

An aerial photograph of Vancouver, British Columbia, showing the city skyline, the harbor with many boats, and the surrounding mountains. A large green rectangular box is overlaid on the center of the image, containing the title and logo.

Earthquake Preparedness Strategy Update



Overview

- 
- An aerial photograph of Vancouver, British Columbia, Canada. The central focus is the Vancouver City Hall, a large, light-colored, modern building with two clock faces on its facade. A Canadian flag flies from a tall pole on the roof. The city is spread out around the hall, with various residential and commercial buildings visible. In the background, the city meets the water, and the mountains of the Coast Range are visible under a partly cloudy sky. A large green rectangular overlay is positioned in the center of the image, containing a bulleted list of four items. The list is white text on a green background. The background image shows a mix of urban development, green spaces, and a major road in the foreground with cars and a truck.
- Background
 - Current Response Capability
 - Assessing the Risk
 - Reducing the Risk & Preparing to Respond

- Assess risks and redundancy in lifelines
- Assess seismic state of public buildings and infrastructure
- Report back with a strategy for seismic improvement of private buildings
- Enhance public preparedness – including drills and exercises



ASSESS RISK

- Assessments of buildings and bridges
- Hazard Risk Vulnerability Assessment

REDUCE RISK

- Seismic upgrades to bridges
- Non-structural retrofit of City buildings
- Enhanced public preparedness education
- Building code improvements

PREPARE TO RESPOND/RECOVER

- Dedicated fire protection system
- Heavy urban search & rescue team
- Consolidated radio & dispatch for fire and police (E-Comm)
- Emergency supply containers
- Emergency operations centre

1990-2010

Earthquake science
has evolved

Capacity to model
earthquakes has
advanced

Learnings from
CHILE,
CHRISTCHURCH,
& JAPAN

2011

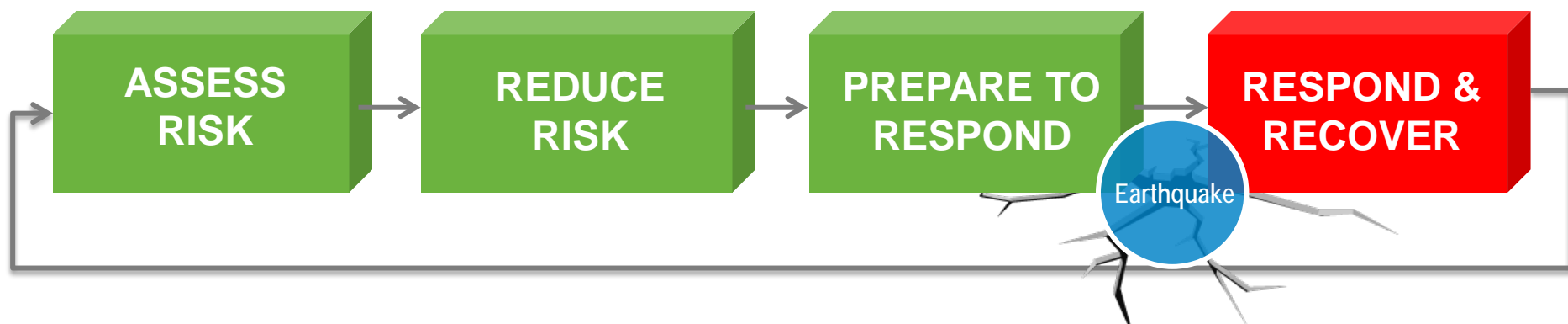
Development of the
Earthquake
Preparedness
Strategy

Concurrent
implementation of
Quick Win initiatives

2012-2013

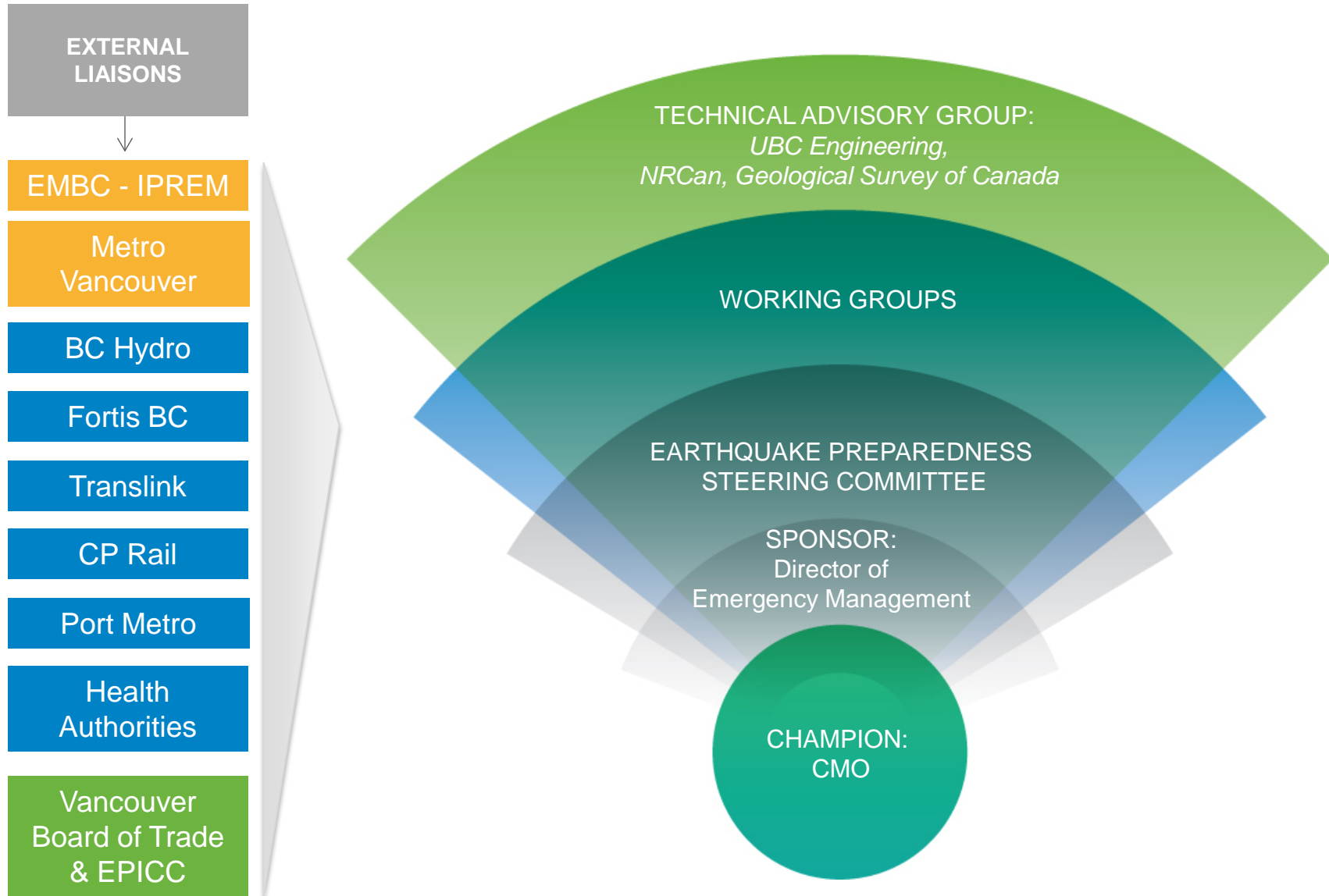
The Strategy: 56 Actions Over 5 years

12 Primary Actions + **44** Supporting Actions

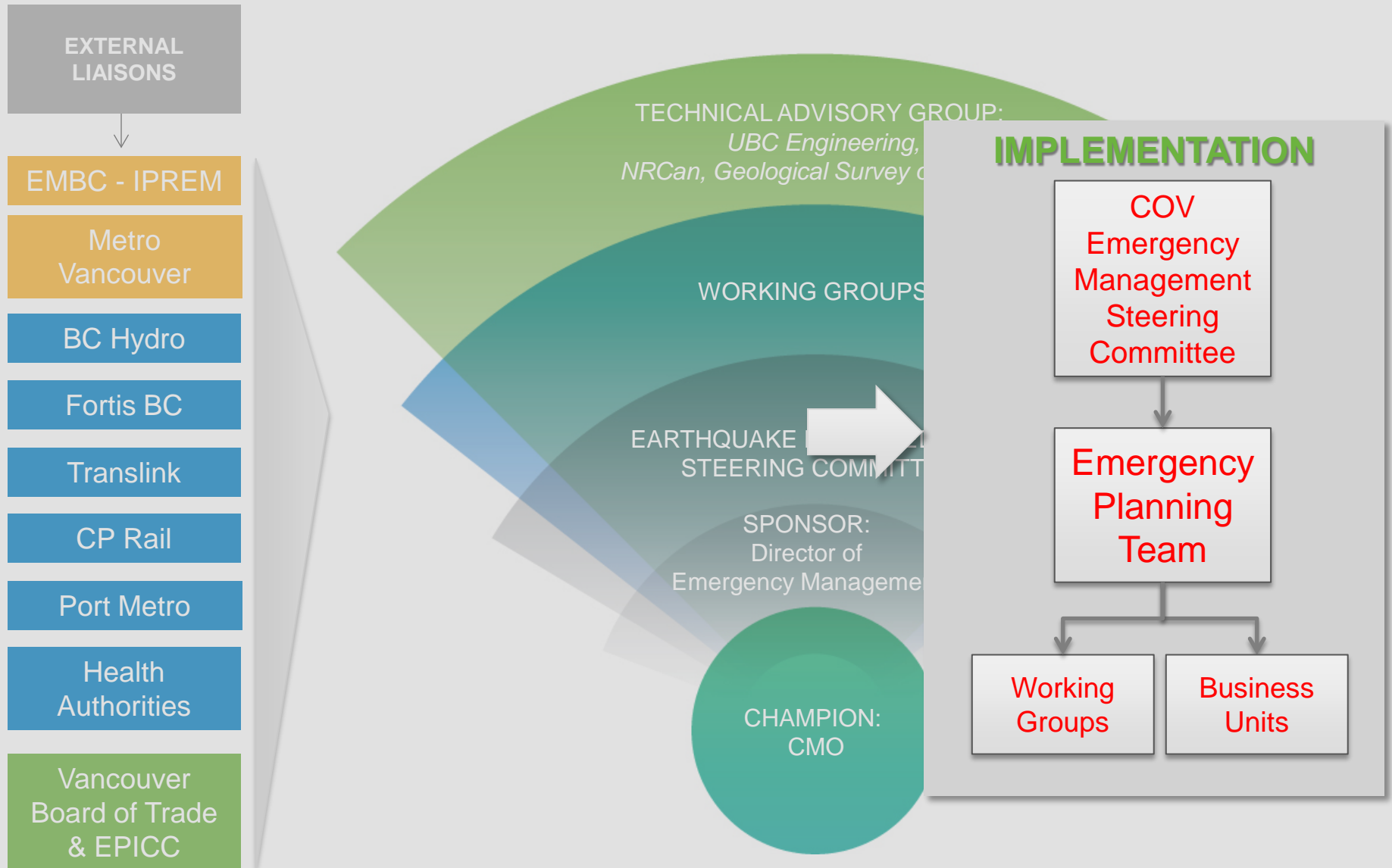


Increased efforts to **REDUCE RISK** lead to faster **RECOVERY**

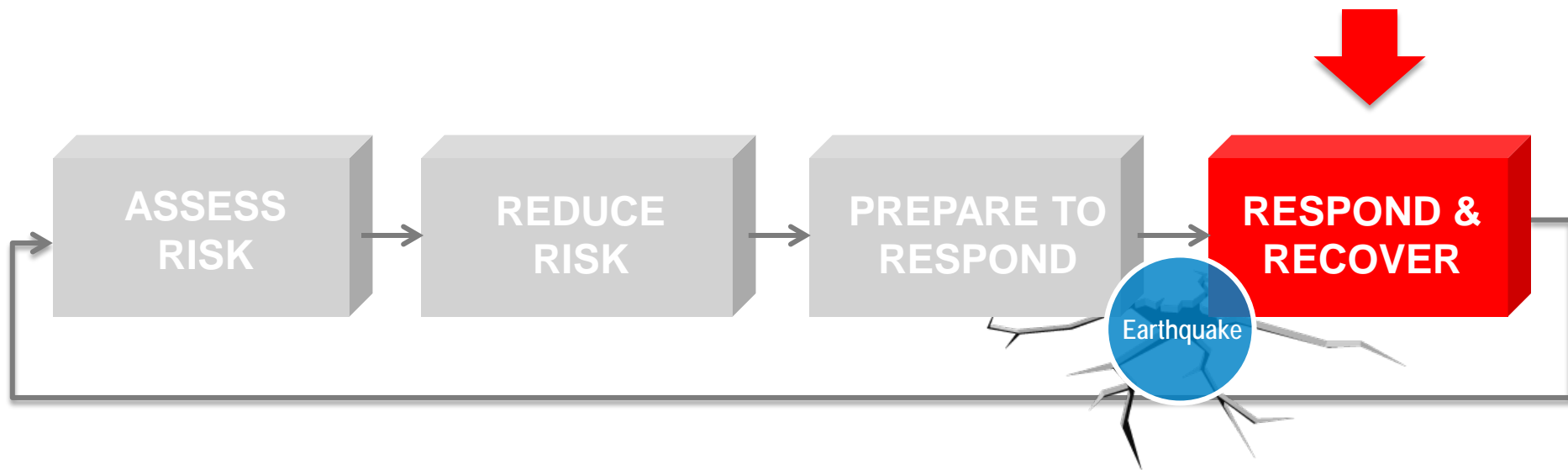
Partners and Organizing Structure



Partners and Organizing Structure

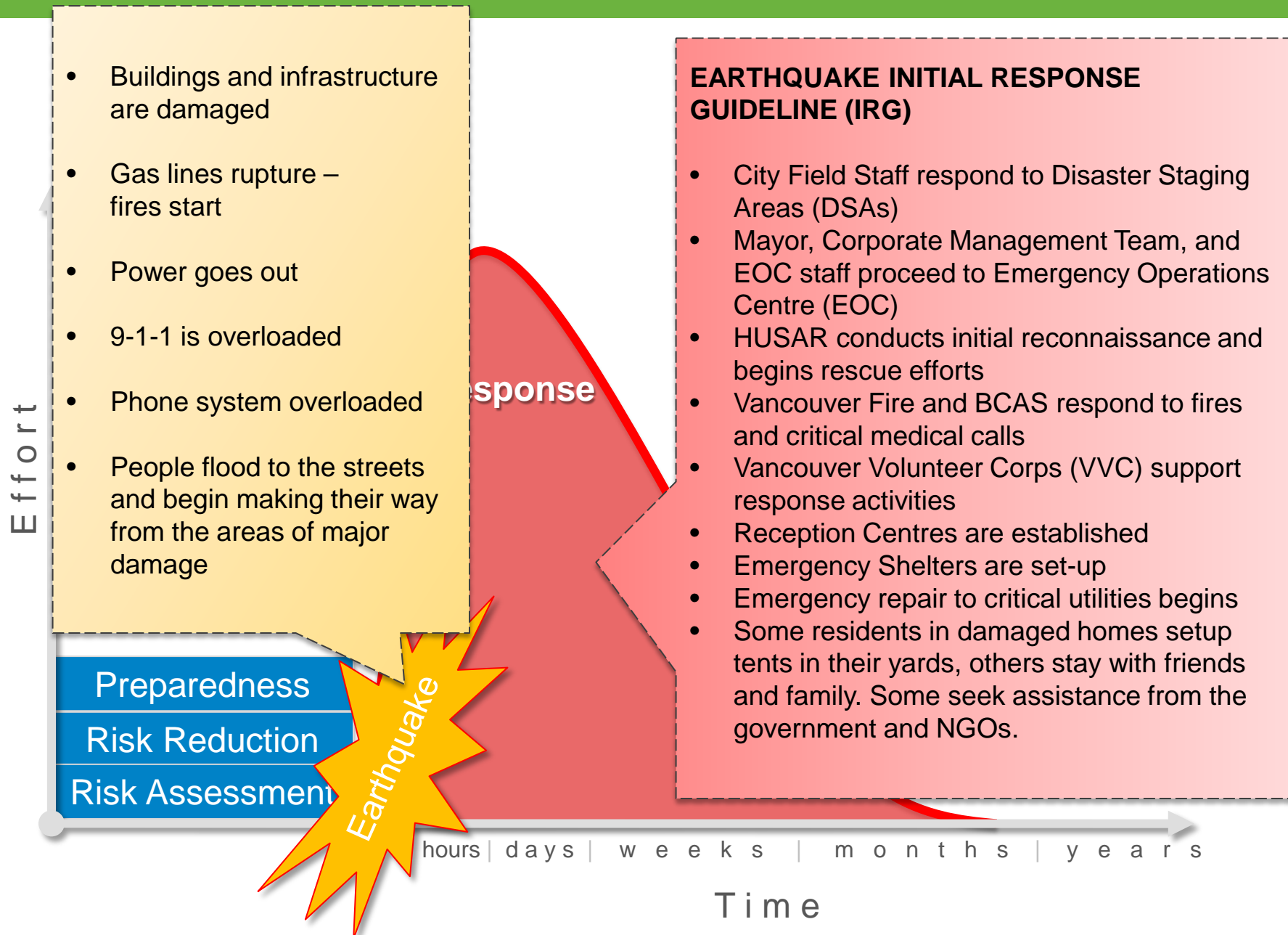


RESPONSE AND RECOVERY

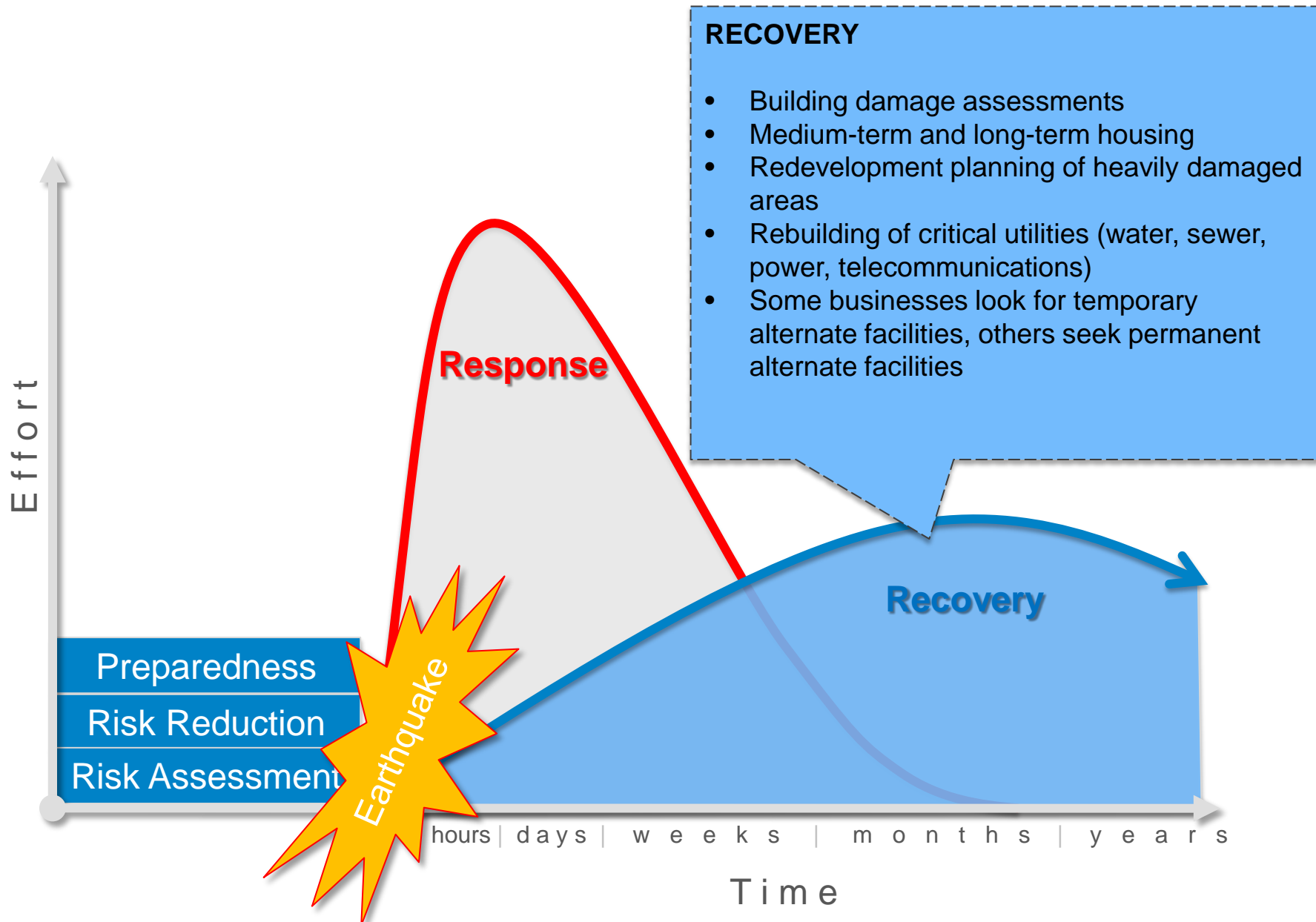


Current activities and assets to ensure an effective response and rapid recovery

Disaster Response and Recovery Timeline



Disaster Response and Recovery Timeline





CITY OF
VANCOUVER



Wallet Cards



Assets and Tools: Heavy Urban Search and Rescue

- Multi-purpose team, critical in responding to trapped people in damaged buildings and structures and can support a wide range of other disaster response activities
- 125 trained members, including:
 - Rescue technicians
 - Engineers
 - Paramedics
 - Doctors
 - Search dogs
- Simulated earthquake site for training
- Lost Federal funding, now supported by City and Provincial funding



Assets and Tools: Vancouver Volunteer Corps

- Christchurch demonstrated importance of trained volunteer response
- Vancouver Volunteer Corps (VVC) launched in 2012. Over 800 members, comprised of:
 - ✓ 300 general VVC members
 - ✓ 400 Emergency Social Services volunteers
 - ✓ 100 Neighbourhood Emergency Assistance Team (NEAT) volunteers
- 150 VECTOR emergency communications volunteers
- Annual exercises and drills



Exercises

- Monthly tabletop exercises with CMT
- Regular activation of emergency operations centre for planned events

Response deployments

- Hurricane Katrina 2005 (HUSAR)
- Christchurch Earthquake 2011 (Staff)
- Johnson's Landing Landslide 2012 (HUSAR)
- Calgary Flood 2013 (Staff and HUSAR)



Significant steps taken to ensure an effective response, however, additional steps to be taken over next five years to improve response.

Response and Recovery Actions

A large red arrow pointing horizontally to the right, positioned to the left of the first action item.

1. Develop an on-going city-wide emergency training and exercise program, including an annual earthquake drill and opportunities for ongoing staff engagement.

2. Develop memoranda of understanding with other Canadian Cities to support rapid deployment of resources following a disaster.

3. Continue refining earthquake response plans in key areas, including provision of medium-term shelter, provision of potable water, building damage assessment, and community response.

ACTION

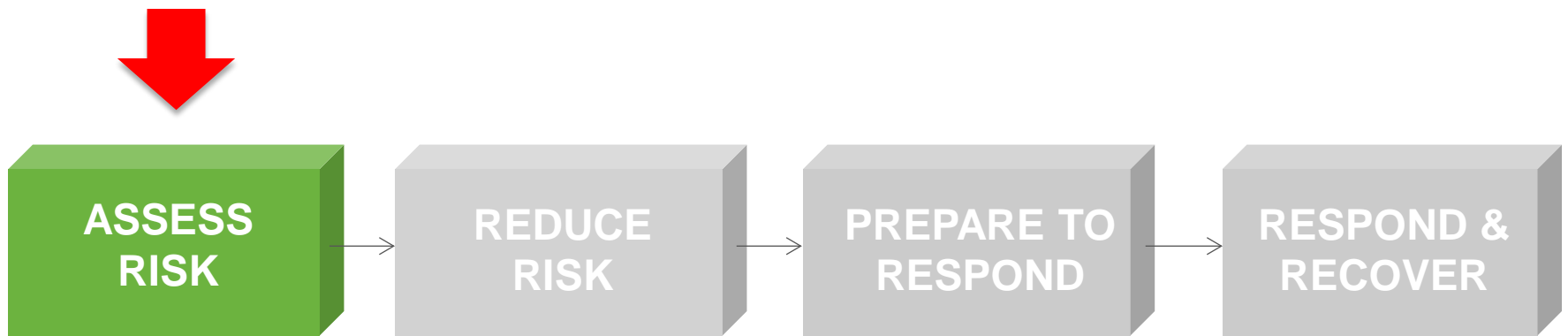
ASSESS
RISK

REDUCE
RISK

PREPARE TO
RESPOND

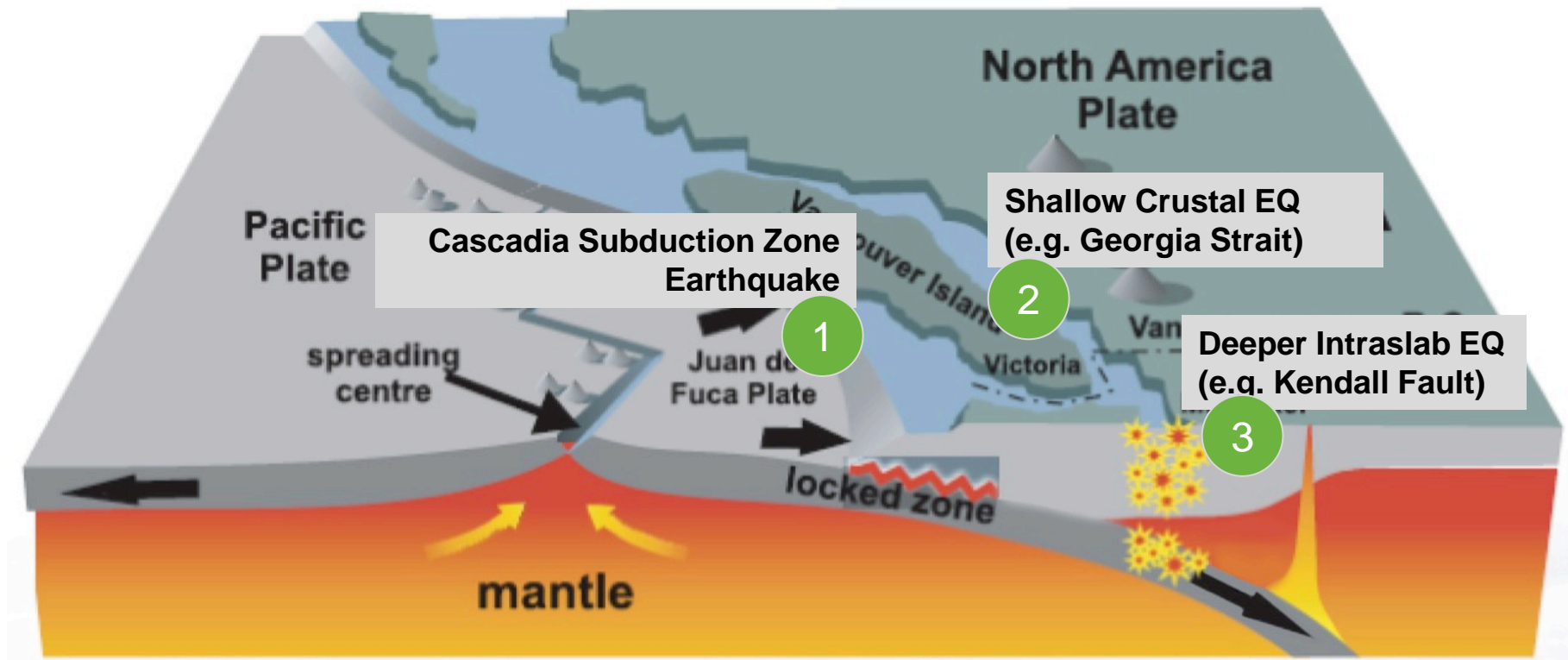
RESPOND &
RECOVER

ASSESSING THE RISK



- EARTHQUAKE SCENARIOS
- GENERAL IMPACTS

Earthquake Scenarios



- ① Cascadia Subduction Zone: ('megathrust') earthquake - M 9+
- ② Georgia Strait: shallow crustal earthquake - M 7.3
- ③ Kendall fault: intraslab, deep earthquake - M 6.8

Liquefaction

When silty and sandy soils temporarily act as a liquid due to ground shaking, bringing silt up to the surface and damaging infrastructure and buildings. Underground pipes can “float up”.



Ground
Shaking

Lifelines

Networked utility systems that provide critical services that residents, businesses, and industry rely on.

Examples:

- Water and sewer systems
- Telephone system
- Road and rail systems
- Power and gas systems

Lifeline Damage

Building Damage

People

Economy

Ground Shaking

Shake Map

Georgia Strait M 7.3
Planning Scenario

Georgia Strait Fault
Peak Ground Velocity



Key City Infrastructure

Hospitals



DFPS Pump Stations



City Hall Campus



EOC



Police



Community Centres



Fire Halls



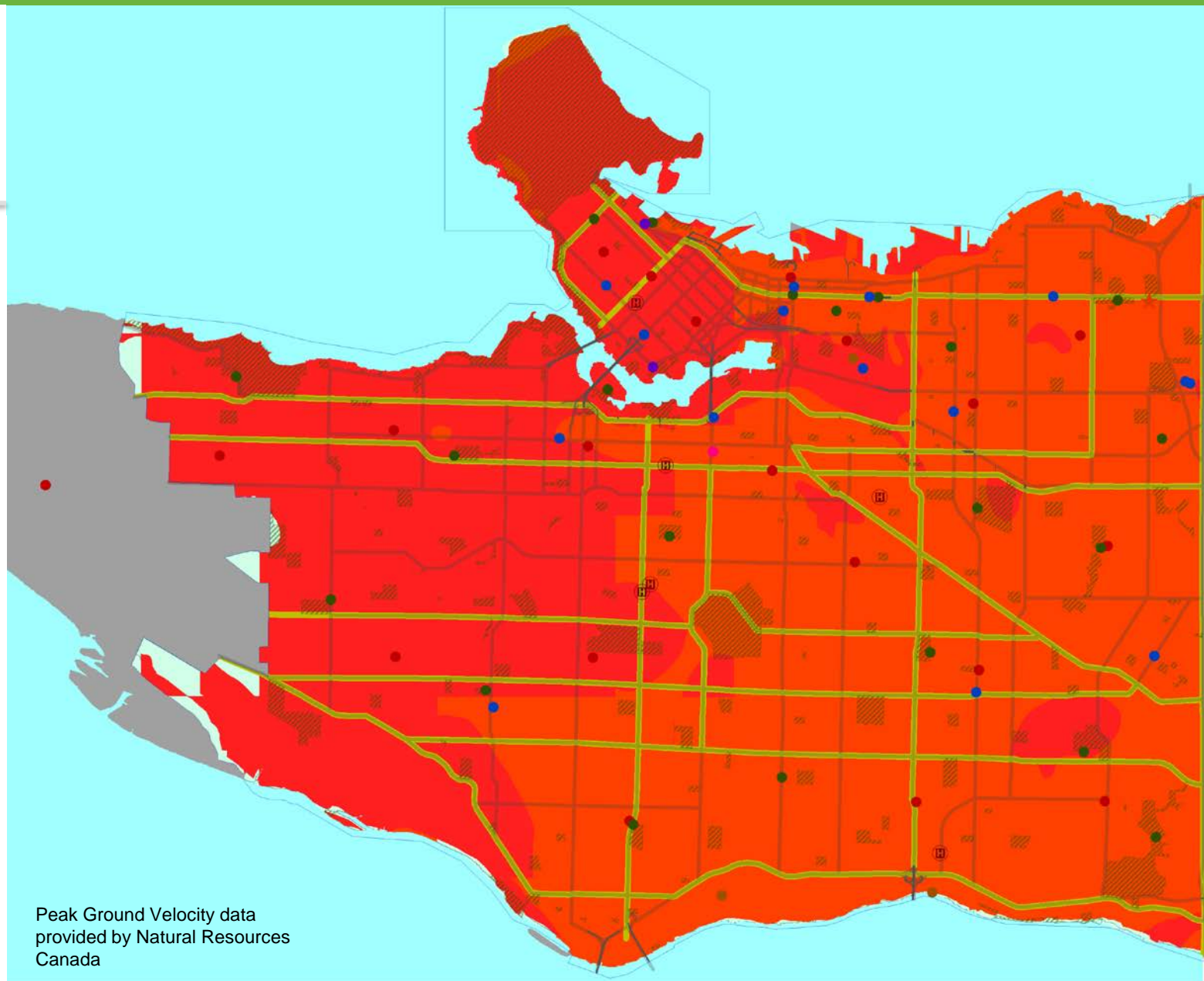
City Works Yards



Bridges & Structures



Disaster Response Routes



Peak Ground Velocity data
provided by Natural Resources
Canada

Liquefaction Susceptibility

Liquefaction Susceptibility

Liquefaction Potential



Hospitals

DFPS Pump Stations

City Hall Campus

EOC

Police

Community Centres

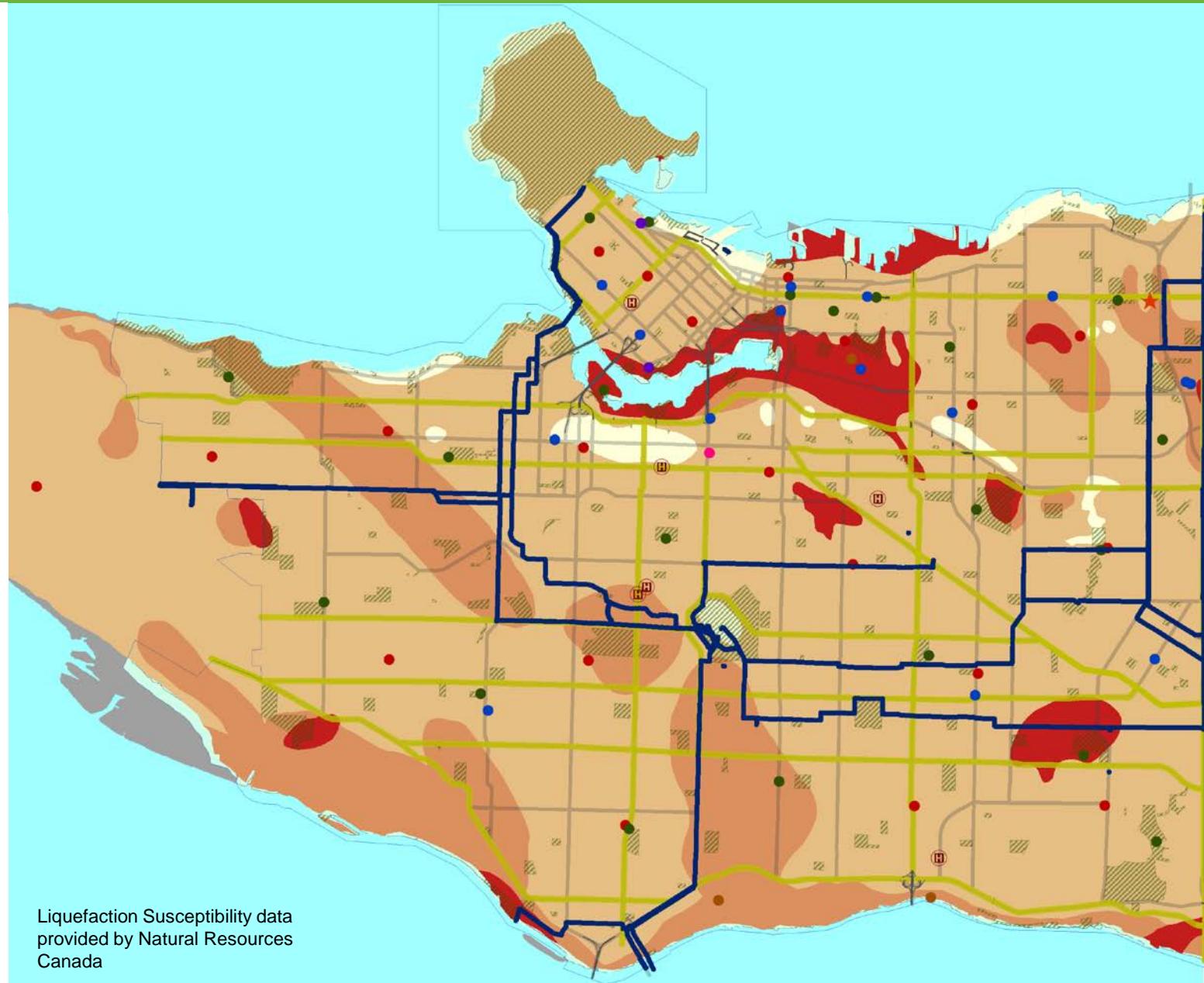
Fire Halls

City Works Yards

Bridges & Structures

Disaster Response Routes

GVRD Water



Liquefaction Susceptibility data
provided by Natural Resources
Canada

Tsunami Run-up Potential

Tsunami Run-up Potential

Highlighted area shows 2 m above high tide

Opportunities for alignment with climate change adaptation efforts related to sea level rise.

Key City Infrastructure

Hospitals



DFPS Pump Stations



City Hall Campus



EOC



Police



Community Centres



Fire Halls



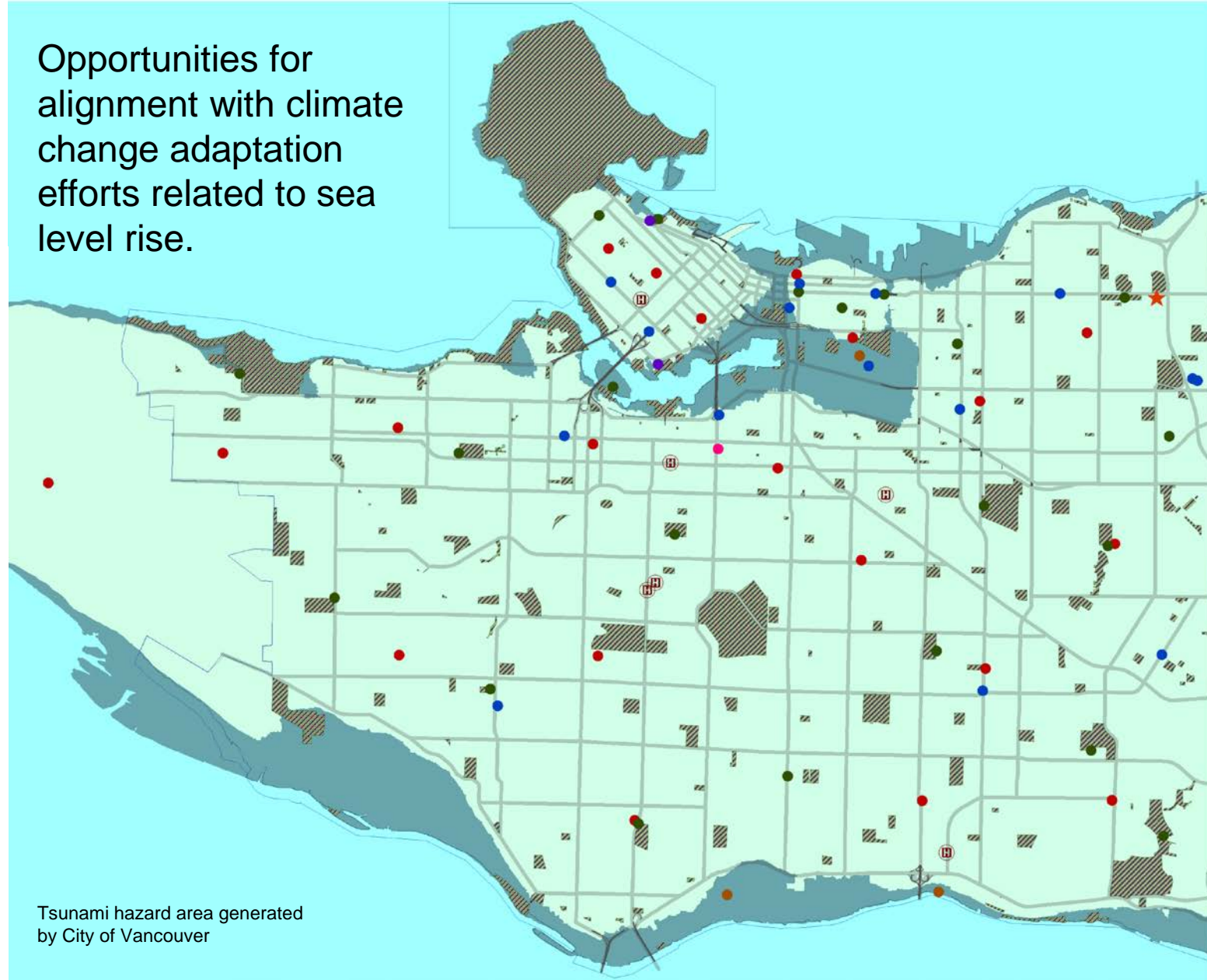
City Works Yards



Bridges & Structures



Disaster Response Routes



Tsunami hazard area generated
by City of Vancouver

Assess Risk Actions

4. Analyze weak links in our supply chain for critical supplies and services required in earthquake response

5. Enhance inputs to the earthquake impact estimation model

- Maintain a digital inventory of buildings & lifelines
- Improve earthquake hazard maps

6. Work with regional partners to develop shared models of earthquake risk

ACTION

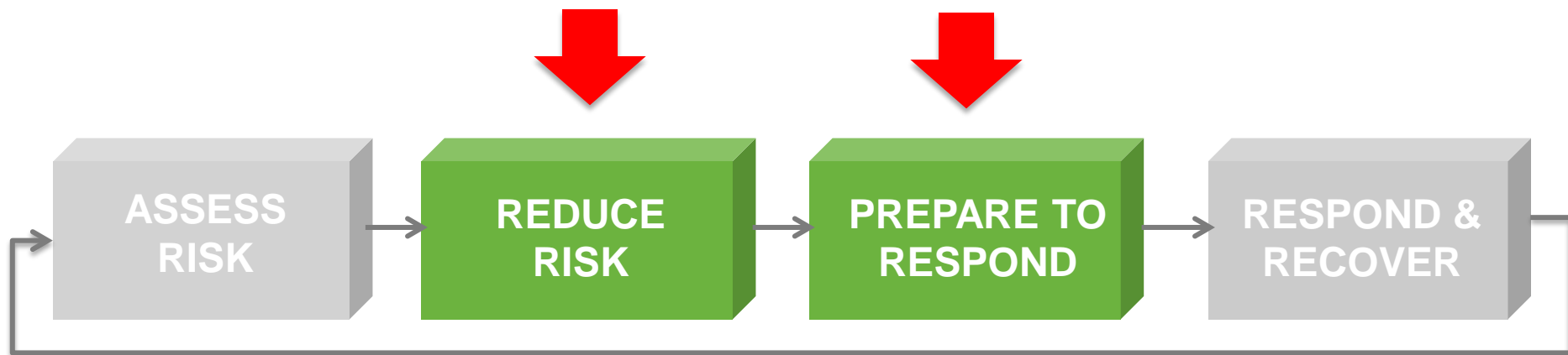
**ASSESS
RISK**

**REDUCE
RISK**

**PREPARE TO
RESPOND**

**RESPOND &
RECOVER**

REDUCING RISK AND PREPARING TO RESPOND



- IMPACTS ON SYSTEMS
- ASSOCIATED ACTIONS

Impacted Systems

Ground
Shaking

Liquefaction

Fire

Landslides

Tsunamis

Impacts

Lifelines

- WATER SYSTEMS
- SEWER SYSTEMS
- ENERGY SYSTEMS
- TRANSPORTATION SYSTEMS
- COMMUNICATIONS SYSTEMS

Buildings

- CITY FACILITIES
- PRIVATE BUILDINGS

People

Economy

Impacted Systems: Lifelines

Ground
Shaking

Liquefaction

Fire

Landslides

Tsunamis

Impacts



Lifelines

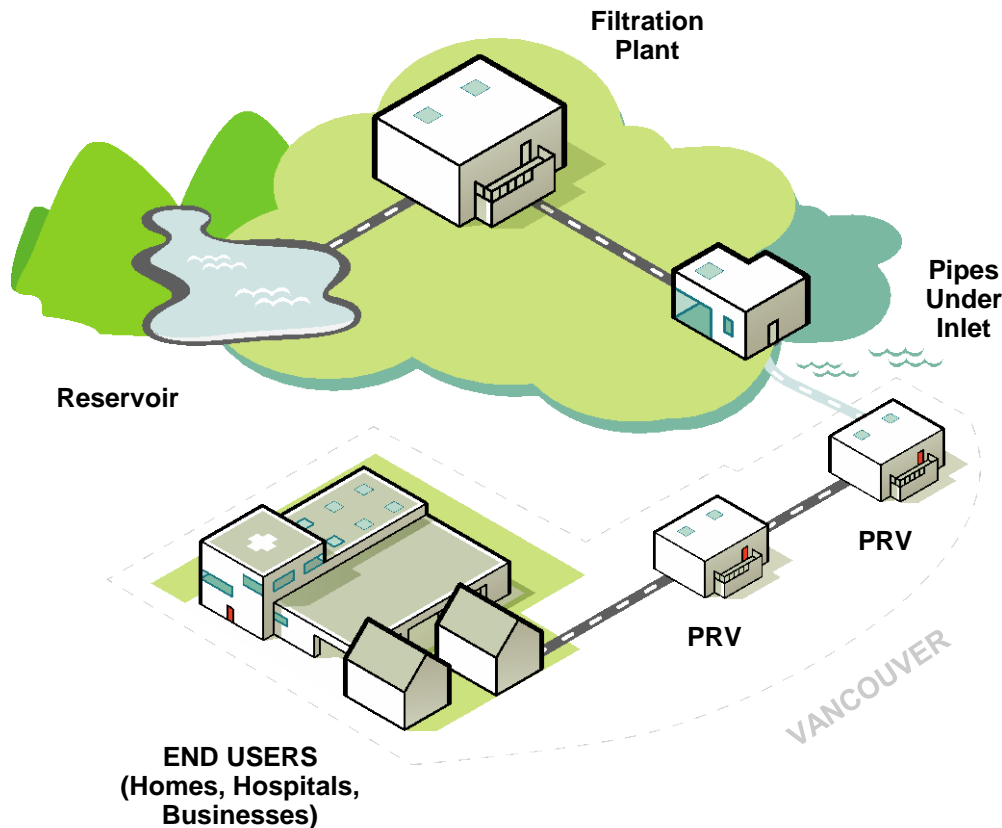
- WATER SYSTEMS
- SEWER SYSTEMS
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- COMMUNICATIONS SYSTEMS

Buildings

- CITY FACILITIES
- PRIVATE BUILDINGS

People

Economy



Consequences of Damage

- Service from North Shore reservoirs is interrupted
- Lack of water/pressure for fire fighting
- Hospital operations impacted
- Lack of water for households, businesses, industry
- Localized flooding

Action to Date

- Water Utility Response Plan
- Dedicated Fire Protection System (DFPS)
- Maintain emergency wells

Neighbourhood Water Station, Christchurch



Neighbourhood Portable Showers, Christchurch



Risk Reduction Actions

7. Harden key components of water system in high risk areas

8. Develop generator deployment and refueling plan for pressure reducing valve stations

9. *Work with Metro Vancouver to increase seismic resilience of reservoirs, water main crossings from the North Shore, and key mains and couplings*

Preparedness Actions

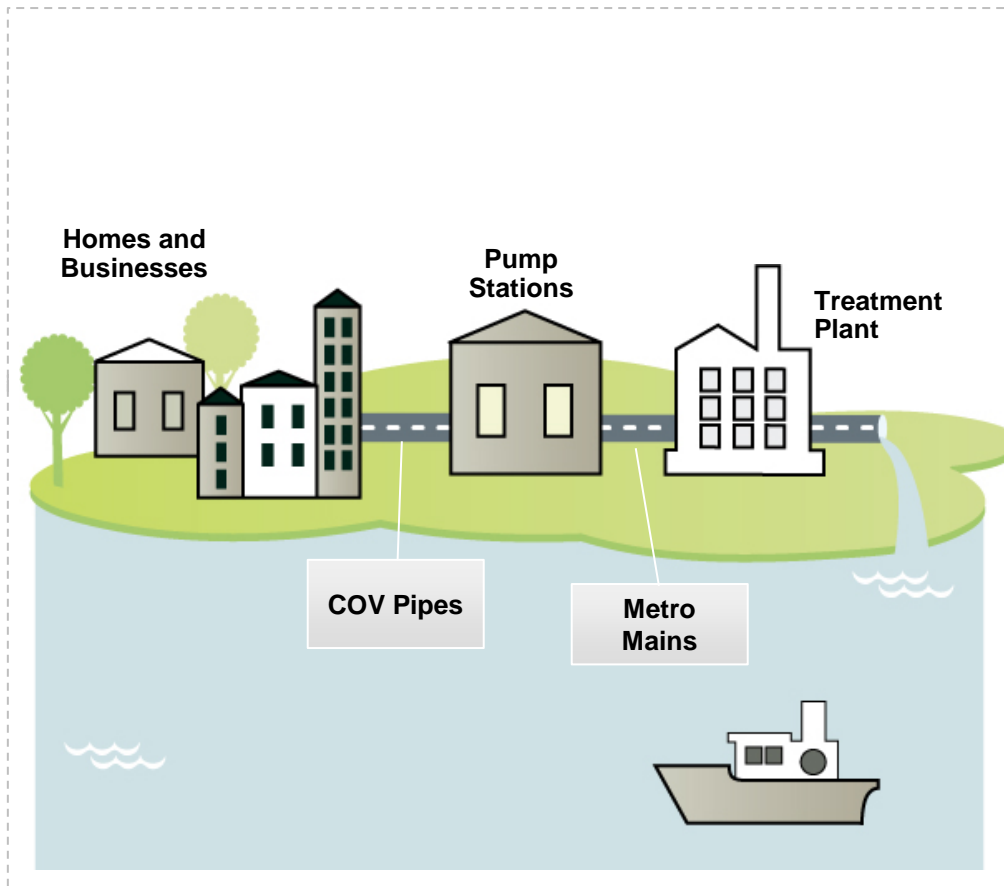
10. Enhance post-earthquake access to firefighting water supply

11. Continue to grow volunteer corps to assist with Dedicated Fire Protection System

12. Develop plan for mass provision of potable water and shower facilities

13. *Continue to work with health authorities to enhance post-earthquake water servicing plans*

Impacted System: Sewer System - Overview



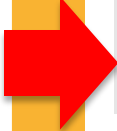
Consequences of Damage

- Sewage back-up in neighbourhoods
- Inability to use household toilets
- Raw sewage will likely be discharged into marine environment

Action to Date

- Sewer utility response plan
- Regional plans to upgrade treatment plants

Risk Reduction Actions



14. Change pipe materials and install flexible couplings in high-risk areas

15. Develop generator deployment and refueling plan for pump stations

16. Work with Metro Vancouver to increase resilience of key mains and couplings

Preparedness Actions

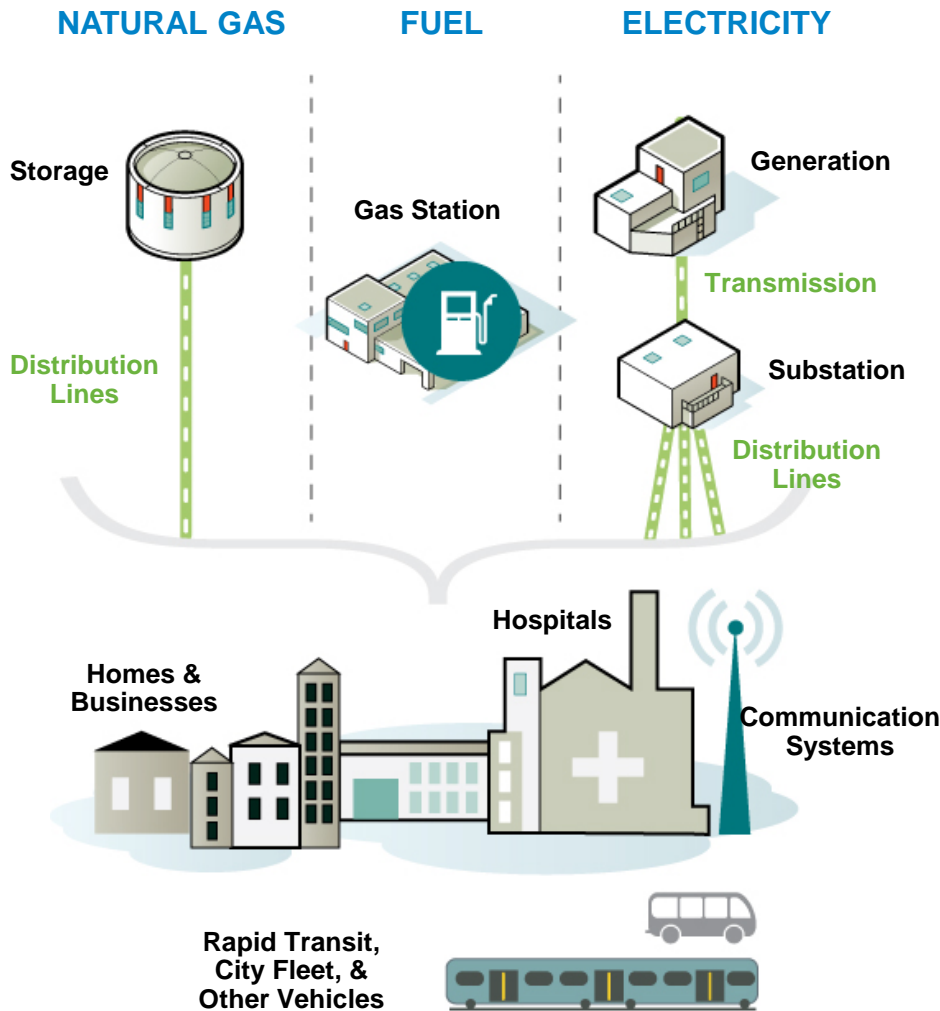


17. Plan for mass provision of alternate toilet facilities (i.e. porta-potties and chemical toilets)

18. Plan for more frequent testing of water system given potential for contamination from damaged sewer infrastructure.

19. Develop public notification and beach closure plan in conjunction with health authorities

Impacted System: Energy System - Overview



Consequences of Damage

- Power outages and gas leaks impact most critical infrastructure
- Natural gas leaks cause fires and outages
- Above-ground power lines may be downed impacting public space
- Fuel tank leaks cause environmental damage and reduce vehicle fuel supply

Action to Date

- Developed Neighbourhood Energy Utility strategy that helps reduce reliance on elect. grid
- Installed backup power at critical City facilities, such as fire halls and data centres
- Electric grid redundancy as a legacy of the 2010 Winter Olympic Games

Risk Reduction Actions



20. Reduce dependence on the electricity and natural gas grids by facilitating local energy generation and reducing energy requirements in buildings

21. Continue to develop post-disaster Neighbourhood Energy Utilities (NEUs) to build community disaster resilience

Preparedness Actions

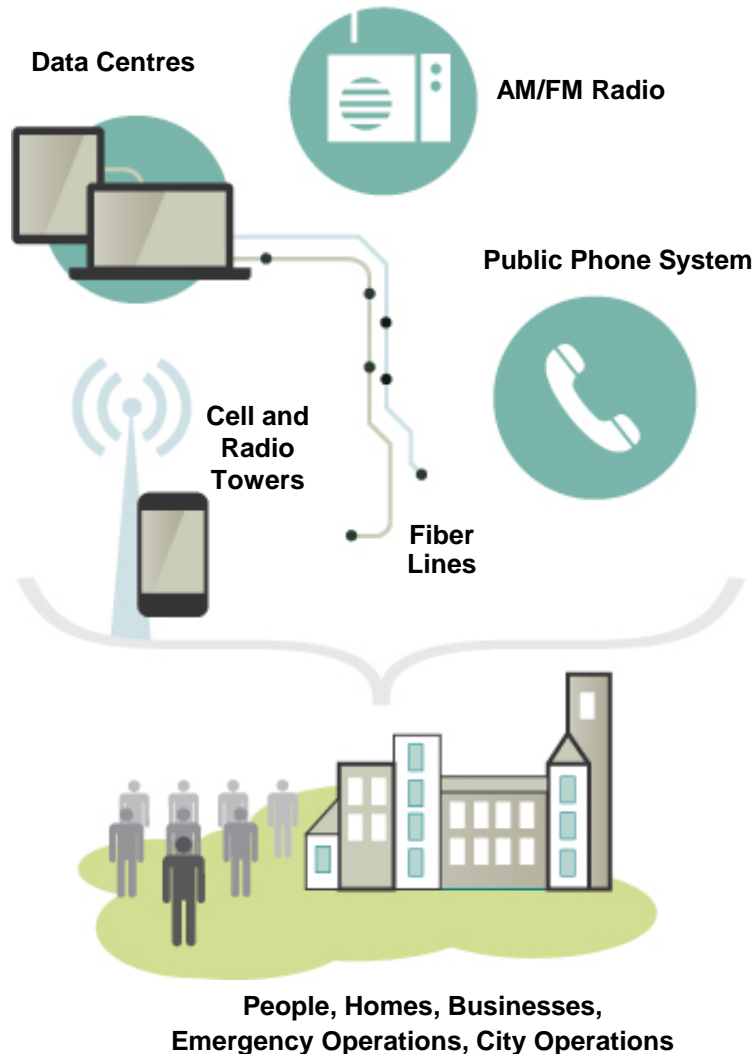


22. Develop plan for backup power needs across City operations (i.e. key facilities, sewer and water pump stations)

23. Enhance public education program to train residents and businesses how to cope with outages

24. Review gasoline and diesel fuel requirements across the City and ensure City-owned fueling stations are earthquake resilient

Impacted System: Communications Systems - Overview



Consequences of Damage

- Cell/telephone systems overloaded
- People cannot get through to 9-1-1
- People have difficulty connecting with friends and family
- Businesses cannot conduct operations
- City and responders cannot get critical information to the public
- Critical data is lost

Action to Date

- Developed response plans that do not rely on traditional communications systems
- Installed satellite phones and radios at key City facilities
- Established an emergency communications volunteer group (VECTOR)
- Incorporated family reunification planning in Neighbourhood Emergency Preparedness workshops

Impacted System: Communications Systems – Further Work

ACTIONS

Risk Reduction Actions

25. Work with the telecommunications companies to ensure antennas and other structures are seismically resilient and include appropriate backup power

Preparedness Actions

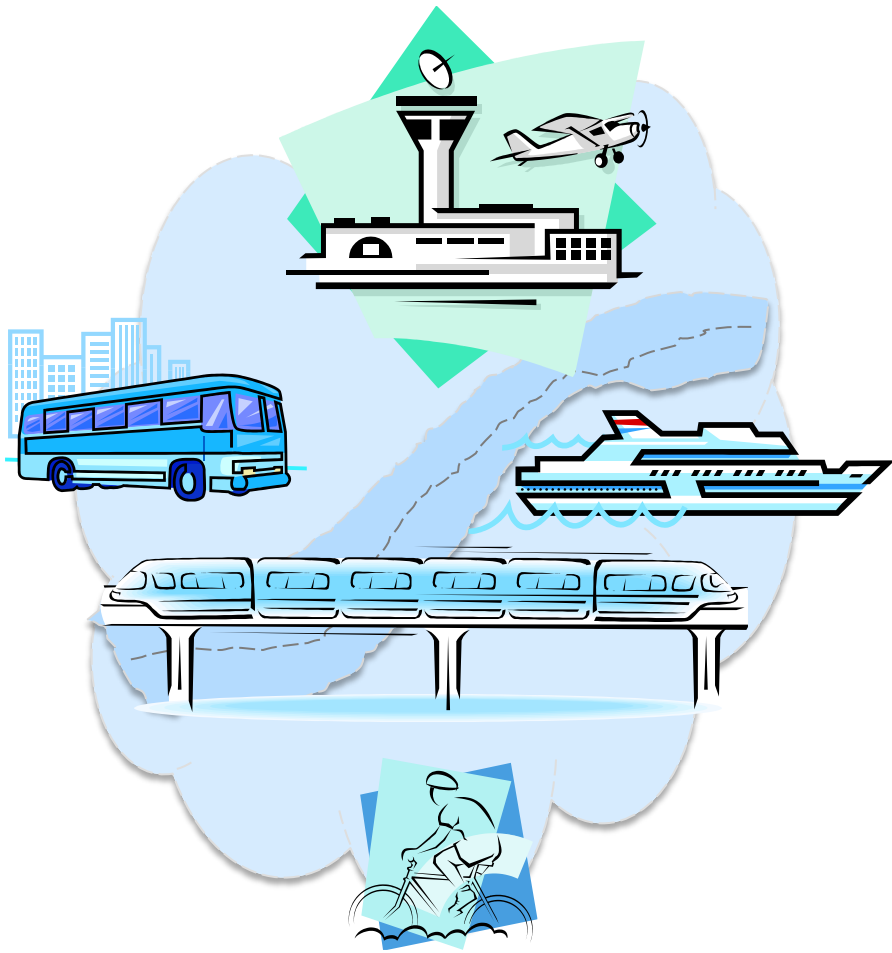
26. Update the City emergency communications plan

- include social media & explore additional methods of communicating with public (e.g. cell text message broadcast, smart phone apps)

27. Develop alternate City website hosted on out-of-area server

28. Develop staff-family reunification system

29. Exercise city-wide and key partner emergency communications as part of annual earthquake drill



Consequences of Damage

- First responders delayed due to road damage
- Bridges and Skytrain lines shut down until inspected
- Downed trolley wires block roads
- Movement to and from downtown peninsula limited due to debris and bridge and road damage
- Public transit service limited for weeks or months
- Aid to the region delayed due to damaged roads, bridges, port and airport facilities
- People can't move around the region

Action to Date

- Developed Bridge Response Plan
- Seismic upgrades to key bridges (\$14 million in seismic upgrades over past 20 years)
- Developed Disaster Response Routes

Impacted System: Transportation Systems – Further Work

ACTIONS

Risk Reduction Actions

30. Complete upgrading of Granville Bridge and approaches in the next capital plan to ensure it can be used by responders within hours following an earthquake

31. Work with external partners (e.g. Translink, BC MOTI) to prioritize risk reduction efforts on transit guideways, tunnels, bridges, and bus system

Preparedness Actions

32. Install seismic sensors on key bridges to decrease inspection time

33. Enhance Emergency Social Services plans to support people on the downtown peninsula

34. Continue working with the Integrated Partnership for Regional Emergency Management (IPREM) to expand the Disaster Response Route network to marine transportation.

Impacted System: Buildings

Ground
Shaking

Liquefaction

Fire

Landslides

Tsunamis

Impacts

Lifelines

- WATER SYSTEMS
- SEWER SYSTEMS
- ENERGY SYSTEMS
- TRANSPORTATION SYSTEMS
- COMMUNICATIONS SYSTEMS

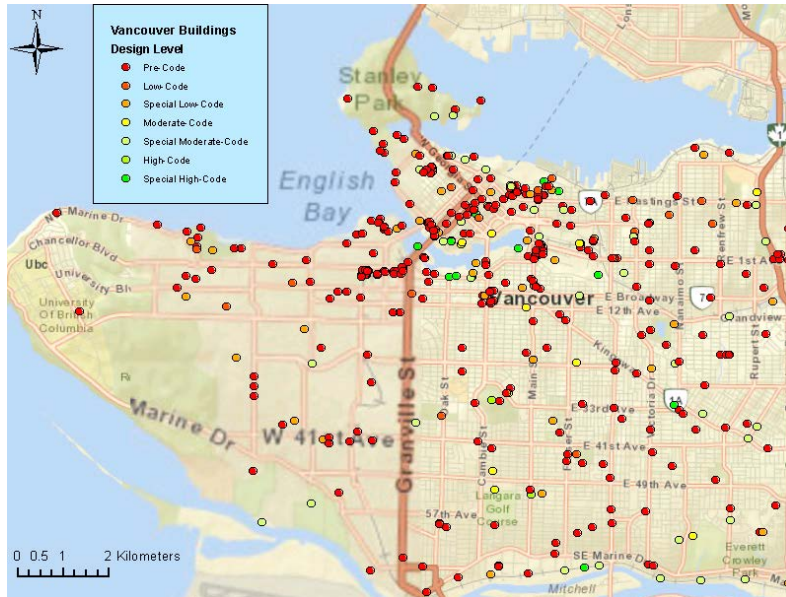
People

Economy



Buildings

- CITY FACILITIES
- PRIVATE BUILDINGS



500+ facilities:

e.g. City Hall, Police Stations, Community Centres, Libraries, Fire Halls, Works Yards, Non-market Housing

Consequences of Damage

- Reduced emergency response capacity due to damaged fire halls, community centres
- Delays overall response and recovery operations
- Many City services are relocated to undamaged alternate sites, impacting core function of these alternate facilities (e.g. libraries, community centres)
- Loss of data due to data centre damage
- Displaced residents from non-market housing

Action do Date

- Added a seismic assessment to facilities conditions audits
- Planned disposition of East Wing
- Built a post-disaster Emergency Operations Centre
- Re-located key computer systems to data centres in post-disaster building



ECONOMY

Risk Reduction Actions



35. Continue to address high-risk City facilities, prioritizing those on City Hall Campus.



36. Incorporate non-structural seismic safety program into facilities management

Preparedness Actions



37. Develop business continuity plans to support identification of alternate business locations

38. Establish a damage control centre for City facilities to coordinate assessment and prioritize facility restoration.



Consequences of Damage

- Building collapse and damage
- Year+ closure of downtown
- Hazardous materials release from industry
- Schools and hospitals damage delays recovery
- Out-migration of residents
- Loss of property tax revenue
- Inspections will take months given current capacity

Action to Date

- Developed HUSAR team to respond to building collapse
- Updated seismic provisions in building bylaw
- Developed rapid damage assessment program



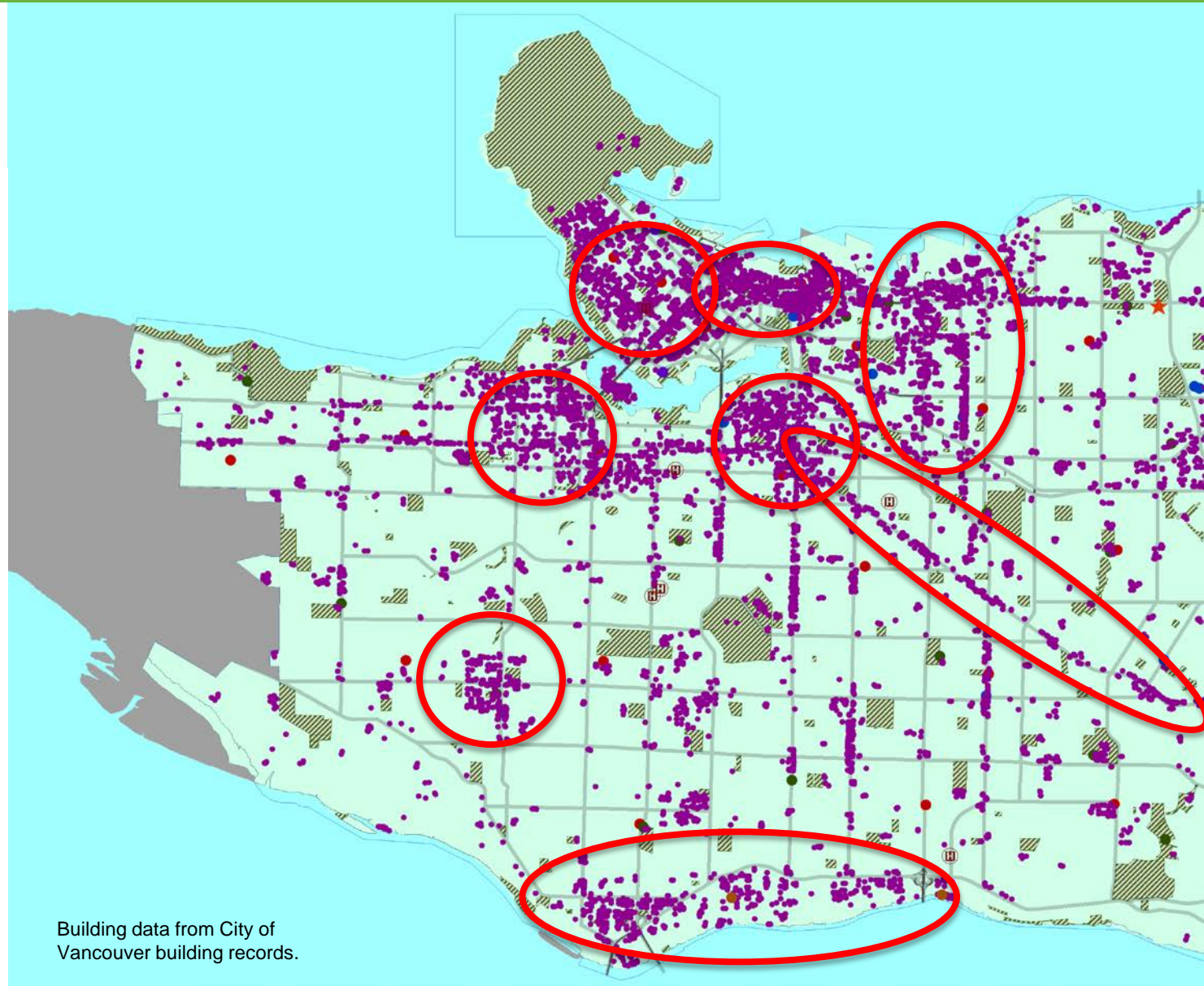
- 60% of Vancouver's building stock built before seismic building codes
- No damaging earthquake in modern times means all the vulnerable buildings remain

Impacted System: Private Buildings - Overview

Large pre-1973 seismic code buildings

Key City Infrastructure

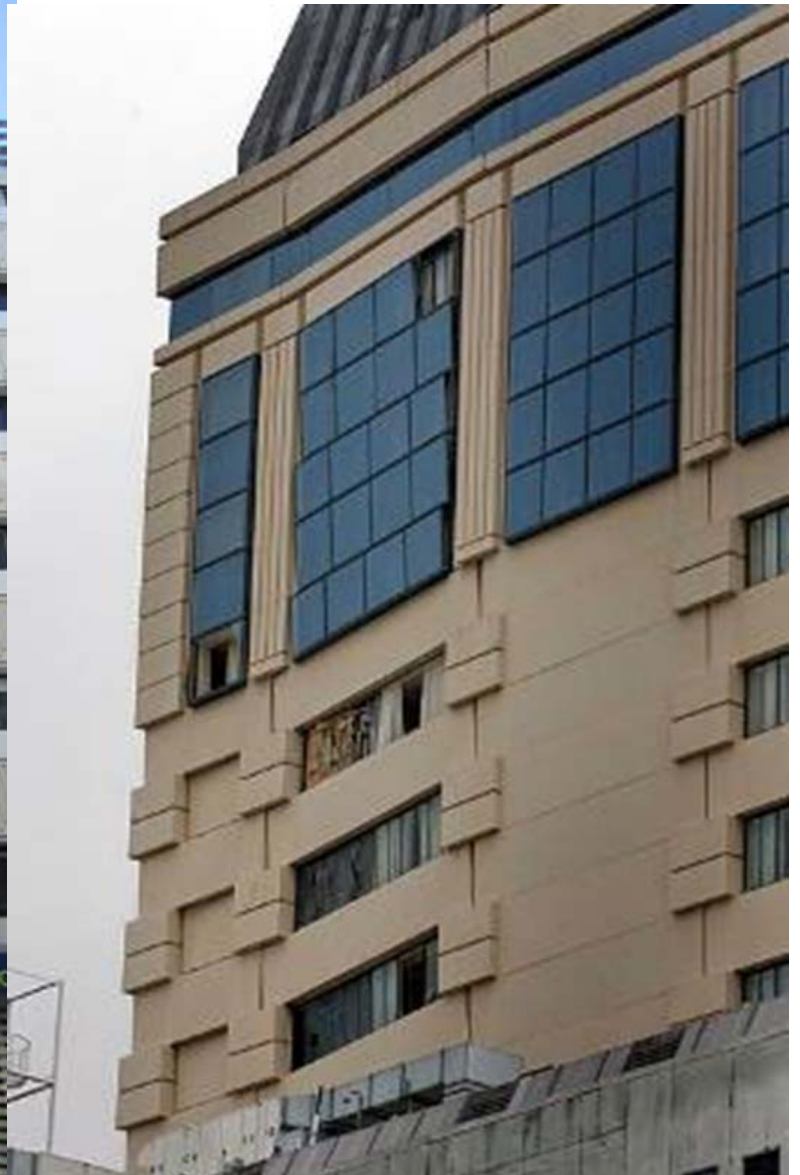
- Hospitals
- DFPS Pump Stations
- City Hall Campus
- ECOM
- Police
- Community Centres
- Fire Halls
- City Works Yards
- Bridges & Structures



Banding Protects Pump Station, Christchurch



Damage Closes Many Blocks Downtown, Christchurch



LIFELINES

BUILDINGS

PEOPLE

ECONOMY

Risk Reduction Actions

39. Establish a technical committee to advise City on high-risk building abatement options

40. Establish consistency in the application of seismic upgrade requirements for existing buildings

41. Facilitate knowledge transfer of seismic building and retrofit techniques between the scientific, regulatory, and development sectors

42. Fast-track adoption of seismic provisions in the 2015 National Building Code update

Preparedness Actions

43. Mandate storage of structural drawings with fire plans to speed-up assessment of complex/high occupancy buildings

44. Provide tools for residents in single-family homes to self-assess damaged structures

45. Incorporate minimum of two structural engineers on HUSAR team

46. *Engage private sector Structural Engineers in damage assessment program*

Impacted Systems: People and Economy

Ground
Shaking

Liquefaction

Fire

Landslides

Tsunamis

Impacts

Lifelines

- WATER SYSTEMS
- SEWER SYSTEMS
- ENERGY SYSTEMS
- TRANSPORTATION SYSTEMS
- COMMUNICATIONS SYSTEMS

Buildings

- CITY FACILITIES
- PRIVATE BUILDINGS

People

Economy



Two residents embrace near collapsed building, Christchurch, NZ (2011)



Volunteers at work, Christchurch, NZ (2011)

Impact of Earthquake

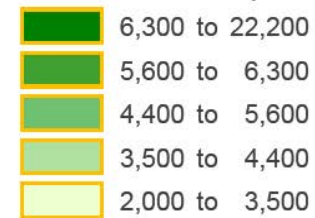
- Deaths and injuries
- Displacement of residents
- First responders and social services overwhelmed
- People lose incomes and livelihoods
- Increased physical abuse and social problems
- Desire to help/volunteer

Action to Date

- Developed a Neighbourhood Emergency Preparedness Program to train public in basic emergency preparedness
- Developed plans for Reception Centres and Emergency Shelters
- Stockpiled emergency supplies to assist rapid establishment of these services

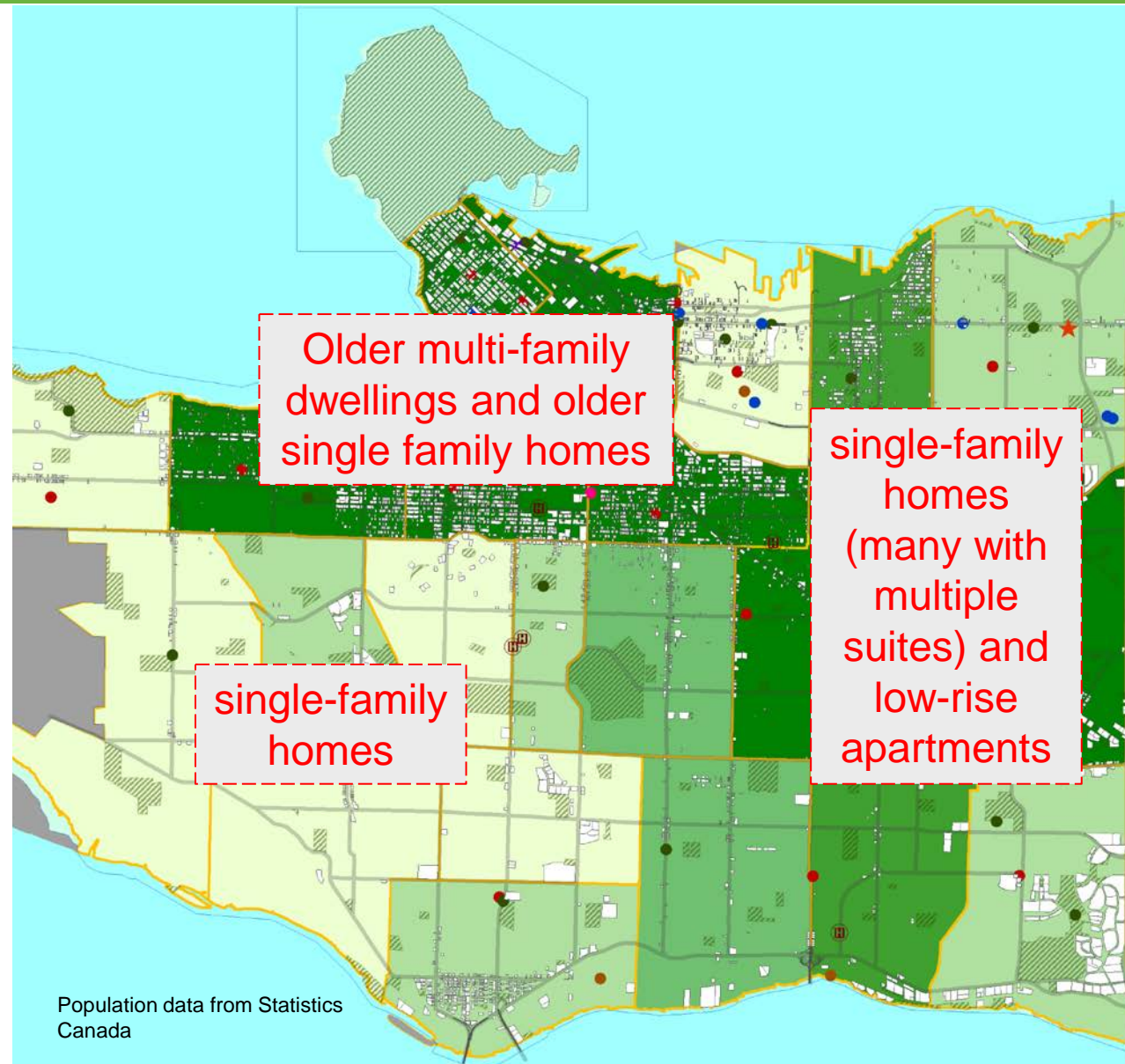
Impacted System: People - Population Density

Population Density By Neighbourhood Residents Per Square Kilometer



Key City Infrastructure

- Hospitals
- DFPS Pump Stations
- City Hall Campus
- EOC
- Police
- Community Centres
- Fire Halls
- City Works Yards
- Bridges & Structures



Damage to All Types of Buildings, Christchurch



Risk Reduction Actions



47. Expand public education program with new material and methods of outreach targeting vulnerable populations

48. Develop an earthquake preparedness video to engage and motivate the public to take action

Preparedness Actions

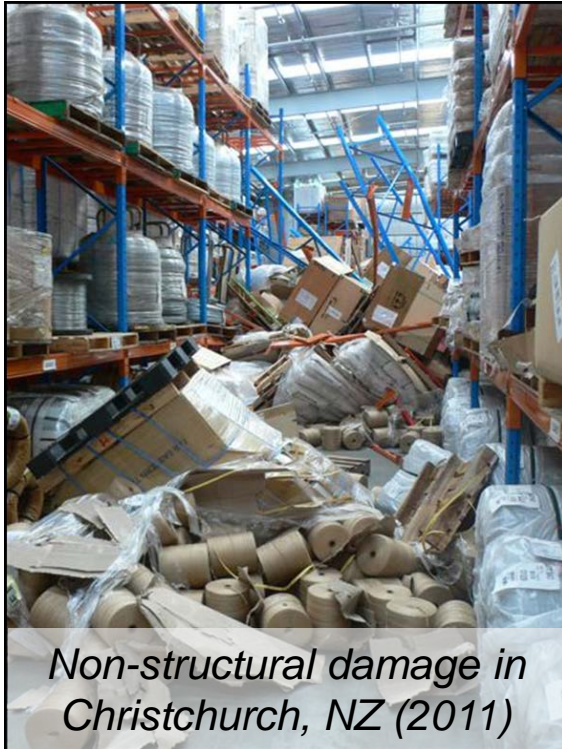


49. Develop Community Disaster Support Hubs to facilitate community-based response

50. Revise public education program to include safety assessments and basic rescue

51. Integrate Emergency Social Services into Damage Assessment Teams

52. *Work with partners to update emergency shelter plans and develop temporary housing plan*



Non-structural damage in Christchurch, NZ (2011)

- Western Canada's economic centre
- Major regional Central Business District
- Canada's largest port
- 34% of regional jobs in Vancouver

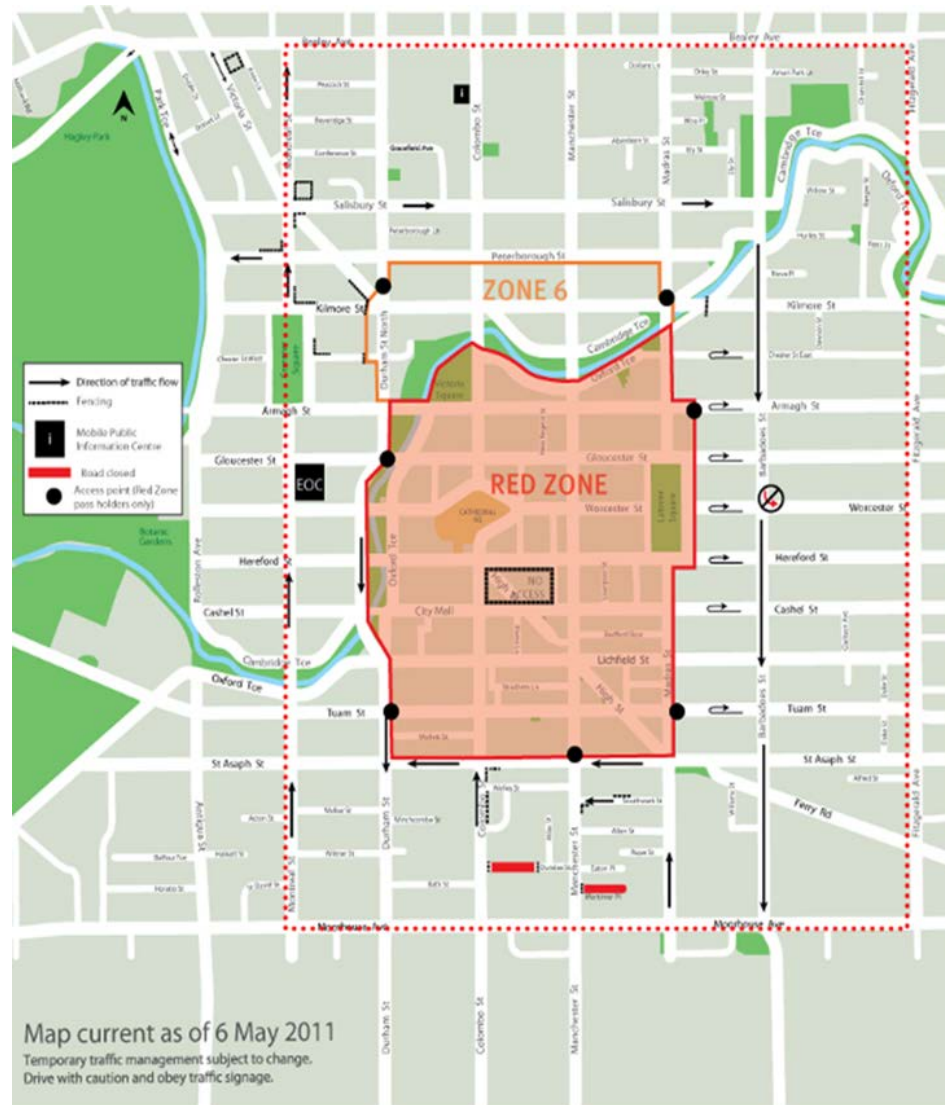
Consequences of Damage

- \$75 billion in expected losses from a Cascadia Subduction Zone earthquake (total) = 5.2% of the National GDP
- Anything above 1-2% of GDP will cause national recession
- Lost jobs
- Outmigration of residents
- Long-term decline in Port's prominence
- Loss of tourism

Action to Date

- Engaged with the business community to raise awareness and identify options to support small to medium business in preparing for emergencies.
- Provide personal and family preparedness training to local business staff

Downtown Christchurch Closed For Several Years



Displaced Coffee Shop Moves Outside, Christchurch



LIFELINES

BUILDINGS

PEOPLE

ECONOMY

Risk Reduction Actions



53. Continue to develop business preparedness program to raise awareness and support preparedness in small and medium-sized businesses

54. Incorporate emergency preparedness and business continuity resources on the City's website to facilitate access

Preparedness Actions

55. Establish business community liaison position in City's Emergency Operations Centre

56. *Work with BIAs to develop Business Access Program to facilitate temporary access to buildings in cordoned areas*

Summary – 56 Actions

12 Primary Actions + **44** Supporting Actions

3
ACTIONS

21
ACTIONS

32
ACTIONS

ASSESS
RISK

REDUCE
RISK

PREPARE TO
RESPOND

RESPOND &
RECOVER

12 Priority Actions

ASSESS RISK

1. Analyze weak links in our supply chain for critical supplies and services required in earthquake response
2. Enhance inputs to earthquake impact estimation model (e.g. earthquake hazard maps)

REDUCE RISK

3. Incorporate non-structural seismic safety program into facilities management
4. Harden key components of water system in high risk areas
5. Complete upgrading of Granville Bridge and approaches in the next capital plan to ensure it can be used by responders within hours following an earthquake
6. Establish a technical committee to advise City on high-risk building abatement options
7. Continue to address high-risk City facilities, prioritizing those on City Hall Campus

PREPARE TO RESPOND

8. Enhance post-earthquake access to firefighting water supply
9. Update emergency communications plan (include social media & explore additional methods of communicating with public)
10. Develop Community Disaster Support Hubs to facilitate community-based response

RESPOND & RECOVER

11. Expand public education program with new material and methods of outreach targeting vulnerable populations
12. Continue to develop business preparedness program to raise awareness and support preparedness in small and medium-sized businesses

- The City is ready to respond at any time
- Significant work done or underway in assessing and addressing risk
- Staff gaining experience for preparedness, response and recovery whenever possible
- Capital and operating budgets reflect ongoing enhancements across organization





Thank you
Questions?