APPENDIX E

Low Impact Development and Best Management Practices (BMPs)

Historically, subdivision, site development and building/architectural design plans have been developed without input from environmental planners, hydrogeologists, ecologists and water resource engineers. The plans have been prepared based on performance standards set by municipal bylaws or guidelines and the business objectives of the landowners. Typically, water resources engineers are employed to address stormwater management after a preliminary site plan has been prepared. In this way, stormwater management facilities are designed to handle a predetermined amount of runoff and to mitigate the negative impact of the proposed development. An alternative approach to reduce or prevent adverse impacts instead of mitigating them is to adopt water management as on of the basic design criteria (MOE 2003).

There are many economic benefits with the adoption of Low Impact Development. Subdivision/site planning generally reduces the cost of the development due to:

- lower grading requirements/costs;
- lower tree clearing costs;
- lower servicing costs (swales instead of storm sewers);
- lots with mature trees are more saleable/valuable;
- lots that back on to greenbelts are more saleable/valuable;
- tourism dollars in areas with sports fishery; and
- lower end of system clean up costs (i.e., dredging, etc.).

The following general planning and design criteria should be incorporated in new developments:

- preserve existing topography and natural features
- protect surface water and groundwater resources
- adopt compact development forms;
- adopt alternative site development standards; and
- re-create natural habitats within development areas.

Adoption of compact housing designs such as cluster single dwellings, medium density townhouses and low-rise apartments, and high-rise apartments can compensate for restrictions in the area of developable land due to environmental features. A certain level of development density may be achieved while reducing the extent of disturbance to the site and the amount of site works required.

Figure A.5: Cluster Single Detached Dwellings

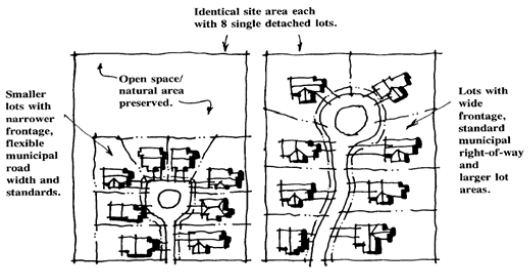
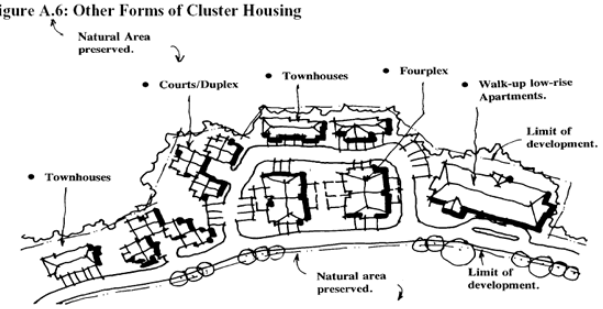


Figure A.6: Other Forms of Cluster Housing



Modified from City of Calgary 2000; AENV and OMOE 2003

LID Practice			Criteria	Advantages	Disadvantages	Q	F	E	R
Lot-Level BMPs									
Flat lot grading	Constraint	*Topography*	< 5%	• A reduction in the minimum allowable lot grade promotes natural infiltration and creates greater depression storage. Due to the problems of physically being able to grade below 2%, there should be an elevated apron around buildings (within 2 to 4 metres) to ensure that water does not drain towards the building foundation.	• May cause ponding and limit use for short durations.	▲	▲	▲	●
		Soils	None						
		Bedrock	None						
		Groundwater	None						
		Area (ha)	None						
Soak-away pit	Constraint	*Topography*	None	• Reduces the volume of runoff from a site, reducing the size and cost of downstream stormwater control facilities. • Designed to receive runoff from individual roof leaders.	• Rooftop gutter screens are needed to trap particles, leaves and other debris, and must be cleaned regularly.	▲	▲	▲	●
		Soils	Loam (min infiltration rate ≥ 15 mm/h)						
		Bedrock	> 1 m below bottom						
		Groundwater	> 1 m below bottom						
		Area (ha)	< 0.5						
Rear yard infiltration	Constraint	*Topography*	< 2%	• Reduces the volume of runoff from a site, reducing the size and cost of downstream stormwater control facilities. • Can retrofit areas where space is limited. • Potential for clogging is reduced for rain gardens compared to end-of-pipe infiltration techniques (basins and trenches) because water is generally cleaner	• Applicable in small drainage areas only.	▲	▲	▲	●
		Soils	Loam (min infiltration rate ≥ 15 mm/h)						
		Bedrock	> 1 m below bottom						
		Groundwater	*> 1 m below bottom*						
		Area (ha)	*< 0.5*						

LID Practice			Criteria	Advantages	Disadvantages	Q	F	E	R
Infiltration trench	Constraint	*Topography*	*None*	• Infiltration system with subsurface storage component that treats runoff from several lots • Can be implemented above- or below-ground	• Potential for groundwater contamination if improperly designed. • Infiltration trenches will provide marginal flooding and erosion control because sized for recharge and water quality.	▲	▲	▲	●
		Soils	*Loam (min infiltration rate ≥ 15 mm/h)*						
		Bedrock	*> 1 m below bottom*						
		Groundwater	*> 1 m below bottom*						
		Area (ha)	*< 2*						
Green Roofs	Constraint			• Reduce city "heat island" effect • Reduce CO_2 impact • Reduce summer air conditioning cost • Reduce winter heat demand • Potentially increase roof life 2-3 times • Treat nitrogen pollution in rain • Negate acid rain effect • Help reduce runoff volume and peak rates of stormwater	• Require periodic maintenance (i.e. fertilizer and care) • Initial cost may be higher than conventional roof.				
Cisterns and Rain Barrels	Constraint	None	None	• Stormwater can be used for irrigation or infiltratioin between storms. Useful in areas having low permeable soils, where infiltration is slow.	• Covering the rain barrel is recommended to prevent mosquitoes from breeding.				

LID Practice			Criteria	Advantages	Disadvantages	Q	F	E	R
Conveyance BMPs									
Grassed swales	Constraint	*Topography*	*< 5%*	• The use of grassed swales (also referred to as ditch and culvert servicing) is viable for lots which will accommodate swale lengths the culvert length underneath the driveway (not just the driveway pavement width). • Grassed swales provide numerous benefits (water quality enhancement, reduction of water quantity peak flows and volumes, easier snow removal, storage for snow removal) and are recommended for implementation wherever feasible. • Simple and versatile.	• Infiltration capacity can be limited over time if salt effects soil structure. • May need periodic maintenance.	●	▲	●	▲
		Soils	*None*						
		Bedrock	*None*						
		Groundwater	*None*						
		Area (ha)	*None*						
Perforated pipes	Constraint	*Topography*	*None*			●	▲	▲	●
		Soils	*Loam (min infiltration rate ≥ 15 mm/h)*						
		Bedrock	*> 1 m below bottom*						
		Groundwater	*> 1 m below bottom*						
		Area (ha)	*None*						

LID Practice			Criteria	Advantages	Disadvantages	Q	F	E	R
Pervious catchbasins	Constraint	*Topography*	*None*	• Normal catchbasins with larger sump physically connected to exfiltration system.	• More susceptible to clogging and compaction as a result of no pretreatment and the weight of water in the catchbasin.	●	▲	▲	●
		Soils	*Loam (min infiltration rate ≥ 15 mm/h)*						
		Bedrock	*> 1 m below bottom*						
		Groundwater	*> 1 m below bottom*						
		Area (ha)	*None*						
Treatment and Pretreatment BMPs									
Wet pond	Constraint	*Topography*	*None*	• Removes soluble and solid pollutants • Provides erosion control, habitat, aesthetic and recreational opportunities • Relatively less frequent maintenance schedule	• More costly than dry ponds • Requires larger land area • Potential negative downstream temperature impacts • Potential topography or land designation constraints • Sediment removal relatively costly when required	●	●	•	○
		Soils	*None*						
		Bedrock	*None*						
		Groundwater	*None*						
		Area (ha)	*> 5*						
Dry pond	Constraint	*Topography*	*None*	• Batch mode has comparable effectiveness to wet ponds • Not constrained by land area required by wet ponds • Can provide recreational benefits	• Potential re-suspension of contaminants • More expensive operation & maintenance than wet ponds (batch mode)	▲	●	•	○
		Soils	*None*						
		Bedrock	*None*						
		Groundwater	*None*						
		Area (ha)	*> 5*						
Wetland	Constraint	*Topography*	*None*	• Pollutant removal capability similar to wet ponds • Offers enhanced nutrient-removal capability • Potential ancillary benefits (i.e. terrestrial and aquatic habitat)	• Requires more land area than wet ponds • Potential negative temperature impacts downstream • Potential for topography or land designation constraints • Potential for nuisance problems	●	•	●	
		Soils	*None*						
		Bedrock	*None*						
		Groundwater	*None*						
		Area (ha)	*> 5*						

LID Practice			Criteria	Advantages	Disadvantages	Q	F	E	R
Infiltration basin	Constraint	*Topography*	*None*	• Potentially effective in promoting recharge and maintaining low flows in small areas • May be appropriate as secondary facility where maintenance of groundwater recharge is a concern • No thermal impact • No public safety concern	• Appropriate only to relatively small drainage areas and residential land uses • Constrained by native soil permeabilities • Pretreatment is recommended • Potential contamination of groundwater must be investigated • Generally ineffective for water quantity control • High rate of failure due to improper design, pollutant loading, lack of maintenance	▲	▲	▲	●
		Soils	*Loam (min infiltration rate ≥ 15 mm/h)*						
		Bedrock	*> 1 m below bottom*						
		Groundwater	*> 1 m below bottom*						
		Area (ha)	*< 5*						
Filter strips	Constraint	*Topography*	*< 10%*	• Water quality benefits may be realized if part of an overall stormwater plan (i.e. as secondary facility) • Effective in filtering out suspended solids and intercepting precipitation • May reduce runoff by reducing overland flow velocities, increasing time of concentration, and increasing infiltration • Can create wildlife habitat • No thermal impact	• Limited to small drainage areas with little topographic relief • Uniform sheet flow through vegetation difficult to maintain • Effectiveness in freeze/thaw conditions questionable	●	○	▲	▲
		Soils	*None*						
		Bedrock	*None*						
		Groundwater	*> 0.5 m below bottom*						
		Area (ha)	*< 2*						
Sand filters	Constraint	*Topography*	*None*	• Useful around parking lots because large surface area can be designed with lower head requirements. • Effective in nutrient removal.	• Potential for clogging.				
		Soils	*None*						
		Bedrock	*None*						
		Groundwater	*> 0.5 m below bottom*						
		Area (ha)	*< 5*						

LID Practice			Criteria	Advantages	Disadvantages	Q	F	E	R
Oil/grit separators (3-chamber separator)	Constraint	*Topography*	*None*	• Offline, 3-chamber (oil, grit, discharge) separators may be appropriate for commercial, industrial, large parking or transportation-related areas less than 2 ha. • Bypass prevents the scouring and resuspension of trapped pollutants in heavy rainfall events • Effective in removing sediment load when properly applied as a source control for small areas • Effective in trapping oil/grease from runoff	• Scour and resuspension of trapped pollutants in heavy rainfall events • Difficult to maintain • Relatively high O&M costs • Online design of 3-chamber separators has resulted in poor pollutant removal performance • Relatively high capital costs compared to manholes • Applicable for drainage areas less than 5 ha	▲	○	○	○
		Soils	*None*						
		Bedrock	*None*						
		Groundwater	*None*						
		Area (ha)	*< 1*						

Alternative Site Design Options

Site Design Options	Advantages	*Disadvantages*
Reduced Road Widths	• Reducing the road width to 6 m on local roads permits two way traffic without street parking or one way traffic with parking. This reduces the overall pavement area, and costs for the subdivision. The reduction in the pavement area will minimize the amount of land to be disturbed and grading works. It will also provide more flexibility for the planner or designer to align the proposed road along existing contours and integrate it into the existing landform.	
Reduced Building Coverage	• Same population density and ability to preserve natural features. **Compact Development Designs** • Cluster single lots with reduced lot frontages and alternative road/grading standards, • Higher density forms such as duplex and semi-detached, • Condominium singles, • Medium density housing forms such as townhouses, fourplex and low-rise apartments; and • High density housing such as high-rise apartments.	• Many of the compact development forms can only be implemented with flexible site design standards (building setbacks, grading requirements, minimum street gradient and turning radius, width of internal streets, locations of site services, and provision of street boulevard areas).
Porous Pavement Options	• Less need for curbing and storm sewers – rainfall volume reduction • Improved road safety because of skid resistance • Infiltration	• Use may be restricted in cold regions • Requires permeable soils • Lack of expertise • Potential for clogging
Reduced cul-de-sac turning radius	• A reduction in pavement and overall land consumption can be achieved if the cul-de-sac turning radius is reduced from 14 to 11 metres.	

A wider range in allowable lot grading	• Flatter lot grading should be promoted in naturally flat areas but radical changes to the existing topography should not be made. Municipal grading standards may also need to be modified for development within areas of varying topography to permit steeper lot grading. This flexibility will assist the designer to site the buildings along the slope and fit the built form into the terrain with minimum disturbance to the existing topography.	• Perceptions of temporary, ponded water may impede implementation • Municipal grading standards may need to be modified
Higher maximum allowable slopes on roads (10% instead of 6%) and individual lots (2:1 instead of 3:1)	• The increase in range of maximum allowable slopes allows planners/engineers greater flexibility in designing developments within the existing topography. Economic and environmental benefits from reduced grading requirements. • Narrower road surfaces will also mean reduced amounts of road salt/sand and lower construction costs. These issues are best addressed holistically perspective recognizing the environment, the economy, and the functionality of the subdivision/site design. • An increase in the allowable elevation differences for intersection approaches will allow designs with fewer changes to the existing topography.	• May be some drawbacks such as greater requirements for sanding/salting these roads during the winter and increased erosion potential in roadside ditches.

Increase rear lot overland drainage	• Provide greater opportunity for reducing peak flows and stormwater volumes. Overland drainage also provides opportunities for water quality improvement through settling, adsorption, filtration, and infiltration.
	• Opportunities to increase rear lot overland drainage include:
	  • allowing lots backing on to one another to drain through each other; and
	  • increasing the allowable length of rear yard swales and contributing drainage area
		• Perceptions of temporary, ponded water may impede implementation
		• Municipal grading standards may need to be modified

Porous landscape options for infiltration and evaporation (Rain gardens)	• Rainwater gardens can provide an aesthetically pleasing amenity and good use for open spaces.	• Lack of expertise and experience in our region