TECHNICAL BULLETIN

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Case Study:
Amble Greene, District of Surrey, BC
alternative stormwater management systems

I. Introduction

Conventional stormwater systems are designed to efficiently convey water away from surfaces and to prevent the accumulation of standing water. The standard curb and gutter system with storm sewers effectively achieves this objective, however this conventional approach often fails to address other stormwater concerns, such as the protection of water quality, stream channels and riparian habitat, as well as ground water recharge.

Figure 4-1 - Streets were edged with a grassy shoulder enabling infiltration capacity at the roadside, an essential aspect of the overall stormwater system.

To address these stormwater related issues, some municipalities in the Fraser Valley began using innovative stormwater infiltration systems for certain new developments. Designed in 1979, Ambleside Greene was the largest of these developments. The infiltration system in Amble Greene (a development within the larger Ambleside site) is made up of a combination of grass swales and French drains. One small section of Amble Greene is connected to a traditional storm drain system; most of the site is not. The infiltration system is designed to allow continuous and ubiquitous infiltration of stormwater. For enhanced infiltration, the project design calls for a simple street section without a conventional "curbed" road system, as shown in Figure 4-1 and 4-4.

II. Project Description

The site investigated is the single-family residential development, Amble Greene, within the greater rural residential community of Ambleside Greene in the City of Surrey, B.C. In the mid 1970s, Surrey's Urban Growth Area Plan designated the larger Ambleside Greene for low-density, single-family residential development.

The initial objectives of this project were: (1) to maximize the amount of stormwater runoff that could be infiltrated on-site, thereby reducing the annual volume that is discharged off-site; and, (2) to use a more economical approach to treating stormwater in rural, low-density residential areas. The City of Surrey's approval of the application was based on the following attributes:

1. *Single-family residential with an average 2.7 density units per acre;*
2. *A phased project plan that indicated the westerly portion as the second phase with the possibility of increased density.*
3. *A community layout that created useable open space;*
4. *The preservation of substantial vegetation; and*
5. *The development of trails and the landscaping that would ensure a low maintenance parkway system.*

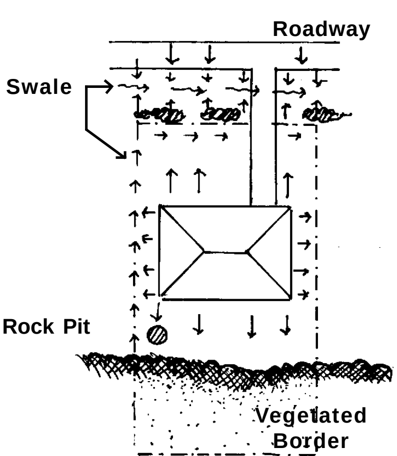


Figure 4-2 - Lot layout

Generally, the site design in Amble Greene adheres to a curvilinear street and utility pattern with a 20-metre street right-of-way. All of the residential lots were designed with rock pits to increase immediate on-site drainage, and were graded for positive drainage toward the street and/or to the rear property line as shown in Figure 4-2. The stormwater system is an infiltration system that depends on swales, French drains and retention areas to infiltrate 100% of all rainwater that falls on the site. One small section is conventionally drained by storm drains and stormwater collectors tied into the district storm drain system. By providing only a minimum of storm connections on site, the majority of runoff is able of move slowly through the soil via infiltration. By increasing the level of stormwater infiltration and the time of concentration, the overall runoff from the site is reduced.

The stormwater retention system was designed for 5-year runoff peaks, with an overflow capacity to allow for a 100-year storm when the infiltration capacity of the soil would be exceeded. During large storms (3" of rain or more in a 24 hour period), excess water is routed directly to on-site retention/infiltration areas as shown in Figure 4-4.

III. Site Conditions

Prior to development, the area was largely forested. In the area, the majority of rainfall events are considered relatively 'minor' and calculated at less then one-half inch per 24 hours, as shown in Figure 4-3. Within this forested landscape, rainwater that did not evapotranspire infiltrated into the ground and/or flowed to the ocean via creeks. As development occurred, many of these waterways were disturbed, significantly altering the natural infiltration and surface flow of the area.

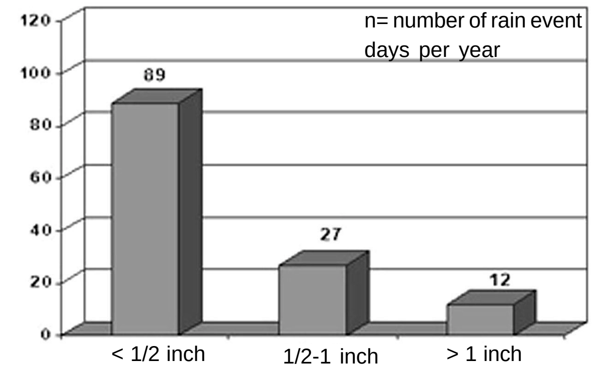


Figure 4-3 - Number of Minor, Moderate, and Substantial Rain Events per year. (data source Kwantlen Park Resource Centre from Jan. 1, 1962-May1, 1996)

Generally the soil profile throughout the site is composed of a layer of topsoil, which varies in thickness from 0.1 metres to 0.5 metres, above a fairly compacted layer of gravely sandy soil, which reaches depths of 2.0 metres. Immediately below this gravely soil, is a more impervious layer, which is referred to as 'hardpan' and composed of fine sand and silty-clay.

This subsurface hardpan layer, which is relatively impervious, does not limit the capacity of this soil for infiltration, even in the wetter winter months. This is for two reasons: 1) the significant depth of the surface soil above this layer; and, 2) the relatively low water table in the area below the hardpan. The gravely, sandy layer above the hardpan has an infiltration capacity rate of 180 mm/hour during summer conditions. During the wetter winter periods, this layer acts as a water reservoir with a very high capacity to hold water. Alongside the low water table, this particular soil profile permits gradual, yet consistent, percolation of stored infiltration design and function.

In certain locations of the site, the hardpan layer is encountered directly beneath the topsoil, affecting the infiltration capacity. To address these site variations, Amble Greene's infiltration system is composed of storm drain connections to an adjacent conventional storm sewer (in total, 12 units connect to the main storm line near the 16th Ave boundary of the site) and an alternative system of French drains and grass swales throughout the rest of the site. For maximum infiltration efficiency, the French drain system was constructed at depths of 1-1.2 metres into the sandy, gravely strata.

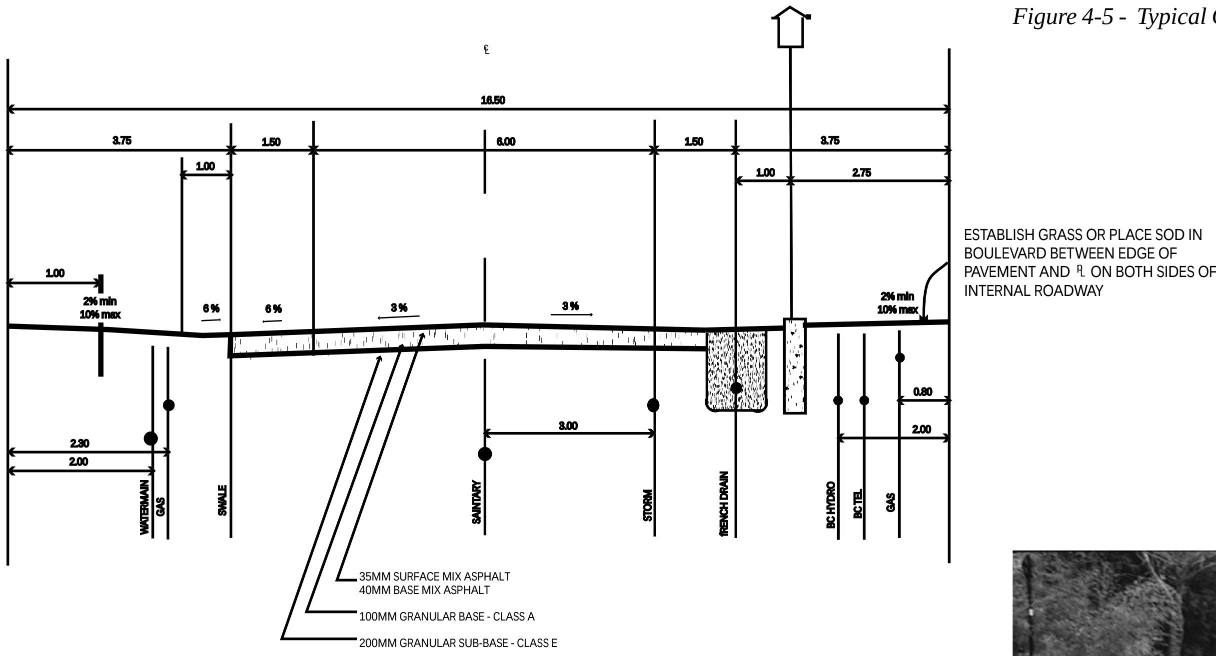
IV. Evaluation

To date, the system has experienced problems relating to four factors:

1) The built condition for Amble Greene did not reflect the engineer's technical specifications for the site. The design specifications identified the ground water elevation, the depth of the rock pits, and the minimum elevation of the building foundation required for each lot. However, many of the home's built elevations were much lower than the minimum elevations specified. In these situations, positive drainage away from the house to the swale and French drain system was not achieved.

2) Driveways were designed to cross swales and French drains. The driveway crossings at Amble Greene, as indicated in Figure 4-6, inhibit the system and allow for the accumulation of standing water. Additionally the swales are unpronounced and allow little surface hydraulic movement on a site that is extremely flat, resulting, again, in the accumulation of standing water. It could be argued that the use of design standards such as swales and French drains requires additional standards, such as lanes with rear access to garages in order to create an efficient and functionally sound system.

Figure 4-4 - These "blue/green" retention areas double as community lawns during ordinary circumstances.



Typical Road Cross-section for 20.00m. R/W

Figure 4-5 - Typical Cross Section

Figure 4-6 - Driveways crossing swales and french drains inhibit the system and allow for the accumulation of standing water.

3) Homeowners lacked awareness and understanding of the stormwater infiltration design and function. Some homeowners made changes to the system that inhibited drainage, such as installing swimming pools that obstructed the flow of the swale; replacing the drainage material in rock pits with more organic matter and plantings; and, installing additional crossings through the swale drainage systems.

4) Other problems related to the initial construction standards. Within three years of construction, the French drains had to be cleaned out due to silt migration and build-up in the drains. Although the system was cleaned at that time, it is not known whether construction practices or the type of fabric barrier used is to blame. This has not been a problem since.

Overall, the project has been successful at minimizing stormwater runoff from the site. And, despite the underlying hardpan layer impeding the flow of water to the deeper water table, the soil layer above the hardpan layer acts effectively as a reservoir during saturation periods. It appears that these 2 metres of generally compacted soil have adequate storage capacity for even the 100-year storm. (There have been two hundred year storms since the project was built.) There are no discharges of stormwater from the infiltration-based portions of the site. Due to the effectiveness of the stormwater system at Amble Greene, ninety five percent of the developer’s contributions for downstream drainage facilities were rebated 2 years from the end date of construction.

COST

In current dollars, the system costs translate into approximately $150 per linear metre of the storm-water system for a total system cost of $140,100. The installed system was substantially less expensive than the conventional alternative at that time. These findings are summarized in Table 4-1.

MAINTENANCE

The infiltration system requires regular maintenance such as, seasonal clean up of foliage and vegetative debris (which accumulate on swales and rock pits) and additional topdressing, over-seeding and fertiliz-ing. The United States Environmental Protection Agency recommends a 5-year maintenance cycle for grass swales. This maintenance includes: scraping the base of the swale to remove sediment; restoring the original cross section and infiltration rate of the swale; and seeding to replace ground cover (USEPA, 1999). An added maintenance cost to the Amble Greene system was attributed to the repair of poorly constructed connections between foundation footing drains and rock pits, which were causing minor drainage problems. Finally, the designers and developers failed to use the standard detail at pavement edges where unimpeded water flow from pavement to grass is desired. Because a two-inch drop between the pavement edge and the adjacent seeded topsoil was not maintained the grass quickly created a dam that blocked water from reaching streetside infiltration areas. This situation has the potential to cause additional retrofit costs, although to date a retrofit has not been required at Amble Greene.

Infiltration system
Captures a volume of runoff and infiltrates it into the ground.

Detention Ponds
Capture a volume of runoff and temporarily retain that volume for subsequent release. Detention systems do not retain a significant permanent pool of water between runoff events.

Retention Ponds
Capture a volume of runoff and retain that volume until it is displaced in part or in total by the next runoff event. Retention systems therefore maintain a significant permanent pool volume of water between runoff events. (USEPA pg. 5-7)

V. Summary

The site and soil conditions at Amble Greene made the combination system a viable economic alternative to a conventional stormwater system, while permitting infiltration of stormwater on this site. The system at Amble Greene effectively mitigates stormwater runoff, and even in periods of saturation effectively infiltrates and stores stormwater in the soil reservoir. Overall, this system has been successful in addressing stormwater related concerns such as water quality, stream channel and riparian habitat protection, and ground water recharge.

Resources

Hislop, Davis, Drainage Department, Engineering, City of Surrey. 2000 Personal contact.

J.F. Sabourin and Associates Inc. 1997. "Evaluation of Roadside Ditches and Other Related Stormwater Management Practices." Metropolitan Toronto and Region Conservation Authority.

Hans Schreier, Institute of Resources and Environment, University of British Columbia. 2000. Personal contact.

Office of Science and Technology. 1999. "Preliminary Data Summary of Urban Storm Water Best Management Practices." USEPA.

Table 4-1 - Case Summary

	Amble Greene
Project Description	
DEVELOPMENT	
Location	South Surrey
Development Type	residential
No. of Units	153
Developer	Shell Canada
Size	9.9 Acres
Date of Construction	1979
ROAD	
Street Pattern	curvilinear
Typical ROW width	20 meters
UTILITIES	
Pattern	curvilinear
STORMWATER	
Type of System Constructed	**infiltration**/ exfiltration/ storage
Area serviced	9.9 Acres
Level of SWM	100-year storm
Large Storm situation	3" in 24 hour
System Length	934 meters
Culverts	no
Site Condition	
BIOPHYSICAL	
Settlement Patterns	Forested
Post Development Conditions	Residential
HYDROLOGICAL	
Average Rain Event	<1/2 inch in 24 hr (See figure 4-3)
GEOTECHNICAL	
Soils Profile - surface	0.1- 0.5 metres
sub soils	to 2.0 metres (gravely sandy)
Site Grades	undulating
Water Table Elevation	low
Soil Infiltration Capacity	180mm/hour
HABITAT	
Urban Forest Coverages	forested border

Stormwater Installation Cost

Cost per meter:
$70.00 CAN (1979)

This translates into a current system cost of $150 dollars per linear metre for a total system cost of approximately $140,100 CAN (2000)

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