TECHNICAL BULLETIN

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The Headwater's Project – The East Clayton Neighbourhood Concept Plan Environmental Benefits

I. Introduction

Measuring the benefits of alternative community design patterns has become an important means for understanding the influence of established land use and community design standards and practices on community and regional sustainability. In this study we provide an overview of the Headwaters Project, a demonstration of sustainable development principles and performance standards in the Lower Mainland community of East Clayton, and examine the Greenhouse Gas reductions and water quality benefits associated with its implementation.

II. Background

Headwaters Project - East Clayton Neighbourhood Concept Plan

The 250-hectare East Clayton site is located on the eastern border of Surrey, geographically the largest and one of the fastest growing municipalities in the Lower Mainland Region. The East Clayton Neighbourhood Concept Plan (NCP), the first phase of the Headwaters Project, was developed over a one-and one-half year period through an integrated and consultative design process and is intended to produce a more sustainable alternative to typical and increasingly problematic suburban development practices. The resulting NCP conforms to seven sustainable planning principles (see right column) that were approved in principle by Surrey City Council in1999. When implemented, the Plan will both protect the East Clayton environment while providing a variety of affordable dwelling types for a wide range of income earners. The draft East Clayton NCP was presented to the public in July 1999 and the Land-use Plan was approved by the Surrey City Council in November 1999.

III. Research Approach

Using the CMHC "Tool for Evaluating Neighbourhood Sustainability," we first compare the atmospheric impacts (Greenhouse Gas [GHG] emissions) of the community pattern proposed for East Clayton, with those produced by more typical suburban development. The model applies multivariate regression to a set of site design variables (including land use and housing mix , socio-economic makeup, and location factors) in order to examine how a single dependent variable (i.e., Vehicle Kilometres Travelled [VKT]/household) is affected by the values of one of more independent variables (i.e., land use mix). For the purposes of evaluating the longer-term GHG emissions consequent to the East Clayton pattern, we compare two scenarios, the first one for the year 2010, and a second one thirty years later, for the year 2040.

We then provide a description of the proposed ecological infrastructure system, outlining its anticipated benefits on local streams and hydrology.

The *East Clayton NCP* is guided by the following seven principles:

No. 1 *Increase density and conserve energy by designing compact walkable neighbourhoods. This will encourage pedestrian activities where basic services (e.g., schools, parks, transit, shops, etc.) are within a five- to six-minute walk of homes.*

No. 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.*

No. 3 *Communities are designed for people; therefore, all dwellings should present a friendly face to the street in order to promote social interaction.*

No. 4 *Ensure that car storage and services are handled at the rear of dwellings.*

No. 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.*

No. 6 *Provide narrow streets shaded by rows of trees in order to save costs and to provide a greener, friendlier environment.*

No. 7 *Preserve the natural environment and promote natural drainage systems (in which storm water is held on the surface and permitted to seep naturally into the ground).*

IV. Findings - Anticipated Benefits

Neighbourhood Attributes

The average overall density of East Clatyon will be approximately 25 units per hectare (between 9 and 10 units per acre). Eventually, a rapid bus will serve East Clayton, providing connections (at 7-8 minute intervals) to the larger municipality and region.

A high level of land use integration is proposed for East Clayton. Housing will consist of low, medium, medium-high and high density forms in detached, semi-detached, fee simple row housing and town housing, and apartments, with secondary suites and coach houses in low and medium density areas.

Transit, stores and services are within a 5-7 minute walk of all homes.

The community is organized around a fine grained interconnected system of streets and lanes. Bicycle routes and greenways are an integral component of this interconnected system.

Automobile Air Quality and Greenhouse Gas Mitigation Benefits

Table 8-1 shows the GHG performance of the East Clayton pattern compared to a hypothetical conventional suburban development of a similar size and location as the East Clayton example. As shown in Scenario 1, vehicle kilometers traveled per household (VKT/hh) and per capita production of GHG will be reduced in the short term by a minimum of 31% - from 9100 kg CO_2 equivalent to 6300 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 47% reduction - from 8600 kg CO_2 equivalent to 4600 kg CO_2 equivalent of GHG emissions, over the suburban-type development (see Table 8-2). These combined reductions are attributable primarily to a more efficient use of land (through higher average densities, greater land use mix, and local work opportunities), and an interconnected street system that will encourage walking and cycling while reducing dependence on overtaxed arterial streets.

Table 8-1

Air Quality Comparison	Scenario 1 2010		Scenario 2 2040	
Neighbourhood Attributes	**East Clayton**	**Suburban Type[1]**	**East Clayton**	**Suburban Type[1]**
Urban Context	inner suburb [2]	inner suburb [2]	inner area [3]	inner area [3]
Land Area	250 ha	250 ha	250 ha	250 ha
Road Layout Type	primarily grid	random curvilinear	primarily grid	random curvilinear
Total length of non-expressway roads	26km	20km	26km	20km
Total number of intersections	112	60	112	60
Total length of wide arterials (4 lane)	2.5km	5	2.5km	5
Daily Bus Vehicle Service Hours	14.6	5	16.2	14.6
Total Length of bike routes	7km	0	7km	0
Socio-Demographic Data	**East Clayton**	**Suburban-type**	**East Clayton**	**Suburban-type**
Total number of residential units	4928	2250	4928	2250
Total Residential Density (units/ha)	20	9	20	9
Housing Mix (1=total mix; 0=no mix)	0.74	0	0.74	0
Number of grocery stores (1-km radius)	8	0	8	0
Number of jobs (1-km radius)	4464	0	4464	0
Number of jobs (5-km radius)	40000	40000	120000	120000
Locational Characteristics	**East Clayton**	**Suburban-type**	**East Clayton**	**Suburban-type**
Distance to CBD	12km	12km	3km	3km
No.of Jobs (5-km radius)				
Distance to nearest rapid transit station (rapid bus)	1km	1km	1km	1km
Distance to nearest commuter rail (SkyTrain)	8.7 km	8.7km	3km	3km
NEIGHBOURHOOD PERFORMANCE COMPARED				
Weekday Household Travel Behaviour	**East Clayton**	**Suburban-type**	**East Clayton**	**Suburban-type**
Average Vehicles Owned/Household	1.17	1.65	1.13	1.6
Average VKT generated/household:	51.6	78.8	38	72.8
Average PKT generated/household:	16.2	19.7	13	19.8
Annual Household Vehicle Emissions	**East Clayton**	**Suburban-type**	**East Clayton**	**Suburban-type**
Auto	5900	9000	4400	8300
Transit	220	270	180	270
Total Household Vehicle Emissions	**6120**	**9270**	**4580**	**8570**

Notes:

1. The term "suburban-type", as defined by the tool, refers to development with characteristics typical of modern suburban developments (including low net densities, curvilinear street patterns with cul-de-sacs extending out to wide arterials). All neighbourhood characteristics relating to "suburban-type" development have been derrived from the tool and applied to an area of a similar size as East Clayton.

2. "Inner suburbs" are defined by the model as communities that are located between 5 km and 10 km away from the CBD, which for the purposes of this study is considered the Surrey Centre, located approximately 12 km away from East Clayton. This distance also corresponds to the average distance to work for residents in this area.

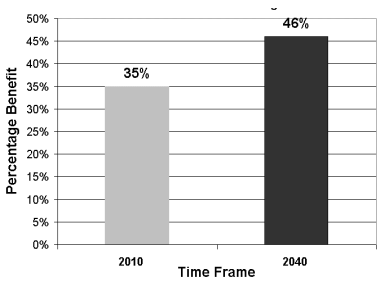
3. "Inner areas" are defined by the model as communities located between 0 and 5 km away from a CBD. Assuming that East Clayton's more concentrated development pattern is repeated in adjacent areas over the next 30 years, and a corresponding increase in regional services and jobs, the neighbourhood classification was changed from "inner suburban" to "inner area", with the CBD now being considered the municipality of Langley, just under 3 km to the east.

Air Quality Comparison

Table 8-1 - Scenario 1 shows East Clayton as envisioned in the year 2010, with a sustainable density of approximately 20 units per hectare, integrated land uses, and connected by frequent local rapid bus service to the regional SkyTrain rapid transit system, located 8.7km 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.

Long Term Benefit

Table 8-2 - The long term air quality benefit (GHG emissions) of the proposed East Clayton pattern over conventional suburban-type pattern would be at least 45% if the East Clayton pattern of development were replicated over a 30 year time frame.



Water Quality and Environmental Protection

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

Water Quantity

Rainfall data for the Surrey areas show that the majority of rain that falls is from frequent, but small storm events (i.e., those smaller than 25 mm). Table 8-3 illustrates the amount of rainfall that will be captured by the proposed infiltration system. Designed to absorb 25 mm (1 inch) of rainfall per day (including the first 25mm of larger storm events), East Clayton's infiltration system will capture and infiltrate almost 90% of total annual rain that falls on the site (see Table 8-4). This level of infiltration is necessary in order to maintain the hydrological cycle of the soils such that stream baseflows are maintained, peak flows are sufficiently reduced, and the over-saturation of downstream farm fields is minimized.

Water Quality

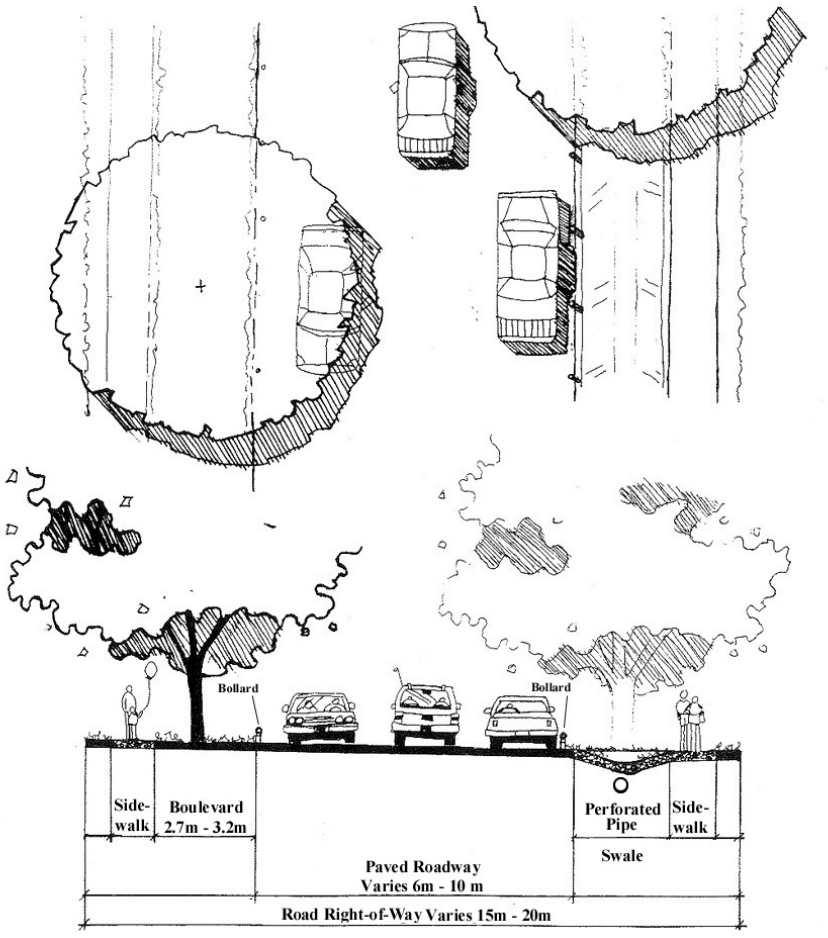
East Clayton's infiltration-based system is designed to both capture and filter runoff before it replenishes the aquifer. Roadside infiltration trenches, on-site devices and retention basins will be designed to sequester silts and pollutants from first flush runoff and prevent them from entering streams (Figure 8-1).

Once in place, the system will maintain current "pre-development" peak rates discharged to streams; maintain current "pre-development" annual total water volume discharged into streams; and protect existing base flows in receiving streams. Overall, the reduction in impact on streams and their associated habitat when compared to conventional subdivisions is anticipated to be between 90% and 100%.

Ecological Infrastructure

The NCP's ecological infrastructure systems will allow natural infiltration to occur, thereby maintaining the hydrologic cycle in the watershed. This will ensure consistent stream flow of the site's streams and avoid detrimental downstream flooding of existing waterways and lower agricultural lands.

Figure 8-1 - Local Road Standard



Storm Event Characteristics

Table 8-3 - As shown, the majority of rain falling on the site is from relatively small storms (i.e., accumulating less than 1 inch).

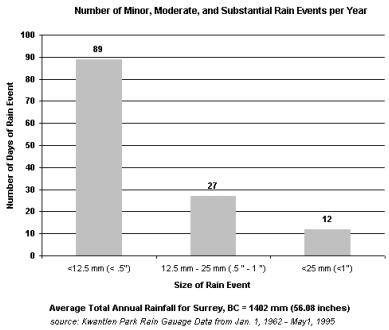
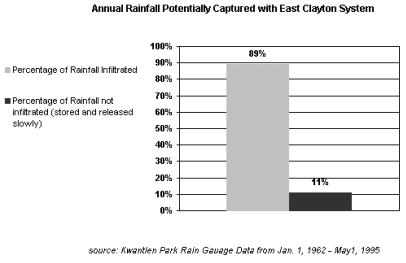


Table 8-4 - With a capacity of infiltrating approximately 24mm (1 inch) per day, the East Clayton system will absorb almost 90% of all rain that falls on the site.



V. Conclusions

This study shows how a combination of efficiencies, as proposed by the East Clayton Neighbourhood Concept Plan, can result in a number of air and water quality benefits.

Using the CMHC-sponsored "Tool for Evaluating Neighbourhood Sustainability", the study found that the high degree of land use integration, higher than average densities, integrated street system, and local employment opportunities proposed for the East Clayton community will contribute to significant reductions in GHG emissions when compared to more conventional suburban development. Over the short term, these benefits manifest in a 35% reduction of GHG emissions over more conventional suburban development. Over the long term, if East Clayton's pattern is continued in adjacent districts, these benefits could translate into a 45% per capita reduction of GHG emissions over more conventional suburban development. East Clayton's integrated network of narrow streets, together with yard and street infiltration devices, will facilitate an infiltration-based stormwater system. This system will capture up to 90% of all 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.

When taken together, these projected benefits provide strong evidence that East Clayton will be a more environmentally sustainable and socially equitable community alternative for future Surrey residents. (For additional analysis of the economic benefits associated with such a pattern, please see Technical Bulletin No. 2.) When ultimately translated into regulatory bylaws and development standards, 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 Canadian municipalities.

The *East Clayton Neighbourhood Concept Plan*, the first phase of the Headwaters Project, is a partnership between the City of Surrey, the UBC James Taylor Chair in Landscape and Liveable Environments, Pacific Resources Centre and a host of government and related organizations. Its purpose is to provide a replicable model of how to develop more sustainable communities throughout British Columbia's Lower Mainland Region and, potenitally, beyond.

Notes:

[1] For a more thorough explanation of the "Tool for Evaluating Neighbourhood Sustainability", please see CMHC Socio-Economic Series Research Highlight, Issue 50 – Revision. (http://www.cmhc-schl.gc.ca/rd-dr/en/index.html)

[2] Constituencies 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 A.C.T. Program (Federation of Canadian Municipalities), 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.

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