

July 18, 2016

# **Communicating Multi-Objective risk – A new geotechnical need for transportation**

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## Highways have Geotechnical Assets

There are four independent geotechnical assets

- These are in addition to important elements of bridge, tunnel, pavement, culvert, and other assets

They can be managed to reduce life cycle cost

They can be managed to improve corridor and system performance

Examples of poor geotechnical asset performance follow:

# Geotechnical Assets

## 1. Retaining Walls





# Geotechnical Assets

## 2. Slopes





# Geotechnical Assets

## 3. Embankments





# Geotechnical Assets

## 4. Subgrade



**Safety is Priority #1 – but nobody was hurt in examples shown**

**Life Cycle Cost is clearly not optimized**

**Other MAP-21 Goals are impacted**

- Infrastructure condition
- Congestion
- Reliability
- Environmental sustainability

## MAP-21 (FAST Act) National Performance Goals

1. Safety
2. Infrastructure Conditions: State of Good Repair
3. Congestion Reduction
4. System Reliability- improve efficiency
5. Freight Movement and Economic Vitality
6. Environmental Sustainability
7. Reduced Project Delivery Delays

Look at four key goals...



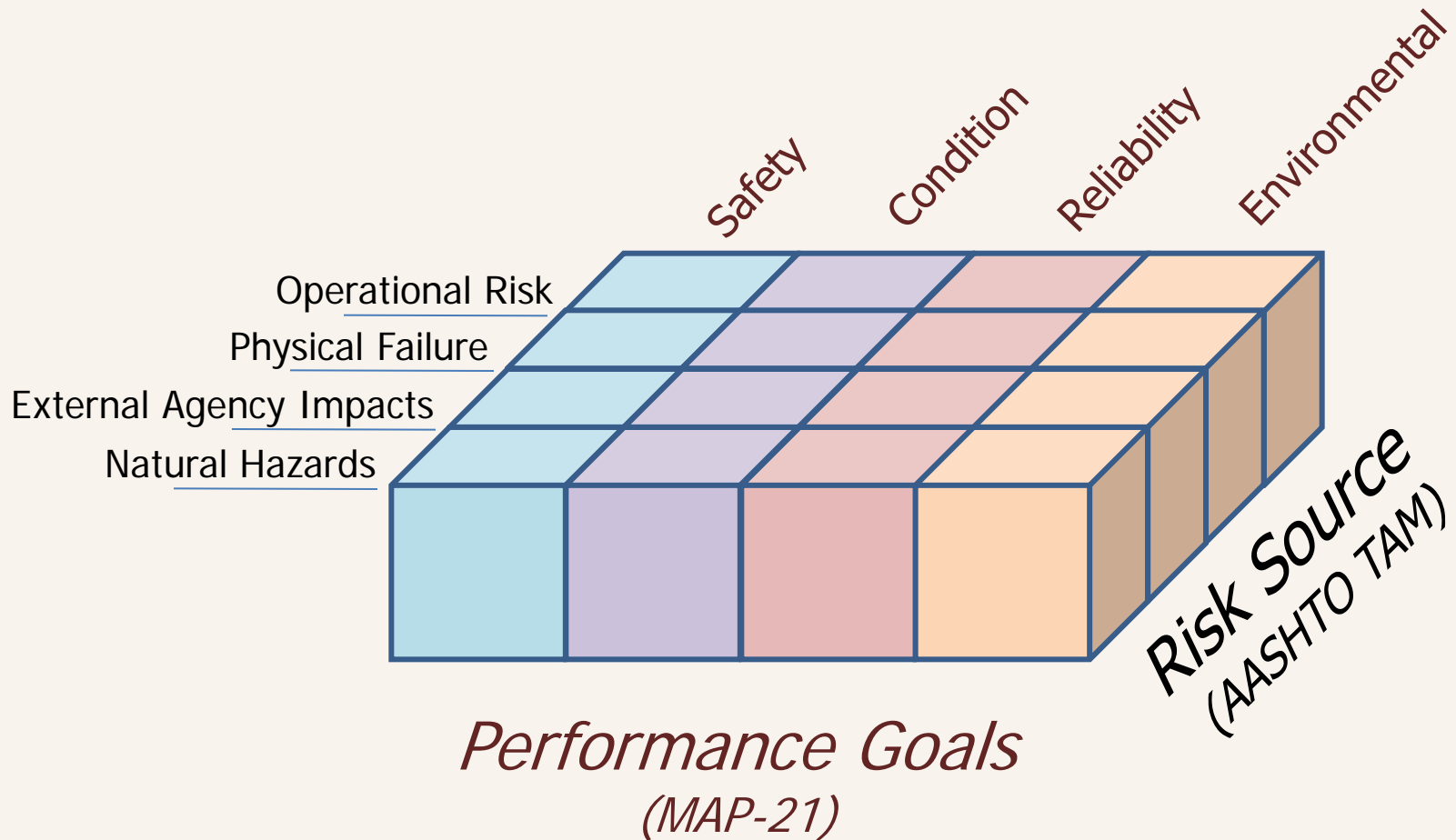
## AASHTO Risk Sources

- 1. Natural Hazards**
  - e.g. extreme/rare events
- 2. External Agency Impacts**
  - e.g. poor materials or construction
- 3. Physical Failure**
  - e.g. deterioration
- 4. Operational Risk**
  - e.g. poor design, operation, or business decision



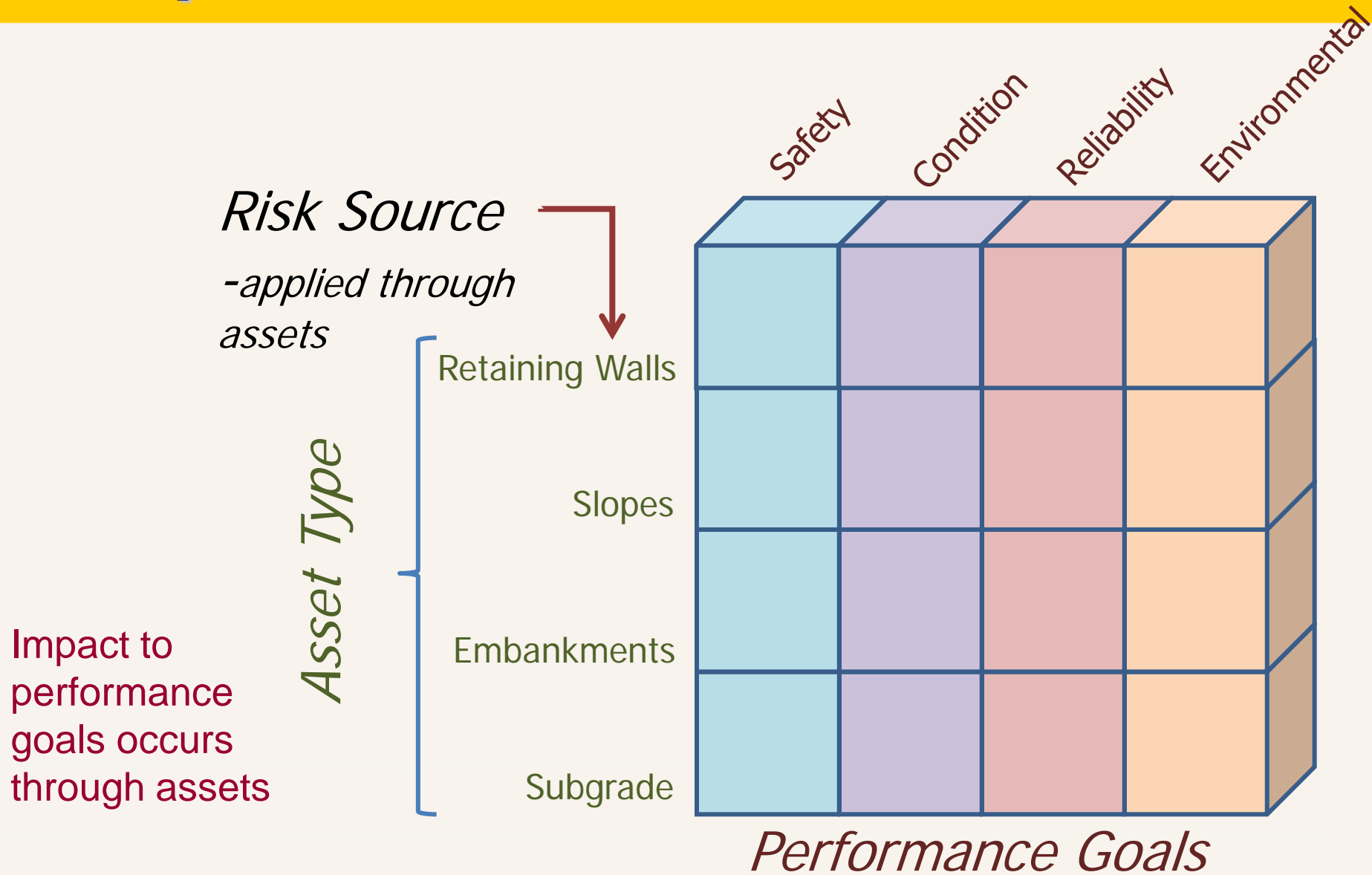
AASHTO TAM Guide (Section 5.4.1)

# Multiple Consequences



Consequences can be expressed using performance goals

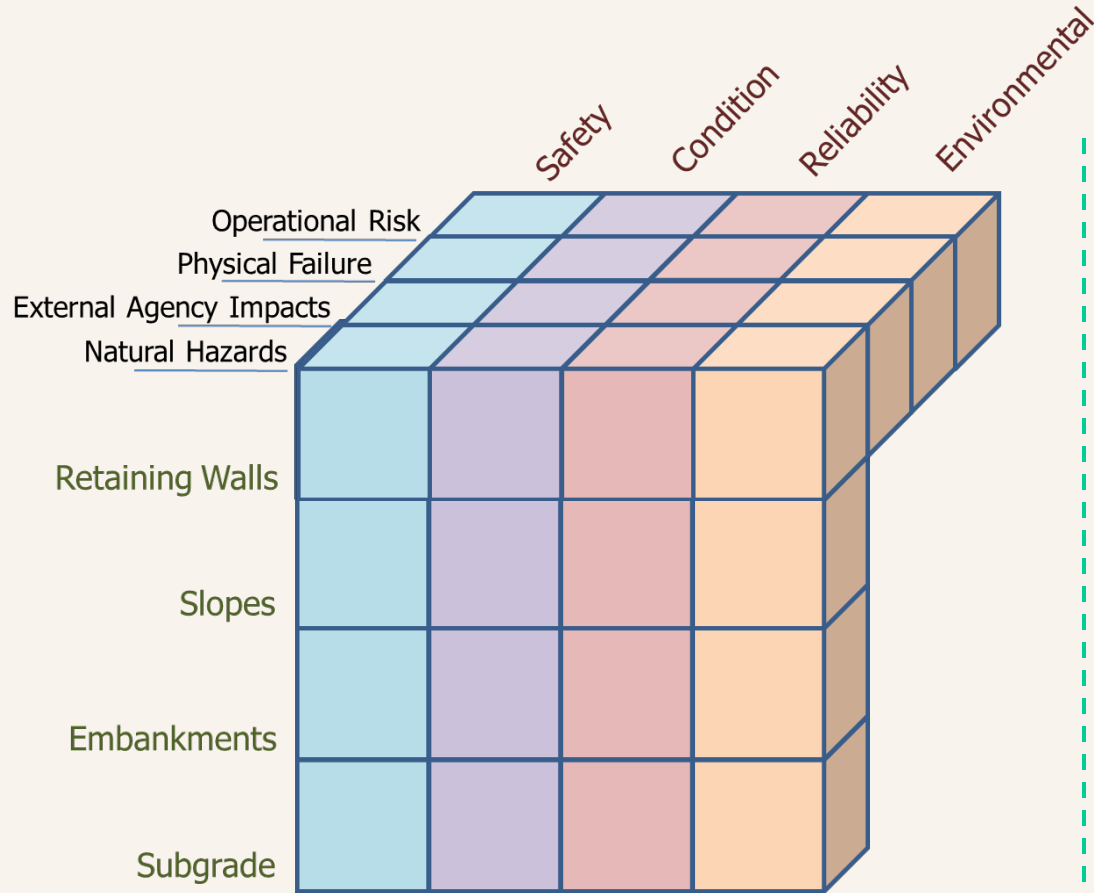
# Multiple Risk Paths



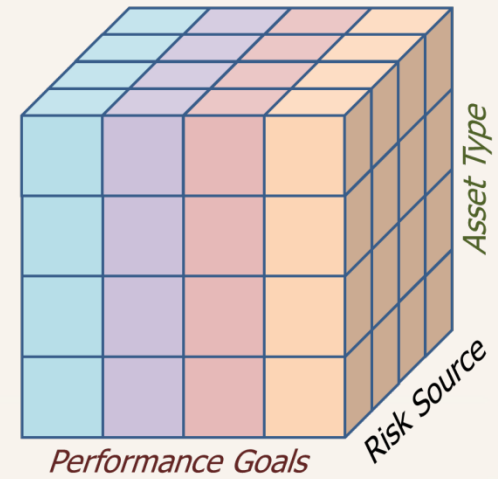


# Multiple Elements of Risk

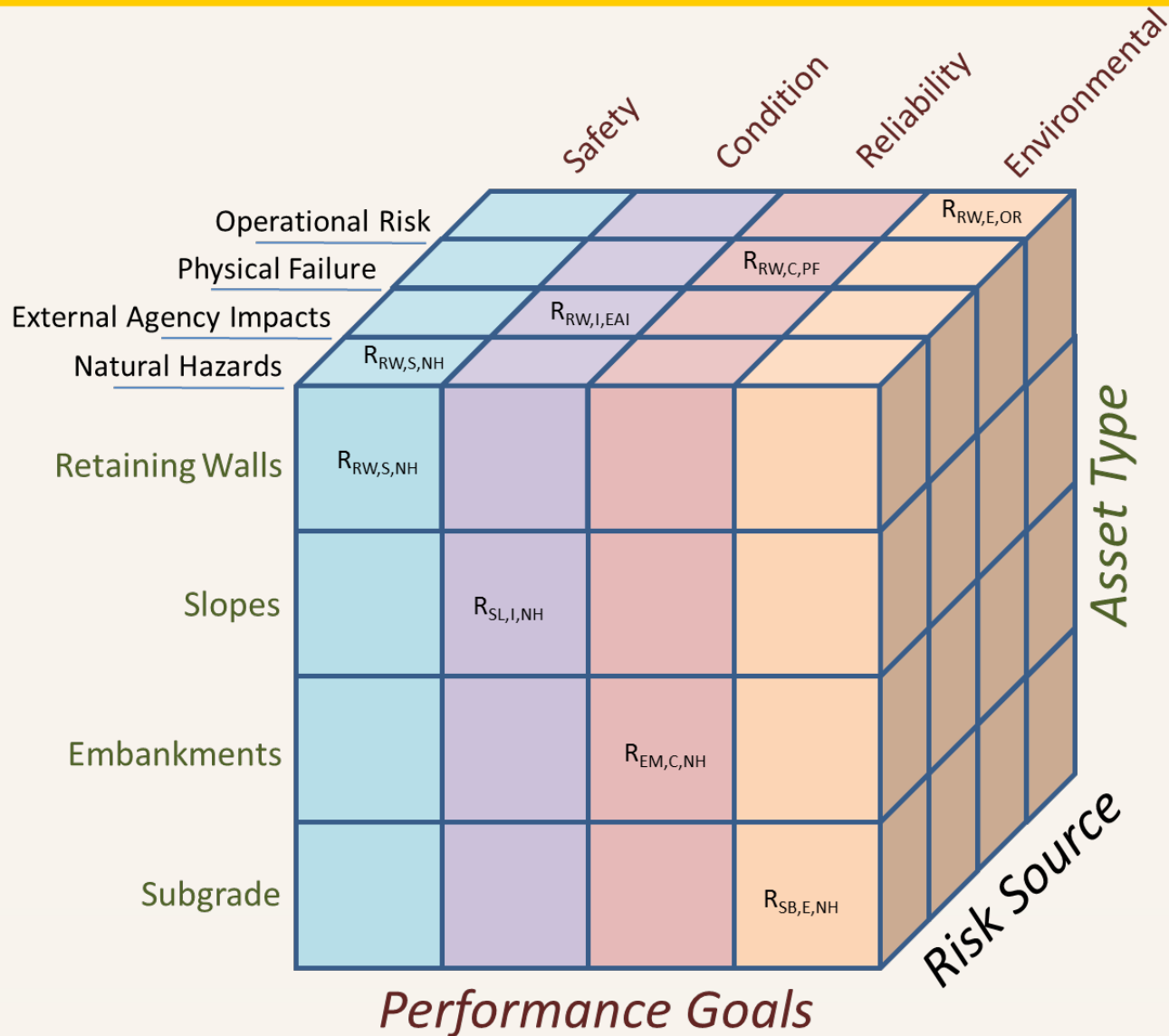
## Compiling risk source, path and consequence



Expanding  
for 4 Risk  
Sources:  
**Risk Cube**



# Risk Cube



## The Risk Cube visualization:

- Facilitates clear communication of “the risk of what?”
- Recognizes that risk comes from a **source**, acts on an **asset**, and impacts specific performance **objective(s)**
- It takes three coordinates (x,y,z) to describe a risk at an elemental level
- Allows elements of the cube to be considered independently and to the extent warranted based on risk level relative to other elements and the sum of all risks
- Communicates the contribution and need for geotechnical asset management by allowing recognition of significant impact when multiple objectives are considered
- However – the risk cube visualization can be used for any set of risks, assets and performance objectives



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# *Thank You*