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Customizing Your Waste Composition Study

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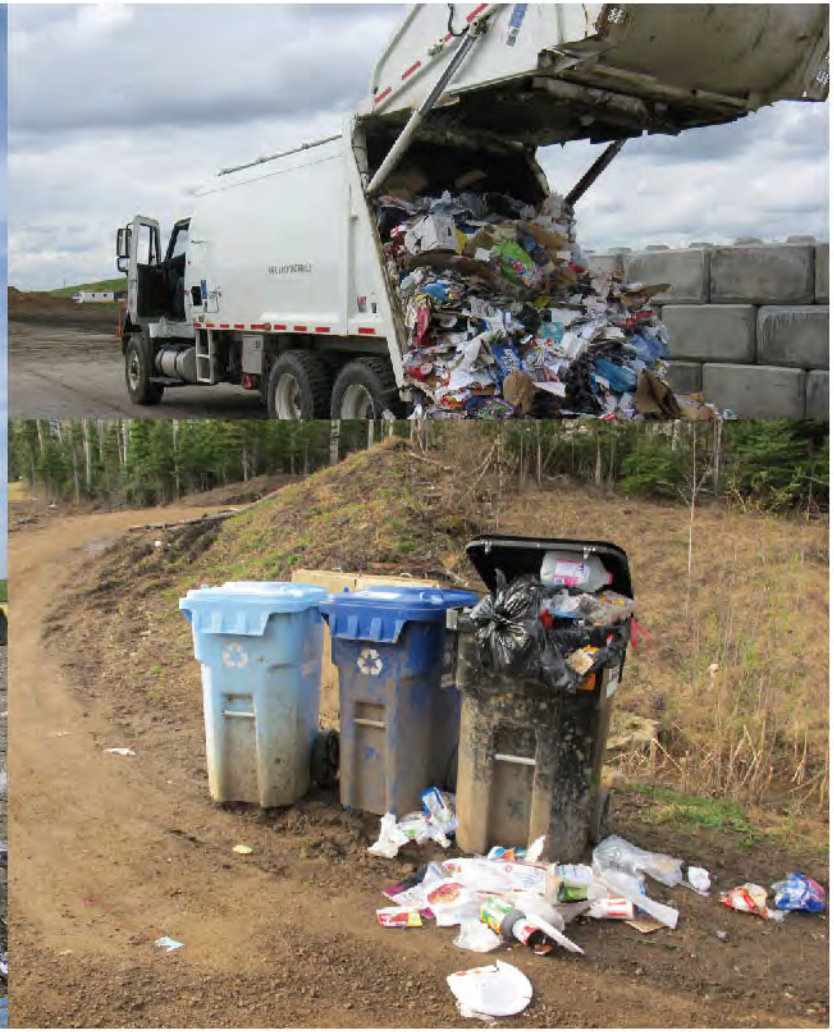
Presentation Outline

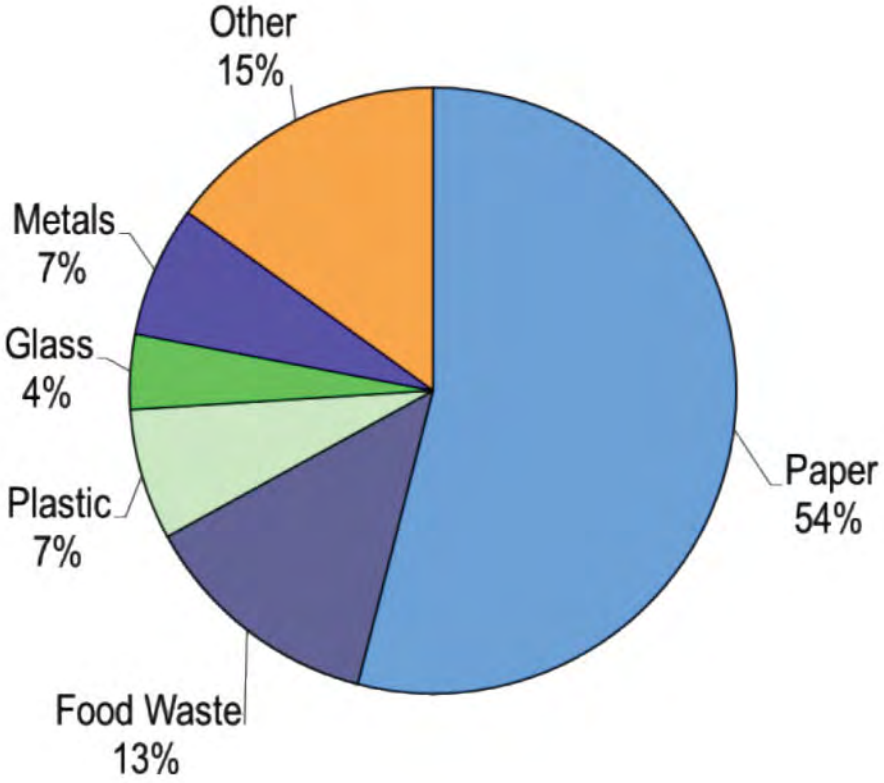
- 3 Commonly Used Terms & How They Are Slightly Different
- Further Defining Waste Composition
- Customizing Your Study - What You Need To Ask 1st, 2nd, and 3rd
- Waste Composition Study – Statistics
  - Definitions
  - Distribution
  - Randomness
  - # of Samples
- Example Scenarios Predicting Sample Sizes
- Cost Considerations
- Developing a Sampling Plan
- Alternatives to Physical Sorting

Collection



Sampling

Sorting, Weighing, Compiling & Stats



3 Commonly Used Terms & How They Are Slightly Different

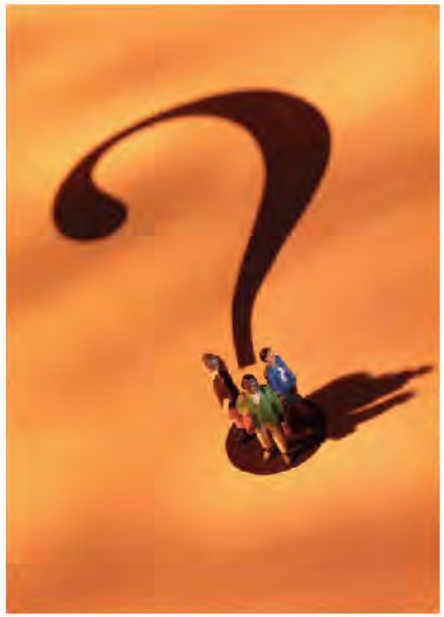
- **Waste Composition**
  - Average mixture of materials
  - Measured - generator or waste facility
- **Waste Characterization**
  - Waste Generation – per capita….plus
  - Waste Composition
- **Waste Audit (Often Stewardship) – implies evaluation:**
  - Typically at generator (setout / participation rates)
  - Assess opportunities to improve recovery

Waste Composition Study Further Defined

- **Separate predetermined quantity of waste from the mixed or composite waste, manual sorting of waste components for predefined categories and sub-categories**
- **Can be done at:**
  - Source (household, curbside, common collection container)
  - Collection and transport vehicles
  - Transfer Station
  - Landfill
  - MRF
  - WTE Facility

Customizing Your Study - What You Need To Ask First

1. **Why Are You Undertaking A Waste Comp Study?**
   - Establish a baseline – mass by category
   - Evaluate impact on recycling through a system change
   - Evaluate behavior - participation rates
   - Determine chemical / physical properties
     - moisture contents
     - combustion characteristic
     - organic content
   - Facility design (processing & disposal)



Customizing Your Study - What You Need To Ask Second

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2. What sectors, streams and categories?

- Residential, ICI, C&D, Hazardous Waste
- Recyclables, Organics, Garbage
- Newsprint, Organics, Metals, Plastics……

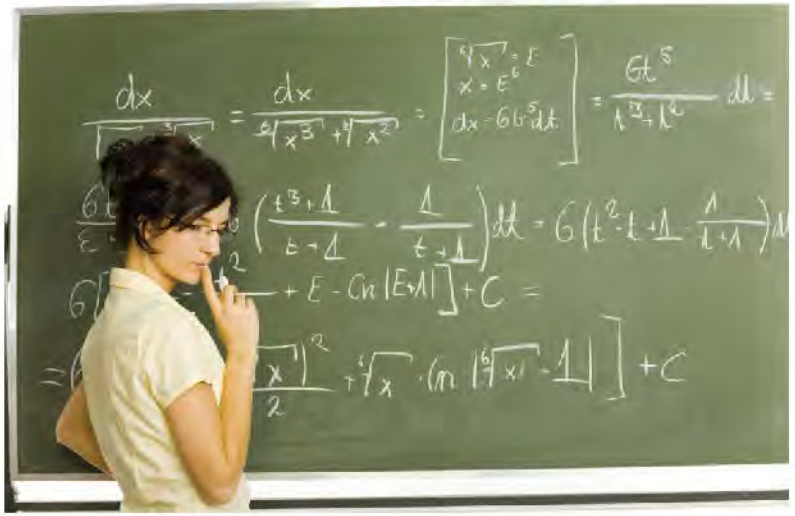
Customizing Your Study - What You Need To Ask Third

3. ***How important is the information / how am I using it?***

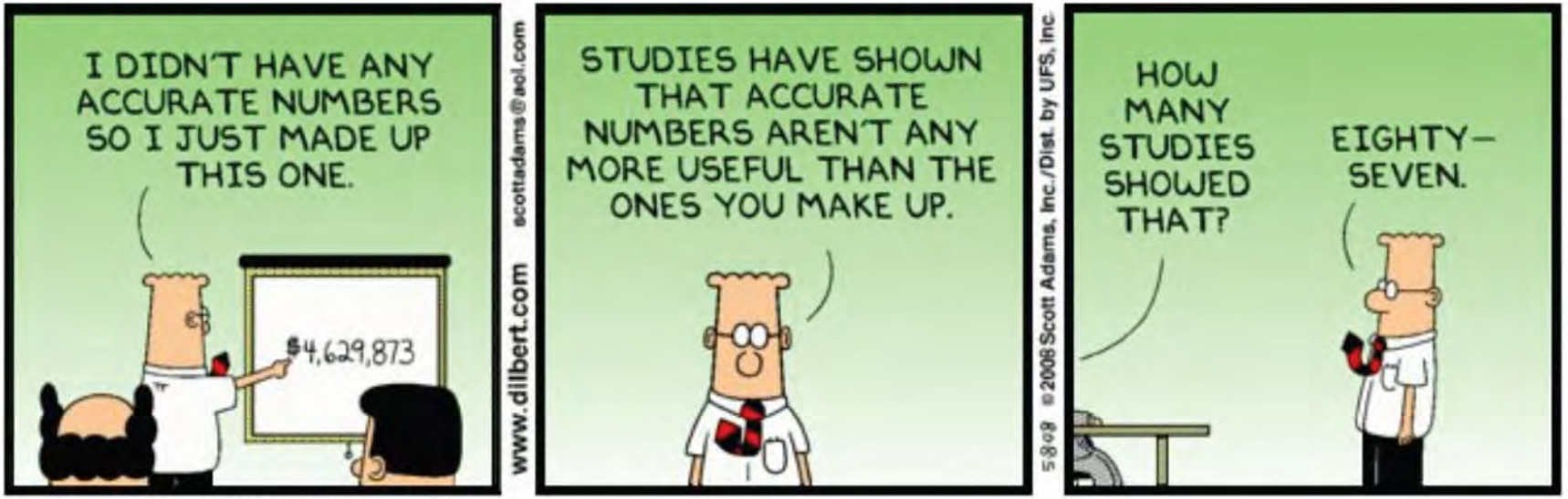
   - Screening Level Work or Detailed Engineering Design (sensitivity)
   - "Statistically Representative" – Always requested almost never defined by clients
   - Confidence Level and Interval
   - Funds Available vs. Diminishing Returns

Considerations Related To The 3 Questions

- **Considerations When Answering Previous Questions**
  - Temporal (Seasonal) Variation
  - Spatial (Socioeconomic) Variation
  - Economy
  - Generator or Processor
  - Budget
  - Safety Constraints
  - Physical Constraints (too big to measure and weigh)
  - Collection Schedules



Waste Composition – Why Statistics ?



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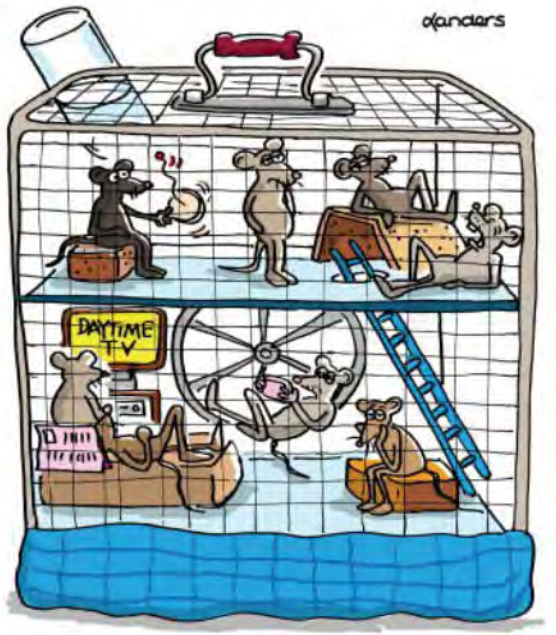
Determining Sample Size

- **"The number of sampling units which are to be included in the sample."** (OECD 2013)
- **Main guiding principle for determining sample size is "Statistically Representative"**
  - Cannot sample entire population
  - Use standard program sampling procedure: CCME, Provincial Framework, Stewardship Ontario



Without Statistics lab mice would have nothing to do.

Waste Composition Study- Sample Size ..

- **ASTM (2008) requires:**
  - Mean (Previous Study)
  - Standard Deviation (Previous Study)
  - Desired Confidence Interval
  - Expected Confidence Level

$$n = (t / \quad s/e \quad x \quad)/2$$

Components	Mean	Standard Deviation
Newsprint	0.1	0.07
Corrugated	0.14	0.06
Plastic	0.09	0.03
Yard	0.04	0.14
Food	0.1	0.03
Wood	0.06	0.06
Other Organics	0.05	0.06
Ferrous	0.05	0.03
Aluminum	0.01	0.004
Glass	0.08	0.05
Other organics	0.06	0.03

Waste Composition Study- Statistics

- **Some concessions???**
  - How much higher or lower than the population mean you are willing to let your sample mean be?

    CONFIDENCE INTERVAL

  - How confident do you want the sample mean to fall within the pre-specified interval?

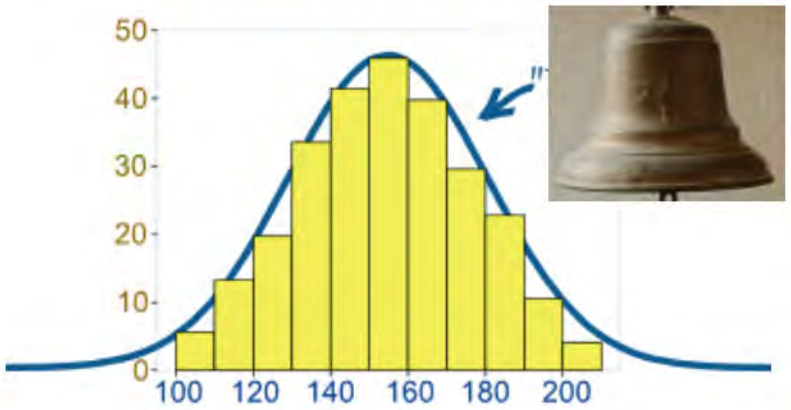
    CONFIDENCE LEVEL
    80%, 85%, 90%, 95%, 99%

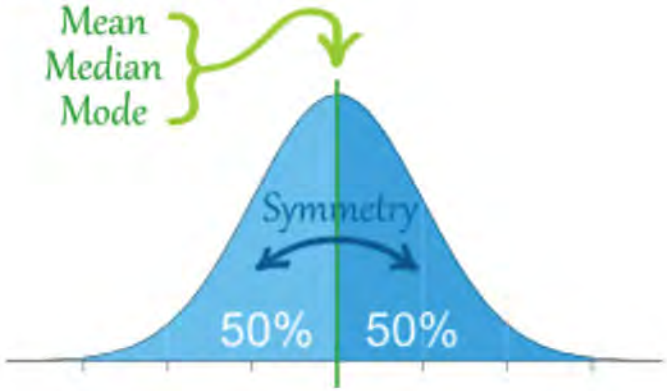
  - How much variance do you expect in your data analysis?

    STANDARD DEVIATION

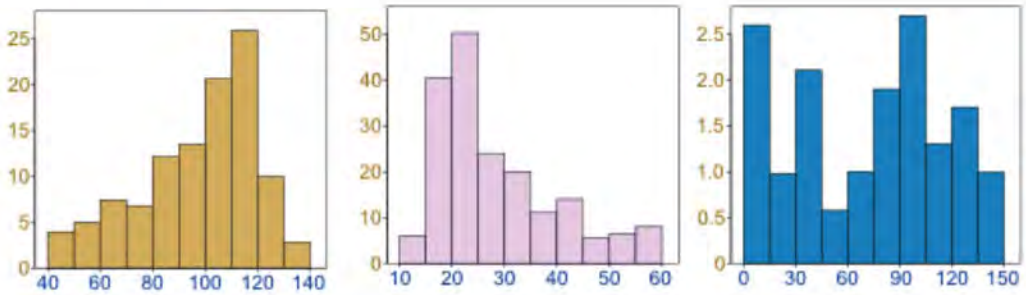
Waste Composition Study- Distribution

- The population is normally distributed





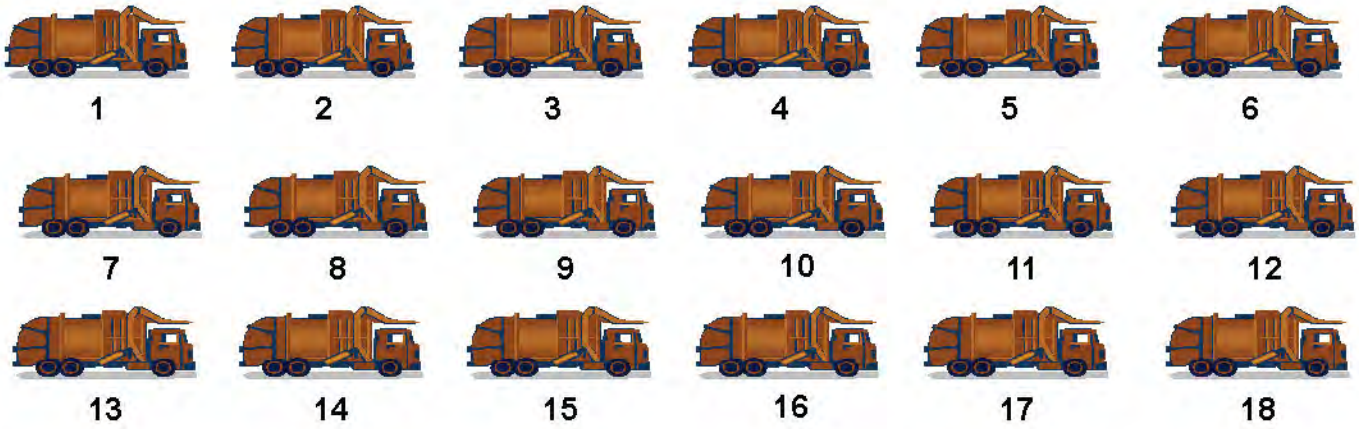
- Samples



Objective: Population Mean ~ Sample Mean

Waste Composition Study- Randomness

Randomness Example – Collection Truck



All 18 trucks have equal chance of being selected

- Use Microsoft Excel's RAND() function
- Develop an automation tool (EBA has it!)

Sample #
5
2
8
12
6
9

Scenario Sample Sizes - What are you using the data for?

Promotion and Education	Performance Optimization	Detailed Facility Design
Lower confidence level required	Typical confidence level required (about 90%)	Accuracy is critical – high confidence level required
Smaller community/ municipality	Materials Recovery Facility (MRF)	Large municipality with baselines established
Goal is to get diversion rates, or garbage reduction, develop a general baseline	Help determine bottom line returns and assess if a change in process is needed	Designing a organics processing facility or determining if WTE is appropriate for waste stream

Scenario 1 – Reporting to Council

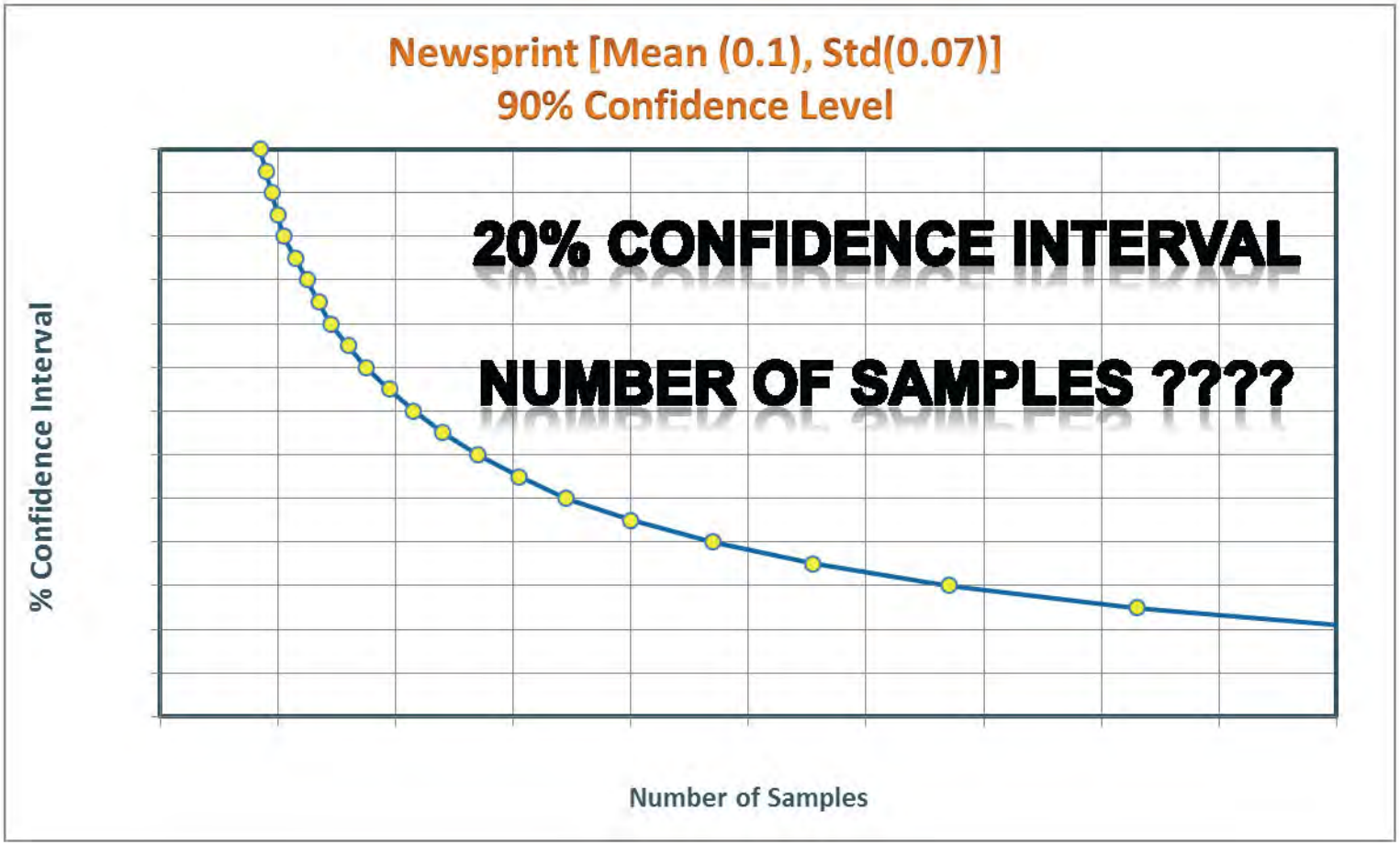
- Smaller municipality - Immature waste diversion programs
- Interested in residential waste diversion opportunities
- Baseline to report to member communities of commission

Scenario 1 Details

- **Diversion opportunities:**
  - What can be diverted?
    - Metal
    - Wood
    - Paper, OCC
    - Plastic
    - Organics

- **Desired Confidence Level & Interval**
  - 90% ± 20%

Scenario 1 – Samples

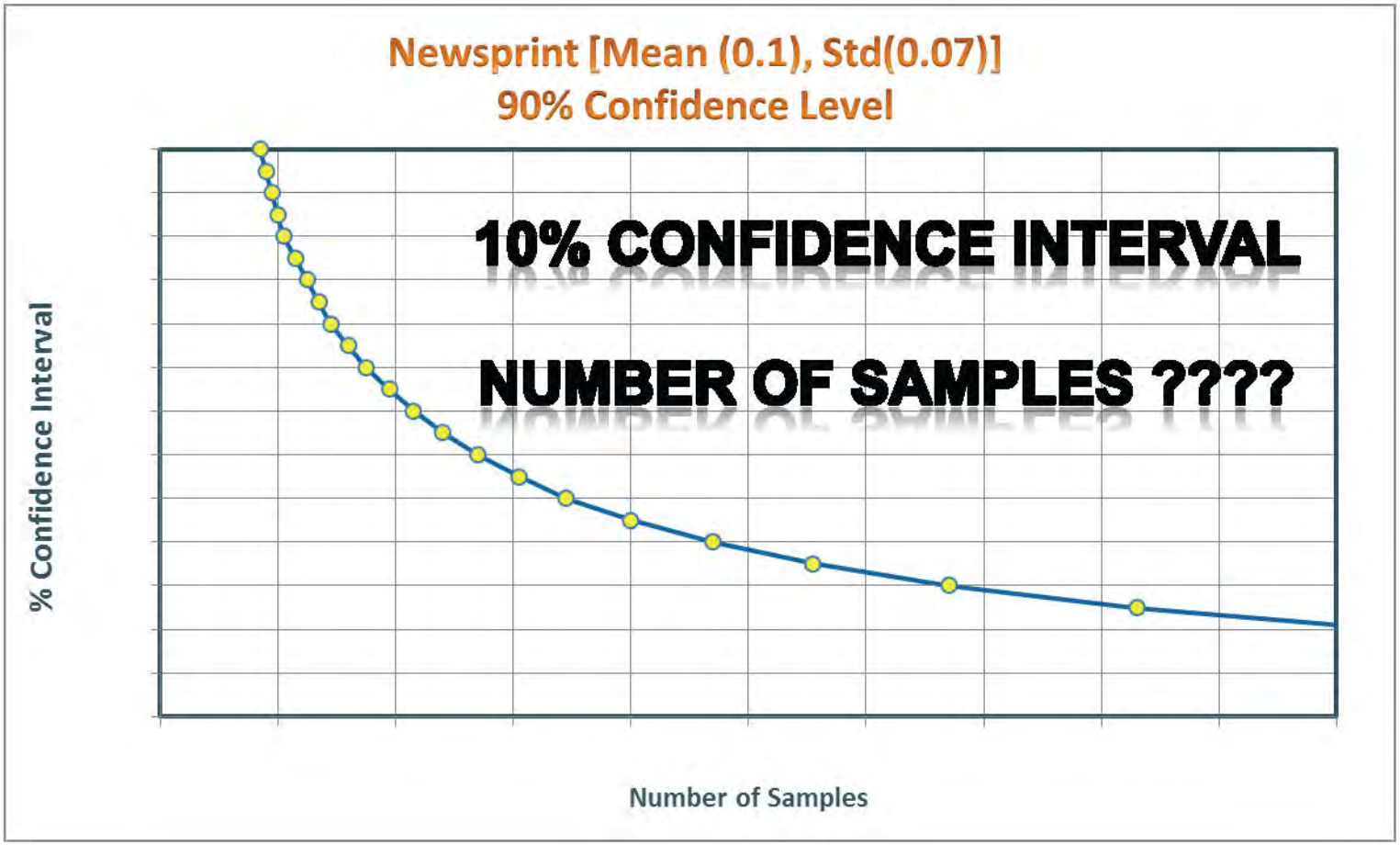


Scenario 2 – Performance Optimization

- MRF Improvements Up to $10 million in equipment upgrades and/or labour enhancements
- Consider spending ~ larger % of budget on research and composition study
- Desired Confidence Level 90%
- Confidence Interval ± 10%

Scenario 2 - Samples

> 130 Samples

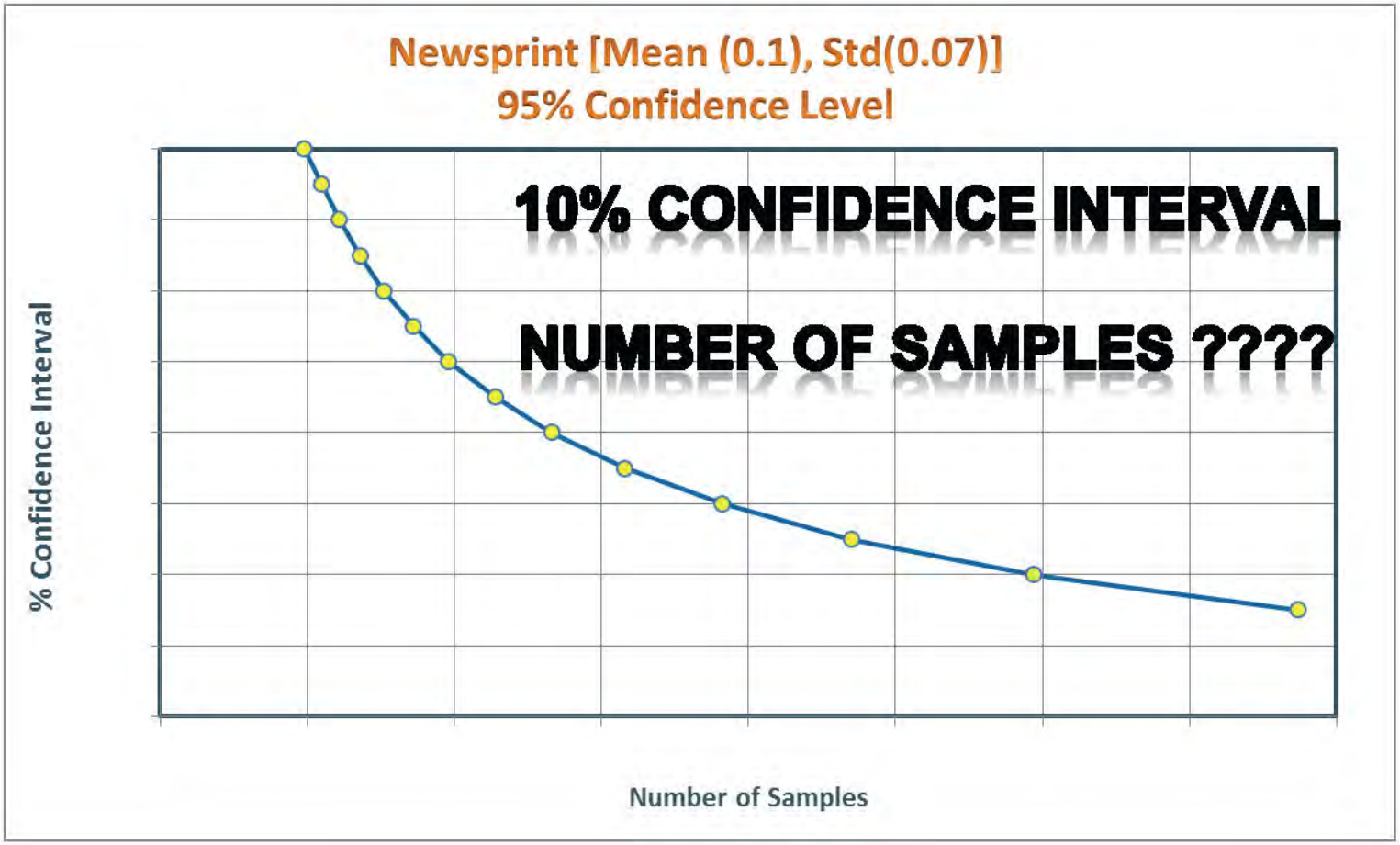


Scenario 3 – Detailed Facility Design

- Large processing facility design and construction
- Processing system sensitive to feedstock
- Large capital costs
  - > $50 million
- Desired Confidence Interval 95%
- Confidence Level ± 10%
- Examples:
  - Waste-to-energy (WTE) Facility
  - In-vessel Composting Facility
  - Anaerobic Digestion Facility

Scenario 3 – Samples

> 180 Samples



of Samples Required by Case/Components

Component	Case 1 – Promotion and Education	Case 2 – Performance Optimization	Case 3 – Detailed Facility Design
Ferrous	26	99	141
Wood	69	272	387
Paper	35	134	194
Plastic	9	32	45
Organics	8	26	37

Costs

- **Need to consider diminishing return**
- **Cost factors:**
  - Number of samples to be sorted
  - Number of material categories (very influential on sorting labour costs)
  - Cost of insurance, if not already covered by prime and other contractors
  - Time for coordination with municipal staff (haulers and landfill employees)
  - Sorting location and how to dispose of waste after sort

Estimated Costs

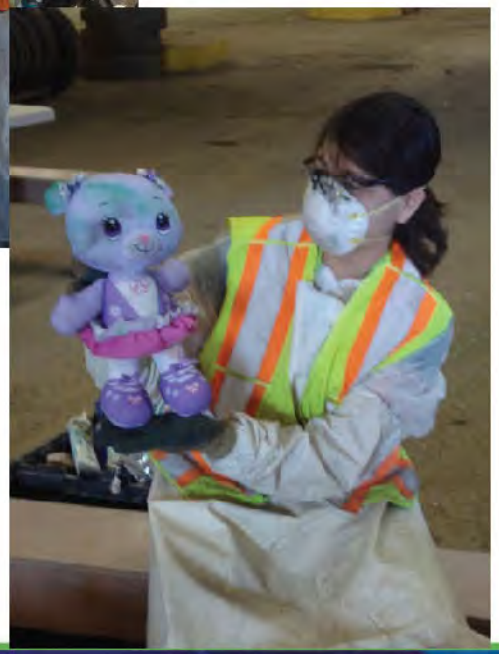
- Based on number of samples and waste stream (reference: Provincial Waste Characterization Framework, 2005) Today's estimated values (Bank of Canada)

Number of Samples	Residential Waste Composition Study	Number of Samples	ICI Waste Composition Study	Number of Samples	C&D Waste Composition Study (visual inspections)
60	$50,000 ($57,255)	120	$75,000 ($85,884)	160	$20,000 ($22,902)
120	$80,000 ($91,609)	240	$130,000 ($148,865)	320	$30,000 ($34,353)
180	$110,000 (125,963)	360	$190,000 ($217,572)	480	$35,000 ($40,079)

What is Customized in Your Work Plan?

- Health and Safety Plan – Safety needs to be a priority!
- Number of sorters to hire
  - Training of the sorters
- Sorting location – generator site (curbside) vs. disposal site (landfill)
- Collection schedule
- Communication plans
  - Collection staff, sorting staff, consultants, municipal employees
- Material categories

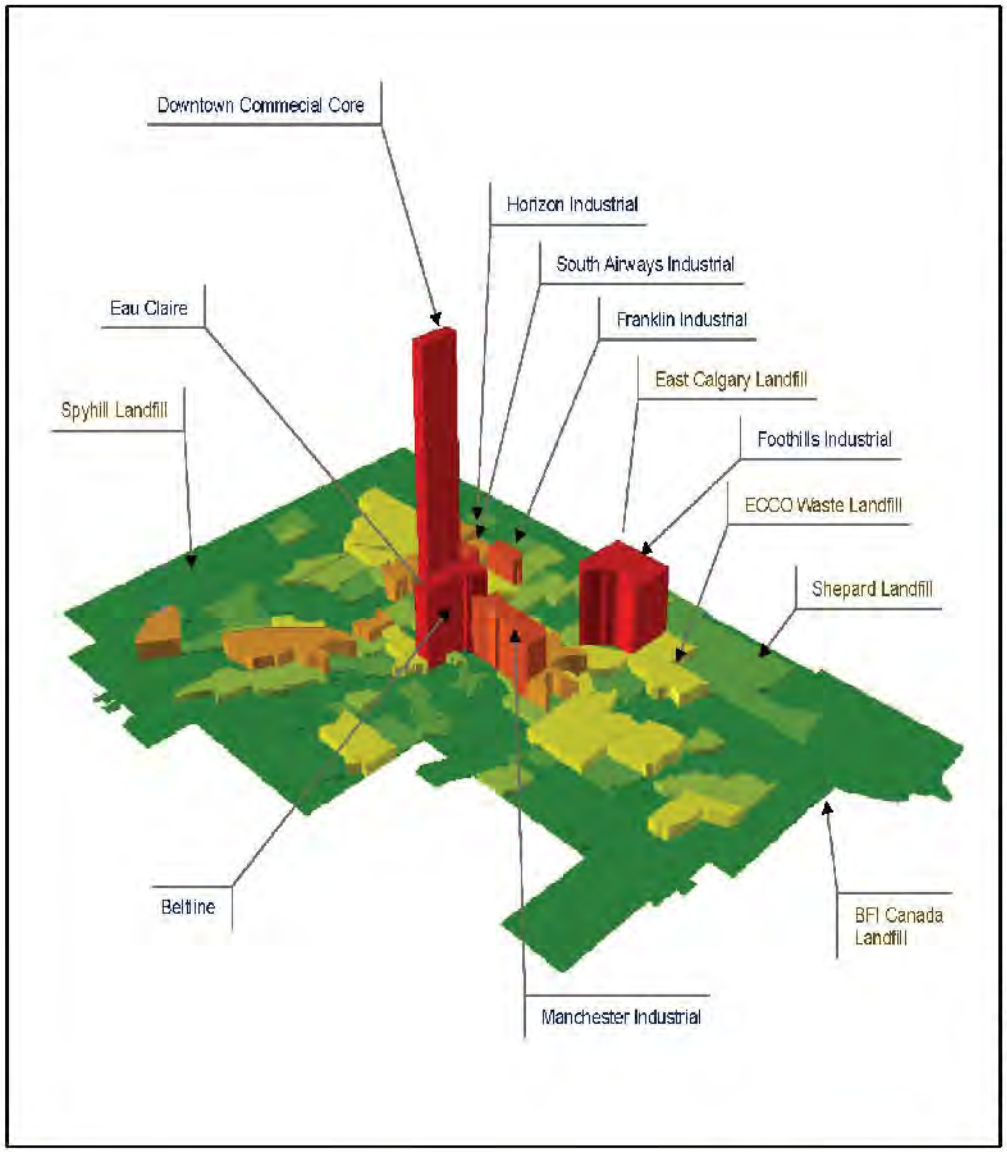
The Importance of Sorting Staff!



Alternatives to Physical Sorting

- Visual Assessment (C&D some ICI)
- Modeling ICI and C&D and residential
  - GIS Systems

ICI Waste Generation- Example



CALGARY

ICI Waste Generation Model

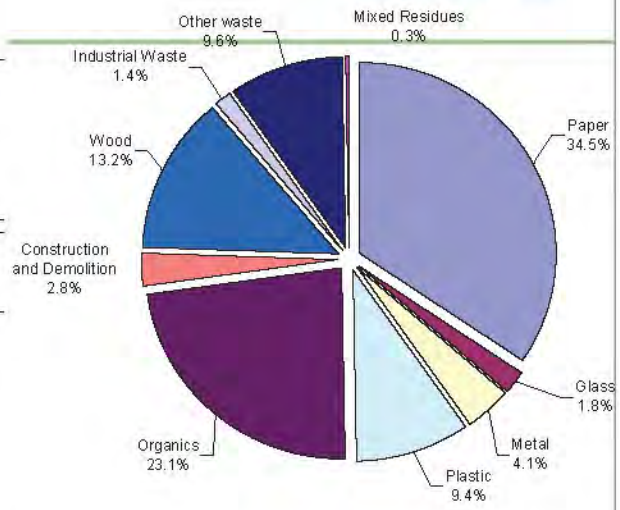
TOTAL WASTE GENERATED IN THE CITY OF CALGARY

Legend

Total Waste Generated In 2004 (tonnes)

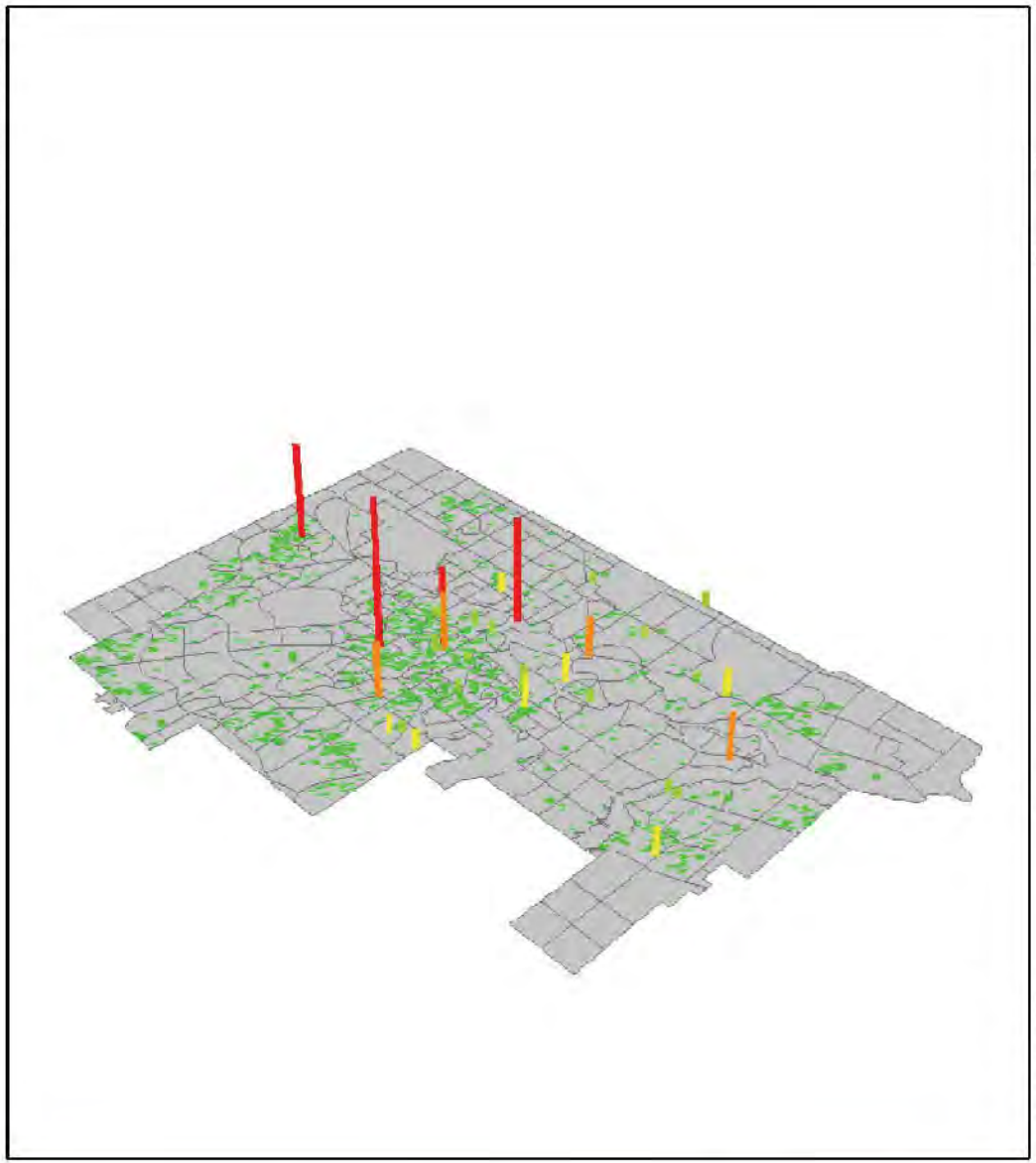
EBA Engineering Consultants Ltd.

Figure F.16



Waste	Mass (Tonnes)
Paper	265,250
Glass	14,000
Metal	31,500
Plastic	72,000
Organics	177,500
Wood	101,250
Other (C&D, Industrial, etc.)	107,750
Calgary Total	**769,250**

C & D Waste Generation- Example



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C&D Permit Waste Generation Model

TOTAL WASTE GENERATED IN THE CITY OF CALGARY

Legend

Total Permit Waste Generated in 2004 (tonnes)

- 0 - 400
- 401 - 800
- 801 - 1700
- 1701 - 3500
- 3501 +

Note
Graph elevations are displayed at 1:1 ratio

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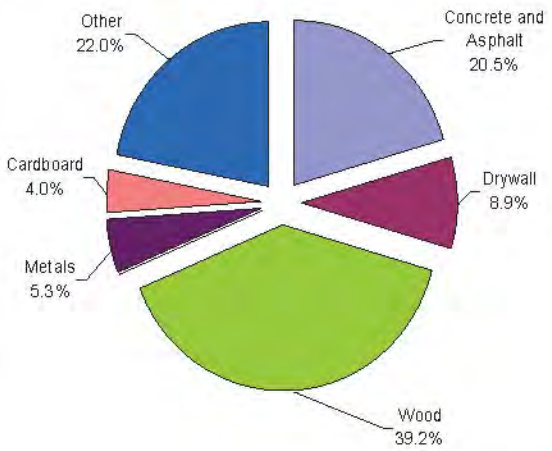
Information supplied by:
City of Calgary, Data & Analysis, Data Collection

Date: November 25, 2005	
Project No.: 0905-96002555	
Drawn by: JD	Reviewed by: SM
Datum: NAD 83	Projection: UTM
Revision No: 3	Figure F.36



Waste	Mass (Tonnes)
Concrete & Asphalt	40,000
Drywall	17,250
Wood	76,250
Metals	10,250
Cardboard	7,750
Other (Insulation, ceramics, etc.)	42,750
Calgary Total	**194,250**

Informative Sources

- CCME,1999. *Recommended Waste Characterization Methodology for Direct Waste Analysis Studies in Canada.*
- Washington State Department of Ecology, 2003. *Guidelines for Waste Characterization Studies in the State of Washington.*
- Ontario Stewardship, 2005. *Guide for Single Family Waste Audits.*
- *Provincial Waste Characterization Framework, (Alberta), October 2005.*

ARE WE THERE YET ??

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Thank You!