People Don’t Use Water… Residential Units Do!

Re-Thinking How We Assess System Use

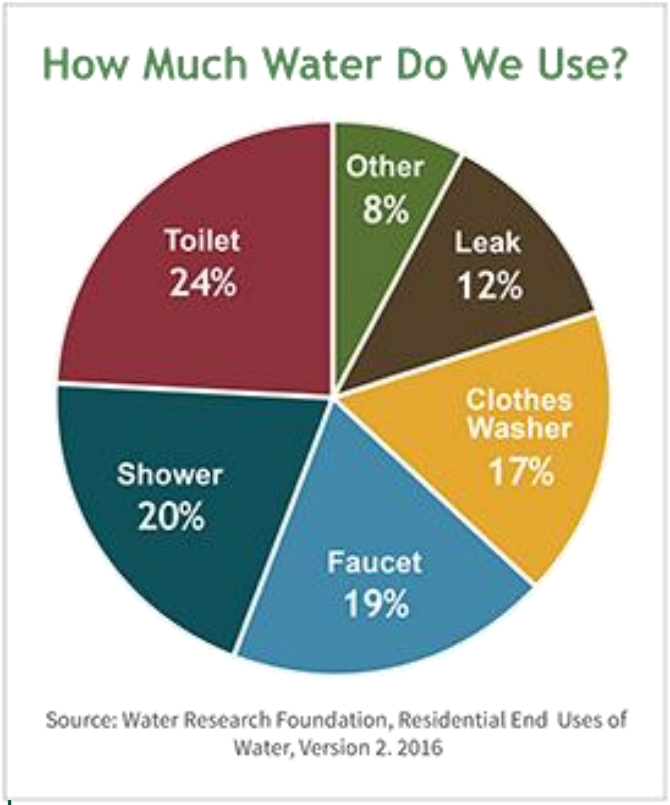
Kevin Brown, P.Eng, ing. | Robinson Consultants Inc [Vaughan, ON]

November 12, 2025

Introduction

- Over 25 years in Consulting
- Infrastructure Planning and Hydraulic Modelling
- Not trying to change the world. Nor how municipalities do things.
- Want to create a ***discussion***. We can start with 5 minutes at the end of my presentation.

Sorry for the False Advertising…



- Of course, People DO Use Water
- Residential Water Use:
  - Bathrooms: 50%
  - Kitchens: 15-20%
  - Clothes Washer: 17%
  - Leaks/Other: 15-20%
- But there are *practical limits* on the amount of household water use
- "System Use" (hydraulic capacity) versus "Plant Use" (daily capacity)

People Don't Use Water... Residential Units Do!

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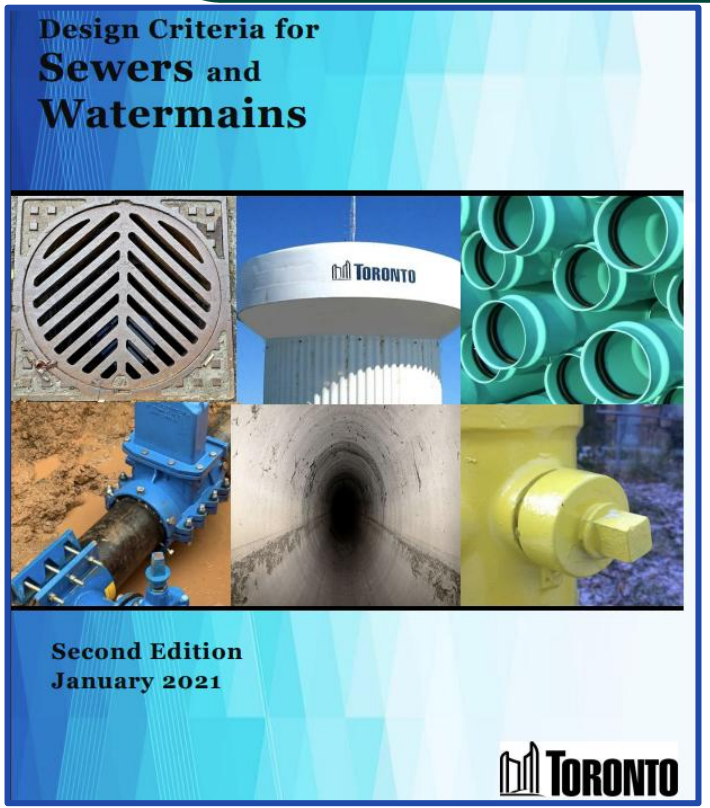
How Many Cows in the Field?

- Everyone knows that cows have FOUR legs
- To determine how many cows there are in this field, just count the legs, and divide by four.

$$N_{cows} = \frac{N_{legs}}{4}$$

Design Criteria – Toronto



Population Equivalents Based on Type of Housing

When the number and type of housing units within a proposed development is known, calculating the population for the proposed development will be based on the following:

Table 4: Persons per unit

If type of housing is …	Then persons per unit is …
single family dwelling	3.5
semi-detached	2.7
townhouse	2.7
duplex	2.3
triplex	3.7
apartments or condominium:	
bachelor	1.4
1 bedroom	1.4
2 bedroom	2.1
3 bedroom	3.1
4 bedroom	3.7

Average wastewater flows for new local sewers	
average wastewater flow	450 litres/capita/day

Design Criteria – London

London
CANADA

Design Specifications & Requirements Manual

Corporation of the City of London
P.O. Box 5035
300 Dufferin Avenue
London, ON N6A 4L9

October 2003

Updated: August 2019

For design purposes, the following densities shall be used:

Type Of Use	People / Unit
Low density residential	3 people per unit
Medium density residential	2.4 people per unit
High density residential	1.6 people per unit

Total Water Demands

Gross water consumption rate recorded for the City is 470 to 600 L/d (121 IGPD to 132 IGPD) average per capita.

Domestic Water Demands

Average day domestic (residential) unit demand for design shall be 255 litres per capita per day.

Design Criteria – Chatham-Kent

Chatham-Kent
Public Utilities Commission

WATERMAIN AND SANITARY DESIGN MANUAL

June 2023 (Version 2.0)

C.1.3.2 Residential Wastewater Flows

The average dry weather flow (ADWF) shall be calculated using the following formula:

ADWF = # of Dwelling Units x # of People per Unit x Average Daily Domestic Flow

People Per Unit Values:

Single Family Housing	3.0 ppu
Semi-Detached Housing	2.7 ppu
Row Housing	2.1 ppu

Average Daily Domestic Flow, q = 340 L/cap/day.

Design Criteria – Ottawa

Ottawa

CITY OF OTTAWA

Sewer Design Guidelines

Second Edition, October 2012

SDG002

Table 4.2 Per Unit Populations

Unit Type	Persons Per Unit
Single Family	3.4
Semi-detached	2.7
Duplex	2.3
Townhouse (row)	2.7
Apartments:	
Bachelor	1.4
1 Bedroom	1.4
2 Bedroom	2.1
3 Bedroom	3.1
Average Apt.	1.8

Figure 4.3 Peak Flow Des

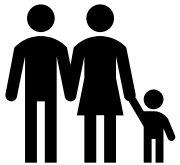
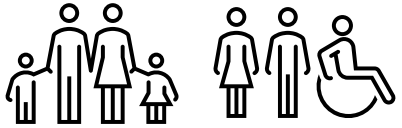
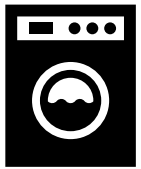
AVERAGE WASTEWATER FLOWS:

Residential Average Flow:	350 L/c/day
Commercial Average Flow:	50,000 L/gross ha/d
Institutional Average Flow:	50,000 L/gross ha/d
Average Light Industrial Flow:	35,000 L/gross ha/d
Average Heavy Industrial Flow	55,000 L/gross ha/d

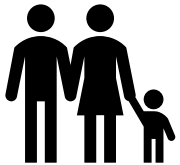
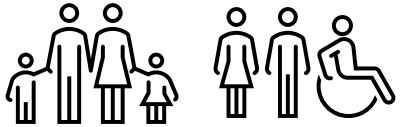
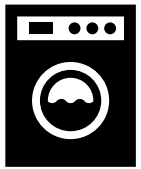
What Are Our Objectives?

System Understanding	Make sure that we understand how systems are performing
System Analysis	Identify where the systems aren't performing as expected (ie: degradation, over-use, other)
System Planning	Make sure that there is enough capacity for future need
Fiscal Responsibility	Make smart decisions, because we aren't spending OUR money

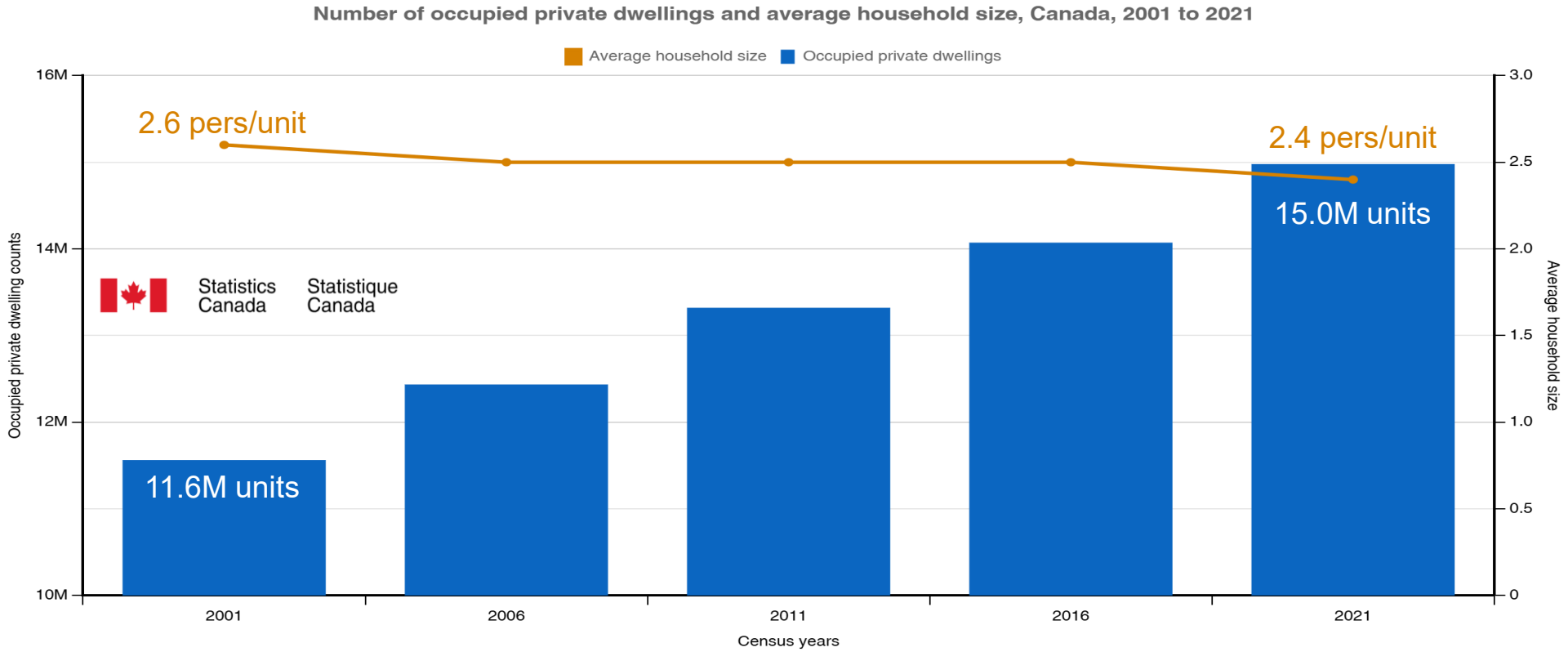
Plant Use by Household

		
	3 showers/day	7 showers/day
	1 load of laundry/day	2 loads of laundry/day
	3 meals/day	3 meals/day(+)

System Use by Household

		
	1 shower at a time	2 showers at a time
	1 load of laundry at a time	1 load of laundry at a time
	1 meal being prepared at a time	1 meal being prepared at a time

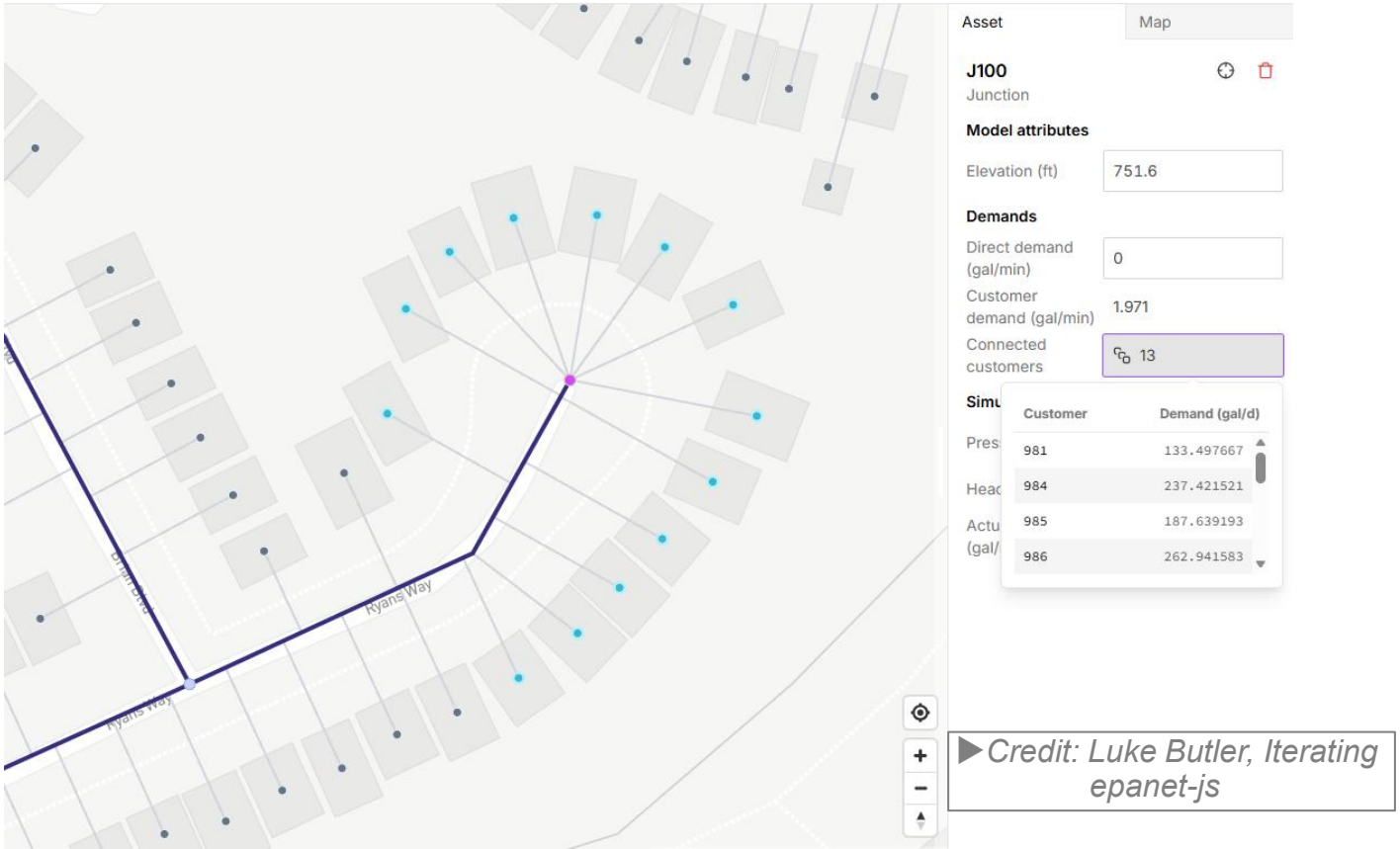
Household Size Trend (Canada)



What This Tells Us

Residential units ARE a good indicator of system and plant use.

We Have Household Usage Data



▶ *Credit: Luke Butler, Iterating epanet-js*

Potential Unit-Based Approach

	TORONTO			
	ppu	Lpcd	LpUd	SF Equiv
Single-Family	3.5	450	1,575	1.00
Semi-Detached	2.7	450	1,215	0.77
Townhouse	2.7	450	1,215	0.77
Apartment (1 bdrm)	1.4	450	630	0.40
Apartment (2 bdrm)	2.1	450	945	0.60
Apartment (3 bdrm)	3.1	450	1,395	0.89
Apartment (average)	2.2	450	990	0.63

	LONDON			
	ppu	Lpcd	LpUd	SF Equiv
Low-Density	3	255	765	1.00
Medium Density	2.4	255	612	0.80
High Density	2.1	255	536	0.70

	CHATHAM-KENT			
	ppu	Lpcd	LpUd	SF Equiv
Single-Family	3	340	1,020	1.00
Semi-Detached	2.7	340	918	0.90
Row Housing	2.1	340	714	0.70

	OTTAWA			
	ppu	Lpcd	LpUd	SF Equiv
Single-Family	3.4	350	1,190	1.00
Semi-Detached	2.7	350	945	0.79
Duplex	2.3	350	805	0.68
Townhouse	2.7	350	945	0.79
Apartment (1 bdrm)	1.4	350	490	0.41
Apartment (2 bdrm)	2.1	350	735	0.62
Apartment (3 bdrm)	3.1	350	1,085	0.91
Apartment (average)	2.2	350	770	0.65

Potential Unit-Based Approach

	TORONTO	LONDON	CHATHAM-KENT	OTTAWA	AVERAGE
Single-Family	1,575 LpUd	765	1,020	1,190	
	1.00 SF_{eq}	1.00	1.00	1.00	**1.00**
Semi-Detached	1,215		918	945	
	0.77		0.90	0.79	**0.82**
Townhouse	1,215	612	714	945	
	0.77	0.80	0.70	0.79	**0.77**
2-Bdrm Condo/ Apartment	945	536		735	
	0.60	0.70		0.62	**0.64**

What About Peaking?

- Harmon factor is typically used by most Ontario municipalities
- **PF = 1 + 14/(4 + P**)

$$PF = 1 + \frac{14}{4 + \sqrt{\frac{P}{1000}}}$$

- Since **P** is the Population, we could accomplish the same thing by substituting P = 3*U

$$PF = 1 + \frac{14}{4 + \sqrt{\frac{3 * U}{1000}}}$$

Examples in Practice

- Treatment Plant Reserve Capacity
- Hydraulic Modelling - Calibration
- Planning Studies
- Additional Residential Units (Housing Accelerator Fund)

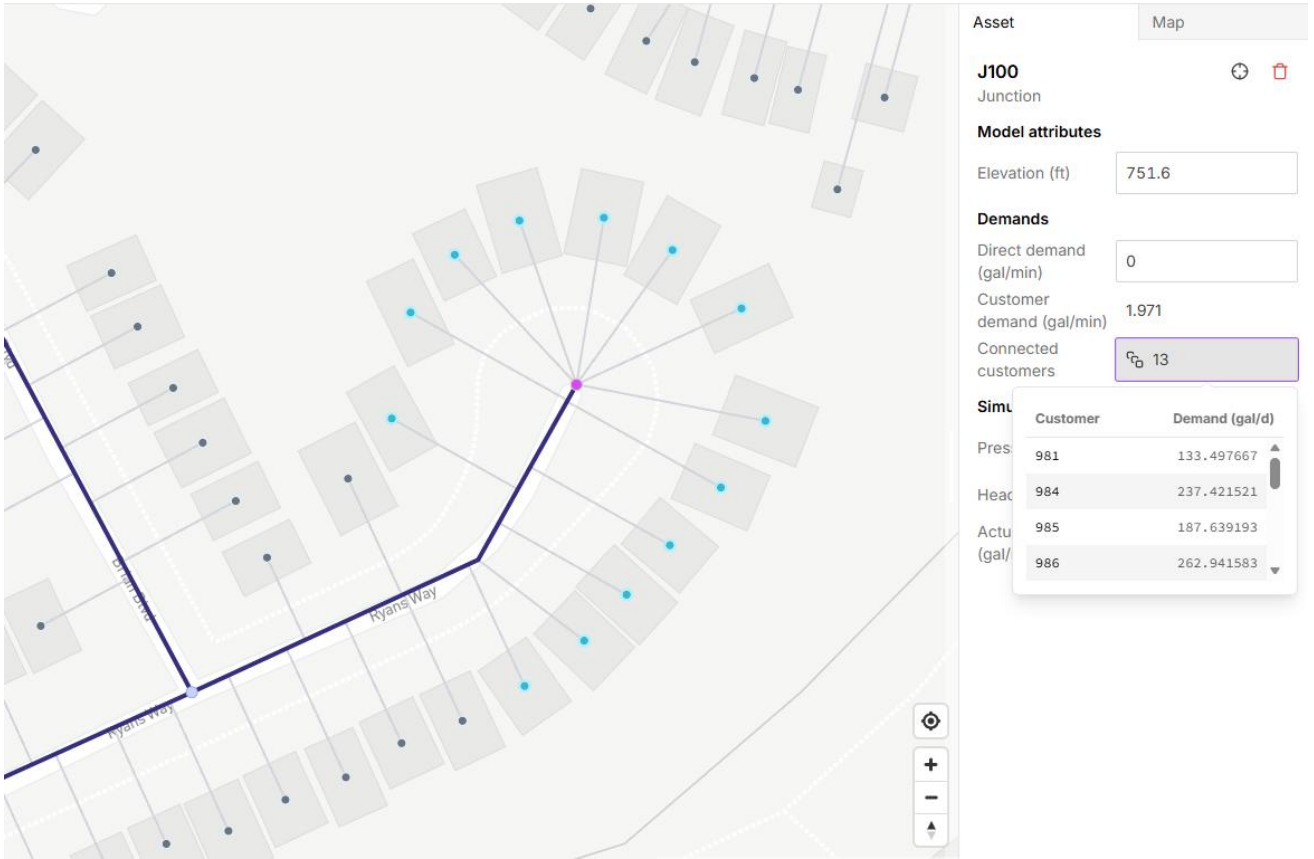
Treatment Plant Reserve Capacity

- Plants are often designed for a specific population projection
- As communities evolve, we often re-assess reserve capacity
- MOE Procedure D-5-1:
  - $C_u = C_r - ([L \times F \times P] \div H)$, where
    - L = Unconnected Approved Lots
    - F = Flow per Capita
    - P = Existing Serviced Population
    - H = Existing Households or Residential Connections
  - $\frac{L}{d} = \frac{L}{d} - \left(\left[Units \times \frac{L}{pers \cdot day} \times pers\right] \div Units\right)$
  - $\frac{L}{d} = \frac{L}{d} - \left(\left[Units \times \frac{L}{unit \cdot day}\right]\right)$

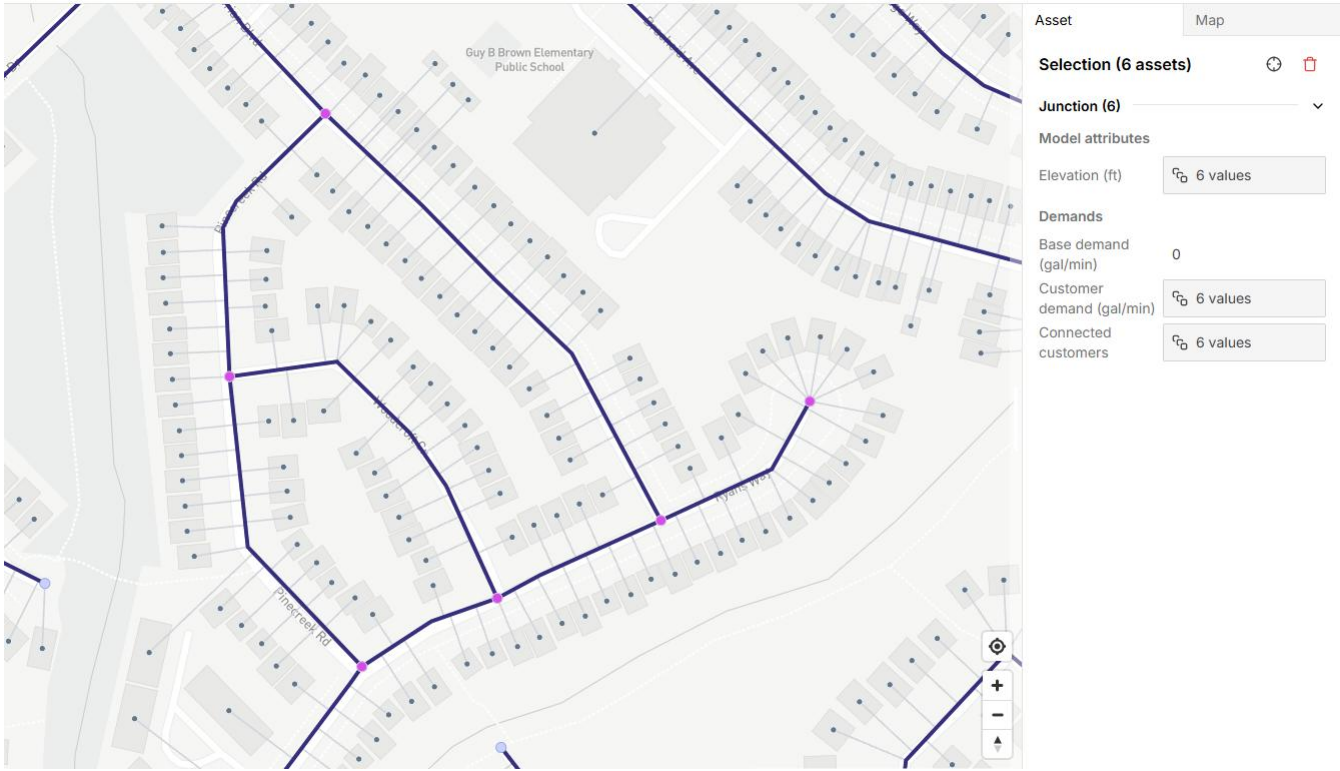
Hydraulic Modelling

- We used to have skeletonized models, and accounted for populations in a service area
- This was consistent with the “per capita” design criteria…
- Today, we can model individual lots, units and water meters
- So WHY NOT model based on units?

Hydraulic Modelling



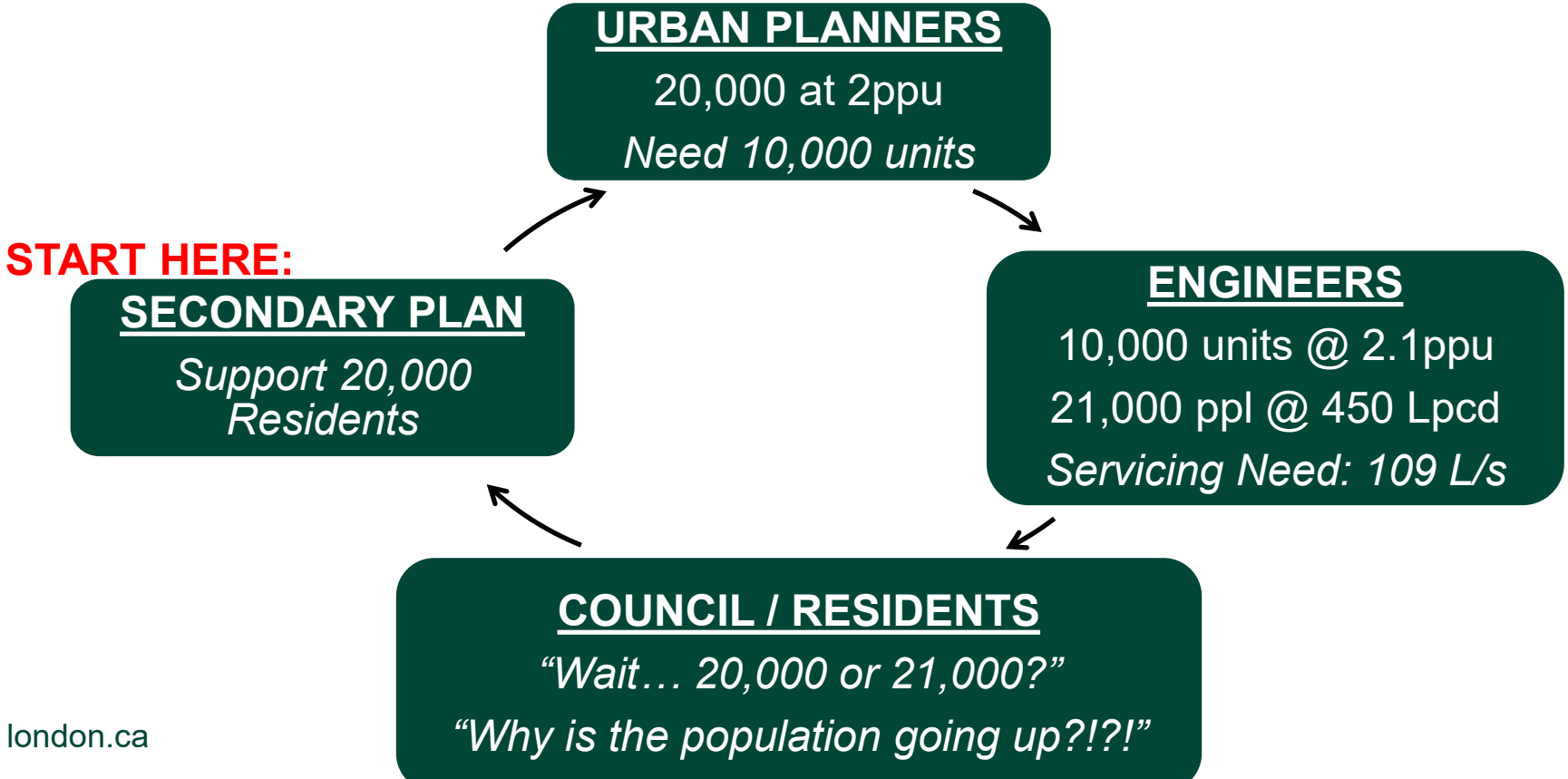
Hydraulic Modelling



Planning Studies

- Urban Planners often START with a target, as people+jobs
- The Planners will assess the Built Form required to accommodate this target.
- Then the Engineers get involved…

Planning Studies



Additional Residential Units (Housing Accelerator Fund)

- Background: New legislation permitting up to 3 (or 4) units per residential lot. As-of-right zoning.

- Challenge: Unlike Secondary Plans or Formal Rezoning, these units are hard to PLAN for.

- But they are easy to TRACK, using Building Permits

Additional Residential Units (Housing Accelerator Fund)

- How to account for ARUs?

▼ *Graphics Credit: City of Richmond Hill More Homes for More People*

Scenario	Units	People
Existing	1 Single Family	**3.5** Residents
Future (1)	1 Single Family 2 Apartments 3 Units Total	1 @ 3.5 = 3.5 2 @ 2.1 = 4.2 **7.7** Residents
Future (2)	2 Semi-Detached 1 Apartment	2 @ 2.7 = 5.4 1 @ 2.1 = 2.1 **7.5** Residents
Future (3)	3 Apartments	3 @ 2.1 = **6.3**

Questions?
Open Discussion?