WATER SENSITIVE URBAN DESIGN

Demonstration Site Fact Sheet:

KINROSS BUSINESS & INDUSTRIAL PARK, HEATHERBRAE

SITE TYPE	**Brownfield Industrial**		
PRIOR LANDUSE	Rural agriculture and bushland		
ADDRESS	Cnr Pacific Hwy Bypass & Masonite Road, Heatherbrae (Raymond Terrace)		
LGA	Port Stephens		
LAT – LONG	32^0 46' 56.00" S 151^0 44' 24.36" E		
DEVELOPER	**Residual Pty Ltd**		
Address:	PO Box 21 Raymond Terrace NSW 2324		
Ph:	02 4980 3100	Fax	
Email:		Website:	
WSUD CONSULTANT	**STORM_CONSULTING Pty Ltd.**		
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Email:	info@stormconsulting.com.au	Website:	http://www.stormconsulting.com.au
DESIGN ENGINEERS	**STORM_CONSULTING Pty Ltd.**		
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Email:		Website:	

THE DEVELOPMENT

Kinross Business and Industrial Park is a brownfield industrial development located in the Heatherbrae industrial area on the eastern edge of Raymond Terrace. Expansion beyond the existing masonite factory at the south western corner of the site commenced in 2006. Stormwater infrastructure works are complete for the first stage of the development, but are in progress for the second stage. Construction of new (light industrial) factories has begun on some new lots.

BIOPHYSICAL SETTING

Being at the western edge of the marine sands forming the Stockton Bight, the entire site is underlain by deep unconsolidated sands forming the Tomago Sand Bed aquifer. The aquifer supplies up to 25% of raw water accessed by Hunter Water Corporation for the Newcastle and lower Hunter region. Natural topographic relief did not exceed 2 m, but has been further reduced through land forming preparations for industrial development; the entire site is essentially flat with minimal fall towards Windeyers Creek.

The average annual rainfall is similar to that of nearby Newcastle Nobbys Signal Station AWS (1,145 mm) whilst the median rainfall is 1,068 mm[1]. The average "areal actual annual evapotranspiration" (over 30 years) is about 800 mm[2].

[1] Over 137 years to 2004. BOM website: http://www.bom.gov.au/climate/averages/tables/cw_061055.shtml
[2] http://www.bom.gov.au/climate/averages/climatology/evapotrans/IDCJCM0008_evapotranspiration.shtml

PLANNING PROVISIONS

Local Environmental Plan

The overall objectives of the most recent local planning instrument, *Port Stephens Council Local Environmental Plan (LEP) 2000*, do not include specific provisions for water resources or wastewater. Neither do the residential water saving provisions of BASIX apply as the development is for industrial purposes.

The entire site is zoned 4(a) Industrial - General, whose objectives include "to allow industrial development only after comprehensive hazard analysis and risk assessment provide adequate safeguards designed to protect the surrounding environment and ecological balance." Some 20% of each allotment must be maintained as landscaped open space, but this can include stormwater drainage swales and retention basins.

Section 94 Development Contribution Plan:

The site lies within *Plan District No.2 - Raymond Terrace* (1999) of the s 94 plan:

http://portstephens.local-e.nsw.gov.au/planning/38311/38318.html

Contributions are based on a number of factors, including, "the demand for the maintenance and upgrading of infrastructure such as roads and services, resulting from development". "Services" includes drainage infrastructure.

Development Control Plans, Policies & Guidelines

The site specific DCP "*DCP LD13 Development Guidelines - Water Quality - Kinross Industrial Estate, Heatherbra*e" (April 2003), applies to the site. Its purpose is;

> "to maintain the water quality of the groundwater area within the Tomago Catchment of the Hunter Water (Special Area) Regulation 1997, administered by the Department of Land and Water Conservation, due to its use for drinking water."

The DCP specified the following water quality objectives:

POLLUTANTS	RETENTION CRITERIA
Coarse Sediment	80% of average annual load for particles less than or equal to 0.5mm
Fine Particles	50% of average annual load for particles less than or equal to 0.1mm
Total Phosphorus	45% of average annual pollutant load
Total Nitrogen	45% of average annual pollutant load
Litter	70% of average annual litter load greater?
Hydrocarbons, motor fuels, oils and grease	90% of average annual pollutant load

The plan further requires that development applications for individual allotments must include a Stormwater Management Plan (SMP).

None of Council's LGA-wide sectoral DCPs specifically address WSUD, as these matters are largely addressed in above locality-specific DCP, and augmented via the following series of policies, strategies and plans

- **Sustainability Policy** – sets the overall environmental objectives.
- **Urban Rainwater Tank Policy** – promotes the use of rainwater tanks.
- **Local Approvals Policy for the Conversion of Septic Tanks for Rainwater Storage** (for Irrigation Purposes) – an innovative policy to assist reuse of septic tanks following connection to reticulated sewerage.

- **Port Stephens Draft Urban Stormwater and Rural Water Quality Management Plan** – contains WSUD components

These can be accessed at:

- http://portstephens.local-e.nsw.gov.au/council/1080.html
- http://portstephens.local-e.nsw.gov.au/environment/31259/39243.html

Acid Sulfate Soils:

Clause 51A of the Port Stephens Local Environmental Plan 2000 requires development consent for specific works within five (5) land classes. The site lies within Class 4, requiring Planning Instrument provisions for ASS be complied with for:

- Works beyond 2 m below the natural ground surface;
- Works by which the watertable is likely to be lowered beyond 2 metres below natural surface.

Investigations undertaken note that whilst the soils are slightly acidic, they do not constitute ASS or PASS. Consequently a management plan was not required.

DESIGN

IWCM Objectives and Background

Council's main objective is to ensure that flooding or environmental harm is not caused as a result of the proposed development. To achieve this aim it is necessary to detain peak flows for all storms up to the 100 year ARI. The site overlies the Tomago sand beds and the infiltration rate into the sand is very high (180 to 3600mm/hour).

Because of such a high infiltration rates the site developed very little runoff in its undeveloped state, as rainfall events in excess of 180mm/hour were infrequent. Maintaining these near zero runoff characteristics post-development, where a large proportion of the surface will be covered by impervious surfaces and buildings, is a very difficult task.

The site in its pre and post-developed runoff states drains in two directions. While all major overland flows ultimately end up at Windeyers Creek, the bulk of the site drains directly toward the creek and does not cross another property. A small proportion of flows generated from the west of the site in the vicinity of the Weathertex factory drains toward Masonite Road and then east toward the creek.

IWCM Design Principles & Issues

A critical component of DCP LP13 is that stormwater may only be infiltrated into the underlying Tomago aquifer with significant justification as indicated below:

> "The stormwater management strategy for the DCP area shall allow for no infiltration of subdivision stormwater (lots and roads) at source points, through conveyance or through end of pipe controls. Discharge shall be to Windeyers Creek.
>
> Any variation to this principle (and associated variations within other clauses within this DCP) will require significant justification and endorsement from the Department of Land and Water Conservation, prior to any development approval being granted."

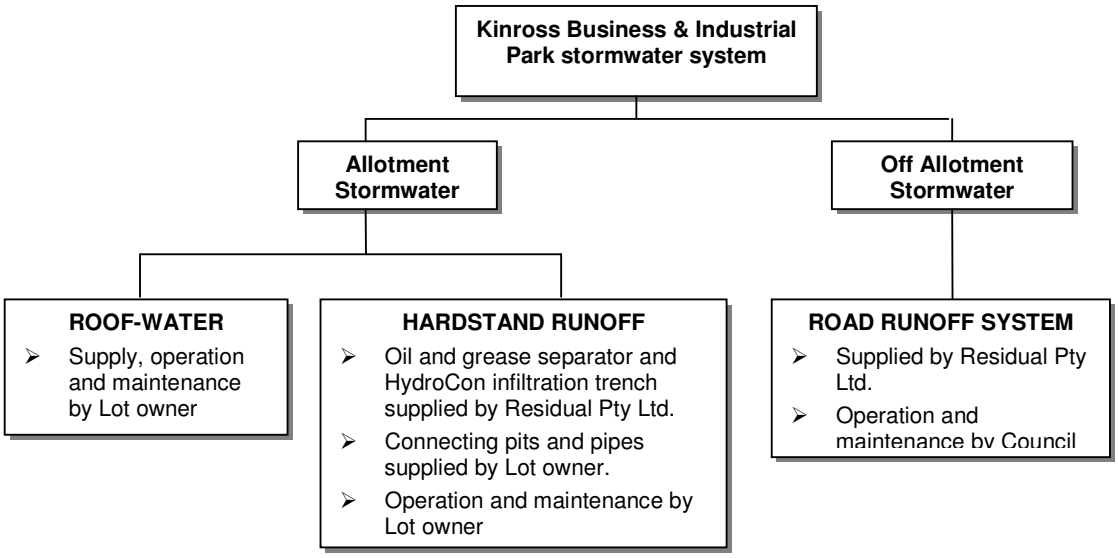
Previous work by STORM_CONSULTING documented a DIPNR preferred strategy of protecting the quality of the groundwater in the aquifer by preventing infiltration and treating the stormwater in surface wetlands prior to discharge into Windeyers Creek.

This strategy was formed in response to a policy of not allowing infiltration by DIPNR – it was not the preferred approach recommended by STORM. STORM's preferred approach was to maintain the existing hydrological regime of this site by firstly treating and polishing the stormwater and then continuing to allow infiltration of treated stormwater.

Following a continuous process of consultation with Council and DIPNR, Council permitted the infiltration of stormwater. Council's permission of this process is considered to constitute the above mentioned "significant justification" required under the DCP and as a result the SMP now encompasses the broad principle of infiltration on this sandy site.

The design philosophy[3] employs an integrated treatment train approach for water quantity and quality management. The stormwater system for Kinross Business Park can be broken down into 3 sub-systems:

- Hardstand runoff system – this is a system separate from the roof water system designed to treat runoff from all ground areas within each Lot prior to infiltration in the vegetated easements;
- Roof-water system – this is a system to manage runoff from all roof areas within each Lot; and
- Road runoff system – this is a system to treat all road runoff external of the lots prior to infiltration.



Incorporated WSUD Elements

Rain and stormwater from each of the three sub-systems is treated via treatment trains employing a number of devices. Beginning independently, the Hard Stand and Road sub-systems link towards the end of each system. The Roof-Water sub-system is independent of the other two.

Roof-Water System (lot-based)

- Rainwater Tanks – to reduce volume of runoff from the site, reduce sediment load that would otherwise enter the roof infiltration trench, plumbed into building for toilet flushing, irrigation of landscaping, vehicle washing, and other suitable uses as nominated by developer.
- Infiltration/seepage trench - to drain tank overflows, ultimately recharging the groundwater aquifer instead of being piped to Windeyers Creek.

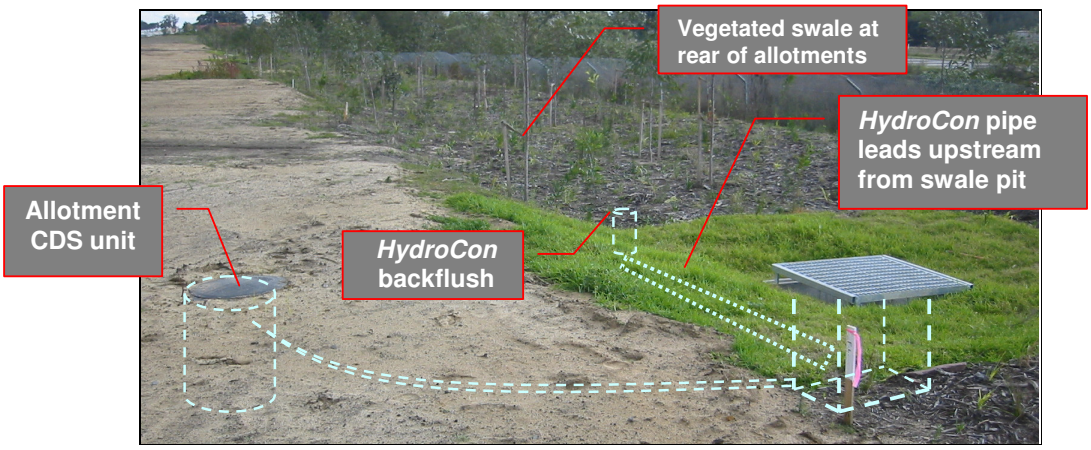
Hardstand Runoff System (lot-based)

- On-site runoff collection system – kerb and gutter, pits and pipes designed for a minimum 1in 10 ARI storm event.

[3] Ref. Kinross Industrial Estate Heatherbrae Rezoning Application - Storm Consulting (Nov 2001)

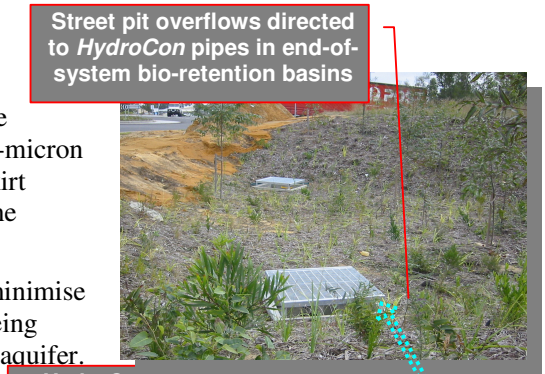
- Oil/grease separator – collects oil and grease to minimise the likelihood of the HydroCon infiltration pipe being blocked over time and pollution of the underlying aquifer.
- Small CDS units – collect coarse sediment to minimise the *HydroCon* back-flushing service frequency.

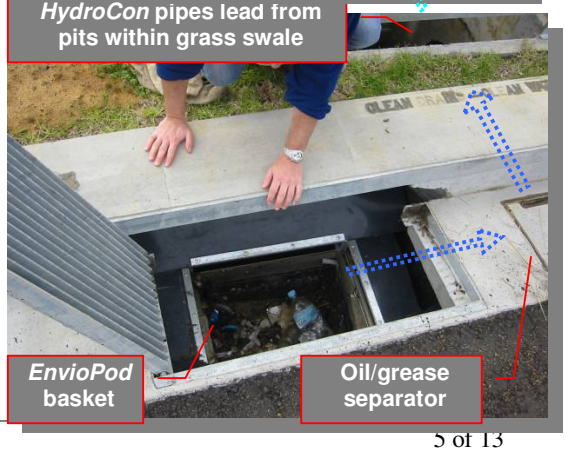
- *HydroCon* infiltration trench – collects and infiltrates stormwater flows generated from hardstand areas. The permeable concrete pipe located within the trench allows water to permeate through the walls of the pipe and seep into the trench. The pipe provides significant stormwater treatment including capture of metals, phosphorus and sediments.
- Stormwater easements – to facilitate infiltration of any lot runoff up to the 100 year ARI storm event. Note: easements will allow runoff from storm events larger than the 100 year ARI storm event to freely drain off the site. Some flooding of the rear of the lots is expected in events larger than the 100 year ARI.



Road Runoff System (external to lots)

- *EnviroPod* pit baskets – to capture litter and coarse sediment. Flows are directed into a cleanable 200-micron filter bag (0.16m^3 capacity approx.) by a rubber skirt attached to a steel frame. Overflows can bypass the basket.
- Oil/grease separators – collects oil and grease to minimise the likelihood of the *HydroCon* infiltration pipe being blocked over time and pollution of the underlying aquifer.
- CDS units – collect coarse sediment to minimise the *HydroCon* back-flushing service frequency.
- Pits connected to a bioretention trench/grassed swale located behind the kerb on each side of the road.
- End-of-system bio-retention basins – to infiltrate surcharged flows from lots and road bioretention trenches/grassed swales.





IMPLEMENTATION ISSUES

There were a few challenges experienced during both the planning (rezoning) and the construction phases. Considerable effort and resources were invested into demonstrating that this strategy would protect the underlying Tomago aquifer as this type of stormwater treatment system has never been previously implemented.

The developer invested in a research project which was realised by way of designing and constructing a pilot scale system within the grounds of the Weathertex factory site. University of Technology Sydney monitored this project as part of Alison Dunphy's PhD.

The Contractor had some difficulties in constructing the works and as a result errors where made and rectification works were necessary. The key learning point is to have higher levels of supervision as well as very open communication to ensure that the design intent is realised, particularly for projects that are not typical in their construction.

OPERATIONAL PERFORMANCE

Flow Quantity

Design Storms

- 1 year ARI storm events for gravel trenches
- 1 in 3 month storm event for *HydroCon* pipes
- The lot based infiltration trench must be sized so that there is no overflow in a 5 year ARI storm event.

Peak Flows

The proposed road drainage system has been designed such that there is effectively no flow to Masonite Road from the proposed development. The system is able to infiltrate the whole of the 100 year ARI as the capacity of the road system in Masonite Road could not be guaranteed

As can be seen from Figure 1, all flows up to the 50 year ARI are less in the post development state. However the 100 year ARI post development peak flow does exceed the pre-developed peak flow.

Table 1: Windeyers Creek Peak Flows

Storm Recurrence Interval	Pre-Development Peak Flow (m^3/s)	Post Development Peak Flow (m^3/s)
3 month	0.236	0.000
1 year	0.315	0.000
5 year	0.601	0.015
20 year	0.956	0.578
50 year	1.167	1.259
100 year	1.362	1.915

The flood regime in this area is governed by a major flood in the Hunter River causing a backwater effect up Windeyers Creek. In fact flow may under such conditions actually reverse direction in Windeyers Creek and flow upstream. In such a case the flow leaving the Windeyers Creek Catchment has very little impact on the peak flood level as has been verified by flood modelling undertaken for Council by WBM. Minor increases in peak flows for only major events can be managed sustainably and without any increase in the risk of flooding to others in the catchment.

It is critical to implement and maintain the measures proposed to manage the peak flows leaving the site to ensure that they do not cause erosion or damage to Windeyers Creek.

Water Quality

Lot-based system:

There is a complete treatment train proposed for stormwater on the lots. The treatment train will involve the use of a sediment and oil trap to remove coarse sediments and oils from the flow. The water is then to be treated in a HydroCon treatment system as follows:

1. The pH of water in the pipes is altered by the alkalinity of the pipes themselves. This facilitates the settling of pollutants from the water column.
2. The velocity of flow through the pipe wall is so low that velocities inside the pipe are also very low. This enhances the settlement process described above as well as allowing for the settlement of very fine particles inside the pipe.
3. Water passing through the pipe wall experiences an adsorption process via anionic exchange facilitating the adsorption of phosphorus and metals.

Thus the pipes are predicted to remove close to all sediment including very fine particles, 99% of metals and more than 50% of phosphorus. The pipes will not remove nitrogen. Nitrogen levels on this industrial estate are not expected to be high and nitrogen removal will occur in the sand that surrounds the pipe and as it percolates to the aquifer below. A minimum buffer of 1m of sand is to be maintained in each location on this site to buffer the aquifer and remove residual nitrogen from the flow.

Modelling of a sand filter constructed at Kiama and designed by STORM with a 1m depth of sand was predicted to remove greater than 45% of the nitrogen from the water column. Estimated performance of the lot-based system proposed for Kinross is summarised in Table 2.

Table 2: Estimated retention percentages from the Lot based stormwater system

Pollutant	Sediment	Phosphorus	Nitrogen	Visible Oils/Grease
Sediment and Oil Trap	100% coarse sediment	20% to 30% on attached particles	20% to 30% on attached particles	100% visible oil and grease and treat minimum 90% of flow
HydroCon system	80% of fine sediment	50% of remaining phosphorus	No retention	N/A
Sand media outside of pipe	N/A	Minimal adsorption by sand	Up to 45% retention of total nitrogen.	N/A
Council SMP requirement	50% of average annual load for particles ≤0.1mm	45%	45%	90% average annual pollutant load
Total Retention	Up to 80% of fine sediment	> 50%	45%	100% of visible oil and grease and treat min 90% of flow

Road Runoff:

The proposed swales will be grassed and underlain with an impermeable liner to create a bioretention system along each side of the road. A subsoil drainage system will be installed at the base of the trench just above the liner to ensure the trench is free draining.

Typically the use of swales and bioretention systems is known to reduce sediment, nutrients and greases/oils. Metals are also absorbed by the vegetation in the trench. The proposed system will enable compliance with Council's SMP requirements with Windeyers Creek significantly benefiting from the adoption of an infiltration approach.

Table 3 details the expected performance of the proposed combined bioretention and HydroCon pipe system.

The proposed system will enable compliance with Council's SMP requirements with Windeyers Creek significantly benefiting from the adoption of an infiltration approach.

Table 3: Estimated retention percentages from the Road stormwater system

Pollutant	Sediment	Phosphorus	Nitrogen	Visible Oils/Grease
Bioretention system	100% coarse sediment	20% to 30% on attached particles	20% to 30% on attached particles	100% visible oil and grease and treat minimum 90% of flow
HydroCon system	80% of fine sediment	50% of remaining phosphorus	No retention	N/A
Sand media outside of pipe	N/A	Minimal adsorption by sand	45% retention of total nitrogen.	N/A
Council SMP requirement	50% of average annual load for particles ≤0.1mm	45%	45%	90% average annual pollutant load
Total Retention	Up to 80% of fine sediment	> 50%	45%	100% of visible oil and grease and treat min 90% of flow

Alternative Water Supplies

Net Potable Water Substitution

Not computed as rainwater tank sizing and specific uses by individual allotment holders is unknown.

Rainwater Harvesting

DCP LP13 encouraged the use of rainwater tanks for capture and use for non-potable purposes on each allotment.

Stormwater Harvesting

There are no precinct scale stormwater harvesting measures. The stormwater is treated and infiltrated to continue to supply the aquifer, as outlined below.

Greywater Reuse

There are no precinct scale greywater treatment and reuse measures.

Sewer Mining

There are no precinct scale sewer mining treatment and reuse measures.

Groundwater recharge and/or extraction

A key feature of the WSUD design is the treatment of stormwater by filtration and infiltration to groundwater. Most water falling on the site will continue to enter the groundwater with minimal net change in recharge rates.

Hunter Water Corporation will continue to extract significant volumes of water from the Tomago Aquifer, requiring close attention to ongoing maintenance of all elements of the stormwater treatment train.

Maintenance

Operations and Maintenance Frequency

Lot based system

Lot owners are responsible for preparing Operation and Maintenance Plans for the preventative maintenance of their lots. A suggested list of maintenance activities is listed

in Appendix E of STORM's (2005) *Kinross Business Park Stage 1 – Stormwater Management Code*.

Maintenance activities may affect areas including the rain tank, roof water infiltration trench, stormwater infiltration trench, GPTs and major overland flow paths.

Gross Pollutant Traps (GPT)/Pit Baskets

The CDS units are to be inspected quarterly and as needed following storm events . All three types of CDS can be cleaned using the same type of maintenance vehicle.

Pit baskets are designed to be lifted and cleaned by two people – the procedure for pit basket cleaning is to be developed by Council.

Entry into confined spaces is not required for either GPT or pit basket cleaning activities.

Annual Maintenance Cost

Not known.

APPENDIX 1 – Land Zoning

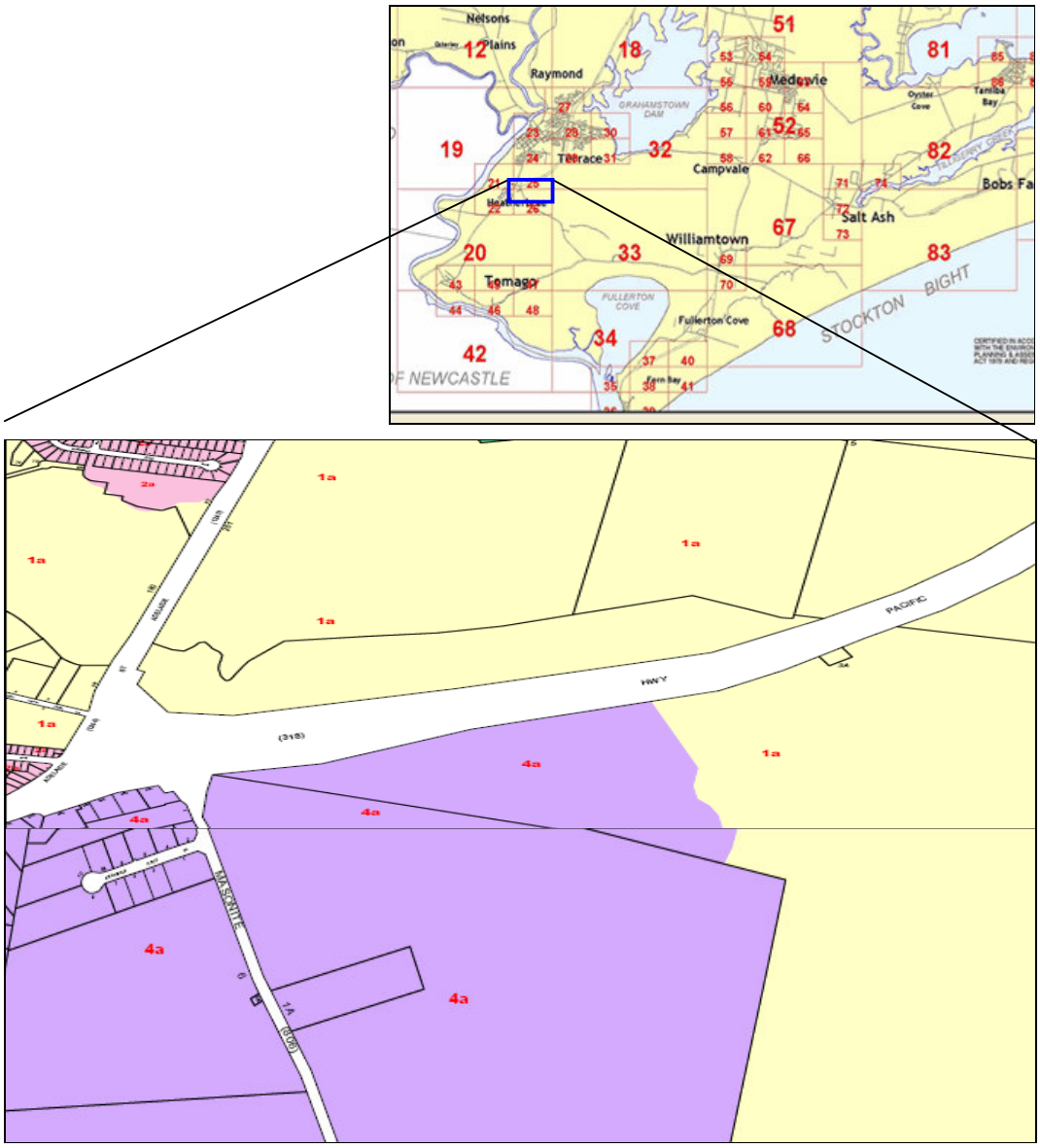


Figure 1: Kinross Business and Industrial Park

Source: Port Stephens Council Environment Plan 2000 (http://www.portstephens.nsw.gov.au/LEP/LEP_Col.htm)

APPENDIX 2 – Layout & Design Diagrams

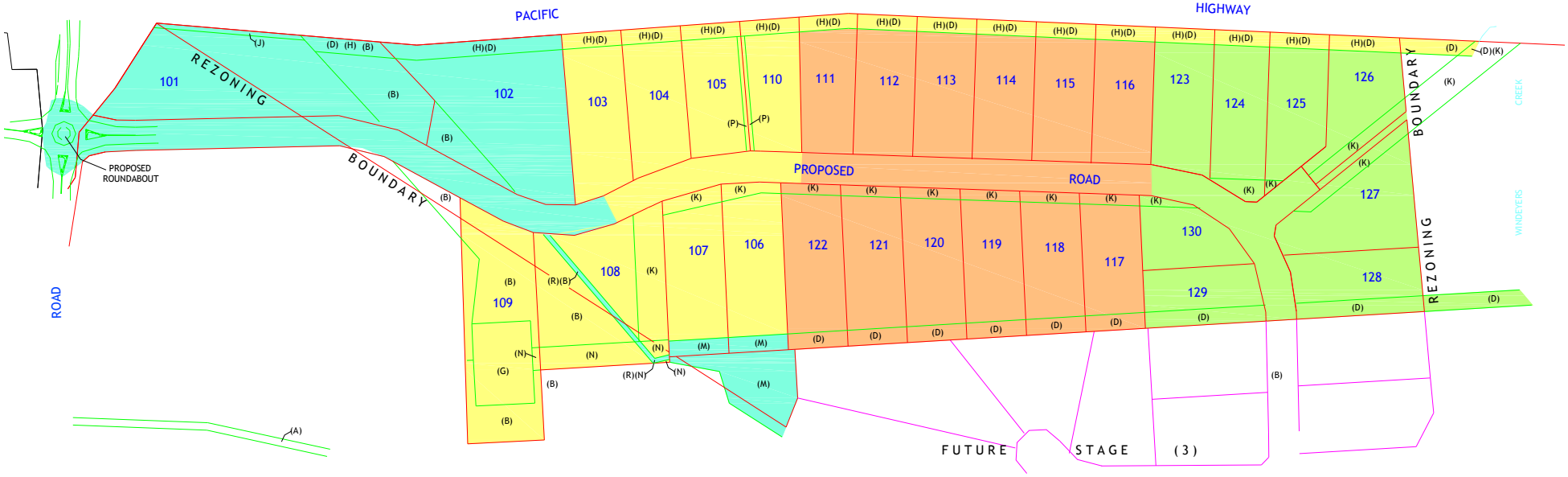


Figure 2: The Stormwater Code applies to Lots (101 to 130) as shown

Source: Storm Consulting

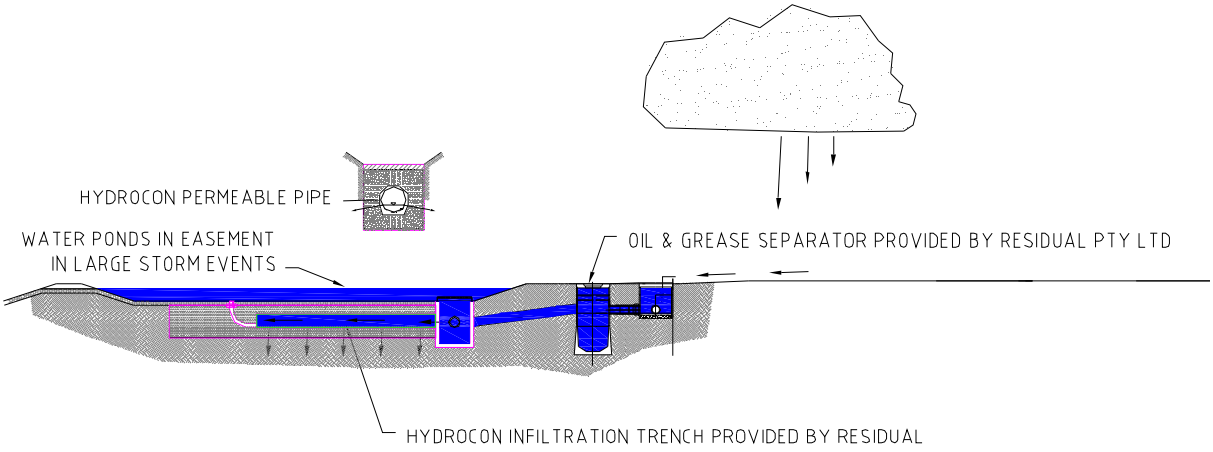


Figure 3: *HydroCon* infiltration system with oil/grease separator (schematic only)

Source: Storm Consulting

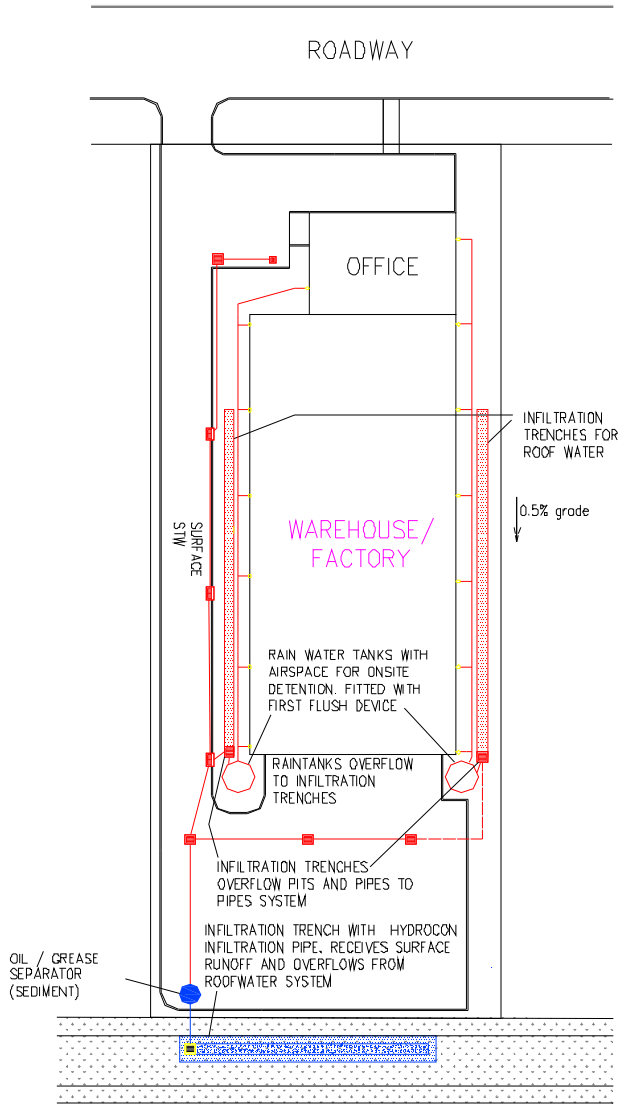


Figure 4: Typical Kinross Business & Industrial Park allotment drainage layout

Source: Storm Consulting

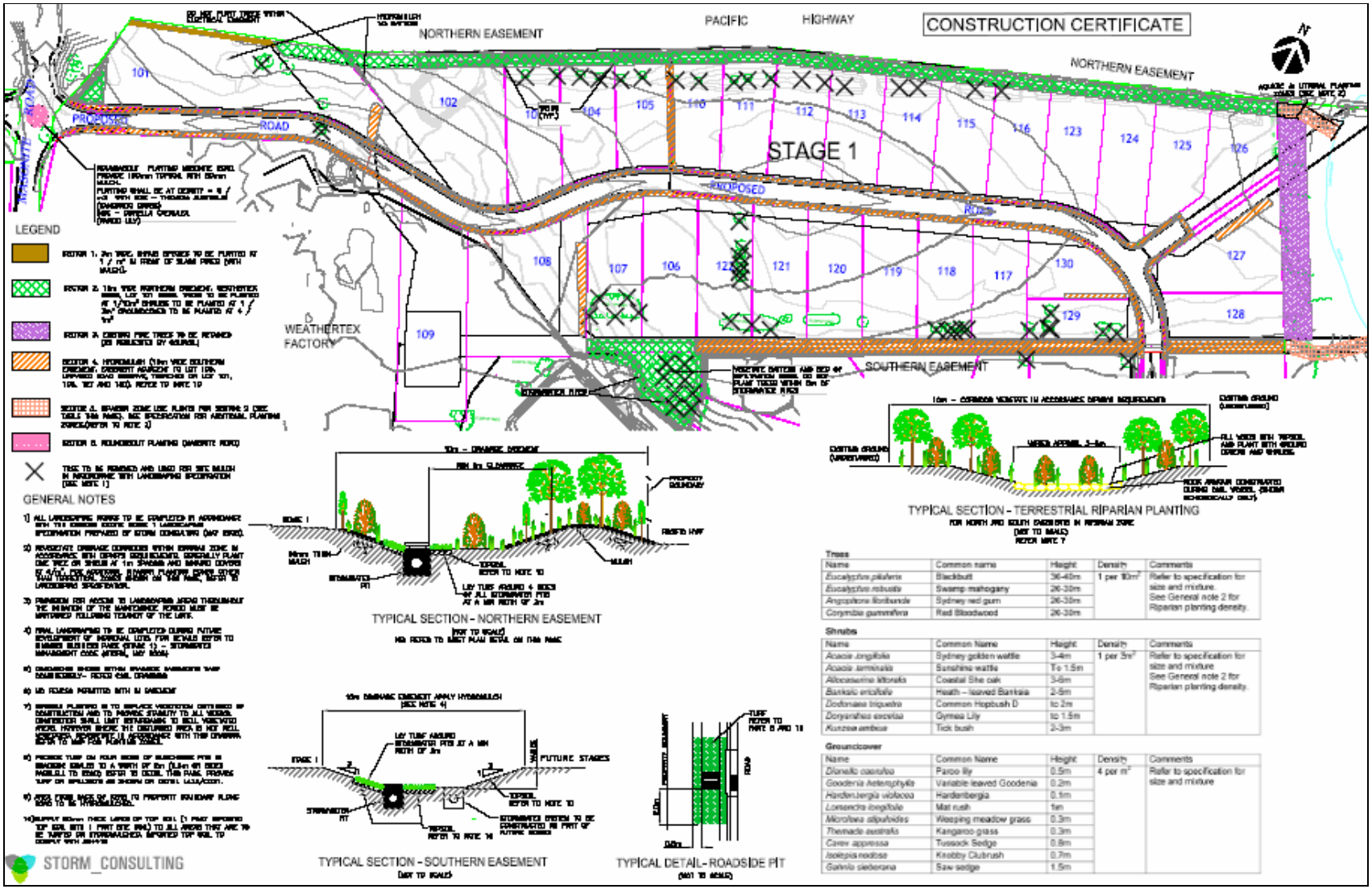


Figure 5: **Kinross Business & Industrial Park – overall site drainage layout**
Source: Storm Consulting