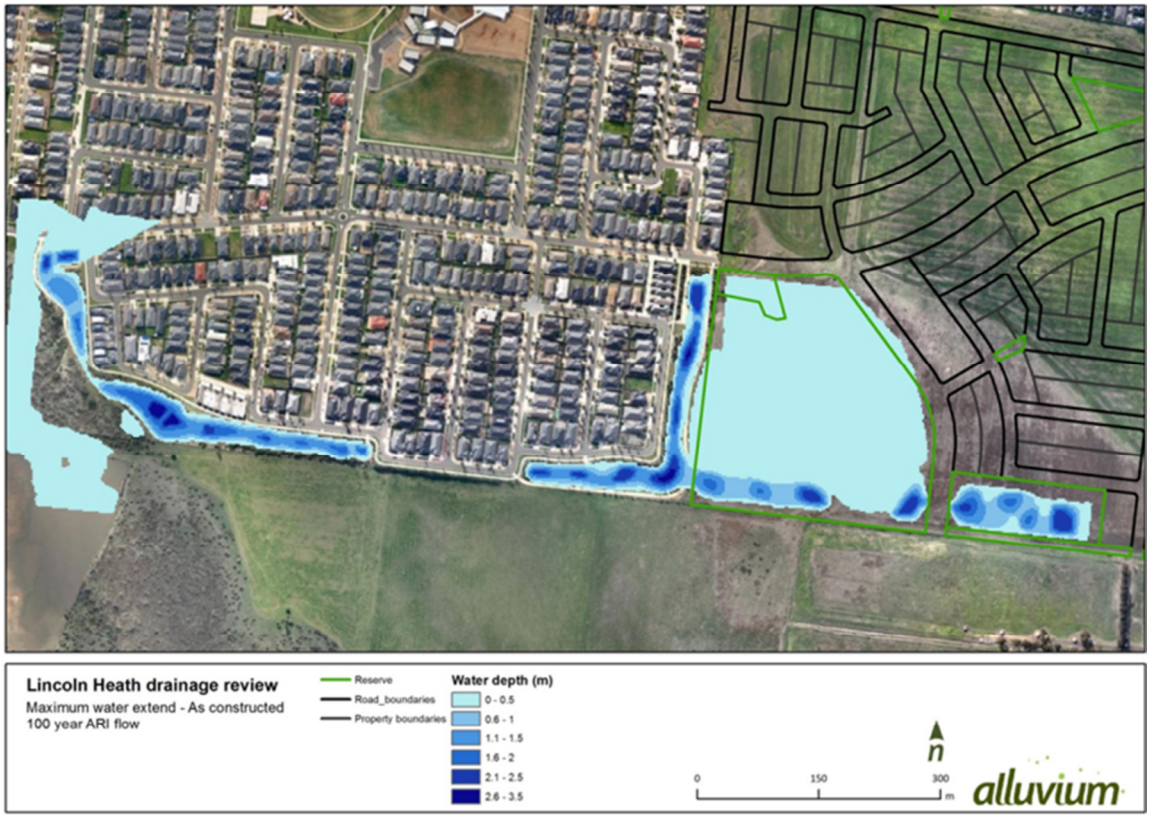

Figure 9. *Tuflow results: 'As constructed' levels*

Potential Modifications

As previously mentioned detail design will need to optimise the bund height between the EVC area and the required pipes to drain the EVC area following flood inundation.

6 Integration with Point Cook South PSP

The larger Point Cook South PSP is located immediately south of the Lincoln Heath South PSP. Following discussions with the MPA, it is likely that the planning for the Point Cook South PSP will not be completed before residential development is fully completed within Lincoln Heath South. The natural drainage path for the Lincoln Heath South site is through the Point Cook South PSP, which ultimately outfalls to Melbourne Water's "D1 drain". The topography, flood characteristics and environmental issues along the D1 drainage system are relatively complex. These issues combined with the PSP planning timelines resulted in the decision to pursue a drainage strategy that connects to the west rather than providing a deeper outfall to the south as part of a possible future development of the Point Cook South area.

While it's practical to pursue a drainage solution for Lincoln Heath South that integrates with the existing Alamanda Estate to the west, an important element for the Alluvium review was to consider the impact and future integration with the Point Cook South PSP.

Following Alluvium's hydrological and hydraulic review of the Craigie strategy we are of the view that the current proposal to drain Lincoln Heath South westwards via the Alamanda Estate via a linked wetland system, does not limit or constrain future options to integrate with Point Cook South. The key reasons for this view are as follows:

- The 100 year peak discharge westwards is less than 0.4 m^3/s compared with 2.7 m^3/s generated from a pre-developed catchment that consists of Lincoln Heath South and Alamanda Estate East. Therefore flexibility exists to convey additional flows through the Point Cook South PSP in the future if required.
- The linear wetland / basin system within Lincoln Heath South provides the opportunity to control overland flows along a future road reserve that runs north – south through the Point Cook South PSP. Ultimately this is likely to transition to a waterway corridor at some point within the Point Cook South PSP.
- The linked wetland system could include a pit and valve system to allow the release of low flows to the downstream system if deemed desirable from an environmental perspective.

The proposed strategy will not increase drainage requirements downstream compared to pre development conditions and therefore doesn't represent an additional drainage burden in terms of infrastructure and land take within Point Cook South PSP area.

One final issue to consider is that the proposed north – south road within Lincoln Heath South is required to be elevated to incorporate the bund and proposed culvert crossing. The height of the road is approximately 1.8 metres above natural surface. This will necessitate some filling at the time of development for the future Point Cook South PSP. However as was the case for Lincoln Heath South and Alamanda Estate, minimum fill levels in Lincoln Heath South will be driven by required cover of pipe drainage systems which have to free drain to the downstream outfall system.

7 Stormwater quality management

As part of the updated Craigie strategy the following stormwater treatment areas were proposed to meet Best Practice Environmental Management (BPEM) targets:

- Sediment basin: 1,700m^2
- Wetland: 8,400m^2 (consisting of two cells of respective areas 3,990m^2 + 4,445m^2)

The MUSIC models were reviewed with Figure 10 illustrating the model layout. The only major change to the original model was that the wetlands within PSP1207.1 were sized to compensate for the fact that the north western sub-catchment (9.4 ha) drains into the north of the Alamanda wetlands. That is, the wetlands within PSP1207.1 are sized to achieve pollution reduction that would be required were that 9.4ha draining into them.

As mentioned above the Craigie strategy proposes to outfall 9.4 ha of the Lincoln Heath South PSP into the existing sediment basin within the Alamanda Estate. Whilst the Alluvium investigation recommends that the proposed wetlands compensate for this diversion, the Alluvium review also checked the size and capacity of the existing sediment basin. From this review it appears that the asset is of sufficient size to accommodate the additional sediment load from Lincoln Heath South. This outcome is consistent with the fact that Craigie usually oversizes his sediment ponds compared to the minimum best practice requirements (note it was Craigie who sized the existing Alamanda sediment pond).

Figure 10. *PSP1207.1 MUSIC modelling layout*

The results indicate that the minimum areas required to meet BPEM is 1,200 m^2 for the sediment basin and 8,400 m^2 for the wetland. The results based on this configuration are provided in Table 3.

Table 3. MUSIC results

Pollutant	Generated load (kg/year)	Target load Reduction (kg/year)	Achieved load Reduction (kg/year)	% reduction
TSS	21,307	17,046	17500	82%
TP	45	20.3	28.2	62.6%
TN	321	144.4	144	45%

This result indicates that the proposed treatment by Craigie (Sept 2014) is conservative. If required the review identified that the sediment basin could be reduced in size while still meeting BPEM requirements.

8 Whole of water cycle management

City West Water (CWW) advise that water and sewerage networks have the capacity to service this development. In considering whole of water cycle or alternative water supply options for the Lincoln Heath South PSP, this is a relatively small PSP area and therefore the scope to propose and implement a stormwater harvesting scheme that would potentially require additional land is not considered reasonable.

Based on initial discussions with CWW a third pipe network supplying residential demand has not been considered due to doubts over the capacity of the local recycled water network to meet those demands. There is however an opportunity to supply recycled water to the PSP's open space.

City West Water have confirmed that a recycled water pipeline (225mm) travels along Sneydes Road before turning into Point Cook Road where the diameter is reduced to 150mm. The pipeline supplies Class A recycled water with a total dissolved solids concentration of approximately 1000mg/L that is suitable primarily for irrigation use (Figure 11).

Figure 11. *Recycled water main alignment (Source: City West Water)*

City West Water suggests that the supply from this main is constrained, so the purpose of this work is to estimate irrigation demand for the estimated open space and consider if there may be sufficient capacity to supply that open space. At the point where the recycled water main turns east they have supplied pressure and flowrate information indicating that in summer, when the recycled water supply is experiencing higher demand, maximum flowrates of 10 l/s (at 40m head or pressure) or 20 l/s (at 30m head) are potentially available.

If recycled water were to be extended to the Point Cook South PSP, the intention would be to irrigate that PSPs open space. Providing third pipe to residences is not being considered. Based on plans provided by MPA it is estimated that the PSPs open space area is approximately 0.4 ha. Irrigation demand analysis was completed, taking into account suitable crop factors for warm season grass, passive use and irrigation efficiency of 75% to determine seasonal irrigation demand. In summary, irrigation demand was estimated at 3.5 ML/ha/year with seasonal average daily demand (in kL/day) summarised in Figure 12.

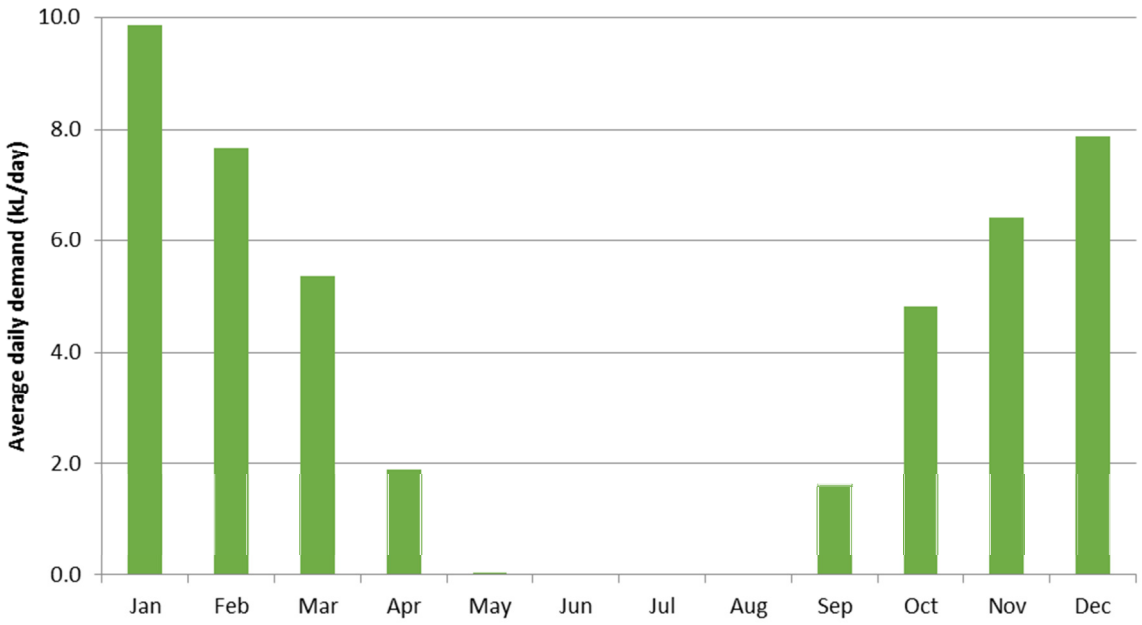

Figure 12. *Seasonal average daily demand*

This result indicates that an average summer demand of approximately 10kL / day. If we assume that an irrigation cycle takes one hour then a demand of approximately 3 l/s is required. Based on the information provided by City West Water this could be theoretically possible if the recycled water main could be extended the approximately 150-200m to the indicative location of the open space in MPA's preliminary plans. Further, based on the relatively flat topography pressure of 30m is considered sufficient to satisfy irrigation requirements.

It is also assumed that Council would assume responsibility for the irrigation network required.

It is proposed that the results of this initial analysis be discussed with City West Water and Council to understand how such a proposal would integrate with broader strategic plans and if further system modelling is required.

9 Summary

There were a number of objectives (Section 2) that this review aimed to address. These objectives are listed below with a brief summary of the key points from this review.

- *Flood management*: the review confirms that there is sufficient flood storage within the system, including that volume provided by the EVC wetland area. The review identified flooding issues associated with the "as constructed" scenario. The review suggests checking if the bund elevation is as per the design intent, and if it is lower undertaking rectification works.
- *The drainage layout*: modelling of the proposed linked pipe system indicates that, from a hydraulic perspective, the system operates as intended
- *EVC area*: the EVC area is engaged during 1 in 100 year event and provides approximately 10ML to the system's storage. Some questions remain as to the adequate management of draining that area following a flood event, and this may require specialist ecological advice
- *Stormwater quality requirements*: the review has identified that the proposed area of sediment basin may be conservative and could be reduced from 1,700 m^2 to 1,200 m^2 while still meeting best practice environmental management (BPEM) requirements.
- *Integration with surrounding PSPs*: the current strategy of draining to the Alamanda Estate doesn't rule out or preclude future connection to the Point Cook South PSP to the south in future, potentially via future road reserves.
- *Whole of water cycle management*: the most practical alternative water supply option to provide greening at the PSP open space area is likely to be recycled water supplied from City West Water's main within Point Cook Road. The estimated irrigation demands appear to be within City West Water's parameters, however the reasonableness of this proposal is yet to be confirmed by City West Water.