

REPUTATION RESOURCES RESULTS



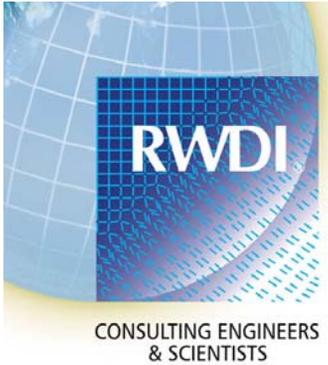
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Development of a Multi-User GIS-Based Emission Inventory Tool

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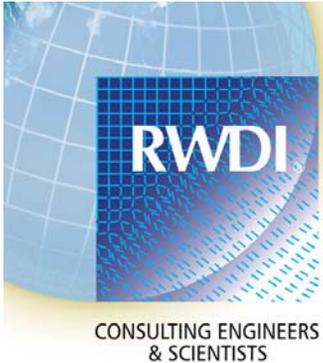
Colin di Cenzo
Environment Canada (P&YR)
Vancouver, British Columbia, Canada

14th Annual International
Emission Inventory Conference
Las Vegas, Nevada
April 11–14, 2005



Overview

- Background
- Approach
- Conceptual Paradigm
- GIS-EI Tool Mechanics
- GIS-EI Tool Software
- Closing

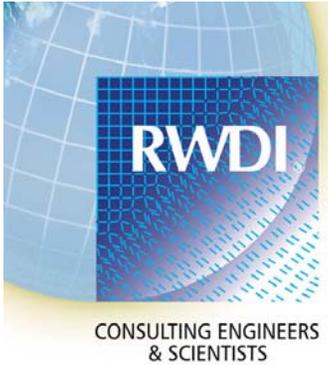


Background

- EC commissioned the development of a powerful, multi-agency GIS solution to enhance air quality management

Minimal Functionality:

1. Create EIs from first principles (*ab initio*)
2. Generate maps, backcast/forecasts and reports
3. Produce emissions data for modelling systems
4. Based on ESRI's ArcGIS software system



Approach

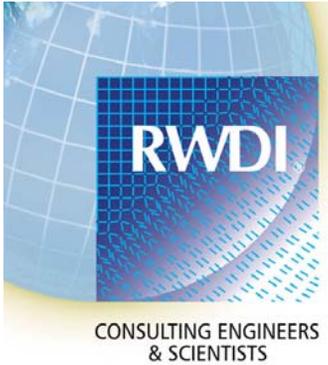
Step 1: Develop a robust data model

Step 2: Prototype land-use and population emissions

Step 3: Land transportation activity-based emissions

Step 4: Emission report generation functionality

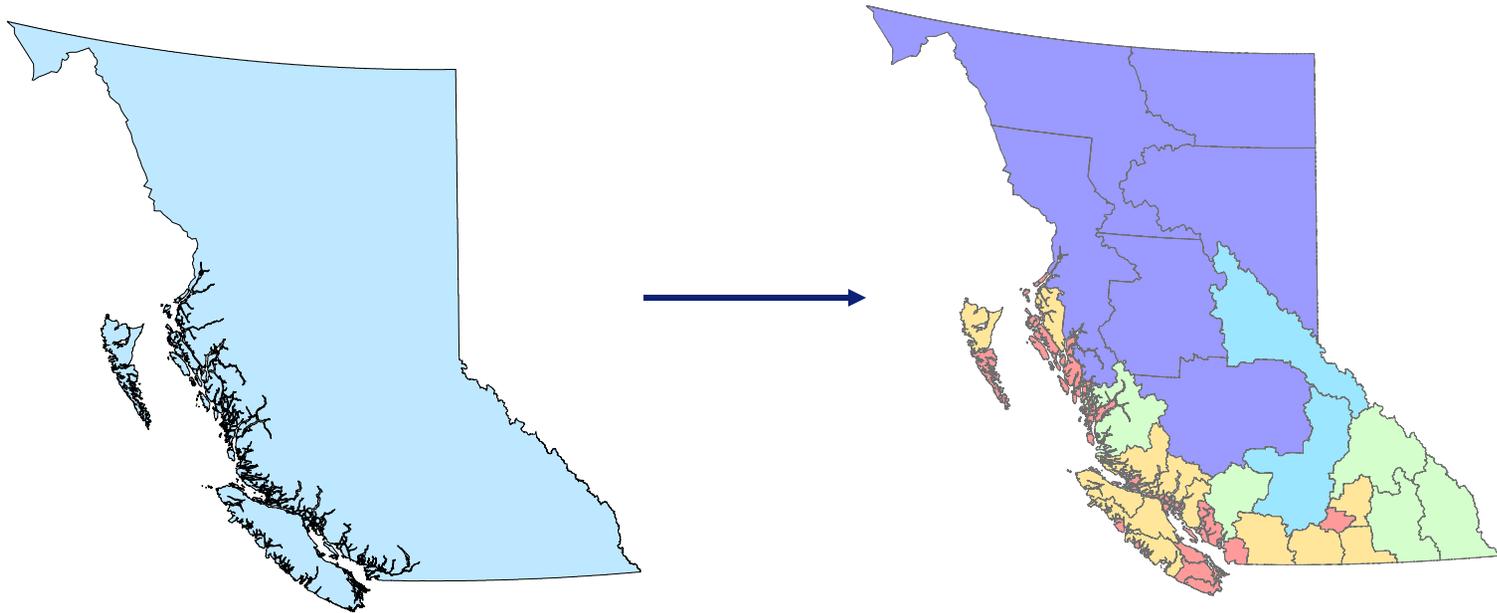
Step 5: Emission model input generation

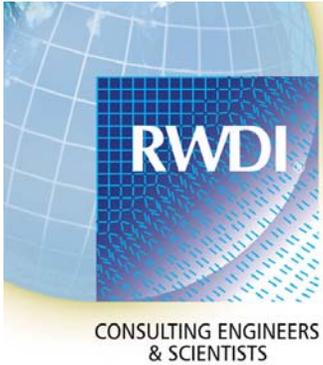


Traditional Conceptual Paradigm

“Top-Down”

- In Canada, national EIs are typically generated using a “top-down” approach

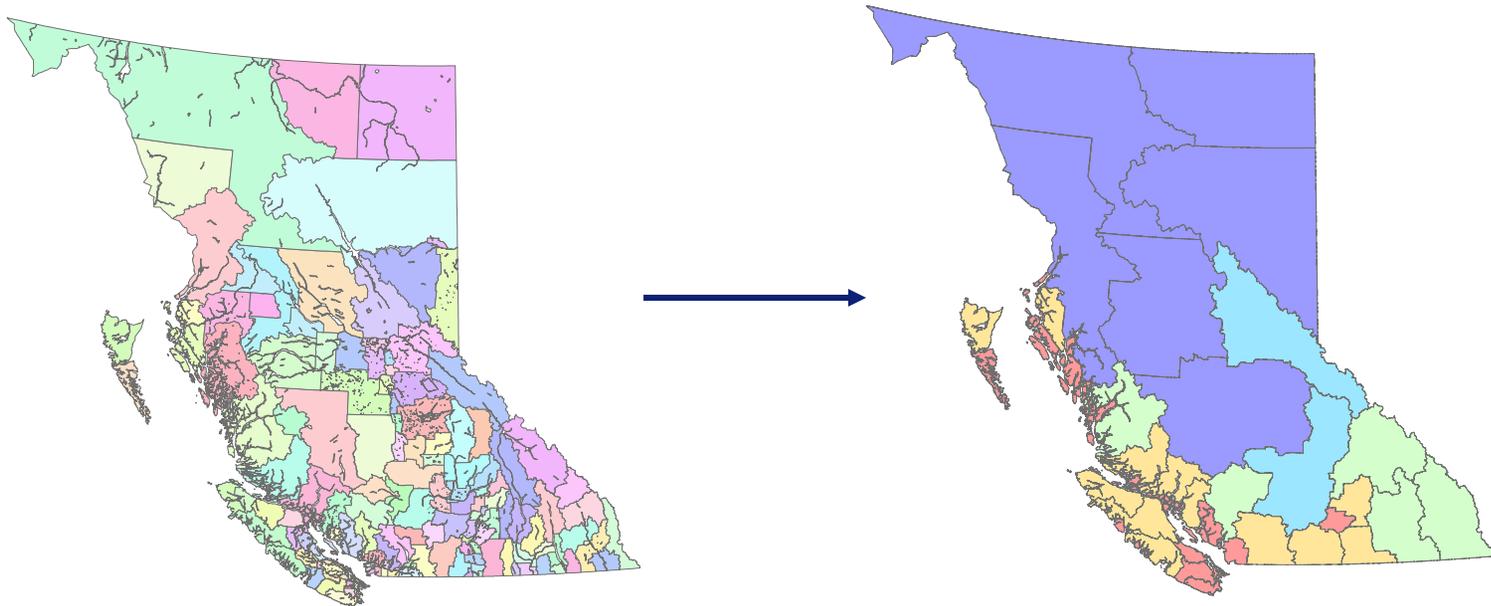


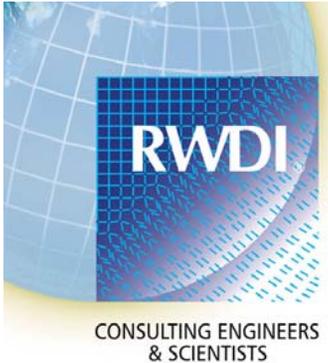


GIS-EI Tool Conceptual Paradigm

“Bottom-Up”

- The GIS-EI Tool is designed using a “bottom-up” approach

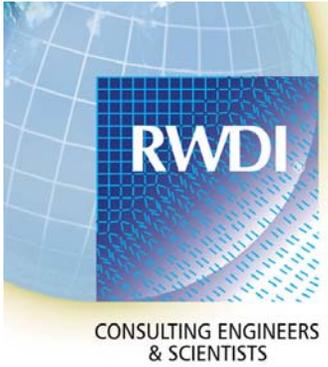




GIS-EI Tool Conceptual Paradigm

Advantages

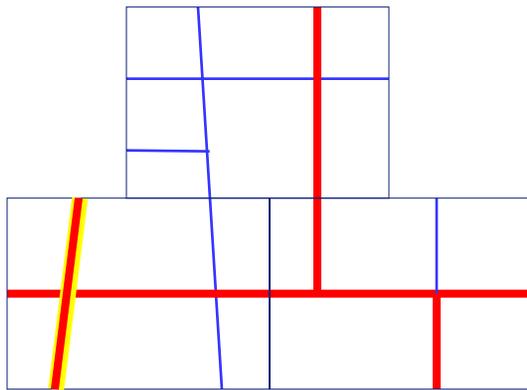
- Much simpler in theory to compute emissions (no disaggregation necessary)
- Different EFs can be applied in different areas for the same source type
- If an attribute is changed in a particular region, you only need to re-compute that region's total, as opposed to re-computing the entire inventory



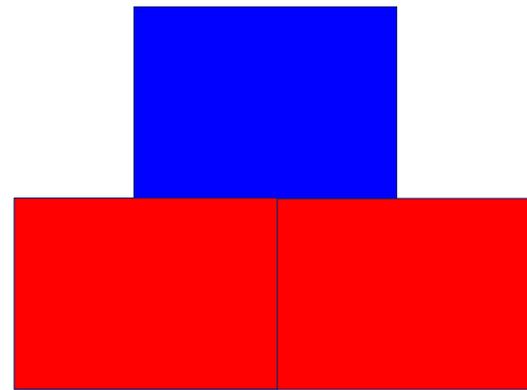
GIS-EI Tool Conceptual Paradigm

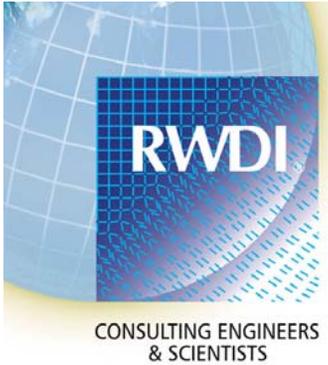
Example: Road Emissions

Road Emissions



Summarized Emissions

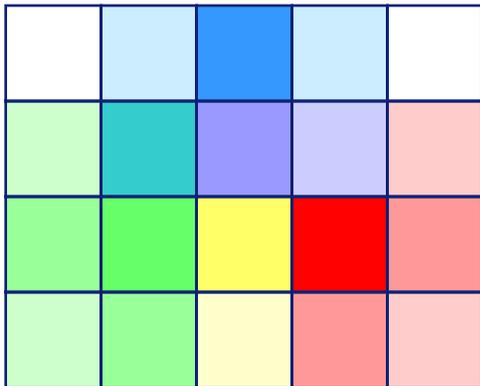




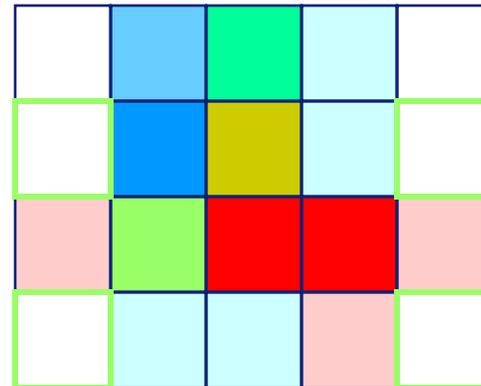
GIS-EI Tool Conceptual Paradigm

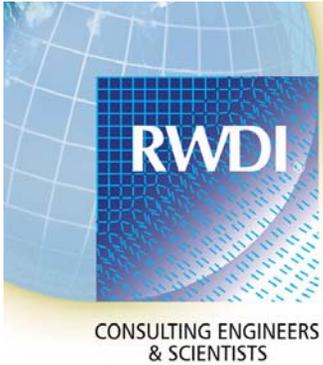
Example: Gridding Road Emissions

Traditional Gridding



GIS-EI Tool Gridding





GIS-EI Tool Mechanics

Emission Estimate (EE)

$$EE = EF \times A \times CF \times SF$$

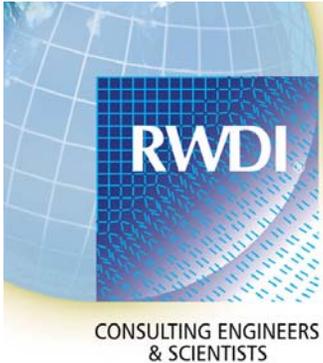
where:

EF = Emission Factor

A = Activity

CF = Control Factor

SF = Scaling Factor



Activity

- Processes that cause pollutants to be released
- Based on the EF and availability of attribute data
- Comprised of a single or combination of attributes
- In the GIS-EI Tool, all necessary attribute data are provided through GIS layers (feature classes)

Examples:

Number of People

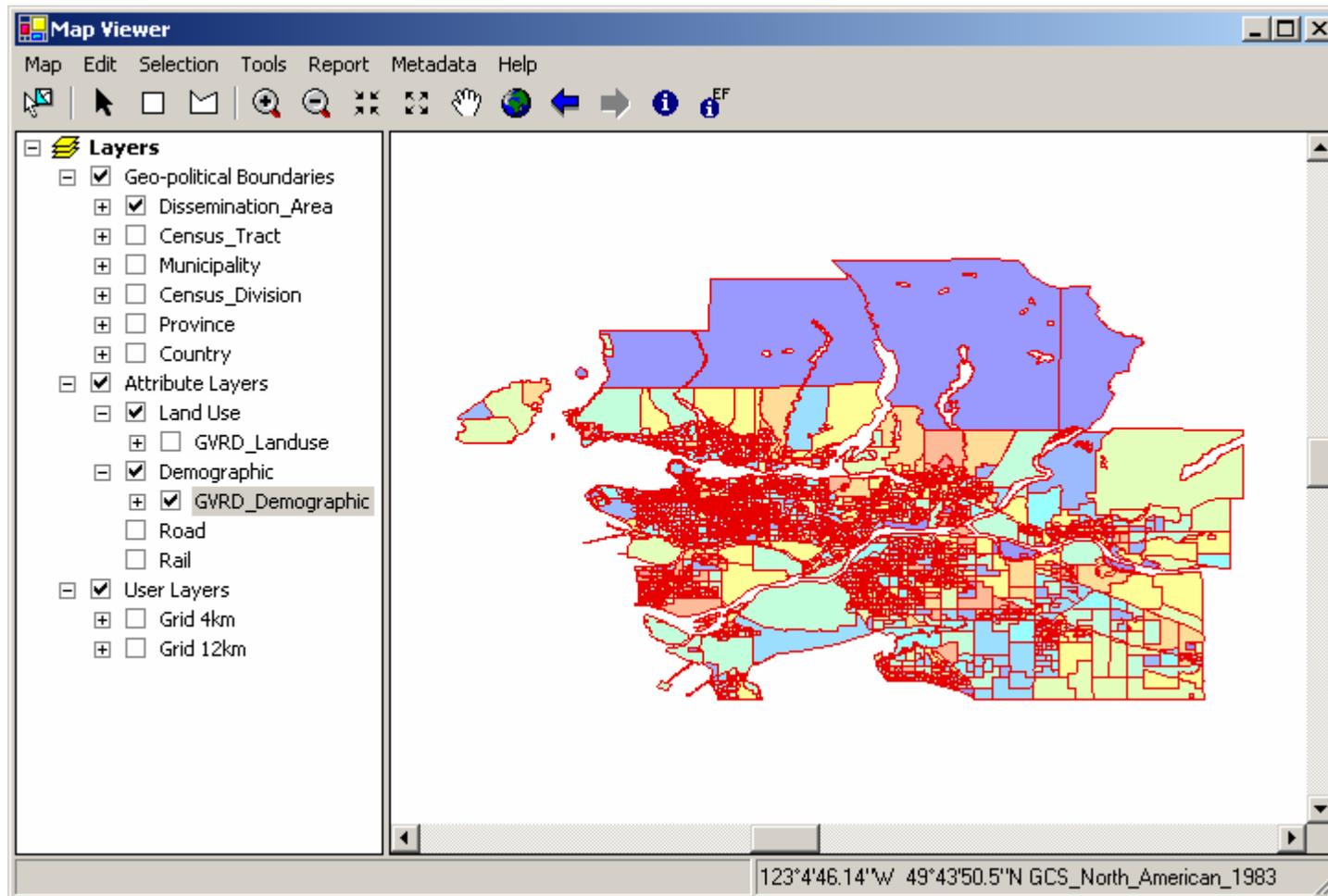
(Number of Lanes) x (Length of Road)

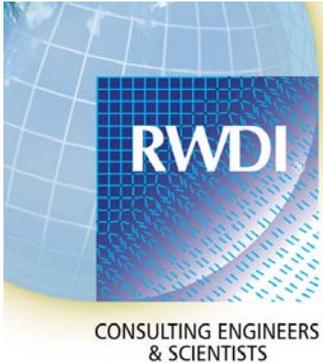
Number of People per Household



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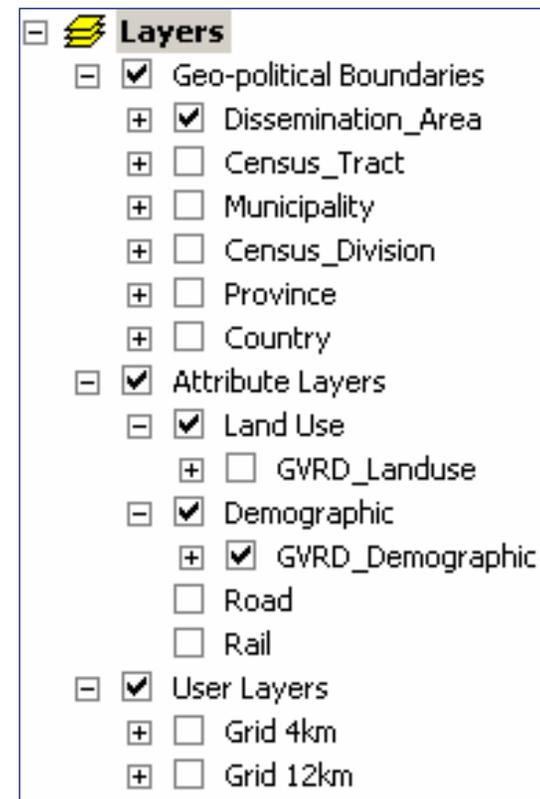
Main Application

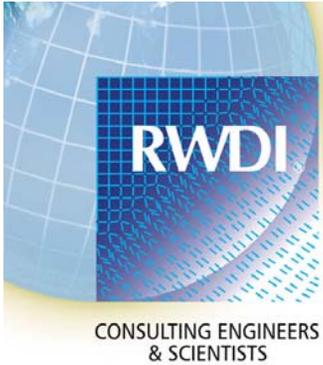




Geo-Political Layers

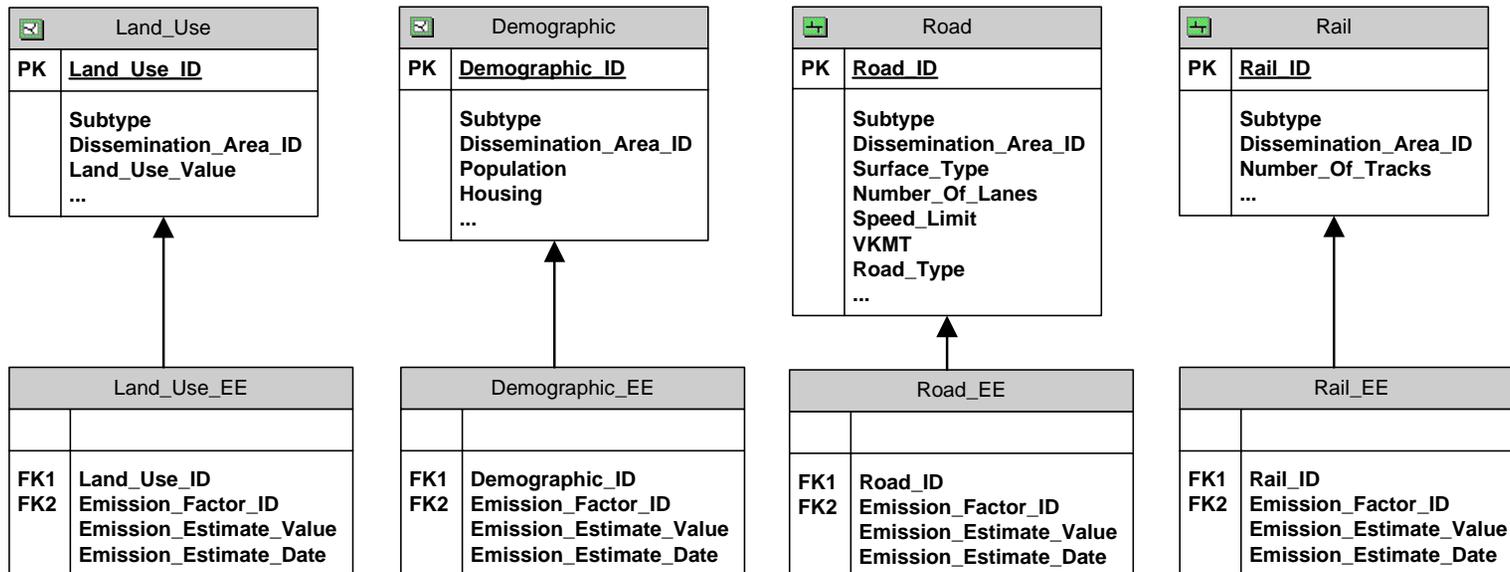
- Polygon-based feature classes that correspond to geo-political elements
- Users interact with them to determine locations for editing factors, computing emissions and extracting inventories
- Smallest geo-political layer is Dissemination Area (foundation of all other geographic layers)

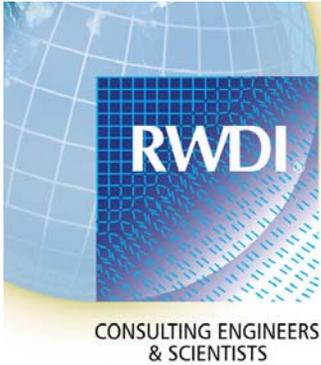




Attribute Feature Classes

- Emissions are computed on a “per feature” basis
- Used to determine the Activity for a given EE
- Associated with a geometry (polygon, line, point)
- Attributes are editable

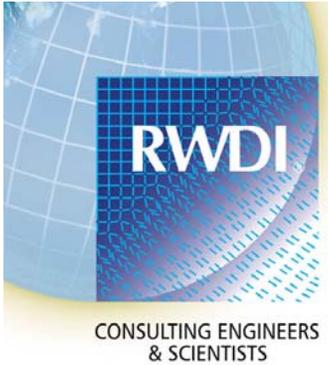




Source Classification Codes

- Primary means of classifying and allocating emissions
- Users can update, modify, or define their own new SCC (U.S. SCCs do not fully describe Canadian sources)
- Source Sectors – user defined groups of SCCs for post-processing and reporting (e.g. NAICS)

Type	SCC	Level1	Level2	Level3	Level4
AREA	2101001000	Stationary Source Fuel Co...	Electric Utility	Anthracite Coal	Total: All Boil...
AREA	2101002000	Stationary Source Fuel Co...	Electric Utility	Bituminous/Subbituminous ...	Total: All Boil...
AREA	2101003000	Stationary Source Fuel Co...	Electric Utility	Lignite Coal	Total: All Boil...
AREA	2101004000	Stationary Source Fuel Co...	Electric Utility	Distillate Oil	Total: Boilers
AREA	2101004001	Stationary Source Fuel Co...	Electric Utility	Distillate Oil	All Boiler Typ...
AREA	2101004002	Stationary Source Fuel Co...	Electric Utility	Distillate Oil	All IC Engine
AREA	2101005000	Stationary Source Fuel Co...	Electric Utility	Residual Oil	Total: All Boil...
AREA	2101006000	Stationary Source Fuel Co...	Electric Utility	Natural Gas	Total: Boilers
AREA	2101006001	Stationary Source Fuel Co...	Electric Utility	Natural Gas	All Boiler Typ...
AREA	2101006002	Stationary Source Fuel Co...	Electric Utility	Natural Gas	All IC Engine
AREA	2101007000	Stationary Source Fuel Co...	Electric Utility	Liquified Petroleum Gas (L...	Total: All Boil...
AREA	2101008000	Stationary Source Fuel Co...	Electric Utility	Wood	Total: All Boil...
AREA	2101009000	Stationary Source Fuel Co...	Electric Utility	Petroleum Coke	Total: All Boil...
AREA	2101010000	Stationary Source Fuel Co...	Electric Utility	Process Gas	Total: All Boil...
AREA	2102001000	Stationary Source Fuel Co...	Industrial	Anthracite Coal	Total: All Boil...
AREA	2102002000	Stationary Source Fuel Co...	Industrial	Bituminous/Subbituminous ...	Total: All Boil...
AREA	2102004000	Stationary Source Fuel Co...	Industrial	Distillate Oil	Total: Boilers
AREA	2102005000	Stationary Source Fuel Co...	Industrial	Residual Oil	Total: All Boil...
AREA	2102006000	Stationary Source Fuel Co...	Industrial	Natural Gas	Total: Boilers
AREA	2102006001	Stationary Source Fuel Co...	Industrial	Natural Gas	All Boiler Typ...
AREA	2102006002	Stationary Source Fuel Co...	Industrial	Natural Gas	All IC Engine
AREA	2102007000	Stationary Source Fuel Co...	Industrial	Liquified Petroleum Gas (L...	Total: All Boil...
AREA	2102008000	Stationary Source Fuel Co...	Industrial	Wood	Total: All Boil...
AREA	2102009000	Stationary Source Fuel Co...	Industrial	Petroleum Coke	Total: All Boil...



Emission Estimates

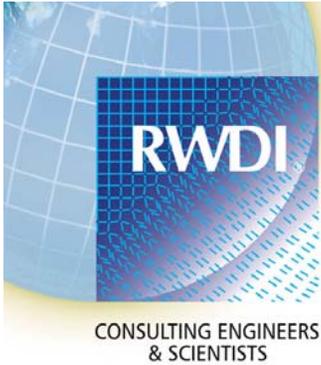
- The base element that makes up an EI within the GIS-EI Tool
- Viewer for users to display existing EFs

The screenshot shows a dialog box titled "Emission Factors" with a close button (X) in the top right corner. The dialog is divided into several sections:

- Select SCC:** A text field containing "AREA - 2810003000 - Miscellaneous Area Sources - Other Combustion - Cigarette Smoke" and a "Search" button to its right.
- Select Pollutant:** A table with columns for "Short Name", "Full Name", and "CAS". It contains five rows, each with a checkbox in the first column:

Short Name	Full Name	CAS
<input type="checkbox"/> CH4	Methane	74-82-8
<input type="checkbox"/> CO	Carbon Monoxide	630-08-0
<input checked="" type="checkbox"/> CO2	Carbon Dioxide	124-38-9
<input type="checkbox"/> HFC	Hydrofluorocarbon	420-46-6
<input type="checkbox"/> N2O	Nitrous Oxide	10024-97-2
- Enter Emission Factor Information:** A section with five input fields: "Factor" (0.01), "Units" (tonnes/person/year), "Conv. Factor" (1), "Activity" (Population in GVRD), and "Units" (people). The "per" text is placed between the Conv. Factor and Activity fields.
- Enter Optional Factors:** A section with a "Scalar Multiplier" field (1.0) and a "Control" field showing a calculation: $1.0 = 1.0 \cdot 0.0 \times 0.0 \times 0.0$. The fields for "Control Efficiency", "Rule Effectiveness", and "Rule Penetration" are all set to 0.0.

At the bottom of the dialog are three buttons: "OK", "Apply", and "Cancel".



Exporting

The following export options are available:

1. Map Viewer Images
2. SMOKE-ready Spatial Surrogates
3. SMOKE-ready Emission Files (IDA)
4. Delimited ASCII Text Files

Surrogate Apportionment

Grid: Activity: people

Columns: 172 Rows: 103

Spatial Surrogate Code:

Output File:

Report - Export EI - Text

Layer: Geo-Political Layer User Polygon Layer Grid 4km Label Field: CELL_ROW CELL_COL

Source Classification Codes

Type	SCC	Level1	Level2	Level3	Level4
<input type="checkbox"/>	AR...	2101002000	Stationary Source Fu...	Electric Utility	Bituminous/Subbitumi... Total: All Boiler Types
<input type="checkbox"/>	AR...	2101003000	Stationary Source Fu...	Electric Utility	Lignite Coal Total: All Boiler Types
<input checked="" type="checkbox"/>	AR...	2101004000	Stationary Source Fu...	Electric Utility	Distillate Oil Total: Boilers and IC ...
<input checked="" type="checkbox"/>	AR...	2101004001	Stationary Source Fu...	Electric Utility	Distillate Oil All Boiler Types
<input checked="" type="checkbox"/>	AR...	2101004002	Stationary Source Fu...	Electric Utility	Distillate Oil All IC Engine Types
<input type="checkbox"/>	AR...	2101005000	Stationary Source Fu...	Electric Utility	Residual Oil Total: All Boiler Types

Source Sectors

Source Classification Sche...	Code	Name
<input type="checkbox"/>	NAICS	111191 Oilseed and Grain Combina...
<input type="checkbox"/>	NAICS	111120 Oilseed (except Soybean) ...
<input type="checkbox"/>	NAICS	111160 Rice Farming
<input type="checkbox"/>	NAICS	111150 Corn Farming

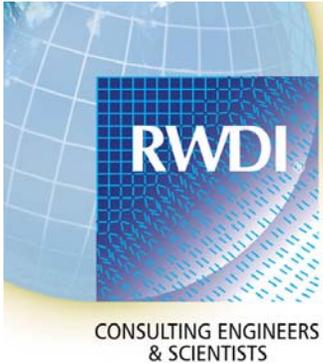
Pollutants

Short Name	Full Name	CAS
<input checked="" type="checkbox"/>	CH4	Methane 74-82-8
<input checked="" type="checkbox"/>	CO	Carbon Monoxide 630-08-0
<input type="checkbox"/>	CO2	Carbon Dioxide 124-38-9
<input type="checkbox"/>	HFC	Hydrofluorocarbon 420-46-6

Pollutant Groups

CAC
 Greenhouse Gases

Output File:



Closing

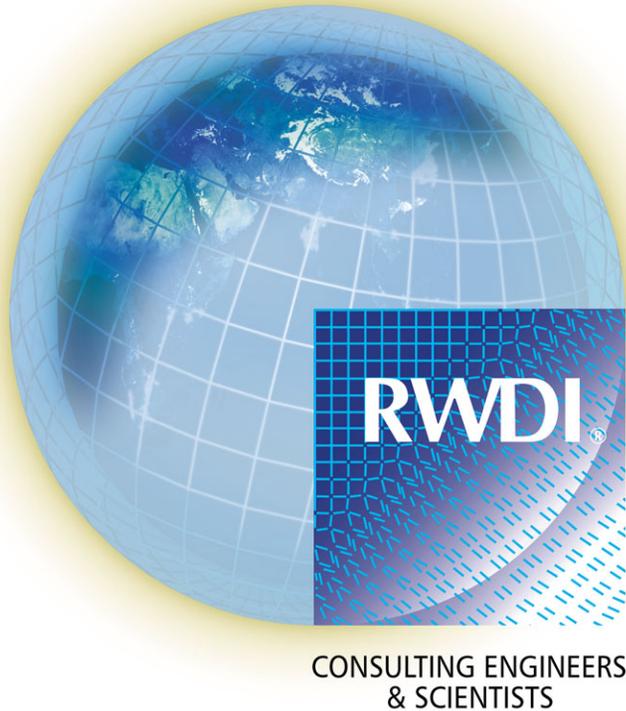
Phase 1 development is nearing completion

- Compute population and land-use based emissions
- Compute emissions from road and rail networks
- Export to SMOKE-ready input files and other formats

Phase 2 and Beyond:

- Import additional attribute feature classes
- Upload/output data tables (EFs, SCCs, etc.)
- Backcast/Forecast
- More robust metadata
- Advanced QA/QC tools
- Integration of pre-generated point and biogenic sources
- Location independent, simultaneous multi-user access
- Version control and Scenario Management

REPUTATION RESOURCES RESULTS



Acknowledgments

- ESRI Canada
- Greater Vancouver Regional District
- BC Ministry of Water Land and Air Protection
- Environment Canada, Pollution Data Branch
- Environment Canada, Pacific & Yukon Region

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