Neil M Craigie Pty Ltd
ACN 074 582 282 ABN 29 074 582 282

Waterway Management Consultants

LINCOLN HEATH SOUTH ESTATE
POINT COOK ROAD, POINT COOK

ADDENDUM TO SWMS

MANAGING THE EVC HYDROLOGY ISSUES

For: Australand P/L

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Neil M Craigie

Director ***Neil McKinnon Craigie*** *BE(Civil), MEngSci, MIEAust, CPEng*
Email: nmcraigie@bigpond.com
40 Jamieson Court, Cape Schanck, Vic. 3939, Australia
Mobile: 0427 510 05

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1. INTRODUCTION

The surface water management strategy (SWMS) report dated 24 September 2014 defined the proposed stormwater management system to serve Lincoln Heath South. As part of that SWMS the modelling also broadly assessed the hydrologic impact of development on the EVC reserve areas, highlighted the need for appropriate design responses, and flagged the options available to mitigate these impacts into the future as part of detail design. A key recommendation was to obtain expert ecological advice in final design of hydraulic structures to suitably protect the EVC reserve areas.

The SWMS report was the subject of a peer review by Alluvium dated November 2014. That report concurred with the SWMS report and, using independent 2D hydraulic modelling, virtually reproduced all the key flood levels, discharges and volumes. Alluvium repeated the recommendation of the SWMS to obtain expert ecological advice in final design of hydraulic structures to suitably protect the EVC areas.

Despite these two reports agreeing on what the issues were, and recommending advice to be sought and measures to be taken to address the hydrologic impacts as part of detail design, both Melbourne Water (MW) and Wyndham City Council (WCC) have requested all the design issues be fully resolved before approval is given to the Section 96A application.

This addendum to the SWMS has been prepared to provide the additional design recommendations for hydrologic protection of the EVC areas. The MUSIC model has been used to generate flows and volumes and water levels in the EVC areas for existing conditions (the basis for comparison) and several scenarios for management of development drainage.

2. EXISTING CONDITIONS HYDROLOGY

Figure 1 is a nearmap.com extract showing the current site conditions and abutting development. Figure 2a is directly extracted from Ecology Heritage Partners (EHP) report of October 2014. It shows the Ecological Features and main EVC areas. Figure 2b shows the site survey plan.

The total rural catchment now draining to the EVC areas is basically the whole of Lincoln Heath South (43 hectares). Under existing conditions surface water can only escape southerly from the Lincoln Heath South site by broad shallow overflow from the shallow ephemeral wetland areas when levels exceed 7.0 m AHD. The EVC areas are classified as seasonal freshwater wetlands, which in hydrologic terms are basically characterised as subject to non-continuous wet season inundation in most years and generally dry season dry-out. Permanent inundation is a key threat to the long term sustainability of such wetlands.

A MUSIC model was set up to generate flow and quality data on a daily time-step for the 40 year period of record 1970-2010 at Melbourne Airport. This station is the reference station required to be used for this area by MW. The MUSIC model was setup to export modelled fluxes, storage levels and volumes to an Excel spreadsheet which was then interrogated to produce bar charts and statistics for inflows, outflows, water levels and storage volumes.

Under existing conditions the stage-area-storage relation for the EVC areas is as shown in the table below.

TABLE 1	**Stage-area-storage for existing wetlands area**	
Stage (m)	**Area (m2)**	**Storage (m3)**
6.85	0	0
6.90	15,500	390
7.00	66,000	4,465
7.10	120,000	13,765

The wetlands can be considered to have Normal Top Water Level (NTWL) of 7.0 m. At higher levels the wetlands overflow southerly across a frontage of about 50 m near the southwest corner of the site.

The volume of 4,465 m3 was set as the permanent pool volume for modelling purposes (no gravity outlet at lower levels) and as prismatic conditions are assumed in MUSIC the default base of the wetland is 4,465/66,000= 0.07 m below NTWL or 6.93 m. Initial storage contents were set at zero for the simulation run. Extended detention depth was set at 0.01 m with orifice diameter of 5 mm and overflow weir width of 50 m.

Figures 3(a) and (b) show the charted storage volumes and water levels through the 40 year simulation. Water level of 0.0 m represents the NTWL of 7.0 m, for which storage volume is

4,465 m^3. The wetland area was set at 6.6 ha. Storage volume of zero represents complete dry-out of the wetlands.

Table 2(a) Summary Results for EVC wetlands - Existing Conditions

	Days	% of record	Days/yr
Total days in simulation	14,610	100%	
Total days when wetlands are fully dry	11,304	77%	283
Total days when wetlands have some water in them	3,306	23%	83
Total days when wetlands are overflowing (>=7.0 m)	1,190	8%	30
Longest dryout	840 (2.30 yrs)		
Longest full period (>=7.0 m)	175 (0.48 yrs)		

Table 2(b) Summary Results for EVC wetlands - Existing Conditions

Daily Statistics	Inflows (m3)	Outflows (m3)	Storage (m3)	Water Level (m)
40 yr Total	1,423,830	653,317		
Mean	97	45	704	-0.06
Median	6	0	0	-0.07
Maximum	13,392	13,565	6,120	0.03
Minimum	0	0	0	-0.07
5%ile	0	0	0	-0.07
10%ile	0	0	0	-0.07
20%ile	0.1	0	0	-0.07
50%ile	6	0	0	-0.07
60%ile	12	0	0	-0.07
70%ile	23	0	0	-0.07
80%ile	46	0	483	-0.06
90%ile	131	0	3,880	-0.01
95%ile	278	0.4	5,110	0.01
98%ile	968	202	5,150	0.01
99%ile	2021	933	5,240	0.01

Figure 1 **Nearmap.com extract showing existing site conditions in May 2014.**

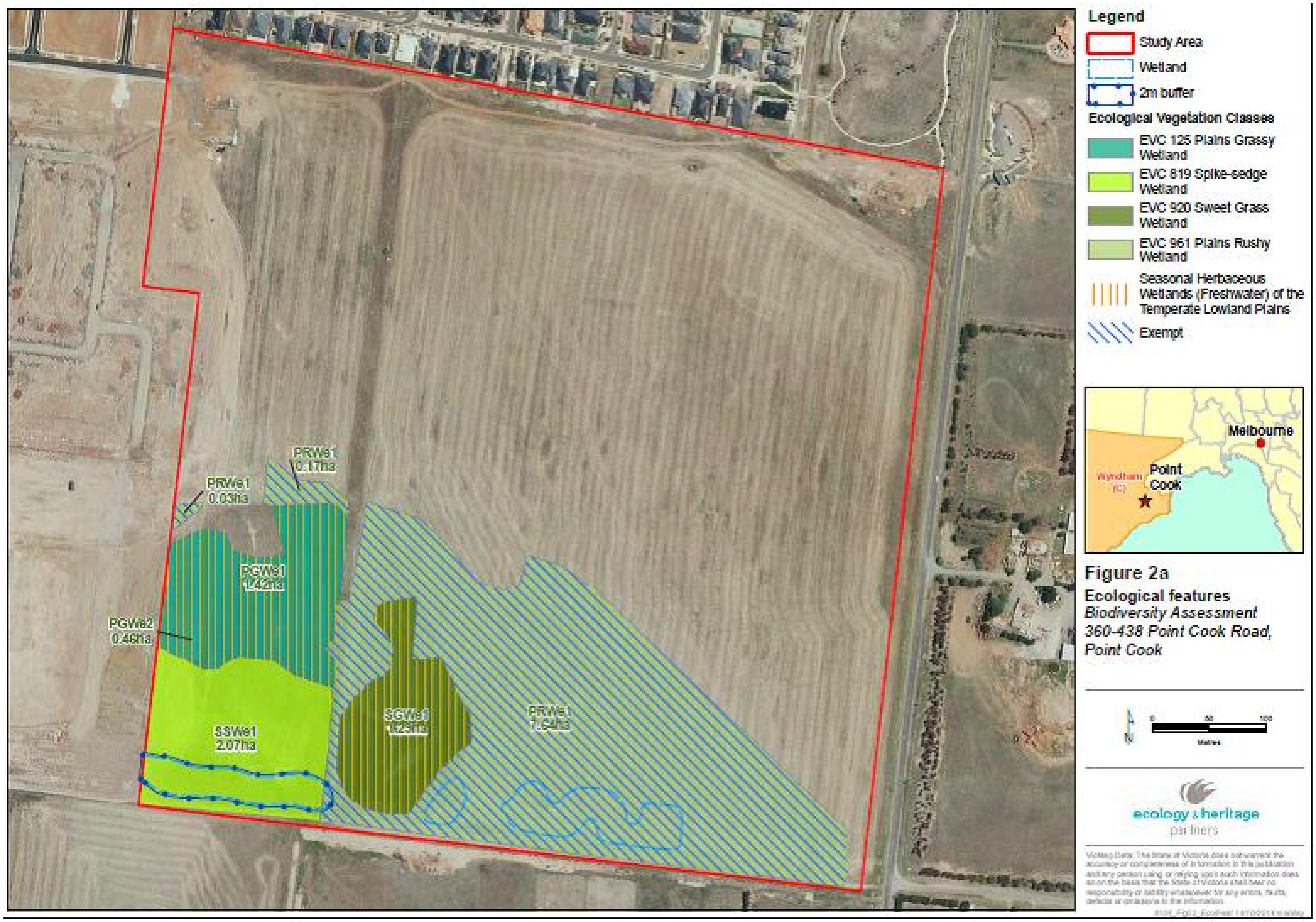

Figure 2(a) **Existing Ecological features Biodiversity Assessment. (with outline of proposed stormwater treatment wetlands)**

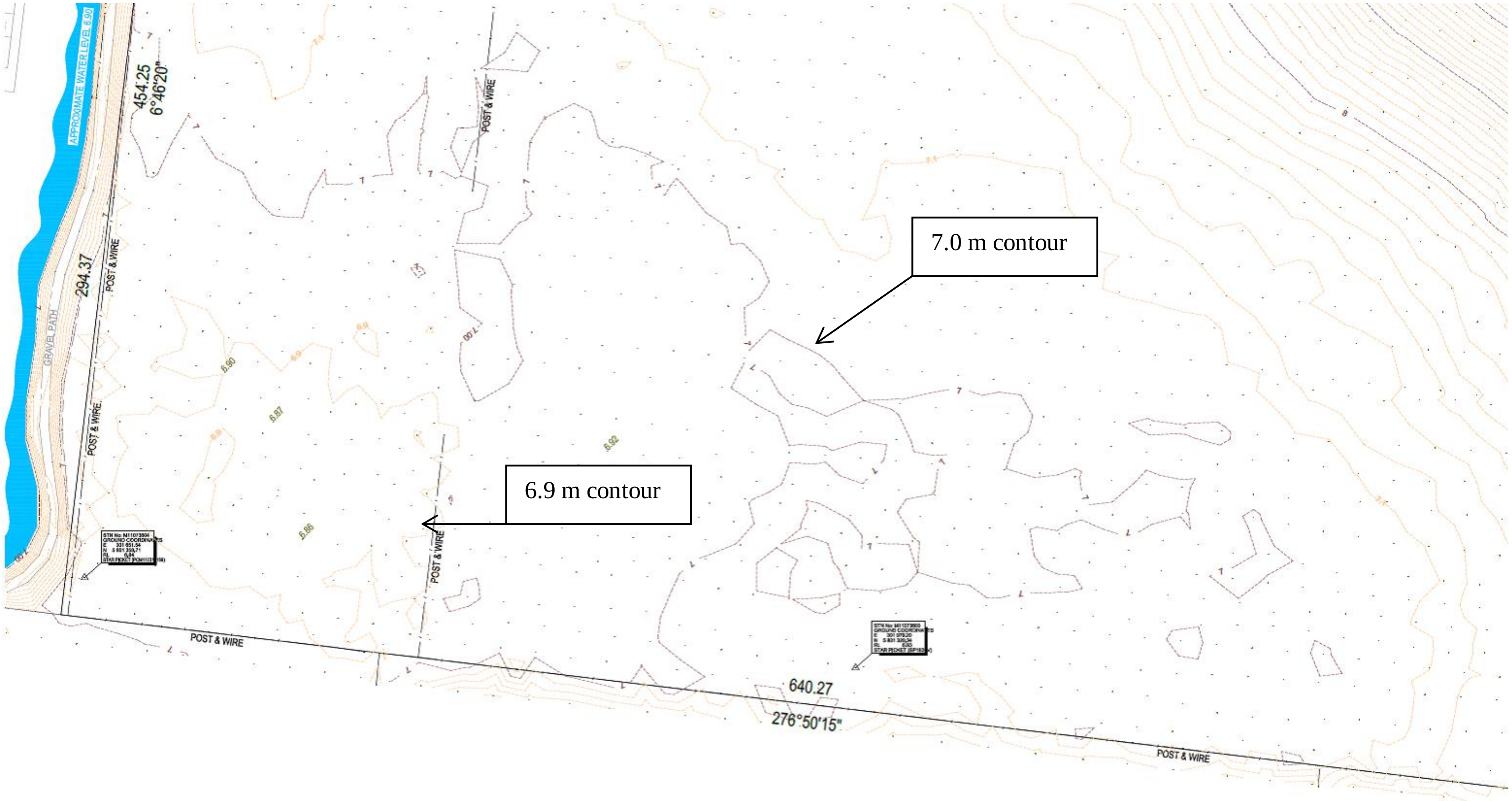

Figure 2(b) **Survey contours across the ephemeral wetland areas**

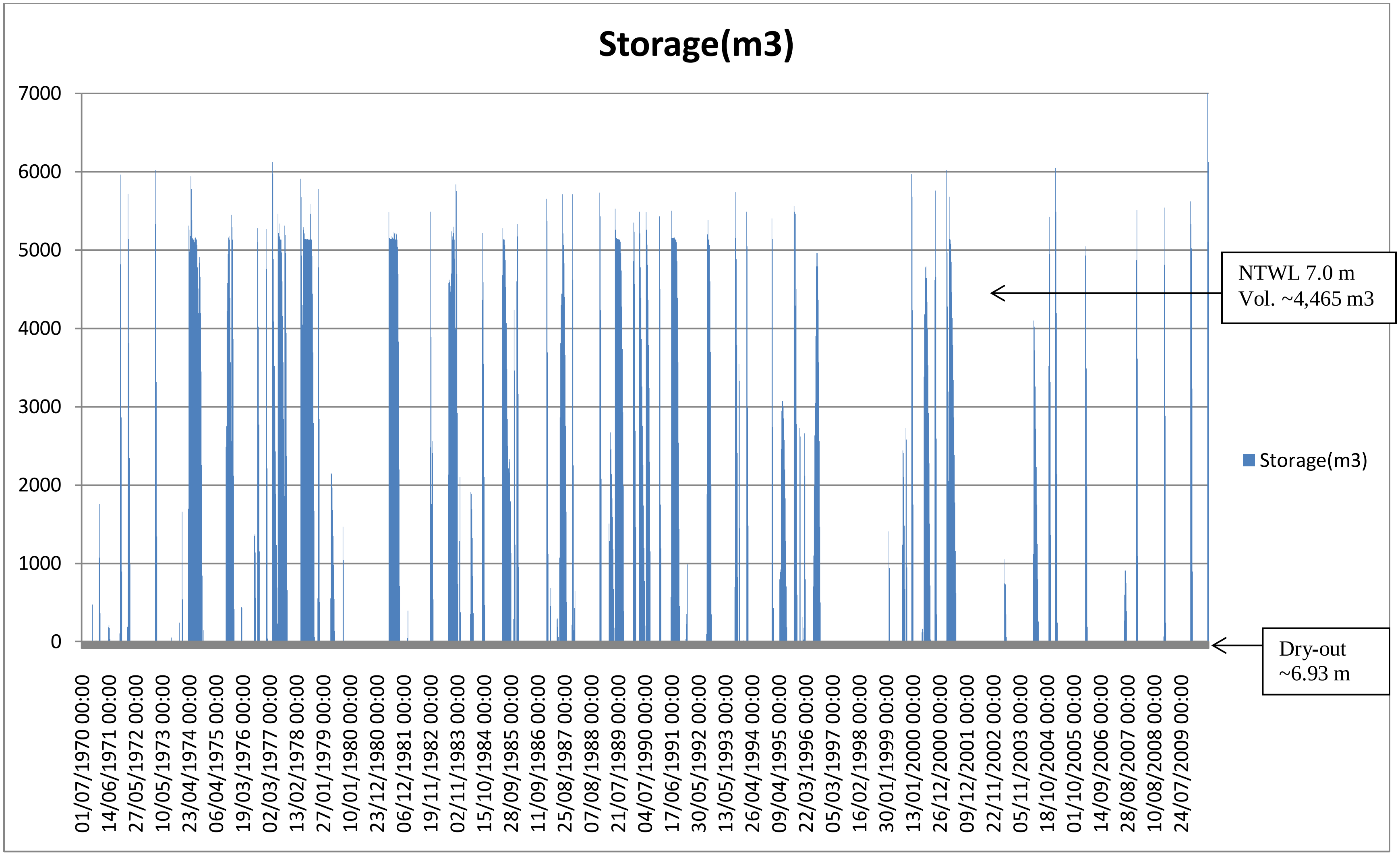

Figure 3 (a) **Daily Storage Volume Fluctuations for 1970-2010 (Existing rural Conditions 43 ha catchment)**

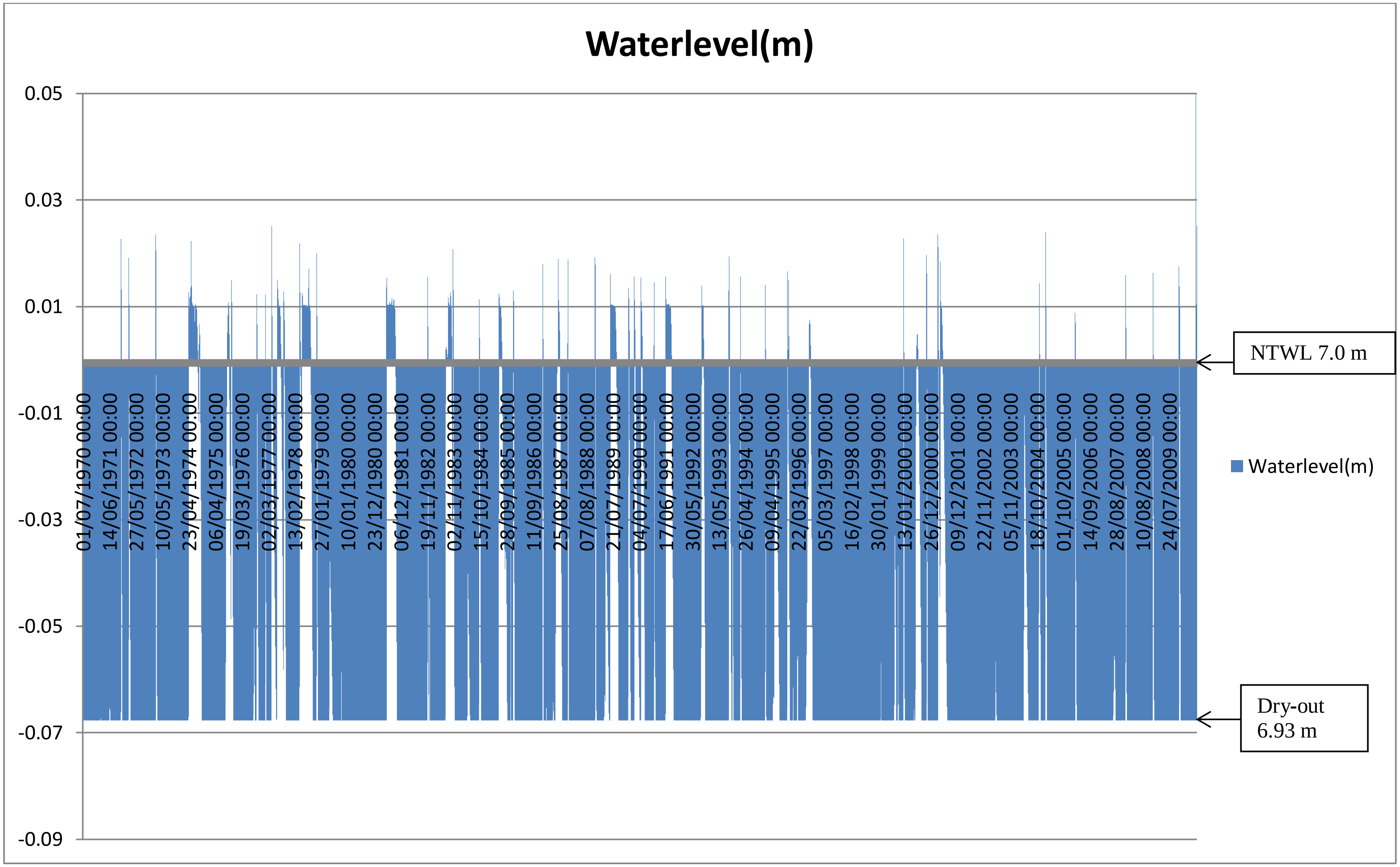

Figure 3 (b) **Daily Water Level Fluctuations for 1970-2010 (Existing rural Conditions 43 ha catchment)**

3. DEVELOPED CONDITIONS HYDROLOGY

Figure 4 shows the proposed development plan, the main stormwater layout and the balance EPBC/EVC areas to be retained and protected.

The EPBC/EVC areas will reduce to about 5.8 ha at NTWL of 7.0 m with total direct catchment reducing to about 6.5 ha including batters for abutting roads. The stormwater wetland system will skirt the southern boundary and be separated from the residual EPBC/EVC areas by a levee bank at crest level of 7.5 m.

3.1 Impact of full bypassing of development drainage

A modified MUSIC model was set up to generate the same outputs assuming that the development drainage system bypassed all flows around the 6.5 ha residual catchment area to the EPBC/EVC areas. This under-estimates the true inflows to the wetlands (because it excludes flood overflow inputs of the northern wetland levee), but quantifies the greatest impact theoretically possible in terms of drying out of the wetlands.

A consequence of the levee construction (to confine the new linear stormwater wetland system) is that short term flood levels in the EVC areas may be ponded higher and longer than under existing conditions.

Under the post-development conditions the stage-area-storage relation for the EVC areas is as shown in the table below.

TABLE 3	**Stage-area-storage for EVC wetlands area after development**	
Stage (m)	**Area (m2)**	**Storage (m3)**
6.85	0	0
6.90	8,350	210
7.00	58,000	3,530
7.10	60,000	9,430
7.50	65,000	34,430

In this scenario it is assumed that there is no gravity outflow available so that wetland contents will in effect vary according to the pattern of inflow and evaporation.

The level of 7.0 m (storage 3,530 m3) remains the important reference level for wetland operation. The wetlands are therefore still considered to have Normal Top Water Level (NTWL) of 7.0 m Extended detention depth was set at 0.5 m which means that the top of extended detention depth matches the overtopping level of the linear stormwater wetlands. Orifice diameter was set at 5 mm to represent negligible outlet capacity with overflow weir width of 50 m.

The volume of 3,530 m3 was set as the permanent pool volume for modelling purposes (no significant gravity outlet at lower levels) and, as prismatic conditions are assumed in MUSIC the default base of the wetland is set at 3,530/58,000= 0.06 m below NTWL or 6.94 m. Initial storage contents were set at zero for the simulation run.

Figures 5 (a) and (b) show the charted storage volumes and water levels through the 40 year simulation.

As shown in Tables 4 (a) and (b), inflows and periods of inundation of the wetlands are significantly reduced compared with existing conditions. Outflows to the south are blocked by the levee. Inflows drop by more than 85% and the number of days of complete dry-out rises from 77% to 93%. However shallow water will still spread over at least part of the wetlands 7% of the time on average.

It is worth noting that the threat of high ponded levels did not arise under this modelling scenario. Maximum rise above NTWL was only 0.06 m over the 40 year simulation period. In reality higher levels will occur when the linear stormwater treatment wetland overtops about every 2 years on average. As proposed in the SWMS it will be essential to add an outlet structure and one-way valve to drain the wetlands down into the stormwater wetlands after such flooding events occur.

It may be expected that the EVC wetland extents will contract but not completely disappear under this management scenario.

Table 4(a) Summary Results for EVC wetlands
Developed Conditions - Full Bypassing of Development Drainage

	Days	**% of record**	**Days/yr**
Total days in simulation	14,610	100%	
Total days when wetlands are fully dry	13,632	93%	341
Total days when wetlands have some water in them	978	7%	24
Total days when wetlands are overflowing (>=7.0 m)	24	0.2%	<1
Longest dryout	1,005 (2.75 yrs)		
Longest full period (>=7.0 m)	110 (0.3 yrs)		

Table 4(b) Summary Results for EVC wetlands
Developed Conditions - Full Bypassing of Development Drainage

Daily Statistics	Inflows (m3)	Outflows (m3)	Storage (m3)	Water Level (m)
40 yr Total	214,310	72		
Mean	15	0	101	-0.06
Median	1	0	0	-0.06
Maximum	5,979	1	7,060	0.06
Minimum	0	0	0	-0.06
5%ile	0	0	0	-0.07
10%ile	0	0	0	-0.07
20%ile	0.1	0	0	-0.07
50%ile	0.7	0	0	-0.07
60%ile	2	0	0	-0.07
70%ile	3	0	0	-0.07
80%ile	6	0	0	-0.06
90%ile	13	0	0	-0.01
95%ile	25	0	371	0.01
98%ile	40	0	1,750	0.01
99%ile	210	0	3,079	0.01

Figure 4 **EPBC/EVC areas to be retained and protected and proposed future road network and main drainage layout.**

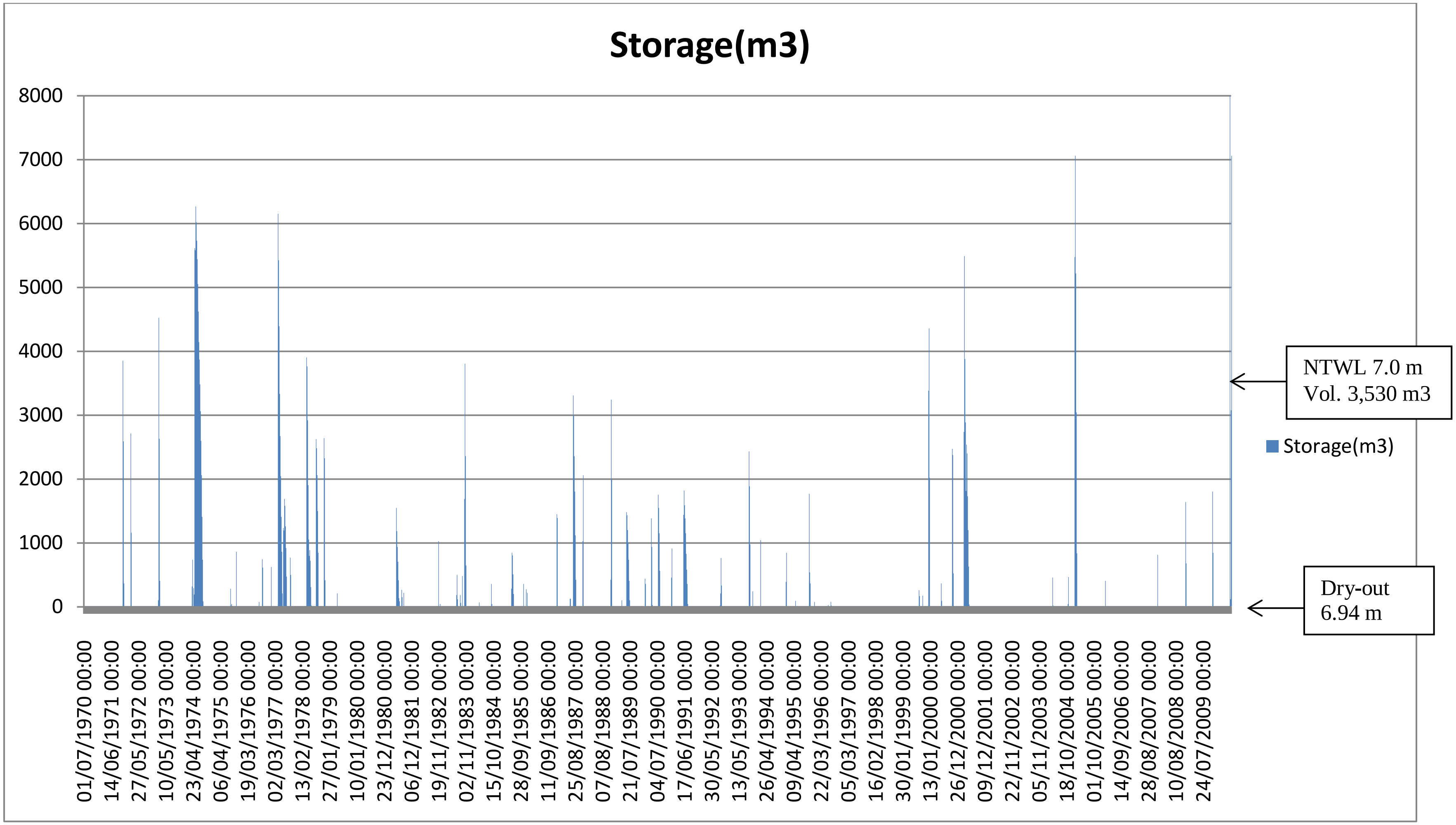

Figure 5 (a) **Daily Storage Volume Fluctuations in the EVC wetlands for 1970-2010 (Developed estate, 6.5 ha residual catchment, full bypassing of development drainage)**

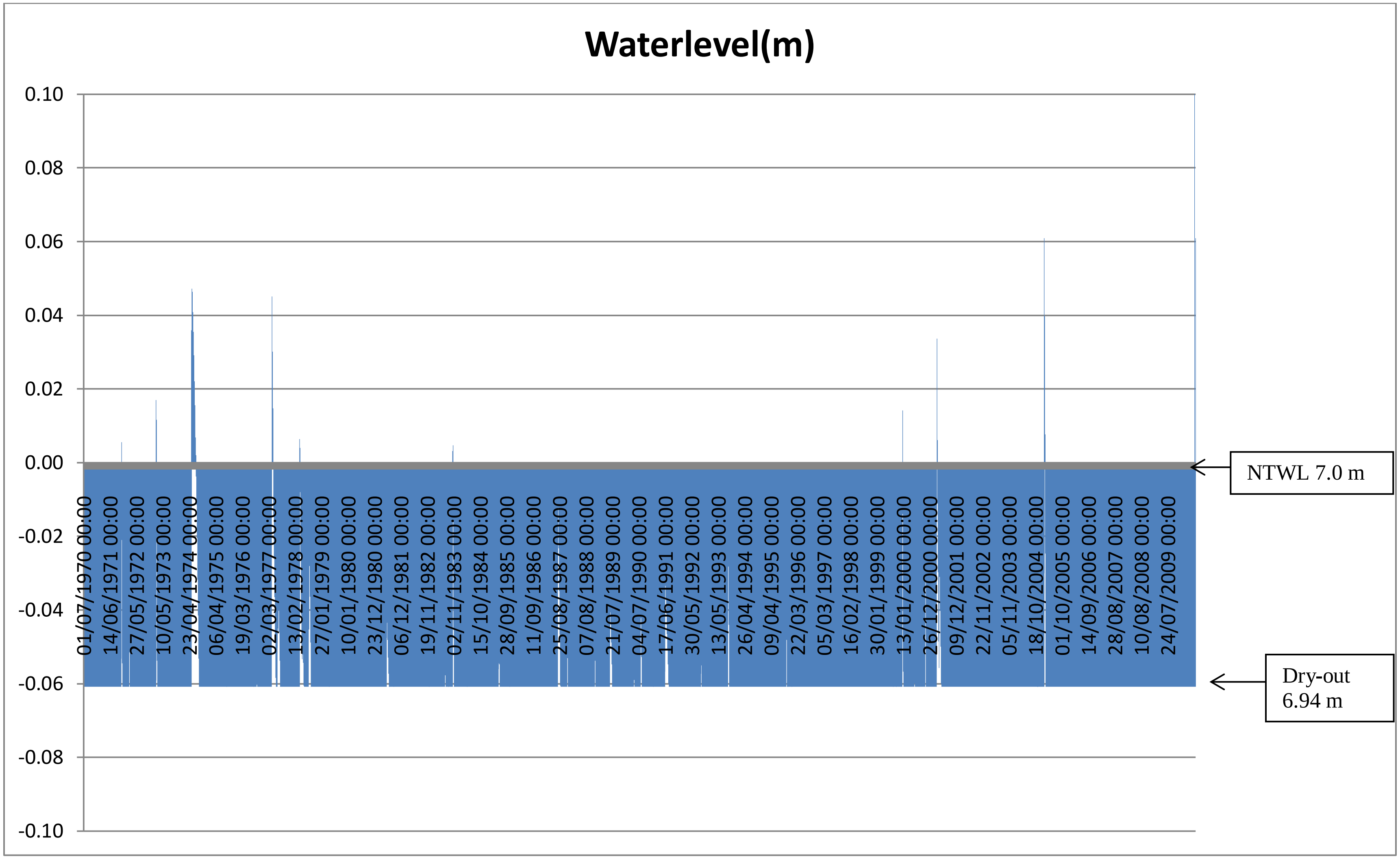

Figure 5 (b) **Daily Water Level Fluctuations in the EVC wetlands for 1970-2010 (Developed estate, 6.5 ha residual catchment, full bypassing of development drainage)**

3.2 Maintaining a reasonable simulation for wetland hydrology

3.2.1 General Comments

Assuming that the drying impacts quantified in Section 3.1 are not acceptable for EVC wetland protection, the proposal under the SWMS to provide extra inflows via overflow from the north confining levee of the stormwater treatment wetland presents the most practical approach to impact mitigation.

The RORB modelling in the SWMS and the 2D hydraulic modelling by Alluvium in the peer review report, both confirmed that the northern levee crest of 7.50 m will overtop for events >2 year ARI.

Based on the results in the tables in Section 3.1, additional inflow frequency rarer than 2 years ARI on average will not do much to mitigate the drying impact of the levee protection system, so it is likely to be necessary to insert a lower crest level and narrower spillway into the levee at a suitable location.

The issues for design are:

- frequency of inflow to the EVC areas (effectively determined by the crest level for overflow from the linear stormwater wetland treatment system),
- rate of inflow to the EVC areas (effectively the width of the overflow spillway);
- quality of inflow to the EVC areas (effectively determined by the location of the spillway along the linear wetland system), and
- drawdown capacity out of the EVC areas after flooding events.

The MUSIC modelling in the SWMS report indicated that best practice stormwater treatment standards are exceeded before the wetland connection to the Alamanda wetlands. Hence for best water quality, the overflow spillway location should be towards the western end of the Lincoln Heath South wetland.

Although inflow frequency and rate are important considerations, post-event drawdown capacity is likely to be more critical. Prolonged inundation at levels well above NTWL will threaten the EVC values.

Under existing conditions the modelling confirms that the ephemeral wetland rarely exceeds about 7.0 m water level as passive outflow occurs to the south. It is essential that the ephemeral wetland area be able to quickly drawdown back to about this NTWL after flooding.

A consequence of the levee construction (to confine the new linear stormwater wetland system) is that when stormwater inflows from the treatment wetlands are allowed, short term flood levels in the EVC areas will likely rise significantly above what could occur under existing conditions, because all outflows are initially trapped by the levee.

This is of no major concern provided that suitable structures are added to ensure drawdown occurs in reasonably short time periods after cessation of flooding. In fact the potential exists for the EVC areas to be enhanced with time through manipulation of the hydrology via these structures.

The proposal advanced in the SWMS was for a 300 mm syphon pipe to be laid below the 1200 mm link pipe to discharge floodwaters south as occurs under existing conditions. This outlet would operate for water levels above the existing outlet of 7.0 m or it could be raised to 7.05 or 7.10 m if desired to increase the wetting area. That is a matter to be determined in detail design with expert ecological advice.

The syphon approach also means that most of the water initially trapped in the EVC wetlands is ultimately released to the south and is not then transmitted west through the Alamanda wetlands and out to Cunninghams Swamp. This is a desirable outcome.

Above 7.20 m the ponded waters are able to escape via backflow across the inflow weir as the water levels subside in the linear stormwater wetland system. As the latter occurs on no more than a 5 day cycle after flood events there is no threat to the EVC vegetation for ponded water above this level.

3.2.2 Methodology

The overall MUSIC model was adjusted to treat the Southeast Alamanda and Lincoln Heath South urban drainage system as one unit with its combined wetland treatment area, separate from the southwest Alamanda system.

Exported fluxes for spillway overflows only were then imported to the Lincoln Heath EVC reserve area catchment to form the EVC wetland model. The two models were run to generate daily results for the 40 year period.

The modelling simulated an overflow spillway on the north levee with crest level of 7.20 m, which is the Top of Extended Detention Depth (TEDD) for the linear wetland system. The spillway width was set at 5 m.

Outflows from the EVC wetland model for levels below 7.20 m were determined using the 300 mm diameter syphon outlet at 7.0 m.

The stage-area-storage relation for the EVC wetlands and the default NTWL and empty levels remain unchanged from the full bypass model.

These assets are shown in concept form on Figure 6.

3.2.3 Results

Figures 7 (a) and (b) show the charted storage volumes and water levels through the 40 year simulation. Tables 5 (a) and (b) below show statistical outcomes.

Table 5(a) Summary Results for EVC wetlands
Developed Conditions – With Treatment Stormwater Inflows

	Days	% of record	Days/yr
Total days in simulation	14,610	100%	
Total days when wetlands are fully dry	12,463	85%	312
Total days when wetlands have some water in them	2,147	15%	54
Total days when wetlands are overflowing (>=7.0 m)	232	1.5%	6
Longest dryout	680 (1.85 yrs)		
Longest full period (>=7.0 m)	113 (0.31 yrs)		

Table 5(b) Summary Results for EVC wetlands
Developed Conditions – With Treatment Stormwater Inflows

Daily Statistics	Inflows (m3)	Outflows (m3)	Storage (m3)	Water Level (m)
40 yr Total	1,648,458	1,217,387		
Mean	113	83	350	-0.05
Median	1	0	0	-0.06
Maximum	55,296	6,2035	2,5100	0.37
Minimum	0	0	0	-0.06
5%ile	0	0	0	-0.06
10%ile	0	0	0	-0.06
20%ile	0	0	0	-0.06
50%ile	1	0	0	-0.06
60%ile	2	0	0	-0.06
70%ile	3	0	0	-0.06
80%ile	6	0	0	-0.06
90%ile	13	0	1,210	-0.04
95%ile	26	0	2,530	-0.02
98%ile	45	0	3,350	0.00
99%ile	1,009	2,513	4,928	0.02

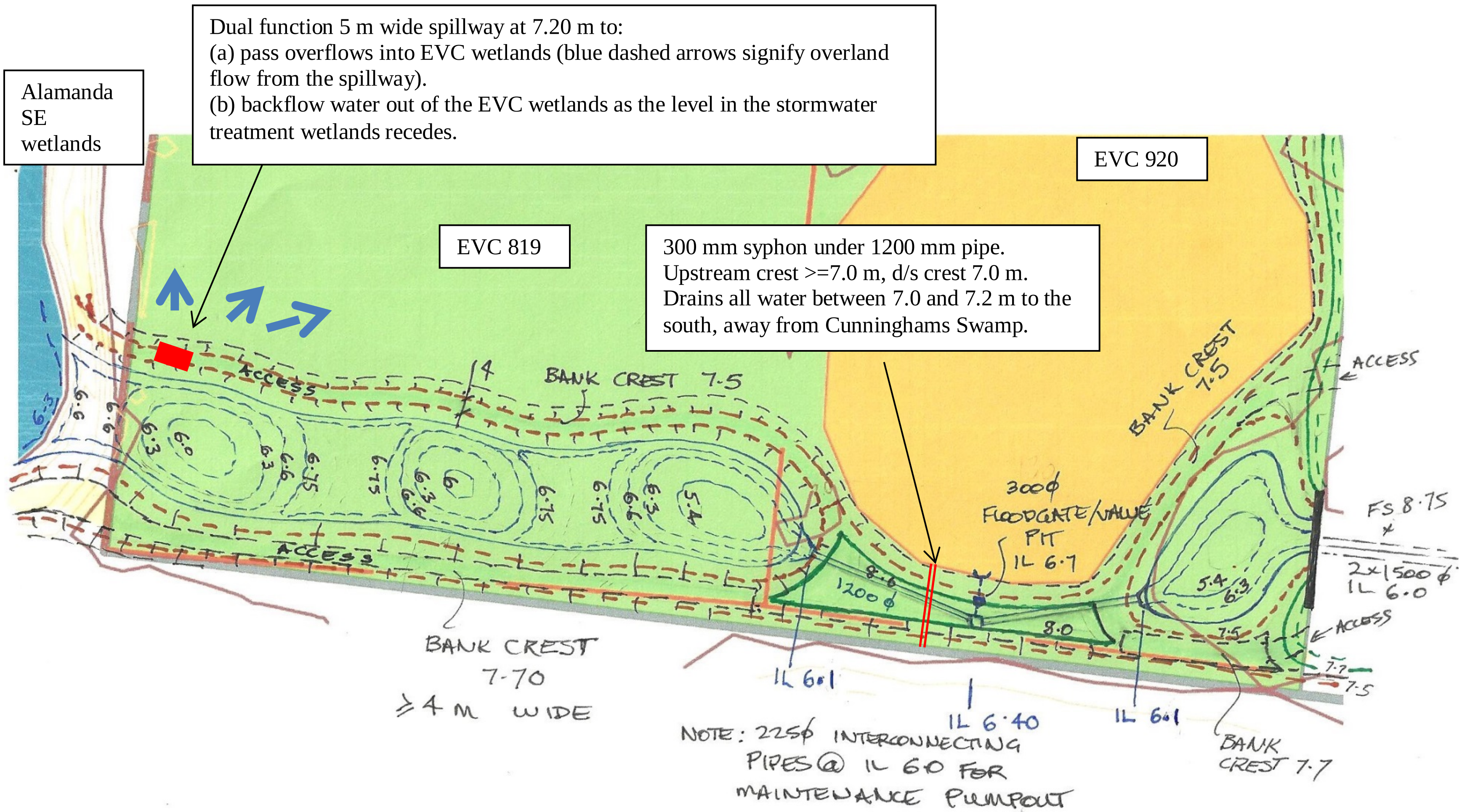

Figure 6 **Concept design detail for proposed new linear stormwater wetlands and link pipe, west of north-south connector road to Alamanda wetlands. Also showing proposed EVC wetland inflow and outflow structures.**

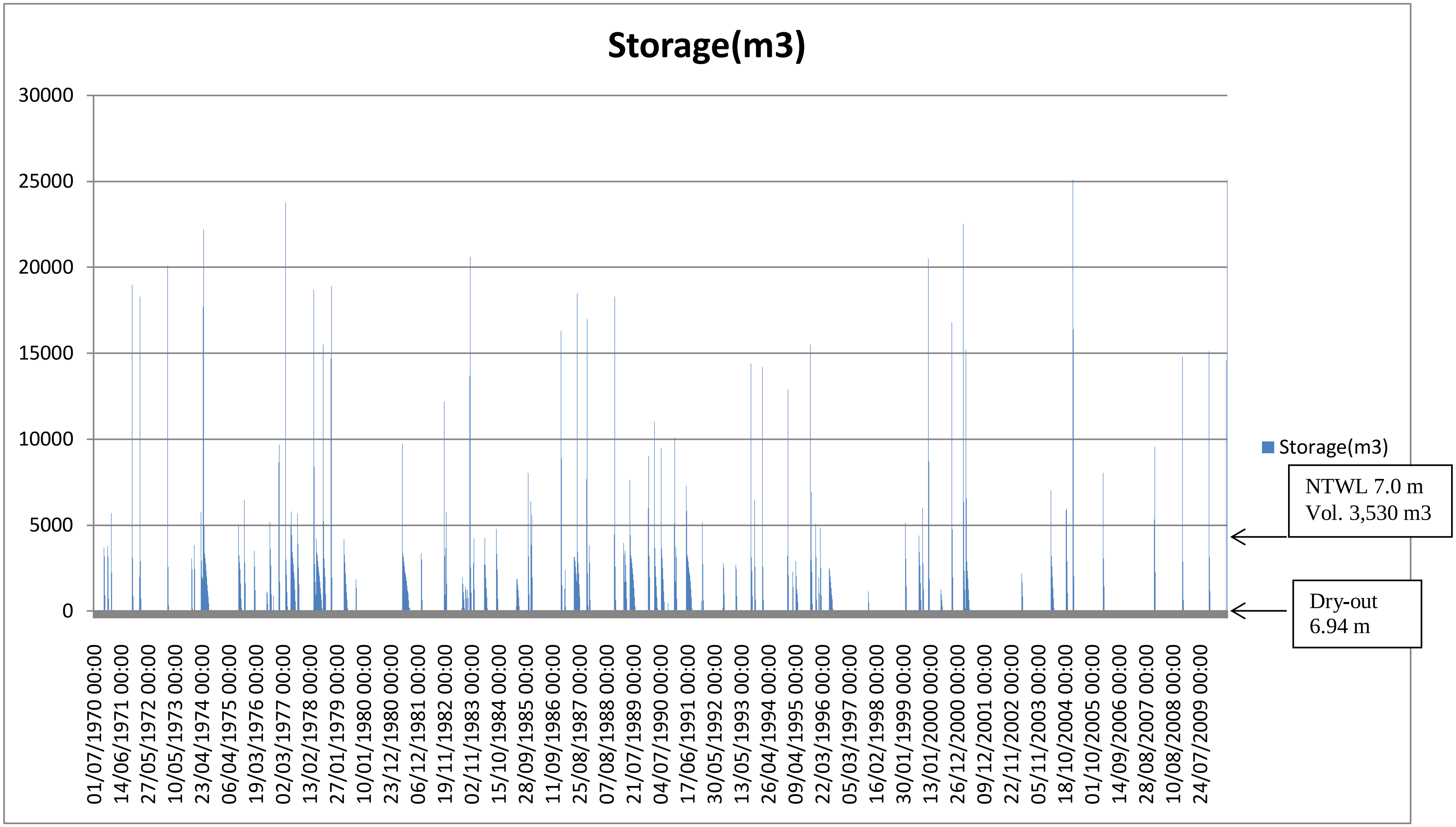

Figure 7 (a) **Daily Storage Volume Fluctuations in EVC wetlands for 1970-2010 (Developed estate, 6.5 ha residual catchment, 5 m wide spillway at 7.2 m on north levee, 300 mm syphon outlet to the south at 7.0 m)**

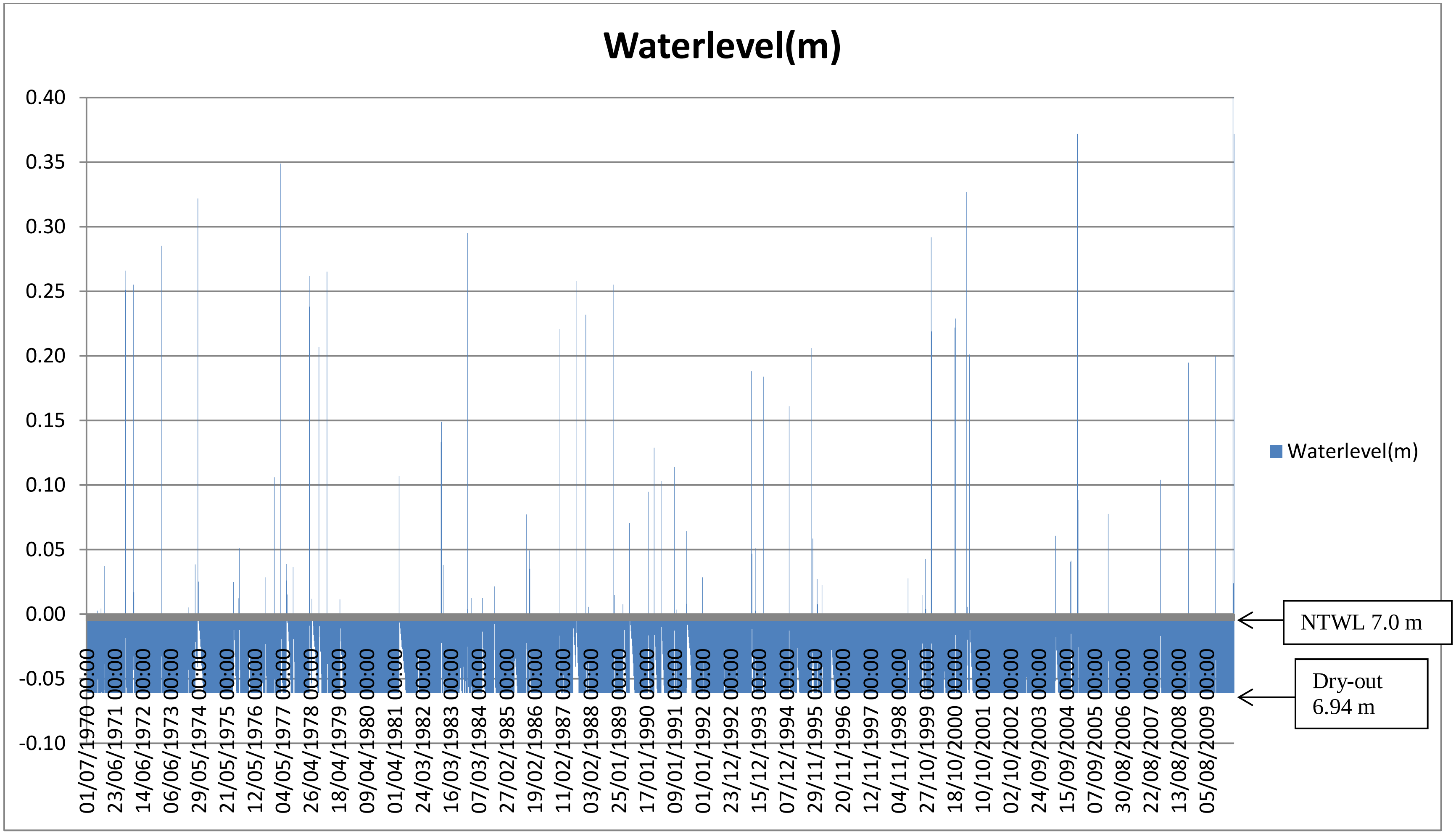

Figure 7 (b) **Daily Water Level Fluctuations in EVC wetlands for 1970-2010 (Developed estate, 6.5 ha residual catchment, 5 m wide spillway at 7.2 m on north levee, 300 mm syphon outlet to the south at 7.0 m)**

4. DISCUSSION AND RECOMMENDATIONS FOR DETAIL DESIGN

The results in Section 3.2 are compared with those for existing conditions (in Section 2) in Tables 6(a) and (b). The comparison shows the proposed stormwater treatment wetlands and the inflow/outflow system:

- increases total (and mean annual) inflows to the EVC wetlands by about 15%;
- increases total (and mean annual) outflows to the south from the EVC wetlands by about 32%;
- causes peak water levels over the EVC wetlands to rise much higher (maximum by about 0.34) and more often in major floods (but are short-lived);
- reduces periods when water is stored in the EVC wetlands from about 23% to about 15% of the year on average;
- reduces periods when EVC wetland water levels are above 7.0 m from about 8% to less than 2% of the year on average;
- Reduces maximum dry-out durations by about 19%;
- Reduces longest full durations by about 35%.

From these results it is concluded that:

- The SWMS strategy approach to ensure long term protection to the EVC wetlands by allowing controlled inflow from the stormwater wetlands and providing an outlet structure to the south to drawdown the area after flooding, is valid.
- The proposed 300 mm diameter syphon is more than adequate to drawdown the EVC wetlands to NTWL of 7.0 m after the passage of major floods.
- There may be merit in providing an adjustable control over the inlet to restrict the rate of drainage after flooding events, and/or lift ponding levels to best manage the wetlands in the longer term.
- The spillway crest level of 7.2 m and width of 5 m are close to optimal, but could be slightly lowered (to increase frequency of flow to the EVC wetlands) and narrowed (to reduce the rate of flow to the EVC wetlands in each event) to achieve an even better match to existing conditions.

Table 6(a) Comparison Results for EVC wetlands

	Days		% of record		Days/yr	
	Existing	**Proposed**	**Existing**	**Proposed**	**Existing**	**Proposed**
Total days when wetlands are fully dry	11,304	12,463	77%	85%	283	312
Total days when wetlands have some water in them	3,306	2,147	23%	15%	83	54
Total days when wetlands are overflowing (>=7.0 m)	1,190	232	8%	1.5%	30	6
Longest dryout	840 (2.30 yrs)	680				
Longest full period (>=7.0 m)	175 (0.48 yrs)	113 (0.31 yrs)				

Table 6(b) Comparison Results for EVC wetlands

Daily Statistics	**Total Inflows (m3)**		**Outflows to south (m3)**		**EVC Storage (m3)**		**EVC Water Level (m)**	
	Existing	**Proposed**	**Existing**	**Proposed**	**Existing**	**Proposed**	**Existing**	**Proposed**
40 yr Total	1,423,830	1,648,458	653,317	862,343				
Mean	97	113	45	59	704	350	-0.06	-0.05
Median	6	1	0	0	0	0	-0.07	-0.06
Maximum	13,392	55,296	13,565	9,936	6,120	25,100	0.03	0.37
Minimum	0	0	0	0	0	0	-0.07	-0.06
5%ile	0	0	0	0	0	0	-0.07	-0.06
10%ile	0	0	0	0	0	0	-0.07	-0.06
20%ile	0.1	0	0	0	0	0	-0.07	-0.06
50%ile	6	1	0	0	0	0	-0.07	-0.06
60%ile	12	2	0	0	0	0	-0.07	-0.06
70%ile	23	3	0	0	0	0	-0.07	-0.06
80%ile	46	6	0	0	483	0	-0.06	-0.06
90%ile	131	13	0	0	3,880	1,210	-0.01	-0.04
95%ile	278	26	0.4	0	5,110	2,530	0.01	-0.02
98%ile	968	45	202	0	5,150	3,350	0.01	0.00
99%ile	2,021	1,009	933	2,513	5,240	4,928	0.01	0.02

Recommendations for Future Detail Design

With the input of expert ecological advice:

- Confirm the impact of reducing the rate of drainage out of the EVC wetlands storage by re-running the EVC Wetlands model with the extended detention outlet reduced from 300 mm diameter. If favourable to wetlands management, design the outlet control structure on the 300 mm diameter syphon accordingly.

- Confirm if there is value in reducing the crest level and/or width of the overflow spillway from the linear stormwater treatment wetlands into the EVC wetlands.

In my opinion, there is no reason why such refinements could not be made conditional in a permit and completed as part of future detail design.

Neil M Craigie