SEISMIC RISK ANALYSIS OF HIGHWAY SYSTEMS: APPLICATIONS AND USER FEEDBACK

by

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prepared for

PEER Annual Meeting
Palm Springs CA

March 8, 2003

PRESENTATION

- ***SRA Overview***
- Results
- User Feedback
- Closing Comments

REDARS:
Risks from Earthquake DAmage to Roadway Systems

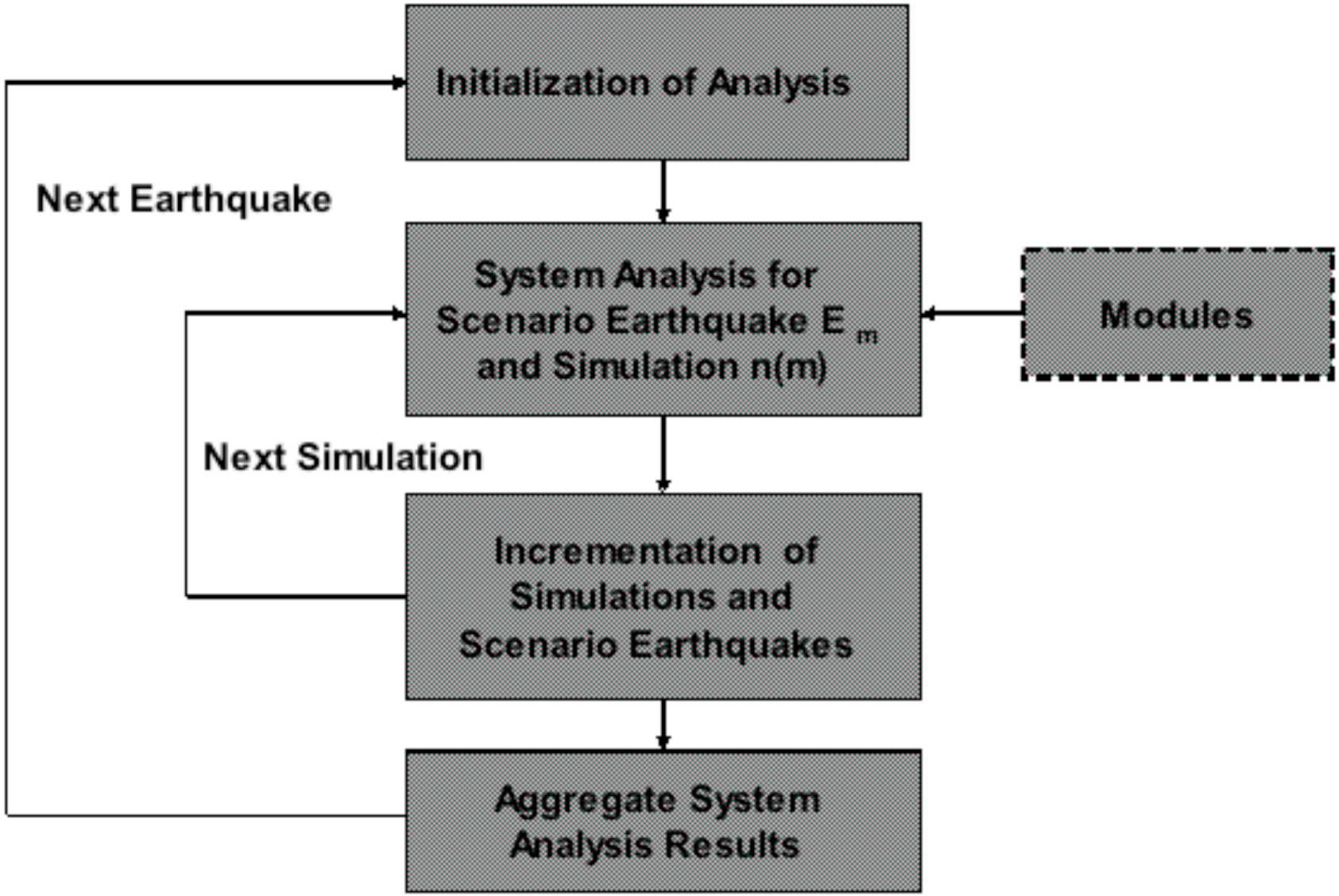
- **Methodology for SRA of Highway-Roadway Systems**

- **Meets Important Needs:**
  - **Estimate How EQ Damage to Highway System Affects Post-EQ Traffic Flows**
  - **Enables Users to Consider these Effects during Decision Making**

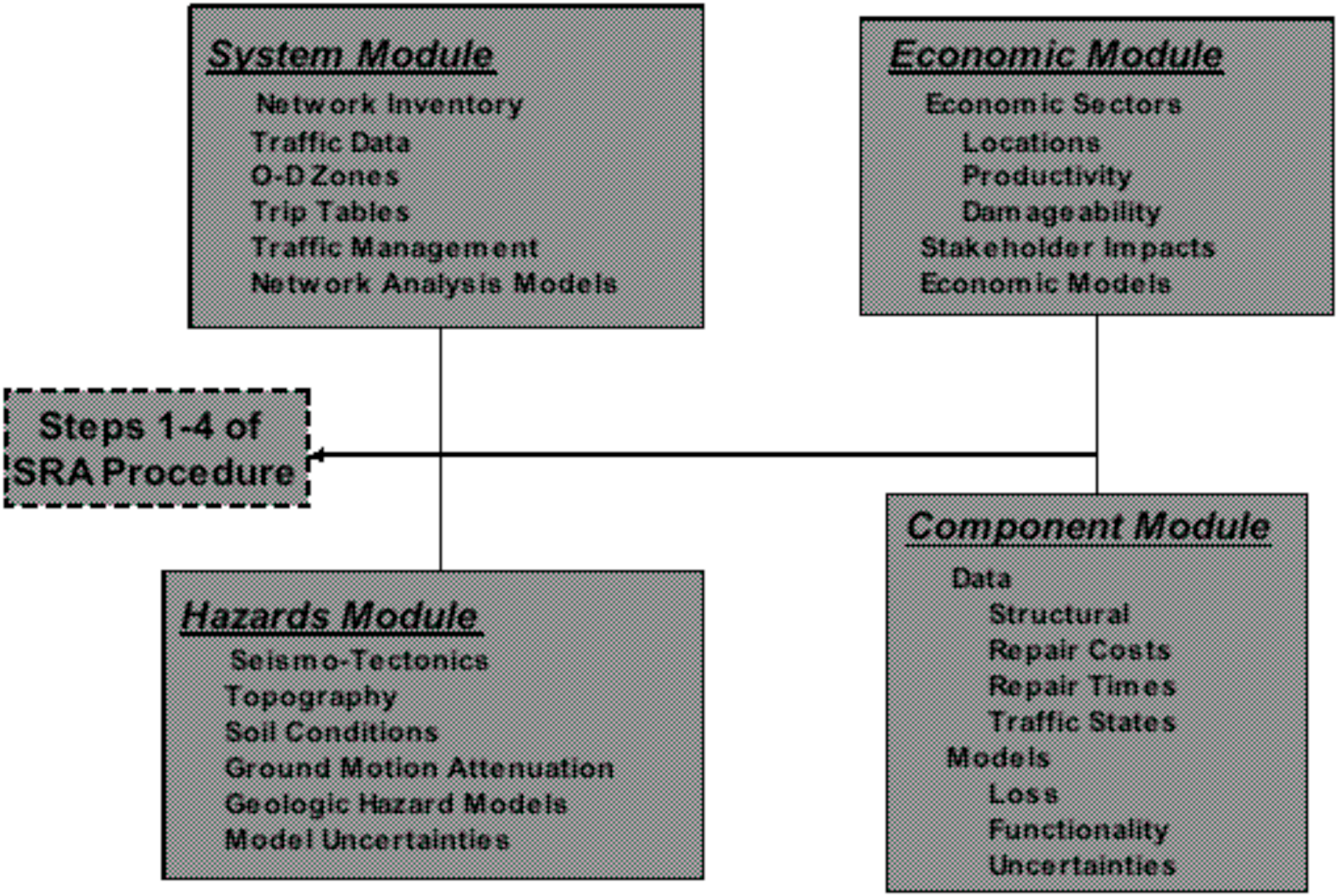
    Pre-EQ Planning

    Post-EQ Response

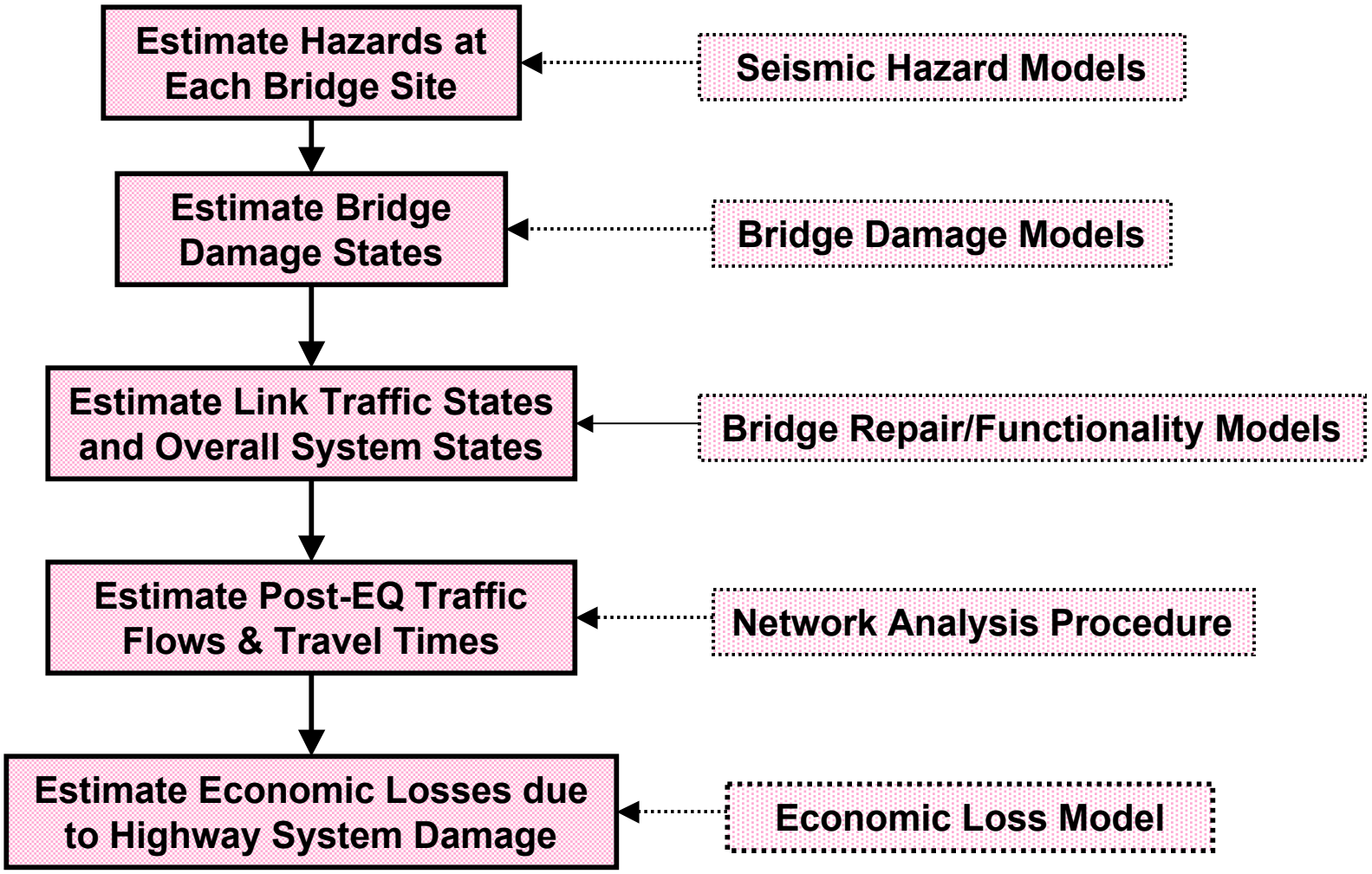
SRA PROCEDURE FOR HIGHWAY SYSTEMS



REDARS MODULES



ANALYSIS PROCEDURE FOR EACH SCENARIO EQ AND SIMULATION



FEATURES

- ***Modular***
  - ***Facilitate Future Incorporation of New/Updated Models***

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- ***Scenario-Based (Deterministic) & Risk-Based (Probabilistic) Analysis Capability***

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- ***Multidisciplinary***

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- ***Diverse Ways to Present Results for Decision Makers***

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- Modular
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- Scenario Based (Deterministic) and Risk Based (Probabilistic) Analysis Capability
- Multidisciplinary
- Diverse Ways to Present Results for Decision Makers
- ***Will be Public-Domain Software***
  - ***Beta Testing in 2004, Public Release in 2005***

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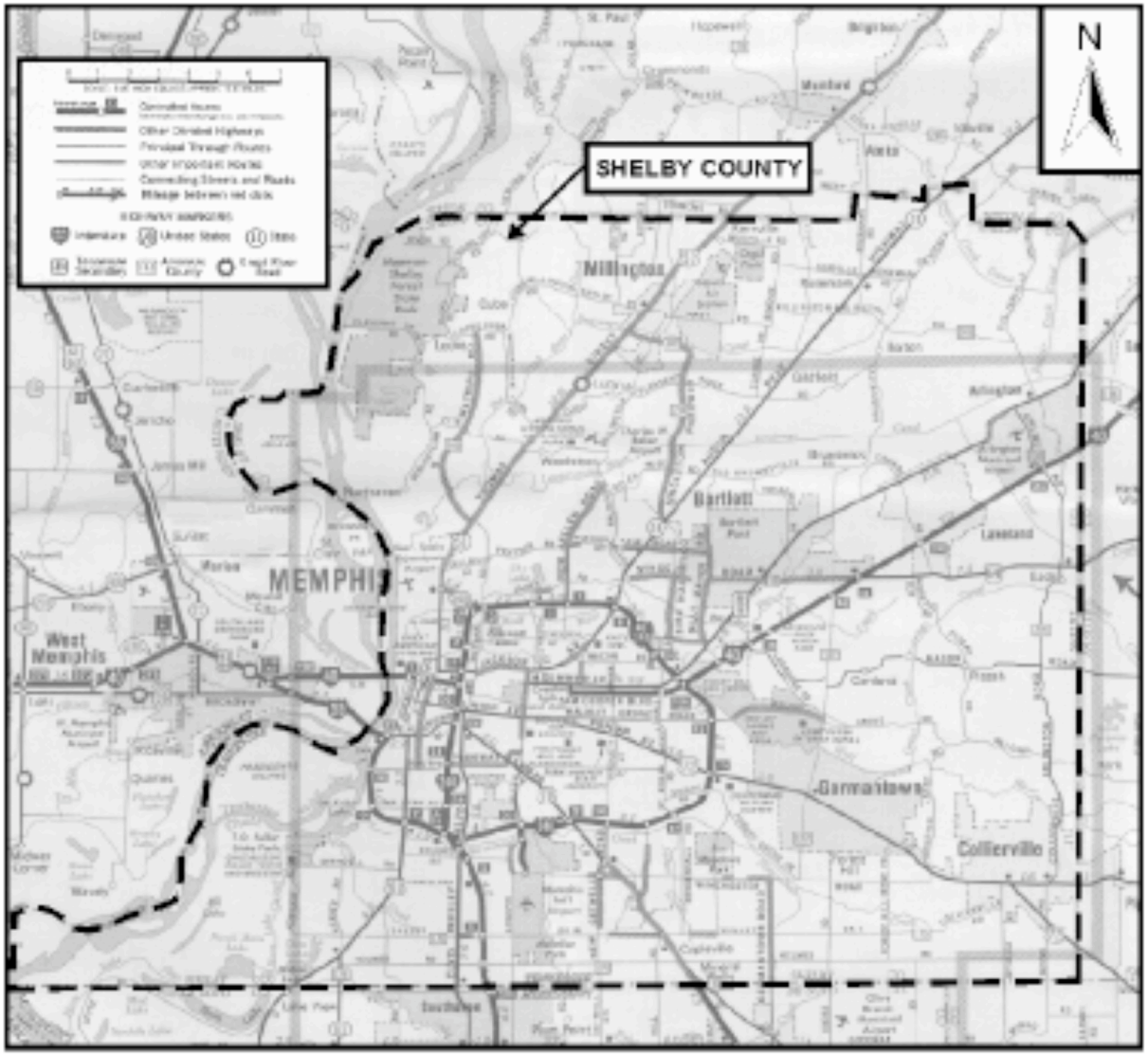
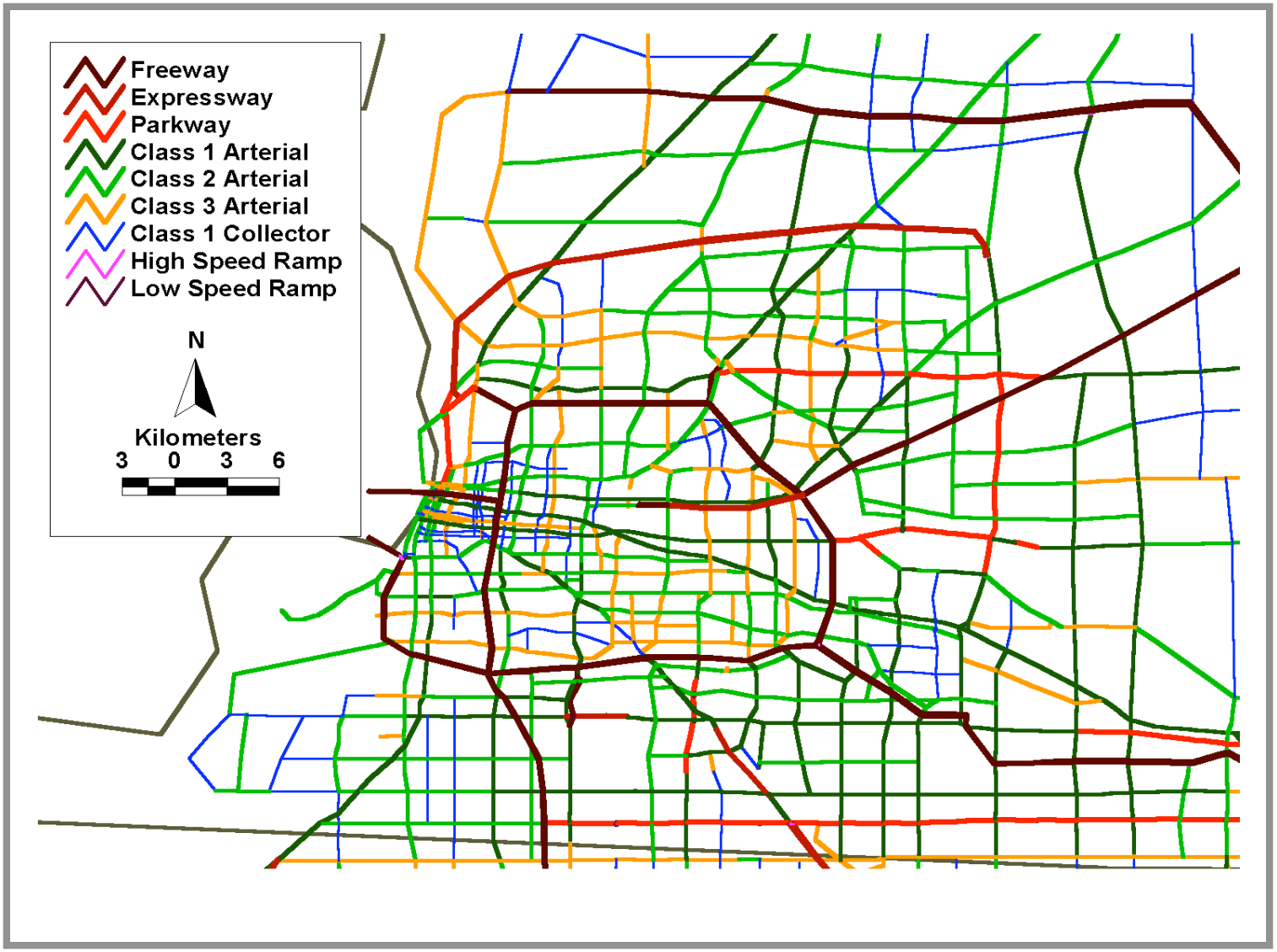
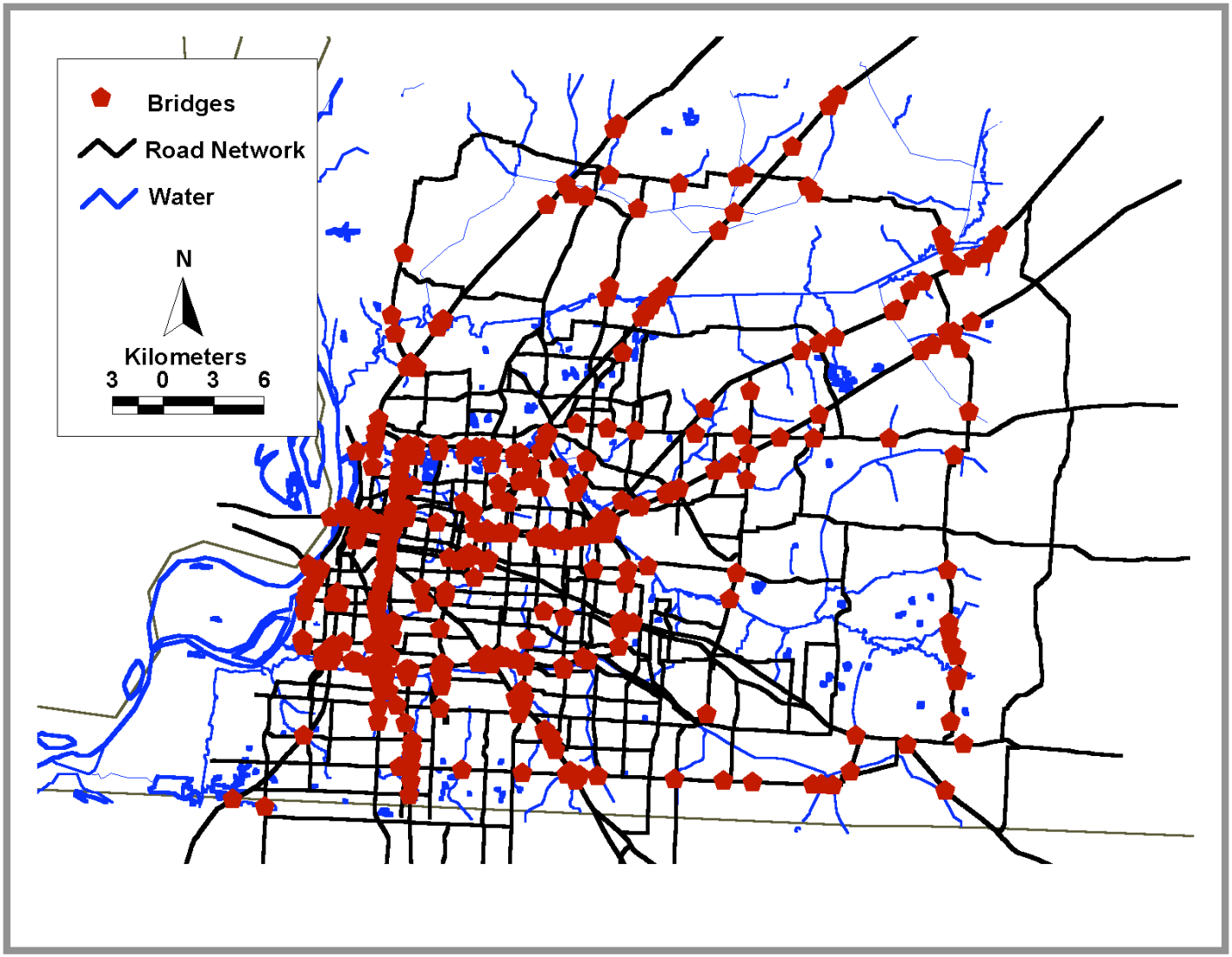
SHELBY COUNTY, TENNESSEE



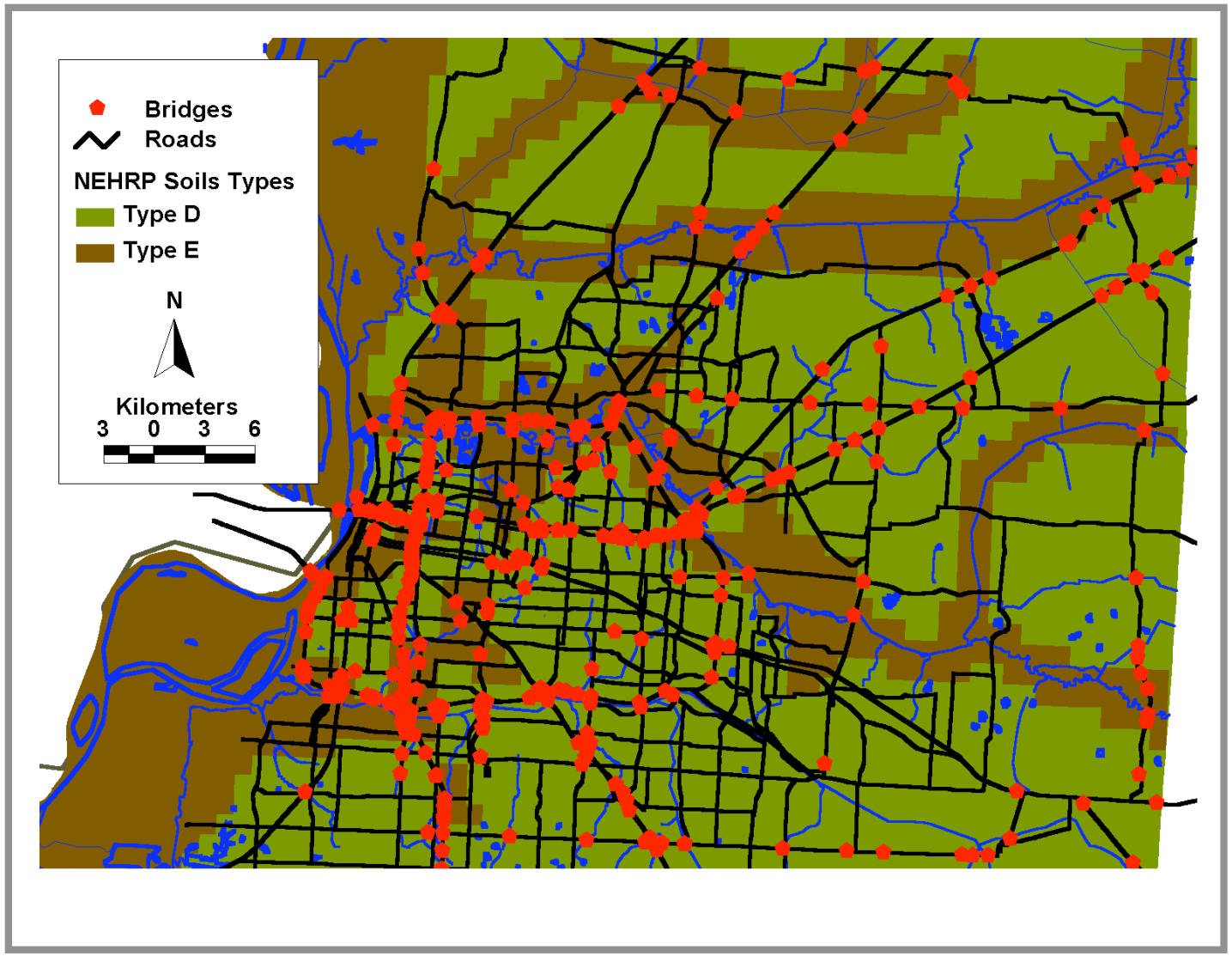
HIGHWAY-ROADWAY NETWORK



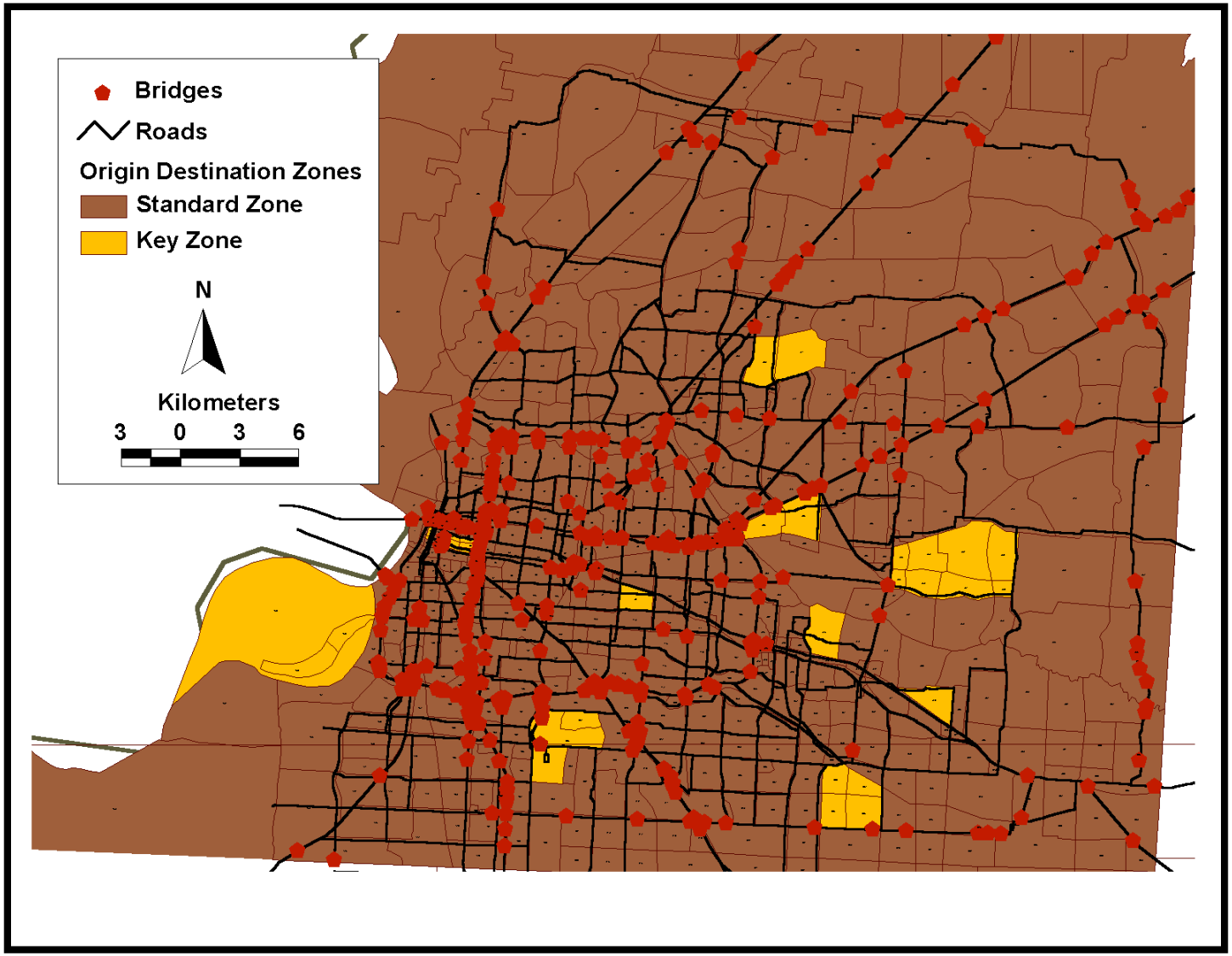
BRIDGES



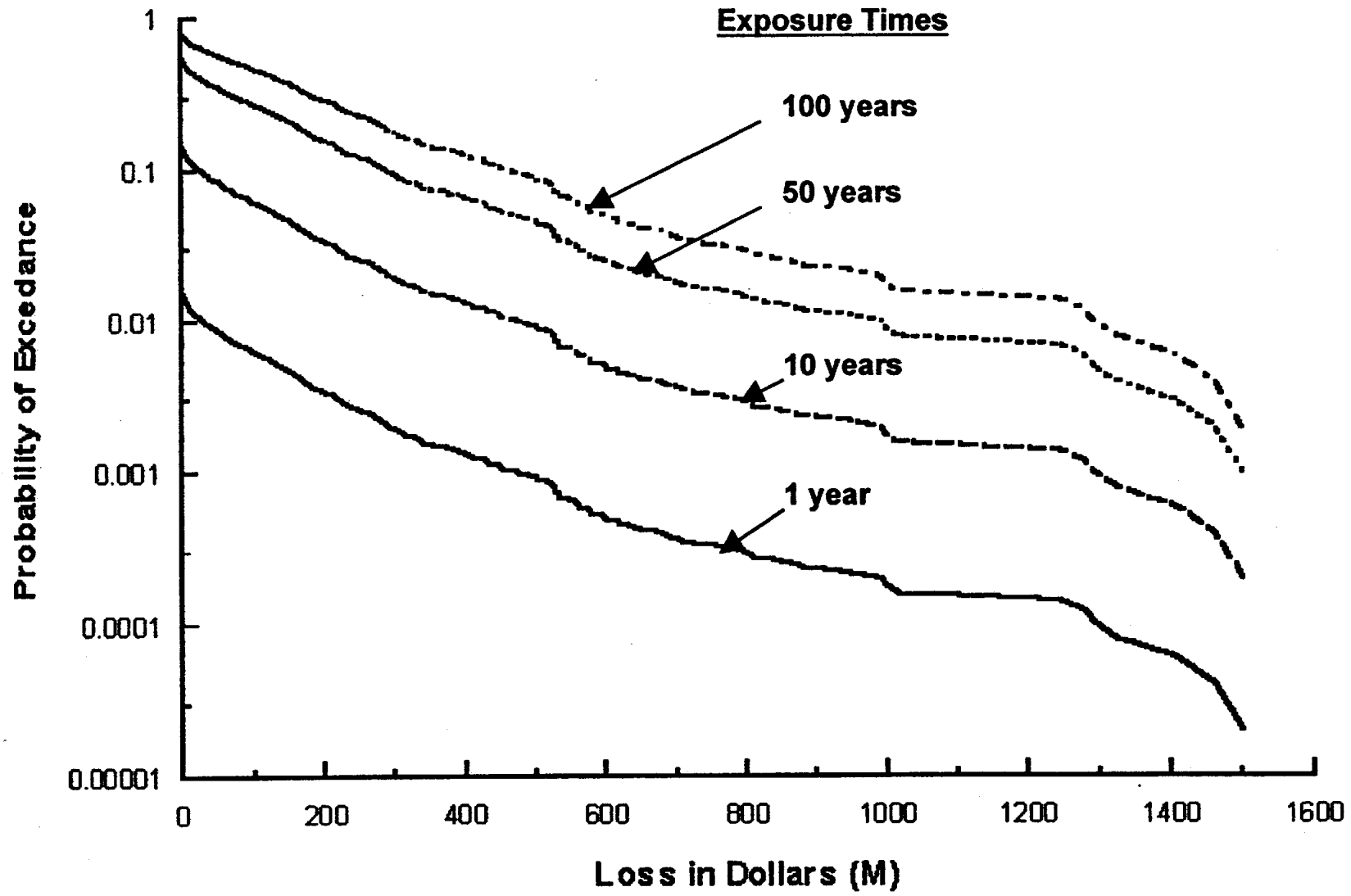
SOIL CONDITIONS



ORIGIN-DESTINATION ZONES



ECONOMIC LOSSES DUE TO TRAVEL TIME INCREASES



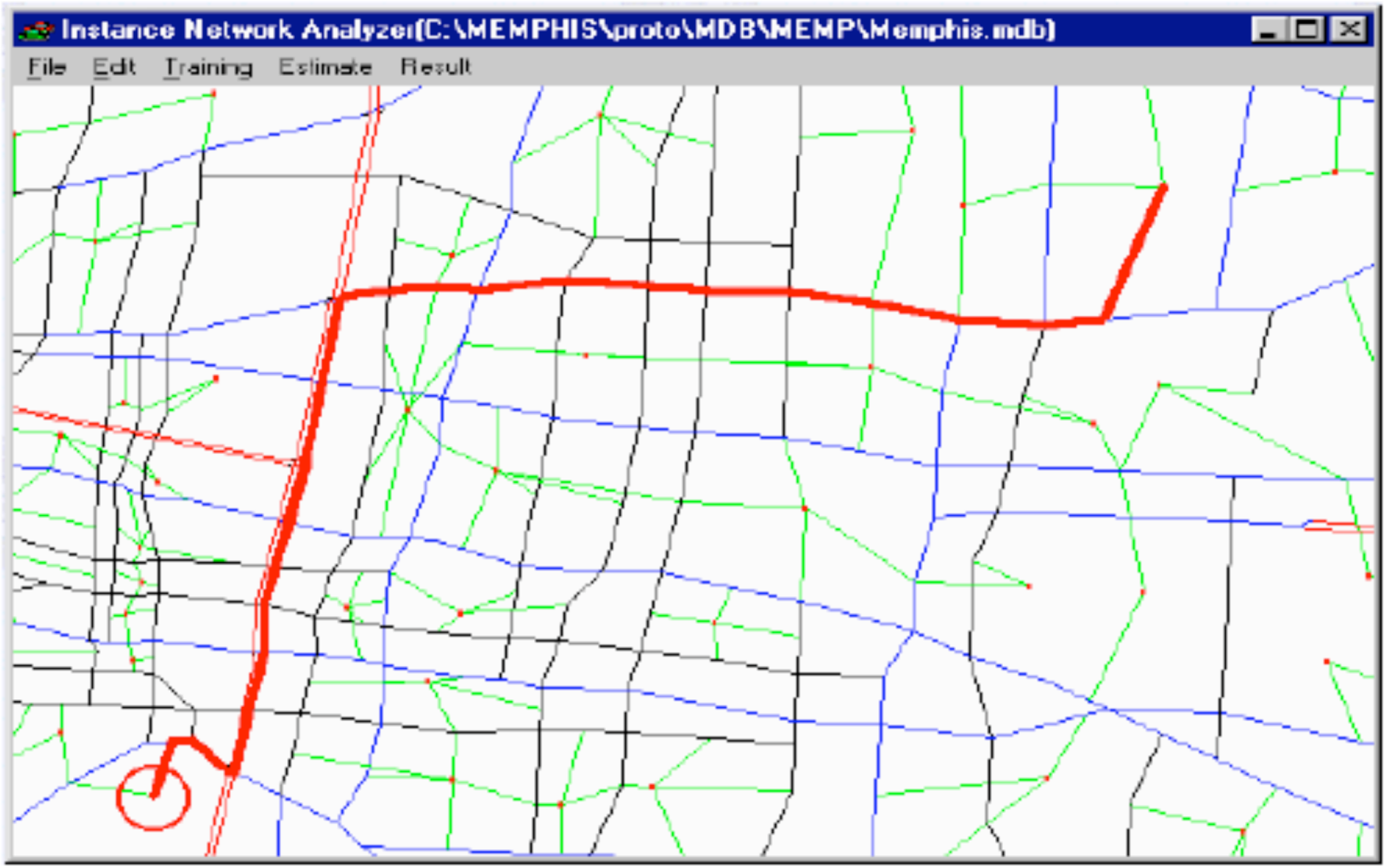
ECONOMIC LOSSES FOR SELECTED EQS

		Earthquake/Simulation				

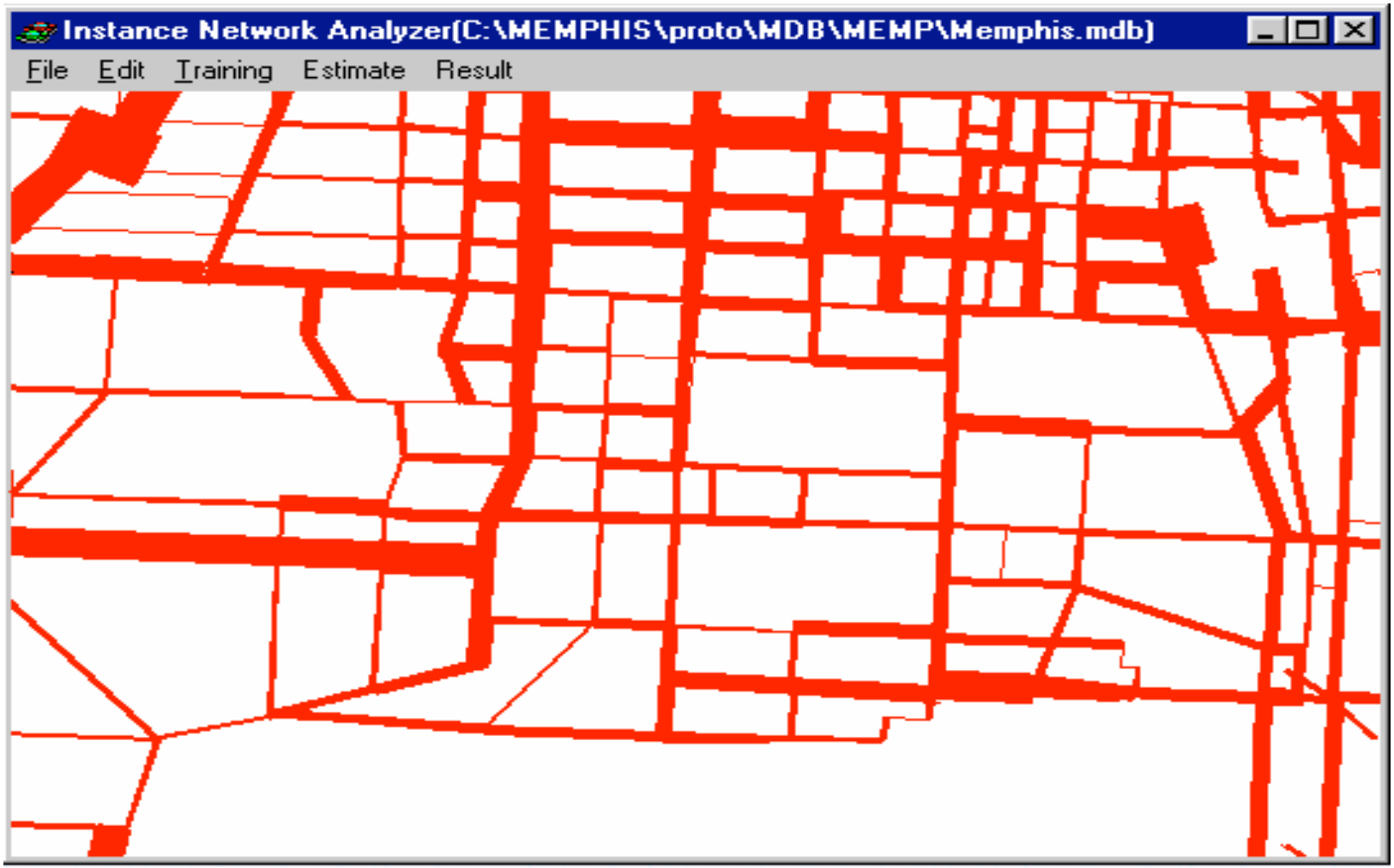
POST-EQ TRAVEL TIMES FOR EQ 41789-1

	Origin-Destination Zone			

TRANSPORTATION NETWORK ANALYSIS: MINIMUM-TIME TRAVEL PATHS



POST-EQ TRAFFIC VOLUMES



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PEER PROJECT 601: CALTRANS MINI-WORKSHOPS

- **Mini-Workshops**
  - **Caltrans District 7, Los Angeles CA**
  - **Caltrans District 4, Oakland CA**
  - **Caltrans Headquarters, Sacramento CA (2 Workshops)**
- **Objective: To Obtain Caltrans Input Regarding:**
  - **Possible Uses of SRA**
  - **How REDARS may be Improved to Enhance Usefulness**

END USER FEEDBACK:
POSSIBLE SRA APPLICATIONS

- ***Pre-EQ Assessment of Need for Seismic Strengthening of Bridges along Critical Lifeline Routes***

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- ***Pre-EQ Planning and Management of Repair Resources***

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- ***Post-EQ Traffic-Management/Detour-Route Planning***

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- ***Post-EQ Coordination of Emergency Response Activities between Agencies***

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- ***Pre-EQ Identification of Vulnerable Sections of Highway System***

END USER FEEDBACK: DECISION VARIABLES

- **Possible Decision Variables:**
  - **Bridge/Component Damage States**
  - **System States at Various Times after EQ**
  - **Economic Losses (Repair Costs, Costs of Time Delays)**
  - **Travel Times (Aggregate, System-Wide)**
  - **Travel Time (Between Selected Locations)**
  - **Minimum-Time Travel Paths and Distances (Between Selected Locations)**
  - **Traffic Volumes along Selected Links**
- **Consistent with Current REDARS Output**

END USER FEEDBACK:
SRA RESEARCH-RECOMMENDATIONS

- ***Rapid Post-EQ Updating Procedures in Real Time***

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- ***Improved Fragility Models for Pavements, Tunnels, Embankments, Retaining Walls, Culverts***

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- Rapid Post-EQ Updating Procedures in Real Time
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- Fragility Models for Pavements, Tunnels, Embankments, Retaining Walls, Culverts
- ***Improved Models for Collateral Seismic Hazards for Spatially Dispersed Lifeline Systems (Liquefaction, Landslide, Fault Rupture)***

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- Rapid Post-EQ Updating Procedures in Real Time
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- Improved Models for Collateral Seismic Hazards for Spatially Dispersed Lifeline Systems (Liquefaction, Landslide, Fault Rupture)
- ***Further Calibration/Upgrading of Network Analysis Models (Including Post-EQ Trip Demands)***

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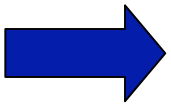

Closing Comments

SOME POSSIBLE PERFORMANCE METRICS FOR HIGHWAY SYSTEMS

- **X % Allowable Increase in Post-EQ Total Travel Time (Vehicle Hours Traveled)**
- **Y % Allowable Increase in Post-EQ Travel Time between Critical O-D Pairs (e.g., between Damaged Region and Emergency Hospital)**
- **Z % Allowable Increase in Post-EQ Travel Time along Critical Emergency-Response or Lifeline Routes**
- **System Traffic Flows must be Restored to within P % of Pre-EQ Flows within D Days after EQ**

FUTURE RESEARCH ISSUES: INPUT DATA

- **Highway Systems Include Many Bridges, Components, Sites**
- **Federally Available Electronic Data Bases may not Provide All Data Needed for Upgraded Models that may be Developed**
  - **e.g., NBI Bridge Database Not Intended for Seismic Analysis Applications**
- **Important Consideration when Planning Research to Improve Models for SRA Applications**
- **May Need Parallel Effort to Develop Electronic Database of Required Input Data**

ACKNOWLEDGEMENTS

- Federal Highway Administration and MCEER
- Current and Former MCEER Project Management:
  - Ian Buckle, UNR; Jerry O'Connor, MCEER; Ian Friedland, FHWA
- Other Members of SRA Project Team:
  - Craig Taylor (Natural Hazards Management Inc.)
  - Jim Moore (Univ. of Southern California)
  - Ron Eguchi, Charlie Huyck, and Sungbin Cho (ImageCat)
  - Jean-Paul Lavoie and Chip Eitzel (Geodesy)

USE OF SRA FOR PRE-EQ RISK REDUCTION DECISION MAKING