PAKENHAM RACECOURSE RELOCATION: BALANCING STORMWATER NEEDS

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ABSTRACT

Pakenham Racing Club purchased a 250-ha greenfield site at Tynong to develop a new racing and training facility. The site is located within a floodplain and external to local drainage schemes, so extensive investigations were required to prepare a stormwater strategy. Environmental assessment identified growling grass frogs (an endangered species) residing on the site.

Pakenham Racing Club engaged Dalton Consulting Engineers (DCE) as principal consultant for the design and construction of the new facility. In addition to new habitat ponds for the growling grass frogs, the stormwater strategy also needed to provide overland flow paths for major-events, a stormwater harvest system to ensure adequate water for irrigating the racecourse and stormwater quality treatment.

DCE developed RORB, MUSIC and TUFLOW stormwater models to simulate stormwater flows on-site. The modelling was used to ensure that all aspects of the stormwater strategy would function as designed and that vegetation will be protected from scour. DCE received a 12d International Innovation Award in 2012 for design work on the project.

The first works to take place on site were the environmental works to construct suitable habitat for the growling grass frogs. Once the habitat ponds were established, construction on the remainder of the site began in 2012. Pakenham Racecourse received a grant from the Office of Living Victoria (state government) for rock and vegetation components of the low-impact development infrastructure in 2014.

The paper and presentation will be a case study of the Pakenham project from a low-impact development perspective. The technical problems overcome via flood modelling will be addressed.

KEYWORDS

Low impact development, flood modelling, Water Sensitive Urban Design (WSUD), stormwater harvesting, stormwater management.

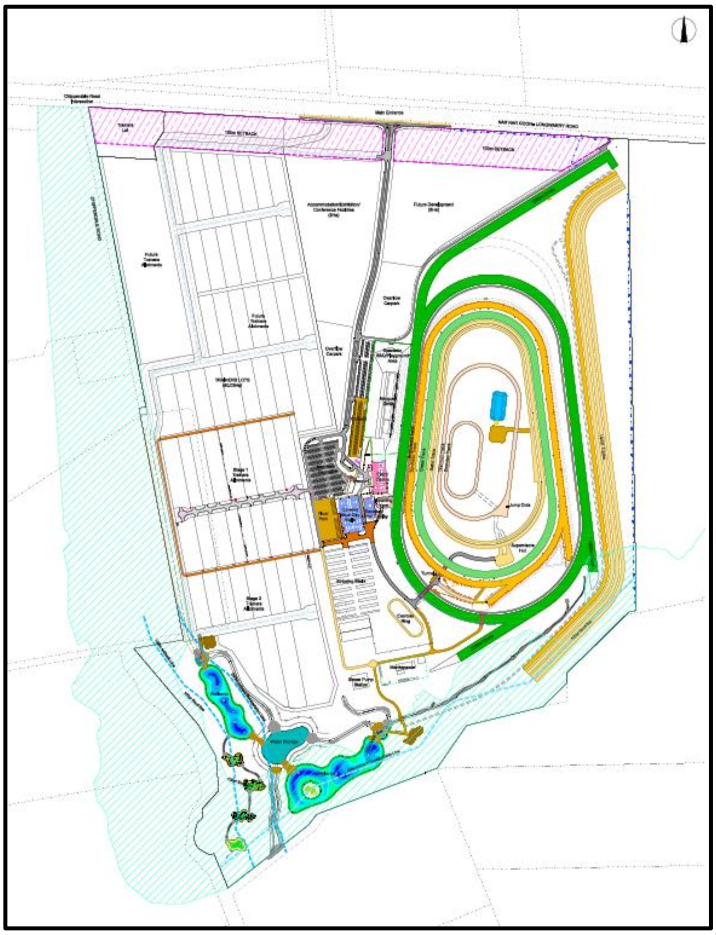
PRESENTER PROFILE

Sonya Harrison joined DCE as a Project Manager in 2014 and has over eight years of experience in the design and delivery of engineering projects. Sonya is an expert in parks and open space master planning, project management and client negotiation as well as Greenfield developments.

1 INTRODUCTION

The relocation of Pakenham racecourse is the first newly built of its kind in Australia in over 50 years. It aims to establish a legacy for its outstanding amenities, stormwater management innovation and overall environmental sustainability. The new sporting facility extends approximately 250ha. Stormwater conveyance and treatment were key elements of the planning and design process. From a stormwater perspective, the site conveys flows from two (2) external catchments of 644ha to the north and 840ha to the east with an inflow off these catchments of $19.6m^3/s$ and $30m^3/s$, respectively. The stormwater management strategy for the Pakenham Racecourse allows for the management of these external flows on site through diversion, retardation and treatment, utilizing the additional stormwater as a site resource, while minimising the impact on the receiving water body, Ararat Creek.

Figure 1-1: Pakenham Racecourse – Stormwater Master plan



As illustrated in Figure 1-1, the completed racecourse comprises a series of four (4) frog ponds established to rehome growling grass frogs observed in the existing dam, two (2) connected stormwater treatment wetlands and a storage dam. The water from the storage dam is then pumped into a central irrigation dam within the racecourse track and used for all irrigation needs at the site.

Of key importance, the site contained a multitude of stormwater, groundwater and environmental constraints from the presence of growling grass frogs to a high water table, leading to multiple time and cost variations in an already tightly constrained project. This paper outlines the integrated strategy that was implemented to address these issues while engineering a fully sustainable, state of the art facility that will be in the forefront of ingenuity for years to come.

2 INTEGRATED WATER MANAGEMENT AT THE PAKENHAM RACECOURSE

2.1 PROVIDING CONTEXT

Pakenham is located within an hour's drive, south east of Melbourne. Originally a separate town entity, it was a stopping place for Cobb & Co coaches bound for distant Gippsland towns.

Pakenham is now an integral element of Melbourne's south east fringe. There is a regular train service and it is a rapidly growing commuter suburb of Melbourne south east.

The Pakenham Racing Club (PRC) was formed in 1875. Like many racing clubs, it suffered peaks and troughs aligning with the economic times. In the 1960's, the funding provided through the Totaliser Agency Board allowed the upgrading of the facilities and growth of training at the facility. By 2000 there were around 80 trainers at the club with over 150 horses training daily at the site.

2.1.1 SITE HISTORY

In 2008, Racing Victoria reduced the status of the racecourse that dropped both the number of race meetings as well as its training status. The club was in an almost unique position where it owned its site, enabling the Committee to decide on a rejuvenation of the club by selling it's centrally positioned site and relocating.

In 2009, the club purchased its new site at Tynong, about a 15 minute drive from the racecourse. The new 250ha site was 10 times larger than the former site. The site was essentially low lying farmland that had been used for dairy farming. As it was located within one of Melbourne's "Green Wedge" zone (GWZ), there was significant planning required to expedite the new Zoning and subsequent Planning Permits. A GWZ is assigned by the Department of Transport, Planning and Local Infrastructure (DTPLI), Victoria and is allocated land for the purpose of recognizing, protecting and conserving land for agriculture, environmental, historic, landscape, recreational and tourism purposes in addition to its other natural resources (Department of Transport, Planning and Local Infrastructure 2014)

The Rezoning was placed on a Priority Planning process in view of the significance and extensive employment generation. The sale of the former site was settled on 4 January, 2013, with the last meeting held on 9th February, 2014. In the interim, work commenced on the new racecourse on 6th August, 2012.

2.1.2 FROM FARMLAND TO RACECOURSE

Master planning for such a project was extensive and DCE developed many iterations before the club embarked on an approved layout for the site. Stage 1 of the development involved:

- A 2400m reinforced sand turf Course Proper, including a 1200m chute;
- A 2000m inside all weather synthetic track (Polytrack);
- Two 1500m sand tracks for training;
- Two tunnels and accompanying fenced horse paths, including access points to the tracks;
- A $10M events centre/grandstand;
- A two tiered corporate marquee lawn;
- 145 fully under cover and enclosed horse stalls;
- Maintenance shed and compound;
- Irrigation dam and wetlands;

- Vehicular access road and car parking;
- 18 lot subdivision for trainers with direct horse access to the course;
- All the requisite sewer, water, electrical and communications infrastructure;
- Lighting;
- All the requisite race day facilities for jockeys, trainers and stewards; and
- Formal racecourse facilities such as finishing posts, stewards towers, lighting, and communications facilities for race day.

With the prior site use being farmland, there was no infrastructure of any significance at or adjacent to the site. Significant infrastructure was required externally to service the site. Being farmland and within a GWZ, there had been little, if any, consideration of stormwater planning or any infrastructure servicing for the site prior to the proposed development.

These conditions provided some high risk environmental challenges for the transformation from rural to racing. Water sustainability was also a critical environmental challenge for the site.

2.2 A LOW IMPACT DEVELOPMENT

The Pakenham Racecourse relocation has been planned as a low impact development from the project's outset. From a stormwater perspective this has been primarily through the adoption of Water Sensitive Urban Design (WSUD) principles and the inclusion of stormwater harvesting and reuse.

Across Australia, WSUD has been adopted as a framework for integrating water cycle management into urban planning and design. Moreton Bay Waterways and Catchment Partnership (MBWCP 2006) succinctly define it as follows:

> *Water Sensitive Urban Design (WSUD) is an internationally recognised concept that offers an alternative to traditional development practices. WSUD is a holistic approach to the planning and design of urban development that aims to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems. It promotes the integration of stormwater, water supply and sewage management at the development scale.*

While each statutory authority emphasizes different aspects of WSUD in its adoption, there are several common principles of WSUD adopted in Australia which can be broadly grouped into the following:

1	**Retain and enhance existing stormwater features**	(Department of Water 2011; MBWCP 1996; Sydney Metropolitan CMA 2009; Victorian Stormwater Committee 1999)
2	**Maintain hydrology by reducing the runoff and peak flows**	(Department of Water 2011; MBWCP 1996; Melbourne Water 2013; Victorian Stormwater Committee 1999)
3	**Improve the water quality entering receiving waterways**	(Department of Water 2011; Sydney Metropolitan CMA 2009; Victorian Stormwater Committee 1999)
4	**Integrate stormwater treatment into the development landscape**	(MBWCP 1996; Melbourne Water 2013; Sydney Metropolitan CMA 2009; Victorian

		Stormwater Committee 1999)
5	**Add value while minimising development costs**	(MBWCP 1996; Melbourne Water 2013; Victorian Stormwater Committee 1999)
6	**Reduce demand for potable water**	(MBWCP 1996; Sydney Metropolitan CMA 2009)

The Pakenham Racecourse project at Tynong has adopted these key WSUD principles in order to, not only minimise the negative impacts of the development, but to positively enhance the natural water cycle in the area. The Joint Steering Committee for Water Sensitive Cities (JSCWSC 2009) provides a vision for the application of WSUD principles:

> *The most innovative WSUD approaches also incorporate the design of localized water storage, treatment and reuse technologies. Such approaches, often referred to as distributed systems, can involve the application of these alternative technologies at lot, neighbourhood or district residential scales.*

Key infrastructure associated with stormwater at the Pakenham Racecourse site embodies the JSCWSC vision: stormwater treatment wetlands, stormwater harvesting and reuse systems and the construction of stormwater-fed environmental habitat zones for threatened species. In encapsulating WSUD principles, as will be outlined in this report, the project is a demonstration of WSUD implementation achieving a low-impact development.

2.2.1 ENHANCING STORMWATER MANAGEMENT – INTEGRATING EXISTING AND NEW FEATURES

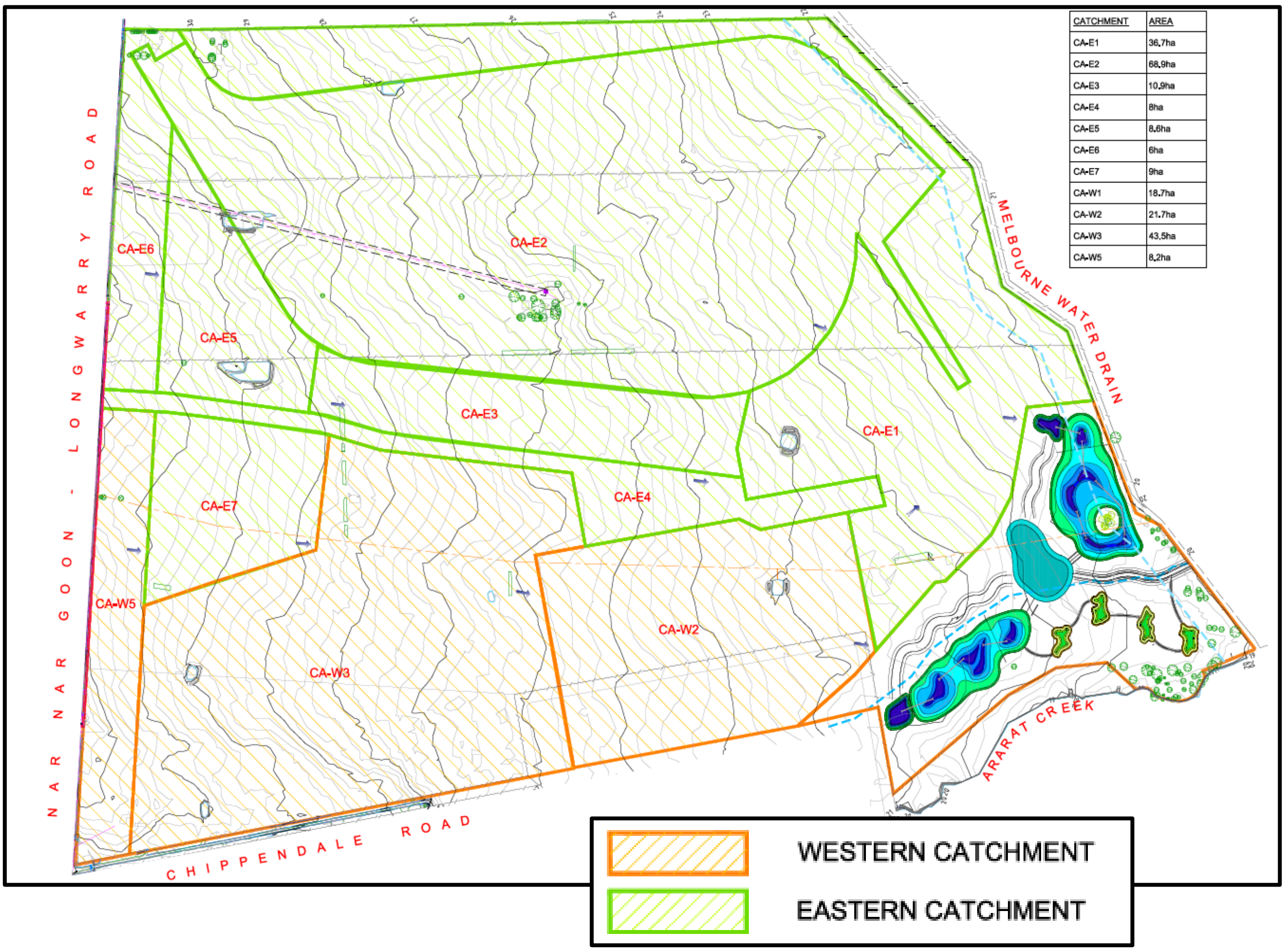
The relocation of the Pakenham racecourse was an ambitious project aimed at maximising existing stormwater and environmental elements of the site and utilising the existing site parameters to enhance the site's potential, striving for a fully self-sustained facility.

A number of site features were observed during the design and construction phases of the project from existing dams and native habitat to the presence of a high ground water table. Through resourceful engineering, the site parameters and constraints were used to enhance the functionality and sustainability of the developed racecourse facility.

Overview of Stormwater and Environmental Management

Integrated into the stormwater management and treatment system, there are two (2) large wetlands (refer to Figure 2-3) that treat the runoff from the eastern and western catchments, as highlighted in Figure 2-1 and Figure 2-2. From the wetlands, treated water is captured and stored in a large dam located to the south west of the property (refer to Figure 2-4). Excess runoff from the site discharges directly to Ararat Creek or the Melbourne Water diversion drain when the dam is at full capacity.

Figure 2-1: Pakenham Racecourse – Stormwater Master plan



The large storage dam is used as buffer storage to supply water for track irrigation as well as a trickle supply to top up the growling grass frog (GGF) ponds during summer months when evapotranspiration is high. Four (4) designated and specifically designed ponds are located south of the western wetland, established for the rehoming of the GGF.

Figure 2-2: Stormwater and GGF management elements

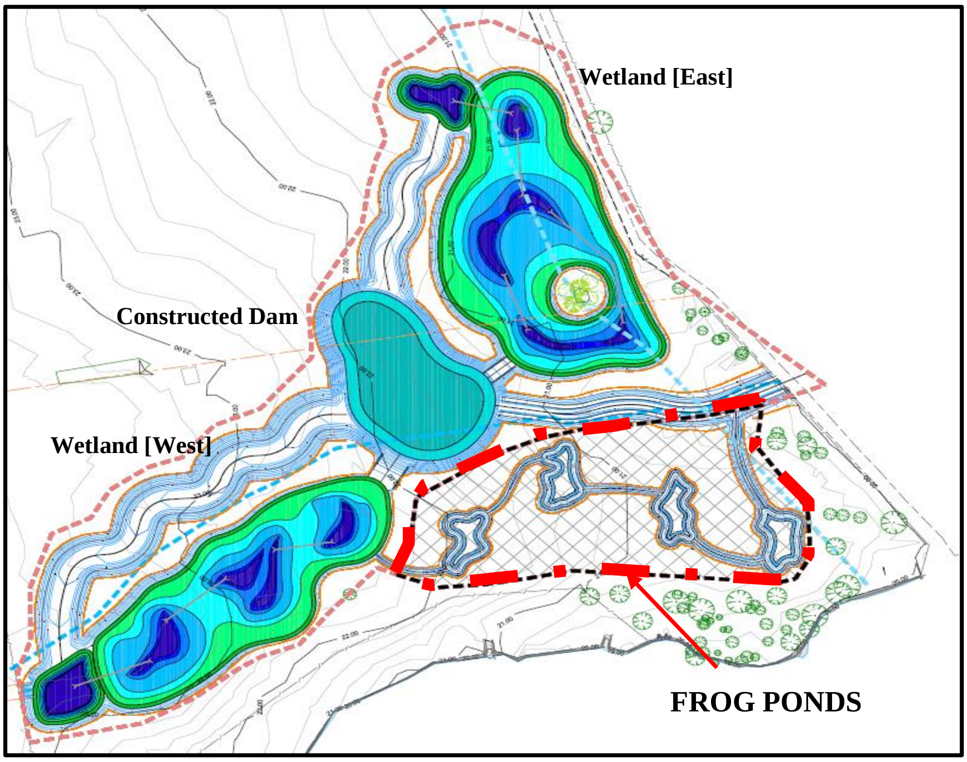


Figure 2-3: Wetland (24th February, 2015)

Figure 2-4: Southern Storage Dam (24th February, 2015)

Relocation of Growling Grass Frogs

The GGF or Litoria raniformis is a large tree-frog distributed throughout Australia and is considered a threatened species in all Australian states. In accordance with the Department of Environment and Primary Industry (DEPI) – formally the Department of Sustainability and Environment (DSE), the habitats of these species cannot be disturbed until new suitable replacement habitat has been provided for the native population and relocation has been successfully completed (Department of Sustainability and Environment 2010).

In 2009, the presence of growling grass frogs were observed during a site environment evaluation. Subsequently, racecourse construction and all associated facilities were delayed until an appropriate replacement habitat was designed, constructed and established. In 2011, when vegetation was well developed and the new GGF environment was deemed suitable, the frogs could be rehomed and the racecourse construction could commence, including the infill works for the existing dams.

Figure 2-5: Frog Pond (12th December, 2011)

Figure 2-6: Frog Pond (17th December, 2012)

Figure 2-7: Frog Pond (24th February, 2015)

The three images above; Figure 2-5 to 2-7 illustrate the conditions of the GGF ponds at various stages after initial construction. The vegetation is now well established and the local environment has inherited a healthy ecosystem. High quality treated stormwater from the storage pond is used as required to top up the GGF ponds.

2.2.2 STORMWATER QUALITY

As an integral component of the stormwater management for the development, water quality is treated through the wetland system prior to reuse or discharge into the frog pond system or the Ararat Creek. Modelling was undertaken to ensure the proposed wetlands could cater for the increased runoff from the development and subsequent monitoring has been undertaken post construction to confirm water quality targets are being achieved.

Urban Stormwater Treatment Requirements, Victoria

In Victoria, the residential subdivision planning requirements are contained in Clause 56 of the Victorian Planning Provisions (Department of Sustainability and Environment

2006). This provision requires that all stormwater runoff from a developed site meets the Urban Stormwater – Best Practice Environmental Management Guidelines (BPEMG) with quality objectives as outlined below (Victorian Stormwater Committee 1999):

- 80% reduction of typical urban annual total suspended solids (TSS) load;
- 45% reduction of typical urban annual total phosphorus (TP) load;
- 45% reduction of typical urban annual total nitrogen (TN) load; and
- 70% reduction of typical urban annual litter or gross pollutant (GP) load.

This includes all sites where fraction impervious has been increased and natural ground conditions have been altered. It was important that water quality for the subject site was managed to this standard as there were multiple elements of the facility that could affect stormwater quality including a development lot, local roads and hardstands areas.

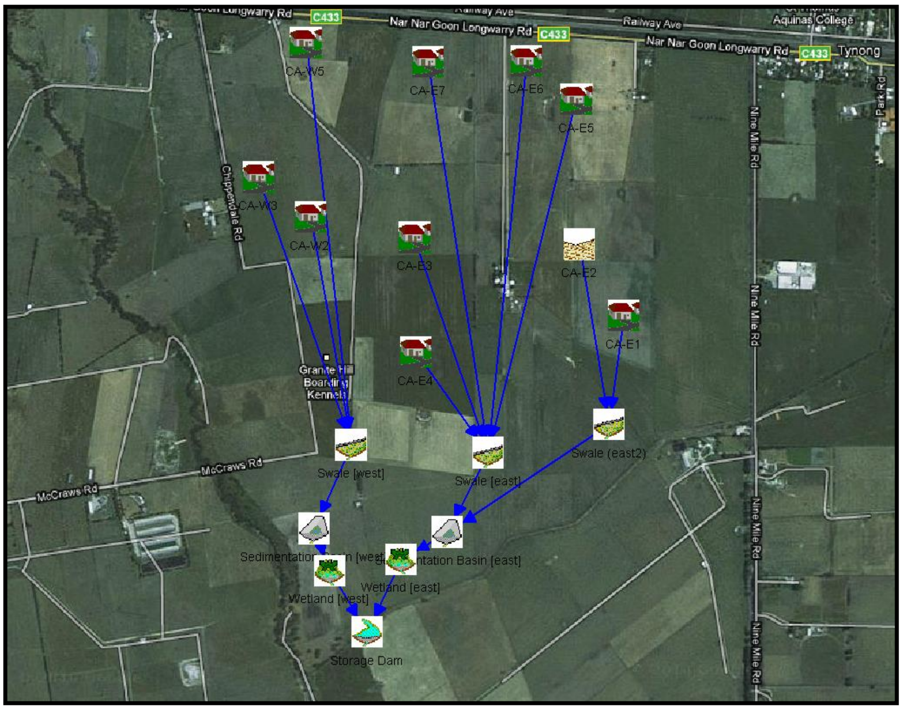
Water Quality Modelling

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) is a concept design tool used to estimate pollutant generation from a defined catchment and demonstrate performance of stormwater treatment systems including wetlands, biofiltration systems, gross pollutant traps, swales, sediment ponds, buffer strips and others (Melbourne Water 2010).

The subject site for Pakenham racecourse has been developed, resulting in a reconfiguration of the catchment, including elevated fraction imperviousness, increased runoff and pollutant load, increased stormwater velocities and redirection of flows. In accordance with BPEMG, stormwater treatment is necessary for these flows prior to reuse or discharge to the receiving waterways.

In the concept phase of this project, MUSIC was used to size the stormwater treatment areas and volumes as well as to estimate the size of buffer storage required to achieve the required reuse (refer to Figure 2-8 for model layout). The program allows for such parameters as soil seepage in the catchments, pervious areas and evaporation in each of the treatment nodes.

Figure 2-8: MUSIC Modelling Layout – Pakenham Racecourse



Water Quality Sizing and Results

The wetlands were sized based on the MUSIC model as outlined in Table 2-1, providing an overall stormwater pollutant reduction in line with BPEMG as highlighted in Table 2-2.

Table 2-1: Stormwater Treatment Sizing – Pakenham Racecourse

	Surface Area (m^2)	Extended Detention Depth (m)	Permanent Pool Volume (m^3)
Wetland [East]	22 000	0.50	11000
Wetland [West]	12 000	0.50	6000

Table 2-2: Stormwater Treatment Train Effectiveness – Pakenham Racecourse

Pollutant (kg/year)	Source Load	Residual Load	% Reduction	BPEMG Required % Reduction
Total Suspended Solids (TSS)	193 000	18 600	90.4	80
Total Phosphorus (TP)	439	91.8	79.1	45
Total Nitrogen (TN)	3080	1320	57.1	45
Gross Pollutants (GP)	28400	0.00	100.0	70

Water Quality Monitoring

Treated runoff from Wetland [East] and Wetland [West] are diverted into the central dam, water from which is then pumped to the irrigation dam within the race track or, alternatively, discharged into Ararat Creek when storage capacity is exceeded. Overflow from Wetland [West] is diverted via the storage tank to the series of frog ponds before discharging excess flows into Ararat Creek.

Due to the importance of preserving the GGF habitat as well as the high value of the turf being irrigated, it is critical that the water quality of the treated stormwater from the wetlands be maintained at the high quality that the MUSIC modelling indicated. The presence of a high water table caused concerns that the groundwater would interact with the treated stormwater, resulting in a high level of salinity in the storage dam and ultimately compromising the irrigation supply, GGF ponds and discharge quality to Ararat Creek.

To address this, stormwater quality monitoring, including salinity testing, was periodically conducted to ensure that this habitat is well preserved. The findings from this monitoring indicate that the water quality requirements are surpassed through the wetland treatment system and are not reduced at the storage stage.

2.2.3 MINIMISING POTABLE WATER CONSUMPTION

One of the principal objectives for the site was to ensure sustainable operations of the grounds, with minimal potable water use for site irrigation. The proposed strategy was to connect to the potable water supply and use this to supplement the irrigation requirements for site establishment. Once the site was fully established and operational, the irrigation supply would be sufficient to meet the site demands and the potable supply would become obsolete.

Stormwater Harvesting and Reuse Design

An irrigation dam is located within the race track and receives treated stormwater runoff that is pumped from the southern treatment system, comprising two wetlands and a dam (refer to Figure 2-9). It was originally believed that the site would require potable water supply for an estimated 12-18 months in order to ensure grounds and vegetation establishment, with sustainable irrigation practice being implemented only once grounds were operational. To cater for this, the irrigation dam was also fitted with an inlet pipe with the potential to fill the dam with potable water from the South East Water (SEW) main system. This would be triggered manually when low water levels were observed in the stormwater treatment system and subsequently in the irrigation dam.

Figure 2-9: Irrigation Transfer Main

Irrigation Demand

From comparable racing complexes such as Mornington Racecourse and Cranbourne Racecourse, it was estimated that an irrigation supply of 150ML/year would suit the demand at the Tynong site. This allows for irrigation of the grass proper and grass inside track plus standard irrigation use for the inside track areas. The requisite irrigation supply is then distributed over the 12 month cycle according to standard seasonal demands as is common practice for existing racing facilities. Irrigation demand for the grounds was determined, taking into consideration efficient turf selection, which was installed to further maximize capture of excess runoff and minimise irrigation requirements.

Using the existing MUSIC model, the parameters for the catchment were used in conjunction with the rainfall data for the extended period. Storage requirements downstream of the wetland were then modelled in order to achieve 90% reliability for a demand of 150ML/year. Based on a 30ML storage dam, a water balance model was analysed using MUSIC model outputs. Results indicated that a yield of 150ML/year is achievable with a 99% efficiency, while a yield of 240ML/year is achievable at 91% efficiency. The remainder of irrigation needs would require accessing the potable water supply connected to the irrigation dam. Larger storage dams were also modelled, with a 40ML dam providing a yield of 150ML at 100% efficiency. Ultimately, a 30ML dam was constructed, providing ample irrigation, not only for maintenance but during the track and vegetation construction and establishment period.

Irrigation Dam Construction

A dam was constructed inside the racing track to supply all irrigation needs for the grounds (refer to Figure 2-10 and 2-11). Treated stormwater is pumped from the storage dam in the south east to top up the irrigation dam as required.

Groundwater issues were observed throughout construction of the site due to the presence of a high water table. These construction issues commenced during initial earthworks and persisted through track construction and turfing. This constraint was particularly taxing while the storage pond was being constructed in 2012. A perched water table was present with seasonal depth fluctuations between 1.5 and 3 metres above the design base of the storage dam. To rectify this, hydrogeological inspections and reports were completed, recommending excavations and rock lining works. This proposed solution would have exacerbated the construction cost.

As an alternative, the base of the dam was lined with a series of drainage pipes, redirecting the water back through the treatment system to be used as a resource in irrigation. The additional water at the site became an excellent opportunity to help ensure that irrigation demands for the site were met, throughout both the establishment and maintenance phase.

Figure 2-10: Irrigation Dam

Figure 2-11: Irrigation Dam Outlet Pump

Furthermore, when the irrigation dam was established, heavy rainfall maintained a high water level in the stormwater treatment network, including the irrigation dam, providing for ample irrigation supply of the grounds, without the need to access the SEW potable water main as initially anticipated. To date, there has been no need to activate the potable water main within the irrigation dam as the treated stormwater runoff being pumped from the southern dam has met the requirements for the site.

2.3 FLOOD MODELING

Runoff from the 1500 ha external catchment flows through the site during large storm events. In pre-developed conditions, this occurred as shallow sheet flow due to the flat grades at the site and poorly defined overland flow paths. This was observed on numerous occasions prior to work commencing on the racecourse, including a storm event in February 2011, which caused significant inundation across the site as illustrated in Figure 2-12.

Figure 2-12: Shallow sheet flow under predevelopment drainage conditions

In order to determine flood levels, above which buildings should be set and design for stormwater conveyance, DCE undertook hydrologic and hydraulic modelling of the site.

2.3.1 HOW MUCH WATER? A HYDROLOGICAL ASSESSMENT

Due to the size of the upstream catchment and limited availability of topographical survey in the area, a hydrological model to obtain hydrographs at key locations was deemed more suitable, rather producing a detailed hydraulic model for the whole catchment. DCE used RORB runoff routing software to determine hydrographs for application at the boundaries of the hydraulic model. Working with Melbourne Water, the catchment management authority for the area, the RORB models were calibrated to existing models for adjacent catchments and flows were estimated using rational method calculations. The peak flows are summarised in Table 2-3.

Table 2-3: Peak flows determined using RORB software

	Catchment Area (ha)	Peak Inflow (m^3/s)
Eastern Catchment	660	19.6
Northern Catchment	844	29.9

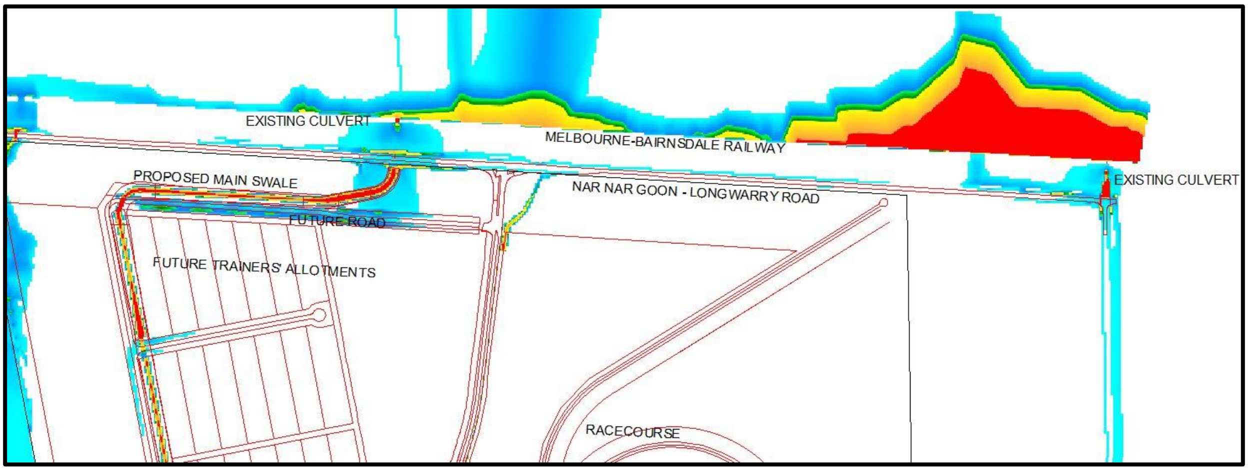
The hydrographs for a range of storm durations and annual recurrence intervals were determined and applied at the upstream boundaries of a two-dimensional hydraulic model.

2.3.2 HYDRAULIC MODELLING

DCE prepared a two-dimensional hydraulic model using Tuflow modelling software. A four (4) metre grid was adopted for the model cell size and applied to a digital terrain model based on site level survey.

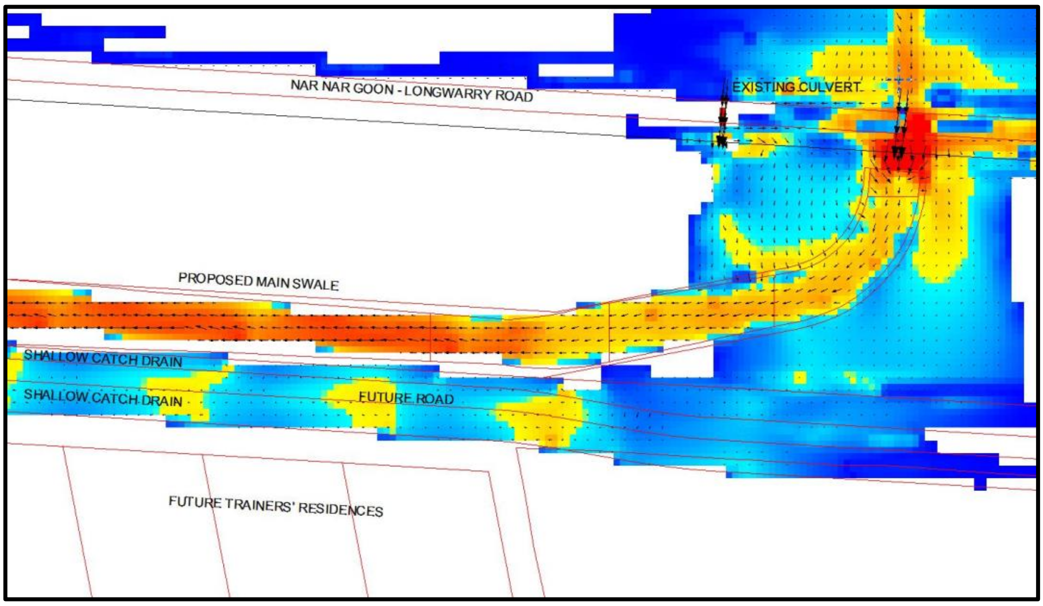
At the upstream extent of the model, the input hydrograph was applied to the existing rural paddock and directed overland. The Melbourne-Bairnsdale railway, which is a raised embankment, was found to act as a dam, with flows only passing at defined culvert and bridge locations (refer to Figure 2-13). Consistent with photos of the 2011 floods, while some of the runoff from the northern catchment bypassed the site in open channels at the east of the site, much of the flows entered the site as sheet flow, and would require management for safe conveyance around the proposed development.

Figure 2-13: Hydraulic analysis of flow depth upstream of the site



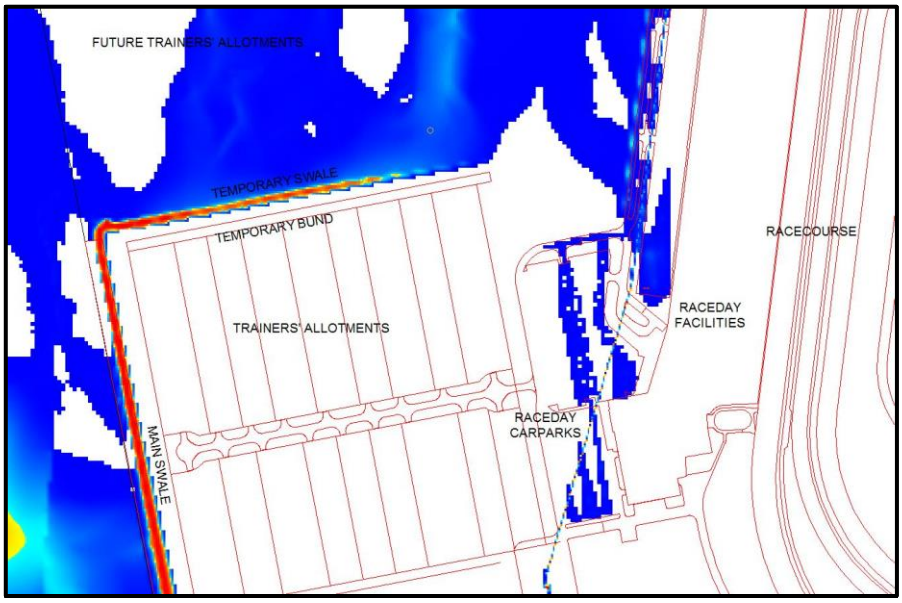
A 20 metre wide swale was designed to convey flows over a distance of approximately two kilometres around the perimeter of the proposed development. Utilising overland flow path maintained the hydrology close to natural conditions, as well as minimising infrastructure cost. The Tuflow model was used to check the suitability of the swale design (Figure 2-14).

Figure 2-14: The Tuflow model demonstrated the effective capture and conveyance of overland flows



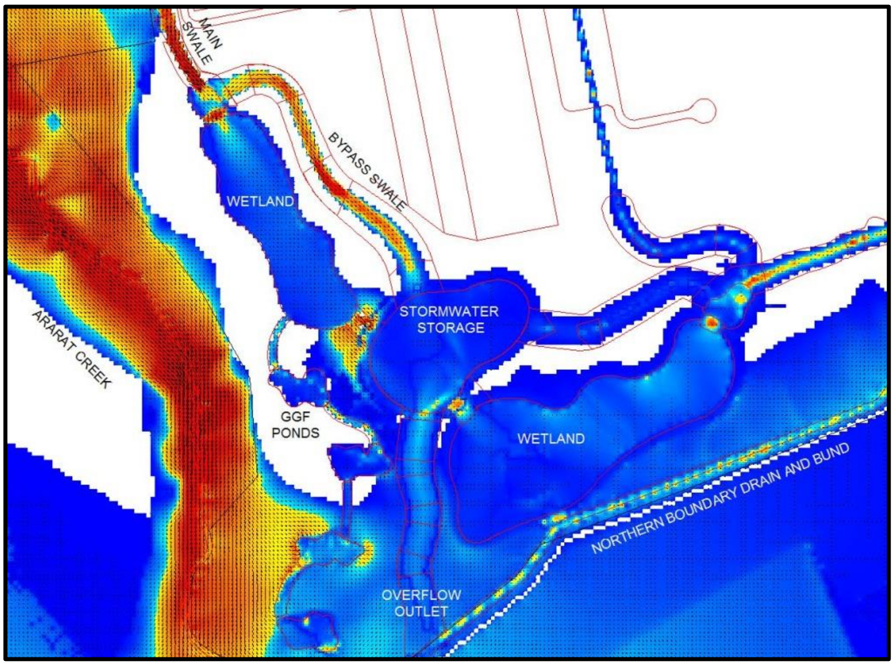
An interim condition scenario was also modelled in Tuflow to verify that construction of the swale could be staged in line with the proposed development. The height of temporary bunds and depth of temporary swales were shown to adequately divert nuisance sheet flows away from the first stage of trainers' allotments (Figure 2-15). Map outputs from the Tuflow model included depth, velocity and hazard distributions. These were scrutinized to ensure that shallow flows developing from rainfall on the site and collecting in race day carparks would not pose a hazard to users during the interim or ultimate conditions.

Figure 2-15: The Tuflow model was used to verify the design of temporary infrastructure



Finally, the velocity outputs were used to verify that the flow velocities entering the wetland during critical duration major storm events were within Melbourne Water's acceptable limits of less than 0.5 m/s. These velocity results were used to refine the extent of proposed rockwork within the wetland system, minimizing the risk of scour and de-vegetation.

Figure 2-16: Flow velocities entering the wetland



3 CONCLUSION

The Pakenham Racecourse relocation project has transformed a 250 hectare swampland within a GWZ with multiple construction, budget and environmental constraints into a world first in stormwater management and environmental sustainability at a grand scale sporting arena.

The proposed development was designed such that the site would be fully sustainable with zero impact on native aquatic habitat, local vegetation or the receiving waterway. To achieve this, the following design objectives were realised:

- All stormwater generated within the site and entering from external catchments are treated through the two wetlands at the south east of the site, prior to transfer to the irrigation dam, frog pond top up or discharge into Ararat Creek;
- All internal and external flows through the site are diverted around the developed grounds to the stormwater treatment and storage system for retention and reuse, minimising increased flows resulting from the development;
- Stormwater is harvested to provide all irrigation needs for the site, minimising requirements for potable water use and maintaining access to the SEW water main for emergencies only;
- Native species of GGF have been preserved at the site through a relocation program within an environmental habitat zone, comprising four (4) frog ponds that interact with the treatment wetlands to ensure water levels and water quality are maintained; and
- Variations to construction costs have been curtailed, minimising unexpected costs where practicable.

This ground-breaking project overcame multiple design and construction constraints including high water table, risk of salinity, presence of GGF, large inflows from external catchments and multiple unexpected variations for an already tight budget. The final product is an impressive state of the art sporting facility, equipped with the latest and greatest racing amenities. Importantly, the site provides an amazing example of integrated water management and preservation of aquatic ecosystem that will safeguard the health of the local environment for the lifetime of the new Pakenham Racecourse and beyond.

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