KERR WOOD LEIDAL
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Appendix A

Rainwater BMP Review

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A.1 Introduction

As part of KWL's work on Phase 3 of the City of Courtenay IRMP, KWL has reviewed as-built record drawings for five (5) installed stormwater BMPs in the City of Courtenay. These BMPs serve various functions, and each are assessed in the context of the goals of the IRMP, including to mitigate the effects of development on the receiving waters at the outfalls of the City's storm drainage system, and to protect the environmental values of the City's watersheds from the hydrologic impacts of development.

For each of the review BMPs, KWL has made comments on the functionality of the provided design and, where applicable, has made recommendations for improving the performance of the different BMPs.

A.2 5th Street Complete Street Rain Gardens

The 5th Street rain gardens are a series of road-side rain gardens located along 5th St. between Menzies Ave. and Fitzgerald Ave. The drawing set reviewed is "5th Street Complete Street, City of Courtenay, City Contract #T18-10, Issued for Record, December 23, 3019, by Urban Systems".

In addition to the record drawings, these installed rain gardens were observed in the field on July 21, 2022.

Observations on the Design

Notes on the design of the system include:

1. The rain gardens received runoff from the street, which enters the rain gardens through curb cuts parallel to the road and traffic direction;
2. The curb cuts lead to a concrete pad and a sediment basin with a grated inlet;
3. The sediment basin is a shallow catch basin, with large (80 mm) drainage holes in the sides, surrounded by peak gravel to allow exfiltration of water into the surrounding rain garden base;
4. Runoff from driveways along this section of street is captured in channel drains that drain to perforated pipes in the rain gardens;
5. Lawn basins in the rain gardens provide an overflow route for any excess water at the surface of the rain garden, connecting to the storm sewer;
6. There are perforated pipes below the rain garden surface that appears to be sloped toward the lawn basins that connect to the storm drainage system. These would provide collection of excess water that cannot be infiltrated below the planted areas;
7. The ratio of impervious area to pervious area (I/P ratio) is approximately 5:1 or less for these rain gardens. This is low enough that there is no concern about pollutant or hydraulic loading overwhelming the treatment capacity of the rain gardens;
8. In-person observation indicates the plantings look healthy, though they do not appear to have spread in all cases, and the rain gardens appear well-maintained. Some sediment removal from concrete inlet pads is needed before the winter season.

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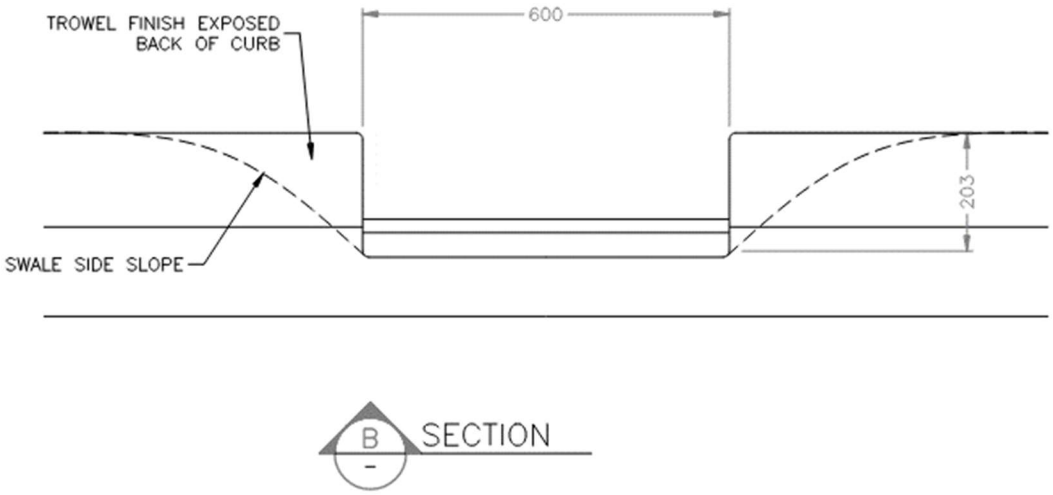
Concerns Identified

There are a number of concerns identified for the design of the 5th Street Complete Street rain gardens:

1. Flow enters the rain garden through a curb cut that is located facing (just opposite of) either a sediment basin or a lawn drain and is connected to the outlet by a concrete swale. While it appears the intent of the concrete pad and directly connected sediment basin is to efficiently handle sediment for ease of maintenance removal, this design short circuits the rain garden such that flow goes from the curb cut to the outlet without ever entering the planted portion of the rain garden. This reduces the opportunity for infiltration of runoff and prevents treatment of runoff through the growing medium soil;
2. The rain garden outlets, both sediment basins and lawn basins, are located at the low points of the rain garden, so that runoff does not have an opportunity to flow into the remainder of the rain garden;
3. The lawn basin outlets are located blow the surface elevation of the growing media; therefore, no water can pond in the rain garden in order to promote infiltration during high intensity events; and
4. It appears the grading of the surface of the rain garden is raised above the elevation of the curb cuts so that the flow that enters the curb cuts is confined to the concrete swale and has no opportunity to spread to the sides and flow into the rain garden from the curb cut inlet (see detail below):



5. The surface of the rain garden is not at a grade below the elevation of the street, so there is no opportunity for flow at the surface to utilize the rain garden before flow would back-up into the street's travel lanes; and

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6. While the channel drains across the driveways are a nice addition to the design, it is not clear if they are necessary in all cases. Where they collect driveway runoff that would not drain to the street due to the raised bike lane they are needed, however, if the driveway elevation and slope would allow the runoff to drain to the street, then it would become part of the street drainage into the rain gardens and the channel drains would not be needed.

Conclusion

The single largest concern with this design is that it does not appear to allow flow from the road surface through the growing medium, which is the primary method of treatment of many contaminants in road runoff. The mechanisms for sediment capture should provide some water quality improvement, but this design completely misses the opportunity of providing better water quality treatment than could be obtained by grit separators, even though the soil and plants are there that could provide the treatment.

Recommendations

To Improve the Design

The following would be recommended to improve the performance of the rain gardens for this design:

1. Overflow outlets should be located as far as possible from runoff inlets to maximize residence time and treatment within the rain garden. The curb cut inlets should not lead directly to any lawn basins;
2. The lawn basin outlets should be raised above the rain garden surface so that ponding and infiltration through the growing media occurs before overflow to the storm drain system; and
3. There should be a depth of ponding available above the surface of the growing medium for water to pond in the rain garden before water backs up into the street. The surface of the rain garden area should be lower in order to allow ponding.

Opportunity for Remediation

The treatment potential of these rain gardens could potentially be improved by implementing retrofits such as:

1. Adding risers to the lawn basin outlets to prevent inflow until the water in the rain garden has ponded to the elevation of the curb cut. The same could be done with the sediment basins, but this would prevent the sediment basins from functioning as intended; and
2. Removing the top centimeters of the growing medium and mulch in the centre of the rain garden and reducing the level of the growing medium surface to form a swale in the growing medium which would allow runoff to flow to the planted areas from the concrete pads at the curb cut inlets. This would require re-planting the plants in the rain gardens where the surface material is removed.

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Recommendations for Policy and Implementation

The following policy and implementation approaches are recommended for consideration to improve the performance of roadside rain garden BMPs:

1. Clarify performance targets for BMPs relative to goals for capture and treatment, e.g.:
   a. Capture and infiltrate X mm of rainfall in 24 hours; and
   b. Treat X mm of rainfall in 24 hours for water quality improvements; treatment must obtain a minimum 80% removal of inflow sediment on a mass basis;
2. State that green infrastructure/source controls for management of road runoff should provide treatment of runoff in addition to capture;
3. State that rain gardens should be designed to provide ponding up to an acceptable limit in order to maximize infiltration capture, with raised outlets for overflow above that ponding limit;
4. Note that the locations of overflow outlets should be located as far as is practical from the inlets; and
5. Note that rain gardens should incorporate pre-treatment for management of coarse sediment, considering ease of access and use of existing municipal equipment.

A.3 The Ridge Phase 1 - Buckstone Investments

The Buckstone Investments Subdivision for The Ridge Phase 1, is a subdivision in the City of Courtenay bounded by Comox Logging Road to the North, Rhys Road to the South, Buckstone Road to the East and Fraser Road to the West. The stormwater management features include an infiltration swale and a wet pond designed for peak flow control for the 10-year return period flow (Q10). It incorporates a spillway to pass the 100-year return period flow (Q100) without uncontrolled overflow of the facility. The drawing set reviewed is “Buckstone Investments, The Ridge Phase 1, Courtenay, BC, City File No. 3320-20-11634-Onsite, Record Drawings January 11, 213 by McElhanney Consulting Services Ltd”.

Observations on the Design

There is no design report accompanying the drawings, so the underlying design goals, performance targets and assumptions for design of the stormwater management features are unknown. Notes on the design of the stormwater system that can be understood from the drawings include:

1. The storm system includes several sections of perforated pipe and exfiltration galleries consisting of perforated pipe surrounded by drain rock and wrapped with geotextile;
2. The design includes a few sections of infiltration swale, consisting of a shallow grassed swale with a perforated pipe surrounded by drain rock below the swale;
3. A stormwater pond is proposed for the Northeast side of the site, providing detention prior to discharge into an existing ditch along Comox Logging Road; and
4. The pond appears to be designed as a wet-dry stormwater pond, with a normal water level regulated by an orifice-controlled discharge pipe, as well as lower-level drain and perforated drains

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in the base of the pond to allow it to drain slowly below the normal water level. It also has a rock-lined overflow for flows in excess of the design flow (Q10) up to the major system flow (Q100).

Concerns Identified

There are a few concerns identified for the design of The Ridge Phase 1 stormwater management:

1. It is not known what the goal is for infiltration and capture into the subsurface soils via the perforated pipes and exfiltration galleries. However, the volume of rock for storage of water for infiltration appears to be minimal. If the subsurface soils have high infiltration rates, these could be very effective, however if the subsurface soils have lower infiltration rates, the volume of drain rock is not large enough to store significant volumes for infiltration; and
2. The pond configuration appears to provide detention with multiple flow controls. However, it is unclear if the pond is intended to provide any other benefits, such as volume capture through infiltration, or water quality improvement through settling and/or infiltration. With the current pond configuration, outlets and inlets are located close to each other and the level of water quality improvement would be expected to be low.

Conclusion

While some volume capture through exfiltration galleries is provided, and rate control via a detention pond with orifice control appears to have been carefully design, it appears that water quality treatment or improvement was not a part of the design for the stormwater management system for this development.

Recommendations

To Improve the Design

Opportunities to improve the design for the stormwater management for this site could include:

1. The potential for water quality improvement for the pond would be increased if outlets are placed as far away from the inlets as possible, to lengthen the hydraulic residence time of the incoming flows; and
2. Additional design features for the pond could be considered to improve treatment potential, such as incorporating a sediment forebay for ease of cleanout, or an island or berm and baffles to lengthen the flow path from the inlets to the outlets.

Recommendations for Policy and Implementation

The following policy and implementation approaches are recommended for consideration to improve the performance of the BMPs:

1. Clarify performance targets for BMPs relative to goals for, particularly for water quality improvement, e.g.:
    a. Treat X mm of rainfall in 24 hours for water quality improvement; treatment must obtain a minimum 80% removal of inflow sediment on a mass basis; and

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2. If not already a requirement, require that drawings be accompanied by a basis of design memorandum that describes the targets that the system is designed for, and the methods and calculations that show how the design meets those targets.

A.4 Courtenay Seniors Village – Headquarters & Dingwall Rds.

The Courtenay Seniors Village is a plan for a Retirement Centre at the corner of Headquarters Road and Dingwall Road. This location is across the road from the Tsolem River, and the project includes an "enhancement area" on the opposite side of Headquarters Road and adjacent to River. The drawing set reviewed is "Retirement Concepts Development Ltd., Courtenay Senior Village, Courtenay, BC, Record Drawings Revision 4, 9 April 2009 by McElhanney Consulting Services Ltd".

Observations on the Design

There is no design report accompanying the drawings, so the underlying design goals, performance targets and assumptions for design of the stormwater management features are unknown. Notes on the design of the stormwater system that can be understood from the drawings include:

1. The stormwater management for the site includes 3 small ponds, 2 in the East corner of the site, along Dingwall Road, and one in the South corner of the site, at the corner of Dingwall and Headquarters Roads.
2. Ponds #1 and #2 overflow into a grassed ditch with riprap 'riffles' at grade breaks that convey the overflow to Pond #3. Pond # 3 overflows to the storm sewer along Headquarters Road.
3. Pond #1 has an overflow that maintains the water level at or below a certain elevation. Pond # 2 has a flow control manhole with a weir set to the Q10 level in line prior to discharge to the grassed swale. The outlet of Pond #3 appears to have no flow control but provides a maximum elevation for the pond prior to overflow. 'Static' water levels, Q10 water levels and Q100 water levels are all indicated on the pond cross-sections. A low-level drain in pond #2 has a valve for closure, so would likely be used for maintenance purposes.
4. Ponds #1 and #2 have a Q100 overflow to the adjacent ditch along Dingwall Ave. Pond #3 has a Q100 overflow at the corner; as there does not appear to be an existing ditch there, the flow would likely discharge on the road on Dingwall Ave. near the corner with Headquarters Rd.
5. A two-chamber oil/water separator is shown on the Northeast side of the site along the "Private Access"; this unit appears to provide treatment of flows from the vehicle-accessible ground level impervious area on that side of the lot.
6. The 'enhancement area' is an existing channel draining stormwater into the Tsolem River. The proposed upgrade appears to be for the benefit of aesthetics and increasing the durability of the channel.

Concerns Identified

There are a few minor concerns identified for the design of the Courtenay Seniors Village stormwater management:

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1. The site ponds appear to provide rate control to the 10-year return period level. There is no accompanying design basis information to confirm that, or understand what the goals are;
2. The ponds appear to provide storage to the 10-year level; it is not clear what flow rates are expected as part of the controls provided, or whether the resulting flows are controlled enough to protect the creek;
3. The fill material around the ponds is described as “impermeable clay material” and one note on mentions “impermeable liner”, therefore it appears that the ponds are not intended to provide any infiltration or volume control;
4. There appear to be external flows that enter Pond 1 - is the purpose of Pond 1 pre-treatment? A forebay could reduce the velocity of incoming flows and allow heavy sediment and debris to settle. Deep pools, riprap or other energy-dissipating control measures could be incorporated to minimize resuspension of trapped sediment and scour in the forebay during high incoming flows;
5. Pond #3 is designed with a vegetated island in the centre; however, the placement of the island and the location of the inlet and outlet present a risk of preferential flow path from inflow point ditch along north side of vegetated island to the pond outlet;
6. The commonly recommended freeboard between the top of the embankment and the elevation of the emergency spillway is minimum 0.3 m which is not achieved for Ponds 2 and 3. The Q100 level of water indicates that 0.3 m may not be required, but it is not clear; and
7. There is no sizing information on the oil/water separator proposed along the private access, so it is unclear if it will provide sufficient treatment for expected flows. However, the on-site ground impervious area is not large, so the separator is likely adequate if correctly maintained. No indication of a maintenance plan for the separator is on the drawings provided. If this unit provides only treatment for floatable oils and not for sediment (commonly called an oil/grit separator) it does not provide the level of treatment that would be desired for runoff from vehicle surfaces.

Conclusion

The site appears to have volume control and the water quality treatment device does not appear to treat for sediment load, which is likely to be a concern for a site in close proximity to the natural receiving water.

Recommendations

To Improve the Design

Opportunities to improve the design for the stormwater management for this site could include:

1. Replace the oi/water separator with an oil/grit separator in the design;
2. Potentially provide pre-treatment and sediment capture for incoming flows to Pond #1; deep pools, riprap or other energy-dissipating control measures could be incorporated to minimize resuspension of trapped sediment and scour in the forebay during high incoming flows;
3. The island could be placed differently in the pond to increase the length of the flow path from the pond inflow to the outlet; alternatively, the outlet ditch could discharge further south (closer to

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spillway) to avoid short circuiting (i.e., enhance hydraulic efficiency) and improve water quality (settling of solids); and

4. Incorporate some volume control, with infiltration in the bases of the ponds, or separately.

Recommendations for Policy and Implementation

The following policy and implementation approaches are recommended for consideration to improve the performance of the BMPs.

1. As above, clarify performance targets for BMPs relative to goals for, particularly for water quality improvement.
2. If not already a requirement, require that drawings be accompanied by a basis of design memorandum that describes the targets that the system is designed for, and the methods and calculations that show how the design meets those targets.

A.5 Marble Place and Malahat Park

The Marble Pl. subdivision is a small development along Malahat Drive. The Malahat Park stormwater pond is on the opposite site of Malahat Drive from the Marble Place subdivision and received storm discharge from the subdivision in addition to flows from upslope on Malahat Drive. The drawing sets reviewed are “Beecher Developments Ltd., Phase 6, as Constructed, December 1992 by McElhanney Engineering Services Ltd” and “City of Courtenay Park 111 Topography & Storm Detention Pond, Malahat Drive @ Mallard Drive, Courtenay, BC, As Constructed, 10 Nov 1997, McElhanney Consulting Services Ltd.”.

Observations on the Design

There is no design report accompanying the drawings, so the underlying design goals, performance targets and assumptions for design of the stormwater management features are unknown. Notes on the design of the stormwater system that can be understood from the drawings include:

1. The drainage from Marble Place crosses Malahat Drive and discharges into the stormwater pond; and
2. At the lower end of the pond is a “pond outlet control structure”, however the design does not appear to provide any flow control, it is simply an inlet headwall for an existing 900 mm pipe. Therefore, though the pond would provide storage for stormwater flows it does not appear that outflow from the pond is controlled to a specific level.

Concerns Identified

There is very little information to review the likely performance of the Malahat Pond, however:

1. If there are no flow controls at the outlet of the pond, the performance of the pond for detention could potentially be improved by addition flow controls. However, if this pond is intended for flood control, controls to provide lower-level detention would have to be carefully modelled to ensure that the flood protection value is not adversely impacted; and
2. There is no indication that volume control or water quality improvement is provided.

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Conclusion

There is too little information to have a clear understanding of the performance intended for the Malahat Pond.

Recommendations

Recommendations for Policy and Implementation

The following policy and implementation approaches are recommended for consideration to improve the performance of roadside rain garden BMPs.

1. If not already a requirement, require that drawings be accompanied by a basis of design memorandum that describes the targets that the system is designed for, and the methods and calculations that show how the design meets those targets.

A.6 North Courtenay Commercial Development - Walmart

The North Courtenay Commercial Development includes area along Cliff Avenue with the main development extending West form Cliff Avenue to the E & N Railway between approximately 30th and 31st Streets, an area of improvement along Cliff Avenue from 29th to 30th St., showing improvements along the road right-of-way is also included. 'Offsite' stormwater improvements are shown on the Northeast side of Cliff Avenue. The drawing sets reviewed are "First Courtside Developments Ltd., North Courtenay Commercial Development, City File No. 3320-20-98279, as Constructed, 20 October 2001 by McElhanney Consulting Services Ltd" and "First Courtside Developments Ltd., Proposed Irrigation Plan, Cliff Avenue, not sealed, 30 July 2001 by McElhanney Consulting Services Ltd.".

Observations on the Design

There is no design report accompanying the drawings, so the underlying design goals, performance targets and assumptions for design of the stormwater management features are unknown. Notes on the design of the stormwater system that can be understood from the drawings include:

1. A portion of Cliff Ave. along the path on the Southwest side of the street incorporates a swale underlain by a perforated pipe. It is not clear what area this drains other than the right-of-way where the path meanders;
2. Drainage from the development site is discharged through an onsite oil/water separator and then through a storm pipe crossing Cliff Ave. to a pond on the opposite side of the road called and 'engineered wetland/detention pond';
3. The main pond has an orifice-controlled underflow outlet (160 mm orifice) and a weir set to a 2-year storm water elevation. A 100-year storm elevation is also shown; and
4. There is a smaller 'constructed wetland' shown to the East of the main pond that receives the 'underflow' from the main pond which will slowly drain over time into the wetland. Up to the 2-year storm it appears all flow will drain to the wetland. The outlet or overflow for the wetland appears to be an existing channel flowing toward the Southeast. There do not appear to be any flow controls on the wetland discharge.

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Concerns Identified

There is very little information to review the likely performance of the Malahat Pond, however:

1. The main pond appears to be a dry detention pond, in that it can fully drain to the base elevation of the pond through the orifice outlet. It should provide some sediment removal through settling but would mainly function for rate control. While the pond appears to provide full rate control up to the 2-year storm, it is not clear if the pond provides detention for the 10-year or any larger storm event;
2. The wetland is located at the downstream end of the main pond. It may be able to provide water quality improvement to the flow that drains to it from the main pond, up to the 2-year storm level. It is unclear what the hydraulic residence time for the wetland is intended to be, or what it is intended to provide treatment for;
3. There is no indication that volume control is provided anywhere in the system, and it is concluded that volume control is not designed for. Some volume control may be achieved through infiltration below the pond and the wetland as they do not appear to be lined; and
4. There is no pre-treatment area that appears easy to maintain; the area just downstream of the energy dissipation area would likely receive coarse sediment that settles out of the flow and may be challenging to clean out when it builds up.

Conclusion

The site appears to provide water quality improvement to the 2-year storm level and rate control to the 2-year storm level, but there is no designed volume control, and it is unclear if there is any rate control above the 2-year storm level.

Recommendations

To Improve the Design

Opportunities to improve the design for the stormwater management for this site could include:

1. Incorporate additional flow controls to provide detention for 10-year and other storm events;
2. Provide easy to maintain pre-treatment area for removal of coarse sediment so that is retained in one location and is easily cleanable; and
3. Incorporate or calculate volume control, with infiltration in the bases of the ponds, or separately.

Recommendations for Policy and Implementation

The following policy and implementation approaches are recommended for consideration to improve the performance of the stormwater management BMPs:

1. If not already a requirement, require that drawings be accompanied by a basis of design memorandum that describes the targets that the system is designed for, and the methods and calculations that show how the design meets those targets; and
2. Clarify volume control and rate control performance targets.

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A.7 Summary of Recommendations for Policy and Implementation

The recommendations for updating policies and implementation practices to improve the performance of accepted and installed stormwater management BMP include the following, based on our review of 5 constructed BMPs within the City of Courtenay:

1. Clarify performance targets for BMPs relative to goals for capture and treatment, and when each are required e.g.:
    a. Capture and infiltrate X mm of rainfall in 24 hours for all lots except single family residential; and
    b. Treat X mm of rainfall in 24 hours for water quality improvements; treatment must obtain a minimum 80% removal of inflow sediment on a mass basis. Water quality treatment is required for all roads, parking areas, laneways and other vehicle accessible impervious surfaces that drain to the storm system;
2. Clarify what level of rate control is required for which land uses, or changes in land use;
3. Require submissions to show how the performance targets are met. If not already a requirement, require that drawings be accompanied by a basis of design memorandum that describes the targets that the system is designed for, and the methods and calculations that show how the design meets those targets; and
4. Clarify specific design needs for rain gardens that treat road runoff:
    a. State that green infrastructure/source controls for management of road runoff should provide treatment of runoff in addition to capture;
    b. State that rain gardens should be designed to provide ponding up to an acceptable limit in order to maximize infiltration capture, with raised outlets for overflow above that ponding limit;
    c. Note that the locations of overflow outlets should be located as far as is practical from the inlets; and
    d. Note that rain gardens should incorporate pre-treatment for management of coarse sediment, considering ease of access and use of existing municipal equipment.