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The Lakes District and Schooner Cove Integrated Stormwater Management Plan (ISMP)

Draft Report
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KWL Project No. 2964.001

Prepared for:

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Executive Summary

The Lakes District/Schooner Cove ISMP has analysed stormwater quantities in both the pre and post development situations. The shallow soils underlain by bedrock and the high percentage of exposed bedrock mean that runoff after development is similar to the current run off regime. There are small increases in runoff however since most flows enter a wetland or a lake these are largely buffered. Modification of existing outlet structures has been proposed to match pre and post flows and this results in a modest 100 mm increase in Enos Lake levels during the 1 in 200 year storm event. Infiltration is therefore of limited value as a stormwater management tool from an erosion perspective. The rock substrate also makes this type of BMP impractical in most or all cases.

The creeks within the study area are not fish rearing although several provide habitat for fish that reside in Enos Lake. The water quality criteria for the area has been set at a very high level and aims to treat all water from roadways and driveways. Runoff from these areas will be routed through water quality raingardens. These will hold all rain evens up to the 6 month event and this represents over 90% of the volume of runoff in a year. The water will filter through 450 mm of organic topsoil containing plants for an average of 6 hours. This process filters out suspended solids, oils, and some organic nutrients and provides a high level of water quality. The existing constructed wet ponds at the south of Enos Lake will be used to treat water from southern catchments and new constructed wetlands will be constructed adjacent to Dolphin lake and the Beaver Pond north of Enos Lake. These wetlands will treat water and extend habitat.

Constructed ephemeral ‘Rainwater Creeks’ are proposed for conveying water from development areas to water bodies. These will be small creeks with cascading sections that should provide aeration to runoff water and will mimic natural creeks over time.

Three Beaver Ponds exist on the site and the one on Enos Creek has previously failed with attendant damage to property. The ISMP recommends that a downstream berm or dam be constructed adjacent to this beaver dam and that a notched weir be used to control flows and provide erosion protection in the event of another failure. The other two beaver ponds do not pose a risk to property but their failure would have a negative effect on the upstream wetlands and downstream creeks. Berms/Dams for public and environmental safety are proposed for these beaver dams as well.

1. Introduction

This document outlines the Integrated Stormwater Management plan (ISMP) for the proposed Lakes District and Schooner Cove neighbourhoods as illustrated on Figure 1-1 (Figure 1-2 shows an enlarged drawing of a water quality BMP). The proposed Lakes District development calls for approximately 1675 residential units generally to the southwest of the existing Fairwinds residential development and golf course. The proposed Schooner Cove neighbourhood calls for 360 multifamily units oriented around a commercial village with 2325m2 of commercial space with a marina and neighbourhood support services. Refer to Figure 1-3 for a potential layout complete with rainwater catchments.

The neighbourhood plans commit to the preparation of an ISMP and an analysis of the Hydrological Impact of development. The Hydrological Impact Study is part of the ISMP.

1.1 Previous Work

The 2011 Neighbourhood Plans contained a Master Rainwater Concept. This included commitments to DFO and MOE guidelines. The BC Stormwater Guidebook and Water Balance Model were also referenced and a commitment to the production of an Integrated Stormwater Management Plan (ISMP) was made. KWL is a leader in the production of ISMP's and we have brought our experience and techniques to this assignment.

The previous Master Rainwater (Stormwater) Concept proposed retaining and/or managing as much water onsite as feasible where geotechnical conditions permit. The goals stated were to mimic pre development flow regimes to the 2-year design storm at the watershed scale and to improve water quality over traditional piped systems. The specific items proposed included:

- The existing detention ponds at the south end of Enos Lake;
- The existing detention ponds within the golf course that accepts flows from Dolphin Lake;
- A new engineered wetland at the north end of Enos Lake; and
- Sediment control ponds at the ends of roadways leading to Enos Lake. These ponds are to remain in place until 75% of development along the catchment has been completed.

The above commitments and concepts were outlined in the stormwater master concept that was included in the Neighbourhood Plans (NP). The land use planning contained in the NP's maximizes setbacks from lakes and ephemeral creeks and therefore provides protection for riparian zones. Further to this the NP's provide areas within roadway cross sections for bioswales or raingardens if required.

2. Physical Setting

Runoff from the proposed Lakes District development drains to three different watercourses. The majority of the development drains to the Enos Lake and downstream watercourse system. A smaller portion of the development drains to the Dolphin Lake and downstream watercourse system. Finally a small and steep ephemeral creek drains the NW portion of the Lakes District.

The Schooner Cove development is situated over three distinct watersheds. Two of the watersheds are situated directly on the shoreline and rainwater will drain directly to the marine environment. The most southern system will convey water southeast toward an existing storm drain system which then to the marine environment.

The proposed development and catchment areas are summarized in the following Table 2-1.

Table 2-1: Summary of Development and Catchments

Catchment	Total Watershed (ha)	Existing Devel. (ha)	Proposed Devel. (ha)	Lakes/ Wetlands (ha)	Remaining Undevel. (ha)
Enos Lake Watershed	234.8	12.3	86.2	23.9	112.4
Watercourse Downstream of Enos Lake	59.6	18.4	29.1	1.3	10.8
Dolphin Lake	78.5	21.5	27.5	5.9	23.6
Watercourse Downstream of Dolphin Lake	N/C	N/C	1.8	N/C	N/C
Schooner Cove West	N/A	N/A	0.45/0.54*	0	N/A
Schooner Cove South	N/A	N/A	0.71/0.34*	0	N/A
Schooner Cove North	N/A	N/A	0.28/0.23*	0	N/A

Notes:
- N/C – Not calculated.
- N/A – Not applicable.
* - A/B where A is area of roofs and B is roadways and parking lots – preliminary layout and may change

3. Hydrology

Monthly precipitation data at the Fairwinds Golf Course has been recorded since 1990 (22 years of data). This data indicates that the average annual precipitation is 912 mm. This is approximately 80% of the annual rainfall totals recorded for gauges at the City of Nanaimo Works Yard and Nanaimo Airport. This is a likely because of the partial rain shadow that Nanoose experiences vis a vis the Vancouver Island mountains. Because there are no Intensity-Duration-Frequency (IDF) curves for the Nanoose area, and no finer timestep precipitation data, an assumption had to be made for the purposes of this ISMP. The precipitation total for Fairwinds matches very closely with precipitation totals for Victoria Airport and this has been used as the best rainfall pattern and intensity for the area. On past projects we have developed design storms for the purpose of hydrologic modelling based on the Victoria Airport modelling. We have used these same design storms for this ISMP for the proposed Fairwinds development. The 10-year return period design storm is illustrated on the following Figure 3-1.

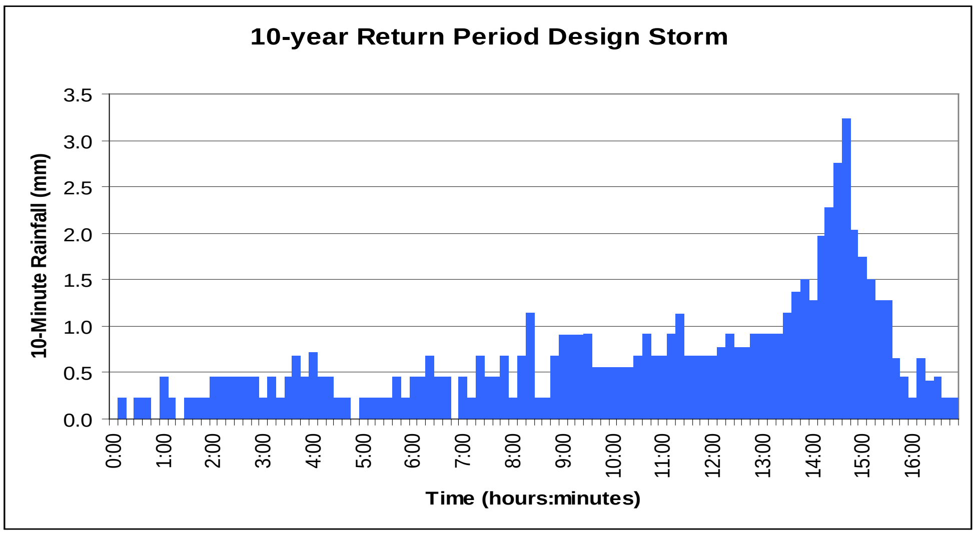

Figure 3-1: 10-year Return Period Design Storm

The above figure shows intensities of rain in mm over ten minute intervals over an 18hour period. This is the rainfall pattern was used to overlay the computer model and calculate runoff. The design storms for other return periods follow the same pattern but are scaled up or down by factors from the 10-year event. These scaling factors were derived from the IDF curves for the Victoria Airport weather station and are summarized on the following Table 3-1.

Table 3-1: Design Storm Scale Factors (Relative to 10-year Event)

Return Period	Scale Factor
6-month	0.488
2-year	0.650
10-year	1.000
25-year	1.171
200-year	1.470

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A key factor in the amount of runoff is the amount of impervious surfaces. Impervious surfaces are surfaces which do not allow precipitation to be absorbed by the underlying soil and result in runoff after only a very small amount of precipitation. These surfaces include roadways, roofs, driveways, parking lots, sidewalks, and decks. In preparing our hydrologic analysis we have assumed that the proposed development areas will have a total impervious percentage of 50%. This includes both the roadways and lots. The Lakes District is comprised of 58% developable area and 42% is proposed parkland.

The other factors relevant to the hydrologic analysis are the catchment size, shape and slope, and soil conditions. The catchment information was defined by reviewing the existing topography as well as proposed storm drain routes through the development. The soil information for the site was obtained from soils maps and descriptions[1]. The soils mapping indicates that the soils surface is generally as follows:

- 80% of the site is underlain by loamy sands and gravels typically ranging from 100 mm to 500 mm in depth overlaying bedrock; and
- 20% of the site is bedrock outcrops.

Due to the relatively thin layer of soil, the natural site has a rapid runoff response compared to areas with deeper soils depths. This means that infiltration and storage is limited and produces runoff events of more intensity, for a given storm, than would be expected for a high infiltration area such as one that is underlain by deep sands or gravels.

[1] Soils of Southern Vancouver Island, MoE Technical Report 17, Report No. 44, BC Soil Survey, August 1985.

4. Stormwater Criteria

Stormwater criteria can be divided into two aspects; stormwater quantity and stormwater quality. Stormwater quantity is both the rate and volume of runoff. Stormwater quality is defined by the concentrations of pollutants in the runoff.

4.1 Stormwater Quantity Criteria

The quantity criteria listed in the Neighbourhood Plans include matching post development runoff, at the watershed scale, to the predevelopment condition up to the 1 in 2-year design storm event. We have modified this criteria to a more stringent and widely accepted set of two criteria. Both the 1 in 6-month and the 1 in 200-year storms have been adopted. The 6-month storm represents a threshold whereby over 90% of the rainfall in a given year falls in events equal to or below this intensity. Therefore it is the critical water quality storm and is universally accepted as such. We have added the 1 in 200-year event as an extreme event to include erosion and flooding risk. The criteria adopted has been to match pre and post flows for the major catchments to this standard. By lowering the threshold to the 6-month storm and adding the 200-year event we have significantly increased the standard from what is promised in the Neighbourhood Plan.

The existing outlets for both Enos Lake and Dolphin Lake and the wetland north of Enos Lake have been modified through the installation of weir structures to control water levels. As a result of these weir structures, and the large size of storage area relative to their catchment areas, these lakes provide significant attenuation and reduction in downstream peak flow rates. There are existing water licences for storage and irrigation of the Fairwinds Golf Course from each of these lakes. Changes in water levels, as a result of the development are not expected to negatively impact either of these already modified facilities.

Enos Creek

Enos Creek drains a wetland with an existing beaver dam on the downstream end which in turn drains Enos Lake. The Watercourse downstream of the beaver dam shows signs of erosion and a waterfall poses a barrier to fish passage. The erosion means that current flows are causing damage and increases in peak flows should be avoided.

Dolphin Lake

The watercourse downstream of Dolphin Lake is comprised of a highly modified creek with detention ponds through the Fairwinds Golf Course and a storm drain outfall to the marine environment.

Schooner Cove

The Schooner Cove Development is divided into three catchments (North, South, and East). The Northern and Eastern Catchments will drain directly to the ocean and the erosion impact, if any, is extremely limited and is not a concern. The Southern Catchment drains through an existing culvert and onto a beach and then the ocean. The culvert capacity will need to be checked for capacity during detailed design and if peak flows exceed its capacity then storage within the Southern Catchment will be required. Erosion is currently prevalent on the channel between the end of the culvert and the head of the beach and will be addressed during detailed design through a diffusion trench that limits current and future erosion.

Based on the above information, the following stormwater quantity criteria was developed:

- If possible, maintain the existing peak flow rates in the existing watercourses;
- If existing peak flow rates cannot be maintained, the existing conveyance structures should be checked for hydraulic capacity;
- If the post development hydraulic capacity of the existing conveyance structures is exceeded, the downstream system should be upgraded;
- For the watercourse downstream of Enos Lake, if the post-development peak flow rates increase then the existing erosion sites should be protected and rehabilitated to prevent further erosion; and
- Rainfall intensities from the Victoria International Airport shall be used for sizing.

The above criteria was used to size and design the stormwater conveyance system.

4.2 Stormwater Quality Criteria

The stormwater quality criteria have been developed to prevent negative impacts as a result of potential pollutants from the proposed development.

Both the BC Stormwater Guidebook[2] and the DFO Land Development Guidelines[3] focus on the 6-month storm event from a water quality perspective. The 6-month event is defined as 72% of the 2-year return period event. The stormwater quality treatment facilities have been sized and designed based on the 6-month 24-hour return period event.

Enos Lake

Enos Lake is habitat for a unique and at risk species of small fish, the Stickleback Species Pairs and or a hybridized version of the pairs which presumably require similar conditions to the original. The current situation and recovery strategy is described in the Species at Risk Act (SARA) report[4]. This report states that the Enos lake species pair has collapsed into a single hybrid swarm. Regardless, one of the long-term goals is to, "*establish or recover a viable population of the Enos Lake species pair, preferably in Enos Lake*", therefore a water quality target to address the needs of this species was selected.

Figure 4-1: Enos Lake Sign

Of the various stormwater receiving environments, Enos Lake is considered the most sensitive. The SARA report states that, "*As a group, sticklebacks are tolerant of a fairly large range of water quality conditions. The current provincial water quality standards for the protection of aquatic life are appropriate guidelines for basic parameters of water quality in lakes with stickleback species pairs. However, some aspects of water quality in species pair lakes need to be maintained in a*

[2] Stormwater Planning, A Guidebook for British Columbia, Ministry of Environment, May 2002.

[3] Land Development Guidelines for the Protection of Aquatic Habitat, Fisheries and Oceans Canada, September 1993.

[4] Recovery Strategy for Paxton Lake, Enos Lake, and Varanda Creek Stickleback Species Pairs in Canada, Fisheries and Oceans Canada, July 2007.

much narrower range than that required for short-term individual survival, as described below." The report continues and identifies the following water quality aspects:

- Light Transmission – suspended solids, dissolved organic carbon, others affecting light transmission;
- Nutrients – nitrogen, phosphorus, total alkalinity;
- Extent of Littoral Habitat; and
- Extent of Macrophyte Beds.

Based on the above, the physical works associated with the proposed development from a water quality criteria will focus on the light transmission aspects. The criteria for stormwater quality shall be the removal of 80% of total suspended solids (TSS) with the secondary benefits such a system will provide. This is a widely used design criteria including in the LEED® *Stormwater Management: Treatment Credit and the King County Surface Water Design Manual*.

The other key water quality aspects will be handled though a regulatory and management perspective as follows:

- The nutrient levels in the Lake should be monitored and the use of fertilizers within the watershed may have to be controlled or eliminated.
- The littoral habitat and macrophyte beds shall be protected by limiting access points to the lake and protecting those areas which are the most productive for the Stickleback. There are reports that the current state of macrophyte beds have been adversely impacted by the presence of non native crayfish.

Other Catchments

For all other catchments, there are no other known specific stormwater quality protection requirements but the high environmental goals set by the developer has led to the adoption of the same water quality standards for the remaining catchments.

Dolphin Lake

A large portion of the catchment is already developed. The lake is much shallower and smaller than Enos Lake and there are lower habitat values in this lake. However the treatment standards for new development are proposed to the same standard as those for Enos Lake.

Schooner Cove

Schooner Cove will drain to the ocean which is a less sensitive receiving environment than Enos Lake. Due to the compact site the treatment standard chosen is 'equivalent to Total Suspended Solids (TSS) and Oil removal that would be expected from a Stormceptor or equivalent'. This standard is lower than what would be expected of a raingarden but will still remove 80% of TSS and a similar percentage of oils. The developer could choose to use a less expensive and more efficient raingarden should the land be available for this. The Stormceptor (or equivalent) is underground and is typically placed under a parking lot.

5. Hydrologic Analysis

The hydrologic analysis was completed using the modelling software XP-SWMM. Models were prepared for both the undeveloped surface condition and for the proposed development surface condition. This was done so that the natural development and post development runoff rates could be compared. The watersheds were divided into a number of sub catchments and entered into the model. The catchment areas and hydrologic model schematic are illustrated on Figure 1-1.

The hydrologic model was run for the 6-month (water quality) storm event and the 200-year (extreme flow and flooding) storm event.

The results of the hydrologic modelling for the natural watershed runoff and post development runoff rates are illustrated in the following figures.

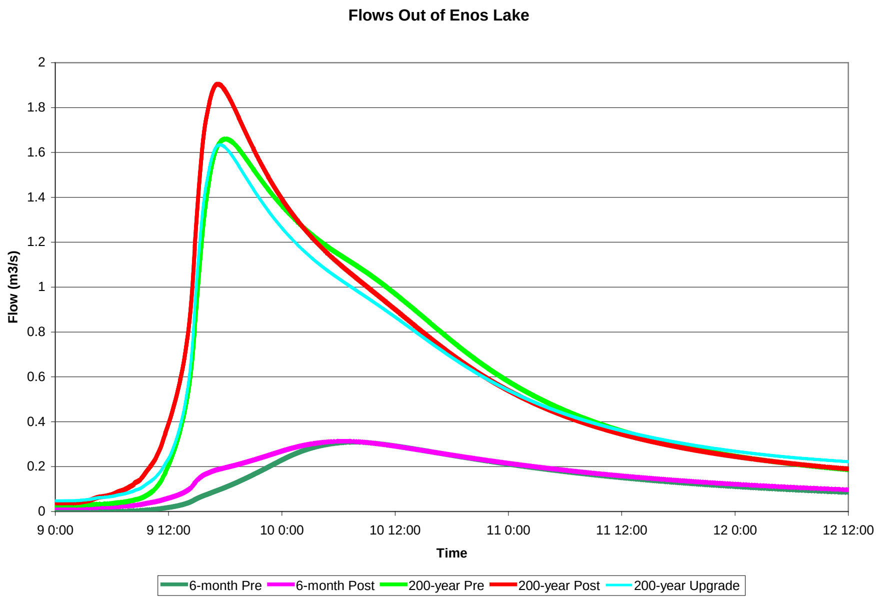

Figure 5-1: Flows Out of Enos Lake

As illustrated in above in Figure 5-1, the peak flow out of Enos Lake would increase as a result of the proposed development (200-year Pre vs. 200-year Post). However, by adjusting the existing outlet structure (narrowing the existing weir to 1.2 m from the current 2.4m); the post development flow is reduced to less than the pre-development flow (200-year Upgrade vs. 200-year Pre). This added hydraulic restriction at the outlet reduces the peak outflow by detaining more of the runoff within the lake. As a result the lake water level will rise by approximately an additional 0.1 m.

Without further stormwater detention, the peak flows in the creek downstream of Enos Lake (at the ocean outfall) will increase slightly as a result of the proposed development downstream of Enos Lake However, through the construction of a hydraulic control at the outlet of the wetland immediately downstream of Enos Lake, and the storage of approximately 0.5 m of water in the wetland during the 200-year storm event, the post development flow can be reduced to below the pre-development level.

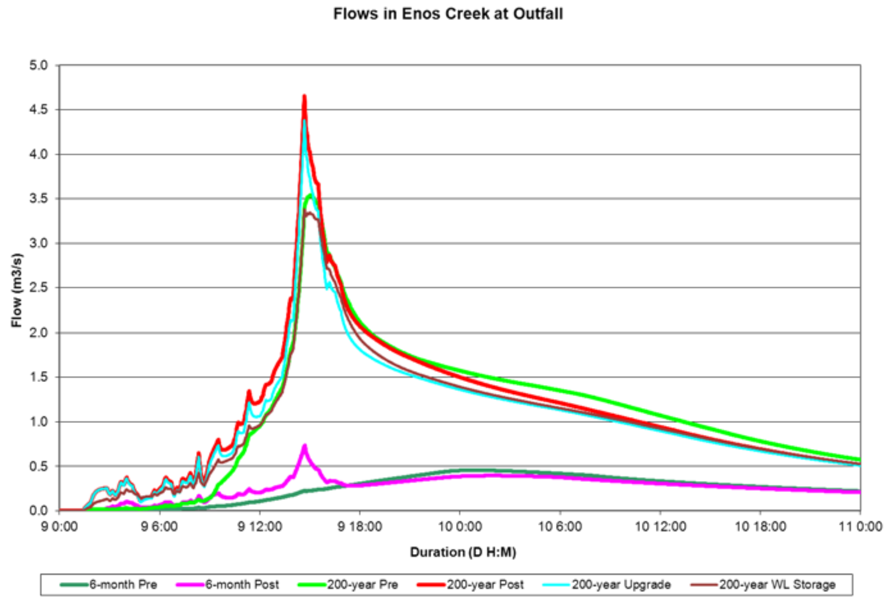

Figure 5-2: Enos Creek Flows at Marine Outfall

The flow rates in the creek downstream of Enos Lake (at the ocean outfall) are illustrated in Figure 5-2 above. Looking at the larger 200 year event the green line represents flows at the ocean outfall pre development. The remainder of the lines are post development as follows:

- Blue – with the previously mentioned change to the existing Enos Lake outlet
- Brown – with the construction of a berm to 'backstop' the Enos Wetland beaver pond and the installation of a flow control structure to store up to 500 mm of water. Note that this response is slightly lower than what is expected in the pre condition.

The wetland outlet can be configured to also achieve a reduction in peak flow rates for more frequently occurring events.

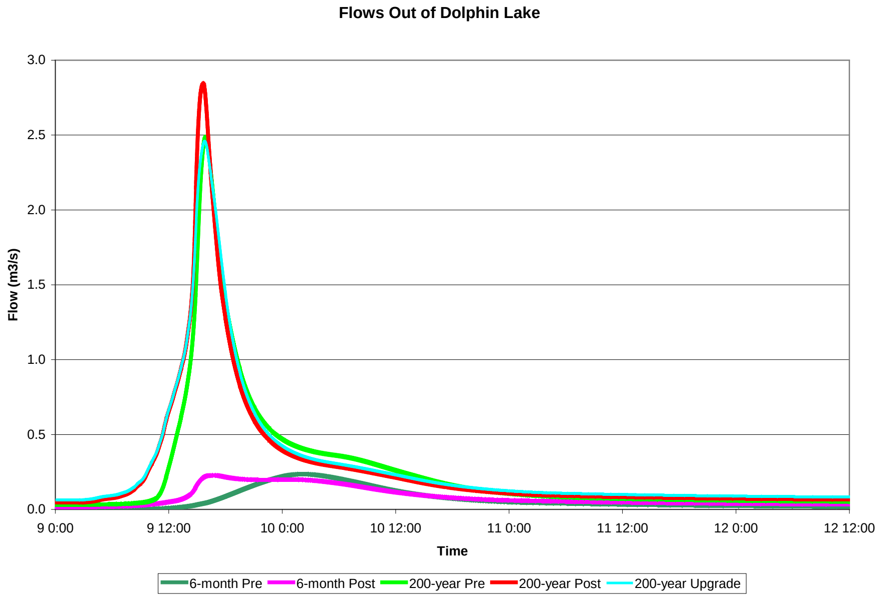

Figure 5-3: Flows Out of Dolphin Lake

As illustrated in Figure 5-3 above, the peak flow out of Dolphin Lake is expected to increase as a result of the proposed development for the 200-year return period event. The 6-month event peak flow remains relatively unchanged but, the shape of the flow hydrograph is changed with the peak occurring earlier (6-month post vs. 6-month pre). However, by raising the ground elevation adjacent to the existing weir outlet structure by 200 mm, the peak 200-year flow rate out of the lake will be reduced (200-year Upgrade vs. 200-year Pre).

It should be noted however that the outlet structure for Dolphin Lake is difficult to model due to low and wide outlet weirs and the adjacent ground topography. A detailed topographic survey would be required in order to model the lake levels more accurately. There are also several detention ponds downstream of Dolphin Lake that will mitigate most or all of any flow increases.

Other Creeks

There are watercourses entering the west side of Enos Lake which although non fish bearing do provide habitat to fish and should be protected. All creeks are depicted on Figure 1-1. The largest of these watercourses is referred to as S 6 (Refer to Figure 1). We have run the hydrologic model for the natural and post-development scenarios. This analysis indicates that the natural and post development 2-year flows (critical erosion event) are both 0.04 m^3/s. In other words there is no increase in peak flows from development. The proposed development accounts for less than 25% of the creek watershed and the attenuation provided by the existing wetland have attenuated flows. Another factor is the location of the creek in the watershed. Since it is very close to the outlet the peak runoff from this section does not coincide with the peak runoff from areas far upstream. This wetland is primarily created by the beaver dam across the outlet. Future protection for this creek will require stabilization of the beaver dam and will require water quality controls on stormwater for lands in the catchment due west of Fairwinds.

Creek S2 just west of Enos Creek is a very steep (average gradient 11%) ephemeral creek. It is rated as a 1st Order Stream which is the smallest classification used. This creek does not provide any habitat for fish. Peak flows in this creek are expected to increase and detention should be considered as an erosion mitigation measure should this be required. A study of the susceptibility toward erosion on this creek should be undertaken during detailed design. At that time the capacity of the culvert under Dolphin Drive will be considered as well.

There are beaver dams at several locations throughout the development site. These include downstream of the two wetlands above creeks S3 and S6, and above Enos Creek (S1). We understand that this latter beaver dam downstream has failed previously and it resulted in flooding of a property downstream on Cormorant Crescent. Construction of berms behind these dams is required to protect property in the case of Enos Creek and for habitat protection for all of them. A failure in the beaver dam could lead to serious erosive degradation of these creeks and property damage for Enos Creek.

Schooner Cove

As noted above two of the three catchments within Schooner Cove will discharge directly to the ocean and Erosion is not a concern and therefore no quantity modelling has been performed.

The existing stormwater system to the south of the proposed Schooner Cove development should be checked during detailed design for hydraulic capacity. If it does not have adequate capacity stormwater detention or upgrades to that system may be required. This will be addressed during detailed design. Existing erosion is present at the discharge point of the culvert exiting onto the beach at Dolphin Bay Road. A detailed design for erosion protection should be completed during the detailed design noted above.

Zoning

None of the hydrographs showed significant increases between pre and post development. The possible exception would be flows in Creek S2. This creek is very steep and ephemeral and does not provide any fish habitat. An erosion review at detail design stage is warranted but storage and or a change in land zoning does not appear to be warranted.

The Neighbourhood Plans propose over 40% of the Lakes District as parkland and the thin soils with underlying rock mean that the runoff regimes between pre and post development are very similar. Thus the land use proposed does not need to change in order to minimize impact. The proposed lot layout presents more compact development with larger green space than has been previously constructed at Fairwinds and this presents a better water quality regime for the water bodies concerned.

Water Balance Model

The water balance model is a simplified hydrologic model that tends to be used by land planners to investigate land zoning and the implementation of Best Management Practices. Unfortunately the model did not properly recognize lakes and could not properly analyse the catchments. A XP SWMM model used for this report is significantly more sophisticated and accurate and is generally the choice for hydrology professionals. For the above reasons we have not relied on the Water Balance Model.

6. Water Quality Analysis

The Neighbourhood plans proposed that the existing wet ponds at the southern end of Enos Lake be utilized for treatment and that a new constructed wetland be built at the north end on the lake outlet. There were also statements that suggested as much infiltration and onsite storage would be used as was practical. These statements alluded to reducing the peak flow rate to limit erosion. The hydrologic modelling completed in this study shows that increases in peak flows are negligible and this coupled with the rock substrate, which has low permeability, makes infiltration both unnecessary and impractical.

The high standards set for water quality are best met through the use of water quality raingardens along with constructed wetlands, and new rainwater creeks. These will produce water quality to a much higher standard than the measures outlined above. Runoff from roadways and sidewalks will be routed through the raingardens for all storms up to the 6 month return period. The raingardens are proposed as either roadside gardens or regional facilities. Figure 1-1 outlines the roadways where regional facilities are not possible and roadside gardens are required. The figure also shows roadways were either roadside gardens or regional facilities may be used. In these situations the regional facilities are shown and sized appropriately. Given the proliferation of rock on the site and concerns surrounding water travelling down fissures into private property it is likely that the majority of raingardens will have an impermeable liner and a subdrain immediately above this. Refer to Figure 1-2 for details of the raingardens.

The raingarden sizing is based on retaining runoff from 6 month storm events for roadways and driveways. This yields approximately 22 m^2 of raingarden proposed for every 100 m of linear roadway. In this way all six month storms will be captured within the 300 mm of freeboard in the raingarden and all of this water will filter through the 450 mm of topsoil and plant material. Water will take over six (6) hours to filter through plant material and organic topsoil. This process removes the majority of pollutants and mimics the natural cleansing found within undeveloped catchments. Studies have shown that raingardens remove 80% of TSS and high percentages of other pollutants from stormwater. There are some sections of catchment at the southern end of Enos Lake that will have their roadwater routed toward the existing wetponds and these will provide treatment. There are also proposed constructed wetlands on Dolphin Lake and on the outlet of Enos Lake that will provide treatment and increase habitat in these areas.

The final water quality provision proposed is the construction of ‘rainwater creeks’ to convey water to existing waterbodies. These creeks will be ephemeral watercourses following natural contours excavated to shallow depths of 400 mm on average. There will be numerous falls and small pools within the creeks and these will serve to oxygenate the water. There are times when the dissolved oxygen levels in Enos Lake have dropped and it is intended that these ‘rainwater creeks’ will help to avoid this in the future.

Homes that front onto greenspace or water bodies are best served through splash pads or rock infiltration pits that eventually drain to these areas.

7. Stormwater Plan Commitments

Based on the above analysis, the stormwater management plan is as follows:

7.1 Stormwater Quantity

1. Modify the existing outlet structures from Enos Lake and Dolphin Lakes as described in Section 4. These structures and the storage in these lakes provide a significant peak flow attenuation benefit for controlling post development peak flow rates. With the modifications outlined, the post development flows are slightly reduced from the natural catchment scenario peak flows. Where feasible excess stormwater should be directed to these lakes to the extent possible.
2. A secondary berm structure be built downstream of the wetlands on Creeks S1 (Enos Creek) , S3, and S6 (Cedar Creek). (See Figure 1-1 for locations). These berm structures must be able to withhold water to approximately the current beaver dam water level and have a low flow outlet.
3. The existing erosion sites between Dolphin Drive and the ocean outfall will be rehabilitated. The existing culverts under Swallow Crescent and Dolphin Drive will be checked to confirm that they can safely convey the 200-year storm event.
4. The existing stormwater system south of Schooner Cove be checked for hydraulic capacity and if inadequate, stormwater detention be provided or that system will be upgraded.

7.2 Stormwater Quality

5. The existing constructed wetponds immediately south of Enos Lake will be utilized for treatment of adjacent areas as outlined on Figure 1-1.
6. New constructed wetlands sized to hold the six month events, as shown on Figure 1-1 will be constructed adjacent and connected to Dolphin Lake and also just upstream on its tributary wetland and the outlet wetland above Enos Creek.
7. New ‘rainwater creeks’ as shown on Figure 1-1, be constructed to convey and aerate water into waterbodies.
8. Post Construction nutrient levels in Enos Lake will be monitored as part of the existing water quality monitoring program and the use of fertilizers within the watershed may have to be controlled or eliminated.
9. The littoral habitat and macrophyte beds shall be protected by limiting access points to Enos Lake and protecting those areas which are the most productive for the Stickleback.
10. Construct Sediment Control Ponds or structures as part of a Sediment Control Plan during each phase of construction. These structures should be in place until 75% of construction in each catchment is complete.

7.3 Report Submission

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Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of Bental Kennedy (Canada) LP for the Fairwinds Lakes District Stormwater Management Plan. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

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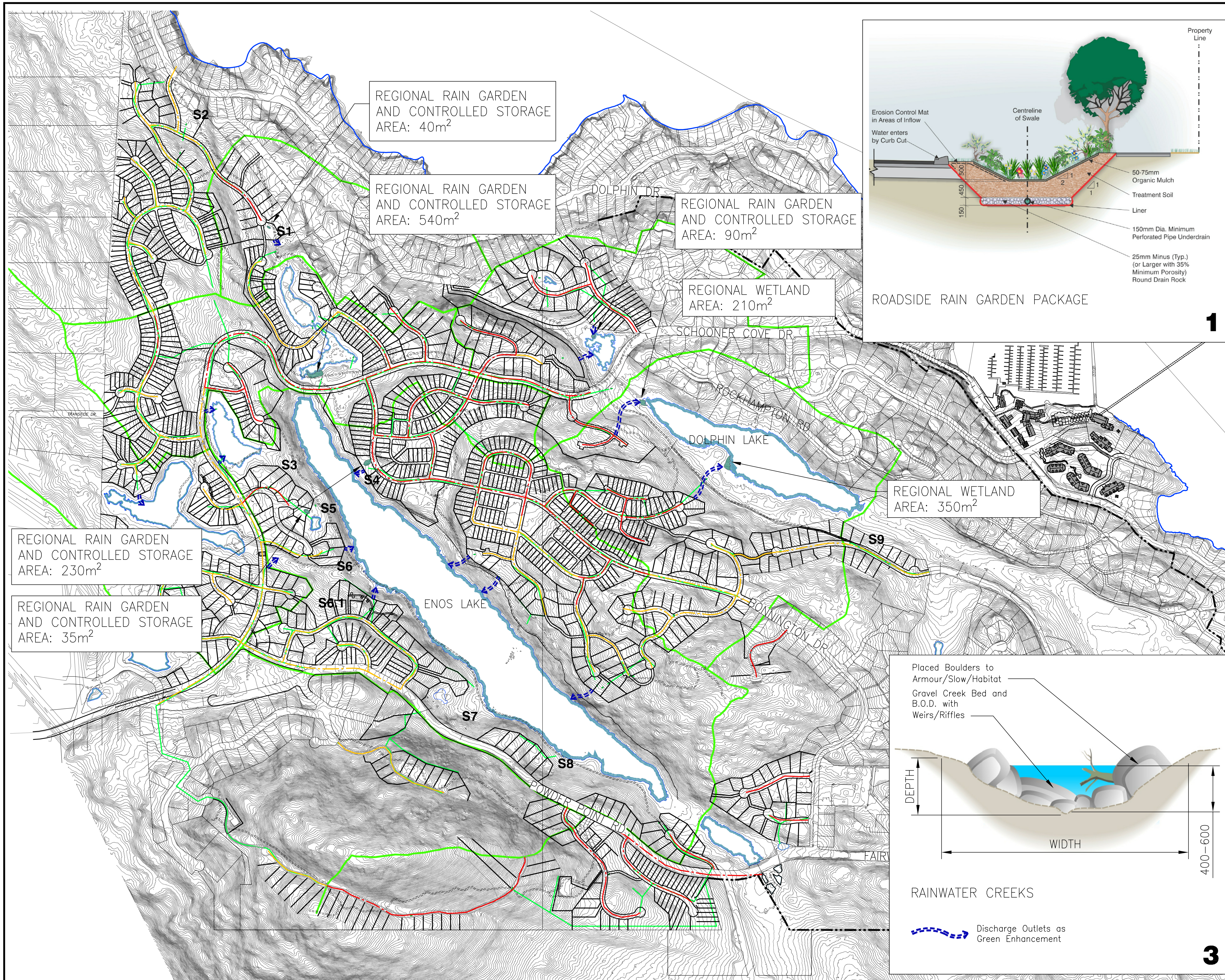
Revision History

Revision #	Date	Status	Revision	Author
1	May 17, 2012	Draft		J. Howard
2	July 13, 2012	Update	Additions as per previous comment for final review	R. Warren



LEGEND

	PROPOSED REGIONAL FACILITY	
	CATCHMENT AREA BOUNDARY	
	PROPOSED DRAINAGE PATHWAY	
	RAIN GARDENS WITHIN ROADWAY	1
	ROADWAYS DRAINING TO REGIONAL FACILITIES	2
	RAINWATER CREEK	3

NOTES:
1. ALL DISTANCES SHOWN ARE HORIZONTAL DISTANCES
2. INCORPORATE REGIONAL FACILITIES WITH EXISTING WETLANDS WHERE POSSIBLE

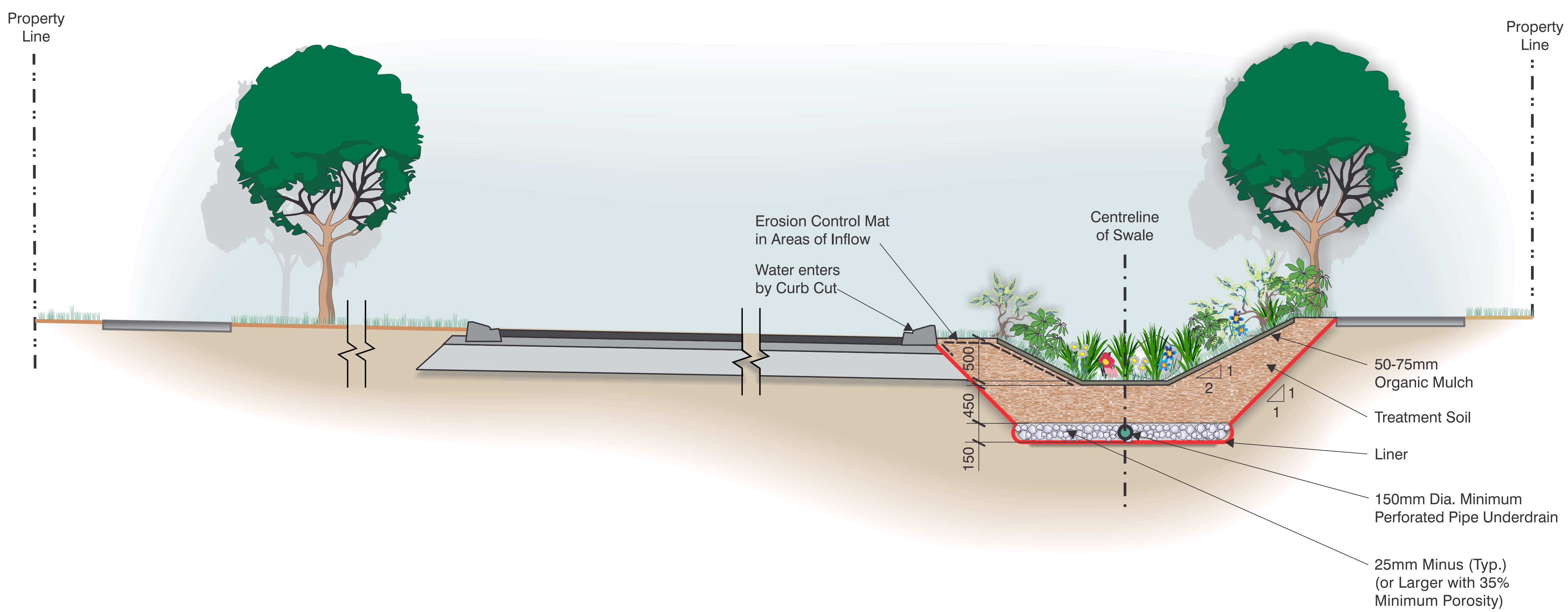
KERR WOOD LEIDAL
consulting engineers

0 100 (1:10,000) 500m

Project No. 2964.001

Date July 2012

FAIRWINDS LAKES DISTRICT
REGIONAL RAIN GARDENS
FIGURE 1-1



Roadside Rain Garden

DESIGN PRINCIPLES

- Approximately 22 m^2 of wetted area of rain garden required for 100 m of roadway.
- Provide pretreatment and erosion control to avoid introducing sediment into the garden.
- At point-source inlets, install non-erodable material, sediment cleanout basins, and weir flow spreaders.
- Swale bottom width - 600mm (min.) to 3000mm (desirable).
- Side slopes - 2:1 maximum, 4:1 preferred for maintenance. Maximum ponded level - 300mm.
- Draw-down time for maximum ponded volume - 72 hours.
- Treatment soil depth - 450mm; (composition: <30% silt and clay, 8-15% organics, 0-10% gravel, 50-70% sand) minimum infiltration rate of 20mm/hr.
- Surface planting should be primarily trees, shrubs, and groundcovers, with planting designs respecting the various soil moisture conditions in the garden. Plantings may include rushes, sedges and grasses as well for erosion control.
- Apply a 50-75mm layer of organic mulch for both erosion control and to maintain infiltration capacity.
- Avoid utility or other crossings of the rain garden. Where utility trenches must be constructed below the garden, install trench dams to avoid infiltration water following the utility trench.
- For linear roadside rain gardens on slopes steeper than 2 %, add timber weirs to achieve $\leq$ 2 % slope. (Max. drop per weir is 200mm).
- Planting area for trees adjacent to pavement to use a minimum of 800mm x 800mm x 800mm of structural soil. Exact required quantities will depend on tree selection.

The Purpose of this Drawing is to Illustrate the Concept of Rain Gardens.

NOT INTENDED FOR CONSTRUCTION.

The Detail Design should Include Input from a Professional Engineer, Hydrogeologist, and Landscape Architect.

Fairwinds Lake District

Notes:

KERR WOOD LEIDAL
consulting engineers

Not to Scale
Dimensions in (mm)

Project No.	Date
2964-001	June 2012

Rain Garden Detail

Figure 1-2

LEGEND

CATCHMENT AREA BOUNDARY

AREA 1

BUILDING SURFACE AREA = 4490 m²
ROAD SURFACE AREA = 5395 m²

AREA 2

BUILDING SURFACE AREA = 2760 m²
ROAD SURFACE AREA = 2320 m²

AREA 3

BUILDING SURFACE AREA = 7075 m²
ROAD SURFACE AREA = 3755 m²

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0 20 (1:1,500) 80m

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FAIRWINDS DEVELOPMENT

SCHOONER COVE STORM CATCHMENTS

FIGURE 1-3