RESEARCH HIGHLIGHTS

February 2001 Socio-Economic Series Issue 78

THE HEADWATERS PROJECT— EAST CLAYTON NEIGHBOURHOOD CONCEPT PLAN

Introduction

The Headwaters Project is a demonstration of sustainable development principles and performance standards in the community of East Clayton, Surrey, BC. Its purpose is to provide a replicable model which can be used to develop more sustainable communities throughout British Columbia's Lower Mainland Region and, potentially, beyond. CMHC co-sponsored the Headwaters Project to highlight the benefits of the alternative design and planning standards.

The first and most important component of the Headwaters Project is the East Clayton Neighbourhood Concept Plan (NCP). Developed over a period of one year and a half, through an integrated and consultative design process, the NCP followed seven sustainable planning principles, which were endorsed by Surrey City Council. Adherence to these principles will help protect the East Clayton environment while providing a variety of dwelling types, accessible to a wide range of income earners.

This Research Highlight provides a brief overview of the East Clayton NCP and examines a number of anticipated environmental and economic benefits associated with its implementation compared to a conventional suburban neighbourhood of similar size. It compares:

- the average per household Greenhouse Gas emissions from urban travel;
- impacts on local streams and hydrology; and
- infrastructure, land, and building costs.

Background

Site Context

The 250-hectare East Clayton site is located on the eastern border of Surrey, and lies approximately 35 km west of downtown Vancouver. Geographically, it is the largest and one of the fastest growing municipalities in the Lower Mainland Region. Situated upland of the region's Agricultural Land Reserve, the site also drains into two of the region's most significant water bodies (the Serpentine and the Nicomekle rivers).

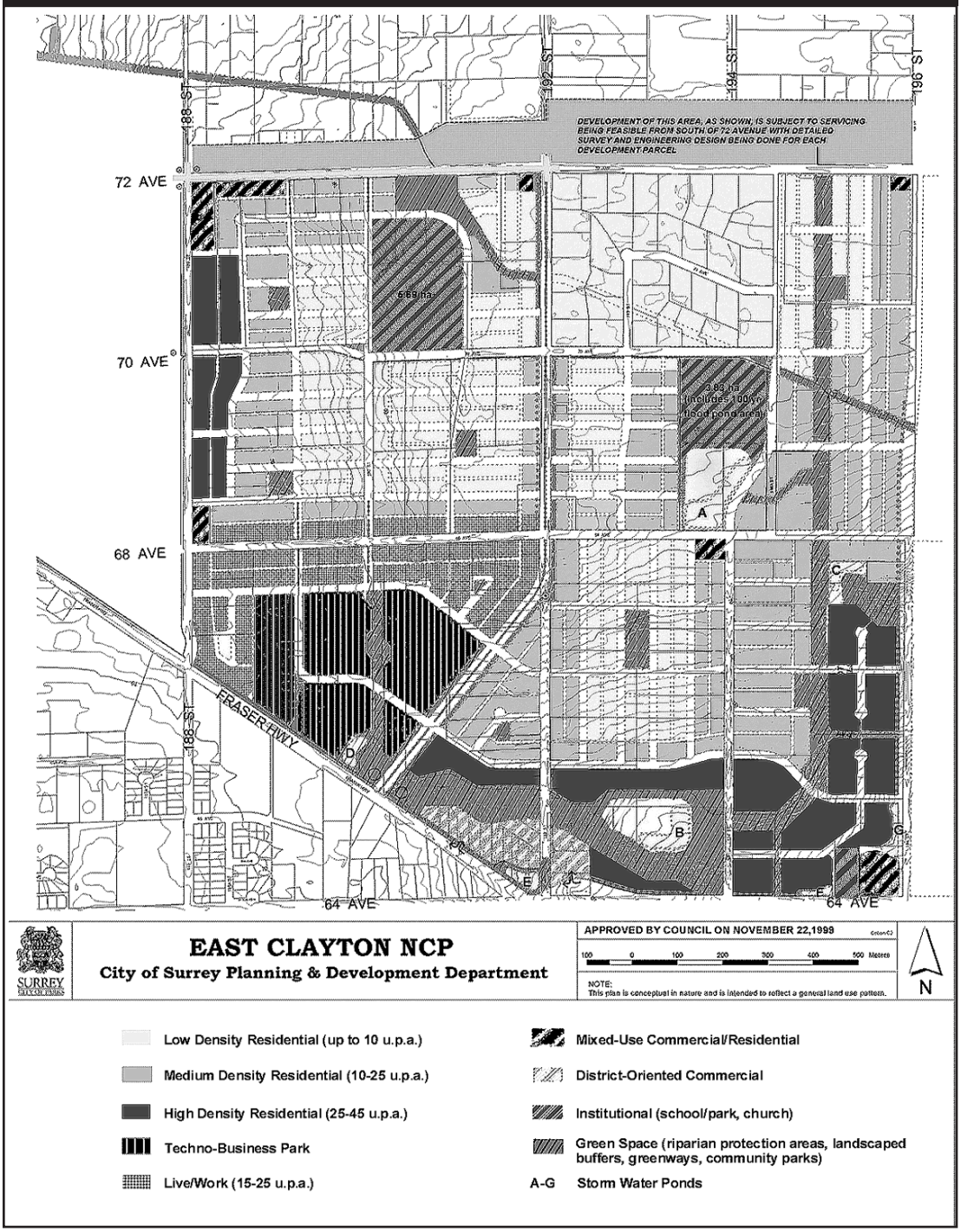
East Clayton NCP

In 1998, the City of Surrey initiated the East Clayton NCP, in partnership with the University of British Columbia (UBC) James Taylor Chair in Landscape and Liveable Environments, Pacific Resources Centre, and a variety of government and related agencies.[1] Public involvement and an integrated, consultative process were the keys to developing the East Clayton NCP. Using performance thresholds outlined in the East Clayton Design Brief, the public and the appropriate private, city and regional institutions designed the land-use plan in a four-day charrette.

The draft East Clayton NCP was presented to the public in July 1999 and the Land-use Plan was approved by Surrey City Council in November 1999 (Figure 1). Final City Council approval of the NCP is scheduled for 2001. The second phase of the project involves the coordination

[1] Groups and agencies involved in the creation of the NCP include: agriculture; City of Surrey planning, engineering, parks and operations/maintenance departments; Clayton Citizen's Advisory Committee; developers and builders; Department of Fisheries and Oceans; BC Ministry of Environment Lands and Parks; Surrey School Board; Translink; fire and safety; and police. Headwaters Project partners include the ACT Program, Canada Mortgage and Housing Corporation, B.C. Agricultural Investment Program, B.C. Ministry of Agriculture and Food, B.C. Ministry of Municipal Affairs, Environment Canada, Fisheries and Oceans Canada, Greater Vancouver Regional District and the Real Estate Foundation of B.C.

Figure 1: East Clayton Land Use Plan (approved November 1999)



and design of the first development project based on the NCP standards and guidelines.

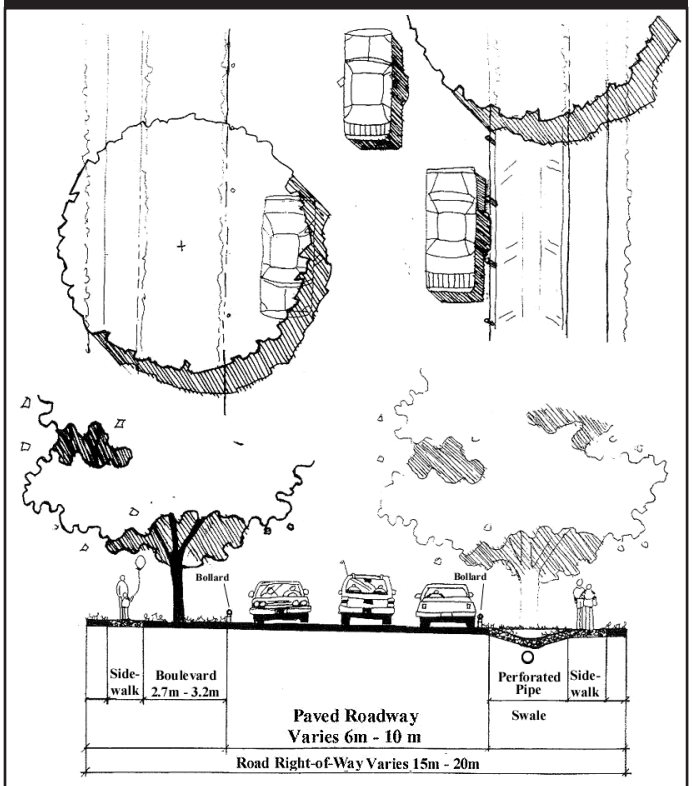
The seven principles, as approved by Surrey City Council, are as follows:

1. *Increase density and conserve energy by designing compact walkable neighbourhoods.* This will encourage pedestrian activities where basic services (for example, schools, parks, transit, shops, etc.) are within a five- to six-minute walk from home. The average, overall density of East Clayton will be approximately 25 units per hectare. Eventually, an express bus will serve East Clayton, providing connections at 7-8 minute intervals to the larger municipality and region.
2. *Provide different dwelling types (a mix of housing types, including a broad range of densities from single-family homes to apartment buildings) in the same neighbourhood and even on the same street.* East Clayton will have detached, semi-detached, fee simple row housing and town housing, and apartments in the same

neighbourhood and, where possible, on the same street. Secondary suites and coach houses are encouraged.

3. *Communities are designed for people; therefore, all dwellings should present a friendly face to the street in order to promote social interaction:* Homes will be set back only short distances from the sidewalk, thereby ensuring more eyes on the street, while creating a larger backyard for private outdoor space. Tree-lined boulevards, infiltration devices and on-street parking will buffer the pedestrian from passing traffic.
4. *Ensure that car storage and services are located at the rear of dwellings*. Where possible, lanes will be provided at the rear of dwelling units so that garages and driveways do not dominate the front yard.
5. *Provide an interconnected street network, in a grid or modified grid pattern, to ensure a variety of itineraries and to disperse traffic congestion; and provide public transit to connect East Clayton with the surrounding region:* Blocks in East Clayton are proportioned to create a fine-grained, interconnected grid, or modified grid of streets, with block lengths averaging 80 to 120 metres, and to allow as many homes to front directly onto public streets.
6. *Provide narrow streets shaded by rows of trees in order to save costs and to provide a greener, friendlier environment.* Paved street widths for local and collector streets range from 6 to 11.3 metres, with rights-of-way ranging from 15 to 22 metres, depending on the specific infrastructure, servicing and amenity requirements (for example, drainage, traffic volume, and urban forestry) of each individual corridor (Figure 2).
7. *Preserve the natural environment and promote natural drainage systems (in which stormwater is held on the surface and permitted to seep naturally into the ground):* Green systems are an essential part of the East Clayton NCP. The ecological structure of the site guided the development pattern rather than the other way around. In addition, the Plan's alternative stormwater and "ecological infrastructure" systems will facilitate natural infiltration of stormwater into the ground. This simple but important feature is crucial for maintaining the hydrologic cycle in the watershed, ensuring consistent stream flow and eliminating this site's contribution to the chronic flooding of lowland farms.

Figure 2: Typical local road cross section



Findings - Anticipated benefits

1. Automobile Use, Ownership and Greenhouse Gas Emissions (GHGs)

An existing software tool[2] was used to estimate automobile use, public transit use, automobile ownership and GHGs resulting from urban travel. The software enables users to estimate annual household GHGs from cars and public transit based on neighbourhood variables that the user enters. Variables include: residential density, land use mix, number of jobs, housing typology mix, road layout type, number of intersections per road km, number of bike routes, transit service, distance to the central business district, household income and others. These variables were entered for four scenarios:

1. the East Clayton NCP;
2. a hypothetical conventional suburban-type[3] development of a similar size and location as the East Clayton example;

[2] For a more detailed description of the software, see CMHC, Greenhouse Gas Emissions from Urban Travel: Tool for Evaluating Neighbourhood Sustainability or Research Highlight #50 under the same title.

[3] The term "suburban-type" refers to a development with characteristics typical of conventional suburbs, including single-use development, single family housing, lower density, and curvilinear street patterns with cul-de sacs extending out to wide arterials.

Table 1: Travel behaviour: Comparison of Four Neighbourhood Scenarios

Household travel behaviour	Scenario 1 - Year 2010 *		Scenario 2 - Year 2040 **	
	East Clayton	Suburban-type	East Clayton	Suburban-type
Average vehicles owned/household	1.17	1.65	1.13	1.6
Average weekday auto use (vehicle kilometres traveled/household)	51.6	78.8	38	72.8
Average weekday transit use (public transit passenger kilometres traveled/household)	16.2	19.7	13	16.2
Annual GHGs/household from automobiles (kilograms of CO_2 equivalent)	5,900	9,000	4,400	8,300
Annual GHGs/household from public transit (kilograms of CO_2 equivalent)	220	270	180	270
Total household GHGs from urban travel (kilograms of CO_2 equivalent)	6,100	9,300	4,600	7,700

3. a short-term scenario, up to year 2010;
4. a long-term scenario, up to year 2040, for both the East Clayton and the conventional suburban-type neighbourhood.

*Scenario 1 shows East Clayton as envisioned in year 2010, with a sustainable density of approximately 25 units per hectare, integrated land uses, and connected by frequent local rapid bus service to the regional SkyTrain rapid transit system, located 8.7 km to the west.

**Scenario 2 shows the air quality benefits 30 years later. If the East Clayton community pattern is replicated across the surrounding landscape, it would translate into increased local and area-wide transit service, lower per household vehicle ownership, the creation of a regional job and service centre and shorter trip distances.

As shown in Table 1, in Scenario 1, vehicle kilometres traveled per household and per household production of GHGs will be reduced in the short term by 35%—from 9,300 to 6,100 kg CO_2 equivalent over the suburban-type development. Scenario 2 shows that, assuming adjacent communities develop according to the East Clayton model, the longer term benefits would be manifest in a 40% reduction—from 7,700 to 4,600 kg CO_2 equivalent of GHG emissions, over the suburban-type development. Also, the rate of vehicle ownership per household is reduced by approximately 30%. This would result in substantial annual saving for the residents, as the average annual cost to own and operate a vehicle in Canada in the year 2000 was over $8,000[4].

II. Water Quality and Environmental Protection

The Plan's system of "ecological infrastructure" and use of best management practices (BMPs) is intended to maintain the quality and quantity of ground and surface water through a system of street side infiltration swales, district-wide urban forestry practices, and on-site infiltration devices, all of which are linked to a continuous network of parks, natural areas and riparian zones.

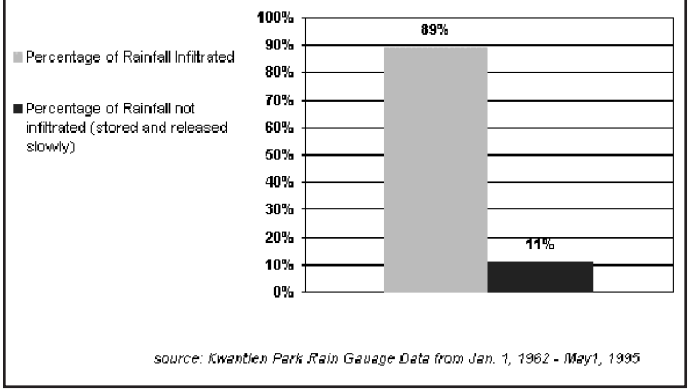
Water Quantity: Rainfall data for the Surrey areas show that the majority of rain that falls on the site is from frequent, but small storm events (that is to say, those smaller than 25 mm per day). Figure 3 illustrates the amount of rainfall that will be captured by the proposed infiltration system. By capturing up to 25 mm of rainfall per day (including the first 25 mm of larger storm events) almost 90% of total rain that falls on the site will be absorbed naturally in the soil. This level of infiltration is necessary in order to maintain the hydrological cycle of the soils such that stream base flows are maintained, peak flows are sufficiently reduced, and the saturation of downstream fields is minimized.

[4] Canadian Automobile Association, 2000. *Driving Costs –2000 Edition*. www.caa.ca

Water Quality: East Clayton's infiltration-based system is designed to both capture and filter runoff before it replenishes the aquifer or seeps into streams. Roadside infiltration trenches, on-site devices and retention basins will be designed to sequester silts and pollutants from first flush runoff and prevent them from entering streams or aquifers.

Once in place, the system will maintain current "pre-development" peak rates discharged into streams; maintain current "pre-development" annual total water volume discharged into streams; and protect existing dry season base flows. Overall, the negative impact on stream hydrology and morphology will be reduced by over 90% when compared to conventional infrastucture systems.

Figure 3: Annual rainfall potentially captured with East Clayton System



III. On-site Infrastructure Cost Reductions

Table 2 summarizes the anticipated infrastructure cost reductions resulting from more cost-effective land development and servicing standards as proposed by the East Clayton NCP. A 4.2 hectare portion of the proposed East Clayton NCP and a similarly-sized conventional suburban development in another part of Surrey are used as bases for comparison.

Just under half of the units in the East Clayton NCP are single-detached and the rest are duplexes or accessory apartments with average unit sizes of 1,661 sq. ft. The conventional plan has only single-detached units with an average unit size of 2,300 sq. ft. Given that the two plans actually have different unit types and sizes, we first calculate the total unit cost (land + building + infrastructure) in each plan based on average sized units (2,300 sq. ft. vs. 1,661 sq. ft.). To compare apples with apples, the cost (land + building + infrastructure) of equal sized structures of 2000 sq. ft. was compared in each plan.

The cost of land per average sized unit is over 60% less and the infrastructure cost savings are over 50% (amounting to savings of over $12,000 per unit) in the East Clayton NCP compared to the conventional plan. Comparing average sized units (which are comparatively smaller in the East Clayton pattern than in the conventional suburban pattern), the total cost savings per unit (land + building + infrastructure) for the East Clayton pattern amount to $99,000, or about a 40% savings.

The total development cost (land + building + infrastructure) per equal sized structure of 2000 sq. ft. is about $40,000 more in the conventional suburban development than in the East Clayton NCP, representing almost 20% savings for the NCP. The cost savings in the East Clayton pattern are due primarily to its increased density and more efficient road layout, which results in less pavement and utility runs per unit and parcel.

This comparison does not consider off-site infrasturucuture costs. However, costs for roads, storm drains, utility trunk lines, and sanitary systems would likely be reduced due to the compact development pattern proposed for the East Clayton NCP. Pressures on storm sewer trunks would also be reduced due to the alternative stormwater management practices.

Next STEPS - Beyond the NCP

Phase One of the Headwaters Project involved the development of the NCP. Phase Two, currently in its early stages, involves the implementation of an actual development on an 8-10 hectare site in the community. The pilot project is a crucial step in implementing the NCP, and in the Headwaters Project in general, because it would establish a clear precedent for future development in the community, and it would provide the model for instituting alternative development standards within the municipal policy framework within Surrey and other municipalities.

Table 2: Cost Comparison

		CONVENTIONAL SUBURBAN SITE	EAST CLAYTON SITE
Site Area	hectares	4.27	4.23
	acres	10.50	10.45
Total Parcels		41	74
Total Dwelling Units [1]		41	111
Parking	stalls per unit	2	2
	total stalls	82	222
Gross Density	d.u./ha.	9.60	26.24
	d.u./acre	3.90	10.62
Lot Coverage	net (lots only)	0.40	0.45
Floor Area Ratio [2]	net (lots only)	0.30	0.55
	gross (lots & ROWs)	0.20	0.38
Average Unit Size [3]	sq.m.	214.00	155.00
	s.f.	2300.00	1661.00
Average Utility Run	m./d.u.	13.80	8.50
	f./d.u.	45.30	27.88
Pavement	sq.m./d.u.	229.00	83.45
	s.f./d.u.	2463.70	897.09
Site Permeability (%) [4]		50.00	49.65
LAND COST [5]			
per unit [6]		$76,829	$28,243
per parcel [7]		$76,829	$42,365
BUILDING COST [8]			
per average sized unit (2300 sq. ft./1661 sq. ft.)		$138,000	$99,660
per equal sized structure 2,000 sq. ft.		$120,000	$120,000
INFRASTRUCTURE COST			
Roadworks		$218,894	$256,853
	Asphalt Paving	$24,553	$38,247
Storm Sewer		$205,820	n/a
Surface Drainage	Swale Pipe [9]	n/a	$99,945
Boulevard Landscaping		$30,000	$36,070
Water Mains		$113,705	$169,107
Water Tie-ins and Connections *		$18,177	$49,211
Sanitary Sewers		$135,255	$229,780
Sanitary Tie-ins and Connections *		$5,000	$13,536
Street Lighting		$44,000	$64,500
Lot Grading and/or Swales		$24,450	$24,221
Hydro/ Telephone installlation (buried services) *		$54,000	$146,196
Boulevard Tree Planting		$20,000	$24,052
Utilities *		$54,000	$89,859
Block interior pathways and emergency access		$12,500	n/a
Block interior pathways landscaping		$4,000	n/a
Total Infrastructure Cost	entire site	$964,354	$1,241,577
	per unit	$23,521	$11,185.38
	per parcel [10]	$23,521	$16,778
TOTAL COST OF AN AVERAGE SIZED UNIT (Land+Building+Infrastructure) [11]			
Average unit sizes (2300 sq. ft.vs. 1661 sq.ft)		$238,350	$139,089
TOTAL COST OF EQUAL SIZED STRUCTURE (Land+Building+Infrastructure) [12, 13]			
Equal sized structures of 2000 sq. ft.		$220,350	$179,143

1 The East Clayton site includes 111 units on 74 parcels: 47 single-family homes, 54 duplexes and 10 accessory apartments. Each unit represents a 'density unit' and, for the purpose of this Research Highlight, is serviced individually.

2 Includes 2 habitable floors.

3 Habitable space is on average 1661 s.f. per dwelling unit. This figure is based on an average single-family home size of 2266 s.f. (47 units), a strata unit size of 1200 s.f. (54 units) and an accessory apartment of 800 s.f. (10 units).

4 Site permeability refers to the percentage of each parcel that is covered with impervious surface (I.e., building, driveway, pathways).

5 Assumes $300,000 /acre for raw land.

6 Per unit land costs are calculated by multiplying bare land cost ($300,000/acre) by the total site area and dividing by total number of units

7 Per parcel land costs are calculated by multiplying bare land cost ($300,000/acre) by the total site area and dividing by total number of parcels.

8 Assumes $60.00/s.f. construction cost for building only. Note: These reflect building costs only for the single-family residential areas used for this study.

9 Assumes $150/linear metre pipe in stone infiltration system.

10 Per parcel infrastructure is calculated by taking the total infrastructure cost and dividing by number of parcels. In the case of East Clayton, a proportion of infrastructure costs, such as individual servicing hook-ups, are dependant upon the number of units. As there are 111 units in the East Clayton pattern, the total infrastructure costs are derived by multiplying those items marked with (*) by 111 units and adding all other infrastructure costs. To calculate the per parcel infrastructure costs, the total infrastructure cost is then divided by the number of parcels (74).

11 Does not include DCCs, developer profit, carrying costs, permit fees, realtor fees, etc.

Conclusions

This study shows how a combination of features, as proposed by the *East Clayton Neighbourhood Concept Plan*, can result in a number of environmental and economic benefits.

The study found that the high degree of land use integration, higher than average densities, an integrated street system and local employment opportunities proposed for the East Clayton community will contribute to significant reductions in GHG emissions from urban travel when compared to more conventional suburban development. Over the short term, these benefits result in a 35% per household reduction of GHG emissions and over the long term, if East Clayton's pattern is continued in surrounding soon-to-be-developed "greenfield" districts, a 40% per household reduction over the more conventional suburban development. East Clayton's integrated network of narrow streets, together with yard and street infiltration devices, will capture up to 90% of the rain that falls on the site, thereby maintaining stream hydrology and eliminating between 80% and 100% of all downstream consequences of development. This is the first large scale community in Canada to attempt meeting these stringent but sustainable hydrological performance objectives.

Finally, assuming equal sized structures of 2000 sq. ft. in each plan, the total land, building and infrastructure costs will be 20% cheaper in the East Clayton NCP than in the conventional suburban plan. Assuming average sized units in each plan (2,300 sq. ft. in the conventional plan vs. 1,661 sq. ft. in the NCP), the total land, building and infrastructure costs savings per unit will be about 40% in the East Clayton NCP.

Combined together, these benefits translate into a more environmentally friendly and affordable community alternative for Surrey residents. The pattern proposed for East Clayton has the potential to be an alternative blueprint for designing new communities throughout the Lower Mainland and in other British Columbian and North American municipalities.

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