The National Academies of
SCIENCES • ENGINEERING • MEDICINE

TRANSPORTATION RESEARCH BOARD

# Return on Investment in Asset Management Systems and Process Improvements

**Monday, May 7, 2018**
**2:00-3:30 PM ET**

***The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.***

RCEP

REGISTERED CONTINUING EDUCATION PROGRAM

## Purpose

Discuss NCHRP Report 866.

## Learning Objectives

At the end of this webinar, you will be able to:

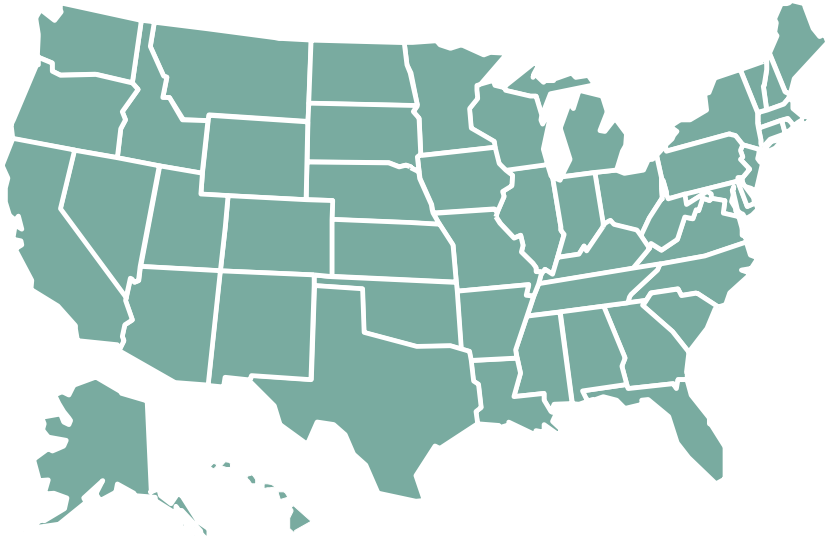
- Describe the framework summarizing different types of costs and benefits of transpiration asset management systems and process
- Describe realized costs and benefits of asset management system implementation for selected case studies
- Determine calculation steps involved in determining return on investment for a potential asset management system or process investment
- Calculate return on investment for a potential investment using a spreadsheet tool

# NCHRP Research Report 866: Return on Investment in Transportation Asset Management Systems and Practices

# NCHRP Project 20-100

# NCHRP is a State-Driven Program

- Sponsored by individual state DOTs who
  - Suggest research of national interest
  - Serve on oversight panels that guide the research.



- Administered by TRB in cooperation with the Federal Highway Administration.

# Practical, ready-to-use results

- Applied research aimed at state DOT practitioners
- Often become AASHTO standards, specifications, guides, syntheses
- Can be applied in planning, design, construction, operations, maintenance, safety, environment


# Additional Publications Available on this Topic

- TCRP Research Report 198: The Relationship Between Transit Asset Condition and Service Quality

*You can learn more about this publication by visiting www.trb.org*

# Join us for…

- **TRB Webinar: Organizational Change for Performance and Asset Management -** May 22, 2018 from 1:00-2:30pm EST, http://www.trb.org/Calendar/Blurbs/177507.aspx
- **12th National Conference on Transportation Asset Management –** July 14-17, 2018, San Diego, CA, http://www.trb.org/Calendar/Blurbs/174677.aspx

# Today's Speakers

- *William Robert, Spy Pond Partners*
- *Chris Williges, HDR*
- *Jennifer Brandenburg, Volkert*

# Return on Investment in Transportation Asset Management Systems and Process Improvements

**TRB Webinar**

May 7, 2018

Bill Robert, SPP

Chris Williges, HDR

# Agenda

01 NCHRP Overview

02 NCHRP Report 866 Overview

03 ROI Framework and Calculation Guidance

04 Calculation Tool

05 Case Studies and Pilot

06 Conclusions

07 Questions & Discussion

# Agenda

1. NCHRP  Overview
2. NCHRP Report 866 Overview
3. ROI Framework and Calculation Guidance
4. Calculation Tool
5. Case Studies and Pilot
6. Conclusions
7. Questions and Discussion

# Presenters

## Bill Robert

Spy Pond Partners

## Chris Williges

HDR

# NCHRP Report 866 Overview

**TRB Webinar:**

ROI in Asset Management Systems and Process Improvements

# NCHRP Report 866 Context

Transportation asset management is predicated on improving decision-making and saving money, but….

- Implementing asset management often involves significant investments
- There is little quantitiative information on the benefits of asset management system and process improvements
- Agencies seeking to invest in better asset maangement have a chicken-and-egg problem when justifying the investment – better systems and data are needed simply to make the case

# Example Questions

- What is the ROI of implementing a new Pavement Management System (PMS) that will foster a preservation approach in the agency?
- What is the payback period for a new asset management system that will require an initial investment of time and money, but save staff time in the future?
- What types of agency and user benefits can we expect from a set of investments in new systems and improved processes?

# Desired Research Outcomes

- **Framework** addressing evaluation of ROI and other financial metrics for asset management system/process investments
- **Set of case studies** illustrating calculation of ROI and demonstrating potential benefits of asset management system/process investments
- **Guidance document** and tool with step-by-step procedures agencies can follow to calculate ROI and other metrics for a proposed asset management system/process investment

# ROI Framework

**TRB Webinar:**

ROI in Asset Management Systems and Process Improvements

# Establishment or Improvements of TAM Systems

Focus on PMS, BMS, and MMS implementation, not TAM practices

## Common types of investments

- Purchase an initial asset management system
- Improve an existing asset management system
- Enhance data collection and reporting methods (automation and quality)

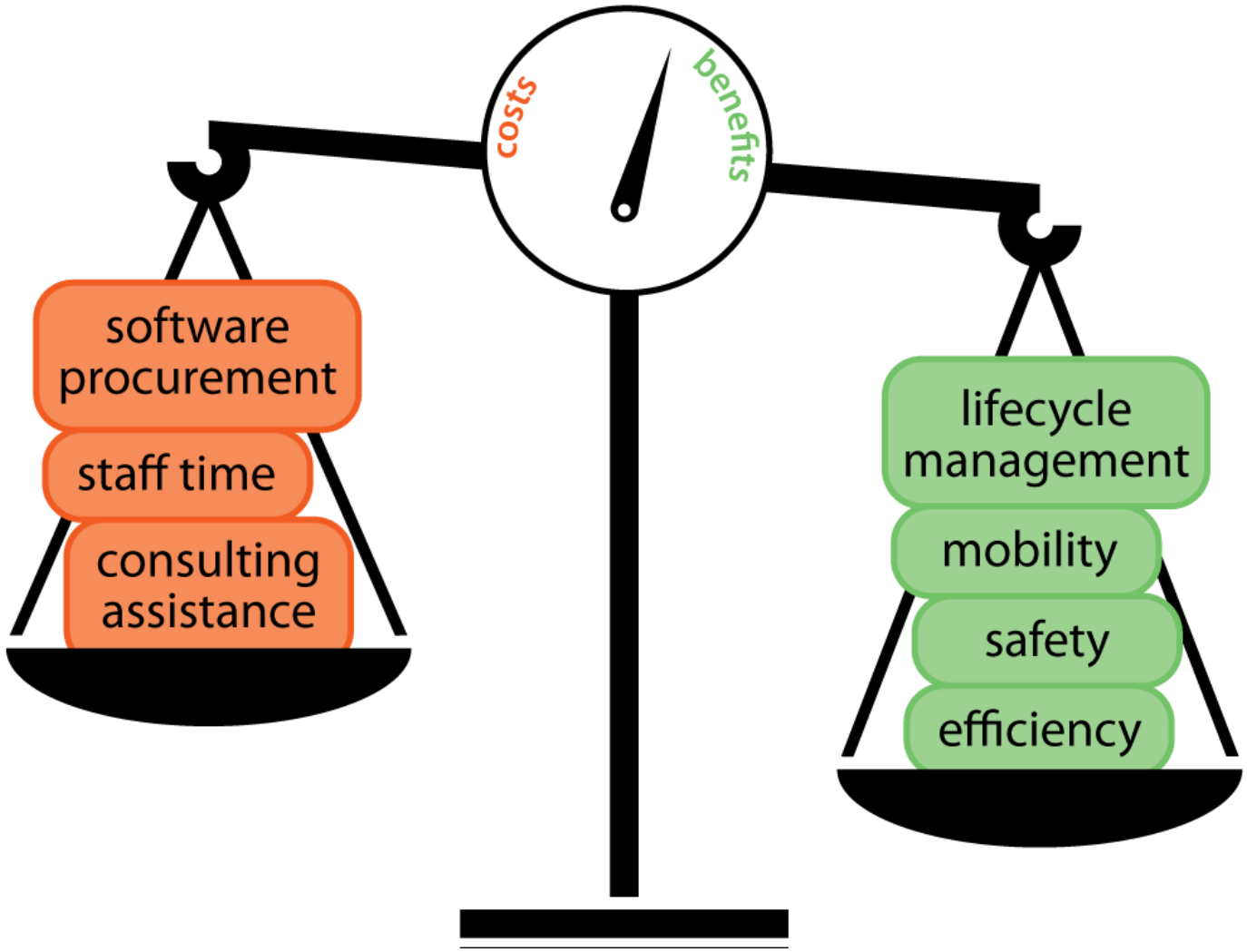
## Commonly found TAM systems

- Pavement management systems (PMS)
- Bridge management systems (BMS)
- Maintenance management systems (MMS)

# Principles for Development of ROI Framework

- Benefits and costs expressed in **dollar terms** whenever possible
  - "Intangibles" assessed qualitatively
- Benefits and costs measured relative to **counterfactual**, or Base Case, of no investment
  - Definition of Base Case may vary across agencies and the types of investment considered
- Future benefits and costs **discounted** to present
- Benefits and costs considered from **broad societal perspective**
  - Estimated separately for agencies, asset users, and general public
- Timing and value of **past or proposed** investments assessed

# Using a BCA Approach



# Prospective and Retrospective Evaluations

## Prospective evaluations

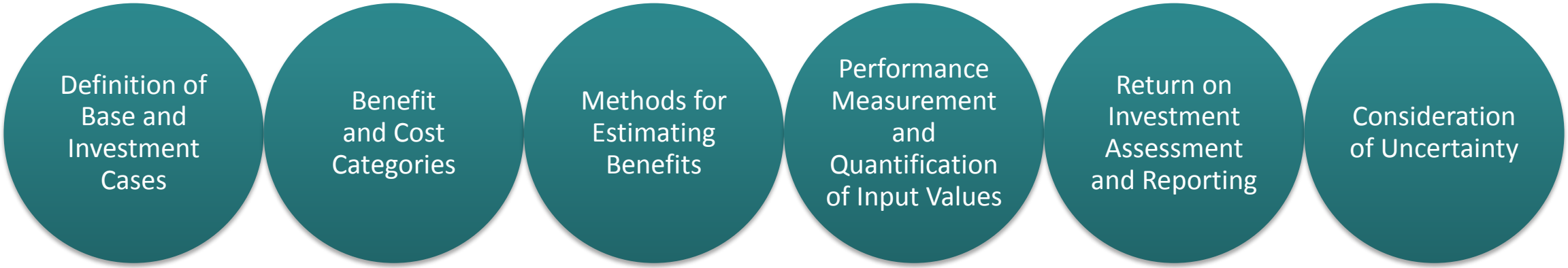
- Observable current conditions
- Projections (user benefits, agency costs, asset conditions) needed for Base Case and Investment Case

## Retrospective evaluations

- Observable starting conditions and Investment Case
- Estimates needed for the Base Case (what if investment not made)

# Elements of ROI Framework

## ROI framework based on benefit-cost analysis (BCA)



# Definition of Base and Investment Cases

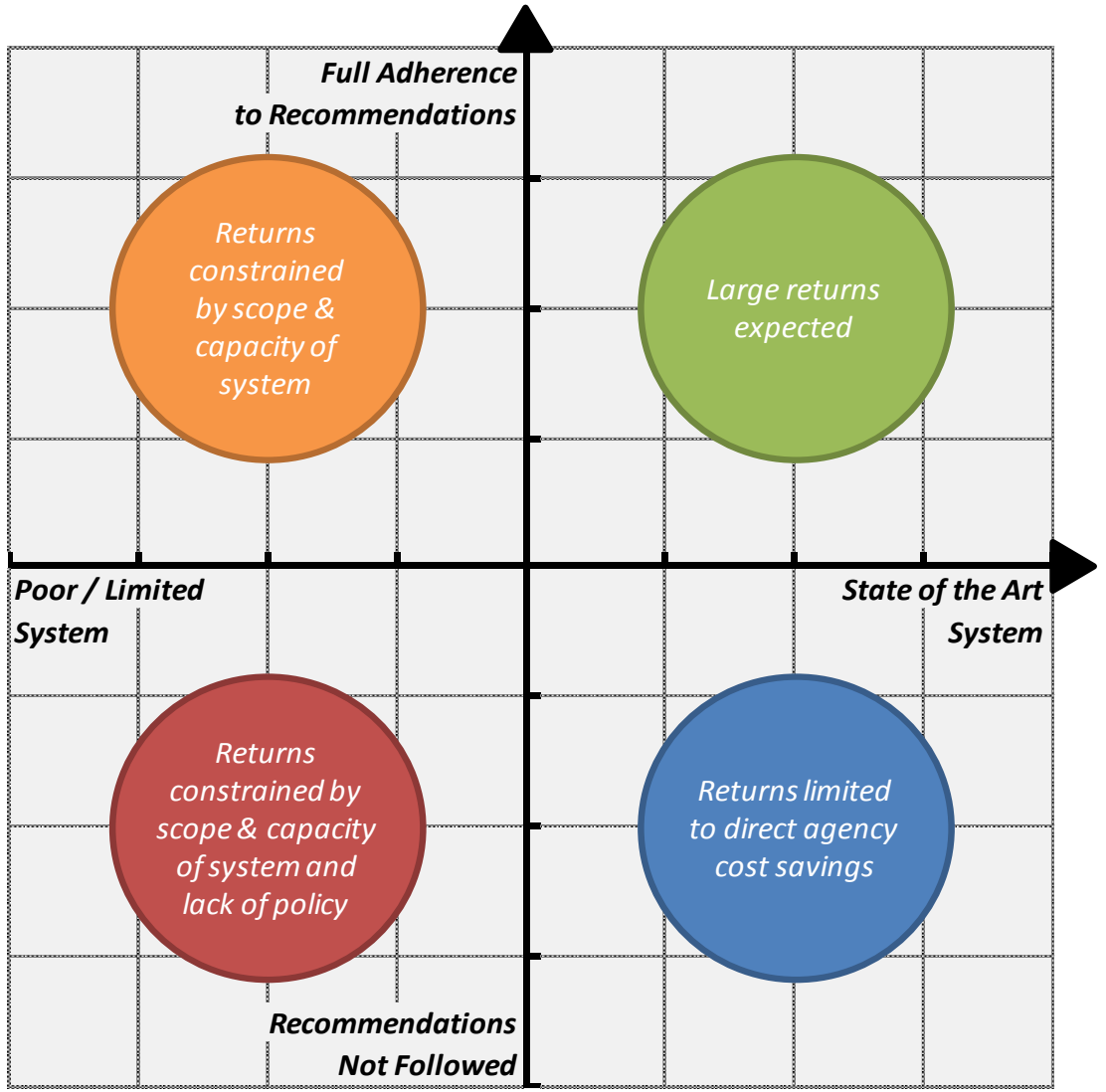
- Base Case – “Business as Usual” if investment not made
  - Continuation of existing methods for asset management
  - Use of legacy TAM systems
- Base Case against must be realistic
  - Cannot do absolutely nothing
- Retrospective evaluations need either:
  - Before/after data to assess impact of new practices
  - Simulation of Base Case performance in a TAM system

# Returns Affected by Agency Decisions

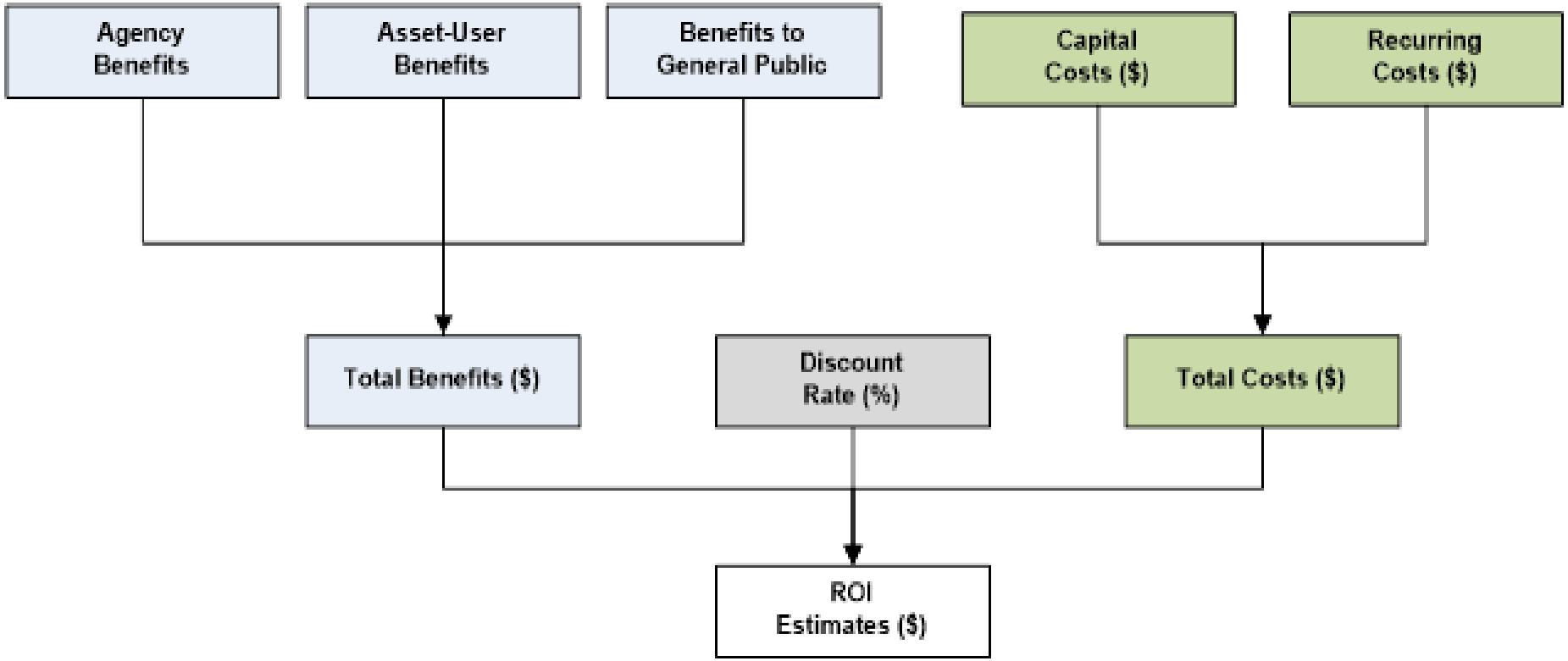
Benefits function of TAM system sophistication

- Percentage of assets covered
- Percentage of agency needs addressed
- Number of potential treatments

…and agency adherence to recommendations (difficult to measure)



# Identification of Benefit and Cost Categories




User disruptions (e.g., construction delays) are disbenefits

# Potential Benefits of TAM Investments

## Direct and Indirect Agency Benefits

- Staff time savings from improved data collection and accessibility
- Cost savings from the optimization of investment strategies
- Lower costs from reductions in failure risks for critical assets (e.g., bridges)
- Avoided outlays for legacy systems, including hardware maintenance and software updates
- Enhanced reputation and level of public trust gained through information sharing
- Delayed capital expenditures due to increased asset life (residual value of assets)
- Worker safety (due to bundling of projects)
- Residual value (remaining asset value at end of analysis period)

# Potential Benefits of TAM Investments (cont.)

## Asset User Benefits

- Vehicle operating cost savings (e.g., reduced wear-and-tear, and reduced fuel consumption) from smoother pavements or more direct routing (e.g., with bridge availability)
- Travel time savings
- Accelerated improvements from timely asset management decisions or increased capacity to program maintenance and rehabilitation projects due to cost efficiency
- Reduced work zone delays
- Safety benefits

## General Public Benefits (Social Benefits)

- Emission cost savings
- Reduced noise generation

# Lifecycle Costs

- Costs over the entire analysis period
- Lifecycle costs need to take into account:
  - Capital and operating costs
  - Renewal costs
- Useful lives of TAM investment and assets are different
- Case studies considered 20-year lifecycle

# Lifecycle Costs (cont.)

## Non-Recurring Costs

- Hardware and software acquisition
- Installation
- Training
- Decommissioning
- Shift in investments (e.g., delay some investments to perform additional preservation)

## Recurring Costs

- Maintenance and repair
- Operating expenses
- Software maintenance costs
- Software updates
- Data collection and data analysis costs

# Methods for Estimating Agency Benefits

- Most agency benefits in the form of agency cost savings
  - Lower outlays/expenditures or reaching same output faster/cheaper
  - Agency costs estimated at Base Case agency output
  - Incremental agency activities to support new TAM systems or practices considered to be costs
- If increased productivity and output estimate both impacts separately
- Labor cost savings or productivity gains to be fully counted as benefit

# Methods for Estimating User Benefits

- User benefits based on intermediate TAM output (e.g., asset condition and usage)

- Estimation of user benefits may require:
  - Algorithms built into asset management systems,
  - Other software products (e.g., HERS-ST)
  - External spreadsheets

# Input Values Needed for Base and Investment Cases

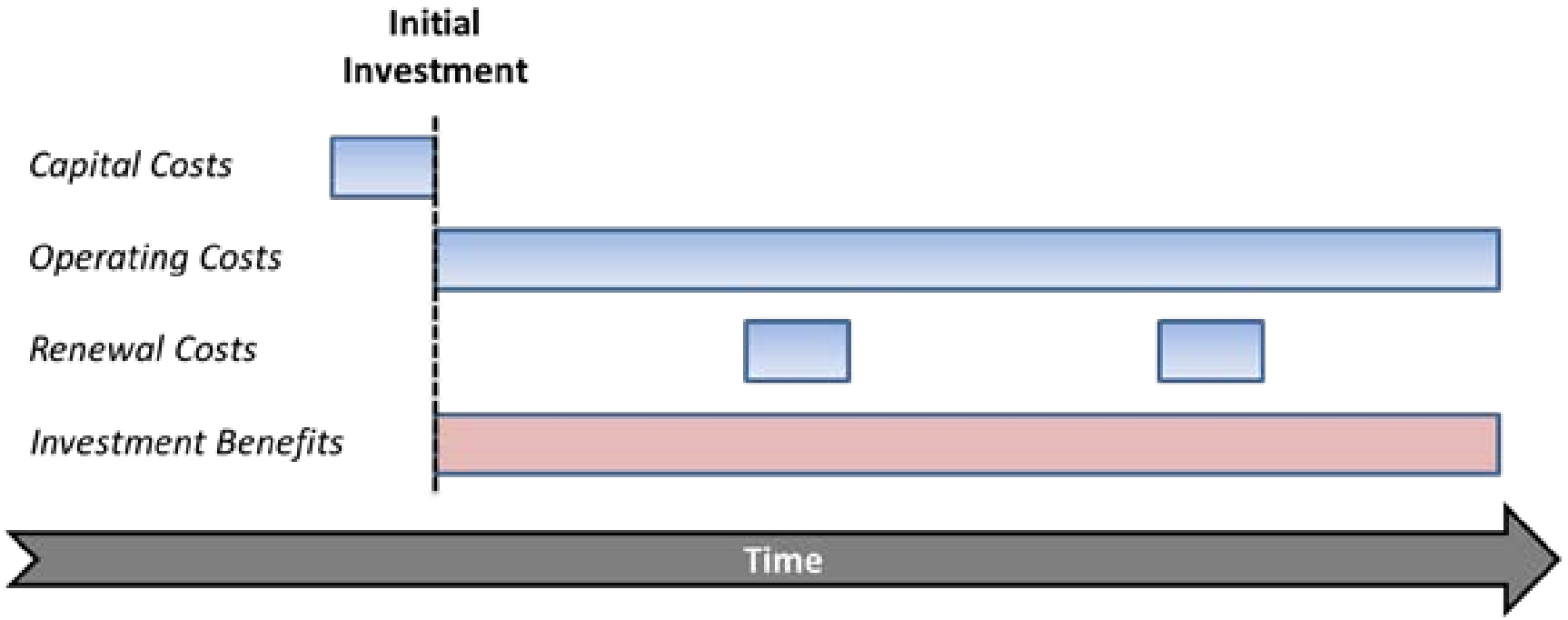
1. Asset condition measures (e.g., pavement smoothness)
2. Traffic volumes affected by TAM investment (from TAM system or other source)
3. Measures of transportation system performance (e.g., travel times and traffic volumes)
4. Other system characteristics (e.g., route detour distance)

# Performance Measurement and Quantification of Inputs

| Technique | Advantages | Disadvantages | Application |
|---|---|---|---|
| Simulation | • Can control circumstances<br>• Multiple choices of performance measures<br>• Available at most agencies<br>• Flexibility in design | • Error in TAM tools is unknown<br>• Unclear if total benefits estimates are over or under true value | Because of flexibility, simulation techniques can be used for either prospective or retrospective evaluations |
| Controlled Field Experiments | • Use of scientific method to validate transportation improvements or data collection processes – objective results | • Time and resources needed to implement experiment<br>• Difficulties associated with identifying control group | Retrospectively (if experiment was set-up at the time of the investment); or prospectively, through Pilot Program |
| Time Series | • Controls for multiple factors<br>• Relatively easy to implement if data is available | • Requires techniques to control for changes to operations and policy over time at a given agency<br>• Yet to be implemented in domain | In retrospective evaluations only |
| Breakeven Analysis | • Can be used in situations where direct quantification of effects is not possible<br>• Helps assess where investment likely to be beneficial | • No performance measurement per se<br>• Cannot be used as basis for estimating returns | In retrospective or prospective evaluations |

# Return on Investment Assessment and Reporting

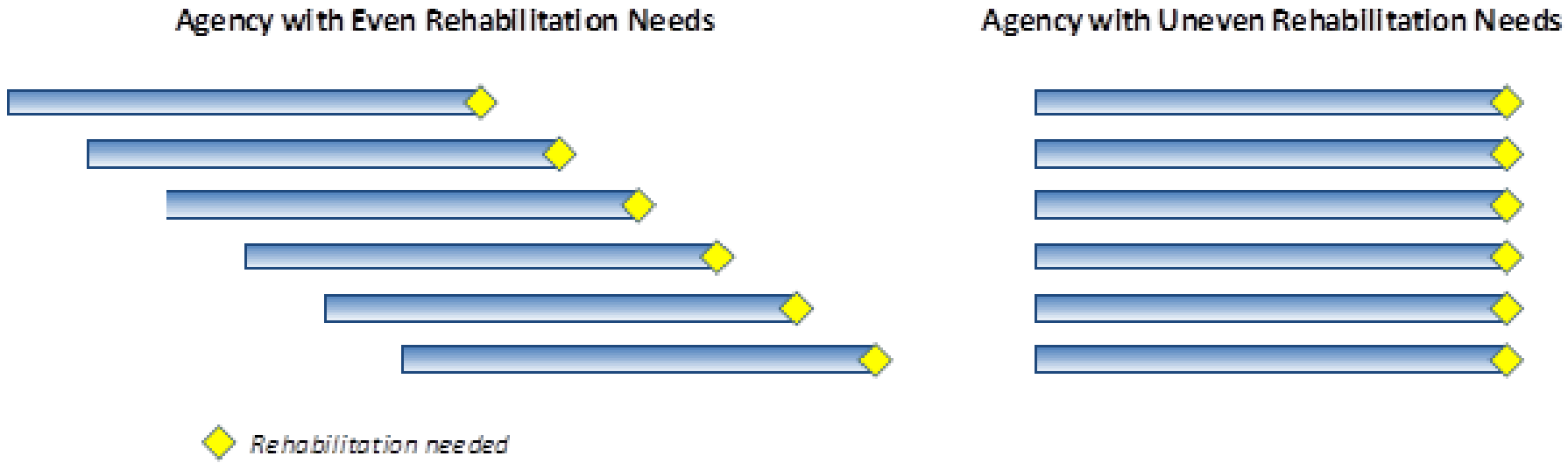
## Distribution of Benefits and Cost Over Time




Discounting helps compare uneven stream of benefits and costs

# Other Issues

- **Ramp-Up in Benefits:** equipment rollout, training, committed projects (report average annual benefits in steady state)
- **Change in Benefits over Time:** interpolating inputs versus benefits, but TAM investments more complex (external factors)



# Return on Investment Measures

- **Net Present Value (NPV)** shows what TAM investment is worth as a discounted, current value:
- **Benefit-Cost (B/C) Ratio** can compare investments of different costs and be used for prioritization:
- **Internal Rate of Return (IRR)** is discount rate at which benefits and costs break even (are equal):
- **Payback Period** is number of years for net benefits (benefits minus costs) to equal initial investment costs

# Consideration of Uncertainty

- Sensitivity Analysis – vary individual inputs
- Quantitative Risk Analysis – model many outcomes (Monte Carlo simulation)
- Scenario Analysis – generate “high” and “low” estimates
- What-If Analysis – test impact of an event or events

Quantitative risk analysis not incorporated into guidance due to complexity

# Calculation Steps

**TRB Webinar:**

ROI in Asset Management Systems and Process Improvements

# Calculation Steps

1. Define Purpose of Study and Scope of TAM Investment
2. Identify Likely Impacts
3. Assess Available Data

Plan

4. Establish Modeling Approach and Identify Tools
5. Collect Necessary Data

Collect

6. Conduct Analysis
7. Estimate ROI and Summarize Results

Analyze

# 1. Define Purpose of Study and Scope of TAM Investment

## Goal of Analysis

- Justify TAM investment already made and in place
- Make the case for a new investment

## Stated Purpose of Investment

- Better/more efficient use of agency resources
- Better management of asset condition or serviceable life
- Improved travel conditions

## Type of Investment

- Install/implement new system
- Upgrade/expand existing system
- Adopted enhanced system management practices

## Assets and Geographic Area Covered

# 2. Identify Likely Impacts

## Where do you expect impacts from the investment?

### Transportation agency

- Reduced work backlog
- Improved decision-making regarding allocation of resources
- Increased staff efficiency
- Reduced expenditures (data collection, lower insurance costs, etc.)
- Enhanced reputation and public trust through information sharing
- Reduced changes of catastrophic failure

### Assets

- Improved asset condition
- Longer life expectancy

### Users and general public

- Improved travel efficiency and reduced accidents
- Fewer negative impacts, such as work zone delays

# 3. Assess Available Data

## Consider type of analysis

- Prospective analyses need:
  - Observable current conditions (e.g., maintenance costs, asset conditions)
  - Projections (e.g., user benefits, agency costs, asset conditions) needed for Base Case and Investment Case

- Retrospective analyses need:
  - Data on observable conditions and agency expenditures before and after the TAM implementation
  - Estimates of historical user benefits, agency costs, asset conditions for Base Case

# 3. Assess Available Data (cont.)

## What data are available?

- Investment cost data
  - Agency financial reports, internal planning documents, brochures
  - Interviews with department staff
- Agency operations
  - Staff involved in legacy systems, frequency of use, worker safety, assets covered, maintenance activities
- Asset conditions
  - Asset age, remaining service life, asset condition, LOS ratings
  - Agency metrics, HPMS, NBI
- Transportation system use and performance
  - Traffic volumes, system performance measures, other characteristics

# 4. Establish Modeling Approach and Identify Tools

## Define Base and Investment cases

- Observe current situation – maintenance costs, asset conditions
- Beware of multiple and potentially overlapping investments
- Establish a reasonable base case of investments and activities - what would actually be done without the TAM investment

## Establish key modeling parameters

- Establish timeframe for analysis
- Consider ramp-up and growth rates
- Economic values (for monetizing benefits) and discount rates
- Factor in TAM sophistication

# 4. Establish Modeling Approach and Identify Tools (cont.)

## Which benefits do you plan to include in the analysis?

- Direct/Immediate Agency Cost Reductions
  - Staff time savings from improved data collection or accessibility of data
  - Lower overall average annual outlays on maintenance and repairs
  - Delayed capital expenditures due to increased asset life (residual value of assets)
- Other Agency Savings
  - Improved worker safety (due to project bundling)
  - Avoided outlays for legacy system upgrades
- Users and General Public (due to improved conditions)
  - Lower vehicle operating costs
  - Potential travel time savings
  - Reduced negative environmental impacts (emissions, noise, etc.)
  - Improved safety

# 4. Establish Modeling Approach and Identify Tools (cont.)

- Which approach will you use to quantify impacts on asset condition?
  - Simulation
  - Time series analysis

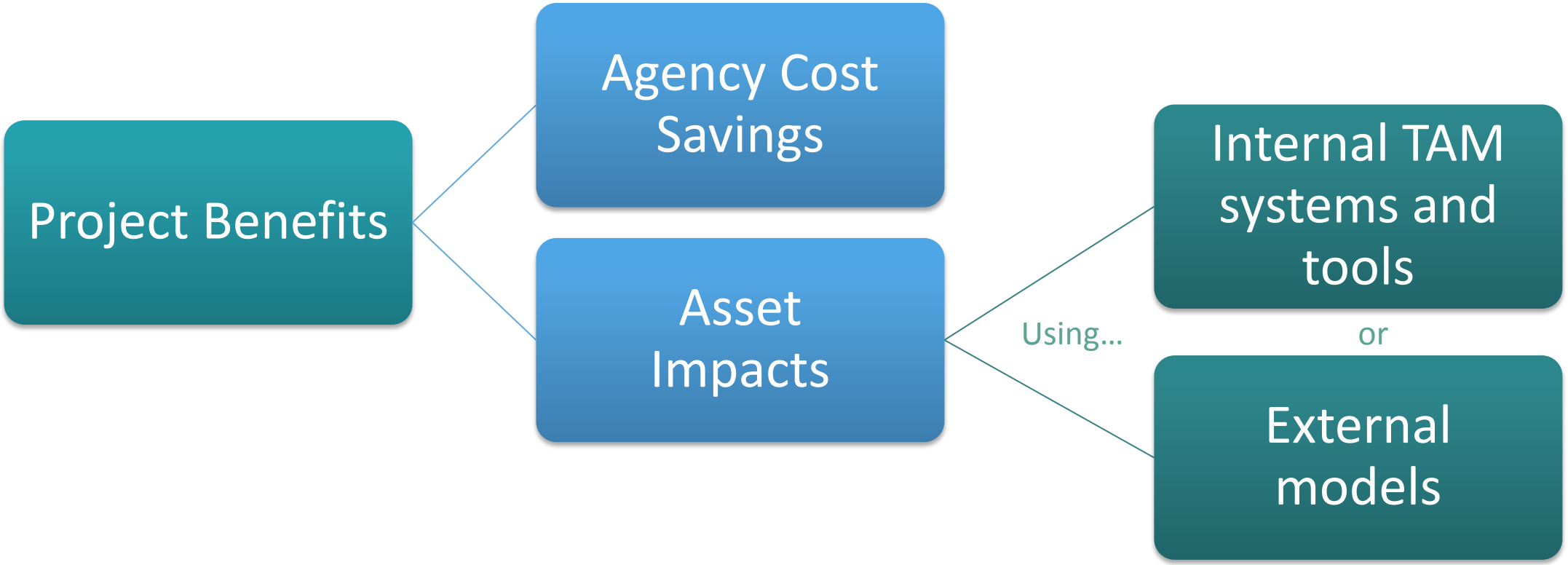
- If simulation, which tools will you use to quantify the impacts?
  - Internal TAM systems and tools
  - External models (e.g., HERS-ST for pavement, NBIAS for bridges, NCHRP 20-100 ROI Calculator)

# 5. Collect Necessary Data

Collect data identified for analysis

- Compile existing data from multiple sources (original data collection unlikely)
  - Agency information
  - Asset conditions
  - Transportation performance (if user benefits)
- Fill data gaps
  - Interpolate/extrapolate
  - Consult case studies or research
  - Examine past investments

# 6. Conduct Analysis



# 6. Conduct Analysis (cont.)

Estimating agency benefits

- Agency cost savings in reduce outlays or increased productivity (staff time, trips into field, etc.)
- Multiple ways to accomplish same task
- New activities or responsibilities
- Staff may be reassigned
- Full value of labor productivity gains

# 6. Conduct Analysis (cont'd)

Estimating asset impacts

- Calculate changes in asset management backlog
- Use in-house TAM system, spreadsheet calculators, decision trees, or eternal models

Estimating user and broader area/community impacts

- Calculate user benefits with algorithms in:
  - In-house TAM systems
  - Existing software products (HERS-ST, NBIAS)
  - NCHRP 20-100 ROI Calculator

# 7. Estimate ROI and Summarize Results

## Calculate ROI Metrics

- Net present value (NPV)
- Benefit-cost (B/C) ratio
- Internal rate of return (IRR)
- Payback period

# 7. Estimate ROI and Summarize Results (cont'd)

## Describe qualitative benefits

- Examples: increase service to public, improved accountability and public trust, reduction in failure risks for critical assets, improved data quality

## Review results for error and unintended bias

- Check for reasonableness
- Compare to literature review and case studies

## Account for uncertainty

- Threshold or breakeven analysis
- Scenario analysis
- What-if analysis

# Spreadsheet Tool for Calculating ROI

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ROI in Asset Management Systems and Process Improvements

# Spreadsheet Tool Overview

- The spreadsheet tool is intended to support ROI analysis of a TAM system or business process improvement
- The tool estimates the benefits and costs of a potential investment by comparing a base case with an investment case
- The tool allows for additional analysis using data from HERS-ST, NBIAS, or a Pavement Management System (PMS)
- Results are summarized using four ROI measures: net present value, benefit cost ratio, internal rate of return, and payback period.

# Inputs - General

- General parameters define the analysis period, discount rate, and some agency and user costs
- The Base Case parameters define the annual agency costs and failure incidents in a scenario with no TAM investment
- The Investment Case parameters define the annual agency costs and failure incidents in a scenario with TAM investment
- The number of predicted failure incidents is used to estimate agency and user benefits resulting from incident reduction

**NCHRP Project 20-100 ROI Calculator**
**Inputs**

***General Parameters***

| Description | Default | Override |
|---|---|---|
| Analysis Start Year | 2018 | |
| Analysis Period (years) | 20 | |
| Discount Rate | 4% | |
| Annual Cost per Full Time Equivalent (FTE) ($) | 75,000 | |
| Personal Travel Value of Time ($/veh-hr) | 12.30 | |
| Business Value of Time ($/veh-hr) | 28.00 | |
| Multiplier for Updating User And Social Costs | 1.00 | |
| Agency Cost per Incident | 10,000 | |
| HERS-ST Analysis Performed? | No | No |
| Supplemental PMS Analysis Performed? | No | No |
| NBIAS Analysis Performed? | No | No |

***Base Case Parameters***

| Description | Value by Year 2018 | 2019 | 2020 | |
|---|---|---|---|---|
| Agency Labor (FTEs) | | | | |
| Hardware & Software Acquisition ($) | | | | |
| Recurring Costs ($) | | | | |
| Contractor Costs ($) | | | | |
| Other Costs ($) | | | | |
| Predicted Failure Incidents | | | | |

***Investment Case Parameters***

| Description | Value by Year 2018 | 2019 | 2020 | |
|---|---|---|---|---|
| Agency Labor (FTEs) | | | | |
| Hardware & Software Acquisition ($) | | | | |
| Recurring Costs ($) | | | | |
| Contractor Costs ($) | | | | |
| Other Costs ($) | | | | |
| Predicted Failure Incidents | | | | |

# Inputs - Optional

- An agency can choose to include simulation results from three systems: HERS-ST, NBIAS, or an agency PMS
- Use of a simulation model should be considered if the TAM investment is expected to impact how an agency invests its capital resources
- An supplemental appendix describes approaches and challenges regarding use results from a simulation tool

***HERS-ST Results - Base Case***

| Description | Value by Period 1 | 2 |
|---|---|---|
| Cost of Selected Improvements ($ 000) | | |
| VMT(M) | | |
| User Cost ($/1000 VMT) | | |
| Maintenance Costs ($/mile of road) | | |
| Emissions Costs ($/1000 VMT) | | |
| Miles of Road (Miles) | | |

***PMS Results - Base Case***

| Description | Value by Year 2018 | 20 |
|---|---|---|
| Agency Expenditures ($M) | | |
| Backlog ($M) | | |
| **Average IRI by Group** | | |
| Interstate | | |
| Non-Interstate NHS | | |
| Non-NHS | | |

***NBIAS Results - Base Case***

| Description | Value by Year 2018 | 2019 |
|---|---|---|
| Total Work Done ($M) | | |
| Backlog ($M) | | |
| User Benefits Obtained ($M) | | |

***NBIAS Results - Investment Case***

| Description | Value by Year 2018 | 2019 |
|---|---|---|
| Total Work Done ($M) | | |
| Backlog ($M) | | |
| User Benefits Obtained ($M) | | |

# Additional Parameters

- Incident costs
- Vehicle operating costs
- Capacity model
- Populated
- with default values based on values used by FHWA for national level analyses in HERS-ST and NBIAS

**NCHRP Project 20-100 ROI Calculator**
**Additional Parameters**

***Incident Cost Model Parameters***

| Description | Value |
|---|---|
| Average incident duration (min) | 180 |
| % ADT subject to incident | 12.5 |
| Average initial stoppage time (min) | 20 |
| % ADT subject to stoppage | 1.4 |
| Average stoppage time (min) | 10 |
| AADT | 5,000 |
| Average % trucks | 5 |
| Average detour length (miles) | 5 |
| Average detour speed (mph) | 30 |
| % cars using detour | 100 |
| % trucks using detour | 100 |
| Cost per fatality ($) | $6,297,098 |
| Cost per injury ($) | $91,601 |
| Cost per property damage event ($) | $3,465 |
| Fatalities/incident | 0 |
| Injuries/incident | 0 |
| Property damage events/incident | 3 |

***Incident Cost Model Parameters for Autos and Trucks***

| | Value by Vehicle Class | |
|---|---|---|
| Description | Autos | Trucks |
| Vehicle cost per hour congested ($/vehicle hour) | $1.51 | $4.62 |
| Vehicle cost per mile free flow ($/mile) | $0.48 | $1.06 |
| Environmental cost per hour congested ($/mile) | $0.09 | $0.21 |
| Environmental cost per mile free flow ($/mile) | $0.03 | $0.05 |

***Incident Cost Model Derived Values***

| | Value by Vehicle Class |
|---|---|

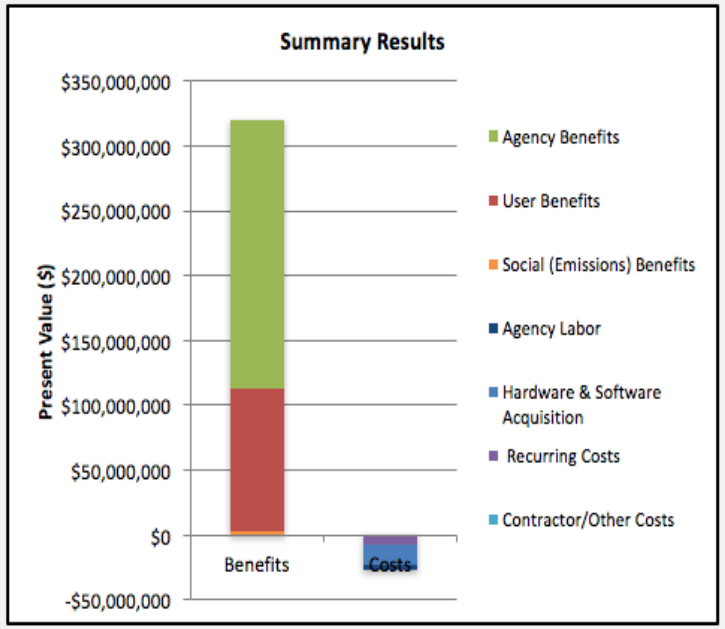
# Results

**DRAFT NCHRP Project 20-100 ROI Calculator**
**Summary Results**
last modified:12/16/16

*Summary Measures*

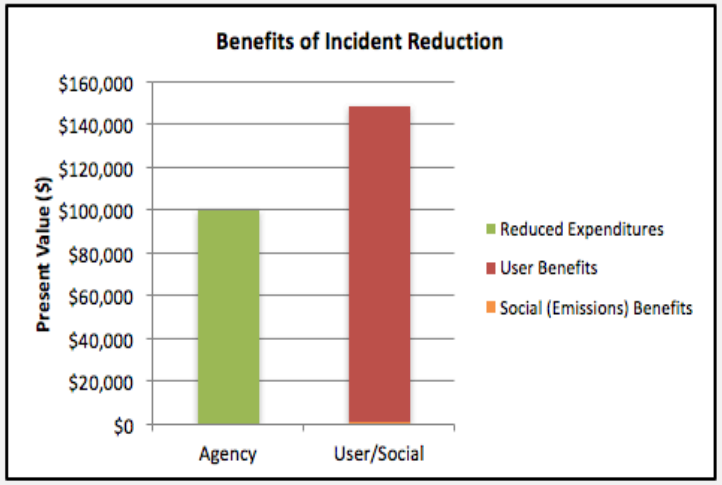
| Description | | Undiscounted | Present Value |
|---|---|---|---|
| **Total Benefits ($)** | Agency Benefits | $388,100,000 | $207,284,364 |
| | User Benefits | $213,195,593 | $110,124,241 |
| | Social (Emissions) Benefits | $4,000,979 | $2,822,701 |
| | **Total** | **$605,296,573** | **$320,231,306** |
| **Total Costs ($)** | Agency Labor | $3,675,000 | $2,646,004 |
| | Hardware & Software Acquisition | $15,000,000 | $11,686,964 |
| | Recurring Costs | $7,000,000 | $4,946,879 |
| | Contractor Costs | $1,000,000 | $706,697 |
| | Other Costs | $0 | $0 |
| | **Total** | **$26,675,000** | **$19,986,545** |

| | Value |
|---|---|
| **Net Present Value ($)** | **$300,244,761** |
| **Benefit/Cost Ratio** | **16.02** |
| **Internal Rate of Return** | **92.02%** |
| **Payback Period (years)** | **2** |




*Agency, User and Social Benefits of Incident Reduction ($)*

| Description | Undiscounted | Present Value |
|---|---|---|
| Reduced Agency Expenditures | $100,000 | $26,238 |
| User Benefits | $147,612 | $38,730 |
| Emissions Benefits | $979 | $257 |

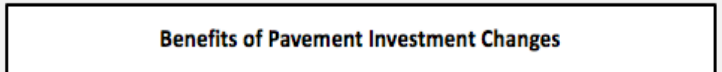



*Agency, User and Social Benefits Predicted Using HERS-ST ($)*

| Description | Undiscounted | Present Value |
|---|---|---|
| Reduced Agency Expenditures | $0 | $0 |
| User Benefits | $58,877,784 | $7,056,111 |
| Reduced Maintenance Expenditures | $100,000,000 | $70,561,108 |
| Emissions Benefits | $4,000,000 | $2,822,444 |

*Agency and User Benefits Predicted Using a Pavement Management System ($)*

| Description | Undiscounted | Present Value |
|---|---|---|



# Case Studies

**TRB Webinar:**

ROI in Asset Management Systems and Process Improvements

# Case Study Overview

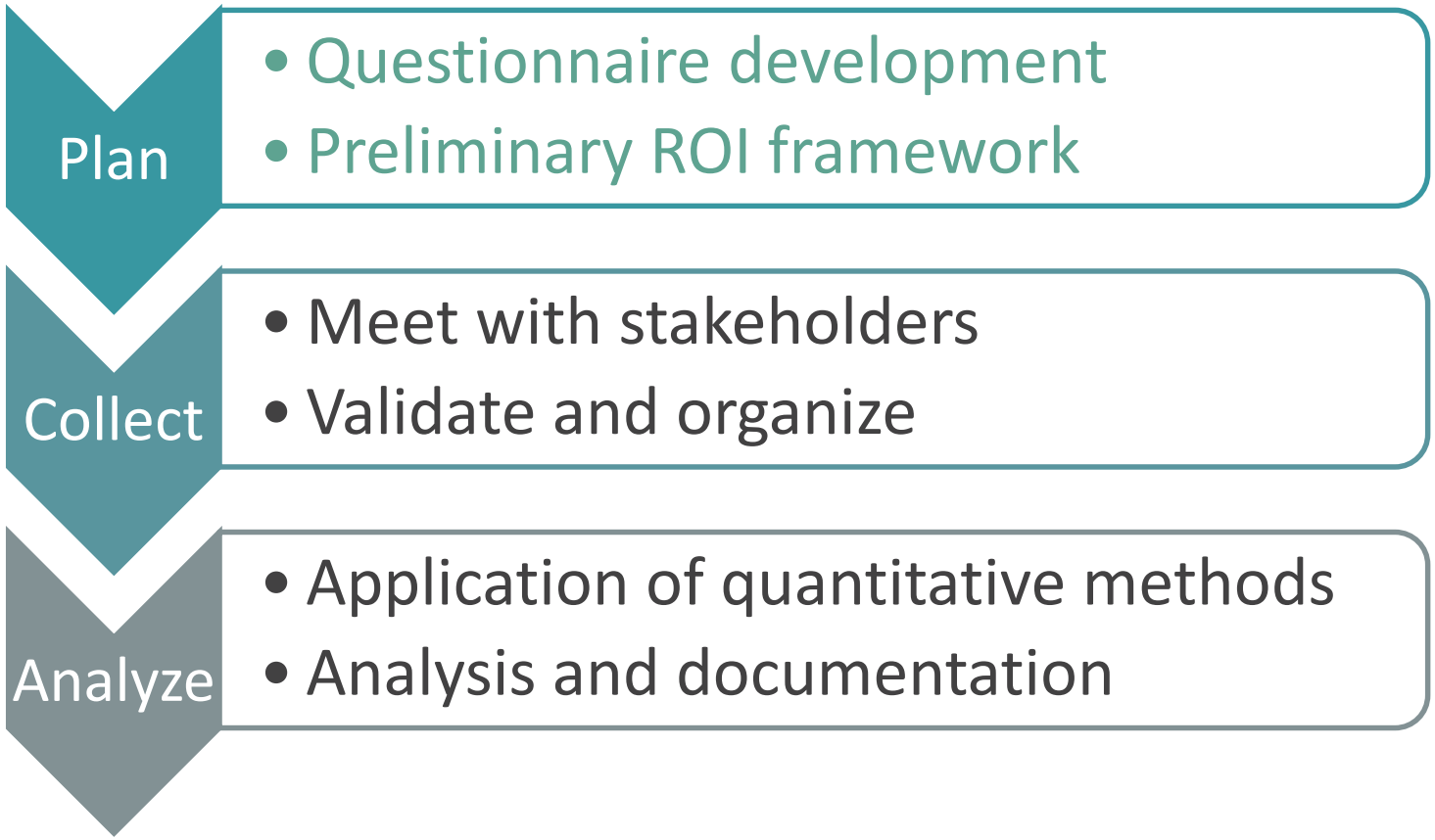
Three case studies were performed to illustrate the realized benefits of TAM improvements and demonstrate the application of the ROI framework

1. Implementation of a pavement management system (PMS) in a Western State
2. Implementation of a bridge management system in an Eastern State
3. Maintenance levels of service approach in a Southern State

An additional pilot was performed to project benefits of implementing a drainage management system in a New England State

# Case Study Process

## Process for Case Study Analysis



# Case Study 1: Western State

- The agency had a relatively comprehensive set of asset management systems, though work was underway to develop improved systems for certain asset classes
- Benefits may theoretically be the result of several different investments
- The research team elected to focus on analyzing the agency's investment in its PMS, concentrating on benefits achieved from 1999 to 2012
- Initial investment in and results from the PMS can be easily isolated from other asset management system investments

# Case Study 1 Approach

1. Calculate costs of PMS implementation and support

2. Approximate effects of implementing the PMS
   a. Estimated change in conditions that would have occurred had the PMS not been implemented
   b. Compared that base case to what actually occurred during analysis period

3. Estimate agency and user cost savings resulting from improved conditions
   a. Agency cost savings: change in residual value of the roadway network
   b. User cost savings: reduction in user costs from improved conditions calculated using models extracted from HERS-ST

# Case Study 1 Results

## Case Study 1 Analysis Results (2012 $M)

| Description | Total | NPV | Annualized |
|---|---|---|---|
| Agency costs | 17.3 | 23.2 | 0.93 |
| User benefits | 47.7 | 56.1 | 2.24 |
| Increased residual value | 182.4 | 182.4 | 7.30 |
| Total benefit | 230.1 | 238.5 | 9.64 |
| Net benefit | 212.8 | 215.3 | 8.61 |

- Benefit cost ratio of PMS implementation: ~10
  ($238.5 million NPV of total benefit / $23.2 million NPV of total cost)
- ROI of investing in the BMS:  41%
  ($9.54 million annual benefit / $23.2 million NPV of costs)
- Largest component of the benefit: increased residual value of the pavement network

# Case Study 2: Eastern State

- State invested in new pavement, bridge and maintenance management systems
- Research focused on investment in BMS
  - Analyzed period from 2009 to 2013 following BMS implementation
  - Benefits were distinct from other TAM processes and their impacts
- Staff reported that use of the BMS enabled a shift in bridge spending to focus on preservation rather than bridge replacement
  - $10M/year + one-time investment of $100M
- Separate implementation of a new bridge inventory and inspection data collection system yielded additional benefits

# Case Study 2 Approach

1. Tabulated costs of BMS implementation and support

2. Simulated two scenarios for the period 2009-2013 using FHWA's National Bridge Investment Analysis (NBIAS)
   a. Reproducing actual conditions
   b. Second simulating an alternative scenario in which preservation spending is limited

3. Compared the two scenarios to determine agency and user benefits yielded by the BMS for the period 2009-2013

# Case Study 2 Results

## Case Study 2 Analysis Results (2012 $M)

| Description | Total | NPV | Annualized |
|---|---|---|---|
| Agency costs | 2.9 | 3.0 | 0.12 |
| User benefits | -202.4 | -201.3 | -8.05 |
| Increased residual value | 283.9 | 273.0 | 10.92 |
| Total benefit | 81.5 | 71.7 | 2.87 |

- Benefit cost ratio of BMS implementation: ~24
  ($81.5 million NPV of total benefit / $3.0 million NPV of total cost)
- ROI of investing in the BMS:  96%
  ($2.87 million annual benefit / $3.0 million NPV of costs)
- Largest component of the benefit: increased residual value of bridges

# Case Study 3: Southern State

- State invested in new management systems
- Research focused on investment in MMS
  - Implemented a maintenance levels of service (LOS) approach
  - First supported the approach outside a system, then implemented the MMS
  - Yielded detailed data on spending by maintenance activity and LOS score
- Used a time series approach to estimate benefits
  - Linear regression model predicting LOS scores over time given budgets, presence of the MMS and other variables
  - Requires sufficient historic data on costs and investment effects

# Case Study 3 Approach

1. Collected data and review for duplicates, outliers, or gaps
2. Pooled at category level for matching to categorical spending
3. Applied descriptive statistics, data visualization, and simple regression models to understand trends in the data
4. Developed statistical model using multiple linear regression to understand change in scores over time
5. Tested multiple models and specifications
6. Reviewed fit assumptions
7. Ran regression diagnostics to determine if any observations influenced analysis
8. Interpreted results

# Case Study 3 Results

- Models provided evidence that implementation of the new TAM system resulted in more cost-effective management of LOS maintenance conditions: results showed a statistically significant relationship between increased spending and score improvements relative to objectives
- Case study did not yield conclusive financial results
  - Study would have benefited from additional data
  - System implementation occurred at same time as a major change in budget, confounding the analysis
- Basic approach nonetheless shows promise for historic analysis

# Pilot: New England State

- Goal was to test the guidance for predicting the return of a prospective investment in an asset management system and/or process improvement
- A New England DOT volunteer to pilot the tool for analysis of the potential installation of a culvert data collection and inventory system
- Expected to reduce the number of failure incidents, resulting in agency, user, and social cost savings

# Pilot Approach

- Estimated cost of implementing a new system
  - Staff
  - System procurement
  - System maintenance and support
- Estimated benefits
  - Reduction in road closure incidents
  - Other benefits expected but difficult to measure – e.g. improved project scoping
- Use tool to calculate ROI

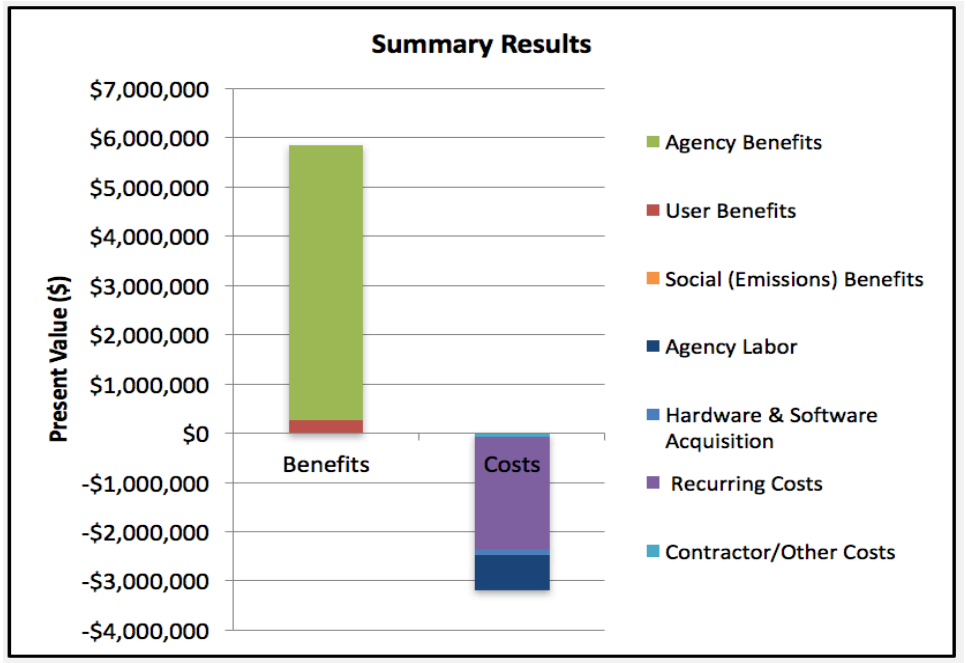
# Pilot Results

## Summary measures

- Net Present Value is $3,137,089
- Benefit/Cost ratio is 2.16
- Internal Rate of Return is 52.40%
- Payback Period is 4 years

## Analysis is subject to certain assumptions and qualifications:

- Could be additional benefits and costs not represented in the model
- Changes in costs or rate of culvert failure may impact results




***Summary Measures***

| Description | | Undiscounted | Present Value |
|---|---|---|---|
| **Total Benefits ($)** | Agency Benefits | $7,000,000 | $5,584,808 |
| | User Benefits | $322,778 | $257,522 |
| | Social (Emissions) Benefits | $5,823 | $4,646 |
| | **Total** | **$7,328,602** | **$5,846,976** |
| **Total Costs ($)** | Agency Labor | $719,958 | $615,400 |
| | Hardware & Software Acquisition | $100,000 | $91,096 |
| | Recurring Costs | $2,300,000 | $1,940,126 |
| | Contractor Costs | $75,000 | $63,265 |
| | Other Costs | $0 | $0 |
| | **Total** | **$3,194,958** | **$2,709,887** |

| | Value |
|---|---|
| **Net Present Value ($)** | **$3,137,089** |
| **Benefit/Cost Ratio** | **2.16** |
| **Internal Rate of Return** | **52.40%** |
| **Payback Period (years)** | **4** |

# Conclusions

**TRB Webinar:**

ROI in Asset Management Systems and Process Improvements

# Conclusions

- Investments in asset management systems and process improvements have demonstrable benefits and a positive return on investment
- NCHRP Report 866 provides guidance and tools for calculating the return of a prospective investment
- The report includes cases studies illustrating benefits of pavement and bridge management systems, as a well as a pilot demonstrating prediction of benefits for culvert management
- See NCHRP Report 866 for more details: http://www.trb.org/NCHRP/Blurbs/177179.aspx

# Acknowledgements


## NCHRP Project Team

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## TRB Project Monitor

- Andy Lemer

## Panel Chair

- Jennifer Brandenburg, Volkert

## Panel Members

- Imad Aleithawe, Mississippi DOT
- Steve Guenther, Caltrans
- Gareth McKay, Opus International
- Pramen Shrestha, University of Nevada, Las Vegas
- Dave Solsrud, Minnesota DOT
- Alan Warde, New York DOT
- Ermias Weldemicael, Colorado DOT

# Questions & Discussion

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ROI in Asset Management Systems and Process Improvements

# Today's Participants

- Jennifer Brandenburg, *Volkert, Inc.*, jennifer.brandenburg@volkert.com
- Bill Robert, *Spy Pond Partners, LLC*, wrobert@spypondpartners.com
- Chris Williges, *HDR*, chris.williges@hdrinc.com

VOLKERT

HDR

spy pond partners, llc

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