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Waterway Management Consultants

**173 ELIZABETH STREET,
COBURG**

**STORMWATER DRAINAGE
MASTERPLAN (SWDMP)**

For: WBCM Pty Ltd

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1. INTRODUCTION

This report presents the Stormwater Drainage Master Plan (SWDMP) for the proposed residential development at 173 Elizabeth Street, Coburg. The Masterplan is founded on and incorporates the philosophy and elements of Water Sensitive Urban Design (WSUD).

The subject site was formerly owned by Kodak (Australasia) Pty Ltd and has been cleared and remediated in recent times.

Section 2 briefly describes the development site and proposals.

Section 3 discusses the requirements for a sustainable WSUD strategy, considers issues, constraints and opportunities, lists the general strategy objectives and then sets the specific strategy targets for reduction in potable water supply and wastewater generation and for stormwater quality discharge.

Section 4 discusses the strategy for reduction in potable water supply and wastewater generation.

Section 5 then discusses the strategy for stormwater management and presents the results of MUSIC modelling to demonstrate achievement of overall compliance with stormwater quality targets, taking into account the water reuse in both the public and private realm.

Section 6 presents conclusions and recommendations.

Note: The assumptions made in this strategy in relation to building design and sizing are as known or proposed at this time. Accordingly these assumptions must be subject to change as design and detail planning evolves.

2. THE DEVELOPMENT SITE

The former Kodak site is now owned by Coburg (Victoria) Pty Ltd and is proposed to be developed for residential purposes. The site covers an area of 20.54 hectares on the east side of Edgars Creek in Coburg North, and includes the bridge crossing over Edgars Creek. It is bounded by Elizabeth Street to the east, Ronald and Boyne Streets to the south and has an access point through to Tilley Street to the north.

Figure 1 shows an aerial shot of the site as it was in 1986, whilst Figure 2 is the site Development Plan and Figure 3 is the Indicative Staging Plan.

The 1986 aerial photo and later photos (eg., those supplied with the Stormwater Audit drawings by Golder Associates) show that pre-existing development imperviousness of the Kodak site was higher than the proposed future use. Undeveloped or otherwise pervious areas across the site totalled no more than 2 ha or 10% of the site, implying about 90% average imperviousness. The proposed site imperviousness is about 75%.

2.1 Site topography and existing drainage services

The site has been surveyed as part of the environmental audit undertaken by Golder Associates for Kodak. The high point of the site is located in the North-East corner on Elizabeth Street (approx RL 72m AHD). A broad ridge line falls toward the South-West to Ronald Street and divides the site into two drainage catchments as indicated on Figure 2.

The catchment to the west of the ridge is approximately 11.3 Ha and drains toward Edgars Creek, with the low point in the southwest corner of the site on Ronald Street (approx RL 48m AHD). The existing typical surface grade in this catchment ranges between 5-10%.

The catchment east of the ridge is approximately 9 Ha and drains toward Elizabeth Street. The low point of this catchment is located at the South-East corner at the intersection of Elizabeth and Boyne Streets (approx RL 54.5m AHD). The existing typical surface grade in this catchment ranges between 2.5-5%.

Golder Associates Stormwater Audit Area plans (August 2007) are overlaid on aerial photography and show the former site use, buildings and roads and all stormwater drainage. There are 5 stormwater pipe outfalls to Edgars Creek shown on the plans (and labelled on Figure 2 as EC1-EC5 respectively), as follows:

- on north boundary (external Tilley Street catchment);
- 65 m south of north boundary;
- about 90 m north of existing 15 m water main easement;
- immediately adjacent to north boundary of MW owned pocket of land;
- about 25 m north of SW corner boundary angling NNW out to creek from boundary.

There are 6 outfalls shown to the Elizabeth Street drain as labelled E1-E6 on Figure 2:

- At the existing water main easement (south side);
- At the former site entrance midway between McNamara and Murphy Streets;
- Just north of Murphy Street intersection;
- Just south of Dunstan Street intersection;
- Midway between Dunstan and Jacka Streets;
- At the southeast corner of the site at the Jacka Street intersection.

The 100 year ARI flood levels for Edgars Creek adjacent to the site as calculated by Melbourne Water are 51.50m AHD at the northern boundary down to 45.50m AHD at the Ronald Street boundary. The flood extent is contained within the Edgars Creek drainage reserve and does not affect the subject property.

2.2 Proposed Development and Modelling Estimates

Table 1 summarises current planning proposals for future development and derives areal estimates for use in hydrologic and water quality modelling as part of the WSUD strategy development. The table also includes the assumptions made for WSUD analysis in regard to lot split up of roof area, impervious area and pervious area, and impervious portions for the various road reserves.

In gross figures, approximately 4.81 ha will be road reserve, 1.18 ha open space (including the bridge area), 0.67 ha mixed use and the balance of 13.88 ha will be residential land.

TABLE 1 Proposed Development Characteristics						
Frontage	Lot Coverage	Total Area (ha)	Average lot size (m2)	Roof Area (m2)	Other imperv. area (m2)	Pervious area (m2)
Terrace	14.3%	1.9783	205	110	40	55
Townhouse	44.5%	6.1821	250	130	50	70
Compact	28.4%	3.9418	343	150	77	115
Villa	7.4%	1.0341	412	175	105	132
Courtyard	5.4%	0.7437	507	200	140	167
Subtotal lots	100%	13.88				
7.5 m roads		0.29			100%	0%
15 m roads		3.87			70%	30%
23.5 m roads		0.65			80%	20%
Subtotal Roads		4.81		-		
Reserves		1.18			10%	90%
Mixed use		0.67			80%	20%
Total Site		20.54				

Internal water demand for toilet flushing and washing machine use can be assumed as 50 KL/yr/lot based on 2.3 persons/house.

Garden irrigation can be assumed to be 4 ML/ha of irrigation area=4*pervious area KL/yr/lot.

3. DEVELOPING A WSUD STRATEGY

3.1 General Principles

As set out in Section 1.3 of Australian Runoff Quality –A Guide to Water Sensitive Urban Design (IEAust 2006), the guiding principles of WSUD are centred on achieving integrated water cycle management solutions linked to an ecologically sustainable development focus aimed at:

- Treating urban stormwater to meet water quality objectives for reuse and/or discharge to surface waters;
- Using stormwater in the urban landscape to maximise the visual and recreational amenity of developments;
- Preserving the natural hydrological regime of catchments;
- Reducing potable water demand through water efficient appliances, rainwater and greywater reuse;
- Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities and/or release to receiving waters;

In regard to stormwater (surface water) management ARQ 2006 lists best practice objectives as including:

- providing flood protection and drainage;
- protecting downstream aquatic ecosystems (including groundwater systems);
- removing contaminants;
- promoting stormwater elements as part of the urban form.

The residential subdivision provisions in Clause 56 of planning schemes set out requirements for the design and assessment of residential subdivisions in urban areas throughout Victoria.

Under the provisions of Clause 56.07 all new residential subdivisions must comply with best practice management standards for water quality treatment and, unless approval is given to the contrary by the responsible authority and there are no detrimental impacts downstream, also ensure no increase in peak discharges of stormwater from the development.

The requirements of Clause 56.07 are integrated in the Moreland Planning Scheme and are fully complied with in the adopted WSUD strategy.

3.2 Site Values, Constraints and Opportunities

Selection of appropriate WSUD techniques must address the particular characteristics, constraints, opportunities and values to be addressed and protected on and around the site. For the subject site these are considered to be as follows:

1. The western title boundary to Edgars Creek is not affected by flooding from Edgars Creek in the 100 year ARI event.
2. There are no significant flora/fauna constraints on the site.
3. The Auditors Statement for the site remediation process concludes that all soils on the site have been fully remediated in accordance with the approved Environmental Audit Report and supporting Statements dated 11 April 2008.
4. The existing sedimentation pondages located on the various site outfalls are integral components of the site remediation works which have been formally completed. They will remain essential assets for management of site runoff quality during the estate construction and buildout phases and should be retained and utilized as long as practicable in accord with the approved Erosion and Sediment Control Plan (ESCP).
5. It is likely that the Construction Environmental Management Plan for the development period will need to incorporate additional surface soil protection measures to manage runoff and to allow the sedimentation pondages to be progressively reclaimed during development. Such works could include establishment of grass buffer strips around contour lines, vegetated contour swale drains linking to remaining sedimentation ponds, hydro-seeding to re-establish grass cover and so on. Protection of the bed and banks of Edgars Creek will also be an important issue that will be addressed during the detail design phase.
6. The existing stormwater drainage connections to Edgars Creek and Elizabeth Street drain will be important strategic assets which should be utilized to the maximum extent as part of ultimate site drainage works.
7. The proposed development envisages lower density site coverage of impervious surfaces (and therefore reduced peak runoff rates) than was the case for the former Kodak use.
8. A major water main passes east-west through the site. The proposal to relay the water main offers an opportunity to regrade/change surface levels of the land area and adjust subcatchment boundaries.
9. One external drainage pipeline enters the site from Tilley Street and discharges to Edgars Creek along the north boundary of the site. No other external pipe or overland flow catchments affect the site.

10. There is no visible evidence of significant saline influences on the land however the extreme turbidity levels observed in the existing sedimentation pondages are likely indicators of soil dispersivity problems. Lining of waterbodies or bioretention systems may be needed to suppress the effects of soil dispersivity and to mitigate any seepage losses. The need for and form of specific lining measures will be determined by geotechnical investigations during detail design.
11. An area of up to 2,200 m² may be available for water quality treatment adjacent to Edgars Creek on the south side of the existing bridge, subject to agreement with MWC who own the land.
12. The proposed development will generate large quantities of stormwater runoff from roofs and other impervious areas that could be stored and re-used to reduce potable supply (and thereby assisting with meeting water quality and quantity objectives by reducing stormwater discharge offsite).
13. The development proposals essentially replace impervious surfaces which previously constituted the former industrial area with alternative but similar areas of buildings, roads and other pavements. Hence 173 Elizabeth Street is a “redevelopment” rather than a “greenfields” development. Therefore if compliance with contemporary best practice management objectives can be achieved it should be judged as “turning back the clock” and restoring surface runoff conditions more akin to original pre-urbanisation conditions. This would be a vast improvement on the pre-existing site conditions.

3.3 General Strategy Objectives

In no order of priority, the specific surface water management strategy objectives for redevelopment of the subject site are as follows:

- minimise offsite discharge of stormwater pollutants to the receiving waterway environment, both during development and in the long term;
- ensure any offsite discharge of pollutants generated from the proposed urban development fully complies with best practice management objectives for environmental protection in receiving waterways;
- maintain and if possible reduce peak discharge rates of stormwater runoff from the development, (especially to the Elizabeth Street drain) cf. with pre-existing (Kodak) site conditions;
- take up practical opportunities for reuse of stormwater generated on site, to reduce input of mains water to the property, to reduce wastewater generation, and to reduce volumes and peak rates of discharge of stormwater and pollutants;
- take up opportunities to reduce water consumption and wastewater generation through use of more efficient plumbing fixtures, appropriate landscape vegetation and treatments and education;
- protect the Edgars Creek waterway and riparian environs;
- maximise the environmental, aesthetic and recreational benefits of surface water throughout the development, while ensuring that such use does not result in any loss of user safety or creation of nuisance;
- ensure the overland flow pathways through the proposed estate comply with all MWC floodway safety guidelines;
- protect all new development areas from flooding threats;
- subject to the above objectives being satisfactorily addressed, locate and design surface water management assets to maximise capital returns and minimise operation and maintenance costs in the long term.

3.4 Specific Strategy Targets

In regard to the management of water throughout the development, the following specific water management targets are proposed for 173 Elizabeth Street, Coburg

- (a) Potable Water Supply and Wastewater Generation (refer to Section 4)
 - 40% reduction in potable water input supply volume to the development.
 - 40% reduction in total wastewater volume (blackwater and greywater) generated and disposed of from the development to the sewerage system.
- (b) Stormwater (refer to Section 5)
 - Compliance with contemporary best practice standards for stormwater discharge quality to the receiving environment (currently 100% removal of gross pollutants >20 mm in 3 months ARI flow, 80% reduction in total suspended solids (TSS), and 45% reduction in both total phosphorus (TP) and total nitrogen (TN)).
 - No increase in peak rate of stormwater discharge compared with pre-existing (Kodak) site conditions, for all events up to and including the 100 year ARI event.

4. POTABLE WATER SUPPLY AND WASTEWATER GENERATION

4.1 General

Reduction in consumptive use of potable water, reduction in discharge of waste water (grey and black) requiring treatment offsite, and reduction in stormwater discharge requiring treatment onsite, will follow from implementing best practice water management actions in the urban environment.

Some of the options are:

- Use of low water use plumbing fittings and appliances throughout the development;
- Consideration of use of fixtures such as “waterless urinals” in toilets;
- Selection of landscape treatments and vegetation communities for both the private and public domains that have high drought tolerance and low general irrigation needs;
- Storage and reuse of roof water;
- Use of air-cooled or other non-freshwater cooled airconditioning systems.

The specific targets are:

- 40% reduction in potable (mains) water input supply volume to the development.
- 40% reduction in total wastewater volume (blackwater and greywater) generated and disposed of from the development to the sewerage system.

Reduction in overall water use is achieved by more efficient use of water (referred to as demand management).

The byproduct of more efficient use of water within the buildings is reduced quantity of wastewater to be discharged from the development to the sewerage system.

Reduction in potable (mains) water input volumes is also achieved by replacement of part of the potable mains supply need with rainwater.

The byproduct of re-using rainwater is reduction in discharge of stormwater volumes from the development to receiving waterways and reduced costs of quality and quantity treatment.

4.2 Demand Management Savings

In WSUD Engineering Procedures: Stormwater (2005), information is presented on historical residential water use in Melbourne (estimated by Melbourne Water 2001), and on potential demand savings via water efficient appliances and fittings (estimated by NSW Department of Infrastructure Planning and Natural Resources (2004)).

The figures summarised in Table 2 indicated a potential 35% reduction in internal water use (and hence wastewater generation) was achievable at that time simply through appliance and fittings efficiencies.

TABLE 2 Residential Water Use Estimates (MW 2001)			
Internal Uses	Pre-WSUD (KL/person/yr)	%total	Water appliance and fittings efficiency savings (NSW DIPNR 2004)
Kitchen	5	5	
Laundry	14	15	
Toilet	18	19	
Bathroom	24	26	
Total Internal Use	61	66	21 (35%)
Total External Use (garden etc)	32	34	-
Total Internal+external	93	100	21 (23%)

Contemporary appliances and fittings are now capable of higher efficiencies than those listed in Table 2 and labelling is now governed by the WELS scheme.

WELS is Australia's Water Efficiency Labelling Scheme that requires certain products to be registered and labelled with their water efficiency in accordance with the standard set under the national *Water Efficiency Labelling and Standards Act 2005*. The scheme rates products as having up to 6 stars for water efficiency-the more stars the better in terms of water efficiency. The scheme replaces earlier AA... rating systems. The WELS Scheme excludes second-hand products and products imported into Australia for personal use.

The water-using WELS products are listed in Table 3 together with efficiencies for base case (0-1 star WELS) and 3 and 4 Star WELS, based on the WELS website (http://www.environment.gov.au/wels_public/productSearch.do).

Toilets that have a higher flow rate than 5.5 litres per average flush volume (<50-55% efficiency) cannot be supplied. Waterless urinals are not currently included under WELS.

TABLE 3 Water Efficiencies						
Product	0-1 Star WELS (base case)		3 Star WELS		4 Star WELS	
	Water Use	Water Savings	Upper limit Water Use	Water Savings (*)	Upper limit Water Use	Water Savings
Showers	15+ L/min	-	9 L/min	>=40%	7.5 L/min	>=50%
Tap equipment	12+ L/min	-	8 L/min	>=33%	7 L/min	>=42%
Toilet (lavatory) equipment	12L+/flush	-	4L/flush	>=67%	3.5	>=71%
Clothes washing machines (top load)	28 L/kg wash	-	14 L/kg wash	>=50%	10 L/kg wash	>=64%
Dishwashers	2.1 L/place setting	-	1.22 L/place setting	>=42%	1.14 L/place setting	>=46%

(*) Relative to base case

There are various scenarios for reduction in water usage which will also relate to the probability of “market acceptance” to the fitting/appliance selection.

Using bathroom shower heads as an example, it may be anticipated that the more efficient the device is (eg., the more restricted the shower spray is), the less likely that it will be “acceptable” to the end user. Current fixtures without regulators typically use 15 l/min or more (the pre-WSUD or base case). With regulated fittings likely to have high acceptance, water usage would drop to 9 l/min (~3 star), for medium acceptance to 6 l/min (~4 star) and for low acceptance to 4.5 l/min (5-6 star).

In regard to dual flush toilet cisterns high acceptance is assumed to equate to 3-star WELS, medium acceptance to 4-star WELS and low acceptance to 5-star WELS. The higher the efficiency the less the flush volume and the more important is the provision of (a) adequate slopes on sewer outlet pipes and (b) use of best quality toilet paper to mitigate blockage threats. The former is a design issue that can be guaranteed. The latter is controlled by the end-user and cannot be relied upon.

In regard to tap sets, experience indicates there is little real concern over water delivery up to 5 star WELS at least.

A strategy based on minimum 4 star WELS fittings in residential developments will meet market user expectations and usually achieve savings of 40% overall in internal water use (and hence wastewater generated). If 4 star WELS appliances are also installed by purchasers, the figures show that water demand savings will be higher. Current market surveys show there is now little cost difference between 3 and 4 star appliance costs and retailer sales lists are dominated by 4 star+ appliances.

Thus demand management alone can achieve the best practice mains water supply target for internal use in residential developments and thereby the wastewater generation reduction target as well.

4.3 Other Savings

The target for reduction of potable water supply input can be supplemented with additional savings which could be achieved through:

- (a) drought-wise landscape design and planting for both the public and private realms to reduce irrigation needs, and/or
- (b) to the extent practically feasible, replacement of potable water supply with roof water on each future building development.

For detached residential housing, harnessing of roof water via suitable raintanks for toilet flushing and external garden uses can easily achieve reductions in potable supply needs of over 30%. Rainwater tanks are to be included for all buildings and are discussed and evaluated further in Section 5.

The decision to adopt rainwater tanks guarantees that, in conjunction with demand management, the target for reduction in potable water supply needs will easily be achieved.

Coburg (Victoria) Pty Ltd intends to “build-out” the development and hence there is full confidence that:

- the proper sizing, installation and plumbing of raintanks will be achieved; and
- the proper selection and fitting of efficient plumbing fittings/fixtures will be made.

Treatment and Reuse of Wastewaters is Not Proposed. Although scope remains for additional savings in potable water supply input through treatment and reuse of grey and black wastewaters, such action does not form part of a feasible strategy for detached housing on a redevelopment or infill site such as at 173 Elizabeth Street in Coburg. The ultimate highly fragmented lot ownership is not practically suited to onsite packaged wastewater treatment and reuse systems. Discharge of (reduced quantities) of wastewater to the regional treatment systems is the practical and sustainable approach.

5. STORMWATER

5.1 WSUD Options

Excess water overflowing from any storage systems (collected from the roof areas) joins with surface runoff from the balance private and public realm land surfaces (balance lot areas, roads, carparks, promenades, parks) to form the stormwater stream.

Management of this stormwater stream must achieve compliance with the stated best practice standard targets prior to discharge to the receiving environment of Edgars Creek, the Yarra River and Port Phillip Bay. This will involve treatment of the water and possibly reuse of some water.

Note: The compliance achievement is referenced to the total source runoff load (volume of water and pollutant loads) on any development which includes all roofs and land surfaces. It follows that any steps taken to intercept roof water and divert it away from the stormwater stream must significantly contribute to achievement of the stormwater target and lessen the need for treatment. Hence reuse of roof water not only reduces input potable supply needs it also reduces stormwater management costs.

Constructed wetlands are one WSUD treatment approach, where management response is concentrated into one or more defined areas. However in the medium-high density inner-suburb environment few suitable areas for such facilities will be found.

Other techniques that are currently being actively promoted by bodies such as Melbourne Water (MW) and the EPA, focus on the site or precinct scale and are aimed at reducing runoff peaks, delaying runoff response and minimising transportation of sediments through the use of "natural" drainage line treatments, swale/trench infiltration systems, grass buffer strips and the like. WSUD techniques that can be applied at the site (individual lot) or precinct scale, offer potential for achieving required water quality treatment with reduced impact on developable land yield.

More recently, much greater emphasis has been placed on re-use potential of stormwater to reduce mains water usage and downstream impacts of increased stormwater runoff frequency and volumes. Better management and integration of the urban water cycle is seen by most as being imperative for maximising longer term environmental improvements in our receiving waterways and bays, as well as for lowering the need for further water harvesting.

From the site values, constraints and opportunities discussed in Section 3.2, it is possible to short list and assess likely feasible WSUD options for water quality and quantity management on the subject site.

5.2 Strategy Approach

Based on pre-existing site and surround conditions and the proposed development form and density, it is considered that a feasible strategy will incorporate some or all of the following items:

- Use of some or all of the existing pipe outlets to Edgars Creek and Elizabeth Street Drain as drainage outfalls for the development.
- On-site water quantity (peak flow rate) mitigation is not required on equity grounds because ultimate site imperviousness will be less than in its former Kodak industrial state, as shown on aerial photos.
- A contribution towards on-site water quantity (peak flow rate and volumes) mitigation could only practically be achieved through the use of properly plumbed rainwater tanks on each building.
- Rainwater tanks which are properly plumbed to meet toilet flushing and external garden needs will effectively address mains water use minimisation objectives whilst mitigating pollutant discharge and volume, frequency and peak flow rates of stormwater discharge from allotments. In this instance tank sizing can be based on using all of the available storage volume to achieve an optimal outcome in regard to potable water savings. Mains water backup connection is needed for internal uses but not to external uses.
- Thus the use of raintanks would resolve most issues associated with lot runoff (thereby contributing to reduction in site discharge frequency and volumes) and leave runoff quality control from the road pavements as the primary residual management task.
- In order to further lessen peak runoff to the Elizabeth Street Drain catchment, pipe flows could be diverted from that area north of the water main reserve westwards to Edgars Creek. Pipeflow diversion may also prove cost effective as it removes the need for a deep pipe crossing under the water main. Relatively minor landforming of the reserve and environs in conjunction with the relaying of the water main would facilitate this objective. Overland flows could still follow their natural pathway if required.
- The final formed water main reserve could incorporate a landscaped vegetated swale with bioretention segments as well in some areas. The swale would need to be located outside the water main trench to comply with MW requirements.
- The central east-west roadway could have a central median (at least where shown as 23.5 m wide) which could be designed to incorporate a bioretention or vegetated swale with grass buffers.

- Formal landscaped bioretention systems could be integrated in the 15 m road reserves between the footpath/s and the back of kerb. Best practice treatment efficiency for such assets is achieved when lot drainage is connected to kerb gutters and not discharged to deep pipes where end-of-pipe treatment then becomes the only option.
- Bioretention or vegetated swales could be located in the fringing reserves along the Edgars Creek north of the bridge and in the northwest corner of the site.
- Commercial pre-fabricated passive filter pits could be a feasible option in the residual southwest catchments to Edgars Creek with bioretention basin/s or swale/s along the creek frontage reserve for TN removal.
- If the MWC-owned land adjacent to Edgars Creek becomes available for stormwater management use through negotiation then a landscaped sedimentation/biotention basin system could replace other assets in that catchment. As there can be no guarantee that MWC will agree to such an asset being constructed on their land, the strategy identifies this only as an opportunity at the present time.
- The proposed mixed use site on the Elizabeth Street frontage between Murphy and McNamara Streets will require additional protection due to higher litter generation potential. Grated side-entry pits would largely address this requirement if acceptable to Council. If that practical solution is not acceptable to Council, it would be necessary to install one or more pit-style litter GPT's. Bioretention systems can also be easily integrated with parking bay barriers in this part of the site to deal with carpark runoff contaminants. Raingardens could also be integrated with landscaping.
- Due to narrow road reserves and limited open space reserves, commercial pre-fabricated passive filter pits could be an option in the residual southeast corner catchment to Elizabeth Street, to the south of the water main reserve. There may be a shortfall in TN removal in this subcatchment unless bioretention systems can be integrated in the 15 m road reserves between the footpath/s and the back of kerb. Otherwise a shortfall in treatment in this catchment could be made up by over-treatment in the balance outfalls to Edgars Creek.

Given the spatial constraints in roads and open space strip reserves, it is likely that there will need to be a high degree of formality in the landscape design elements of the bioretention systems. Best practice treatment efficiency for such assets is achieved when lot drainage is connected to kerb gutters and not discharged to deep pipes where end-of-pipe treatment then becomes the only option.

Photos of example applications of bioretention systems in various settings in urban developments are attached at the end of this report.

A formalised landscape design version of the road insert systems at Cremorne Street (Photo 1) and Mernda Villages (Photos 5 and 6) may offer good possibilities for this project within the 15 m and wider road reserves and for the carparks on the mixed use site. The main entry road central median could also be integrated with a bioretention or vegetated swale such as in Photo 2 or in later photos taken from WSUD Engineering Procedures-Stormwater (pub. CSIRO 2006).

Landscape design will be a key factor in the successful integration of such works in this project.

5.3 Scaling of Water Quality Treatment Systems

5.3.1 Modelling Approach

Given the spatial restrictions on placement of surface water treatment assets in a higher density development of this nature, the favoured measures will be based firstly on raintanks (to reduce runoff volumes and pollutant loads to be treated), and then bioretention systems to achieve the balance treatment capacity required.

The MUSIC model is an ideal tool to assess the effectiveness and sensitivity of sizing of these measures.

Table 1 summarises the subcatchment data and applies the estimating relations from Section 2.2. At this time only the indicative staging of the development has been determined (Figure 3) and no detail on lot distribution within individual stages is yet available.

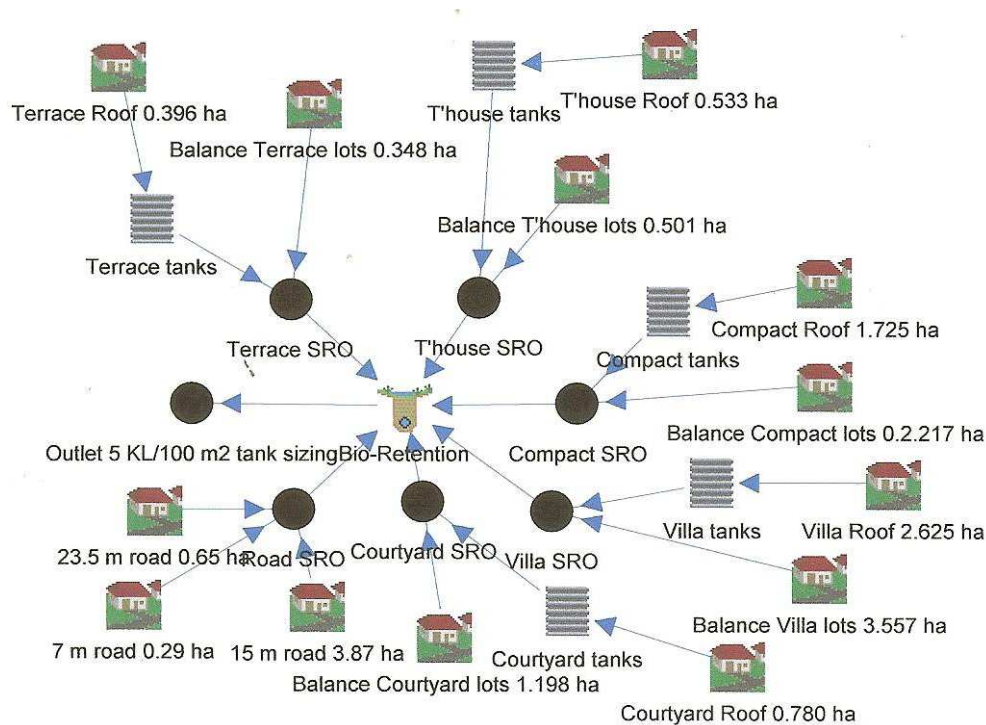
5.3.2 MUSIC Model Setup

The MUSIC model was prepared to allow easy modification for a variety of tank sizes and lot applications, lumping the lot frontage classes together from Table 1 and with a common bioretention node configured as the terminal treatment, as indicated in the following model schematic.

The reserves and mixed use areas were not included at this time because the intention was primarily to assess residential tank sizing implications.

The 6 options set out in Table 4 were run with the area of bioretention required to achieve compliance with the minimum best practice standards being the variable.

TABLE 4 Design Options assessed with the MUSIC model	
Option	Description
1	5 KL/100 m ² roof area tanks for all lots (as depicted on the model schematic)
2	3 KL/100 m ² roof area tanks on all lots
3	No tanks on Terrace lots, 3 KL/100 m ² roof area tanks on all other lots
4	No tanks on Terrace and Townhouse lots, 3 KL/100 m ² roof area tanks on all other lots
5	No tanks on Terrace lots, 3 KL/100 m ² roof area tanks on Townhouse and Compact lots, 5 KL/100 m ² roof area tanks on all other lots
6	No tanks anywhere



MUSIC Model SCHEMATIC for Case 1

The MUSIC model was established using the following parameter values:

- Melbourne 1959 6 minute rainfall sequence as recommended by MWC;
- Rainwater storage assumed to be circular;
- Bioretention systems assumed to have 150 mm extended detention depth, 0.90 m filter depth, 0.7 mm particle size and 360 mm/hr hydraulic conductivity, and surface area the same as filter area reflecting likelihood of mostly hard-edge formalised landscape design.

The model arrangement shown in the schematic assumes that the bioretention system (BRS) intercepts all water from the catchments. This is only true where:

- the BRS is located at the end-of-pipe in a reserve, or
- an alternative distributed network of BRS assets can be located in the streets to command (by gravity) all upstream local catchments.(this in effect requires lot drainage to be connected to gutter inverts and not to deep pipe systems).

The only locations where an end-of-pipe BRS can be built are:

- The EC2 outfall reserve flanking Edgars Creek (restricted space);
- The courtbowl area flanking Edgars Creek north of the EC5 outlet (restricted space);
- Along the northern frontage of the main east-west road-west of the roundabout (15 m section);
- Along the median of the 23.5 m entry road.

If additional BRS area is needed it must be found within the 15 m streetscape design in the 2.5 m verge offsets between kerbs and footpaths.

The option of using parts of the MWC reserve abutting Edgars Creek (EC4 and EC5 outlets) may eventually prove feasible. However because no formal agreements are in place with MWC, this option cannot as yet form part of the drainage strategy.

5.3.3 MUSIC Results and Discussion

The results in Table 5 show that for the proposed lot splitup:

- Total source runoff from the Terrace lots is just 4.3% of total site source runoff.
- Total source runoff from the Townhouse lots is just 5.9% of total site source runoff.
- Without tanks the stormwater runoff from the developed site will be 77.5 KL/year, and a BRS area of at least 1,100 m² will be required for the site to comply with the minimum best practice standards. Distributed equally across the residential/road catchment, this equates to 60 m²/ha of development. (Note: This estimating rate can be used to assess BRS requirements for the mixed use site as well).
- Inclusion of tanks markedly improves nutrient removal performance cf. the no-tank option. This is to be expected since reuse of water is 100% efficient in

removing pollutants from the stormwater stream and TN generation is similar regardless of surface type.

- 5 KL/100 m² tank sizing reduces stormwater runoff by 25 ML/yr (from 77.5 ML/yr to 52.5 ML/yr or 32.5%) with a mains water replacement saving of an equivalent amount, at the cost of 370 m² of BRS area (a saving of 730 m² cf. no tanks). Distributed equally across the residential/road catchment, this equates to 20 m²/ha of development.
- Reducing raintank sizing across the board from 5 KL/100 m² to 3 KL/100 m² of roof area increases stormwater runoff by just 3.1 ML/yr (and increases mains water consumption by the same amount), at the cost of an extra 20 m² BRS area.
- Also deleting raintanks from the Terrace lots increases stormwater runoff by a further 1.7 ML/yr at the cost of an additional 30 m² of BRS area.
- Also deleting raintanks from the Townhouse lots increases stormwater runoff by a further 2.3 ML/yr at the cost of an additional 10 m² of BRS area.

5.3.4 Implications of MUSIC Results

The Need for Tanks

The figures confirm the need for raintanks across the development, especially in catchments where space for alternative treatment systems is problematic. Experience shows that attempting to provide at least 60 m² BRS/ha in 15 m streetscapes will prove unfeasible from either cost and/or landscape design/road safety aspects.

Tank Sizing

It would appear from these results that in this situation no significant problems would arise if tank sizing was uniformly reduced to 3 KL/100 m² roof area. This assumes that 100% of the house roof areas are directed into the tanks on each lot and that the whole tank storage is used for reuse.

Terrace Tanks

With such a small area of Terrace lots the deletion of tanks altogether would not present significant problems in regard to the scale of additional treatment requirements.

Townhouse Tanks

Deletion of the Townhouse tanks appears attractive for similar reasons as the Terrace lots. However the location/density of the Townhouse lots across the development may need to be considered in more detail before a final decision is made. Deletion of these tanks remains an option.

Inserting BRS Assets in the 15 m Streetscape Design

Landscape design and road traffic criteria will determine the potential design layout for BRS assets inserted into these streets. However Council policy in regard to drainage design standards will play a key role in determining final outcomes.

To achieve required water quality outcomes the local drainage networks and BRS assets would ideally need to have the following characteristics:

- Have all lot drains exiting to the gutters;
- Have the BRS assets located immediately on the upslope side of side entry pits;
- Have the surface level of the filter media set at least 100 mm below the inlet gutter level;

Where lot drains must be located at the rear of lots because of topographic constraints, then gravity drainage to the streetscape BRS assets will not be possible and end-of-pipe BRS assets will be required.

Similarly, if Council design policy prevents connection of lot drainage to the gutters then a significant component of the lot drainage discharge will connect to deep pipes. Hence streetscape BRS assets will only deal with runoff from the street reserves, which lowers efficiency of treatment and forces additional end-of-pipe assets to be provided to achieve overall compliance with best practice targets. This would then equate to an increased overall maintenance requirement for Council after asset handover.

It follows then that to do more detailed assessment will also require the stormwater drainage network layout design to be completed. Such design is the next step in the process given that at this time only the indicative staging has been determined (see Figure 3).

In summary then, the clear implications of the MUSIC results are that:

- some mix of end-of-pipe and distributed BRS assets will be required as part of an efficient and sustainable strategy;
- raintanks are an essential component of the overall SWDMP;
- Options 2-5 in Table 4 remain viable options to be considered in the next step of the design process;

TABLE 5 MUSIC results for varying raintank application across residential areas

Case	Parameter	Load removal (%)	End-of-pipe BRS Area (m2)	Flows Discharged (ML/yr)						
				Terrace lots	Townhouse lots	Compact lots	Villa lots	Courtyard lots	Roads	Total
1	Flow (ML/yr)	36.5	370	1.4	2.1	8.9	14.7	4.9	20.5	52.5
	TSS (kg/yr)	80.0								
	TP (kg/yr)	67.8								
	TN (kg/yr)	58.1								
2	Flow (ML/yr)	33.1	390	1.6	2.4	9.8	15.9	5.2	20.5	55.4
	TSS (kg/yr)	80.0								
	TP (kg/yr)	67.4								
	TN (kg/yr)	55.5								
3	Flow (ML/yr)	31.0	420	3.3	2.4	9.8	15.9	5.2	20.5	57.1
	TSS (kg/yr)	80.2								
	TP (kg/yr)	67.5								
	TN (kg/yr)	54.5								
4	Flow (ML/yr)	28.2	430	3.3	4.6	9.8	15.9	5.2	20.5	59.4
	TSS (kg/yr)	80.7								
	TP (kg/yr)	67.0								
	TN (kg/yr)	52.6								
5	Flow (ML/yr)	32.7	385	3.3	2.4	9.8	14.7	4.9	20.5	55.6
	TSS (kg/yr)	80.1								
	TP (kg/yr)	67.5								
	TN (kg/yr)	55.3								
6	Flow (ML/yr)	4.0	1,100	3.3	4.6	17.2	26.7	8.4	20.5	77.5
	TSS (kg/yr)	87.9								
	TP (kg/yr)	68.8								
	TN (kg/yr)	45.2								

6. SUMMARY AND CONCLUSIONS

The recommended strategy has the following components:

- Raintanks to be provided in the development
- Final sizing and application of raintanks to individual lots remains open for detail consideration. Options 2-5 in Table 4 are all feasible.
- All rainwater tanks are required to serve 100% of the house roof area and be plumbed for internal toilet flushing and washing machine use as well as external garden needs.
- Distributed bioretention systems to be inserted in 15 m and 23.5 m roadways and carparks (Photos 2, 5+6 and others);
- Bioretention systems inserted in selected linear reserves such as the water main and creek frontage areas;
- Grated side-entry pits in mixed use carpark areas;

Other options that may be considered during detail design include:

- pre-fabricated underground pit treatment systems, and
- pipeline diversion of the existing area north of the water main out of the Elizabeth Street Drain catchment, westwards to Edgars Creek (to reduce flows in the Elizabeth Street Drain catchment).

MUSIC modelling in Section 5.3 shows that all options can be designed to be compliant with all of the specific targets for stormwater management.

A key determinant of treatment efficiency of the ultimate drainage system (and long term maintenance effort and cost) will be Council policy in regard to connection of lot drainage to street gutters in lieu of deep pipe disposal. Deep pipe disposal dictates end-of-pipe treatment approaches.

Demand management through use of efficient plumbing fittings and replacement of potable supply for selected uses (via raintanks) will easily achieve compliance for targets of wastewater and potable water minimisation.

Compared with the pre-existing (Kodak) site conditions, raintanks can reduce annual volumetric stormwater discharge from the site by up to 30% (and further reduce potable water supply needs by an equivalent volume) and contribute to reduction in peak discharge rates as well.

Considering the vast extent of untreated impervious area that previously existed on the site with no quality or quantity treatment whatsoever, the achievement of the WSUD strategy for 173 Elizabeth Street Coburg will be a most noteworthy outcome for the receiving environment.

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7. ABBREVIATIONS AND DEFINITIONS

AHD	Australian Height Datum. Common base for all survey levels in Australia. Refers to height in metres above mean sea level.
ARI	Average Recurrence Interval. The average length of time in years between two floods of a given size or larger
Ephemeral	Waterways which flow for only short periods of time after significant rainfall events. Also refers to wetlands which are either rarely inundated or only inundated for a very short period of time.
Evapotranspiration	The loss of water to the atmosphere by means of evaporation from free water surfaces (eg. dams or lakes or wetlands) or by transpiration by plants
Groundwater	All water stored or flowing below the ground surface level
ha	Hectare (10,000 square metres)
km	Kilometre (1000 metres)
m ³	Unit of volume = cubic metre. 1 m ³ = 1000 litres=1 Kilolitre
m ³ /s	Unit of discharge = cubic metre/second
ML	Megalitre (1000 cubic metres)
MWC	Melbourne Water Corporation
Pond	A small artificial body of open water (eg. dam or small lake)
Retarding basin	A flood storage dam which is normally empty. May contain a lake or wetland in its base
Sedimentation basin (sediment pond)	A pond that is used to remove sediments from inflowing water mainly by settlement processes. Edge zones may have similar appearance to wetland margins.
Surface water	All water stored or flowing above the ground surface level
Swale	A drainage line with essentially trapezoidal cross-sectional form. Can have rocky or soil bed form, be fully vegetated with indigenous species, or grassed. The base can be fitted with a filter zone to further assist in pollutant removal (termed a bio-retention swale). Foundations can be ripped to encourage seepage losses in suitable soils.
Waterlogging	Term used to describe saturated surface soil conditions where some free surface water may also be present
Wetland	A transitional area between land and water systems which is either permanently or periodically inundated with shallow water and either permanently or periodically supports the growth of aquatic macrophytes (eg. swamp, marsh, fen, bog)

8. REFERENCES

Institution of Engineers, Australia (1987), <i>Australian Rainfall and Runoff, A Guide to Flood Estimation</i>
Stormwater Committee, Victoria (1999), <i>Urban Stormwater Best Practice Environmental Management Guidelines</i> . Pub. CSIRO
Engineers Australia, (2006), <i>Australian Runoff Quality. A Guide to Water Sensitive Urban Design</i>
WSUD Engineering Procedures Stormwater, pub. CSIRO 2006

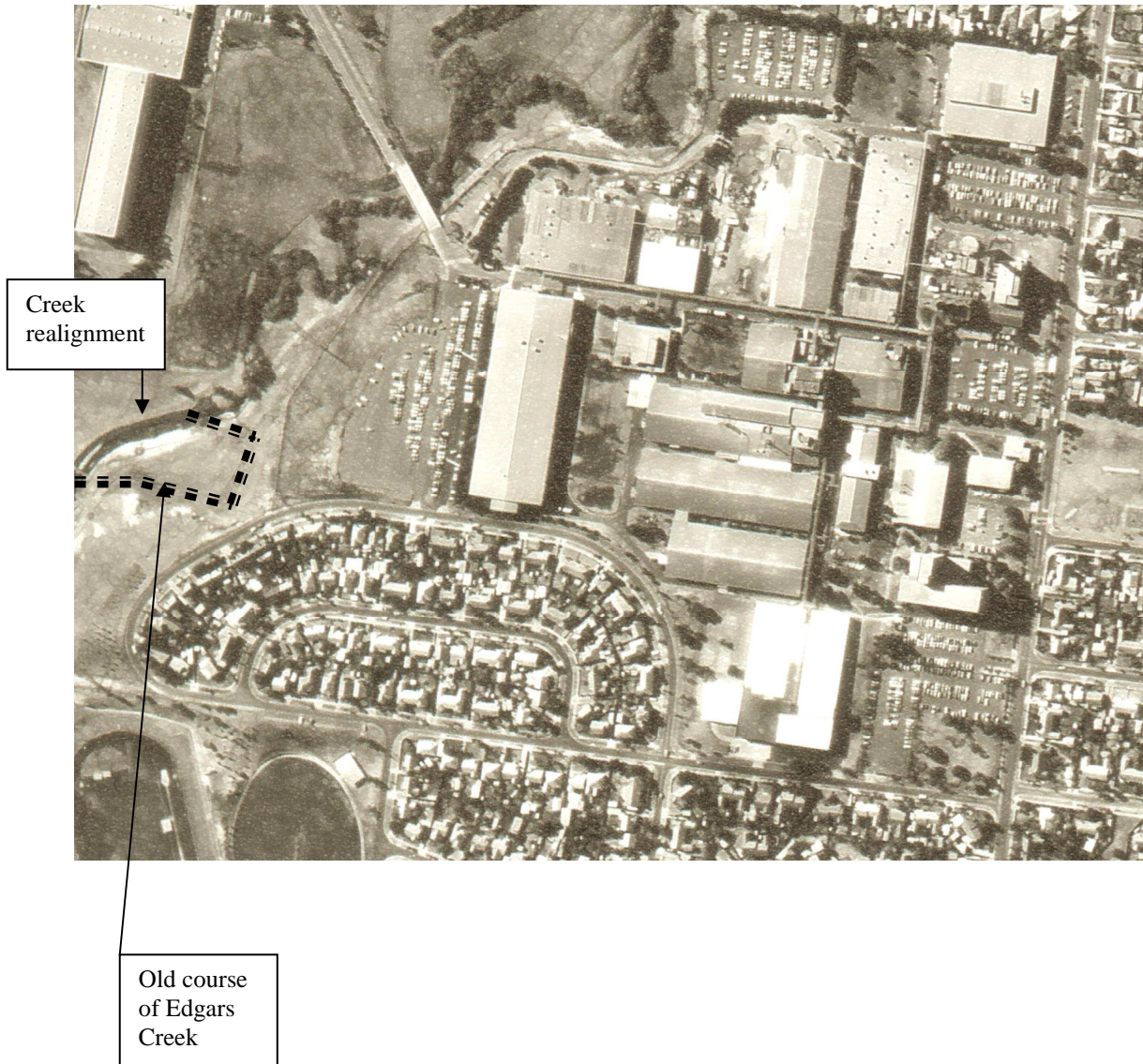
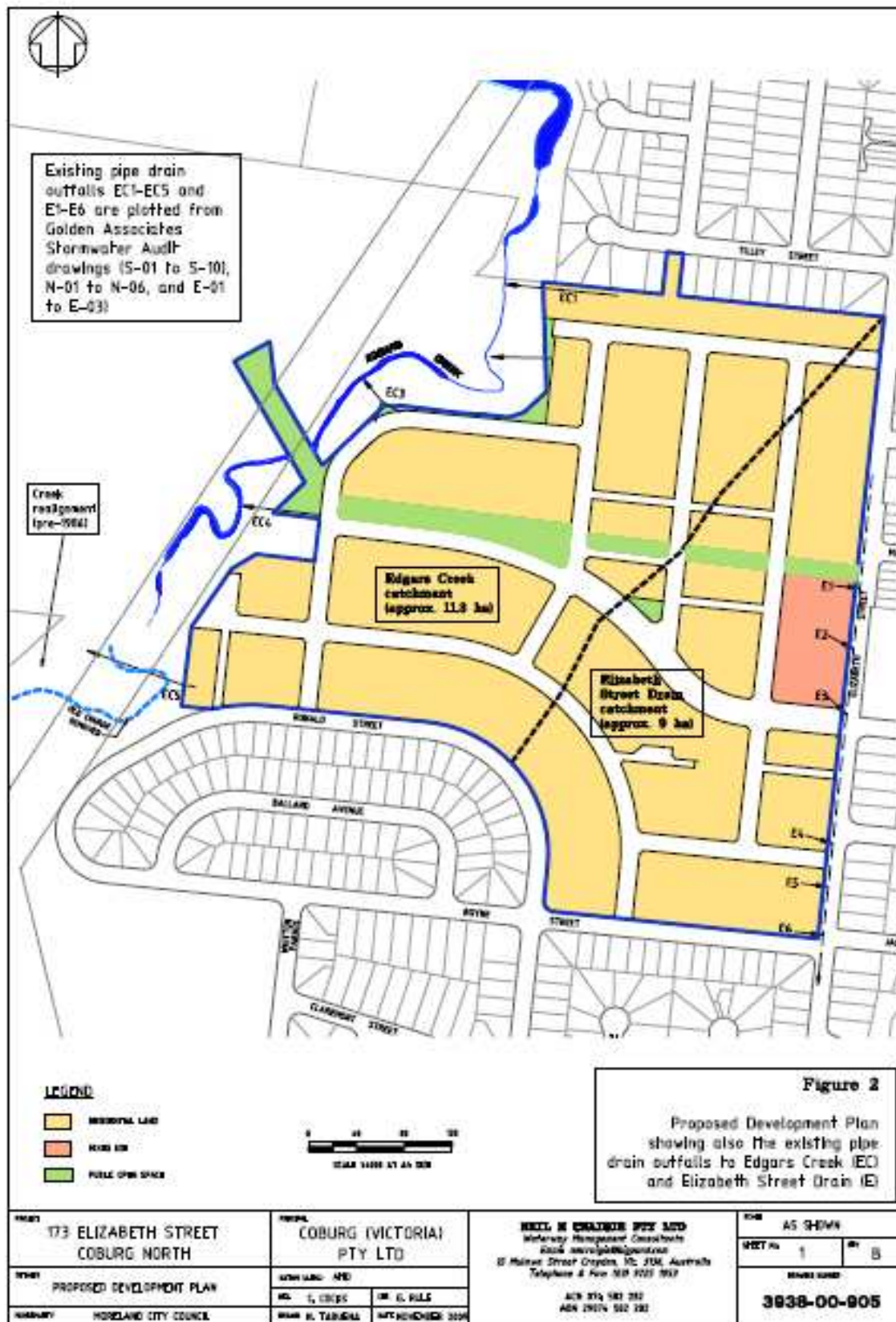


Figure 1

Extract from 1986 Aerial Photograph showing the very high density site coverage of the Kodak (Australasia) P/L property and the realigned course of Edgars Creek in the southwest corner of the site.



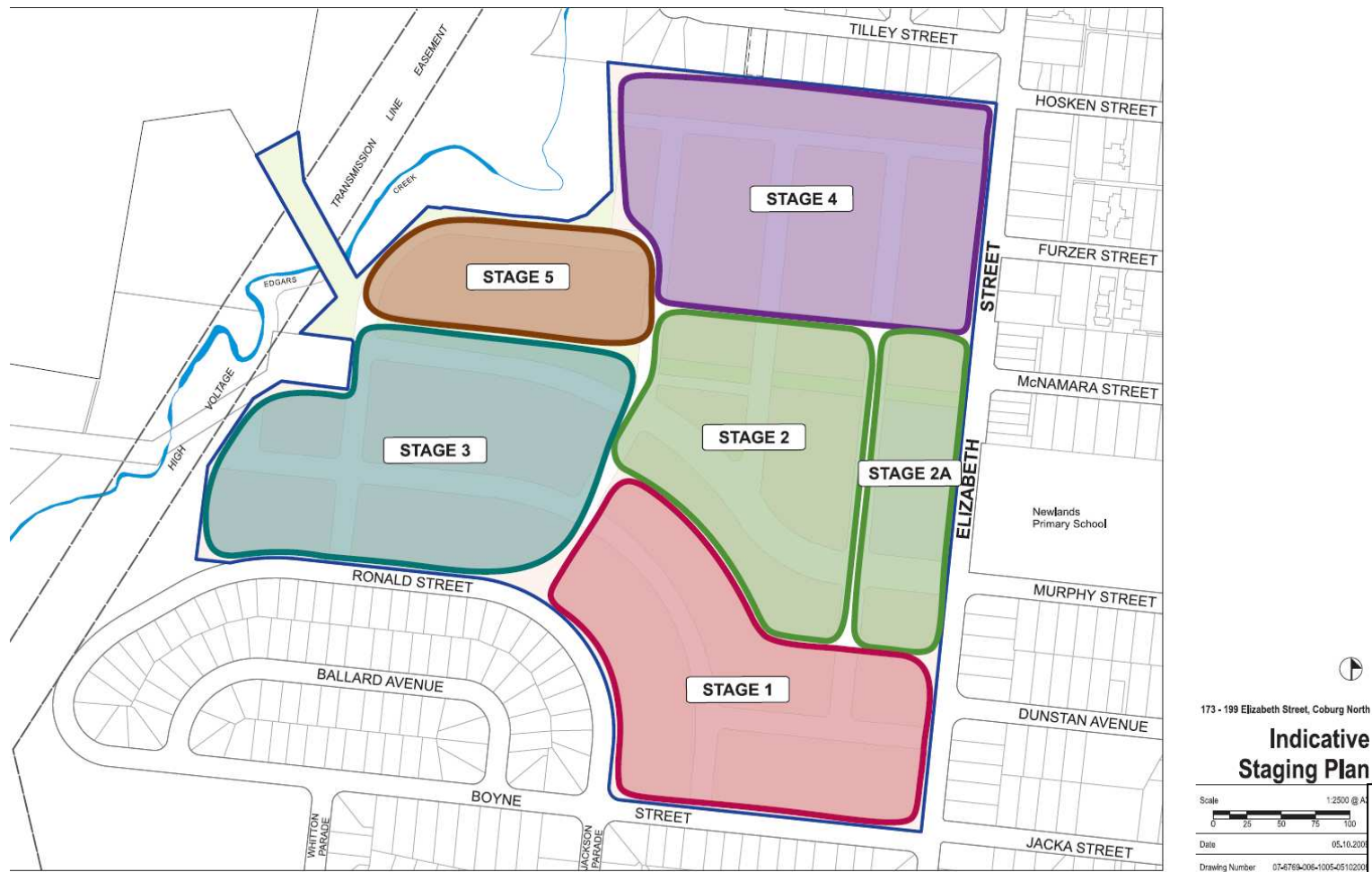


Figure 3
Indicative Staging Plan

**EXAMPLES OF BIORETENTION FACILITIES INTEGRATED WITH
STREETSCAPES AND LOCAL PARKS IN URBAN ENVIRONMENTS.**



Photo 1 Cremorne Street, Richmond BRS in conjunction with parking indents



Photo 2 Tenterfield Estate BRS in road median (VicUrban)



Photo 3 and 4 Lincoln Heath Estate BRS Systems in local park settings





Photos 5 and 6 BRS inserts to road pavement/footpath verge at Mernda Villages. In the photo above bioretention swales are also integrated into the carpark buffer spaces within the pavement area.





Photo 7 Lake Caroline Town Centre BRS-Delfin Lend Lease (TCL)-just after construction

The following photos (8-17) of established BRS basin and swale systems are all taken from WSUD Engineering Procedures-Stormwater (pub. CSIRO 2006)



