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Geotechnical Asset Management Subcommittee AFP00(1)

Geotechnical Asset Management Implementation for Transportation Agencies - Outcomes from Project 24-46

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BGC

Portions of this discussion contain preliminary findings from NCHRP Study 24-46. These findings are based on the submission of draft deliverables and comment responses to NCHRP and are should not be considered as final research product

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Cheesy ‘80s Kickoff Slide

Before April 12, 2008

April 13, 2008

Why manage geotechnical assets?

- Assets have life-cycle expectations
  - Whether those expectations are explicitly defined or not

- Geotechnical assets contribute measurable value to a transportation network
  - Mobility and economic vitality, safety performance, and asset condition costs

Why GAM

Google Street View: September 2017

For Any Asset

At any time in the operational phase, an owner will select one of the following treatment actions for each asset:

- Reconstruct
- Rehabilitate
- Maintain
- Do minimum
  - Do minimum can be a planned decision or the default action in the absence of GAM

Do Minimum Asset Management

on Sept. 4, 2018, work to remove debris and replace a concrete wall that collapsed along Route 45 between a ıe Route 137 overpass. (Lake County Sheriff's Office)

Full coverage

Top coverage

Chicago Daily Herald

Route 45 closed in Libertyville; railroad bridge retaining wall collapses

today

Chicago Tribune

Route 45 near Libertyville expected to reopen Tuesday evening after wall collapse

today

September 3-4, 2018: ~18 hour closure for 28,700 ADT highway, emergency cleanup, and a TBD determined reconstruction/recovery cost

There is a cost of delaying GAM

Avoiding asset management does not eliminate the treatment decision or resulting consequence

Shifting from Legacy Practices

- Geotechnical assets ≠ liabilities or hazards
  - Manage like other assets and avoid disruptive liabilities

- Geotechnical assets satisfy:
  - The definition of asset per AASHTO
  - International Organization of Standards (ISO) definition

- Geotechnical assets are managed assets in other countries and infrastructure systems
  - There is a precedent and benefits are being realized:

    >230,000 slope and embankment assets managed for U.K. Highway and Network Rail agencies

Asset Management Overview

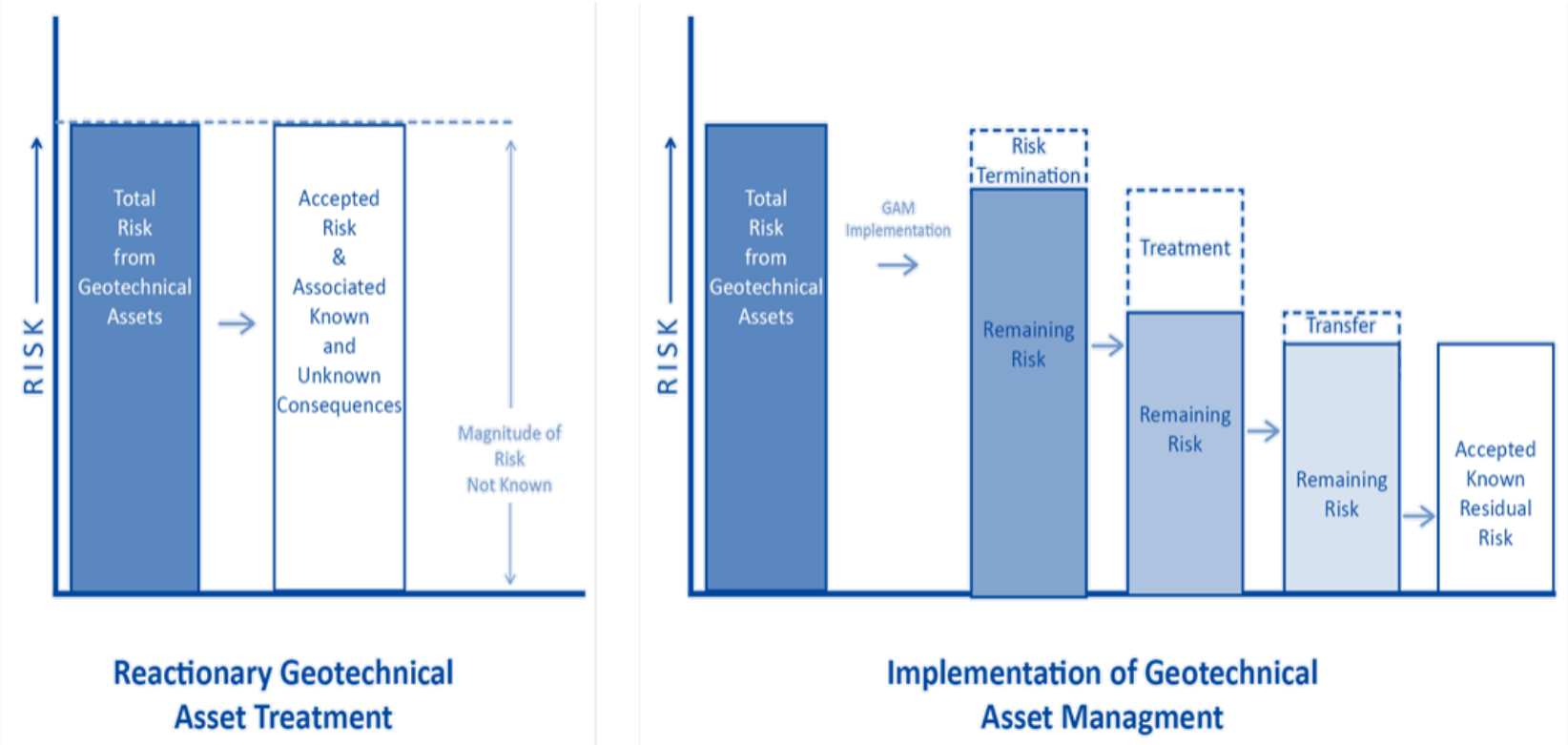
- Goal of asset management (any asset):
  - To align asset design, operation, maintenance, and upgrade decisions with the ***goals and objectives of the agency***

- Much more than bridges and pavements
  - In 2004, first international standardization process across 50 public and private entities in 15 sectors and 10 countries
  - Many guidance resources available

Financial responsibility for GAM

- Without GAM:
  - Accepting unknown levels of risk to safety, mobility, and economic vitality while potentially making unfavorable life-cycle investments
- With GAM:
  - Stewardship of taxpayer funds
  - Good business practice for making investment decisions with limited funds
  - Can evaluate potential changes with time due to agency investment options and external threats

Managing Risk with GAM

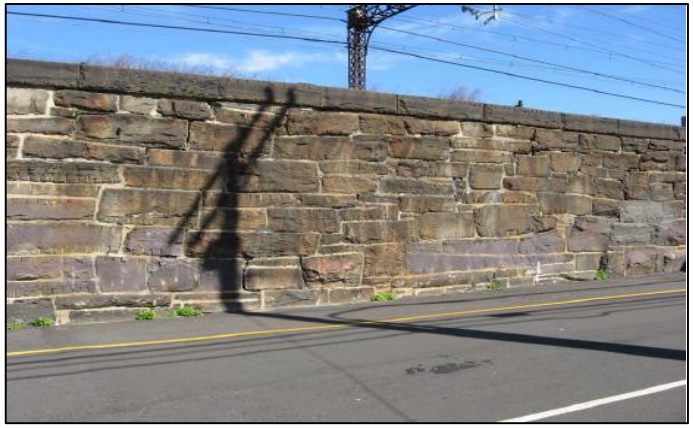


- Measure and communicate risk levels
  - Move from an unquantified “thing” to a known and accepted residual risk

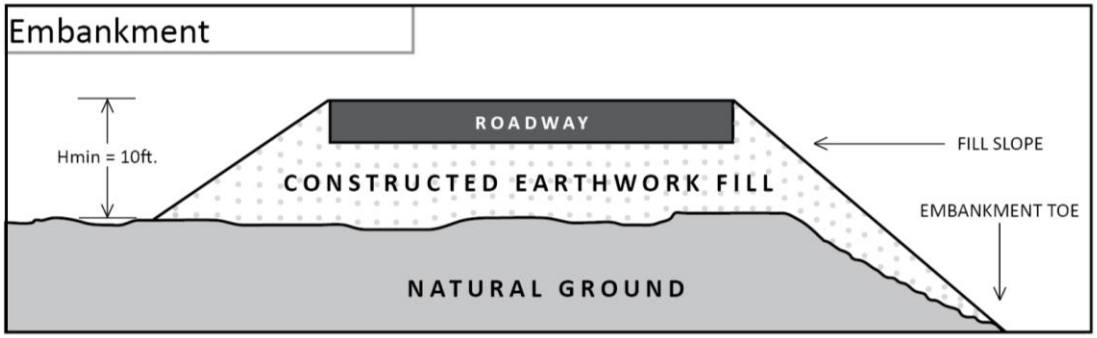
What is a Geotechnical Asset?

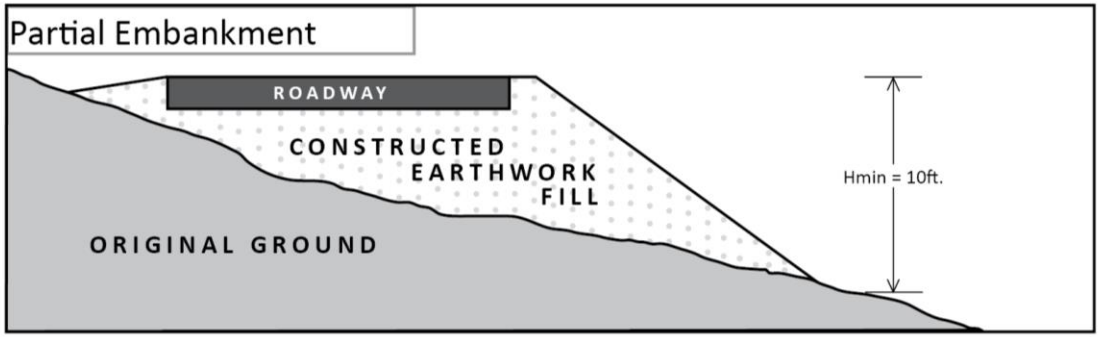
- Geotechnical assets are the retaining walls, slopes, embankments, and subgrades that contribute to the ability of an agency to perform the strategic mission
  - The asset does not need to be distressed!

Retaining Walls: constructed structures that hold back natural soil or rock or engineered materials to prevent sliding of material onto a roadway or other structure, or support a roadway.

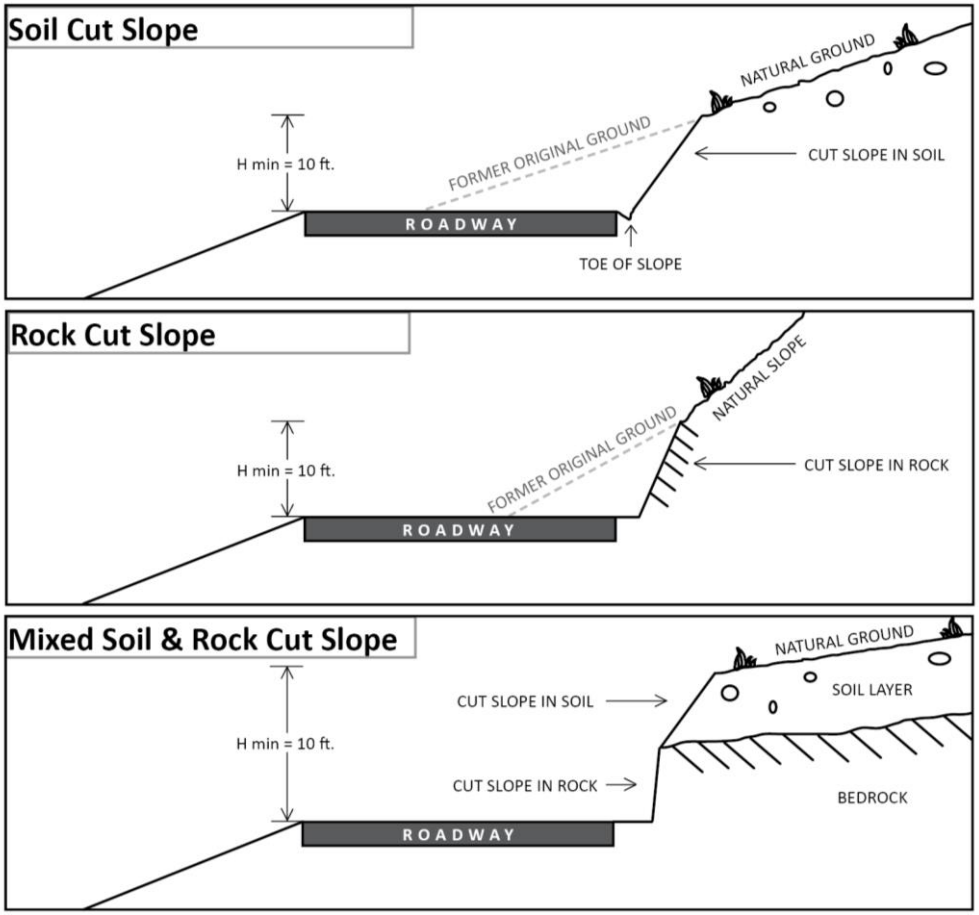



Embankments: constructed earth fill comprised of soil or mixtures of rock and soil that enables a roadway to maintain a required design elevation above lower lying ground.

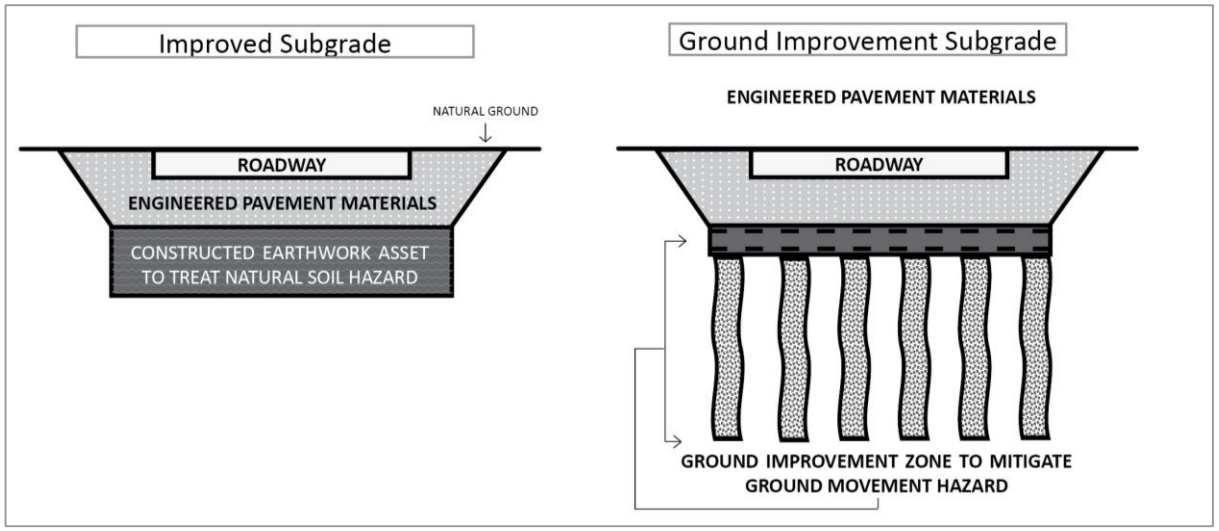


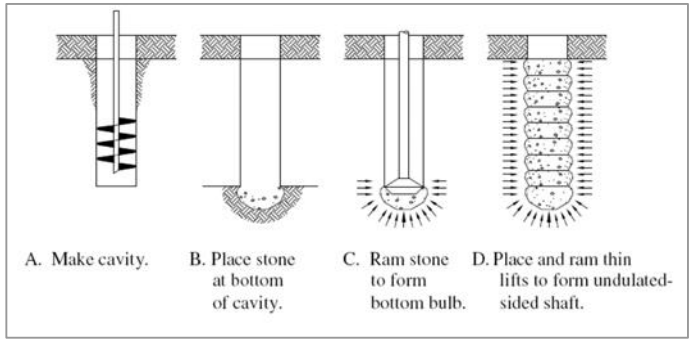


Slopes: A permanently excavated slope (a cut-slope) that is incorporated into the roadway template and within the ROW, easement, or other property boundary.

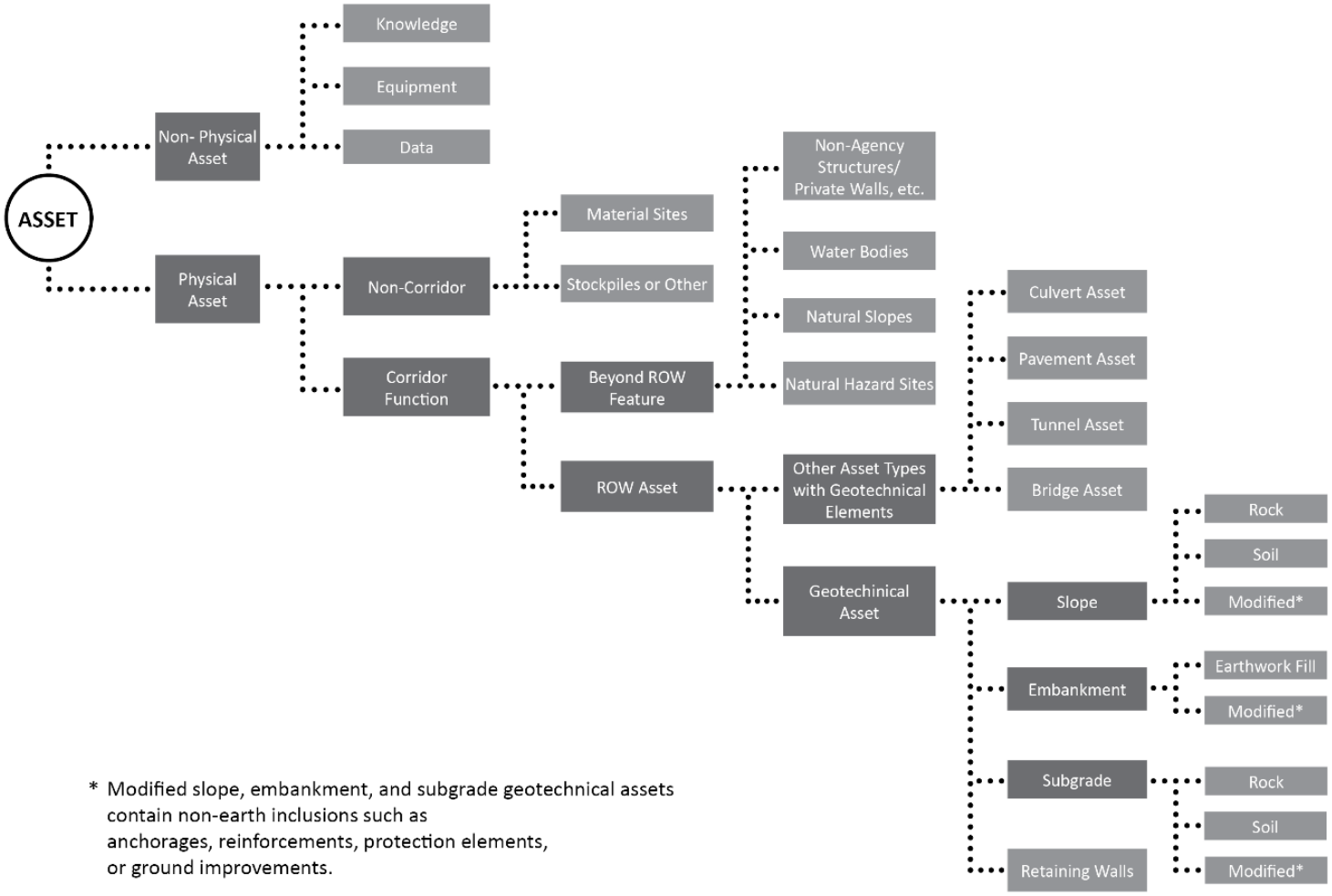


Subgrades: constructed earth material below the engineered pavement layers that creates a life-cycle management need.





GAM Taxonomy Formulation



* Modified slope, embankment, and subgrade geotechnical assets contain non-earth inclusions such as anchorages, reinforcements, protection elements, or ground improvements.

Role of Agency Boundary

- Assets within the boundary
  - Geo-assets are owned and maintained by agency
  - Generally full control – like bridges and pavements
- Hazards originating beyond the boundary
  - Not owned, but possibly managed through reactive means
  - Often associated with a natural hazard site – a geohazard
  - Best considered a “beyond the ROW” feature

Geohazards

Geohazards result from geotechnical, hydrotechnical, tectonic, and snow and ice processes – such as subsidence, landslides, debris flows, erosion, flooding, liquefaction, avalanche and permafrost degradation.

Role of ROW/Boundary

- Assets in the ROW – Designed, Constructed, and Maintained by Agency

Deteriorating embankment within ROW

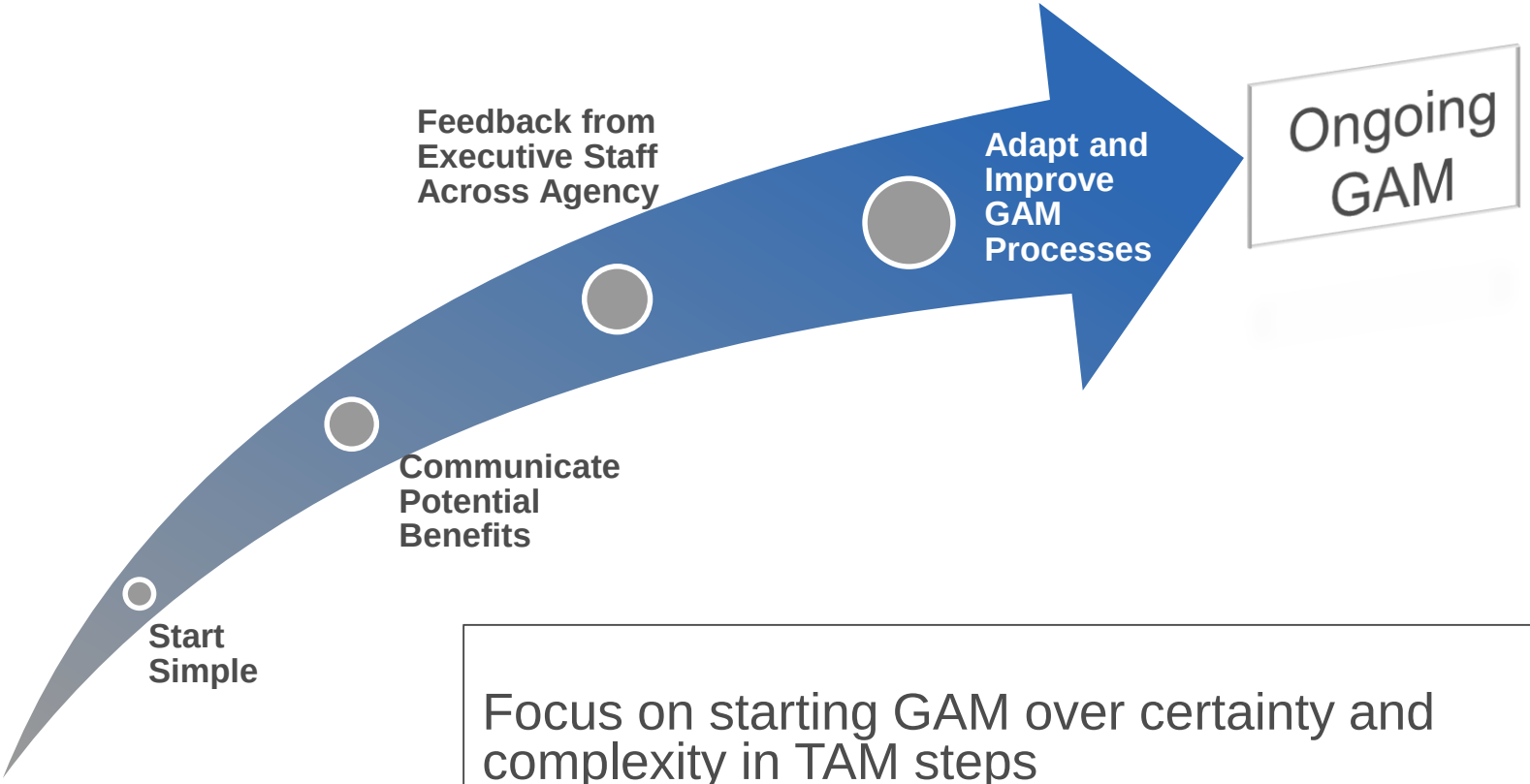
Wall and Slope (rock cut) on ROW and within boundary

Comparing Geotechnical Assets and Beyond the ROW features

Rockfall originating from the slope asset above is due to physical deterioration of a cut made by the agency and also the O&M responsibility of the agency

Rockfall originating from the natural cliffs above are natural events that may effect O&M but also would have occurred with or without the highway being present

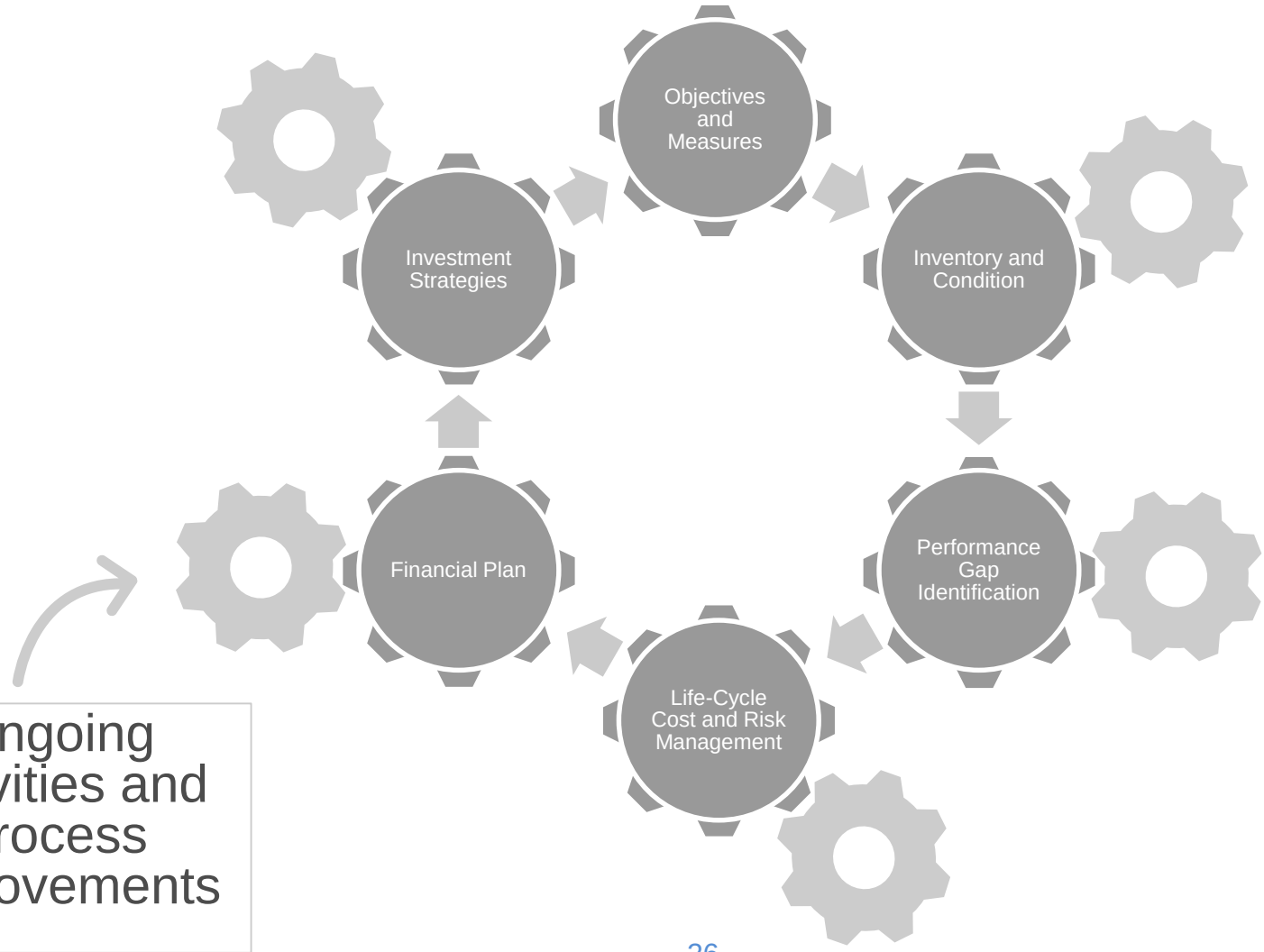
Life-Cycle for Starting GAM



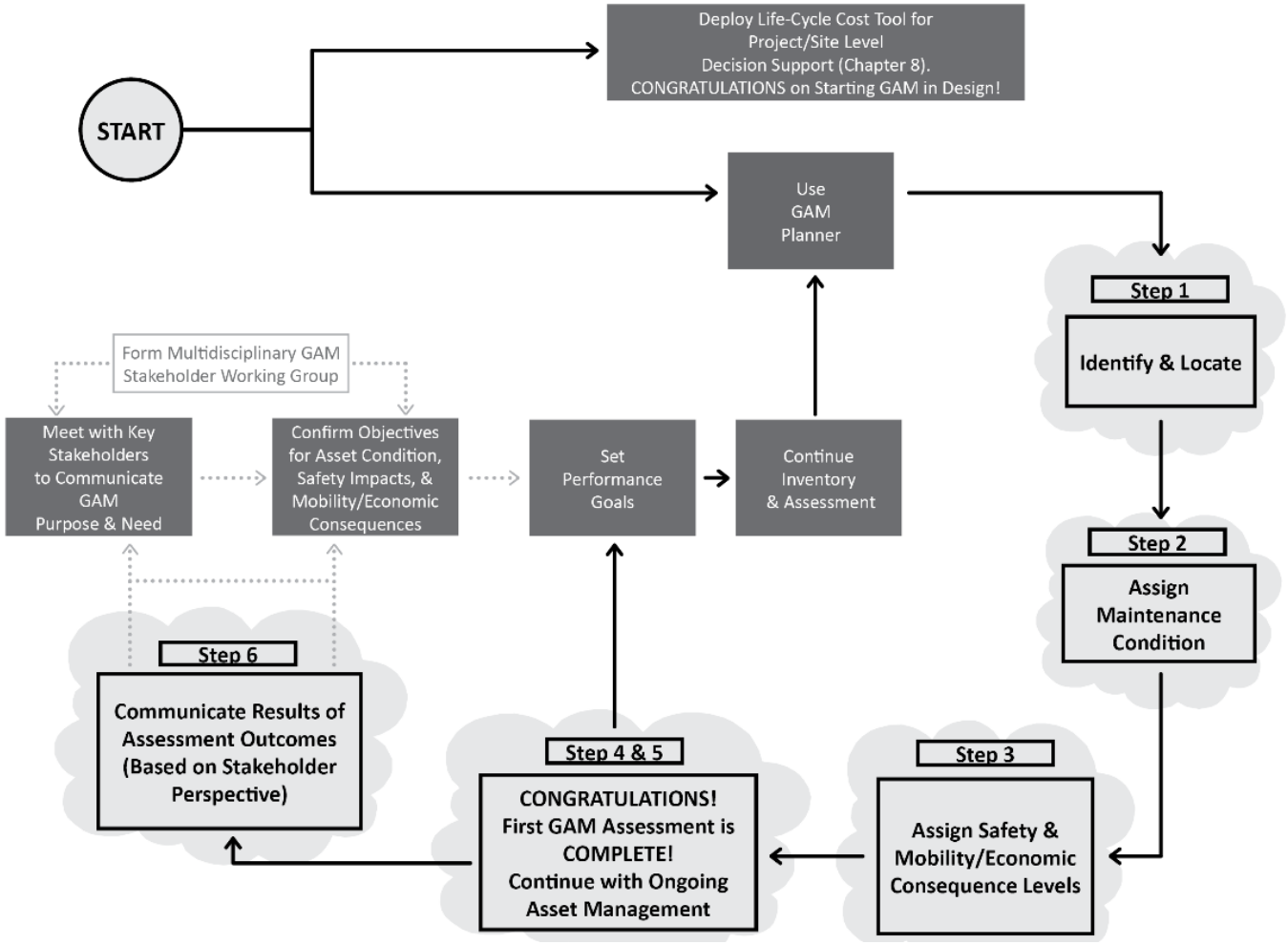
Focus on starting GAM over certainty and complexity in TAM steps

- *Don't let "the perfect" become the enemy of "the good"*

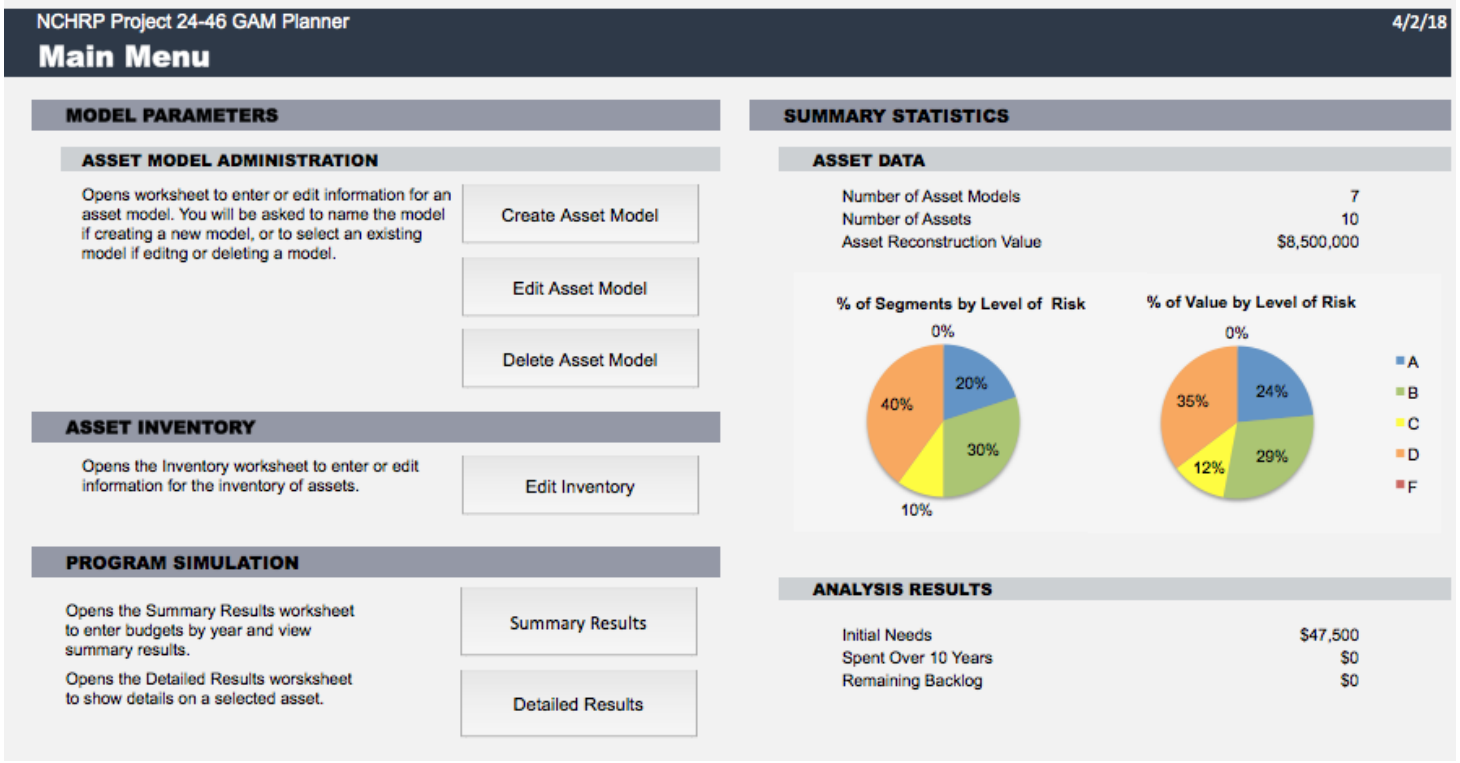
AASHTO Asset Management Steps



Starting with a Simple GAM Workflow



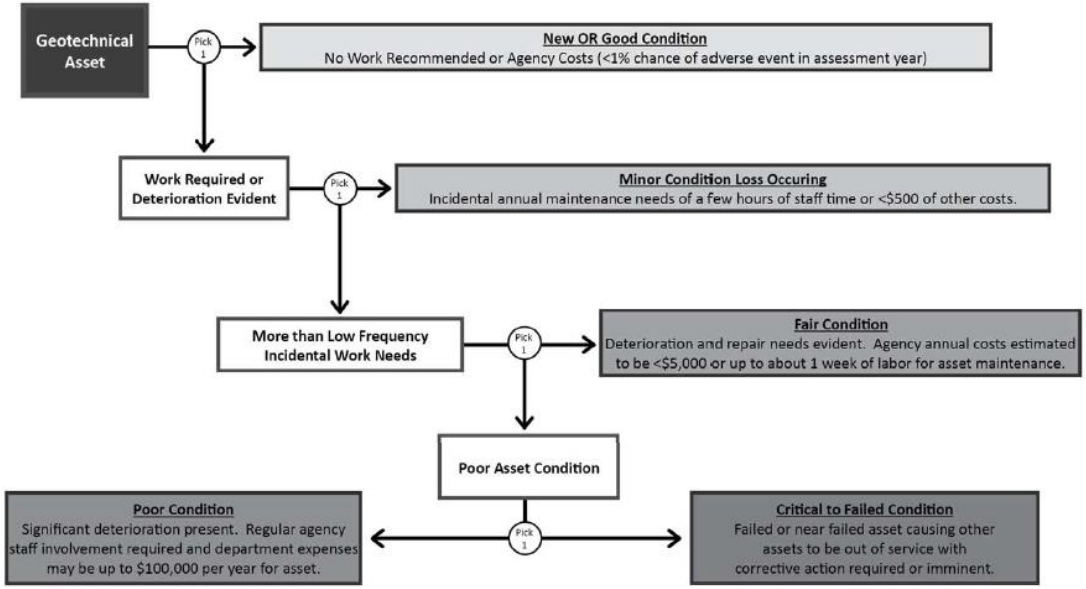
The GAM Planner Tool



- Will be part of upcoming Geotechnical Asset Management Implementation Manual

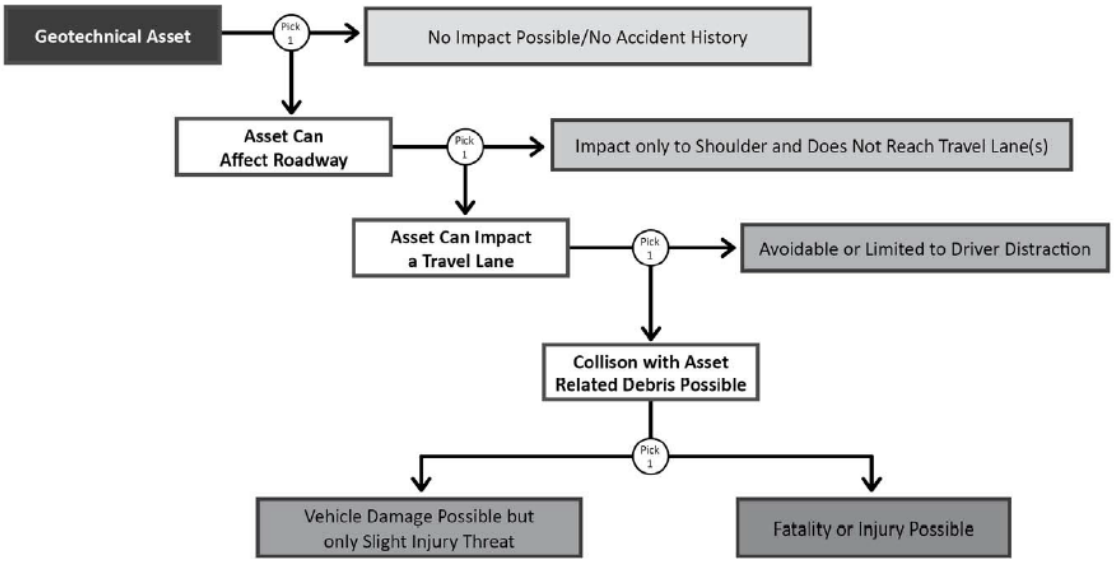
GAM Planner Risk Process

- Likelihood estimate:
  - Operation and maintenance condition input
  - Condition is a 1 to 5 scale of likelihood with a 5 indicating the highest probability estimate



GAM Planner Risk Process

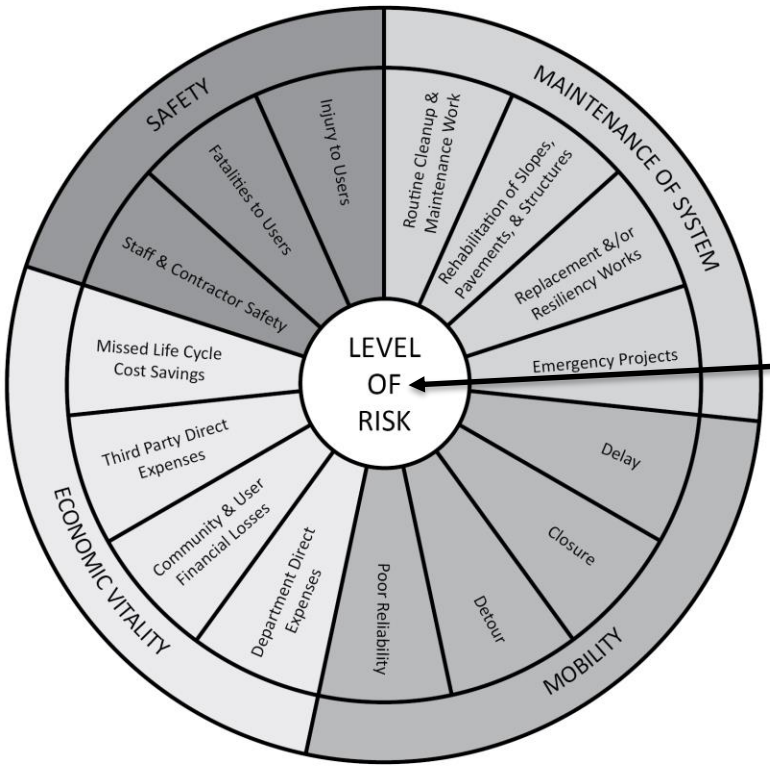
- Consequence inputs
  - Safety consequence level
  - Mobility and Economic consequence level
  - Both use similar 1 through 5 scale



Connecting GAM to TAM

- GAM must be a sound business process with measurable outcomes for success
- Enabling success through:
  - Connecting asset performance to customer perspectives
    - How are users impacted?
  - Connecting asset performance to agency executives
    - How is the agency impacted?

GAM Measure – Level of Risk (LOR)



LOR: A single measure that connects with several executive and customer measures and objectives

Level of Risk (LOR) is a metric determined in GAM Planner process

GAM Measure – Level of Risk

LOR = A

LOR = C

LOR = F

- Examples of different LOR assets

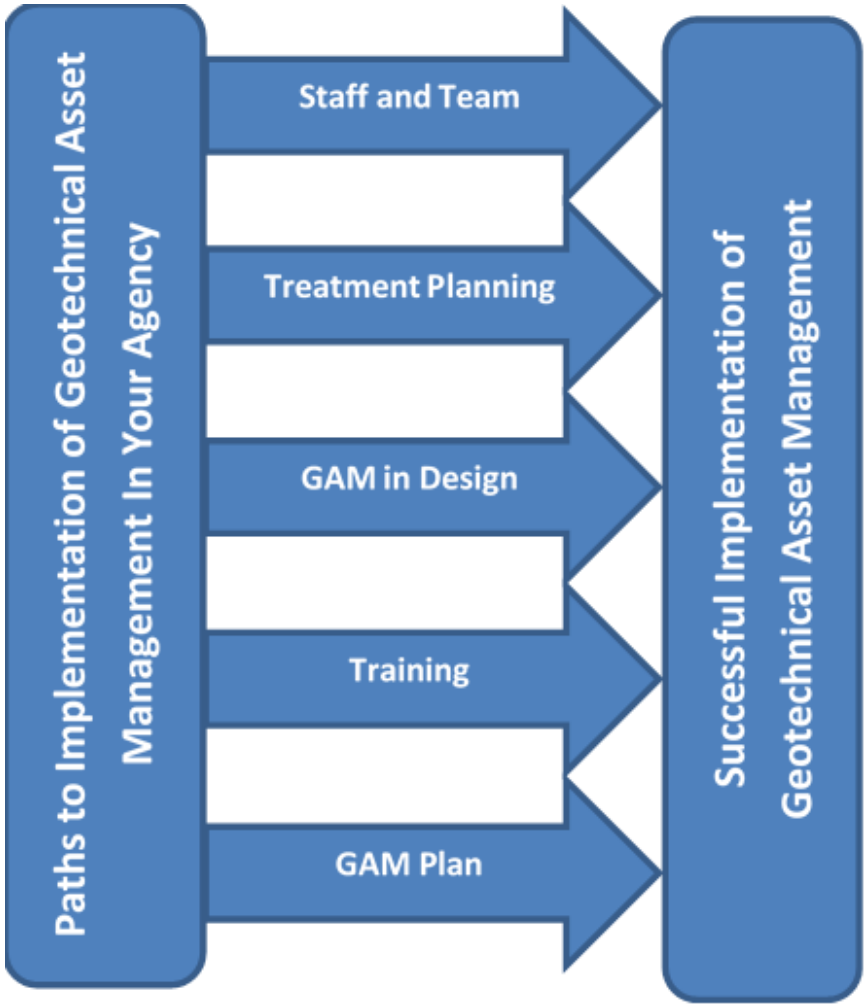
Customer Measures

- Can your agency measure the following?
  - Safety incidents associated with geotechnical asset performance
  - Hours of closure and delay associated with geotechnical asset performance
  - O&M costs for assets

Technical Measure Options

- Internal measures that relate to geotechnical performance characteristics
- Using GAM Planner, example measures:
  - % of segments in each O&M Condition Level
  - % of segments in each Safety Risk Consequence Level
  - % of segments in each Mobility and Economic Consequence Level

Enabling GAM Success

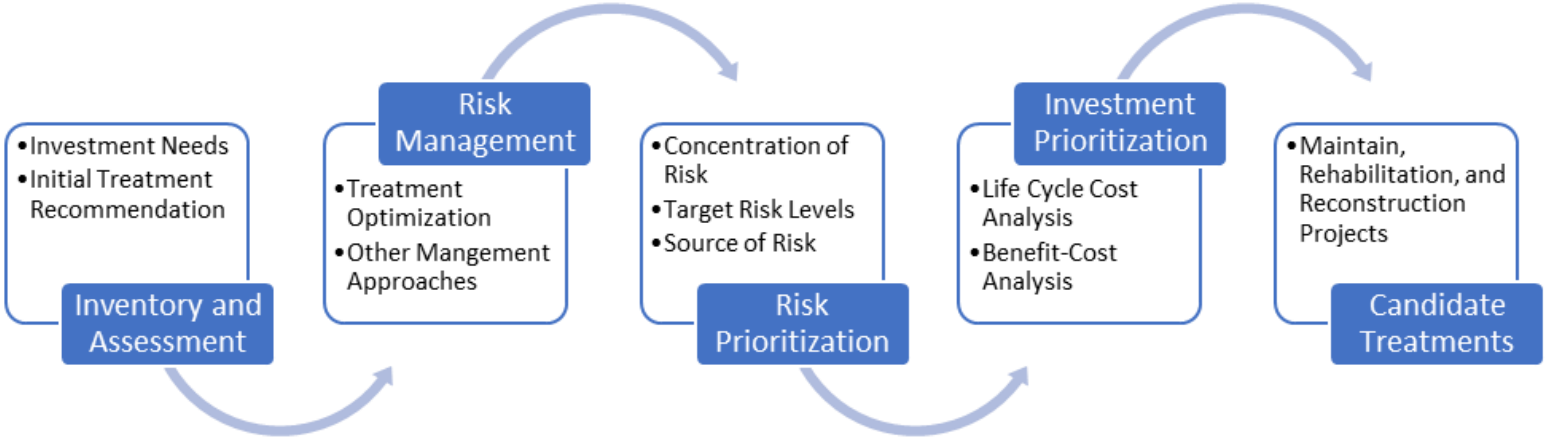


- Optional and flexible approaches towards enabling GAM success

Organization Structure

- Advanced programs have individuals who have full time capacity for GAM
  - Aspirational goal that limit distractions from typical design or construction duties
- Implementation Manual recommends designation of a geotechnical asset manager who interacts with TAM program

Treatment Planning



- Several approaches to prioritize treatments and enable GAM acceptance and investment support

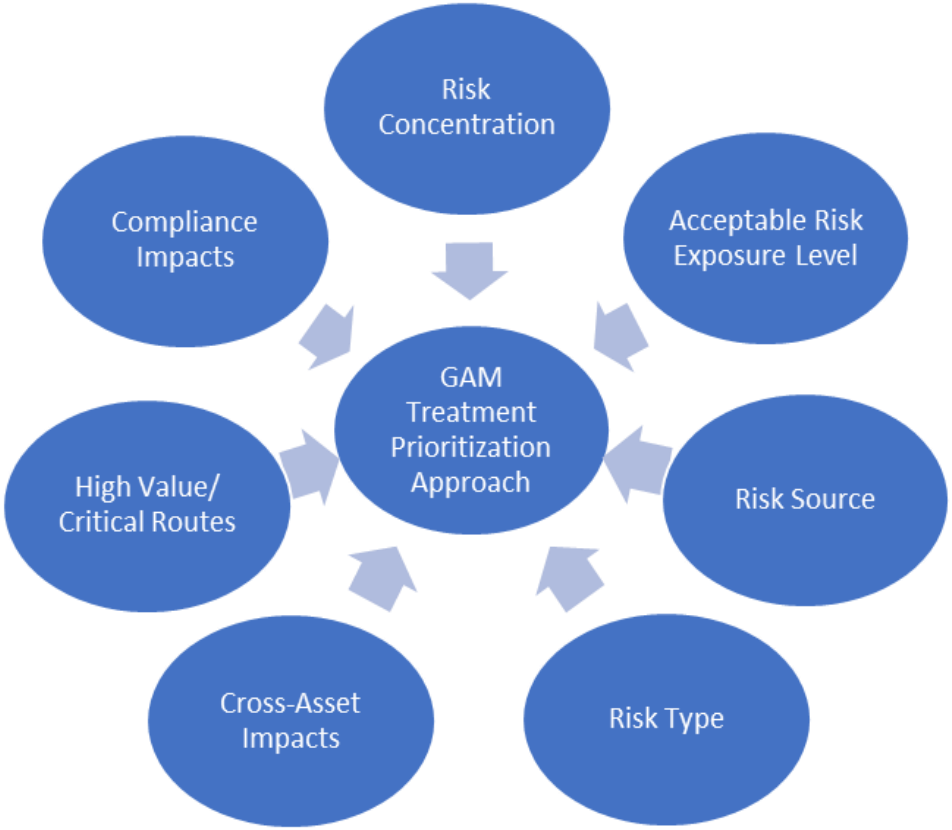
Why Prioritize GAM Planning

- GAM will likely indicate needs far exceed reasonable investment strategies

- Additional prioritization steps guide the process to treatments that provide the greatest value to the organization
  - Objectives will vary by agency and by time within an agency so flexibility is necessary for sustained success

Risk Prioritization

- Risk Prioritization is beneficial process for identifying and guiding treatment decisions that align with executive and stakeholder interest areas



Life-Cycle Investment Prioritization

- Used in GAM Implementation:
  - Comparison of treatment alternatives at the asset/segment level to identify the optimum options from an economic perspective
  - Project level analysis can be performed to optimize investment decision

Project Level NPV

Cost Type	Cost Description	Embankment Reconstruction	
		Option 1 Gentle Side Slopes with ROW Purchase	Option 2 Steep Side Slopes within ROW
Design Cost	Design needs are similar between options	$10,000	$10,000
ROW Cost	Option 1 requires purchase of ROW	$20,000	0
Construction Cost	More embankment material required for Option 1	$100,000	$80,000
Total Initial Cost	Year 0 cost	$130,000	$90,000
Annual Maintenance	Option 2 O&M cost is three times greater due to need for erosion repairs on steeper slopes and roadway barrier maintenance	$1,000	$3,000
50-year Present Worth Value of Annual Maintenance	Cost in current dollars for 50 years of annual maintenance using a 4% discount rate	$21,500	$66,500
Net Present Value	**Sum of initial and annual maintenance costs in current dollars**	**$151,500**	**$156,500**

- Implementation Manual includes Microsoft Excel worksheet with a NPV analysis framework

Data Driven Treatment Decisions

- GAM is a voluntary process that must compete on business case
- Guide staff to be able to answer the question:

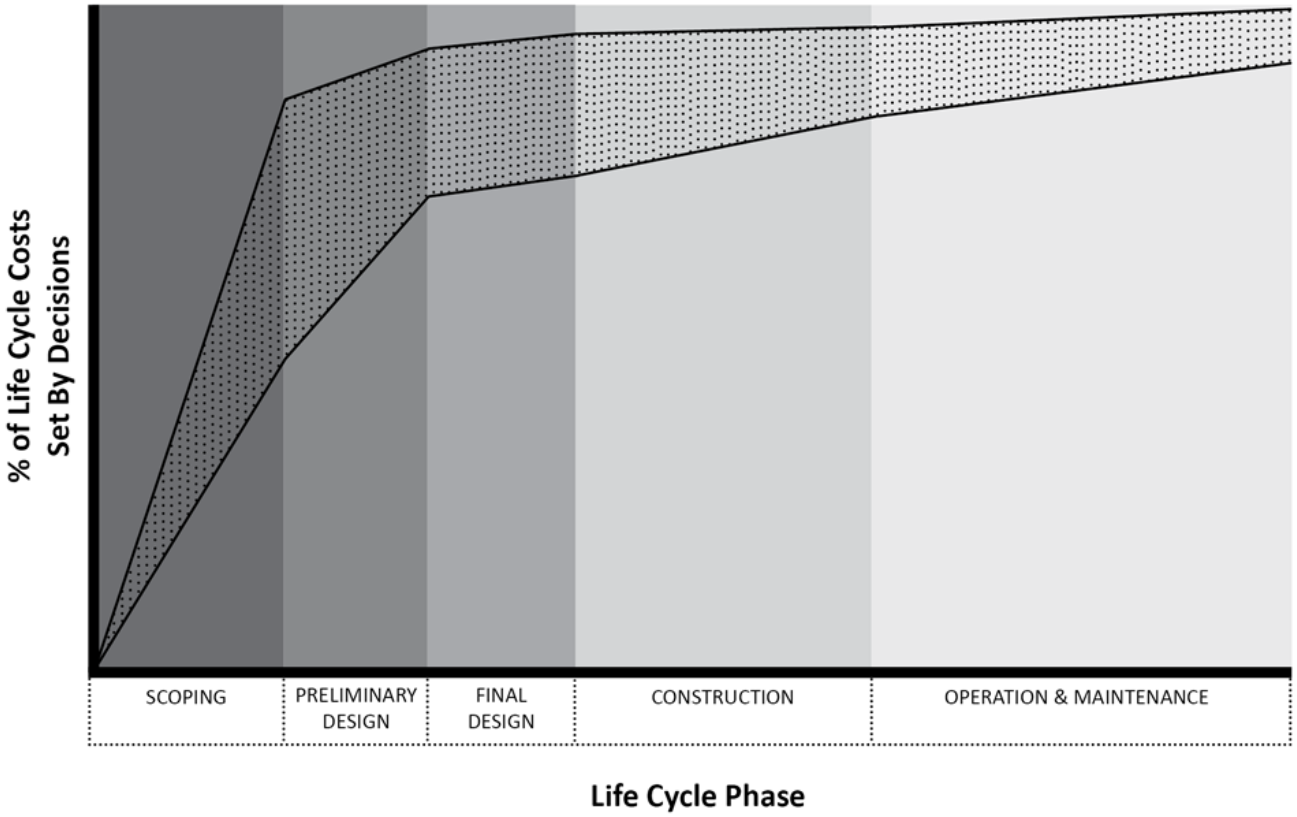
  "***If given $X amount of dollars, what can be done for the greatest return of investment?***"

  Start small - ???

Incorporating GAM in Design

- For new assets and rehabilitation decisions designers can consider questions such as:
  - What is the desired life of the asset?
  - What is the estimated O&M cost for option?
  - What are the agency O&M capabilities and resources?
  - What design changes can influence life-cycle cost?

Incorporating GAM in Design



- Up to 80% of life-cycle cost may be locked in by preconstruction decisions

Questions?