5. STORMWATER MANAGEMENT PLAN

5.1. Stormwater Management Infrastructure Retrofits

The stormwater management plan for Parksville Community Park uses a treatment train approach to address existing and future deficiencies in each subcatchment. Planning and design objectives listed in Section 4 direct the recommended retrofits for stormwater management described for each subcatchment in Section 5 (see Figure 25). Implementation of the stormwater management retrofits (see Figure 26) will allow active discharge of some of the isolated subcatchments, while appropriate design, construction and maintenance of the infiltration facilities in the remaining isolated catchments will alleviate nuisance ponding during the target design event. Table 13 summarizes the recommended stormwater management improvements in each subcatchment discussed in detail in Sections 5.1.1 to 5.1.8, and lists related CPMP activities by number along with estimated implementation timelines. Section 5.2 details non-structural stormwater management approaches that will ensure facilities remain functional for the duration of their expected lifecycle. The following sections detail, by catchment area, the recommended approaches to mitigating the stormwater management deficiencies identified in Table 7. Concept designs are included for some proposed improvements.

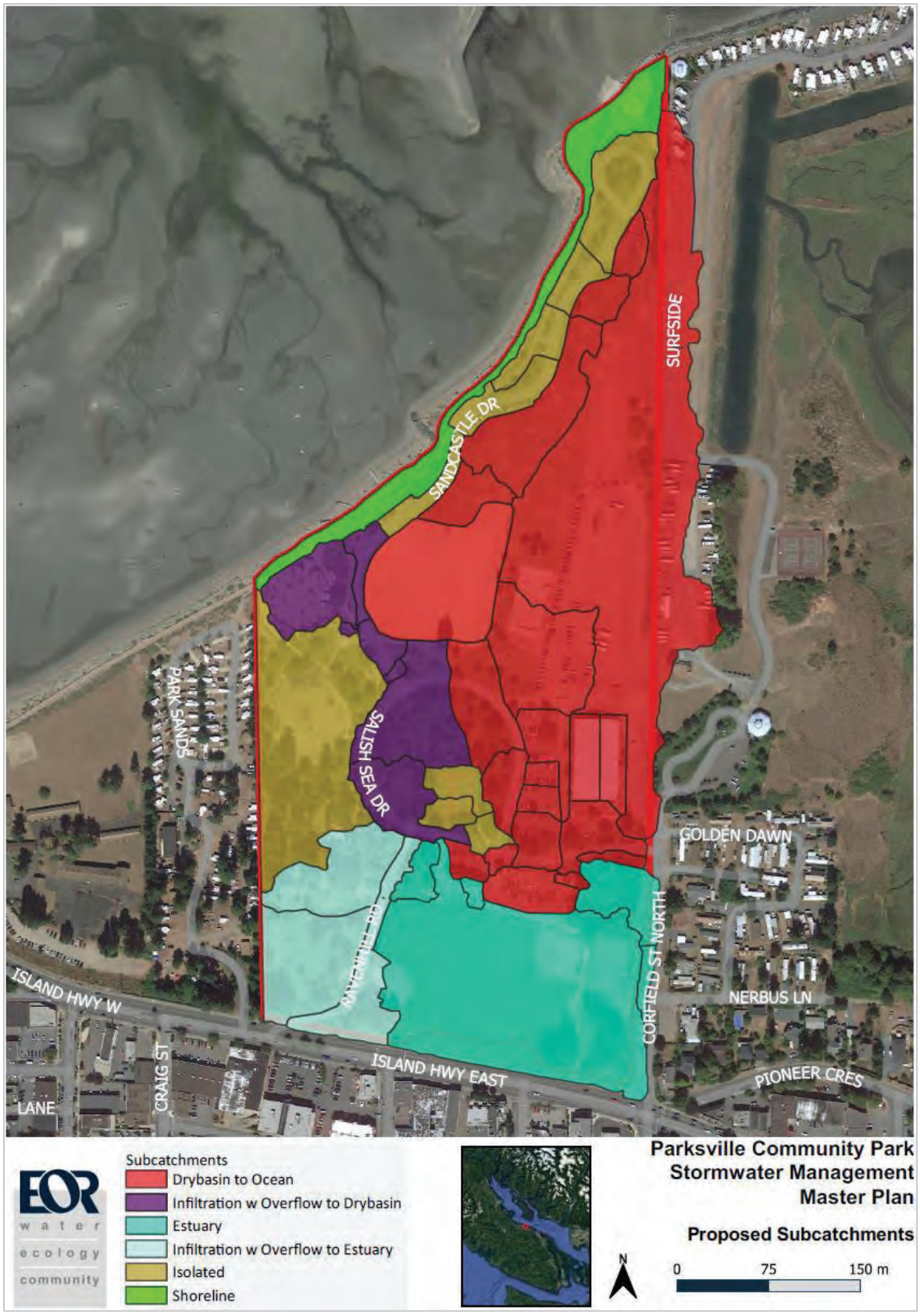


Figure 25. Future stormwater catchments

Figure 26. Future Stormwater Management System

5.1.1. Estuary Catchment

The following objectives guide the stormwater management approach to address the specific existing and future conditions in the southeast catchment:

- Mitigate non-point source pollution to the Estuary
- Prevent surface flooding during future 10-year, 24-hour rainfall event
- Mitigate flooding during extreme events to acceptable levels of risk
- Minimize risk of stormwater practice failure due to clogging or high groundwater

Recommended stormwater management infrastructure and site improvements for the southeast catchment include the following:

A. Install new trunk storm sewer along Nerbus Lane to existing Estuary outfall

Currently stormwater runoff discharged to the Englishman Estuary from the park and through the existing Corfield Street North catchbasins is not treated. This option connects the drainage manhole west of the Lacrosse Box (DMH21) to the water quality unit at the Nerbus Lane outfall, matching the existing invert and the invert from the existing 1000mm connection at the outfall (see Figure 27). The Corfield Street North and Nerbus Lane catchbasins are then connected to the new storm trunk. A sump manhole with water quality baffle provides treatment at J60 (indicated in Figure 27), the manhole where the Corfield Street North catchbasin lead(s) connects to the storm trunk, to prevent sediment and organics from the Park from blocking flows along the low slope alignment. At least one sump manhole should be provided between Corfield Street North and the outfall, to facilitate maintenance along the low slope storm trunk.

B. Establish treatment and an overland flow pathway to Corfield Street North

Consider adding a green roof to the upgraded Kin Hut to reduce runoff and provide treatment. Grade the treed area around Kin Hut to provide positive drainage to Corfield Street North for the ponding area in the northeast corner of the ball diamonds (see Figure 28) and along the paved pathway. Existing infiltration capacity in the area of Kin Hut should be evaluated and, if possible, enhanced with raingardens situated along the positive drainage pathway. Existing trees will constrain grading options and must be carefully incorporated into earthwork undertaken at the time of upgrades. Coordinate timing of the site grading with adjacent planned works identified in the CPMP, such as parking lot paving or Kin Hut upgrades.

Related to CPMP Action 37 (Short Term):

Replace Kin Hut facility with clubhouse to include changing, washroom, storage and meeting facilities.

C. Optional storage for reuse under Lacrosse Box

During or following connection of the new Nerbus Lane storm trunk, inline or offline storage may be installed under the Lacrosse Box for irrigation reuse in the sports field, according to provincial requirements. Storage overflow will be directed into the new storm trunk, as illustrated in Figure 28.

Proprietary devices, such as StormTech by ADS, within a bed of clean gravel, can be utilized to provide storage for stormwater runoff. The irrigation system can be connected to this source of water for use on the sports field. Depending on the type of irrigation, whether spray or drip, different levels of treatment should be considered for the stored water prior to application to the sports field. Treatment options range from mechanical filtration to UV treatment for the highest level of safety. This option may not be feasible with the current price and availability of potable water and the cost of required treatment, however the sewer layout allows for retroactive addition of a storage unit if it becomes practical or desirable at a later time.

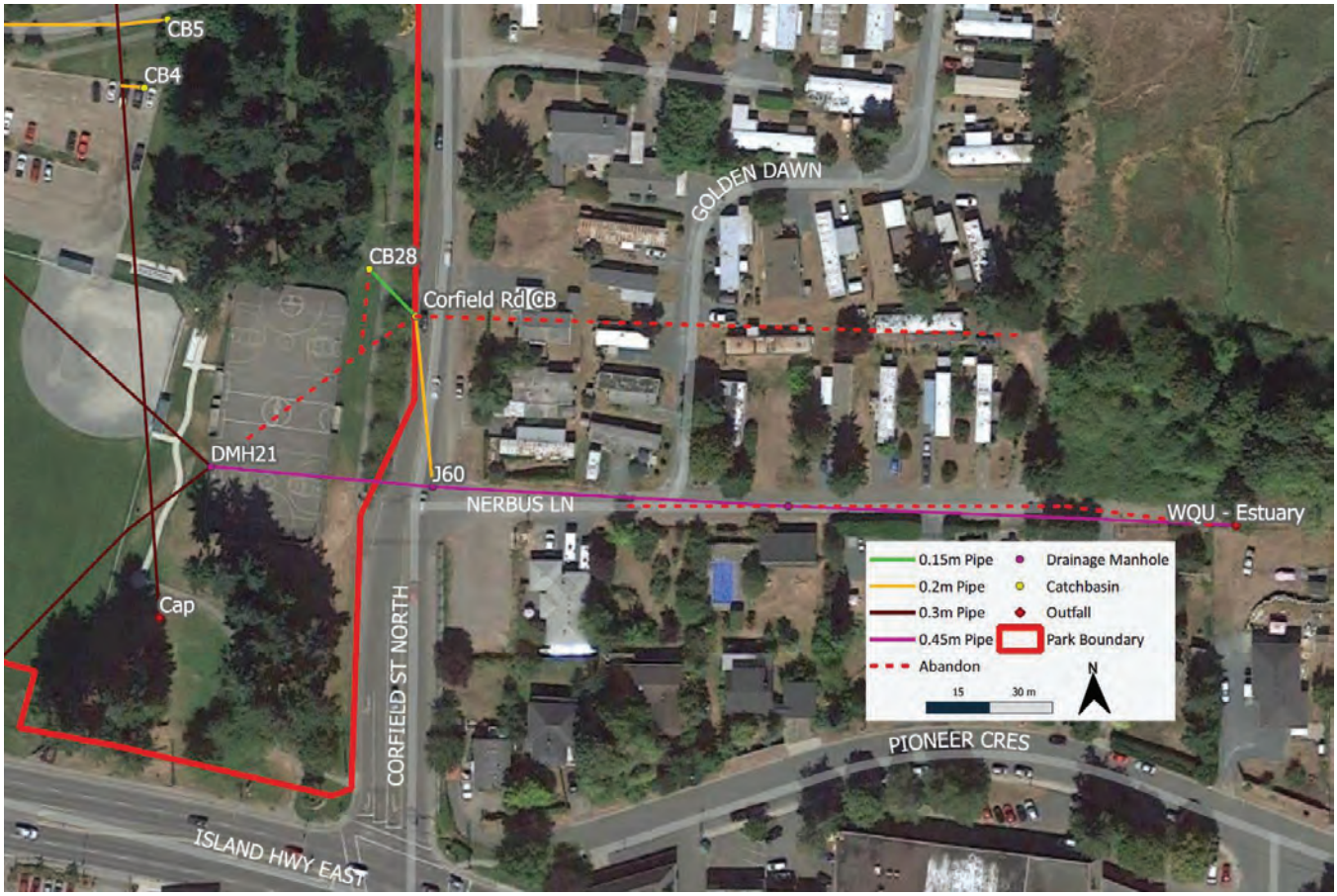


Figure 27. Nerbus Lane storm sewer connection concept

Figure 28. Concept design for stormwater infrastructure upgrades and regrading address deficiencies in the Southeast catchment with optional stormwater storage for irrigation

5.1.2. Ravenhill Road Catchment

The following objectives guide the stormwater management approach to address the specific existing and future conditions in the Ravenhill Road catchment:

- Prevent surface flooding in road during future 10-year, 24-hour rainfall event
- Mitigate flooding during extreme events to acceptable levels of risk
- Minimize risk of stormwater practice failure due to clogging and high groundwater

Currently, runoff from Ravenhill Road enters an infiltration facility located under the sports fields from a single catchbasin on the east side of the road. Details regarding the design of the infiltration facility are not available, and it is assumed that water often pools on the road due to insufficient volume and/or infiltration capacity in that facility. The recommended stormwater improvements detailed below are intended to limit ponding in the roadway to no greater than 6cm during storm events up to the 2100 10-year 24 hour design event. With the improvements listed below, overflow from the infiltration facility during rainfall events larger than the 2100 10-year 24 hour design event will discharge into the storm sewer north of the sports field and ultimately out the Estuary outfall. During large, infrequent events, runoff may also enter the roadway from the amphitheatre area. The volume of water contributing to this facility during the 2100 100-year 24 hour design event will likely result in temporary ponding in the roadway, at depths no greater than 15cm, while slowly discharging through the estuary outfall.

Recommended stormwater management infrastructure and site improvements for the Ravenhill Road catchment include the following:

A. Restore capacity of infiltration rock pits

Replace the existing infiltration rock pit with an inline infiltration facility sized to capture the 2100 10-year 24-hour storm event before overflowing. Ensure design includes cleanouts, a sump catchbasin and an inlet screen/baffle to prevent clogging by organics.

B. Connect to overflow to sports field drainage system

Connect overflow from the new infiltration rock pit to the existing storm sewer immediately north of the sports field and discharging through the new Nerbus Lane storm sewer outlet. The overflow from the new rock pit should come from the top of the rock pit once the full volume has been used, resulting in a reliance on infiltration to manage the majority of runoff entering the facility with rare overflow events discharged to the storm sewer.

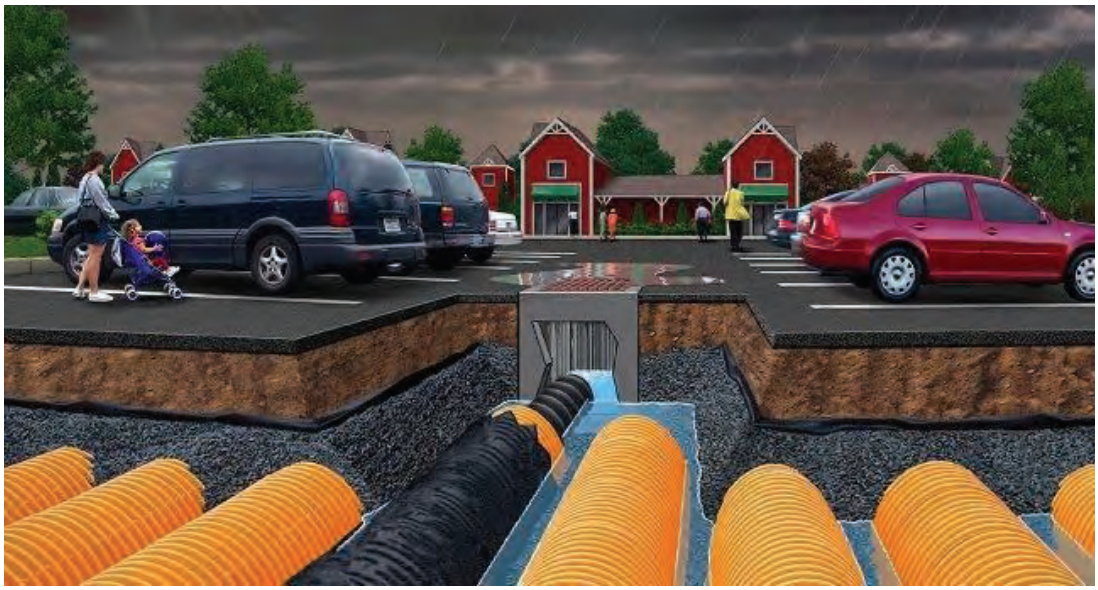


Figure 29. Example of underground storage facility for reuse

5.1.3. Amphitheatre Catchment

The following objectives guide the stormwater management approach to address the specific existing and future conditions in the Amphitheatre catchment:

- Prevent surface ponding in amphitheatre seating area during future 10-year, 24-hour rainfall event
- Mitigate flooding during extreme events to acceptable levels of risk
- Provide overland flow route to Ravenhill Road

Recommended stormwater management infrastructure and site improvements for the Amphitheatre catchment include the following:

A. Install green roofs and raingardens to capture runoff from amphitheatre and access road

Size and locate raingardens to capture additional runoff generated from the impervious amphitheatre and access road during the 10-year, 24 hour storm event. Conceptual design and modeling indicate the need for one rain garden on either side of the proposed stage, size 40.7 and 44.5 m^2 respectively (see Figure 31). An additional raingarden installed within the naturalized area would prevent surface flows to Ravenhill Road during small events, alleviating pressure on the infiltration gallery. Due to the high-profile location of these raingardens, they provide a fantastic opportunity to incorporate educational and high-quality design elements related to the local First Nations regard of water, considering water as a resource, the natural hydrologic cycle and sustainable stormwater management. Consider installing green roofs on all new buildings to reduce runoff.

B. Regrade area to drain overland to Ravenhill Road

Install a berm at the north edge of the viewing area for the amphitheatre and grade the viewing area to ensure positive overland drainage toward Ravenhill Road during large storm events by directing water to a rain garden within the native vegetation area that overflows to a swale directed to Ravenhill Road. Fill and seed low area adjacent to picnic shelter, to prevent ponding during large storms (see Figure 31). Timing and design of site grading and raingardens should be coordinated with the amphitheatre construction to realize mobilization, earth moving and site restoration efficiencies. Designs must incorporate methods of avoiding disturbance within the archaeological site. Consider installing green roofs on all new buildings to reduce runoff.

Related to the following CPMP Actions
(Note that as of 2020, these action items conflict with the defined archaeology zone):

- *24 (Short Term). Create a small section of accessible parking and loading area at the southern section of Beachfront Drive* [now Ravenhill Road] *near the picnic shelter with a curb cut. Connect a path from the Parking to the picnic shelter.*
- *39 (Long Term): Construct additional facilities near picnic shelter area to include parks maintenance, public washrooms and storage.*

C. Establish native vegetation

During site restoration following installation of amphitheatre and regrading, establish native vegetation around amphitheatre lawn viewing area and on slope behind stage, up to Island Highway East. Native vegetation, illustrated in Figure 30, will frame the viewing lawn space, while stabilizing soil, preventing erosion, and taking up stormwater runoff to reduce ponding in the area to the north.

Related to CPMP Action 49 (Ongoing): *Encourage the use of native vegetation and plantings into landscaping nearest to shoreline, with non-native plantings in more formal areas of the Park.*

Figure 30. Examples of landscaping with native vegetation

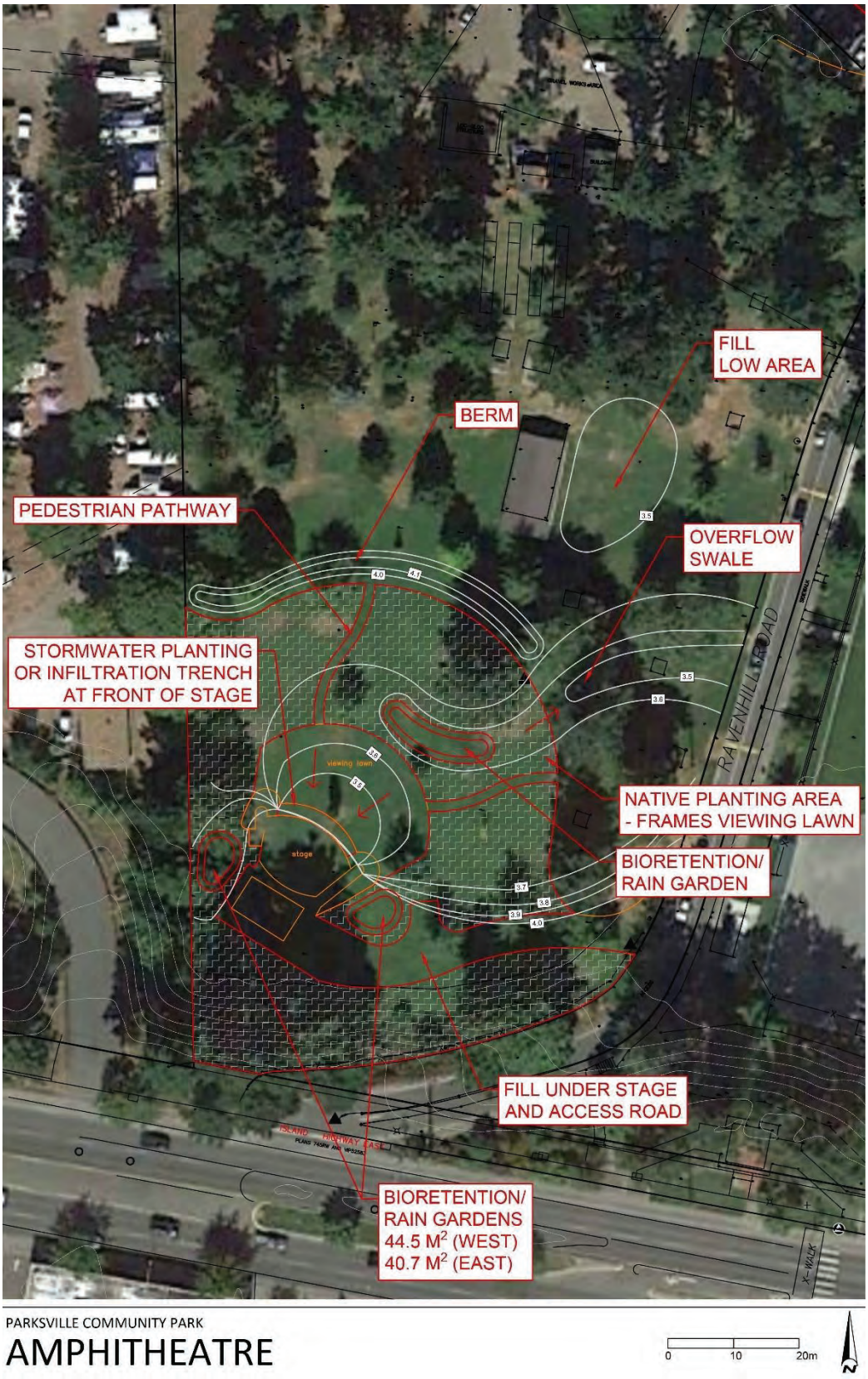


Figure 31. Concept design for site layout and stormwater features at proposed amphitheatre

5.1.4. Southwest Sandcastle Drive Catchment

The following objectives guide the stormwater management approach to address the specific existing and future conditions in the Southwest Sandcastle Drive catchment:

- Mitigate non-point source pollution to Parksville Bay
- Prevent surface flooding during future 10-year, 24-hour rainfall event
- Mitigate flooding during extreme events to acceptable levels of risk
- Avoid maintenance issues at infiltration manhole due to clogging

Recommended stormwater management infrastructure and site improvements for the Southwest Sandcastle Drive catchment include the following:

A. Retrofit storm sewer connection from Sandcastle Drive to trunk sewer

Retrofit a bypass connection to capitalize on existing infiltration infrastructure while large events are able to bypass the infiltration manhole by connecting to the manhole on downstream of the sag, on Salish Sea Drive. Upsize the connection from the downstream manhole to the storm trunk to 450mm from 200mm storm sewer. Several sags along the north side of the Salish Sea Drive circle prevent ponded water from reaching the catchbasins. In order to prevent ponding deeper than 0.15m during the 100-yr 24-hour rainfall event, adjust the road grade while installing the bypass and upsizing the downstream pipe, ensuring positive drainage to the catchbasins and a minimum road elevation of 2.99m at the bypass connection downstream of the sag. Concept is illustrated in Figure 32.

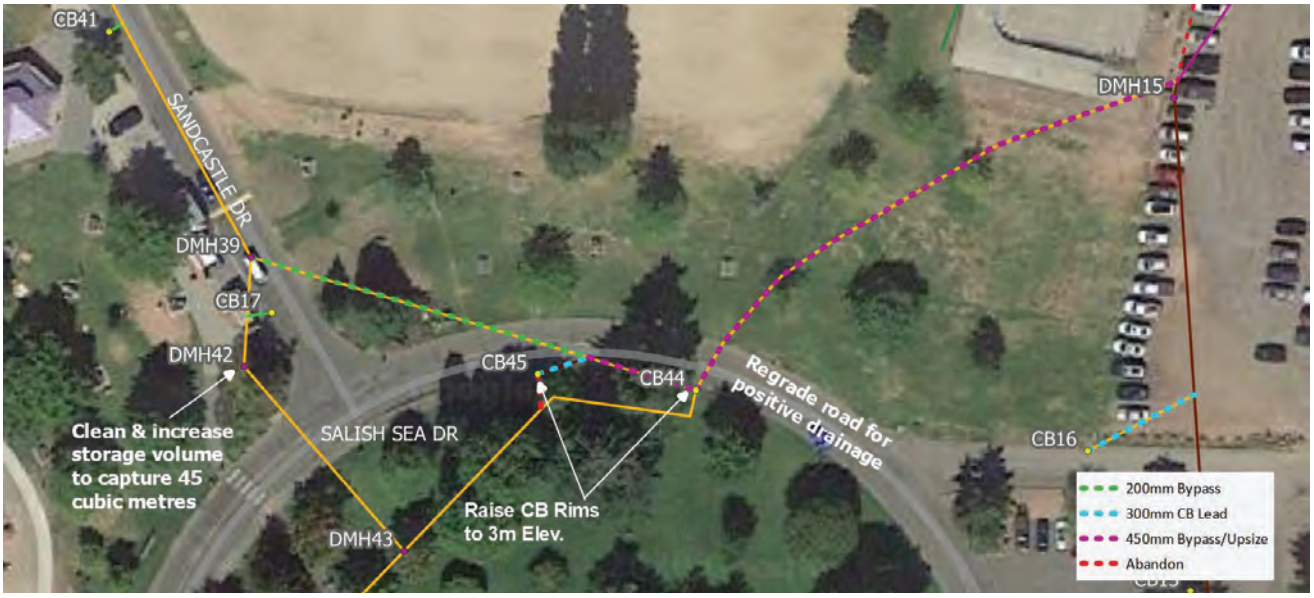


Figure 32: Concept for Salish Sea Drive stormsewer sag correction

B. Restore and retrofit the infiltration manhole to mitigate risk of clogging

In the short-term, remove accumulated sediment and organics from manhole, and install distribution piping with inlet screen and clean out. When the pedestrian connections to the Central Gathering Place are developed, expand the rock pit to capture at least 46 m^3 of runoff, and rebuild the existing garden on top of infiltration manhole into a raingarden. Upgrade could be coordinated with design and construction of the Central Gathering Place to minimize the frequency and duration of disturbance in the area. Use permeable pavers or pavement wherever possible throughout the Central Gathering Place and hardscaping to prevent surface ponding and reduce runoff.

Related to CPMP Action 13 (Medium Term): *Develop a public gathering and eating space with moveable tables, chairs, umbrellas features, landscaping, garbage and recycling facilities near existing washroom structure. Include partially hardscaped area with capacity to host multiple food trucks at one time.*

C. Maintain positive drainage and divert impervious runoff to permeable surfaces

During development of the Central Gathering Place, positive drainage toward Sandcastle Drive must be maintained to prevent isolated ponding areas. Recommended site design principles include incorporating permeable landscapes (pavers, pavements and vegetation) and locating permeable surfaces along the flow path between impervious surfaces and the roadway wherever possible.

Related to the following CPMP Actions:

- *11 (Medium Term). Establish a semi-permanent coffee stand at the gathering space.*
- *12 (Medium Term). Develop interactive seating features and small second gathering space at Arbutus Point.*
- *13 (Medium Term). Develop a public gathering and eating space with moveable tables, chairs, umbrellas features, landscaping, garbage and recycling facilities near existing washroom structure. Include partially hardscaped area with capacity to host multiple food trucks at one time.*
- *17 (Medium Term). Expand the use of the gazebo as a year-round performance space (for music, art, and theatre) with the development of temporary and/or permanent seating such as bleachers or covered seating facing the water.*
- *42 (Long Term): Upgrade existing washroom facilities near the gathering space.*

5.1.5. Tennis Court Catchment

The following objectives guide the stormwater management approach to address the specific existing and future conditions in the tennis court catchment:

- Prevent surface flooding during future 10-year, 24-hour rainfall event
- Mitigate flooding during extreme events to acceptable levels of risk
- Mitigate impacts of coastal inundation

Recommended stormwater management infrastructure and site improvements for the tennis court catchment include the following:

A. Increase capacity of underground infiltration gallery

Two options exist for capturing and infiltrating runoff from the tennis courts and surrounding pedestrian walkways. The first is to clean and rehabilitate the existing underground infiltration galleries located east of the tennis courts, installing leaf screens in the inlets and cleanouts within the galleries themselves. The first option reduces impacts to the area but the available volume is unknown and may or may not be sufficient to accommodate future precipitation conditions. The second option is to install a large gravel or structural cell infiltration gallery within the footprint of the new tennis courts, sized to capture at least the first flush runoff (73 m^3) from the tennis court (see Figure 29 and Figure 33 for examples) during upgrades to the tennis courts. The conceptual design for the tennis court infiltration gallery is illustrated in Figure 34.

Related to CPMP Action 36 (Short Term): *Renovate the tennis court.*

B. Install sump inlet with leaf screen and distribution pipe cleanout for maintenance

The infiltration gallery inlet should be appropriately designed and constructed with a sump inlet, leaf screen and distribution pipe cleanouts to prevent clogging and reduce maintenance efforts required to maintain high levels of infiltration throughout the life of the facility. These protective measures will also protect facility from deposition of sediment/debris during coastal inundation events.

C. Install raingardens southeast of the tennis courts along the pathway

Divert roadway runoff into these raingardens through curb cuts and localized regrading. Concepts are illustrated in Figure 34 to Figure 36. Overflow from the raingardens is directed toward the infiltration storage beneath the tennis courts and the arboretum. Exact siting and grading of these facilities will need to be determined during detailed design.

D. OPTIONAL - Install underground storage for irrigation reuse in the Arboretum

During reconstruction install a storage volume beneath the tennis courts, consisting of a wrapped void space using structural cells, gravel and impermeable geotextile to capture runoff for reuse throughout the arboretum. Install a series isolation cells intended to capture sediment and organics to prevent clogging and facilitate easy maintenance with a vac truck. The underground storage concept is illustrated in Figure 37.

Figure 33: Construction of gravel infiltration gallery

Figure 34. Concept design for gravel storage under tennis courts

Figure 35. Rain garden with curb cut inlet for roadway runoff

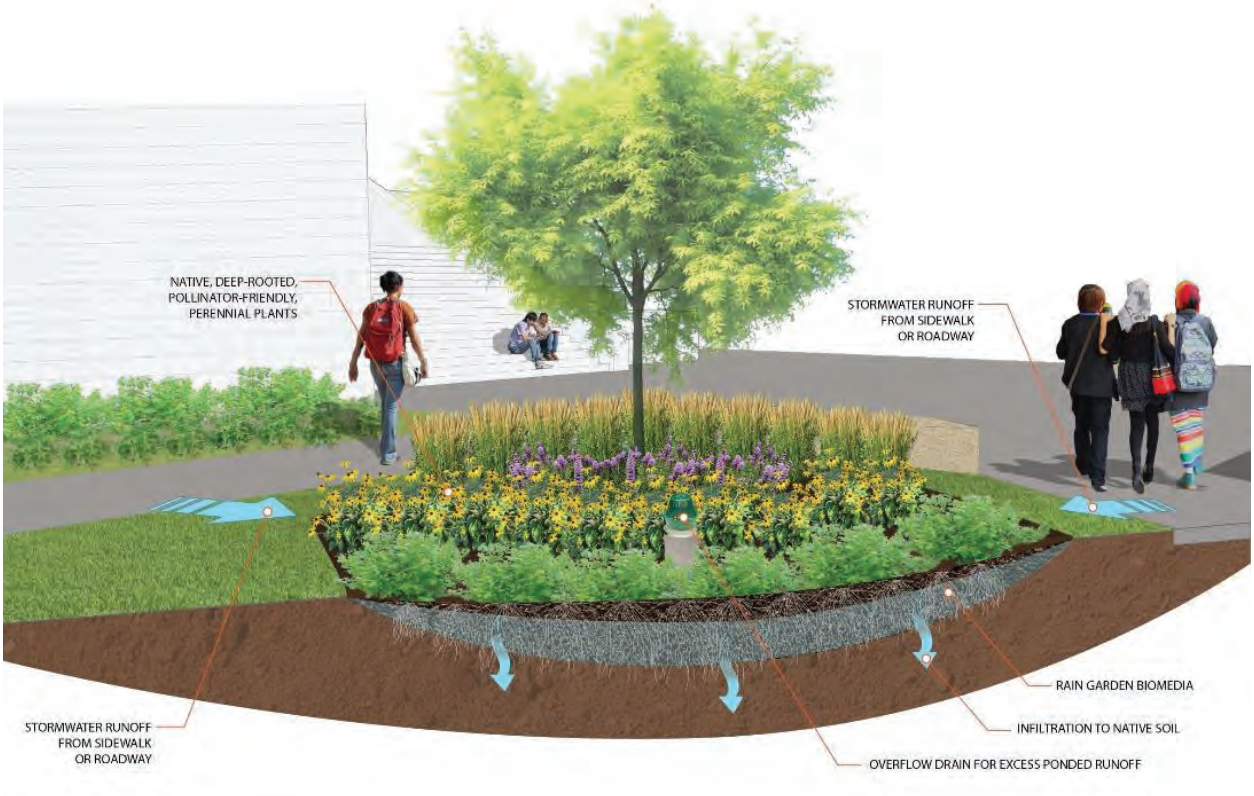


Figure 36. Diagram of key components of a rain garden

Figure 37. Concept design for infiltration gallery under tennis courts for stormwater reuse

5.1.6. Volleyball Court Catchment

The following objectives guide the stormwater management approach to address the specific existing and future conditions in the volleyball court catchment:

- Prevent surface flooding during future 10-year, 24-hour rainfall event
- Mitigate flooding during extreme events to acceptable levels of risk
- Mitigate impacts of coastal inundation

Recommended stormwater management infrastructure and site improvements for the volleyball court catchment include the following:

A. Regrade volleyball courts to provide positive drainage toward dry pond

Increase the height of the existing berm along Sandcastle drive and lower the berm on the eastern side, adjacent to the skate park, to create positive surface drainage toward the swale and dry basin.

B. OPTIONAL – Connect volleyball court sand to native underlying sand

If ponding continues to occur and is considered a nuisance to activities in the Park, consider connecting the sand court to the Quadra sand layer beneath the imported fill material by excavating through the fill layer along the eastern edge of the volley ball court and re-filling with sand. Connections will require oversight by a geotechnical engineer, following recommended seasonal groundwater monitoring. If the aquifer is freshwater, groundwater monitoring in perpetuity would likely be valuable to the City of Parksville, Mount Arrowsmith Biosphere Region and the Regional District of Nanaimo in support of regional drought planning.

5.1.7. Shoreline Sandcastle Drive Catchment

The following objectives guide the stormwater management approach to address the specific existing and future conditions in the shoreline Sandcastle Drive catchment:

- Mitigate non-point source pollution to Parksville Bay
- Prevent surface flooding during future 10-year, 24-hour rainfall event
- Mitigate flooding during extreme events to acceptable levels of risk

Recommended stormwater management infrastructure and site improvements for the shoreline Sandcastle Drive catchment include the following:

A. Increase capacity of underground storage with infiltration

During parking lot upgrades (described and priced in the paving plan), install large infiltration rock pits beneath existing parking lots along Sandcastle Drive. In order to capture the volume required to prevent roadway ponding during the future 10-year, 24-hour rainfall event, infiltration galleries under the West, Centre South and East Parking Lots will be required, as well as beneath the reclaimed Arbutus Point road, or under the new Arbutus Point Parking Lot (see Figure 38). Minimum storage volumes required in each area are listed in Table 12. The Centre North Parking Area catchbasin, located at the lowest point in the road network, should be directed underground, to the south centre infiltration gallery in order to obtain the volume required in a single facility. Figure 29 provides an illustration of structural underground infiltrating storage while Figure 33 provides an example of a gravel style infiltration gallery.

Table 12: Sandcastle Drive Infiltration Facility Volumes

Location	Modelled Volume Required (m^3)	Available Footprint (m^2)
West Parking Lot	89	223
Central South Parking Lot	150	421
East Parking Lot	39	97
Arbutus Point reclaimed roadway, or Parking Lot	45	517 (Parking Lot)

B. Install sump inlets with leaf screens and distribution pipe cleanouts for maintenance

Ensure the inlet at each site is appropriately designed and constructed with a sump inlet, leaf screen and distribution pipe cleanouts to prevent clogging and reduce maintenance efforts required to maintain high levels of infiltration throughout the life of the facility. These protective measures will also protect the facility from deposition of sediment/debris during coastal inundation events.

Figure 38: Sandcastle Drive Parking Lot Infiltration Gallery Locations

5.1.8. Dry Basin Catchment & Overall System

The following objectives guide the stormwater management approach to address the specific existing and future conditions in the dry basin catchment, including the area contributing to the storm sewer system:

- Mitigate non-point source pollution to Parksville Bay
- Fully utilize existing volume in dry pond
- Provide end of pipe treatment and control through dry pond
- Mitigate flooding during extreme events to acceptable levels of risk

Recommended stormwater management infrastructure and site improvements for the dry basin catchment, and throughout the areas contributing to the storm sewer system, include the following:

A. Provide positive surface drainage from contributing areas

Regrade kite field and install an enhanced shallow grass swale along the west side of the skate park to maintain positive drainage to dry pond. Design the planned Sandcastle Drive extension with crossfall to provide positive drainage into the dry pond. Regrading of the kite field could be planned to coincide with installation of the Sandcastle Drive extension to balance some of the required excavation.

Related to the following CPMP Actions:

- *26 (Medium Term): Construct a multi-use path from the current gravel parking lot along the beach volleyball area to the gathering space.*
- *29 (Long Term): Construct a permanent one-way road connecting the northernmost end of Beachfront Drive through the existing gravel parking lot to the eastern exit beside the curling rink. Include a sidewalk, designated bike path, trees, and street parking to create a complete street.*
- *46 (Long Term): Pave a portion of the large gravel lot nearest to the curling rink. Re-evaluate need for overflow lot in 2037.*

B. Connect the existing storm sewer to the dry pond and install an overflow to the existing outfall stub

In support of the Sandcastle Drive extension and pedestrian movement around the site, the dry pond will be reconfigured and planted with native species, mimicking as much as possible the natural estuary habitat (see Figure 39). A forebay will be installed to prevent sedimentation of the reintroduced salt marsh ecosystem during both coastal inundation and large precipitation events. The minimum capacity of the stormpond required to fully contain the 100-year, 24-hour storm event with a partially open outfall is 3,455 m^3. The existing storm trunk, as well as the existing ditch runoff, will be diverted into a forebay on the southern end of the dry basin to allow any sediment to settle before entering the main dry basin (see Figure 26). An overflow pipe connected to the existing outfall stub will be installed to prevent overtopping in large storm events, with an invert elevation that considers the natural groundwater elevations to prevent draining seasonal fluctuations. This inline

facility will provide water quality treatment for stormwater runoff from roads and parking areas prior to discharge into Parksville Bay, providing a buffer for the storm sewer system while the outlet is blocked by tides. Receiving runoff from 55% of the site, this system will facilitate site drainage following future coastal inundation events.

Related to the following CPMP Actions:

- *45 (Short Term): Pave parking lot extension at sports field.*
- *49 (Ongoing): Encourage the use of native vegetation and plantings into landscaping nearest to shoreline, with non-native plantings in more formal areas of the Park.*

C. Install backflow prevention on stubbed outlet to prevent sedimentation and coastal inundation via the storm sewer system

The outfall stub will be fitted with a duck-bill valve on the shore to prevent sediment backing up into the system and to ensure storage is maintained in the pipes while tides prevent outflow. Alternately, a backflow prevention device may be installed at the dry pond overflow, however this will not prevent pipe sedimentation from wave action and the loss of pipe storage during high tides.

D. Correct system deficiencies and protect/maintain Sports Field infiltration gallery from clogging

The catchbasin lead (from CB16) in the roadway north of the Curling Club parking lot is in poor condition, based on the CCTV footage, and undersized to convey the 2100 100-year 24-hour design storm. This results in ponding in the subcatchment area in excess of 150 mm during the future design event. Replacing this 200mm storm sewer with a 300mm pipe will prevent failure of the damaged conduit and provide necessary conveyance capacity during expected future storm conditions (see Figure 32).

When paved, ensure Sports Field parking lot infiltration gallery is appropriately designed and constructed with a sump inlet, leaf screen and cleanouts as needed to prevent clogging and reduce maintenance efforts required to maintain high levels of infiltration throughout the life of the facility.

Figure 39. Native, deep-rooted vegetation in a stormwater detention basin

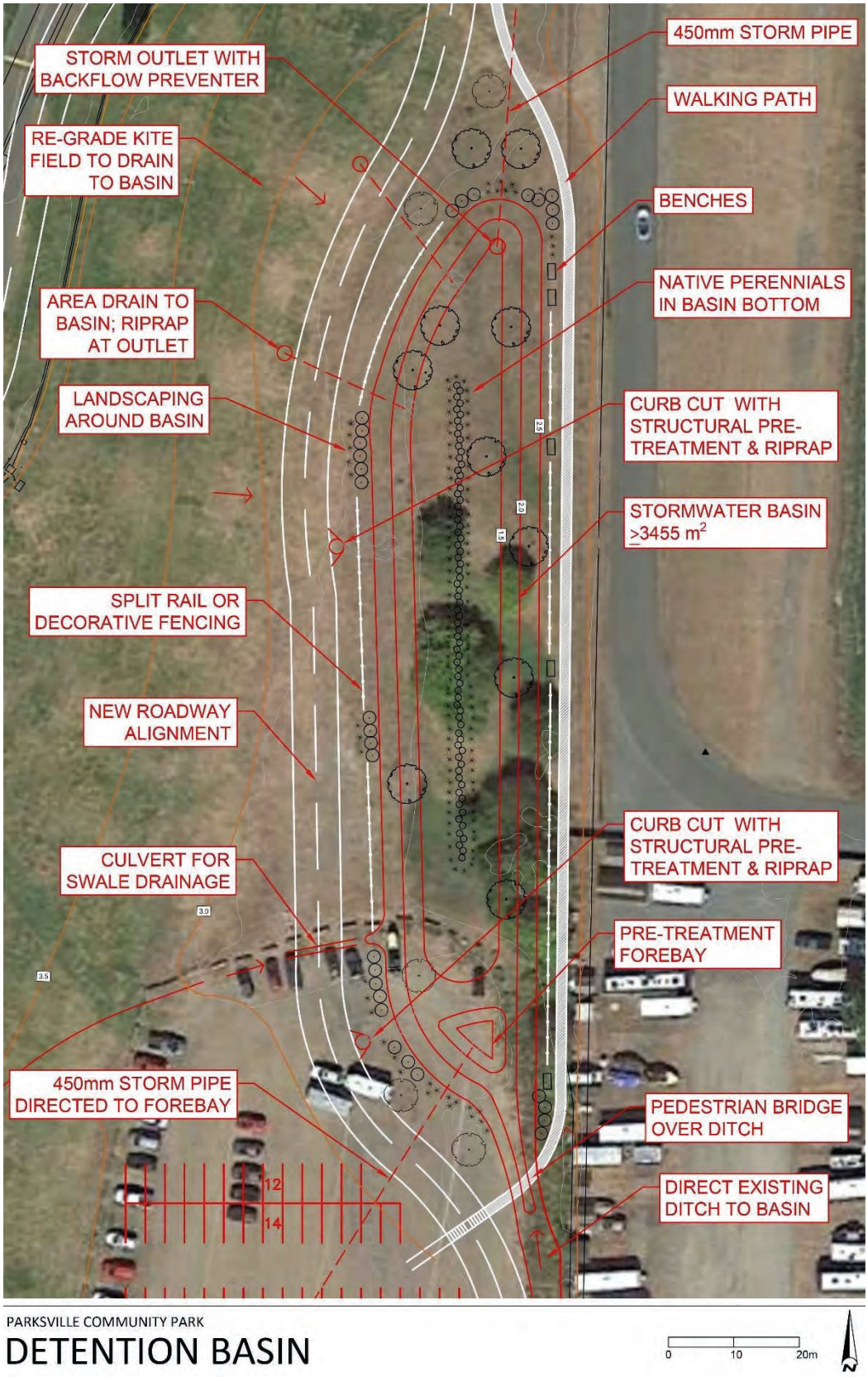
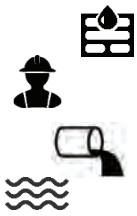


Figure 40. Concept design for large, dry (detention) basin

Table 13. Recommended Stormwater Management Activities and Timing listed by Catchment

Catchment	Recommended Stormwater Management Activities	Deficiencies Addressed	CPMP Project Number (Timing)	Recommended SWMMP Timing	Constraints
Estuary	A. Install new trunk storm sewer along Nerbus Lane to existing Estuary outfall B. Establish an overland flow pathway to Corfield Street North. C. OPTIONAL - Install underground storage for reuse under Lacrosse Box		37 (Short)	Short Term (1-5 years)	Avoid disturbance of archaeological site when regrading for overflow swale Trickle irrigation is recommended due to current provincial treatmetn regulations for rainwater reuse
Ravenhill Road	A. Install new infiltration rock pits along boulevard B. Connect overflow to storm sewer system north of sports field			Short Term	Location of existing infiltration rock pit may be beneath the sports fields
Amphitheatre	A. Install green roofs & raingardens to capture runoff from amphitheatre and access road B. Regrade area to drain overland to Ravenhill Road C. Establish native vegetation		24 (Short) 39 (Long) 49 (Ongoing)	Short Term (with Amphitheatre construction)	Avoid disturbance of archaeological site
Southwest Sandcastle Dr.	A. Retrofit storm sewer connection from Sandcastle Drive to trunk sewer B. Restore and retrofit the infiltration manhole to mitigate risk of clogging C. Maintain positive drainage and divert impervious runoff to permeable surfaces		11 (Med) 12 (Med) 13 (Med) 17 (Med) 42 (Long)	Long Term (10-20 years)	Sewer construction will block access to Sandcastle Drive
Tennis Court	A. Increase capacity of underground infiltration gallery B. Install sump inlet with leaf screen and distribution pipe cleanout for maintenance C. Install raingardens southeast of the tennis courts along the pathway D. OPTIONAL - Install underground storage for irrigation reuse in the Arboretum		36 (Short)	Medium Term (with Tennis Court reconstruction)	Trickle irrigation is recommended due to current provincial treatmetn regulations for rainwater reuse
Volleyball Court	A. Regrade volleyball courts to provide positive drainage toward dry pond B. OPTIONAL – Connect volleyball court sand to native underlying sand			Medium Term (5-10 years)	Understanding of groundwater elevation and fluctuations required prior to connecting to native underlying sand layer
Shoreline Sandcastle	A. Increase capacity of underground storage with infiltration galleries (see Table 12) B. Install sump inlets with leaf screens and distribution pipe cleanouts for maintenance			Medium Term (with beachside parking lot reconstruction)	
Dry Basin & Storm Trunk	A. Provide positive drainage from contributing areas B. Connect the existing storm sewer to the dry pond and install an overflow to the existing outfall stub C. Install backflow prevention on stubbed outlet to prevent sedimentation and coastal inundation via the storm sewer system D. Correct storm system deficiencies and protect/maintain infiltration gallery from clogging		26 (Med) 28 (Long) 29 (Long) 45 (Short) 46 (Long) 49 (Ongoing)	Long Term (with Sandcastle Drive extension)	Avoid disturbance of archaeological site in sports field parking lots Tidal inundation of outlet will temporarily block the outfall, preventing discharge, for a period of time within each 24 hour period

KEY:  = Design Event Storm Sewer Surcharge;  Future Increased Imperviousness;  Design Event Surface Ponding;  Isolated or Limited Overland Flow;  Limited Outfall Treatment;  Coastal Inundation Impacts

5.2. Non-Structural Practices

Non-structural practices are policies and programs that aide in improving or preventing the need for stormwater management. Examples of policies include reducing impervious coverage through land use planning (e.g. reducing parking stall requirements, impervious surface coverage limitations). Examples of programs include maintenance programs for stormwater management infrastructure, pollution prevention programs (e.g. street sweeping), temporary/emergency procedures, and public outreach/education.

In Parksville Community Park, potential non-structural practices may include, but are not limited to:

- Education promoting stormwater as a resource with a place in the landscape. *Related to CPMP Action Item 51 (Medium Term): Ensure educational materials are available on innovative elements of drainage plan (raingardens, water reuse (if applicable), the role of native vegetation and trees in natural hydrology, etc.).*
- Expectation management regarding:
    - the level of service of the stormwater management system, and
    - the role of pervious surfaces in the Park for naturally managing stormwater. For example, some minor ponding in the vegetated areas on the west side of the Park during storm events is indicative of natural hydrology at work.
- Catchbasin maintenance program to prevent clogging of rock pits, underground storage and infiltration facilities.
- Monitoring to support facility design and irrigation management within the Park.
- Temporary emergency procedures to block access to flooded roadways (Sandcastle Drive and the north portion of Salish Sea Drive) during future coastal inundation events. Consider blocking access to park during these events until the inundation recedes, or marking an emergency escape route back out Corfield Street North.

5.2.1. Monitoring

Short-term groundwater monitoring is recommended to support design of stormwater infiltration and storage facilities. Monitoring should include both groundwater levels to determine minimum elevations, as well as quality to identify the source of groundwater fluctuations (coastal or freshwater) to aid in vegetation selection and wet well irrigation potential. The base of infiltration facilities should be above the seasonal high water table.

Continual soil moisture monitoring during the irrigation season will help the City's irrigation specialists ensure irrigation does not trigger runoff, and to delay irrigation to maintain storage capacity within the soil profile when storm events are forecast.

Long-term groundwater monitoring should be considered to support both City and regional planning efforts with greater understanding of the acquifer. Costs for long-term monitoring have been included in the implementation plan.

5.2.2. Inspection

Once construction is complete, annual inspection of municipal stormwater management facilities is recommended to identify the maintenance required to ensure longevity and optimal function of the facilities. The recommended frequency and type of inspection activities for many types of stormwater assets are outlined in Table 18 in Appendix A. As described throughout the table, inspection of all stormwater assets will offer multiple benefits such as identifying the need for preventative maintenance (e.g. cleaning out storm sewers) that will reduce the frequency of costly corrective actions (e.g. storm sewer reconstruction). In addition, areas where nuisance drainage issues have emerged should be inspected prior to major storm events to identify and clear any debris or blockages. If the City implements the recommended maintenance schedule in this plan as well as enforcement of erosion and sediment control standards, the City will not need to retrofit newly constructed stormwater management facilities within the next 10 to 30 years. However, if rapid sediment accumulation occurs the annual maintenance demands will increase and the expected functional lifespan of the facilities will decrease.

5.2.3. Maintenance Program

All stormwater management systems require proper design, construction and maintenance to perform successfully. Historically, stormwater management systems were designed to transport stormwater runoff safely and efficiently from one location to another. Given that these systems were designed to transport or impound runoff from a relatively rare storm event (i.e. recurrence interval of 10, 25 to 100-years) they may experience maximum design conditions a few times in their lifetime. This resulted in lower maintenance requirements over the lifetime of the infrastructure.

However, in response to growing concerns over nonpoint source pollution, flooding and erosion, a new type of stormwater management system has evolved. Modern stormwater management system designs not only convey runoff but also manage runoff by deliberately modifying its flow rate, volume and water quality. Modern stormwater management systems thus address a wider range of concerns by utilizing a variety of techniques such as infiltration, extended dry or wet detention, rain gardens, and vegetated swales. These smaller Low Impact Development (LID) practices are designed to capture small and frequent rainfall close to where it falls. These types of facilities will experience design conditions more often than end-of-pipe facilities designed for the larger, less frequent events across larger drainage areas.

In order to reduce the frequency of costly infrastructure upgrades and the risk of facility failure, the Park's maintenance program is designed to focus on preventative maintenance and corrective actions identified by the findings of regular inspections. A comprehensive list of the optimal frequency of preventative maintenance and corrective actions for the stormwater facilities present and planned in Parksville Community Park is outlined in Table 19 in Appendix A. The Maintenance Program will also include remedial erosion and sediment control measures to mitigate issues identified at constructions sites, as recommended in provincial guidance.

Maintenance activities performed should be recorded and used to inform the annual budget of subsequent years and for similar installations elsewhere in the City. An annual report is recommended as a historic record to track budgeting and typical activities required for use by other City departments, and as the City implements more LID facilities in other settings.

In addition to activities performed by staff, the City should require contractors conducting maintenance activities to provide a summary report that includes the name of the stormwater facility, the date and results of maintenance/cleanout, and the quantity of material removed.

At a minimum, the following should be documented:

- Summary of what was inspected, the findings and time required for inspection
- Summary of maintenance and cleanouts implemented and time required
- Summary of prioritized maintenance action for following year

5.2.4. Administration

Implementation of the PCPSWMMP will rely on the organizational capacity and structure of the City to carry-through on recommendations. Multiple departments have responsibilities related to stormwater management as outlined in Table 14.

Table 14. Municipal Stormwater Management Responsibilities

Department	Stormwater Management Responsibilities
Engineering	Oversee the renewal of stormwater infrastructure in Parksville Community Park through design and construction oversight of capital improvement projects. Coordinate monitoring and analysis with Parks staff. Assist Communications in responding to reported drainage issues.
Operations	Maintain stormwater infrastructure, flush clean outs and remove sediment, sweep streets, inspect and maintain vegetation. Facilitate and conduct monitoring, reporting results for further analysis by Engineering. Assist Communications in responding to reported drainage issues.
Communications	Collaborate with local First Nations to add value to stormwater infrastructure projects, improving aesthetics and educating park users about the Park's past, present and future value in First Nations culture and activities. Coordinate public education and outreach and respond to reported drainage issues.

Capacity development through training is recommended so that Engineering and Operations staff have the required expertise to implement the recommendations of the SMP. Two primary types of training are recommended to support implementation of green infrastructure (GI) or Low Impact Develoment facilities (LID) in a community: erosion and sediment control; and LID construction, inspection & maintenance. Erosion and sediment control certification is available through the Erosion and Sediment Control Association of British Columbia (ESCA BC) which offers three different programs focussed on different roles practitioners take on construction projects. For City projects, where oversight and confirmation that the ESC plan is being adhered to, the ESCA BC recommends the CAN-CISEC training ($450 per person for online training plus $126 Level 1 exam fee, https://cisecinc.org/training-exams/canada-online-training-modules/), while BC-CESCL training is recommended for those installing and maintaining ESC measures ($300 per person ($200 for members) for online training, https://escabc.com/page/Course_CESCL). LID construction and maintenance training may be obtained through a certification program with ongoing licensing requirements (e.g. National Green Infrastructure Construction Program (NGICP)), or through a specifically developed group training program intended to provide staff with the practical knowledge without ongoing costs to maintain certifications. It may be of interest to the City, or in partnership with other Vancouver Island municipalities, to host an LID construction and maintenance training session, at a fixed cost, to provide training for multiple employees at one time. Multi-day group training can typically be conducted for around $5000 and 30-45 people can be accommodated in this type of group session. The implementation plan includes annual ESC training for one person and one group session for LID construction, inspection and maintenance training.

5.3. Implementation Plan

The recommended implementation schedule for the PCPSWMMP includes estimated project costs and recommended timing for construction and maintenance of the elements of the PCPSWMMP described in Section 5.1. This schedule was developed to minimize disturbance by combining with planned infrastructure updates identified in the Parksville Community Park Master Plan, and to facilitate budgeting, partnerships, and grant applications.

Funding needs for the first year include $30,000 to begin the routine activities of the Maintenance Program, staff training, as well as rehabilitation of the rockpits along Sandcastle Drive. An additional $30,000 is designated for groundwater monitoring to inform designs of subwatershed improvement projects planned in subsequent years. As subwatershed improvements are constructed, maintenance costs will increase to include newly built facilities in the program, ensuring longevity of the stormwater infrastructure. Ongoing groundwater monitoring, by a consultant, is included in the implementation plan budget to support initiatives by the City of Parksville and surrounding region.

Table 15 lists the estimated construction, operations and maintenance costs of the recommended stormwater management program over the next 20 years. Major rehabilitation or replacement of raingardens and infiltration facilities are expected to occur after 50-100 years, which is beyond the lifecycle costing included here and has not been included in this cost assessment. Detailed implementation costs are included in Appendix B.

The implementation schedule does not include the following costs that apply to multiple service areas beyond Park stormwater management:

- Road and pathway construction, including stormwater infrastructure required as a result, such as lawn drains
- Routine garden and tree pruning and maintenance
- Routine volleyball court grading
- Turf mowing and maintenance
- Turf Irrigation
- Street sweeping
- Public education and expectations management regarding stormwater system function

Table 15. Implementation Costs 2021-2040 (based on 2021 cost estimates with 3% annual inflation)

Year	1	2	3	4	5	6	7	8	9	10
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Inspection, Maintenance, Monitoring & Training	$60,520	$34,802	$35,430	$43,668	$42,873	$49,506	$56,363	$57,431	$70,676	$63,892
Subwatershed Improvement Projects		$103,290 (Ravenhill)	$306,615 (Amphitheatre)	$1,124,397 (Nerbus Lane)	$242,069 (Sandcastle Dr)		$127,084 (VB Court & Swale)	$119,125 (Tennis Court)		$220,765 (Salish Sea Sag)
TOTAL $	$60,520	$138,092	$342,045	$1,168,065	$284,942	$49,506	$183,447	$176,556	$70,676	$284,658

Year	11	12	13	14	15	16	17	18	19	20
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Inspection, Maintenance, Monitoring & Training	$63,307	$71,600	$70,412	$101,120	$111,148	$110,843	$111,193	$114,772	$137,129	$122,286
Subwatershed Improvement Projects				$2,976,590 (Dry Basin & Outfall)						$437,203 (Possible Sandcastle Reconst)
TOTAL $	$63,307	$71,600	$70,412	$3,077,710	$111,148	$110,843	$111,193	$114,772	$137,129	$559,489

5.3.1.1. Implementation Considerations

The measures to avoid, mitigate or negate the potential adverse effects associated with the activities included in the recommended maintenance program are outlined in Table 16. The maintenance program includes activities such as removing sediment from catchbasins, inlets and distribution piping, storm sewers, and ditches as well as addressing performance issues such as debris blocking inlet or outlet structures and erosion observed along ditches, swales or drainage ways. The measures to avoid, mitigate or negate the potential adverse effects associated with new/retrofit stormwater infrastructure implemented through the PCPSWMMP are outlined in Table 17.

Table 16. Potential Effects and Mitigation Measures for Stormwater Infrastructure Maintenance

Feature	Potential Effect	Mitigation Measures
Utilities and Servicing	Disturbance to utilities or other underground services causing temporary disruption of service and construction delays.	Utility locates must be obtained prior to cleanout (excavation) of ditches and other surface drainage features.
Public Safety	Cleanout of ditches, and storm sewers can create hazards to the public including open manholes and moving construction equipment.	The Park maintenance team will implement appropriate temporary safety features to reduce hazards and risk to the public during maintenance activities. Such features include temporary fences, signage and other means of deterring the public from entering the maintenance area.

Feature	Potential Effect	Mitigation Measures
Traffic Flow	Traffic flow may be negatively affected by maintenance activities and storage of equipment or materials within the right-of-way.	Implement appropriate traffic controls to mitigate traffic impacts. The number and frequency of disruptions in the same area of the Park should be limited by coordinating the schedule of different types of maintenance activities.
Nuisance Rodents	Disturbing the banks of the dry pond during maintenance activities can results in nuisance rodents that would otherwise burrow into the banks.	Minimize the extent of ground disturbance during maintenance activities to the extent possible.
Terrestrial Environment	Potential pollution or inhibition of plant growth/infiltration due to placement of sediment on or off-site.	Sediments removed from pre-treatment structures (e.g. inlet sump catchbasins, water quality units, or dry pond forebays) of infiltration facilities, rain gardens and dry ponds should never be placed into or around stormwater facilities as this may clog the soil, preventing infiltration. Sediment quality should be analyzed to determine the appropriate disposal or beneficial use requirements.
	Damage to existing vegetation associated with grading and accessing the site with maintenance equipment. Removal of existing vegetation associated with maintenance activities.	Vegetation maintenance activities should be limited to managing new growth of woody vegetation at stormwater management facilities. Mowing can help native plants establish within the first few years after planting/seeding while also preventing the establishment of woody or invasive species. However, vegetation below or within 10 feet of the high water level of ponding facilities should not be mowed shorter than 8 inches. Protected vegetation areas should be clearly marked when wheeled or tracked equipment is needed, such as for cleanouts within infiltration facilities.

Table 17. Potential Effects and Mitigation Measures for New or Retrofit Stormwater Infrastructure Projects

Feature	Potential Effect	Mitigation Measures
Cultural Environment		
Archaeological Resources	Disturbance to archaeological resources associated with grading / excavation activities.	"Preventing further impacts to DhSb-2 to the archaeological deposits within Parksville Community Park is the priority recommendation. […] If impacts to the site are unavoidable and are proposed and there are no alternatives, archaeological monitoring under a Heritage Conservation Act (HCA) Alteration Permit is required to minimize impacts and if necessary, record and collect archaeological data." (Parsley and Thompson 2020)
Cultural / Built Heritage	Impacts associated with grading and drainage works.	Design components of retrofit projects should preserve or replace built heritage in the Park, such as pedestrian sidewalks and trails, and include details such as similar or enhanced, aesthetically cohesive surface treatments. Surface grading within retrofit projects should comply with the stormwater management plan to prevent isolated ponding areas.
Social Environment		

Feature	Potential Effect	Mitigation Measures
Utilities and Servicing	Disturbance to utilities or other underground services causing temporary disruption of service and construction delays.	Utility locates must be obtained during the detailed design of the retrofit projects so that the design can be modified as necessary to avoid conflicts and arrange for relocates where necessary. In addition, storm sewer locations, size, material and elevations should be verified during the detailed design phase to avoid construction delays.
Public Safety	Dry ponds pose a drowning risk to anyone that enters the facility during storm events. Construction of retrofit projects can create hazards to public including open pits during excavation and moving construction equipment.	The detailed design of above ground stormwater management facilities should include the appropriate temporary and permanent safety features to reduce hazards and risk to the public. This may include temporary and/or permanent fences, signage and other means of deterring the public from entering a facility or construction zone. Permanent barriers should be aligned with Crime Prevention Through Environmental Design (CPTED) principles and subject to the approval of the City.
Traffic Flow	Traffic flow may be negatively affected by construction and storage of equipment or materials within the right-of-way.	Implement appropriate traffic controls to mitigate traffic impacts. Specific controls are to be developed during the detailed design of the retrofit projects. Repeated disruptions at the same location could be prevented by implementing stormwater retrofit projects during projects planned under the CPMP park infrastructure upgrades or required for other reasons (e.g. road surface upgrades).
Dust and Air Quality	Temporary disruption resulting from construction activities.	Implement appropriate dust control measures during construction.
Natural Environment		
Groundwater	Risk of groundwater contamination from infiltration facilities.	The bottom of such facilities should be designed at least 0.5 m above the groundwater table to limit the risk of groundwater contamination and ensure the facility functions properly. In areas with where the water table is at or near the surface, facilities should be designed to filter and slow runoff rather than infiltrate.
Terrestrial Environment	Damage to existing vegetation (e.g. tree roots) associated with proposed grading and drainage works. Removal of existing vegetation associated with grading and drainage works.	Parksville Community Park has many valuable tree species located throughout, even beyond the limits of the Arboretum. Clearing of vegetation, including brush and potentially trees, may be required at some retrofit project sites. Facility siting and design should be modified to avoid removal of healthy trees. Prepare a tree preservation plan prior to construction and conduct ongoing construction monitoring. Protected vegetation should be clearly marked during construction. Restoration work in or around stormwater management facilities should occur under guidance of Parks staff.

Feature	Potential Effect	Mitigation Measures
Aquatic Environment	Sediment discharge to Parksville Bay or the Englishman River Estuary as a result of temporary construction activities.	The area of disturbance (exposed soils) during construction should be minimized as much as feasible and should be restored immediately after construction. Appropriate measures will be needed to prevent erosion and control sediment during construction and are to be developed during the detailed design of the retrofit projects. Measures should be consistent with best practices consistent with the Land Development Guidelines for the Protection of Aquatic Habitat (Department of Fisheries and Oceans 1993). Erosion and sediment control measures should be inspected and maintained during construction to mitigate downstream impacts on stormwater infrastructure and receiving water bodies (see below). The inspector should be a Certified Inspector of Erosion and Sediment Control (CISEC). At a minimum, inspections should be conducted at least once every two weeks and after each significant storm event. A significant storm event is equal to or greater than 31 mm of rain within 24 hours. Inspections should continue during construction and records of the inspections should be kept by the contractor/City. The project manager should determine if and where remedial measures are necessary.

5.4. Future Studies

Several areas needing more detailed study beyond the scope of this Plan include the following:

- Groundwater monitoring and sampling to identify source of water whether freshwater from inland or sea water, or location in a mixing zone. This will identify potential for opportunity to use stormwater infiltration and wet well irrigation within the Park.
- Succession planning for salt tolerant vegetation within the 2100 Coastal Inundation area to accommodate increasingly frequent coastal inundation events
- Reuse of splash pad water for irrigation, or reuse of stormwater for splash pad.