

Critical Infrastructure Study: Towards Extreme Weather Resilience

Toronto Environment Office

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Sanford Fleming Forum



Agenda

- Toronto Environment Office (10 min)
 - Rational for action on adaptation
 - Initiatives
 - WeatherWise Partnership
- Critical Infrastructure Study (30 min)
 - Context
 - Concept
 - Progress
 - Challenges
 - Next Steps

**AHEAD OF THE
STORM:
Extreme Weather
Resilience in
the City of Toronto**

Recent Canadian Catastrophic Events

- Ice Storm (January 1998)
 - **\$2 billion (2005 dollars)**
- Slave Lake wildfire
 - **\$700 million**
- GTA rainstorm (August 19, 2005)
 - **\$647 million**
- Calgary area windstorm (July 2009)
 - **\$500 million**
- Calgary hailstorm (July 2010)
 - **>\$400 million**
- B.C. wildfires (Summer 2003)
 - **\$200 million**
- Edmonton floods (July 2004)
 - **\$170 million**
- Hurricane Juan (September 2003)
 - **\$115 million**

Model: 2040

Warmer Temps

- *Average annual temp increase by 4.4°C*
- **Average winter temp. increases by 5.7°C**
- **Average summer temp. increases by 3.8°C**
- **Extreme daily min. temp warmer by 13°C**
- **Extreme daily max. temp warmer by 7.6°C**

Vaughan, Ont. tornadoes



Health risks

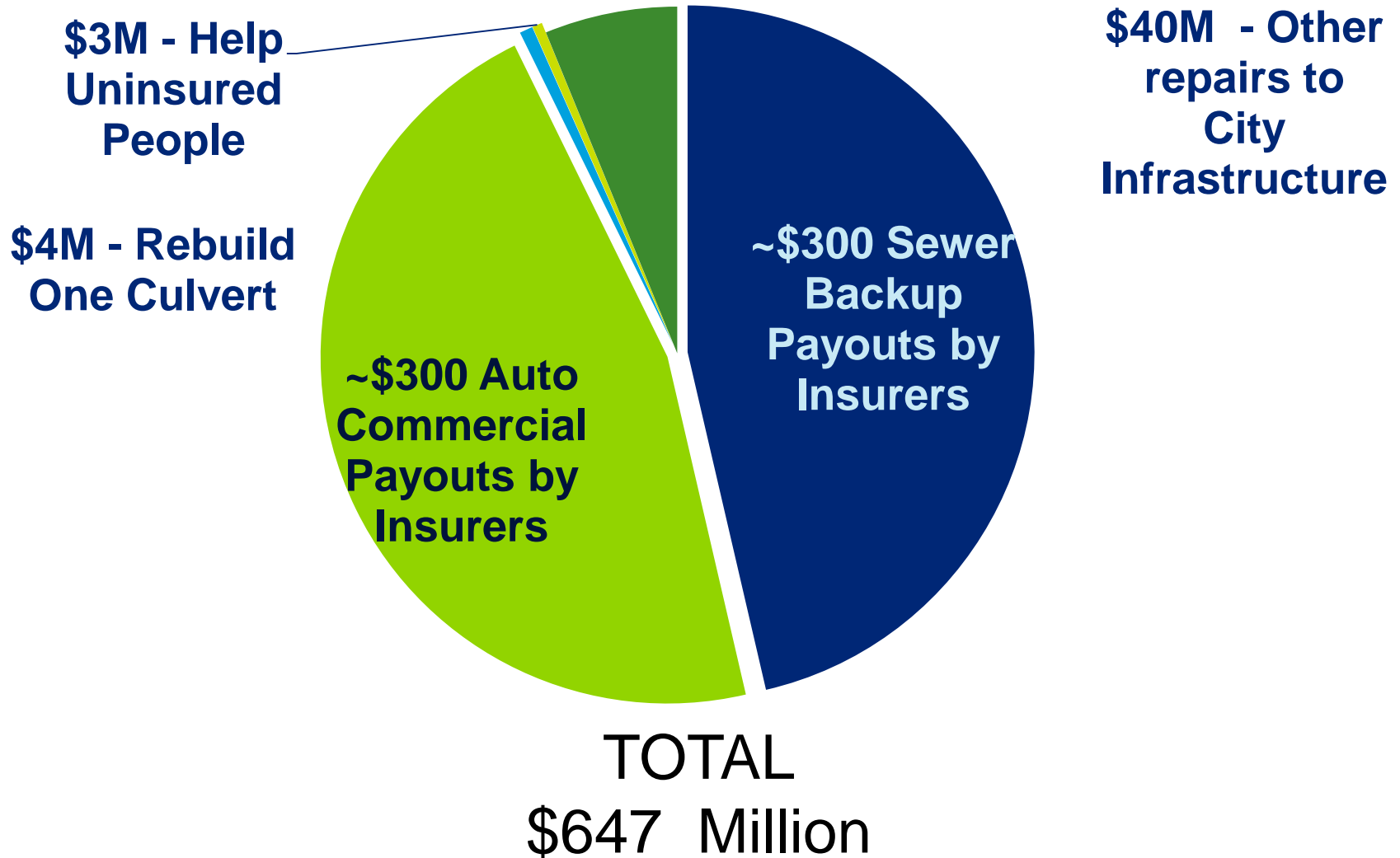






Photos courtesy
Jane-Finch.com

Toronto: August 2005 Storm



Climate Change Risk: Drivers & Challenges

Drivers

- Safety: avoid harm to residents & staff
- Customer service
- Cost avoidance:
 - damage from extreme weather
 - credit & insurance risk rating of City & taxpayers
- Legal liability of organizations & individuals
- Evidence of due diligence

Challenges

- Outdated climate info, codes & standards & procurement policies
- Increasing concentration of built assets
- Aging infrastructure
- Resident behavior & expectations

Climate Change Risk Assessment

Process & Tool developed (Deloitte)

2 Pilots completed:

Roads dept. & Shelter / Support

Roads dept.  **\$12.1 B** replacement value

- 2** time periods: now & 2040
- 7** extreme weather types
- 90** critical asset & service classes
- 15** workshops
- 1700** risk scenarios

Low cost solution.....
where possible



PART No: 111100001
SERIAL No: 111100001
PEEK
TRAFFIC
Cabinet

CAUTION:
HAZARDOUS VOLTA
OR ADJUSTMENTS

FOR PROPER AND
MAINTENANCE IS
MANUAL FOR PER
PROCEDURES

THIS CONTROL
INTERLOCKED
CONFLICT MO
CONFLICT MO

CHANGE THE
TIME OR SET
THEM AFTER

NOTE:

THIS CABINET IS
TS2 1928 STAN
AND MONITOR
IN ACCORDANC

WARNING

UTILIZATION
ACCORDANC
WILL NOT
TRANSFER
THEREFOR
SHOULD E
BEFORE

CH13/14

Basement Flood Program \$743 Million investment over 10 years



Sometimes low cost is not possible

WeatherWise Partnership

60 Participating Organizations

- Insurance, Banking, Telecom, Transportation, Electrical, Real estate, Water, 3 levels of gov't

Purpose

- ID & manage risks to critical infrastructure & services due to extreme weather in Toronto region

Focus for 2012: Electrical system

Focus for 2013: TBD on Nov. 19

The Critical Infrastructure Study

Project Objectives

1. Understand Critical Infrastructure interdependence & city reliance on these sectors.
2. Inform & enhance collaboration with key stakeholders towards building resilience to extreme weather events.
3. Proof of Concept.



Context: Protection vs. Resilience

Critical Infrastructure Protection:

Developing ability of infrastructure to absorb & withstand effects of an incident.



Resilience: Our chosen focus

Critical Infrastructure Resilience:

Developing the ability of infrastructure and surrounding systems to adapt to the consequences of a catastrophic failure



Why TEO

- Climate change/ Extreme weather mandate
- Facilitators of multi-sectoral action regarding extreme weather

Definitions

- **Core Function:** An essential service that must continue in an emergency to ensure the health, safety, and general welfare of residents.
- **Component:** Service, infrastructure or human resource required to support a Core Function.
- **Component Map:** A large diagram showing the relationships between components that are relied upon to deliver a Core Function.
- **Trace:** The process of 'tracing' a specific Critical Infrastructure through the Core Function to get an understanding of where it is relied upon.

Assumptions

1. Extreme weather events can cause **damage to multiple critical infrastructures simultaneously & lead to cascading effects**
2. **Core Functions are considered equal** in their value to a functioning city
3. **Resilience has not been built** into critical infrastructure
4. **Core Functions will be provided to all residents** in the City at the time of an extreme weather event
5. Unacceptable for Critical Infrastructure to operate **below normal capacity**
6. Prevalence of a component supporting a Core Function reflects a **dependency, but cannot represent criticality**

Project Stages & Outcomes

1. **Identify Core Functions of Toronto.**
2. **Component Map:** Map demonstrating interdependency between critical infrastructure sectors & Core Functions.
3. **Trace:** List of the relationships between Critical Infrastructure.
4. **Causal Chain:** Diagram demonstrating how a hypothetical sequence of events creates cascading impacts.

Core Functions in Toronto

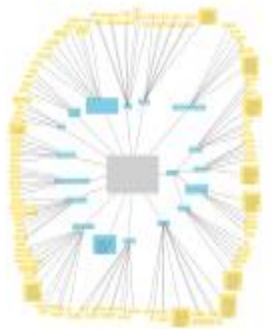
Core Functions	Definition
Transportation	Air, Rail, Road, Streetcar, Subway, Ferry, Bus, Trucking, Shipping
Payment System	Internet Access, Use of Cash, Access to Cash, Point of Sale, Movement of Cash
Sustenance for Residents	Water Supply, Food Supply
Shelter for Resident Population	Environmental Shelter, Emergency Shelter
Communications System	Optic, Radio, Satellite & Telephone Networks, Print, Personnel
Sanitation	Solid Waste, Sewage, Disaster Victim ID & Mortuaries, Industrial Waste, Medical Waste, Drainage
Emergency Response	Police, EMS, Fire , Others (e.g. Army)
Medical Care	Existing Hospitalized, Long-Term Care, Vulnerable & Infirm, Access to Meds, Access to Treatment, Emergency Rooms

Component Mapping

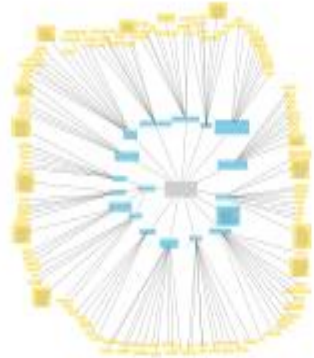
- **Objective**
 - To gain a visual understanding of interdependencies between Critical Infrastructure & Core Functions
- **Approach**
 - Develop rules for mapping consistency
 - Meta-level systems in first level
 - Research & ID components relied upon for delivery of Core Function
 - Verify

Transportation Component Map

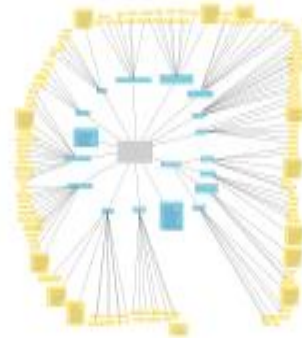
Streetcar



Subway



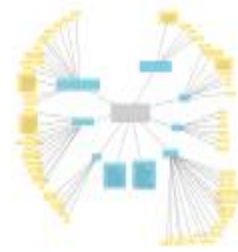
Train



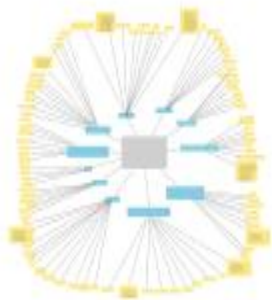
Shipping



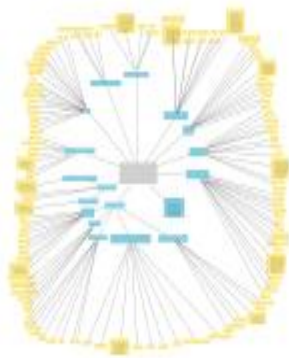
Trucking



Road



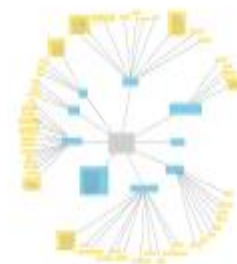
Aviation

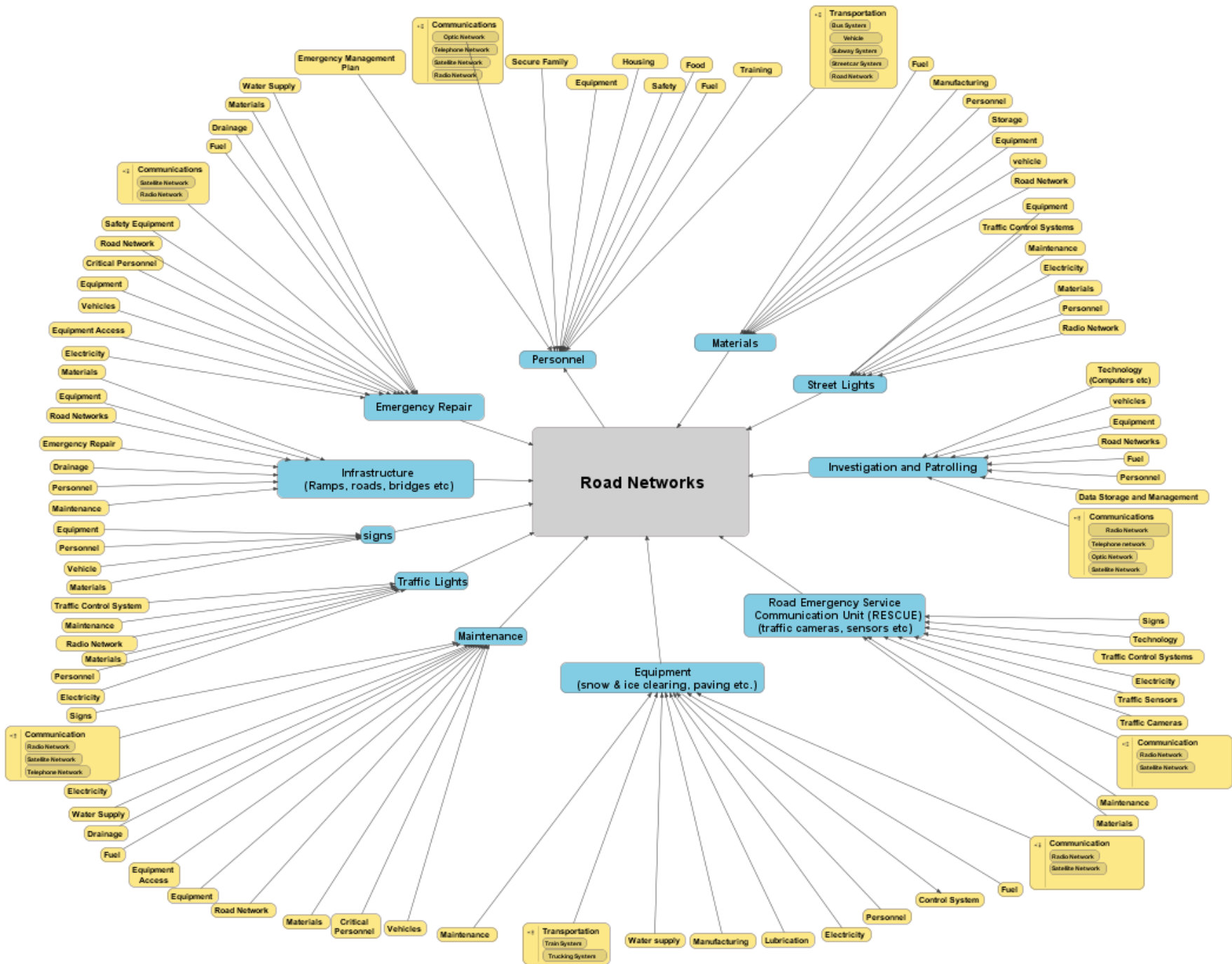


Ferry

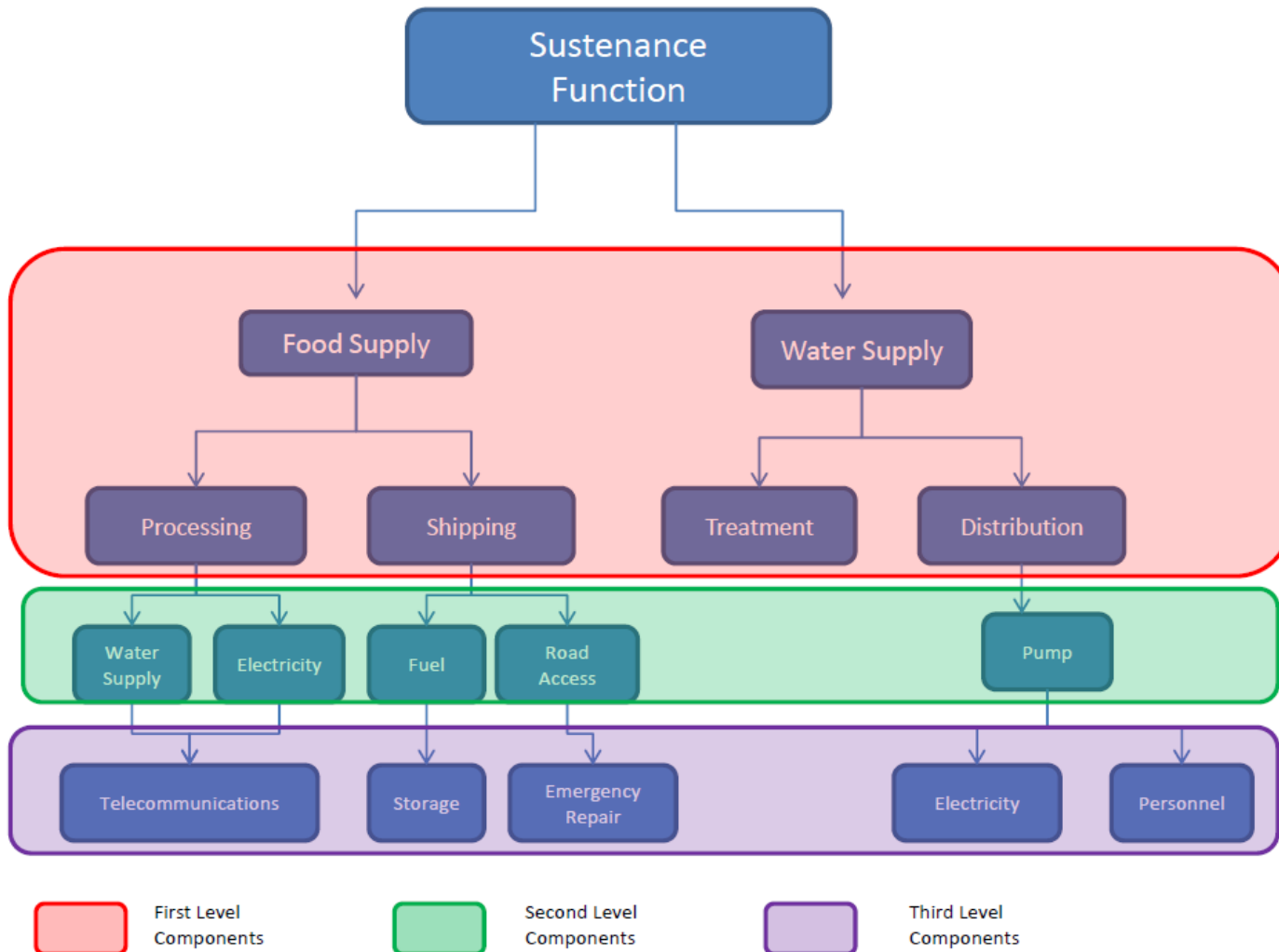


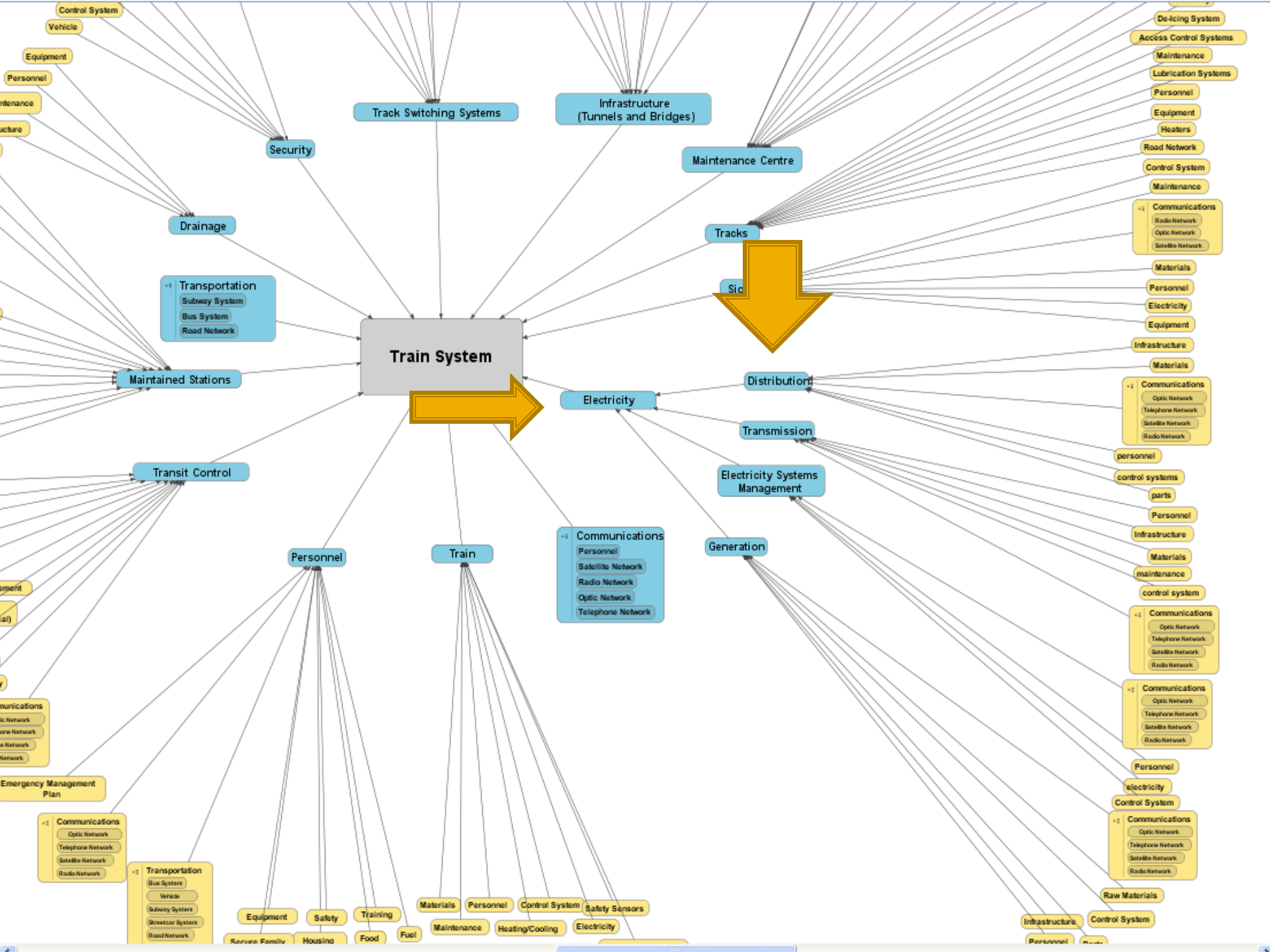
Bus





Component Map Structure Rules

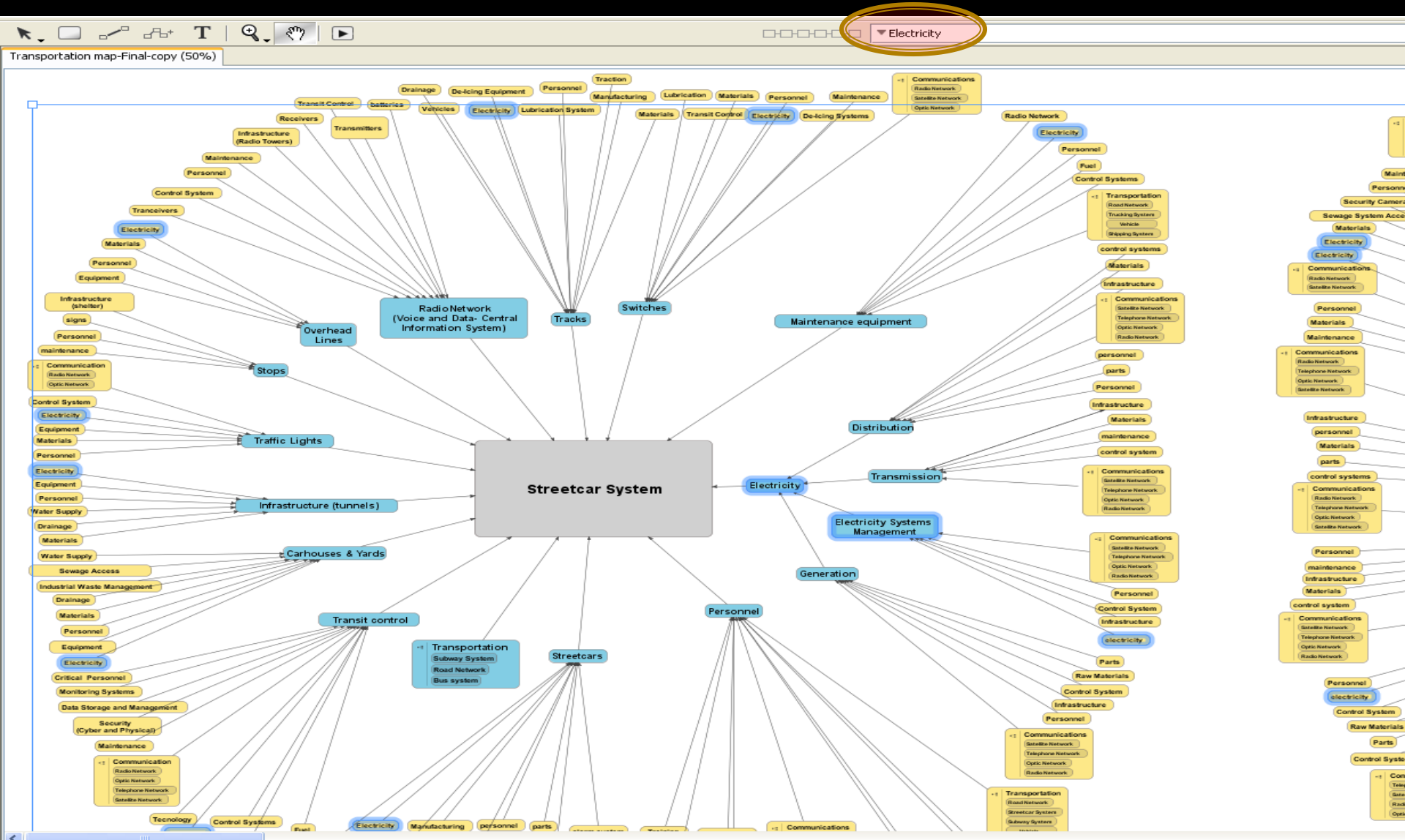




Critical Infrastructure Traces

- **Objective :**
 - List relationships between Core Functions & Critical Infrastructure in a way that allows .
- **Approach**
 - Determine information requirements
 - Design a Trace
 - Develop rules for Tracing consistency
 - Complete a Trace for each Critical Infrastructure throughout each Core Function

Example of Electricity Trace through Transportation Component Map



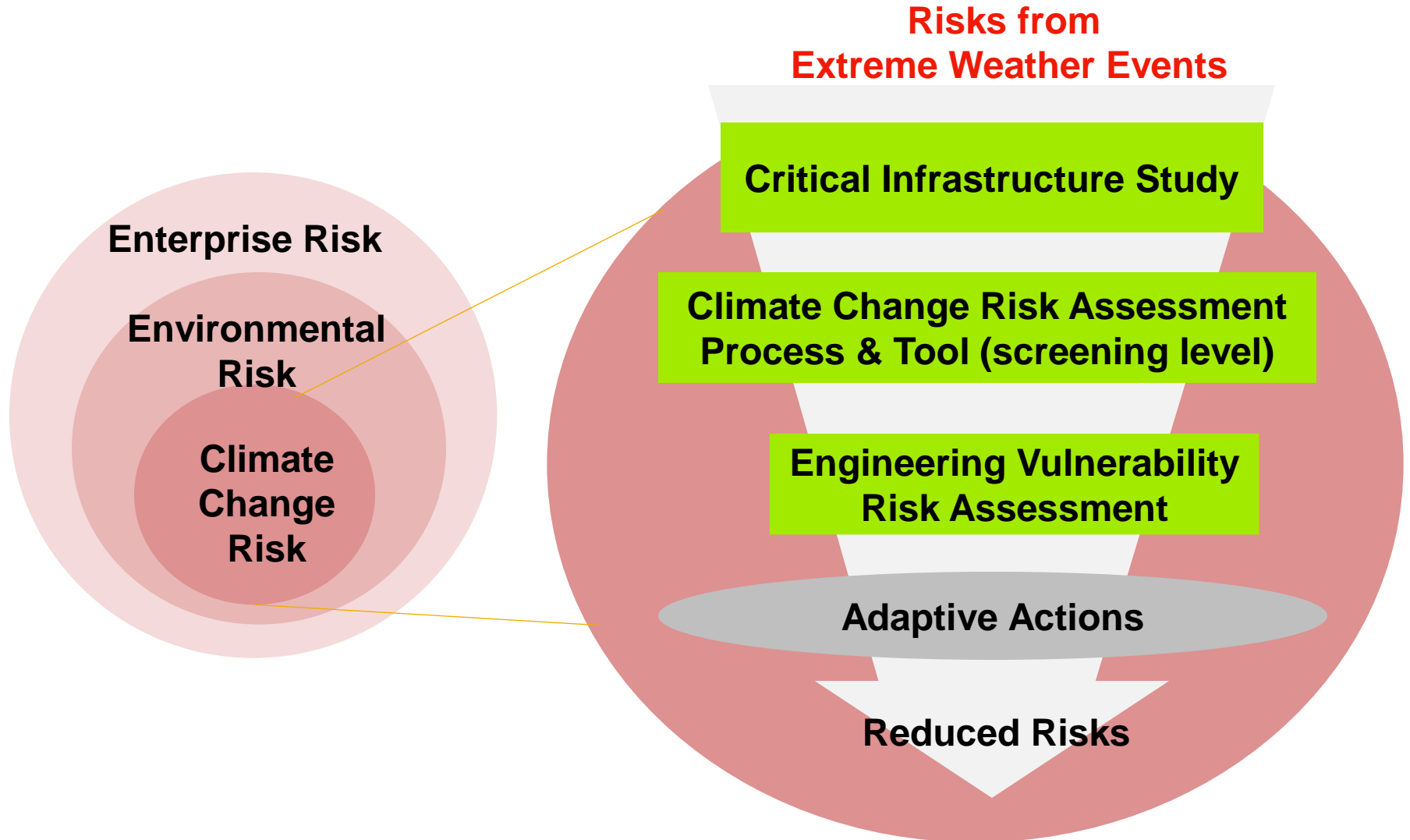
Project Challenges

- Municipal Freedom of Information & Protection of Privacy Act (MFIPPA)
- Stakeholder involvement
- Time & staff commitment

Next steps requiring protection of sensitive information

- GIS mapping of the Traces
 - A Trace that has been transferred to a geographic map in order to identify specific infrastructure that appear within the trace.
- Causal Chains
 - A diagram demonstrating how a hypothetical sequence of events creates cascading impacts.

Next Steps: Stakeholder Engagement



THANK YOU!

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