Report 2

Survey Database and Query Tools

OKANAGAN 20 TRAVEL SURVEY 13

City of Kelowna

City of Vernon

Lake Country
Life. The Okanagan Way.

District of West Kelowna

Westbank First Nation

Peachland On the Lake

RDCO
Regional District of Central Okanagan

2013 Okanagan Travel Survey
Report 2: Survey Database and Query Tools

DRAFT

Submitted to

City of Kelowna

City of Vernon

District of Lake Country

City of West Kelowna

Westbank First Nation

District of Peachland

Regional District of Central Okanagan

Government of Canada

Province of British Columbia

The Union of BC Municipalities

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The views expressed in this document do not necessarily reflect the views or policies of the Union of BC Municipalities, Province of BC, or Government of Canada.

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Exhibits

1.0 Introduction

1.1 Background

In the fall of 2013, the Cities of Kelowna, Vernon, and West Kelowna, Districts of Peachland and Lake Country, the Westbank First Nation and the Regional District of Central Okanagan partnered to conduct a regional travel survey to collect daily travel pattern of their residents. The *Okanagan Travel Survey* was a household-based survey targeted to all residents of the Central Okanagan and City of Vernon (combined population and household totals of 217,994 and 91,372 respectively).

Similar to the survey conducted in the spring of 2007, the goal of the survey was to develop a database of resident travel patterns to be used as the basis for transportation planning, and policy development. The comparison of the 2013 survey results to the 2007 dataset also allowed for the monitoring of changes in travel patterns between those years.

1.2 Survey Scope and Conduct

Data on the travel characteristics of residents are necessary to support the development of a regional transportation demand model and a household travel database, and the monitoring of the regional travel patterns. These tools and datasets in turn provide the basis for the development of evidence-based policies and plans, as well as the monitoring of the achievement of corresponding goals and targets. Therefore, a data collection exercise in the form of a travel survey is required to collect information about the socioeconomic characteristics of residents and their various travel patterns such as:

- trip origin and destination,
- trip purpose,
- travel mode, and
- trip start and end times.

Trip data was collected over a 24 hour period during the weekday (Monday-Friday) in the fall of 2013.

1.2.1 Survey Areas

Residents of the following areas were surveyed ("survey area"):

- City of Kelowna
- City of Vernon

- District of Lake Country
- City of West Kelowna
- Westbank First Nation
- District of Peachland
- Regional District of Central Okanagan

Over the course of a 24 hour period, as residents make trips not just in their local areas, but to other neighbouring regions and beyond, the study area (**Exhibit 1.1**) extended further to:

- North Okanagan
- South Okanagan
- External to the Okanagan Valley

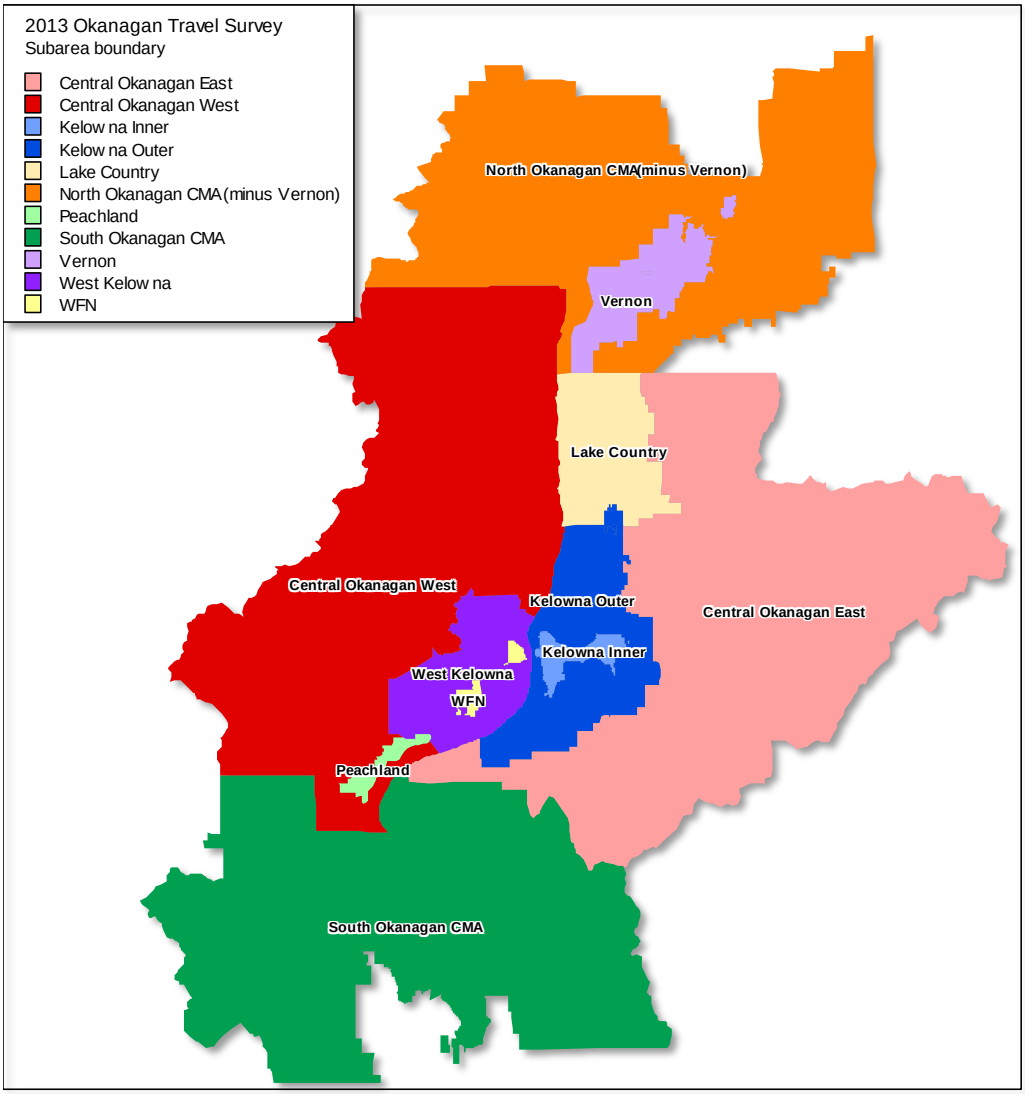


Exhibit 1.1. Study Area

1.2.2 Survey Conduct

The survey was a household-based survey that requires each member of participating households, 5 years and older, to complete a "trip diary" of their trips made within a 1-day period. Each household will be provided, in advance, an assigned date as to when their trip diary survey should be completed. Residents of the survey area were invited through post cards mailed to homes, as well as other media (i.e. digital and print ads, radio ads, road signs, posters, etc.). Specific survey conduct

- Survey Duration: Post card invitations delivered Sept 23-Oct 11, survey closure approx. Oct 31.
- Survey invitation cards were mailed to residents which contained a unique access code to enter the online survey.
- Central to the survey was the online survey website (www.OKTravelSurvey.ca). However those who did not have Internet access were provided a toll-free number to call for a paper-based survey package to be mailed to them, or to respond over the phone.
- A variety of prizes, ranging from cash prizes, gift cards, and prizes donated by sponsors, were provided as an incentive for residents to complete their surveys.

Overall, 6,972 people in 3,057 households completed the survey for a 3.3% response rate. The respondents reported a total of 22,441 trip records over an effective 24 hour period during the survey duration.

1.3 Survey Reports

The survey design, conduct, and results are documented in a series of three reports:

- Report 1: 2013 Okanagan Travel Survey – Survey Design & Conduct
- Report 2: 2013 Okanagan Travel Survey – Survey Database and Query Tools
- Report 3: 2013 Okanagan Travel Survey – Analysis of Survey Results and Baseline Comparison

This report describes the description of the resulting trip database and tools developed to assist and simplify the querying of the database by analysts and planners. For further information regarding the design, methodology and conduct, or the analysis and results of the survey, including comparison to the 2007 baseline survey, refer to Reports 1 and 3, respectively.

2.0 Database Structure

2.1 Introduction

The objective of the 2013 Okanagan Travel Survey was to obtain travel information from study area residents over a 24 hour period of a typical fall season weekday. As people and their characteristics influence their daily travel patterns, information regarding individuals was required to be collected. Furthermore, to contact people in a reliable manner, households were mailed invitation post cards or solicited in other ways in which the household and their members were invited to participate in the survey. Therefore, this required the collection of household information and the resulting survey database consists of three tables containing household, person, and trip data

Although producing the trip table is the ultimate objective of the survey, in order to expand[1] the trip samples to be representative to the study area population, person and household information was required so that the data could be expanded to the known and reliable estimates of household and population totals provided by Statistics Canada's Census data (i.e. truth). Therefore, as the travel survey's household and person datasets are used to develop expansion factors (which are then used to expand and estimate trip totals from the trip table data), only the trip data table and resulting trip statistics should be used from the travel survey[2].

Appendix A provides examples of the questionnaires (mail-back versions) used to solicit household, household member(s), and their 24-hour travel information from respondents. The following database structure and details refer to these questionnaire forms.

2.2 Database Overview

The 2013 Okanagan Travel Survey database is provided in a relational Microsoft Access database file (.mdb). This database file contains the following three tables:

- Household table
- Person table
- Trip table

[1] Refer to Section 4 of *Report 1: 2013 Okanagan Travel Survey – Survey Design & Conduct*

[2] As the Census information is the de facto source of demographic information, the travel survey's household and person datasets are not necessarily used to query the study area regarding its demographic attributes—the Census database should be relied upon for these queries. Rather, as there is no other reliable source of travel data over a 24 hour period for all trip purposes in the study area, travel surveys are the de facto source for trip data for a given study area and only the trip data table and resulting trip statistics should be used from the travel survey.

Each table contains a record (row) of each sample with attributes or data collected from each sample represented by data variables (columns). Each record is uniquely identified by a unique key and this key is used to relationally link the three tables together in a logical and hierarchal manner, as shown in **Exhibit 2.1**.

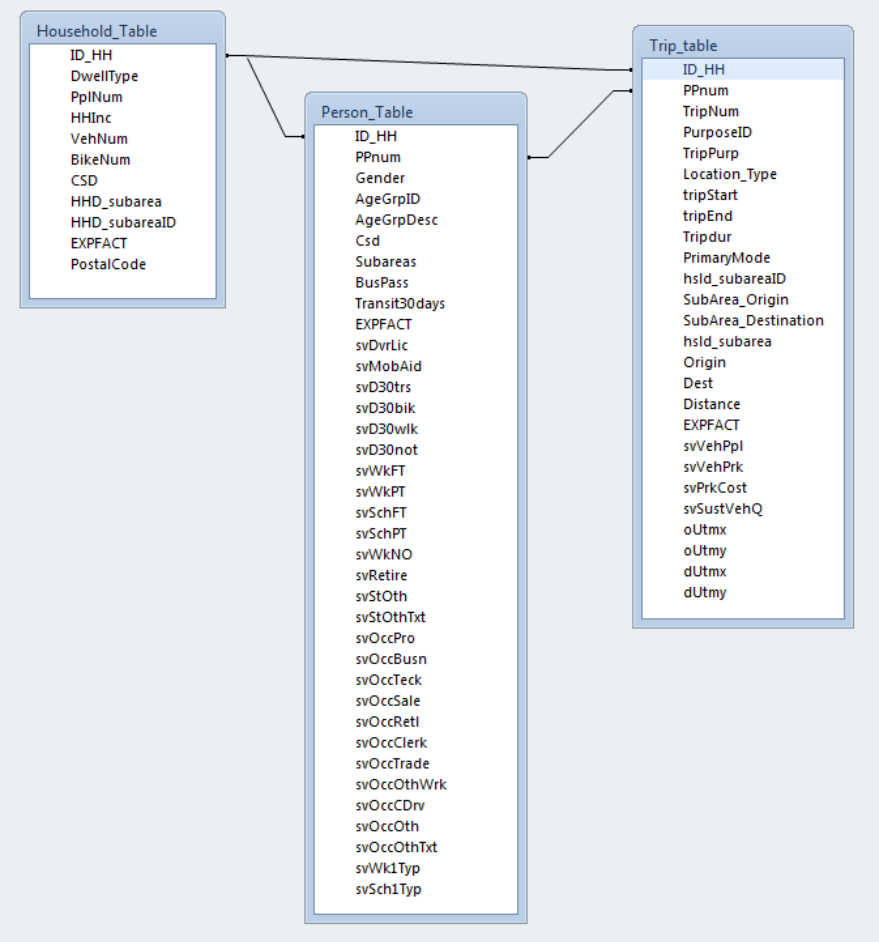


Exhibit 2.1. Survey Data Tables Relationship

The description of the structure for each of the three tables are provided below.

2.3 Household Table

The household table contains information from respondents as to their household characteristics. These include area of residence, type of dwelling, number of people in the household, household income, and vehicle ownership. The specific variables or fields are provided below, including possible answers and their associated codes.

2.3.1 Household Table Structure

HOUSEHOLD IDENTIFER	ID_HH

DWELLING TYPE	DwellType
Description	**Code**
Single Detached House	1
Apartment or Condo	2
Townhouse or Row House	3
Duplex	4
Mobile Home	5
Not selected	-999

NUMBER OF PEOPLE IN THE HOUSEHOLD	PplNum
Description	**Code**
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9 or More	9
Not selected	-999

HOUSEHOLD INCOME	HHInc
Description	**Code**
Less than $25,000	1
$25,000 to Less than $45,000	2
$45,000 to Less than $65,000	3
$65,000 to Less than $100,000	4
$100,000 or more	5
Not selected	-999

NUMBER OF VEHICLES	VehNum
Description	**Code**
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9 or More	9
Not selected	-999

NUMBER OF BICYCLES	BikeNum
Description	**Code**
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9 or More	9
Not selected	-999

CENSUS SUBDIVISION	CSD

HOUSEHOLD SUBAREA	HHD_subarea

HOUSEHOLD SUBAREA IDENTIFIER	HHD_subareaID
Description	**Code**
Vernon	1
Lake Country	2
Kelowna Inner	3
Kelowna Outer	4
West Kelowna	5
WFN	6
Peachland	7
Central Okanagan East	8
Central Okanagan West	9
North Okanagan CMA(minus Vernon)	10
Not selected	-999

HOUSEHOLD EXPANSION FACTOR	EXPFACT

2.4 Person Table

The person table contains information from respondents as to their individual household member characteristics. These include variable such as age group, gender, ownership of bus passes, use of transit in the past 30 days, school and work information, and use of mobility aids. The specific variables or fields are provided below, including possible answers and their associated codes.

2.4.1 Person Table Structure

HOUSEHOLD IDENTIFER	ID_HH

HOUSEHOLD PERSON IDENTIFER	PPnum

GENDER	Gender
Description	**Code**
Male	1
Female	2
Not selected	-999

AGE GROUP	AgeGrpID
Description	**Code**
00-04	1
05-14	2
15-24	3
25-34	4
35-44	5
45-54	6
55-64	7
65 and over	8
Unknown	99

AGE GROUP DESCRIPTION	AgeGrpDesc

CENSUS SUBDIVISION	CSD

SUBAREAS	Subareas

PERSON HAS A MONTHLY OR ANNUAL TRANSIT PASS	BusPass
Description	**Code**
Yes	1
No	2
Not selected	-999

PERSON HAS TAKEN TRANSIT IN THE PAST 30 DAYS	Transit30days
Description	**Code**
Yes	1

PERSON EXPANSION FACTOR	EXPFACT
DRIVER'S LICENSE	svDvrLic
Description	**Code**
Yes	1
No	2
N/A (Under 16 of Age)	3
Not selected	-999

MOBILITY ASSISTANCE	svMobAid
Description	**Code**
Wheelchair	1
Scooter	2
Walker	3
Cane	4
Crutches	5
None of the above	6
Not selected	-999

PERSON HAS TAKEN PUBLIC TRANSIT IN THE PAST 30 DAYS	svD30trs
Description	**Code**
Yes	1

PERSON HAS RIDEN A BIKE IN THE PAST 30 DAYS	svD30bik
Description	**Code**
Yes	1

PERSON HAS WALKED SOMEWHERE ALL THE WAY IN THE PAST 30 DAYS	svD30wlk
Description	**Code**
Yes	1

PERSON HAS NOT WALKED, BIKED, USED PUBLIC TRANSIT IN THE PAST 30 DAYS	svD30not
Description	**Code**
Yes	1

PERSON WORKS FULL TIME	svWkFT
Description	**Code**
Yes	1

PERSON WORKS PART TIME	svWkPT
Description	**Code**
Yes	1

PERSON ATTENDS SCHOOL FULL TIME	svSchFT
Description	**Code**
Yes	1

PERSON ATTENDS SCHOOL PART TIME	svSchPT
Description	**Code**
Yes	1

PERSON IS NOT WORKING	svWkNO
Description	**Code**
Yes	1

PERSON IS RETIRED	svRetire
Description	**Code**
Yes	1

PERSON'S STATUS IS OTHER	svStOth
Description	**Code**
Yes	1

PERSON'S OTHER STATUS DESCRIBED	svStOthTxt

PERSON'S OCCUPATION IS A PROFESSIONAL	svOccPro
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS IN BUSINESS	svOccBus
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS A SKILLED TECHNICAL WORKER	svOccTeck
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS IN SALES	svOccSale
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS IN SERVICES OR RETAIL	svOccSrv
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS IN CLERICAL	svOccClk
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS IN TRADES	svOccTrd
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS OTHER TYPE OF WORKER	svOccMisc
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS A COMMERCIAL DRIVER	svOccDvr
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS IN OTHER	svOccOth
Description	**Code**
Yes	1

PERSON'S OCCUPATION IS IN OTHER DESCRIBED	svOccOthTxt

WORK TYPE	svWk1Typ
Description	**Code**
Office	1
Industrial	2
Retail	3
Other	4
Not selected	-999

SCHOOL TYPE	svSch1Typ
Description	**Code**
Grade School (K-12)	1
Post-Secondary	2
Other	3
Not selected	-999

2.5 Trip Segment Table

The trip table contains information from respondents as to their individual household member's 24-hour travel characteristics during a typical fall season weekday. These include variable such as trip number (to calculate total trips across related trip records), trip purpose, trip mode, start and end destinations, start and end times, estimated travel distance, and other information related to their trip. The specific variables or fields are provided below, including possible answers and their associated codes.

2.5.1 Trip Definition and Characteristics

As the focus of the survey is to obtain information regarding trip patterns and characteristics of survey residents, the definition of a "trip" is important. For this survey, the definition used was:

*"A trip is one-way travel to **a destination** with a **distinct purpose** to travel (e.g. a non-stop trip from home to work)." As such, any trip can be over multiple modes and made alone or with others.*

Non-trips were also defined to provide a better understanding of what constituted a "trip":

"What doesn't count as a trip:

- *walking a dog, jogging or cycling (with no destination)*
- *walk between a parking lot or to and from transit stops*
- *moving around between rooms within the same building, or between buildings on campus*
- *commercial vehicle/delivery/transit driver trips (only personal trips to and from work apply)"*

Refer to **Appendix B** for actual graphic examples of trips used during the survey.

2.5.2 Trip Segment Table Structure

HOUSEHOLD IDENTIFER	ID_HH

HOUSEHOLD PERSON IDENTIFER	PPnum

PERSON TRIP NUMBER	TripNum

TRIP PURPOSE	PurposeID
Description	**Code**
To Work / Work meeting	1
To School	2 (11 or 12)
To a Restaurant	3
For Recreation (gym, swimming, etc.)	4
For a Social outing / Meeting friends	5
For Shopping	6
For Personal business (bank, doctor, errands, etc.)	7
To Home	8
To drive or pick-up someone	9
Other	10
To grade school	11
To post secondary school	12
Not selected	-999

TRIP PURPOSE DESCRIPTION	TripPurp

DESTINATION LOCATION TYPE	Location_Type
Description	**Code**
House / Apartment	1
Office Building	2
Industrial	3
School	4
Store / Mall / Dining / Theatre	5
Daycare	6
Hospital / Medical	7
Bank / Financial	8
Religious Institution	9
Farm / Vineyard	10
Indoor Rec / Gym	11
Outdoor Rec (park, beach, golf)	12
Airport	13
Other	14
Not selected	-999

TRIP START AND END TIME	tripStart --- tripEnd
Description	**Code**
Hour and Minutes (24 hr clock)	hhmm

TRIP DURATION	Tripdur
Description	**Code**
Minutes	mmm

PRIMARY MODE	PrimaryMode
Description	**Code**
Automobile Driver	1 AutoDvr
Automobile Passenger	2 AutoPsg
Transit	3 Transit
Walk	4 Walk
Cycle	5 Bike
Taxi	6 Taxi
School Bus	7 SchoolBus
Other	8 Other

HOUSEHOLD SUBAREA IDENTIFIER	hsld_subareaID
Description	**Code**
Vernon	1
Lake Country	2
Kelowna Inner	3
Kelowna Outer	4
West Kelowna	5
WFN	6
Peachland	7
Central Okanagan East	8
Central Okanagan West	9
Not selected	-999

ORIGIN AND DESTINATION SUBAREA	SubArea_Origin --- SubArea_Destination
Description	**Code**
Vernon	1
Lake Country	2
Kelowna Inner	3
Kelowna Outer	4
West Kelowna	5
WFN	6
Peachland	7
Central Okanagan East	8
Central Okanagan West	9
North Okanagan CMA (minus Vernon)	10
South Okanagan CMA	11
External	12
Unknown	99

HOUSEHOLD SUBAREA DESCRIPTION	hsld_subarea

ORIGIN AND DESTINATION SUBAREA DECRIPTION	Origin --- Dest

TRAVEL DISTANCE (METERS)	Distance

TRIP EXPANSION FACTOR	EXPFACT

WHEN TRAVELLING BY AUTOMOBILE, HOW MANY PEOPLE TRAVELLED WITH YOU?	svVehPpl
Description	**Code**
I rode alone	0
I rode with 1 other person	1
I rode with 2 other people	2
I rode with 3 other people	3
I rode with 4 other people	4
I rode with 5 other people	5
I rode with 6 other people	6
I rode with 7 other people	7
Not selected	-999

WHERE WAS YOUR VEHICLE PARKED?	svVehPrk
Description	**Code**
In a Parking Lot - PAID	1
In a Parking Lot - FREE	2
On the Street - PAID (Parking Meter)	3
On the Street - FREE	4
At Home	5
Not selected	-999

PARKING COST AT THE DESTINATION	svPrkCost

WHEN TRAVELLING BY A SUSTAINABLE MODE (ALL MODES EXCEPT AUTO DRIVER)

WHEN YOU MADE THIS TRIP, WAS THERE A VEHICLE AVAILABLE BUT YOU CHOSE NOT TO DRIVE IT?	svSustVehQ
Description	**Code**
Yes	1
No	2
N/A (Under 16 of Age or No License)	3
Not selected	-999

3.0 Query Tools

3.1 Introduction

As describe in Section 2, the resulting survey database is rich in detail and can be queried in wide range of manner from which to support key policy and planning questions. However, the skills required to extract this information from a database utilizing expansion factors rather than simple record counts may make the access to the database limited. Furthermore, handling of unknown and missing information is required when estimating absolute figures (i.e. quantities) vs. relative figures (i.e. percentages).

Therefore, in order to make the survey results accessible to the widest audience possible, a set of tools were created to allow for relatively simple access to the survey database to perform "drop-down selection" queries of the most common questions that are asked of travel surveys.

3.2 Spreadsheet Tool

For the comparison and trend analysis of the 2013 survey results in relation to the baseline 2007 survey, the two databases were required to be normalized to ensure consistency and therefore comparability (i.e. to allow for an "apples to apples" comparison). In doing so, an analysis spreadsheet was created and additional effort was made to create macros to automate queries for all required analyses. The tool was further refined to allow for simpler "drop-down selection" queries to filter out travel information (mainly trip matricies) by time period and subarea. Both total expanded trip totals and sample totals are provided (via check box selection) to allow for users to calculate statistical validity (refer to Section 4 of this report).

The spreadsheet tool is targeted to an audience of advanced analysts that require the following information:

- Trip totals by origins and destinations per time period
- Trip totals by purpose and origins per time period
- Trip totals by mode and origins per time period
- Trip totals by purpose and mode per time purpose
- Trips totals by age group and mode per area
- Trips totals by age group and purpose per area
- Trip totals by trip purpose and land use type per area

The time period aggregations available are:

- Daily (24 hour period)
- >= 0000 and < 0600 hours (morning period)
- >= 0600 and < 0900 hours (AM peak period)
- >= 0900 and < 1500 hours (mid-day period)
- >= 1500 and < 1800 hours (PM peak period
- >= 1800 and < 2400 hours (evening period)

The area aggregations available are:

- Whole Study Area
- Central Okanagan CMA
- Vernon
- Lake Country
- Kelowna Inner
- Kelowna Outer
- West Kelowna
- WFN
- Peachland
- Central Okanagan West
- Central Okanagan East
- North Okanagan CMA (minus Vernon)
- South Okanagan CMA
- External

3.3 Web Tool

To allow for maximum access to the 2013 survey results, a web-accessible application was developed to provide a wide range of possible queries using "drop-down selection" methods. The website, located at http://www.acuere.ca/stpco/2013okts/ allows for the following combinations of queries to the 2013 travel survey database:

- Total trip tables (total trips and samples) and average distances for:
  - Trip origins by destinations per time of day
  - Trip origins by mode per time of day
  - Trip origins by purpose per time of day
  - Trip mode by purpose per area
  - Trip mode by age group per area
  - Trip purpose by age group per area

The time period and area aggregations are the same as in the spreadsheet tool (see above). However, a secondary web application expands the Kelowna Inner and

Kelowna Outer areas by a 10 sector neighbourhood aggregation (**Exhibit 3.1**). (URL to come)

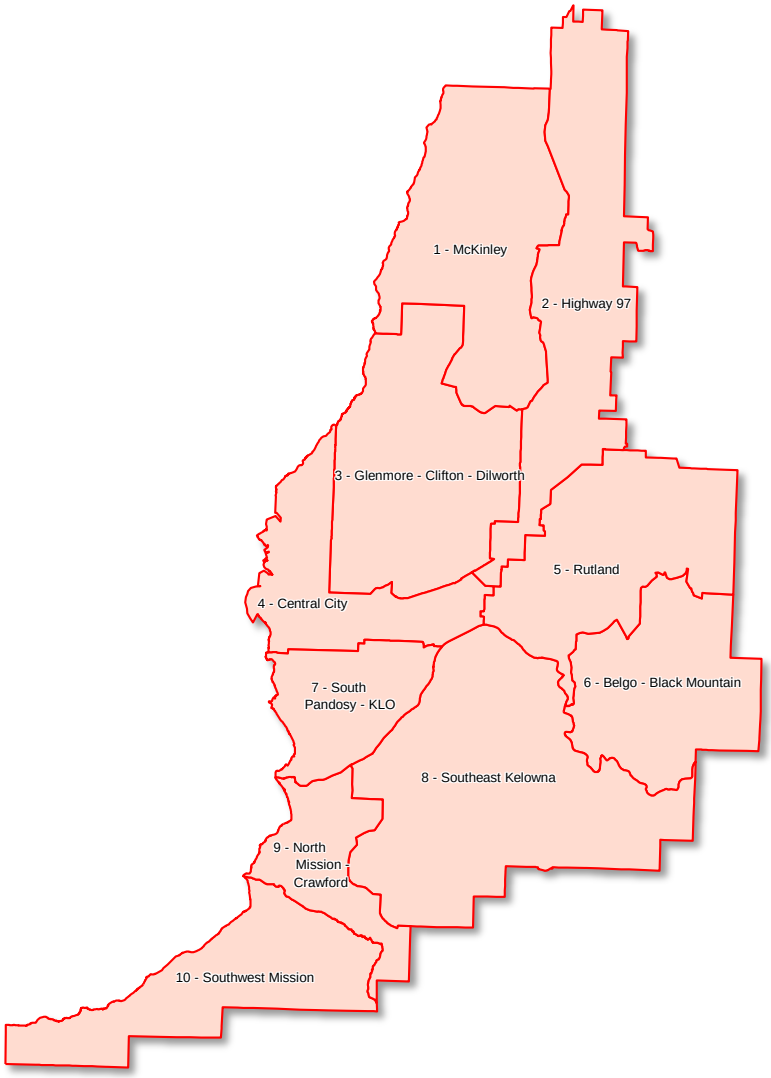


Exhibit 3.1. Kelowna's 10 Sector System

The wide range of combinations of possible queries, as well as the detailed information provided on trip totals, samples, and average distances, allows for the web application to support a similarly wide range of policy and planning questions.

4.0 Statistical Analysis and Examples

Due to the expense and effort that would be required to collect data from a large population, the surveying of a sample or a representative subset of the population is usually appropriate. In the case of a region-wide survey of travelling, a sample size between 2-5% will provide adequate samples to represent most of the major travel patterns for a region. However, ultimately, the sample size depends on the degree of variance of key variables (i.e. trip rate per person, mode share, trip distance) and the probable absolute number of key events or attributes that are queried from the population[3].

For the 2013 Okanagan Travel Survey, with a sample size of 3.3% and over 22,000 trip records obtained, the resulting database of trips can adequately provide answers of regional and sub-regional travel patterns. The following sub-section provide formulas and examples to help users compute the statistical validity (i.e. accepted confidence level and error) of the estimated mean of a survey variable using a given query.

4.1 Statistical Estimation

Three basic formulas can be used to determine the appropriate sample size for a survey and compute the range of sampling errors for each resulting statistic.

In order to use these formulas, the following assumptions are required:

- the distribution of the survey is normal (generally for sample sizes over 30 with variables that have a tendency to adhere to the central limit theorem, which are common in the study of social sciences)
- for large surveys (over 30 samples), the standard deviation, $\boldsymbol{s}$, of the sample can be used as a substitute for the standard deviation of the population, σ, as this parameter is unknown in most cases. Similarly, the sample or estimated mean, $\bar{x}$, can be used in place of the population or true mean, μ.
- the coefficient of variation, $\boldsymbol{CV}$, depends on the variable that is being surveyed (e.g. trips per household) and can differ between locations. Usually, the coefficient of variation can be computed from previously collected local data (sample standard deviation/sample mean). Otherwise, a coefficient of variation from a similar area or an overall average from other areas can be used.

[3] For example, if is desired to query the total number of commuting cyclists originating from a small area and destined to another small area, the actual number of such trips on any given day may be relatively small (e.g. 10 commuting cycling trips from location A to location B) for a sound statistical analysis unless a close to 100% sample from the originating area is obtained (e.g. in the case of querying a very small population, it may be more appropriate and relatively easier to survey the entire population). Essentially, as more constraints are included in the query (i.e. time, space, mode, purpose, distance, etc.), this will reduce the samples available from database, resulting in reduced statistical significance.

The standard deviation of a sample is calculated using the formula:

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} \qquad (1)$$

where:

x_i = i^{th} observation
$\bar{x}$ = sample mean
n = number of samples

4.2 Required Sample Size Estimation

The first step in designing a survey is to determine the number of samples required for statistical validity. To determine the required sample size for a survey, the following formula is used:

$$n = \left(\frac{Z_{\alpha/2} CV}{e}\right)^2 \qquad (2)$$

where:

n = number of samples
$z_{\alpha/2}$ = normal variate
α = 1.0 - confidence coefficient
CV = coefficient of variation
e = accuracy level expressed as a proportion

To use the formula, the user must choose appropriate confidence and error levels. The normal variate ($Z_{\alpha/2}$) depends on the confidence level (confidence coefficient) selected. The value of $Z_{\alpha/2}$ can then be determined by using standard statistical tables. The error level, *e*, is the accuracy range that the user is willing to accept at the chosen confidence level.

To be certain that the degree of confidence never falls below (1-σ)100%, all fractional values of *n* should be rounded up to the next whole number.

Example 1

What is the required number of samples for an estimate of the number of trips per household in a region (coefficient of variation = 0.96) if we want to be 95% confident that our estimate is off by less than 5% error.

Solution

Parameters known:

$CV = 0.96$
$e = 0.05$
$\alpha = 1 - 0.95 = .05 \quad (\alpha / 2 = 0.025)$
$Z_{\alpha/2} = 1.96$

Using Formula (2):

$$n = \left(\frac{(1.96)(0.96)}{(0.05)}\right)^2 = 1416.17 \cong 1417$$

Therefore, to measure the trips per household in a region with the coefficient of variation of 0.96 at no less than a 95% confidence level that the error of the measurement will not exceed 5%, a survey of 1,417 samples needs to be conducted.

4.3 Reliability of a Sample

Assuming that a sample had been chosen in an unbiased manner, it is possible to calculate the degree of error that may be due to sampling by calculating a confidence interval estimate.

The error of a large sample (n≥30) can be determined within a selected confidence level:

$$\bar{x} - \frac{Z_{\alpha/2} s}{\sqrt{n}} < \mu < \bar{x} + \frac{Z_{\alpha/2} s}{\sqrt{n}} \qquad (3)$$

where:

$\bar{x}$ = sample mean
μ = population mean
$z_{\alpha/2}$ = normal variate
α = 1.0 - confidence coefficient
s = sample standard deviation
n = number of samples (≥ 30)

Example 2

What is the error range, at a 98% confidence level, of an estimate of 7.7 trips per household determined from a 1800 sample size survey in a region with a standard deviation for trips per household of 0.87.

Solution

Parameters known:

$\bar{x} = 7.7$
$s = 0.87$
$n = 1800$
$\alpha = 1 - 0.98 = .02 \quad (\alpha / 2 = 0.01)$
$Z_{\alpha/2} = 2.33$

Using Formula (3):

$$7.7 - \frac{(2.33)(0.87)}{\sqrt{1800}} < \mu < 7.7 + \frac{(2.33)(0.87)}{\sqrt{1800}}$$

which reduces to:

$$7.65 < \mu < 7.75 \quad \text{or} \quad e = \pm 0.048$$

Therefore, we can be sure that the estimate of 7.7 trips per household, from a 1800 sample survey within a region with a standard deviation of 0.87 for this measure, has an error range of +/- 0.048 trips per household at a confidence level of 98%.

4.4 Sampling Error of a Proportion Estimate

To determine the sampling error within a level of confidence for an estimate of a proportion *p* in a binomial experiment (e.g. "Proportion of Transit trips"), the following formula is used (large sample size, n ≥30):

$$\hat{p} - \mathbf{Z}_{\alpha/2}\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + \mathbf{Z}_{\alpha/2}\sqrt{\frac{\hat{p}\hat{q}}{n}} \qquad (4)$$

where:

p = proportion of the population
$\hat{p}$ = proportion of the sample
$\hat{q}$ = 1 - $\hat{p}$
$z_{\alpha/2}$ = normal variate
α = 1.0 - confidence coefficient
n = number of samples (≥ 30)

Example 3

From a survey of 1000 samples of the downtown core, it was determined that 44% of the trip types destined to downtown in the morning peak period is auto driver. What is the precision of this estimate at a 99% confidence level?

Solution

Parameters known:

$\hat{p} = 0.44$
$\hat{q} = 1 - \hat{p} = 1 - 0.44 = 0.56$
$\alpha = 1 - 0.99 = 0.01$ $(\alpha/2 = 0.005)$
$\mathbf{Z}_{\alpha/2} = 2.58$
$n = 1000$

Using Formula (4):

$$0.44 - (2.58)\sqrt{\frac{(0.44)(0.56)}{1000}} < p < 0.44 + (2.58)\sqrt{\frac{(0.44)(0.56)}{1000}}$$

which reduces to:

$$0.40 < p < 0.48 \quad \text{or} \quad p = 0.44 \pm 0.04$$

Therefore, based on the survey of 1000 samples, we can be 99% confident that the proportion of auto driver trips destined to downtown in the morning peak period is between 40 and 48%.

Appendix A – Mail-Back Trip Diary Forms

OKANAGAN TRAVEL SURVEY

CONTACT PERSON OF THE HOUSEHOLD: PLEASE FILL OUT THIS FORM AND RETURN BY MAIL

Access Code: ____ - ____ - ____ - ____ - ____

Referral Code: (from your friend who referred you to this survey) ____ - ____

First Name: Surname:

Address: Apt/Unit: (if applicable)

City: Province: B.C. Postal Code:

Home Phone Number: Email: (optional)

1. Dwelling Type:
   - ☐ Single Detached House
   - ☐ Apartment or Condo
   - ☐ Townhouse or Row House
   - ☐ Duplex
   - ☐ Mobile Home

3. Household Income:
   - ☐ Less than $25,000
   - ☐ $25,000 to less than $45,000
   - ☐ $45,000 to less than $65,000
   - ☐ $65,000 to less than $100,000
   - ☐ $100,000 or more
   - ☐ Don't know
   - ☐ Prefer not to disclose

2. Number of People in your Household: (5 years and older)

4. Number of Bicycles: (in working condition)

5. Number of vehicles: (*Circle*)

Number of Vehicles in your Household (including motorcycles & scooters)

	1	2	3	4	5
a. Year of vehicle: (e.g. "2012")					
b. Make of vehicle: (e.g. "Ford" or "Honda")					
c. Model of vehicle: (e.g. "F-150" or "Civic")					
d. Transmission & Fuel Type: (e.g. Trans: auto, manual | Fuel: gas, diesel, propane, hybrid, electric, etc.)					
e. Ownership (*Choose one per vehicle*)					

1. Owned
2. Leased
3. Company
4. Shared/ Co-op

OKANAGAN TRAVEL SURVEY

PLEASE FILL OUT THIS FORM FOR EACH PERSON IN HOUSEHOLD AGED 5 OR OLDER AND RETURN BY MAIL

Person Profile For: _____ (Name or initials)

Home Phone Number: _____ (This is used to link this person to your household)

1. Age:		2. Gender:	☐ Male ☐ Female	3. Have Driver's License?	☐ Yes ☐ No ☐ N/A (e.g. under 16 yrs)

4. Person need use of mobility aids?	Check primary device (1 only):	5. In the past 30 days has this person:		6. Does this person have a monthly or annual transit pass?	
☐ No assistance required ☐ Temporary ☐ Permanent	☐ Wheelchair ☐ Scooter ☐ Walker ☐ Cane ☐ Crutches ☐ None of the above	Taken public transit Cycled Walked somewhere all the way None of the above	☐ Yes ☐ No ☐ Yes ☐ No ☐ Yes ☐ No ☐ Yes		☐ Yes ☐ No

7. Person is: (select all that apply)	8. If working, what is this person's Occupation Type?	
☐ Working full time ☐ Working part time ☐ Full time student ☐ Part time student ☐ Unemployed ☐ Retired ☐ Other (describe):	☐ Professional ☐ Business ☐ Sales ☐ Service/Retail ☐ Clerical	☐ Skilled-Trades ☐ Skilled-Technical ☐ Other workers ☐ Commercial Driver ☐ Other(describe):

9. **If this person works, please list their workplace(s)**

Work #1 Name:		Work #2 Name: (if applicable)	
Type of Workplace:	☐ Office ☐ Industrial ☐ Retail ☐ Other	Type of Workplace:	☐ Office ☐ Industrial ☐ Retail ☐ Other
Address or cross-street:		Address or cross-street:	
Municipality:		Municipality:	

10. **If this person is a student, please list their school(s)**

School #1 Name:		School #2 Name: (if applicable)	
Type of School:	☐ Grade School (K-13) ☐ Post Secondary ☐ Other	Type of School:	☐ Grade School (K-13) ☐ Post Secondary ☐ Other
Address or cross-street:		Address or cross-street:	
Municipality:		Municipality:	

OKANAGAN TRAVEL SURVEY

PLEASE FILL OUT THIS TRIP DIARY FORM FOR EACH PERSON IN THE HOUSEHOLD

Trip Diary form for:

Step 1. _____ (Name or initials)

Step 2. _____ (Assigned Trip Diary Day)

Step 4. Did this person make any trips on this household's assigned Trip Diary Day? ☐ Yes ☐ No

If No, please select reason(s) that apply:
☐ Home Business ☐ Day Off
☐ Telecommute ☐ Out of town
☐ Home Schooled ☐ Other
☐ Sick Describe Other:

Note: **A trip is one-way travel to a destination with a distinct purpose to travel** (e.g. a non-stop trip from home to work).

» What **doesn't** count as a trip:
- walking a dog, jogging or cycling (with no destination)
- walk between a parking lot or to and from transit stops
- moving around between rooms within the same building, or between buildings on campus
- commercial vehicle/delivery/transit driver trips (only personal trips to and from work apply)

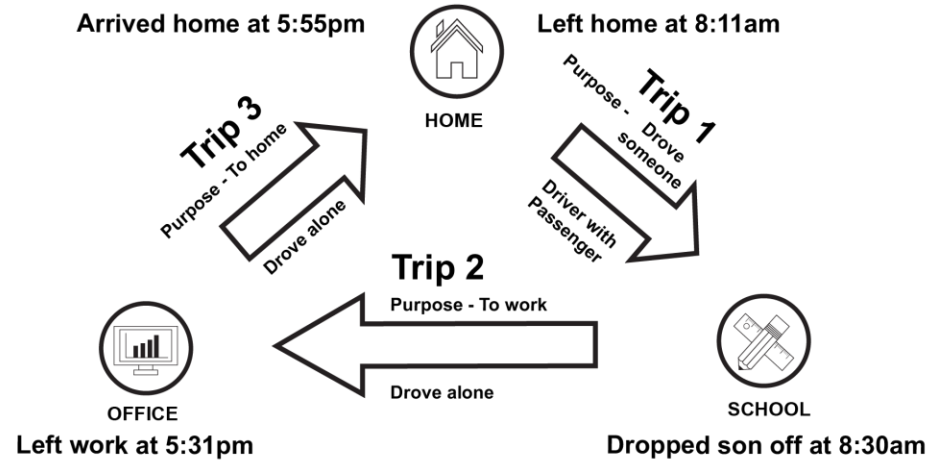
Step 3. TRIP DIARY: Please record all of your trips below on your assigned Trip Diary Day

Trip Locations: Write down the address OR nearby intersection OR landmark. *Include the municipality.*	**1st Trip** I started my first trip from:	**2nd Trip** Next I went to:	**3rd Trip** Next I went to:	**4th Trip** Next I went to:	**5th Trip** Next I went to:	**6th Trip** Next I went to:	**7th Trip** Next I went to:	**8th Trip** Next I went to:
End Location Type: (*Choose only one, write code #*) 1. House/ apartment; 2. Office building; 3. Industrial; 4. School; 5. Store/mall/ dining/ theatre; 6. Daycare; 7. Hospital/ medical; 8. Bank/financial; 9. Religious institution; 10. Farm/ vineyard; 11. Indoor rec./ gym; 12. Outdoor rec. (park, beach, golf); 13. Airport; 14. Other (describe)		Location Type (write code #):	Location Type (write code #):	Location Type (write code #):	Location Type (write code #):	Location Type (write code #):	Location Type (write code #):	Location Type (write code #):
Main Trip Purpose: (*Choose only one, write code #*) 1. To work/work meeting; 2. To school; 3. Restaurant; 4. To recreation (gym, etc.); 5. Social outing; 6. Shopping; 7. Personal Business (bank, doctor, errands, etc.); 8. To go home; 9. To drive or pick-up someone; 10. Other (describe)		Purpose Code:	Purpose Code:	Purpose Code:	Purpose Code:	Purpose Code:	Purpose Code:	Purpose Code:
Start time: Write in Exact Time you left the start location. *Circle AM or PM*		Started at : AM PM	Started at : AM PM	Started at : AM PM	Started at : AM PM	Started at : AM PM	Started at : AM PM	Started at : AM PM
Arrival time: Write in Exact Time you arrived at this destination. *Circle AM or PM*		Arrived at : AM PM	Arrived at : AM PM	Arrived at : AM PM	Arrived at : AM PM	Arrived at : AM PM	Arrived at : AM PM	Arrived at : AM PM
Method of Travel: (*Choose **all that apply**, write code #*) 1. Automobile – driver; 2. Automobile – passenger; 3. Transit bus (specify route numbers); 4. Walking; 5. Bicycle; 6. Taxi/airport shuttle; 7. School bus; 8. Other (describe)								
If not a Driver ("1"), **was a vehicle available to drive**?		Y N N/A	Y N N/A	Y N N/A	Y N N/A	Y N N/A	Y N N/A	Y N N/A
If by automobile: How many other people travelled with you: Example: - "0" if you rode alone - "1" if one other person was in the vehicle with you - "2" if two other people were in the vehicle with you….etc.		# of other people	# of other people	# of other people	# of other people	# of other people	# of other people	# of other people
If by automobile: Did you use pay parking? (if so, specify cost)		$ _____	$ _____	$ _____	$ _____	$ _____	$ _____	$ _____
Where did you go next? (You next trip starts where the previous trip ended)		Go to Trip 2 or this was last trip for the day ☐	Go to Trip 3 or this was last trip for the day ☐	Go to Trip 4 or this was last trip for the day ☐	Go to Trip 5 or this was last trip for the day ☐	Go to Trip 6 or this was last trip for the day ☐	Go to Trip 7 or this was last trip for the day ☐	Go to Trip 8 or this was last trip for the day ☐	Go to Trip 9 (on new sheet) or this was last trip for the day ☐

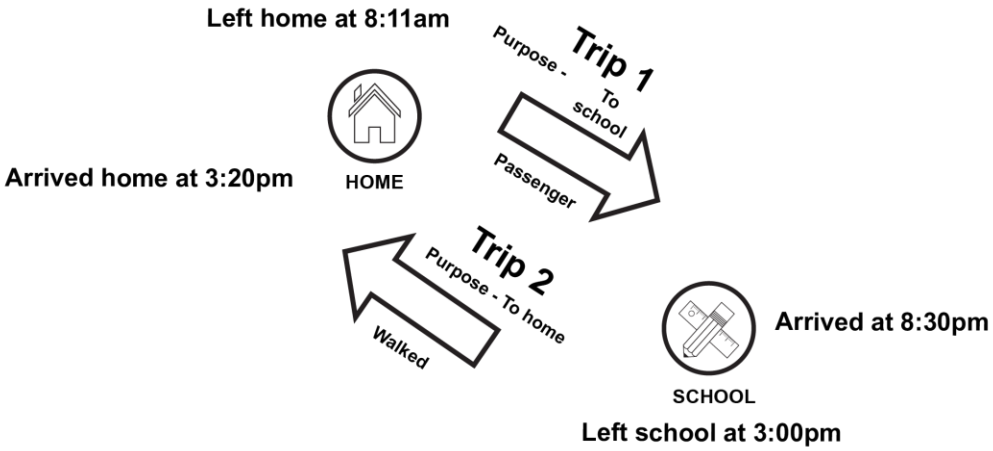
When each person has completed this Trip Diary survey form, please go back to the survey website (www.oktravelsurvey.ca), login with your Access Code and fill in this information online.

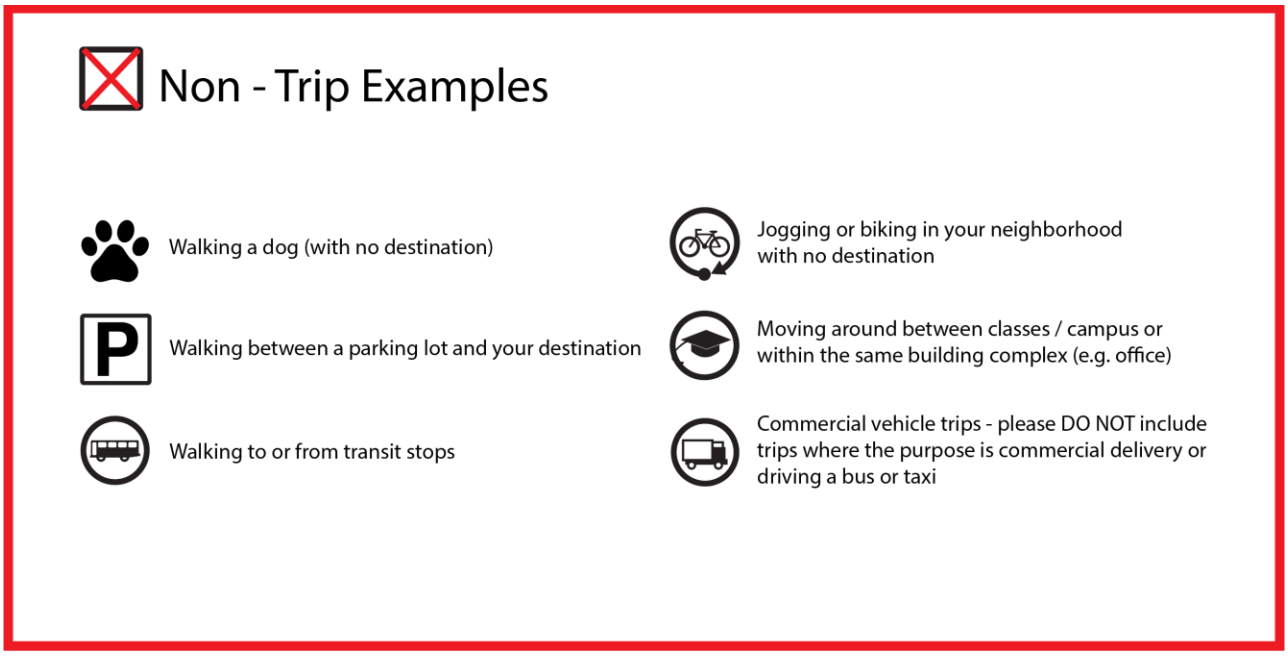
Appendix B – Trip Definition Examples

Work + Drop Off Trip Example



School Trip Example




Non - Trip Examples
Walking a dog (with no destination)
Walking between a parking lot and your destination
Walking to or from transit stops
Jogging or biking in your neighborhood with no destination
Moving around between classes / campus or within the same building complex (e.g. office)
Commercial vehicle trips - please DO NOT include trips where the purpose is commercial delivery or driving a bus or taxi