The Test of Fire: A Comparison of Adapted Four-Step MPO Model Results and Planning Process Findings to Actual Experience

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Chicago Area Model Users Group (CATMUG)
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Colorado Wildfires Signal Mounting Wildfire Threat

A Changing Trend in Wildfire Incidence

- Extreme drought conditions increase fuel availability
- Urban areas that are located at edge of wildland are placed at risk

2012 Waldo Canyon Fire – Threat to Wildland Urban Interface Realized

[U.S. Drought Monitor Map]

July 3, 2012

Released Thursday, July 5, 2012

http://droughtmonitor.unl.edu/
Colorado Springs Response to Mounting Wildfire Threat

Response Elements

- Wildfire Mitigation Plan (WMP) – 2001
- WUI Wildfire Evacuation Appendix – (2008, Updated 2011)
- Community Wildfire Protection Plan (CWPP) – 2011

Key Partners

- Colorado Springs Office of Emergency Management (OEM)
  - Wildland Urban Interface Wildfire Mitigation Plan / WUI Wildfire Evacuation Appendix
  - Community Wildfire Protection Plan
- Colorado Springs Fire Department
  - Neighborhood-level Emergency Notification/Evacuation Plans
- Pikes Peak Area Council of Governments
  - Evacuation Modeling/Planning Process
  - Wildfire Evacuation Traffic Control Plans
Developing a Wildfire Evacuation Planning Approach

Options Considered

✓ Design and Implement Evacuation Signal Control
  • Colorado Springs Traffic Operations Center (TOC) Lead
  • Utilizing Colorado Springs TOC ITS/Signal Control Software

✓ Develop Modeling Supported Evacuation Traffic Control Plans
  • Use Micro-simulation (VISSIM) for evacuation /traffic control simulation
  • Use Travel Demand Model for evacuation /traffic control simulation
Selected Modeling & Planning Approach

- Adapt PPACG 4-Step Travel Demand Model for evacuation simulation
- Use available data to support model adaptation and application
- Leverage Technical Steering Committee Expertise
  - To establish evacuation protocols to be modeled
  - To validate model performance – Are the model results reasonable?
- Use an iterative screening approach to optimize Traffic Control Plans
- Produce Traffic Control Plan maps to meet user requirements
  - OEM strategists
  - Emergency dispatchers
  - Law enforcement traffic control personnel
  - Emergency responders
## Basis for Evacuation Model – Context and Protocols

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>PROTOCOLS, CHARACTERISTICS OR ATTRIBUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINE SCENARIOS</td>
<td>• Identify potential fire spread/risk subareas</td>
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<td>• Evaluate no-notice versus notice evacuation</td>
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<td></td>
<td>• Establish background traffic conditions</td>
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<tr>
<td>TRAFFIC CONTROL</td>
<td>• Intersection-level control</td>
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<tr>
<td></td>
<td>• Signal preemption/emergency operation</td>
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<td></td>
<td>• Route closures</td>
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<td></td>
<td>• Traveler information systems</td>
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<td></td>
<td>• Contra-flow operations</td>
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<tr>
<td>EVACUATION PROTOCOLS</td>
<td>• Required evacuation rate: notice, no-notice, staged evacuation</td>
</tr>
<tr>
<td></td>
<td>• Shelters: locations, capacities</td>
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<td></td>
<td>• Notification means</td>
</tr>
<tr>
<td>EVACUEE BEHAVIOR</td>
<td>• Mobilization time, activity sequence,</td>
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<tr>
<td></td>
<td>• Vehicle occupancy rate</td>
</tr>
<tr>
<td>SPECIAL FACILITIES</td>
<td>Evacuation procedures/responsibilities for schools, jails, nursing homes, hospitals and special facilities</td>
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</tbody>
</table>
## Basis for Evacuation Model – Required Data Inputs

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>PROTOCOLS, CHARACTERISTICS OR ATTRIBUTES</th>
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</thead>
<tbody>
<tr>
<td>DEMOGRAPHIC DATA</td>
<td>• Automobile ownership by TAZ</td>
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<tr>
<td></td>
<td>• Number of households by TAZ</td>
</tr>
<tr>
<td></td>
<td>• Number of persons and age distribution by TAZ</td>
</tr>
<tr>
<td></td>
<td>• Disabled representation within households by TAZ</td>
</tr>
<tr>
<td></td>
<td>• Assisted evacuation group quarters population by TAZ</td>
</tr>
<tr>
<td></td>
<td>• Shelter capacity and locations by TAZ</td>
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<tr>
<td>BACKGROUND TRAFFIC</td>
<td>Background traffic for preload</td>
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<tr>
<td>EVACUEE DESTINATIONS</td>
<td>Evacuee destinations/splits by TAZ/external station</td>
</tr>
<tr>
<td>ROAD NETWORK</td>
<td>• Roadway network layout (links/nodes)</td>
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<tr>
<td></td>
<td>• Intersection control (type/ approach classification hierarchy)</td>
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<tr>
<td></td>
<td>• Number of lanes/link capacity</td>
</tr>
<tr>
<td></td>
<td>• Free-flow link speeds</td>
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</table>
Evacuation Model Application and Planning Process

**PROJECT INITIATION**
- Create Steering Committee
- Establish Modeling & Evacuation Protocols
- Adapt PPACG Travel Model

**DISTRICT LEVEL SCREENING**
- Identify “pinch points”
- Iteratively apply and test traffic control strategies or advance area to Neighborhood Level Screening
- Establish traffic control plan

**NEIGHBORHOOD LEVEL SCREENING**
Conduct Screening Analysis at the Neighborhood Level

**TRAFFIC CONTROL STRATEGIES**
- Evaluate alternative evacuation traffic control strategies
  - Contra-flow operations
  - Road closures
  - No Entry
  - Regional route restrictions
- Establish traffic control plan

**TRAFFIC CONTROL PLANS**
- Prepare District Level traffic control plans for six (6) Districts and Manitou Springs
- Prepare traffic control plans for two (2) Districts at Neighborhood Level (eight (8) neighborhoods)
Step 1: Project Initiation

**Establish Technical Steering Committee**
- Consultant Project Team
- PPACG Modeling Staff
- Colorado Springs Office of Emergency Management
- Colorado Springs Engineering – TOC
- Colorado Springs Police Department
- Colorado Springs Fire Department

**Establish Modeling/Evacuation Protocols**
- Population/vehicles to be evacuated
- Restrictions/shared responsibilities
- Evacuee destinations – “shelter-in-place,” official shelters, other
- Contra-flow/no contra-flow
- Required “time-to-evacuate”
- Resident re-entry restrictions
Step 1: Project Initiation

Adapting the PPACG Travel Model for Evacuation Planning

- Use 2010 PM peak hour model to represent background traffic
- Use hourly volume to capacity (V/C) ratios to evaluate “time-to-evacuate”
- Develop Embedded Evacuation Model(s)
  - Vehicles to be evacuated from U.S Census auto ownership data
  - Assume full evacuation of all households
  - Assume each household evacuates two (2) vehicles
  - Assume the following distribution of evacuee destinations:
    - Official Shelters (15%)
    - Other households in the area (60%)
    - Motels (15%)
    - Out of the County entirely (10%)
Step 2: District Level Screening

- Model / evaluate eight (8) wildfire at-risk districts, each incorporating multiple emergency response neighborhoods
- Model “times-to-evacuate” and screen for “pinch points” using one-hour roadway capacity as the reference criteria
- Develop district-level Traffic Control Plan or advance district to more neighborhood-level analysis
Step 3: Neighborhood Level Screening

- Model evacuation of selected neighborhoods at risk for wildfire
- Model “times-to-evacuate” and screen neighborhoods relative to one-hour roadway capacity reference
- Identify neighborhood evacuation “pinch-points” based on “times-to-evacuate” that exceed one hour (based on one-hour V/C ratios > 1.0)
- Develop neighborhood-level Traffic Control Plan or advance for more detailed traffic control strategy analysis
Step 4: Modeling Traffic Control Strategies

**REVIEW BASELINE MODELING**
- Identify “pinch points”
- Evaluate time-to-evacuate
- Assess role of pass-thru traffic
- Identify route restriction requirements
- Identify options for contra-flow

**MODEL PASS-THRU RESTRICTION**
- Model pass-thru restrictions
- Model route restrictions
- Model No Entry/Re-Entry

**REVIEW PASS-THRU MODELING**
- Identify “pinch points”
- Evaluate time-to-evacuate
- Advance to evaluation of traffic control strategies or pass back to Neighborhood Level Screening

**MODEL TRAFFIC CONTROL OPTIONS**
- Evaluate contra-flow operations
- Evaluate road closures
- Evaluate regional route travel restrictions
- Establish traffic control plan

**PREPARE TRAFFIC CONTROL PLANS**
- Prepare Geospatial Data Base for Traffic Control Plans
- Prepare Traffic Control Geospatial Mapping (C Size)
  8 Neighborhoods
  6 Districts
  Manitou Springs
Step 5: Preparing Traffic Control Plans – Full Area Key Map
Step 5: Preparing Traffic Control Plans – Individual Map Sheet

- Restricted Traffic Flow
- All Lanes One-Way
- Close to Entry

Traffic Flow:
- Evacuation Route One-Way Traffic
- Evacuation Route Two-Way Traffic
June 26, 2012 – Modeled Worst Case Became Reality

- 18,247 acres burned
- 347 homes destroyed plus other structures (Flying W Ranch) – record
- 2 fatalities, at least 6 injuries
- 32,000 persons evacuated - record
- Insurance claims total $352.6M - record
# June 23 – June 26, 2012 – 32,000 Persons Evacuated

<table>
<thead>
<tr>
<th>AREA</th>
<th>EVACUATION ZONE</th>
<th>NOTICE TYPE</th>
<th>DATE - TIME</th>
<th>TIME</th>
<th>COUNT</th>
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<tbody>
<tr>
<td>4-N7</td>
<td>1-Cedar Heights</td>
<td>Notice: Mandatory</td>
<td>6/23 - 1422</td>
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<td>9</td>
<td>Manitou Springs</td>
<td>Notice: Mandatory Allowed to return 6/25</td>
<td>6/23 - 1930</td>
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<td>Part 1-N4</td>
<td>3-Oak Valley, Peregrine, North Mountain Shadows</td>
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<td>4- North Rockrimmon</td>
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<td>Part 4-N5</td>
<td>8-Kissing Camels</td>
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<td>Part 1-N3</td>
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To ensure the safety and smooth flow of traffic during the evacuation, the following traffic control measures have been implemented:

### Traffic Control Measures Implemented

- **Full (Modified) Contra-flow Operations**
- **No-entry / No Re-entry**
- **Roadway Closures**
  - WB Garden of the Gods Road at I-25
  - NB 30th at Fontmore
  - Fillmore/Fontmore at Mesa
- **I-25 / Ramp Operation Closures**
  - All WB traffic from I-25 blocked at the Woodmen Road, Nevada-Rockrimmon, Garden of the Gods Road and Fillmore Street I-25 exits
  - I-25 closed to non-evacuation traffic
District 1 - Baseline Statistics

DISTRICT STATISTICS
- 12,300 Households
- 25,830 Persons
- 6 Egress Portals
  - 30th Street
  - Centennial Boulevard
  - Chestnut Street
  - Garden of the Gods/I-25
  - Nevada-Rockrimmon/I-25
  - Woodmen Road/I-25
- District Size
  - East-west - 4 miles
  - North-south - 4 miles
- I-25 provides primary evacuation route
District 1 - Baseline V/C Ratio Results

LEGEND
Volume to Capacity Ratio

- >= 1
- 0.85 to 1
- <= 0.85
District 1 Neighborhood 2 - Baseline Statistics

NEIGHBORHOOD STATISTICS
- 6,700 Households
- 14,070 Persons
- 3 Egress Portals
  - Centennial Boulevard
  - Nevada-Rockrimmon/I-25
  - Woodmen Road/I-25
- Neighborhood Size
  - East-west - 4 miles
  - North-south - 3 miles
- I-25 provides primary evacuation route
District 1 Neighborhood 2 - Contra-flow Options
District 1 Neighborhood 2 - Initial Contra-flow Option
District 1 Neighborhood 2 – Optimized Contra-Flow Option
Restricted Traffic Flow
All Lanes One-Way
Close to Entry

Traffic Flow
Evacuation Route One-Way Traffic
Evacuation Route Two-Way Traffic

District 1-Neighborhood 2 - Traffic Control Plan Atlas Map Sheets
Did Model Results Match Reality?

✓ Pre-evacuation of some areas took place over as long as 8 hours

✓ On June 26th no-notice evacuation was phased over 6 hours

✓ The maximum interval between phases was 2 hours

✓ Evacuees reported evacuation times of approximately 1.5 hours

✓ Model results for optimized traffic control show link V/C ratios of 1.3 to 1.67 – coinciding with 1 hour and 18 minutes to 1 hour and 40 minutes
A Grateful Community Says Thank You to Police and Firefighters

Thank you Firefighters for protecting our community.

Thank you Firefighters and Police Officers!

Thank you Firefighters and police officers.

Thank you for your service.

Thank you 1st Responders.