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Parking Lot EBuffer in Coupeville, WA

Proposed Installation Details

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Section 1. Introduction to EBuffers

The concept of healthy watersheds has advanced since The Clean Water Act (PL 92:500) passed in 1972 which mandated municipal waste water treatment accomplished by

centralized Publicly Owned Treatment Works (POTW's). As monitoring and overall ecological health appraisal techniques became more sophisticated, Total Maximum Daily Loads (TMDL) for specific water pollutants are now issued for individual water bodies. Both point and non-point discharges contribute to pollutant loads now exceeding known limits for sustainable ecological health. Penn Cove in the vicinity of Coupeville is listed as a TMDL-limited water body.

Phytoremediation uses plants to treat air, water and soil pollutants. Root zone 'reactors' perform a significant rhyzofiltration - removing nitrogen, phosphorous, pathogens, pharmaceuticals, metals, oils/greases, BOD, and solid particles when dosed into the rhizosphere with sufficient dwell time. University research and field-scale demonstrations document specific pollutant removal from water when predictably adsorbed, humified, entrained, mineralized or taken into the plant.

Plant roots in amended soils can create a predictable reactor with design parameters similar to tank-type reactors (Appendix 3: Photo 9). With sufficient dwell time, this phyto reactor will reduce specific targeted soluble and insoluble pollutants including: mineral sediment, nitrogen (organic, ammonia, and nitrate/nitrite), phosphorous, biowaste organics (feces, plant matter, animal, and microbes), petrochemicals (automotive, herbicide, homeowner), metals & metalloids (copper, zinc, arsenic, other), pathogens (mammal), and pharmaceuticals & personal health products (various drugs, surfactants, other).

Rhyzofiltration has three targeted roles to clean water from the Town of Coupeville and Ebey's Prairie:

1. Filter storm water runoff from various surfaces including roofs, parking lots, roads, lawns and parks.
2. Eliminate the discharge into the Puget Sound from Coupeville's Publicly Owned Treatment Works (POTW) by irrigating agricultural crops during the growing season and deep-rooted forest during the dormant season.
3. Ground water collected from agricultural land containing fertilizer and livestock wastes.

Section 2. Proposed Coupeville Parking Lot EBuffer Design Objectives

The core concept – 'Every drop passes within an inch of a root'.

EBuffer® (EBuffer) is a trademarked product developed by Ecolotree Inc. in 1990. EBuffers incorporate the phyto-based rhizosphere treatment concept as an integral part of an engineered water treatment system.

To be effective, an EBuffer must intercept storm water inflow before discharge to ground or surface water bodies. The proposed EBuffer system intercepts the first flush of parking lot runoff after a rain event before release to Puget Sound.

The Coupeville storm water quality for the urban area had normal constituents from streets and based on the BHC investigation (Table 1). The EBuffer prototype will be placed between a parking lot and a stream. Water moves through the root zone reactor in route to the drain.

Table 1: Coupeville Storm Water Analyses (Source: BHC Design Report)

Contaminant	Mean Concentration (mg/L)	Annual Load (kg/yr)
Total Suspended Solids	43.4	76,006
Total Phosphorus	0.222	389
Nitrate + Nitrite Nitrogen	0.211	370
Ammonia Nitrogen	0.053	93
Total Nitrogen	2.0	3,503
Biochemical Oxygen Demand	9.0	15,762
Copper, Total	0.0097	17
Lead, Total	0.0114	20
Zinc, Total	0.04	70
Total Petroleum Hydrocarbons	0.35	613
Fecal Coliform Bacteria	1528	26,670

- Storm water quality sources include Herrera (1995) and Shaver et al. (2007)
- Storm water loads based on 463 million gallons/year assuming 75 % runoff and 20.8 inches of annual rain over the Town of Coupeville covering 1.28 square miles.
- Fecal coliform bacteria concentration units are in CFU/100mL and load units are in billion CFU/yr

This construction technique creates a more-reactive soil root zone having greater capacity to contain and treat contaminant. Rooted soil growing poplar, willow and other plants develops a 'reactor' that passively sequesters and mineralizes nutrients, metals and organic pollutants. The EBuffer built with sufficient soil porosity will provide a level of engineered control for contaminant release to near-surface groundwater or stream.

The EBuffer technique grows predictable roots to a specific depth within a specific backfill soil 'recipe'. Predictability improves regulatory acceptance as a best management practice and an engineered remedy. Coupeville EBuffer soil will be a blend using the excavated soils blended with compost, fertilizer, and specific other texture material such as sand, clay or gravel.

The early proposed EBuffer (Figures 1 &2) shows the principle components. With the installation of the Island Transit parking lot, more fixed features were in place (Figures 5 & 6). The option was proposed to incorporate a rain garden parking edge to be incorporated with the original EBuffer installation limited to 15 feet width due to space constraints on the available NPS site.

Final **Objectives for Stormwater Treatment Using EBuffer**

1. Change the existing storm water management strategy from quick channeling to stream and direct surface discharge to ponded retention, through-root zone infiltration, in rhizosphere treatment, and released either to drainage pipe or percolated to ground water.
2. Reduce the load of storm water contaminants into Puget Sound by an engineered rhyzofiltration design built from available components including native and non-native plants, indigenous soil microorganisms, compost, local soils and other media, a drainage system, and specific grading strategy.
3. Achieve on-site storm water treatment based on flows determined by the 1-day 10 year storm event weather scenario.
4. Manage the EBuffer to accomplish compliance with all federal and Washington State regulatory criteria for discharge to the receiving water body.
5. Grow more plant biomass with potential to sequestering CO_2 as organic material in wood, roots and humus.
6. Achieve landscape-quality ambiance that fits with objectives of National Park Service and EBay Prairie Conservancy.
7. Build and manage site with local trained 'green collar' staff with readily available equipment, materials and plants.
8. Work to optimize economical performance - measured against alternative cleanup options based on time, talent, mass of stuff, and efficiency of delivery.

Section 3: EBuffer Installation Details, Photos and Tables

EBuffer Installation Parts List and Purchase Location

The proposed EBuffer shown in Figures 3 & 4 requires parts listed in Table 2. The details to assist in the purchase by the Town of Coupeville are listed below that.

Table 2: EBuffer installation parts list

Parts List	Note #	Size	Description	Number
ADS tubing	1	5" or 6" diameter	Perferated plastic used for field drainage	300 ft
Root Guard	2	19.5 " width	Geofabric with trifluralin-encased plastic	300 ft
ADS tube valve	3	4" or 6" available	From Agri Drain for 4" or 6" pipe	
Poplar Trees	4	10+ ft	Pole, juvinile stock	100
Willow	5	10+ ft	Pole, juvinile stock	20
Willow	6	5+ ft	Local, rooted or pole, juvinile stock	40
Grass seed	7		Regional, flood tolerant	10,000 sq. ft.
Root medium sand	8		Regional quarry	300 cu.yd.

1. ADS drainage pipe purchased from local agricultural drainage supplier (Figure 13). 6" diameter is a standard size and will work well with the Root Guard and the tube valve.
2. Root Guard (Figure 13) - supplier Hort Enterprises. Typar-type cloth with plastic, triflouralin-encased nodules. Biobarrier 19.5" standard width, 300 ft long will surround 5" ADS pipe. Zip ties can be used to attach barrier. On-line address is http://www.hort-enterprises.com/BIOBARRI/Biobarri.htm
3. ADS tube valve & connectors - Supplier Agri Drain 1-800-232-4742. On-line address is www.agridrain.com ; they have 4" (VV04) and 6" valves (VV06). The valve would need to be connected to the drain line with flexible couplers - 4" (FCAP04) or 6" (FCAP06). This valve would be installed in a stand pipe field constructed to allow access to control flow.
4. Poplar tree poles - Sources can be Segal Hop Farms (Martin Ramos - 509-840-1045 or Ecolotree Inc. (see web site Ecolotree.com).
5. Willow poles - ? Regional nursery? Ecolotree.com has Iowa Willow & Laurel Leaf Willow Poles.
6. Willow trees- Rooted trees can come from regional nursery
7. Grass seed - local seed mix that is used by Town and County for such wet sites
8. Sand - the local quarry is probably a good source

EBuffer Installation Plan

The proposed installation tasks and schedule are listed in Table 3 & 4. The cross section details are based on Figures 3 & 4.

The efficacy of the EBuffer treatment is based on 7 factors:

1. Reactivity – or the ability to treat contaminants-of-concern (COC) - in the root zone soil filter: this is influenced by the soil, root, microbe activity and maturity.
2. Free-board – or the space within a berm above the soil available to hold water – which allows free flow to catches the runoff flush and hold it for slower dosing into and through the EBuffer soil.
3. Available pore volume and drainage rate – the root zone holds water and eventually drains via plant evapotranspiration, pipe drainage, or percolation through the floor to the groundwater. Sandy, organic rich soil will be blended with the native silty-clay loam to improve water holding capacity, drain-ability, and porosity.

4. Input runoff rate and volume – the EBuffer has a limited available volume fixed by the area on the edge of the parking lot. The pavement and roots in the upgrade development (approximately 7 acres). The EBuffer volume will be overwhelmed in a large storm. However, the first flush of large storms and most small storms will drain and be held in the EBuffer surge volume.
5. Plants selected that are tolerant of flooded conditions and large leaf surface capable of a high transpiration rate. Poplar, willow, water-tolerant low bushes and water-tolerant grasses will be planted in the EBuffer soil
6. Engineered components –
    - The berm elevation which needs to be level to hold water
    - A berm overflow to allow water to overflow in large runoff events
    - the ADS pipe drain slope which limits the depth and slope of the ADS drainage pipe is determined by the topography of the site, and it is relatively shallow
    - the ADS pipe will be placed in a gravel pack
    - to prevent root intrusion, Root Guard™ , is used to prevent root intrusion into the ADS pipe to reduce clogging
    - a valve at the outlet of the drainage ADS can reduce or stop flow in low storm frequency periods
7. Operation and Management –
    - Startup is important to allow the grasses and plants to root and cover the soils
    - Mowing in dry periods will be conducted by existing conventional grass mowers
    - Nutrient management will be managed by measuring the foliar analyses
    - Repair and correct observed berm overflow, leakage, or erosion with time
    - Prune, replace, and improve the plants with maturity

Table 3: Proposed EBuffer installation tasks

Task	March '10	April '10	May '10
Final Design - agronomy, tasks, map, operation plan	X	X	
Order trees		X	
Order ADS Tile, Valve		X	
Order Bioguard		X	
Order Sand/Compost		X	
Order/rent special equipment		X	X
Mobe and demobe			X
Island Transit Parking lot edge grade set		X	X
Island Transit rain garden sand delivere/graded		X	X
Set laser leveled grades			X
Remove necessary native soil, bring in sand & compost, course regrade			
Drain Line/Gravel Pack Installation			X
Perimeter Berm Installation			X
Tree Installation			X
Fine Grading Basin with Laser Level			X
Fine Grading Perimeter Berm with Laser Level			X
Drain Line Valve Installation			X
Geofabric and gravel overflow spillways			X
Final inspection, operation trial, modifications			X
Installation Report			

X & * = denotes responsibility of Ecolotree Inc. or on-site operator; **X = Critical performed by Ecolotree**

Table 4: Proposed EBuffer operation and maintenance startup tasks

Task	March '10	April '10	May '10	June '10	July '10	August '10	Sept. '10	Oct. '10	Nov. '10	Dec. '10	Jan. '11	Feb. '11	March '11	April '11	May '11	June '11	July '11	August '11	Sept. '11	Oct. '11	Nov. '11	Dec. '11
Post-installation Inspections				X	**X**	X	X	X	**X**				X	**X**	X	X	**X**	X	X	X	**X**	
Grass Mow				#	X	#	#	#	#					X	X	X	X	#	#	X		
Apply herbicide				#	X	#	#	#	#					**X**		X		X		X		
Scout & apply insecticide			**X**	#	#	#	#	#	#					#	#	#	**X**	#	#	#		
Fertilize the trees			**X**						**X**					**X**			**X**					
Photo documentation			**X**		**X**				**X**					**X**	X		**X**		#	X		
Replant whips									**X**				X	**X**							**X**	
Prune trees									**X**					#			#				X	
Test foliar samples					**X**												**X**					
Perform tree audit									**X**												**X**	
Regrade planting trenches									**X**				X								**X**	
Submit e-mail memo					**X**									X		X		X				
Year-end summary report										**X**												**X**

X & * = denotes responsibility of Ecolotree Inc. or on-site operator; **X = Critical performed by Ecolotree**

= denotes application applied only as needed

Responsibility

1. The EBuffer construction is proposed to be performed by local equipment operators working for the Town of Coupeville and/or Island County.

2. Regulatory compliance is the responsibility of the owner and their consultants with Ecolotree staff support to verify that EBuffer can achieve required pollutant treatment while sustaining plant growth.

3. Ecolotree Staff (Lou Licht) will be on-site to assist in the site layout and construction

Construction Steps

1. The EBuffer design is performed in coordination with Sound Development who engineered the Prairie Station parking lot (Figures 10, 11 & 12).
   - Water from the Prairie Station parking lot enters the EBuffer with relative uniform flow through routine breaks in the wheel stops on the east edge
   - Water drainage form the Coupe Village can be drained into the EBuffer with entry location determined by a field decision.

2. Area:
   - The area available is approximately 13,500 square feet
   - The volume that we want immediately rootable is at least 30 inches below ground surface
   - The average free board will be a minimum of 18 inches
   - The length is approximately 300 feet north to south
   - 15 feet of rain garden from the edge of the parking surface to the property boundary
   - The 33 ft USP land easement extends east from the property boundary along the north south property boundary

3. EBuffer Soils
   - The desired root zone will be a blend of the existing native soil (silty clay), sand from the local quarry, and any available mulch/compost/surface plants
   - Some native soil may need to be removed to allow The soils will be mechanically blended with backhoe, excavator and/or skid loader to coarsely mix the various textures
   - The Island Transit rain garden already has the soil placed

4. The perimeter berm edge elevation grading is critical
   - the Prairie Station parking lot elevation is set (Figure 11)
   - There is approximately 30 inches of elevation change from the north to the south EBuffer ends. This will require the EBuffer to be subdivided into several pools that are surrounded by a level berm edge. The subdivision of the EBuffer will be a field call and berm grading will be performed after this decision.

- Elevation of the parking lot edge needs to be above the water surface of the flooded EBuffer
- Elevation of the pool perimeters need to be near level with an overflow on the south edge of each pool into the next adjacent south pool.
- Elevation of overflow on the south that allows high flows to move into the drainage feeding the retention basin on the southeast edge of the site (Figure 12).

5. Equipment recommendations:
   - A laser level is important to take routine elevations during construction due to the need for adequate height and level constraints
   - Track mounted skid loaders work well if soil is wet for excavation and material placement with a blade attachment for leveling the site
   - Excavator works well to place drainage line
   - A 4" trenches may work for poplar and willow planting to allow correct rooting
   - Agricultural chisel plow, disk or rototiller would help blend soil, sand and compost
   - Dump trucks as needed to place sand/compost but staging may require low compaction/high floatation equipment

6. EBuffer Soil
   - The EBuffer soil will be a blend of the existing silty clay loam with quarry sand and compost.
   - The EBuffer 'floor' bottom of the growing medium blend determines the volume of roots and the ability for treatment. The bottom slope of the growing medium determines drainage to the drain pipe; it is not essential for a slope to the drain
   - Growing medium target blend: 60 – 65% native soil:5 – 10% compost by volume: at least 30% sand
   - Blend does not need to be uniform: Rather it is better for root growth and water drainage if the growing medium is a 'marble cake' blend
   - It is recommended to use available agricultural equipment such as chisel plows, disks and rototiller to create a more uniform growing medium with sand and compost placed throughout
   - Fertilizer will only be added on the perimeter of each tree based on the agronomic analyses of the final blended growing medium

7. The drain line slope and installation is critical
   - The drainage pipe detail (Figure 5) shows the gravel pack, ADS pipe and Root Guard (Figure 13).
   - The site is very flat in relation to the discharge drainage on the South. A steady grade of at least 0.5% the entire drain pipe length is desired the EBuffer length.
   - Putting drainage pipe as deep as possible while maintaining drainage flow will increase treatment in the rain garden basin footprint by extending the root depth and increasing hydraulic retention time (Appendix 3: Figures 3 & 4)
   - The drainage line must have a steady slope from the north to the south

- Drainage pipe will be ADS agricultural slotted pipe. First 50% of length can be 4" ID. Last 50% of length can be 6" to encourage drainage from the entire length.
- Root Guard fabric will be used to keep roots out of the ADS pipe. http://www.hort-enterprises.com/BIOBARRI/Biobarri.htm (Figure 13).
- The drainage pipe will stay root-free if wrapped in Root-Guard fabric. The drainage pipe wrap can be placed immediately before installation.
- Valving the drainage pipe may be advisable for retention of spring rains due to long summer dry period. Valving options can be purchased by local drainage companies; recommended locations to see options include www.agridrain.com Phone 1-800-232-4742.

8. Plant material selection and placement:
   - The planting detail (Figures 3 & 4) show planting layout and root placement
   - Plant stem and root growth are stimulated by improving soil agronomic properties through fertilization and root zone amendments during installation
   - Digging a deeper root trench under the trees using a chain trencher will provide more rooting depth and water to trees during the dry season while adding more water retention volume during the growing season
   - The basic construction will install poplar/willow trees and understory plants proven to grow well in the regional climate. To expand to new climatic zones, it is feasible to start with proven plants from similar climatic zones that are interplanted with native species
   - Native plant material in the EBuffer west 10 feet will be according to the Carletti design.
   - Poplar will be offset between two rows spaced approximately 12 – 15 feet apart as shown in plan and profile views (Appendix 3: Figures 3 & 4). Poplar rooting technique will place 12 - 14 foot-tall poplar or willow trees buried horizontally with 80% of the tree below the growing medium surface; the apical step daylights tall enough to be obvious for maintainers.
   - Poplar will be either DN 21, TD 1529, OP367, DN31
   - Willow will be native or locally grown species available from Washington State Nurseries and/or harvested from Ebey's Prairie groves.
   - Willow will be interspaced between the poplars as shown plan and profile views (Figure 4).
   - Grasses and understory forbs will be planted according to the Carletti design and specifications.

Section 4. EBuffer® Operation

EBuffer Start-up and Operating Requirements

1. When storm water first runs off the parking lots and fills the EBuffer retention basin, verify that elevations of edges are built according to the engineered design with no short circuits on north, east and south edges while still allowing water flow off parking surface.
2. Healthy trees and other plants are critical to grow a large leaf surface for evapotranspiration and growing a deep and extensive root system. Replace any dead or stressed trees with healthy stock in April of the first growing season.
3. Prune all dead stock and remove double leaders from the poplar and willow trees after the first growing seasons.
4. Keep EBuffer as full as possible for intercepting and percolating runoff water into the root zone during storm events
5. If a valve is installed on the drainage pipe, shut the valve in late May to retain water in the root zone.
6. Support plant growth by keeping phyto toxic compounds in water and soil below toxic levels. Based on monitoring data, runoff pollutants in storm water are not expected at stress. Zonal tree health will be monitored and corrected if necessary by soil amendment.
7. It is important for the maintenance staff to use their existing equipment without need for significant equipment capital; thus it is desired to use existing mowers, and other equipment.
8. When the site is wet and soggy, do not use heavy equipment that can cause tire tracking and compaction.
9. Control animal/insect/weed pressures. Insects and weeds are manageable with consistent Site maintenance by trained staff using proper equipment and selected organic-quality chemicals.
10. Record maintenance activity in the first three growing season to aid in planning future installation support budgets

Section 5: EBuffer Installation Details, Photos and Tables

Figure 1: Preliminary EBuffer Bioswale cross section (June 2009)

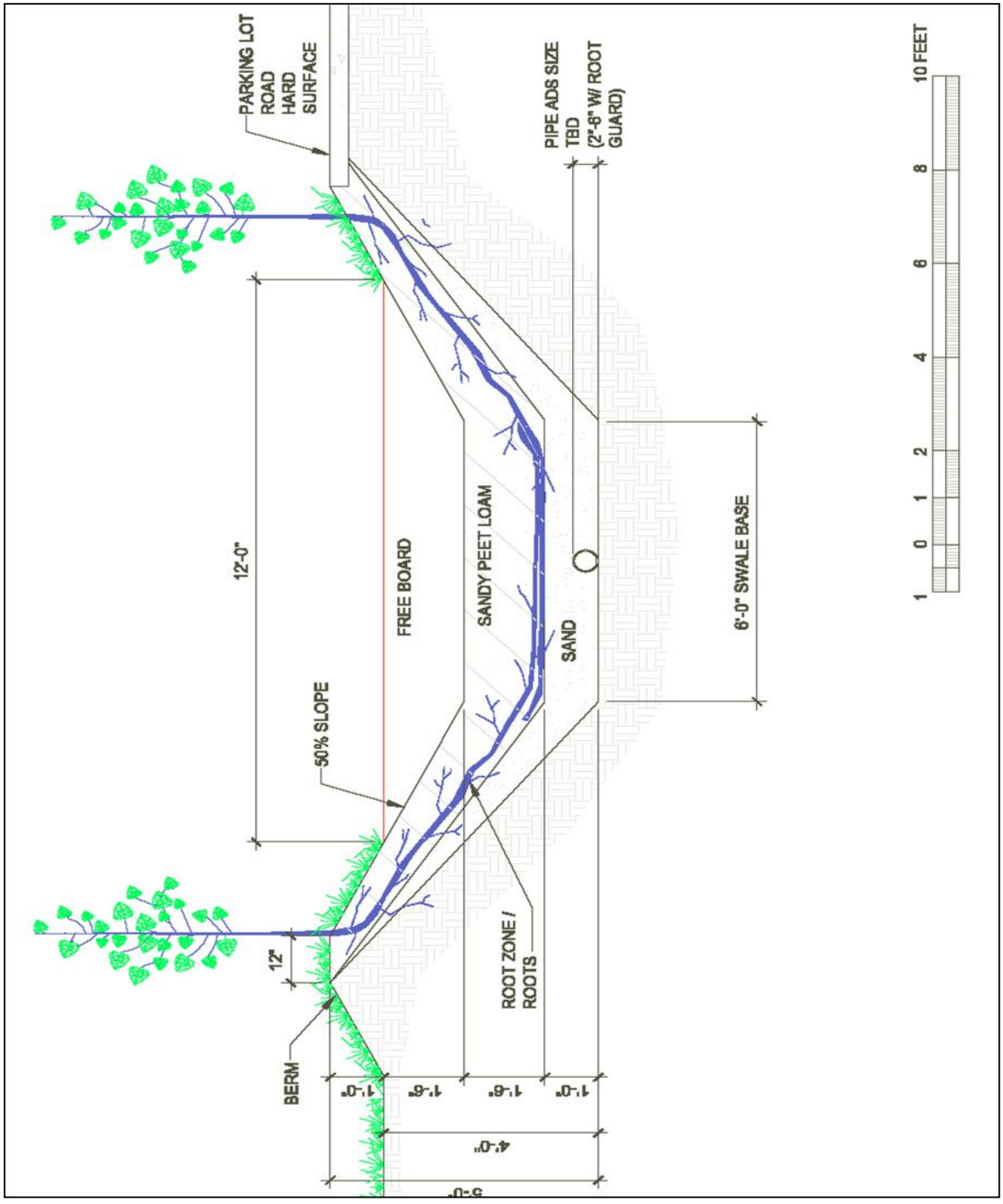

Figure 2: Preliminary Rendition of EBuffer Bioswale (June 2009)

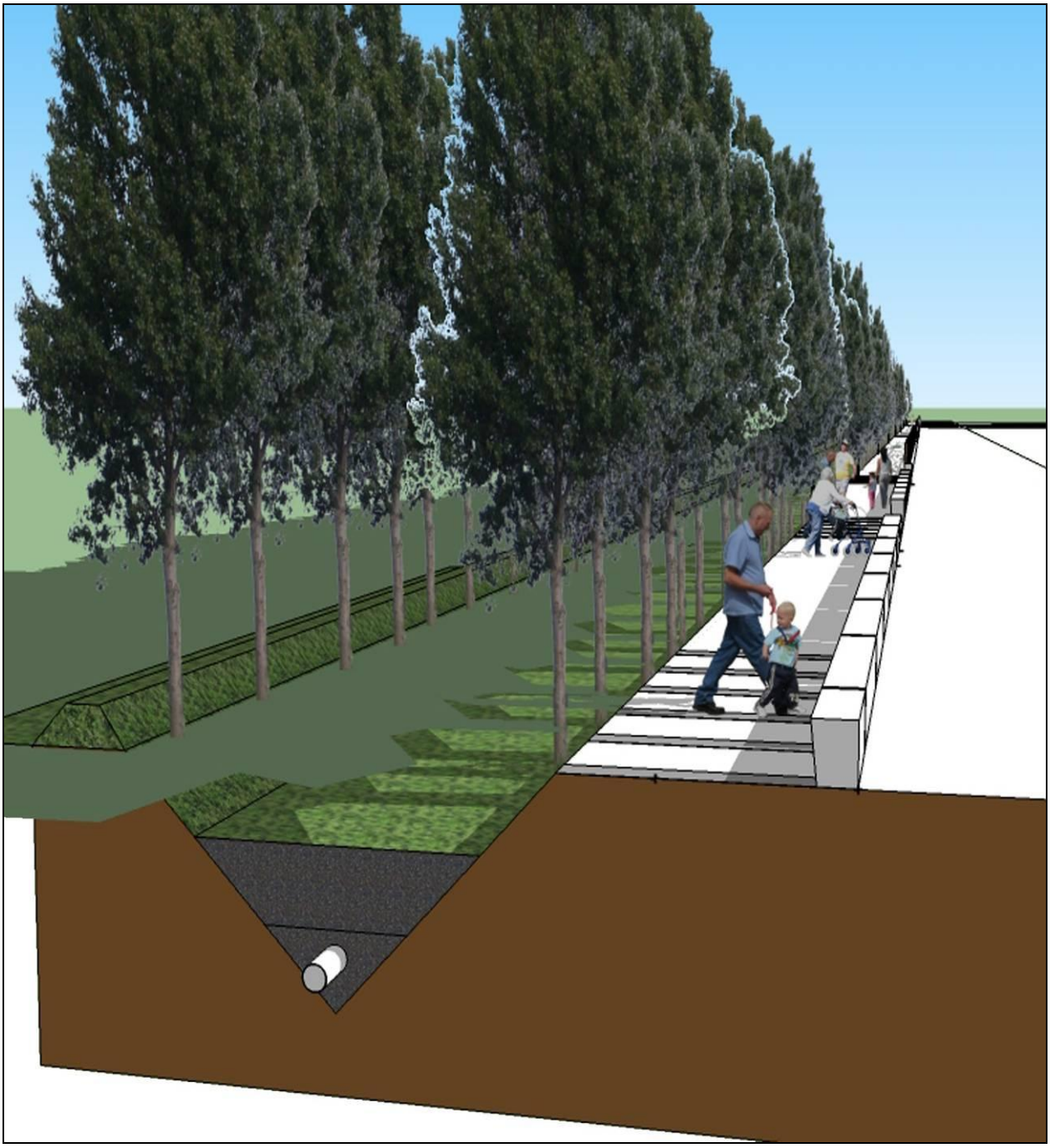

Figure 3: Final Phyto EBuffer Rain Garden Profile View Section (March 2010)

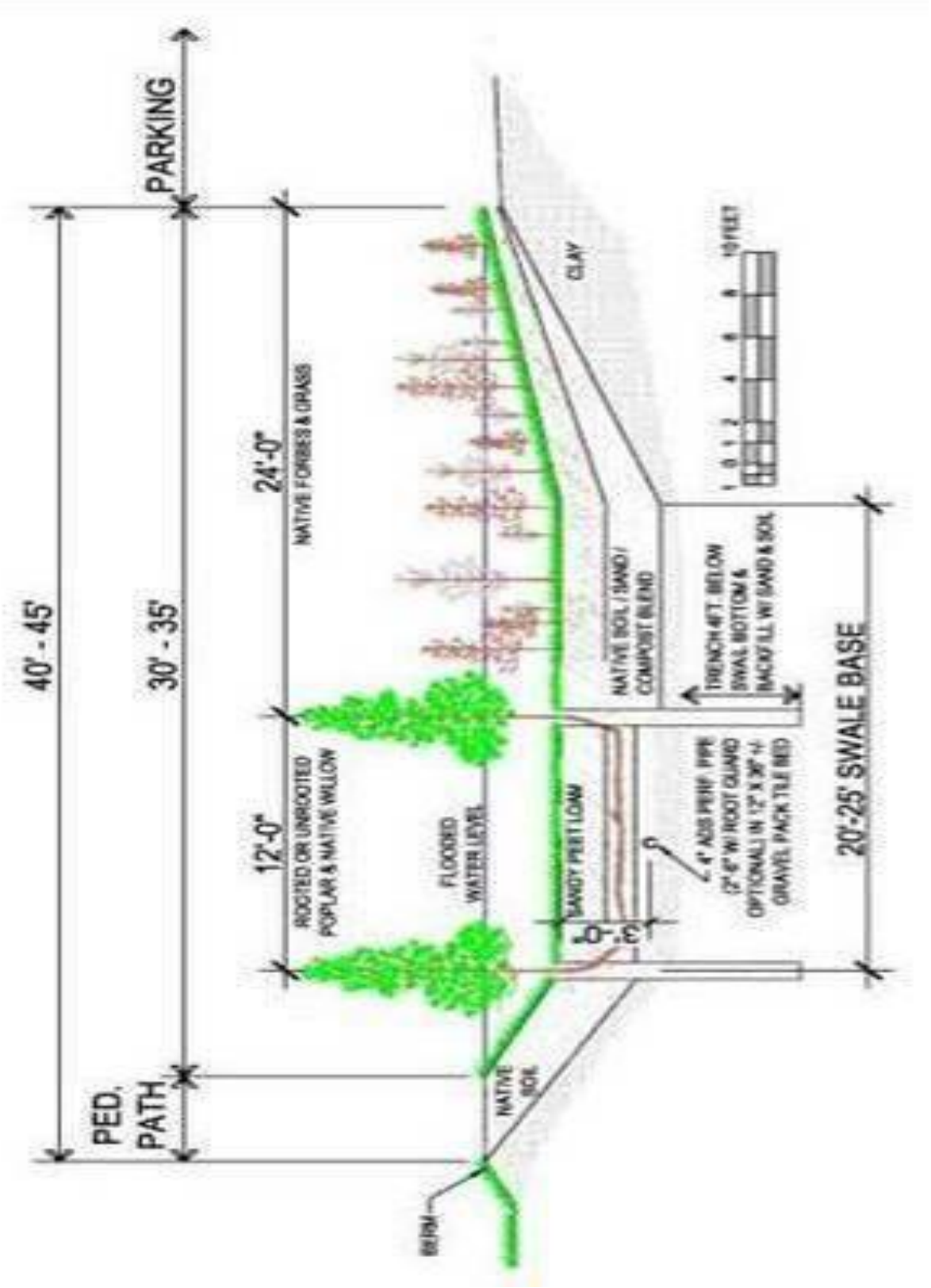

Figure 4: Proposed Phyto Buffer Rain Garden Plan View Section (October 2009)

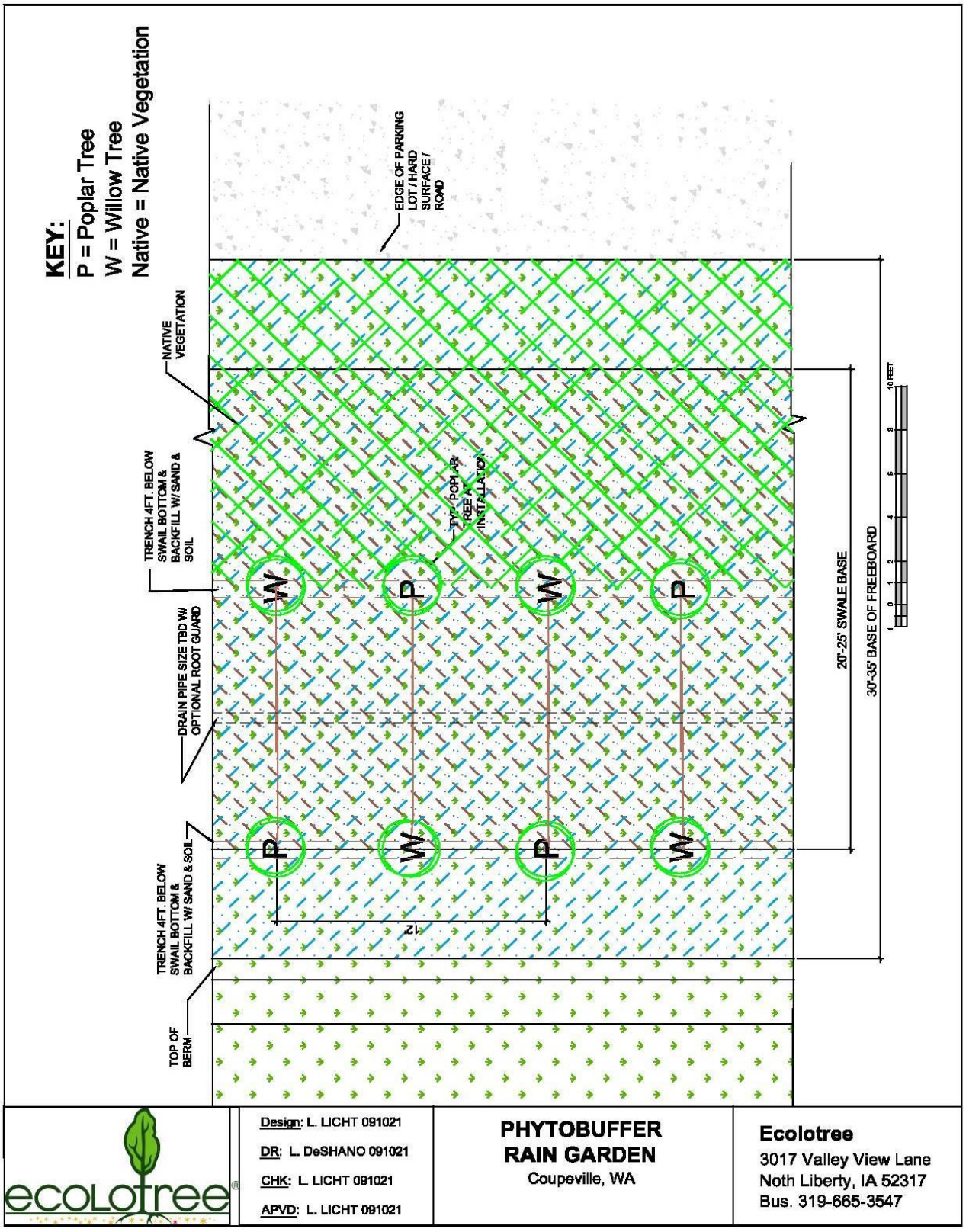

Figure 5: Detail of the ADS drainage pipe with Root Guard wrap in gravel bed

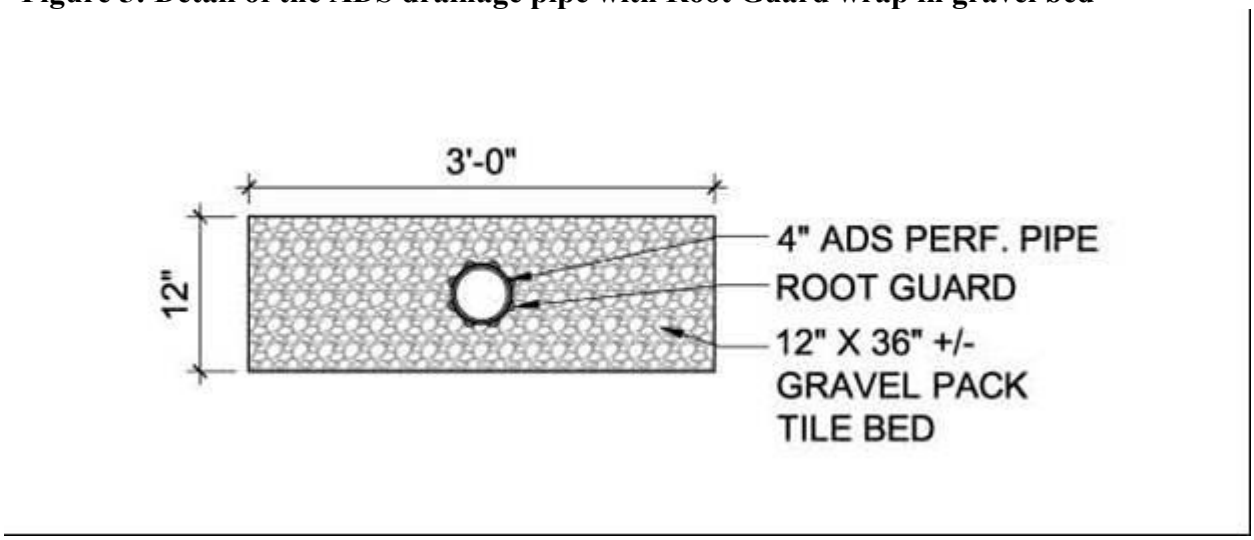

Figure 6: Similar Two–row EBuffer with Grass Understory -Second Growing Season

Figure 7: Aerial Photo of Proposed EBuffer Location (Summer 2009)

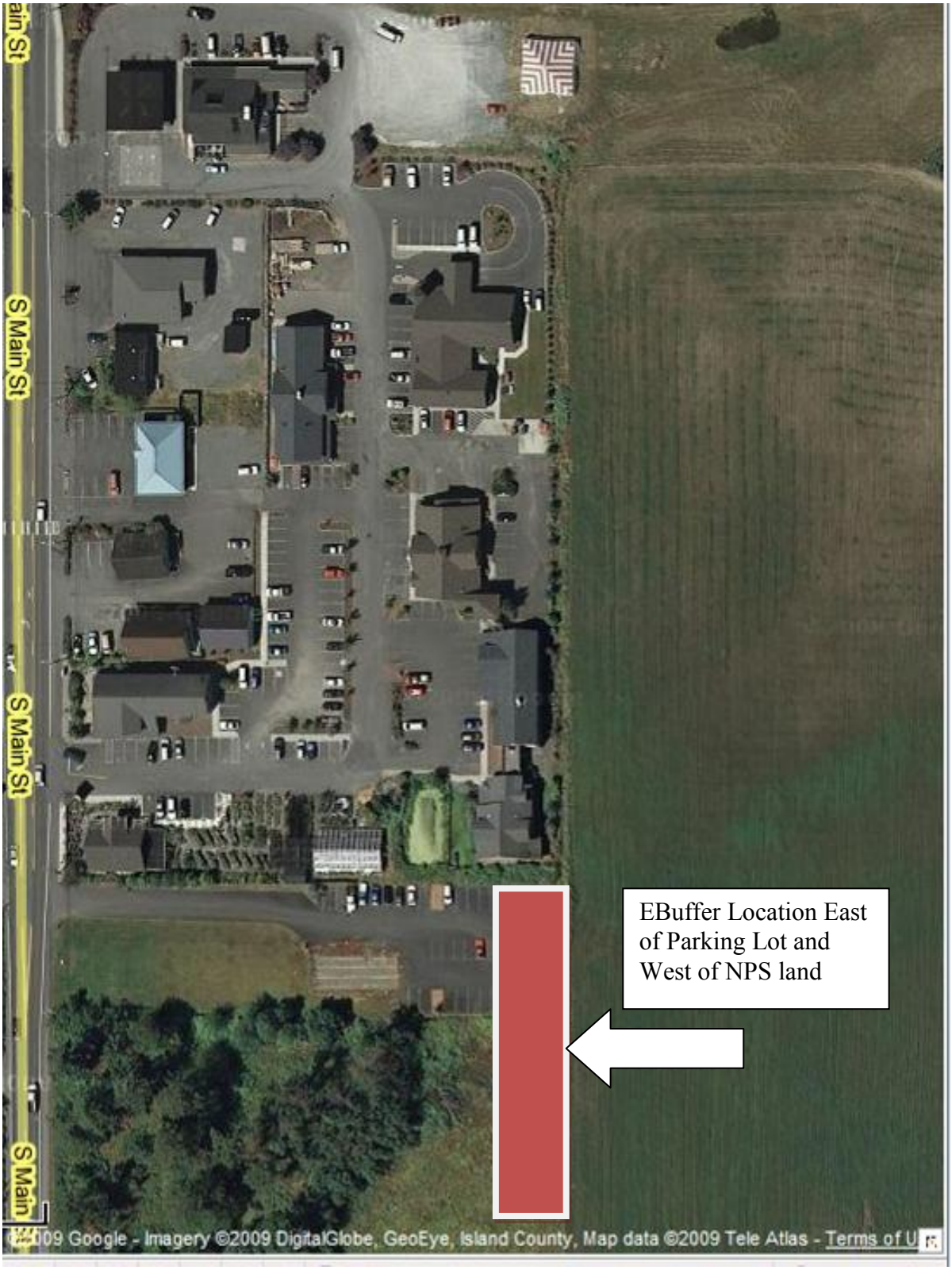

Figure 8: Proposed Location of Coupeville EBuffer (Photo 9.19.09)

Figure 9: South Drainage Ditch EBuffer Tile Drain or Overflow (Photo 9.19.09)

Figure 10: East Drainage Ditch where EBuffer will be built (By Sound Dev. Group)

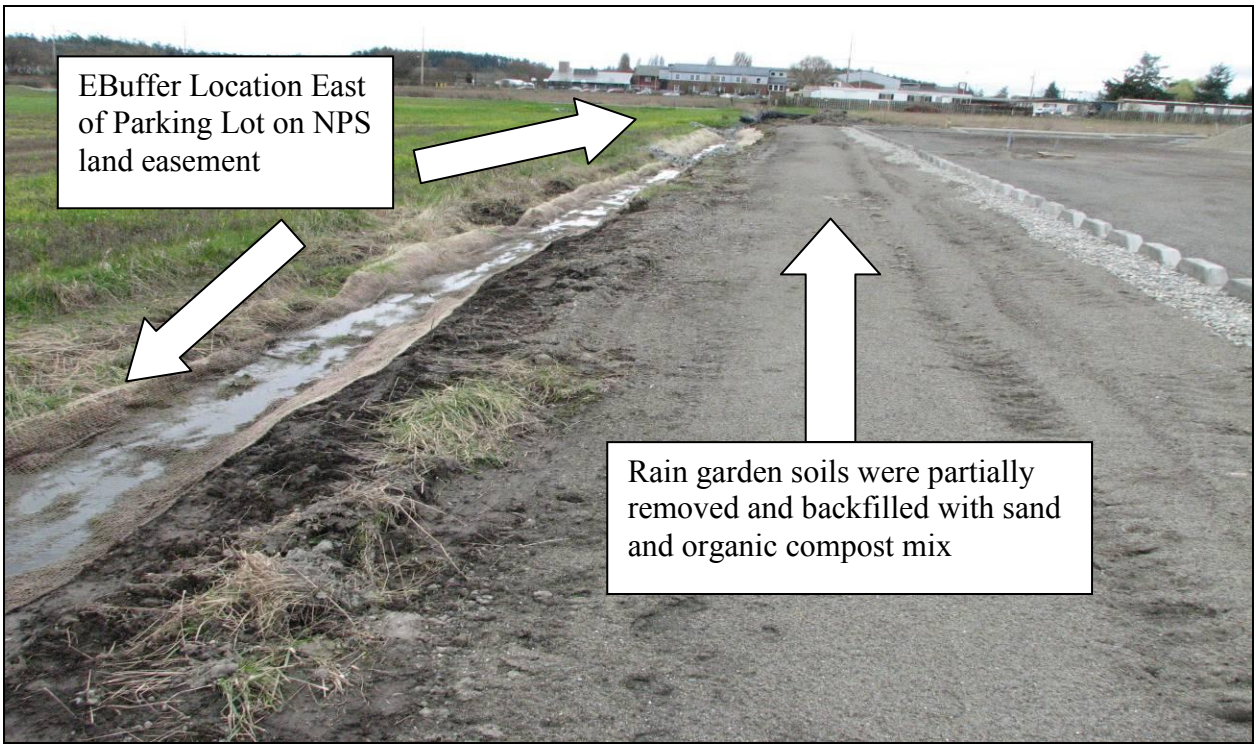

Figure 11: South east corner of Island Transit parking lot (By Sound Dev. Group)

Figure 12: SE corner of rain garden with new soil (By Sound Dev. Group)

Figure 13: Root Guard textile around ADS drainage pipe