“Stormproofing” Roads

Vulnerability Reduction Overview

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Medio ambiente y cambio climático y su impacto en el transporte vial. XVI Congreso Argentino de Vialidad y Tránsito. 22 de Octubre Córdoba, Argentina.

Roads Vulnerability Reduction

What Climate Change Events Impact Roads?

- **Hurricanes/Floods**
- **Landslides**
- **Fires**
- **Earthquakes**
- **Wind**
- **Tornadoes**
- **Ice Storms**
- **Volcanoes**
- **Tsunamis**

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What Can We Do to Prepare for Natural Disasters Associated with Climate Change?

- Planning/Preparation
- Risk Assessment
- Preventative Maintenance
- Apply Best Management Practices
- Preventative Mitigation Measures (Stormproofing)
- Disaster Assistance

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Pre-Disaster Risk Assessment

- Site location, geomorphology, soils, watershed condition, slope, road standard, etc.
- Risk of Failure
- Values at Risk
- Consequences of Failure

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Planning/Preparation

- Identification of Major Routes
- Inventory of Areas of Highest Risk
- Inventory of Structures at Risk
- Alternative Routes
- Availability of Maintenance Equipment
- Temporary Bridges
- “Storm” Patrols
- Backup Communications/Maps

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What can we do to deal with storms?

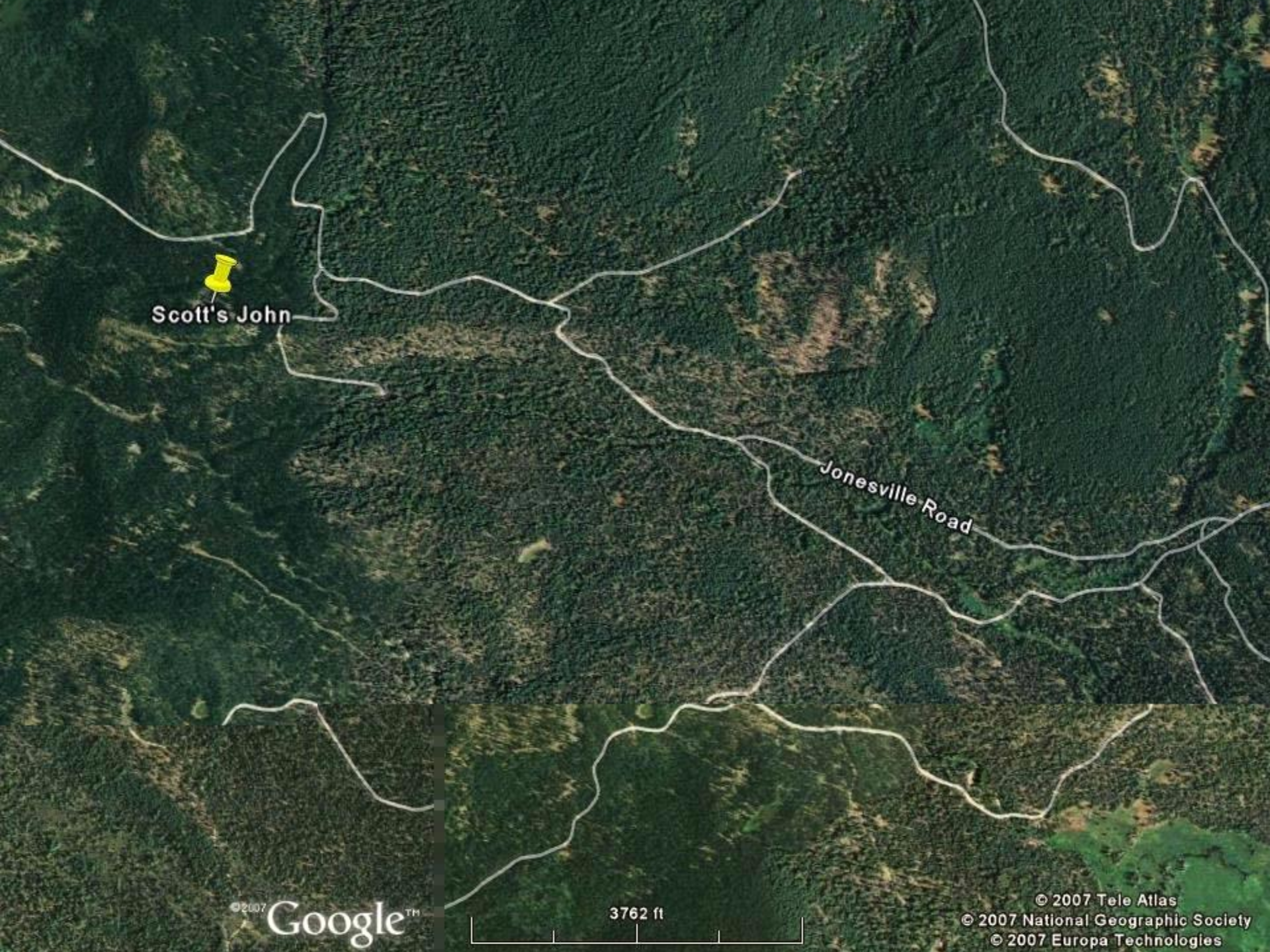
Prepare and Pay Some Now

or

Pay $$$ Later

Crowds panic as flooding threatens Ireland...

Road Inventory


Scott's John
Jonesville Road
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3762 ft
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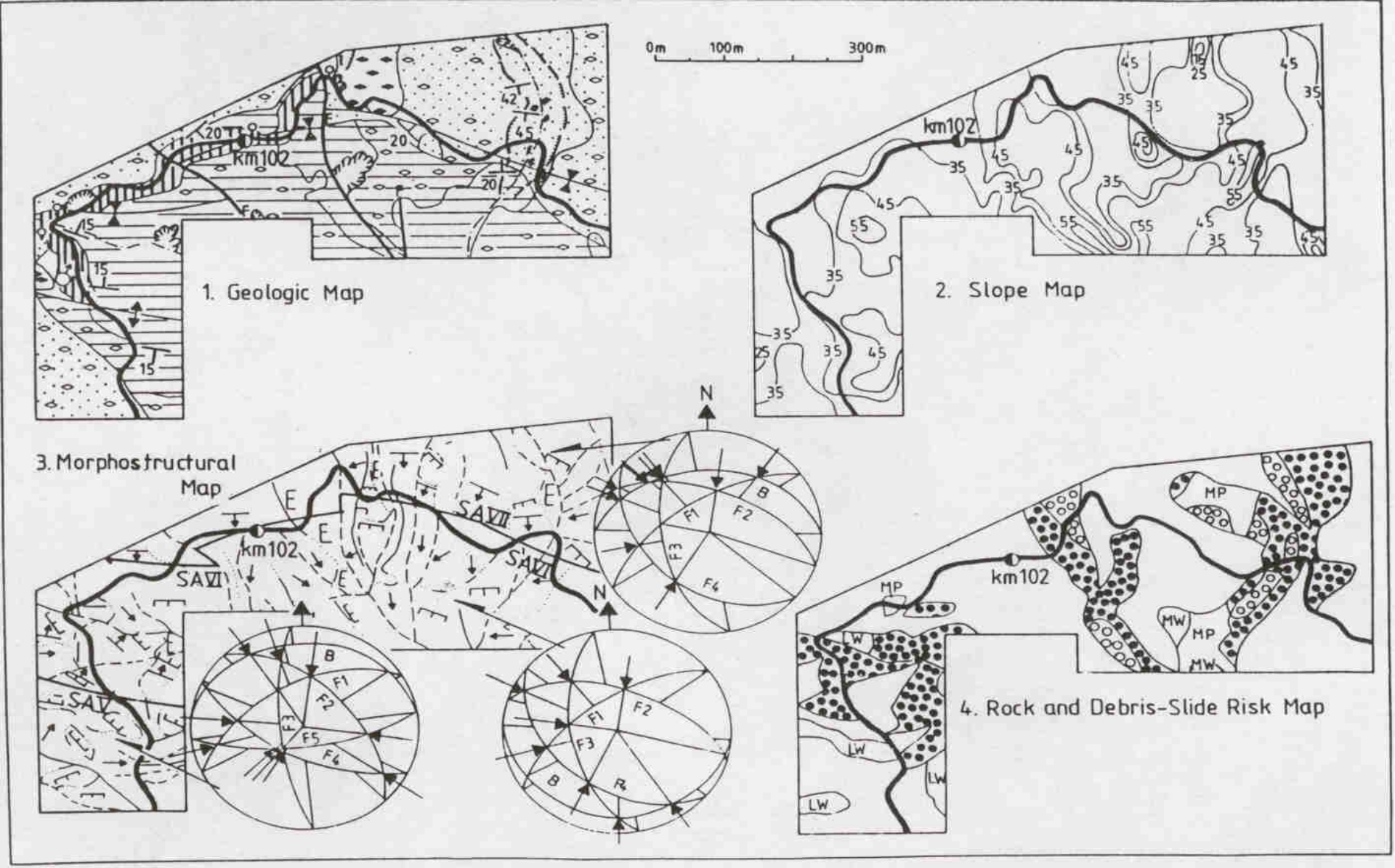

1. Geologic Map

- Thick eluvial or colluvial soil
- Rather thin eluvial or colluvial soil
  In general sparse outcrops of rock

3. Morphostructural Map

- Ridge or crest
- Sharp ridge or crest
- Rivulet
- Limit of slope unit

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Preventative Maintenance

- Clean Ditches and Culverts
- Cleaning and Stabilization of Channels
- Shaping Road Surfaces to Drain
- Clearing Bridge Waterways
- Replacing Riprap
- Maintaining Vegetative Cover

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Application of Best Management Practices

“Best Management Practices” are practices implemented on roads through good design, construction and maintenance, to provide a good level of road service, cost-effective performance, and minimize negative environmental impacts.

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Preventative Mitigation Measures (Stormproofing)

- Having Road Maintenance Current
- Improving Road Surface Drainage
- Having Adequate Cross-Drainage
- Culvert and Channel Cleaning
- Preventing Culvert Diversion
- Increasing Pipe Capacity
- Overflow Protection and Trash Racks
- Low-Water Fords vs Culvert Pipes

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Photo: Gordon R Keller

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Preventative Mitigation Measures (Stormproofing)

- Bridge Channel Cleaning & Scour Protection
- Road-Stream Encroachment-Moving Roads
- Thorough Vegetative Cover (Deep roots)
- Using Soil Bioengineering/Biotechnical Measures
- Gully Control and Prevention
- Local Slope Stabilization Measures
- Pulling Back Unstable Fills, Deep Patch, Drainage Improvements, Soil Nailing
- Changing Road Grade or Alignment, Closure

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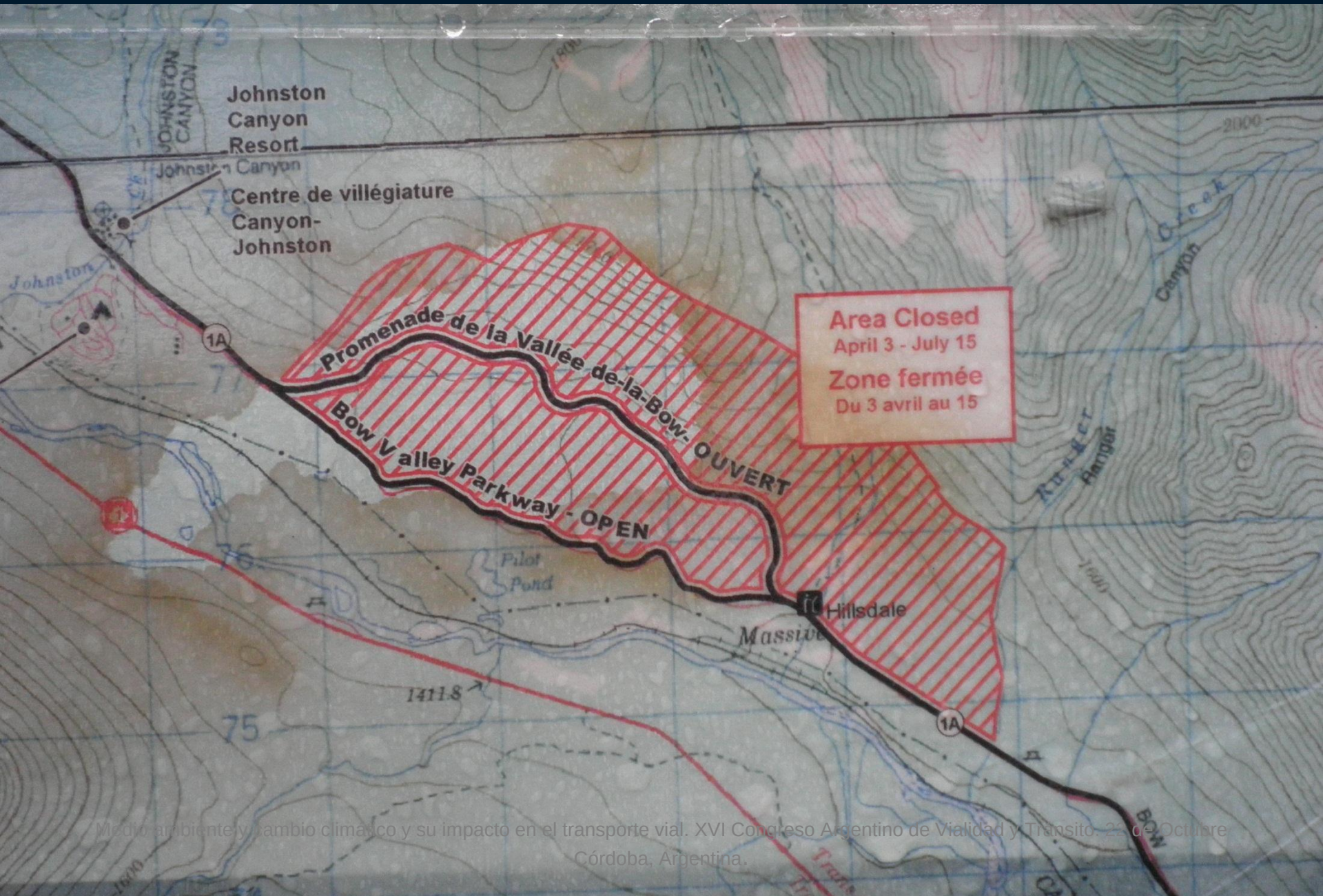
Disaster Assistance

- Emergency (Storm Damage) Surveys
- ICS System Implementation
- Evacuations
- Opening Alternative Routes
- Emergency Repairs
- Temporary Road Openings
- Information for the Media/News Releases

Incident Command System (ICS)

- An organizational structure used for disasters/emergencies for both loare and small scale.
- Size of the structure is flexible, depending on magnitude of the disaster.
- ICS is used by many agencies and countries worldwide.
- Five major management components to ICS:
  - Command Staff
  - Operations
  - Planning
  - Logistics
  - Finance/Administration

Website: www.osha.gov/SLTC/etools/ics/index.html


Johnston Canyon Resort
Centre de villégiature Canyon-Johnston
Promenade de la Vallée-de-la-Bow - OUVERT
Bow Valley Parkway - OPEN
Area Closed
April 3 - July 15
Zone fermée
Du 3 avril au 15
Hillsdale
1A
Pilot Pond
1411.8


PLANNING AND PREPARATION


PREVENTATIVE
MAINTENANCE

BEST MANAGEMENT PRACTICES
(Mejores Prácticas de Caminos)


CONTROL OF SURFACE WATER


CULVERT PROTECTION AGAINST
PLUGGING
AND OVERTOPPING


USE OF FORDS


BRIDGE PROTECTION


ROAD CLOSED
ROAD CLOSED
MOVE OR PROTECT THE ROAD!


EROSION CONTROL-
DRAINAGE & VEGETATION


SLOPE STABILIZATION

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References

- FHWA HEC 18-Scour & other pubs
- TRB 247-Landslides
- ASCE-Debris Flows
- ASCE-Flood Resistent Design
- PIARC-Road Vulnerability
- OAS-Disaster Vulnerability
- Forest Service-T&D Roads Pubs

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Web Sites

- http://downloads.globalchange.gov
- www.desastre.org
- www.zietlow.com
- www.dot.ca.gov/hq/esc/techpubs
- www.pubs.asce.org
- www.fhwa.dot.gov/bridge or publications
- www.piarc.org
- www.osha.gov/SLTC/etools/ics


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Major Retrofits

- New Foundations
- Stiffening of Columns
- Stabilized/Reinforced Piers and Piles
- Wider Bridge Seats
- Slabs and Girders Tied Down
- Anchored Walls
- Add Drainage to Fills
- Relocate Local Roads

High Quality New Construction

- Bridge Structural Design per AASHTO
- Road Design Standards per FHWA
- Geotechnical Investigations
- Good Specifications
- High Quality Control
- New Road/Highway Routes

Specific Aspects of Design

- Drainage Design
  - Small and Large Watersheds
- Scour Countermeasures
- Capacity and Protection of Culverts
- Design and Use of Fords
- Roadway Surface Drainage
- Aspects of Bridge Design

-Retrofits, GRS Abutments, Scour, Capacity

Specific Aspects of Design
(Cont.)

- Slope Stabilization
  - Slide Identification
  - Use of Walls/Buttresses/MSE
  - Rockfall Protection
- Soil Stabilization against Liquifaction
- Selection of Materials
- Erosion Control/Use of Vegetation
- Adecuate Specifications & Quality Control