# 2016 EPA Region 6 Stormwater Conference

## 18th Annual Stormwater Workshop

## Oaklahoma City

## October 2nd – 6th 2016

# ENGINEERING OPTIMAL FINANCIAL, SOCIAL, AND ENVIRONMENTAL RETURNS


**John Parker, ENV-SP, Chief Economist, Impact Infrastructure, Inc.**

**John Wise, PE, CFM, ENV-SP, Managing Principal, Stantec**

**Mikel Wilkens, PE, ENV-SP, Environmental/Sustainability Program Manager VERDUNITY**

# Engineering Optimal Financial, Social, And Environmental Returns


Impact Infrastructure

Stantec

VERDUNITY
A better future, by design.

# Agenda

- 9:30 to 9:45 Introductions and Overview
  - Calculating Triple Bottom Line Returns and Valuing Public Benefits
- 9:40 to 10:20 The Value of Green Infrastructure. Examples:
  - Case 1. Tucson, AZ
  - Case 2. Fort Worth, TX
  - Case 3. Los Angeles, CA
- 10:20 to 10:30 Q&A


# Introductions and Overview

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# Overview

- As projects get more complex, engineers must adjust to new paradigms.
- Federal funding, regulation, best value based procurements, community sustainability and resilience requirements increase the need for decisions based on Cost-Benefit, LCCA, and TBL Analysis.
- Practical and accessible economic tools help engineers deliver value and compelling business cases for green infrastructure to varied stakeholders.


# Calculating Triple Bottom Line Returns and Valuing Public Benefits

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# Sustainability and the Public Good

- There are always public and quality of life benefits associated with infrastructure. Indeed, we build infrastructure for the public good and the public benefits that it brings. That is why these projects are called Public Works.
- Infrastructure projects are often sold on their sustainability benefits or how the infrastructure contributes to resiliency.
- The sustainability benefits can help make the business case for a project that otherwise just looks like a cost on the public ledger.
- These sustainability benefits can include resiliency and insurance against climate change.

# Custodians of the Public Good

- AEC firms are more and more being hired to assess, or be responsible for, infrastructure's impact on sustainability and ecosystems.
- These firms are being asked to minimize the negative externalities of their projects while at the same time maximizing the positive spin-offs and public benefits.
- There is a need for a decision framework that is transparent, objective and can evaluate infrastructure project sustainability.
- CBA can be made to fit this bill, and when standardized and integrated into BIM can be a key risk management tool.

# Green? Prove it!

- The demands to plan, build and operate responsibly are dramatically increasing.
- Stakeholders are becoming more sensitive, organized, and vocal. As a result, infrastructure projects should take responsibility for their externalities.
- Standardization of the data, methodologies, and output from CBA is required to make it accessible to Architecture, Engineering and Consulting (AEC) firms in their familiar planning, design, and construction processes.
- A standardized cost benefit framework that monetizes externalities allows AEC firms to respond rationally and in ways that are simultaneously defensible and transparent to all stakeholders.

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# Sustainable Return on Investment (S-ROI)

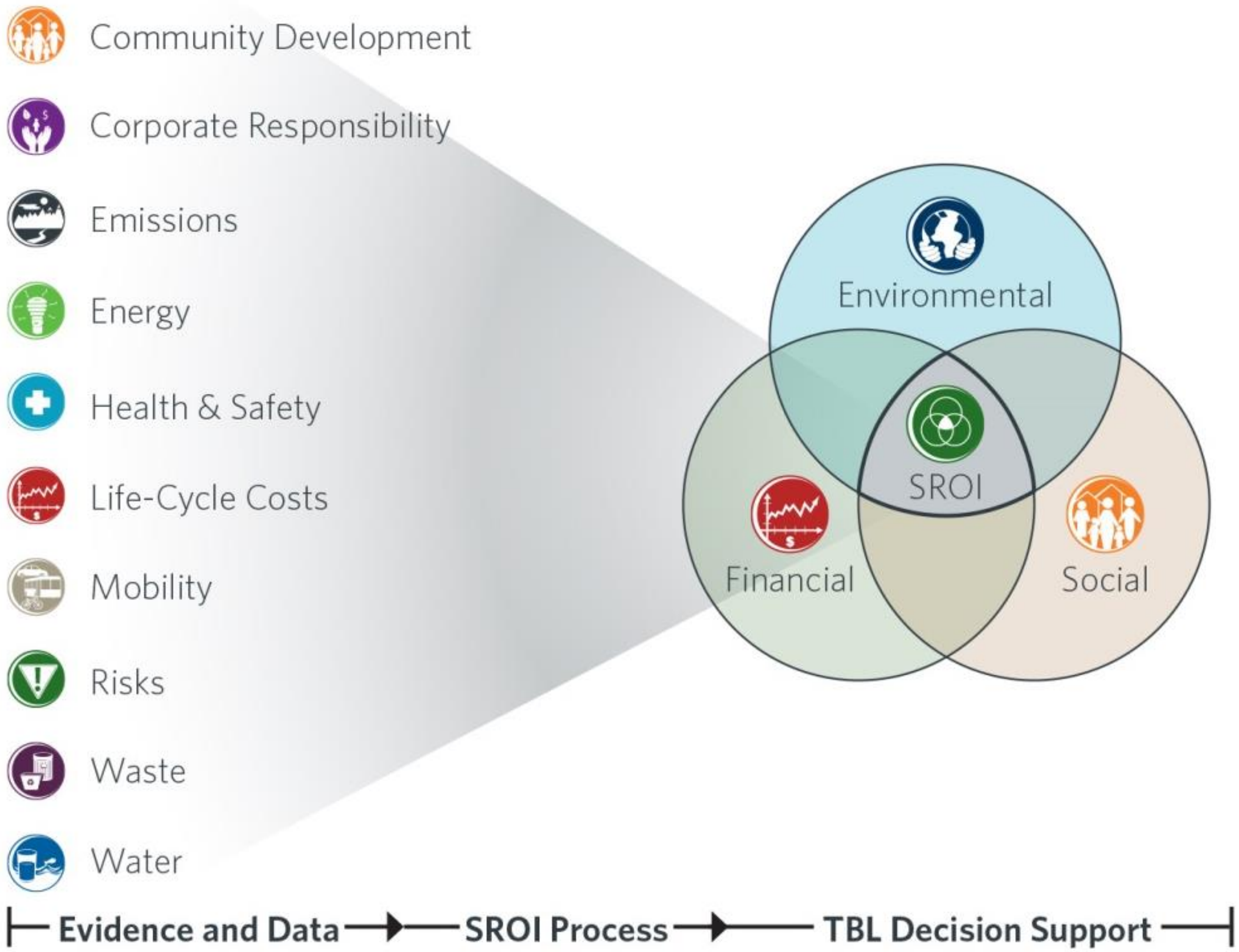
Process for calculating benefits and costs of a project to justify an investment or compare projects.

- Cost-Benefit Analysis (CBA) – measuring financial cash flows and externalities (environmental and social)
- Risk Analysis – measuring the risk associated with inputs and methodologies used in CBA
- Multiple Account CBA – mini CBA's by stakeholder or account

The S-ROI process accounts for a project's triple bottom line – **its full range of economic/financial, environmental, and social impacts.**

# S-ROI

- Monetary valuation of Triple Bottom Line
- Proven method in multiple contexts
- Applicable for program, project level decisions
- Accounts for risk & uncertainty

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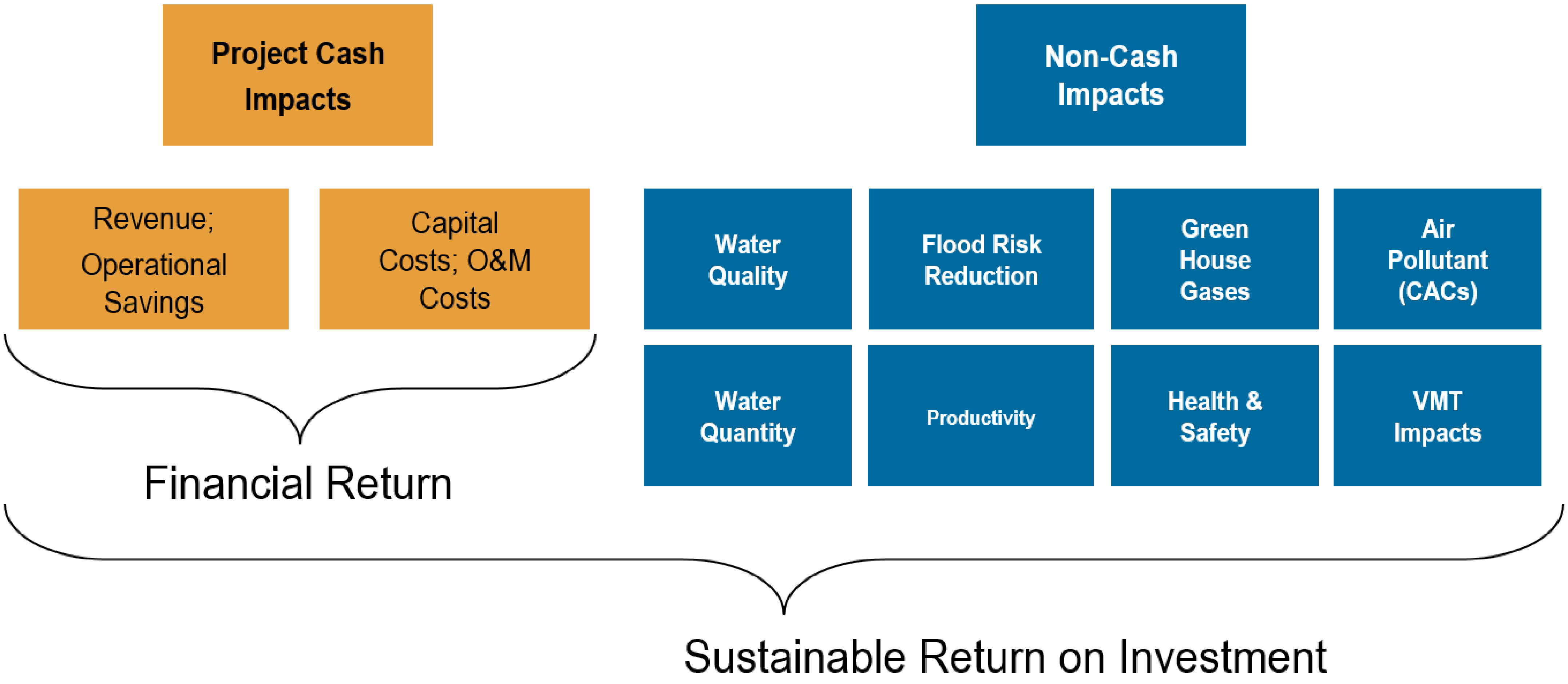
# S-ROI


Project Cash Impacts
Non-Cash Impacts
Revenue; Operational Savings
Capital Costs; O&M Costs
Water Quality
Flood Risk Reduction
Green House Gases
Air Pollutant (CACs)
Water Quantity
Productivity
Health & Safety
VMT Impacts
Financial Return
Sustainable Return on Investment

# When the Chickens Come Home to Roost

- Making comprehensive Cost Benefit Analysis (CBA) part of infrastructure planning exposes environmental and societal risks that may become financial risks.
- Standards engender productivity. They reduce waste, improve communication, and reduce risks.
- CBA has to be standardized and embedded into engineering, architecture and design processes such as Building Information Modelling (BIM).
- If an AEC firm is designing an infrastructure project and has not developed a plan to deal with wetland loss it may have angry birders on its case. When peoples' hackles are raised, environmental and social risks can quickly become project and financial risks with real dollar impacts.
- This is why so many companies in industries with active opponents or sensitive stakeholders are using CBA to put prices on non-market goods and services to determine value

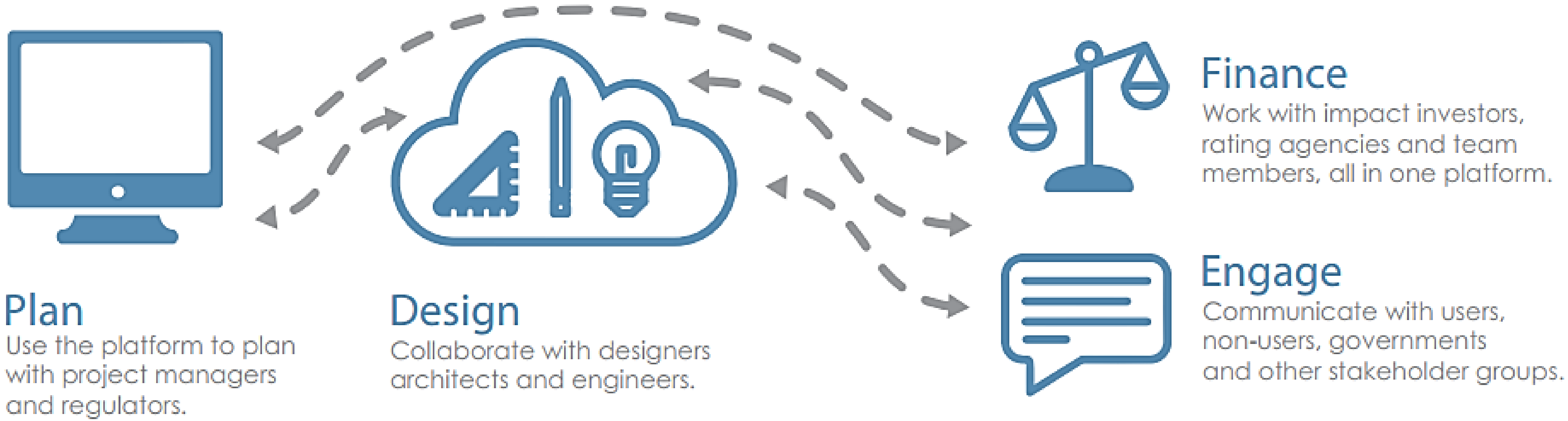
# Standardization Lets Project Professionals Use CBA -1

- Economists wanting to do custom studies are ignoring the standardization being driven by governments, the accumulation of research in databases and the application of benefits transfer using meta-analyses.
- The answer is - don't leave it to economists. Give the tools to those who know the most about the project, the professional planners, engineers and architects. And make it part of the BIM workflow these professionals use so that it can be run often and used for all the small design changes that affect the sustainability of a project.
- Standardization of CBA data and methodologies means that it can be embedded in BIM and automatically extract up to date project data.

# Standardization Lets Project Professionals Use CBA - 2

- As every tree placed in a project is registered in a BIM model and can be fed into the CBA analysis and the urban heat island benefits, the stormwater flood control, water, and air quality and carbon benefits are fed back to the designer in real time.
- Making CBA part of infrastructure planning exposes environmental and societal values and risks that may become financial risks.
- Given advancement in the volume of research, databases and meta-analyses that summarize it, and government initiatives to standardize CBA, large and small design decisions on infrastructure projects that affect sustainability and project risk can be made by project professionals as part of their BIM workflow.

# Autocase: Economic Analysis Software




# The Value of Green Infrastructure

Examples: Tucson, AZ; Fort Worth, TX; Los Angeles, CA

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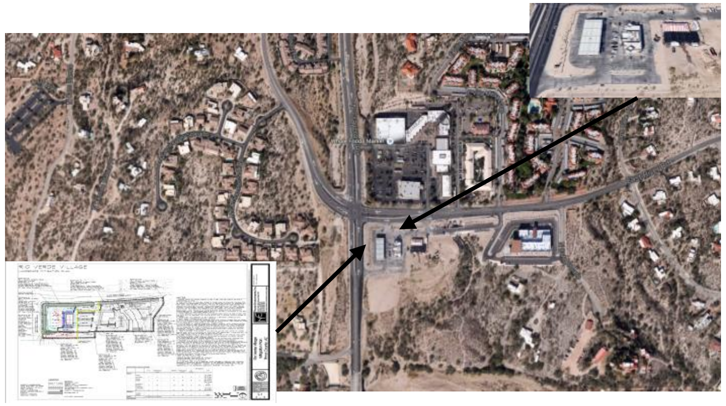
# The Value of Green Infrastructure

Tucson, AZ

Stantec

# The Rationale – Autocase™ and Envision™



To make sensible comparisons between green infrastructure/low impact development and traditional grey infrastructure

- Through a common metric
- To value the risk & benefits of sustainable projects
- Integrating engineering and economic methods to price options for decision-making.
- Identify optimal outcomes
- So that the project is done right and the right project is done.
- To provide a tool for professional designers to utilize and better understand design configurations and the benefits of GI/LID.

# Premise

- In more humid areas GI/LID practices are cost-effective by enhancing the potential for reducing or eliminating the risk of sewer overflows.
- Potential contaminant migration in stormwater tends to be more limited in arid environments as water bodies are few and groundwater is deep.
- Stormwater management important because use of stormwater can offset the need for potable water.
- Vegetation watered with stormwater - potential to decrease energy use, improve quality of life by mitigating effects from the urban heat island.

# Background

- The Pima County Regional Flood Control District and the City of Tucson, created a *Low Impact Development and Green Infrastructure Guidance Manual* to facilitate the adoption of GI/LID practices following a joint *Water-Wastewater (2010) Infrastructure, Supply and Planning Study*
- Despite efficient water use, best practices in stormwater management, and water re-use, renewable water resources are diminishing due to drought across the Colorado River Basin as the population grows.

# Unique Regional Aspects

- Does not have combined sanitary sewers/storm sewer
  - Does not suffer from combined sewer overflow problems
  - The desert environment does experience monsoons with potential for severe flooding
  - Also seeks the beneficial use of stormwater for irrigation.
- AutoCASE™ was made more useful by calculating the cost and benefit based on the desert regions common to the arid Southwest.

# Goal and Rationale

- To evaluate GI/LID benefits in the Pima County environment.
- AutoCASE™ uses economic and risk analysis to evaluate costs and multi-benefits using AutoCAD Civil3D files of GI/LID practices.
- Because of the motivating factors for use of GI/LID unique in Pima County, there is a need to evaluate the costs and multi-benefits of these features in that environment.
- This comparison provides a framework for how community can plan and adapt to become more resilient utilizing GI/LID in stormwater-management.

# Deliverables

- A beta version of AutoCASE TM with initial parameters for GI/LID practices.
- Evaluation costs/multi-benefits of two clustered GI/LID scenarios (commercial site and transportation corridor) considering a series of individual practices.
- List of factors that contribute most to the two scenarios to calculate effectiveness of the GI/LID practices with the associated probabilities.
- Evaluation of the economic and environmental returns from investing in GI/LID practices in the arid west
  - e.g. recreational benefits, air pollution reduction, carbon reduction, water quality improvements, lower urban heat island mortality rate etc.

# GI/LID Features Evaluated

- Eight green infrastructure (GI) features evaluated
- Features also combined in two sites:
  - A commercial site
  - A roadway reach
- Economic analysis used to determine which GI features provide the greatest benefits in Tucson and how they can be used to comply with:
  - Commercial rainwater harvesting ordinance
  - Green streets guidelines

# GI/LID Practices Evaluated

- Water Harvesting Basins
- Bio Retention Basins
- Xeriscape Swales
- Cisterns
- Infiltration Trenches
- Detention Basins (or Extended Detention Basins)
- Pervious Pavers
- Curb Extensions, new & retrofit chicanes, medians, road diets with inlets to gather street water runoff, traffic circles)

# Cost-Benefit Considerations

- Water Costs (assumed to be water costs associated with irrigation reduction/potable water savings, and water pumping costs)
- Energy Savings (especially energy reduction from shading)
- Operation & Maintenance (assumed to include maintenance required for continued functionality of GI).
- A distribution of costs, benefits and possible outcomes as described by the following factors.
  - Direct Financial Return on Investment
  - Sustainable Return on Investment

# Methodology – Risk Analysis Approach

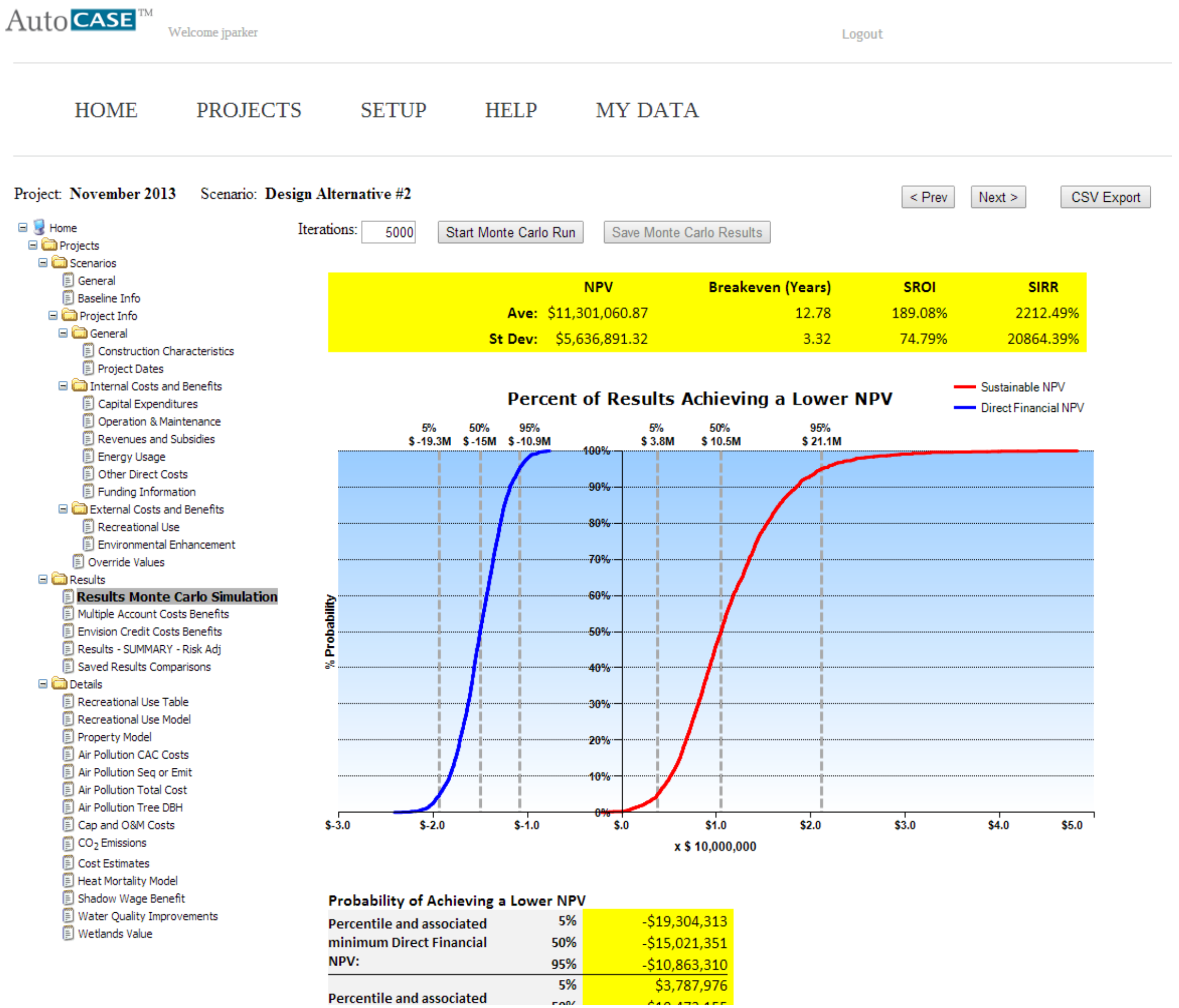
- Reflecting the range of uncertainty about inputs as well as their most likely values.
- A probability distribution representing the outcome of future events, based on limited information.
- Input into a Monte Carlo risk analysis following a cost-benefit approach.

# Outcomes

- Evaluation of usability and usefulness of the AutoCASE™ and applicability of the data used.
- A description of Envision scoring of GI/LID features to articulate the link between GI/LID and Envision.
- An evaluation on the possible use by the City and County for the Envision™ System to assess GI/LID practices.

# Findings

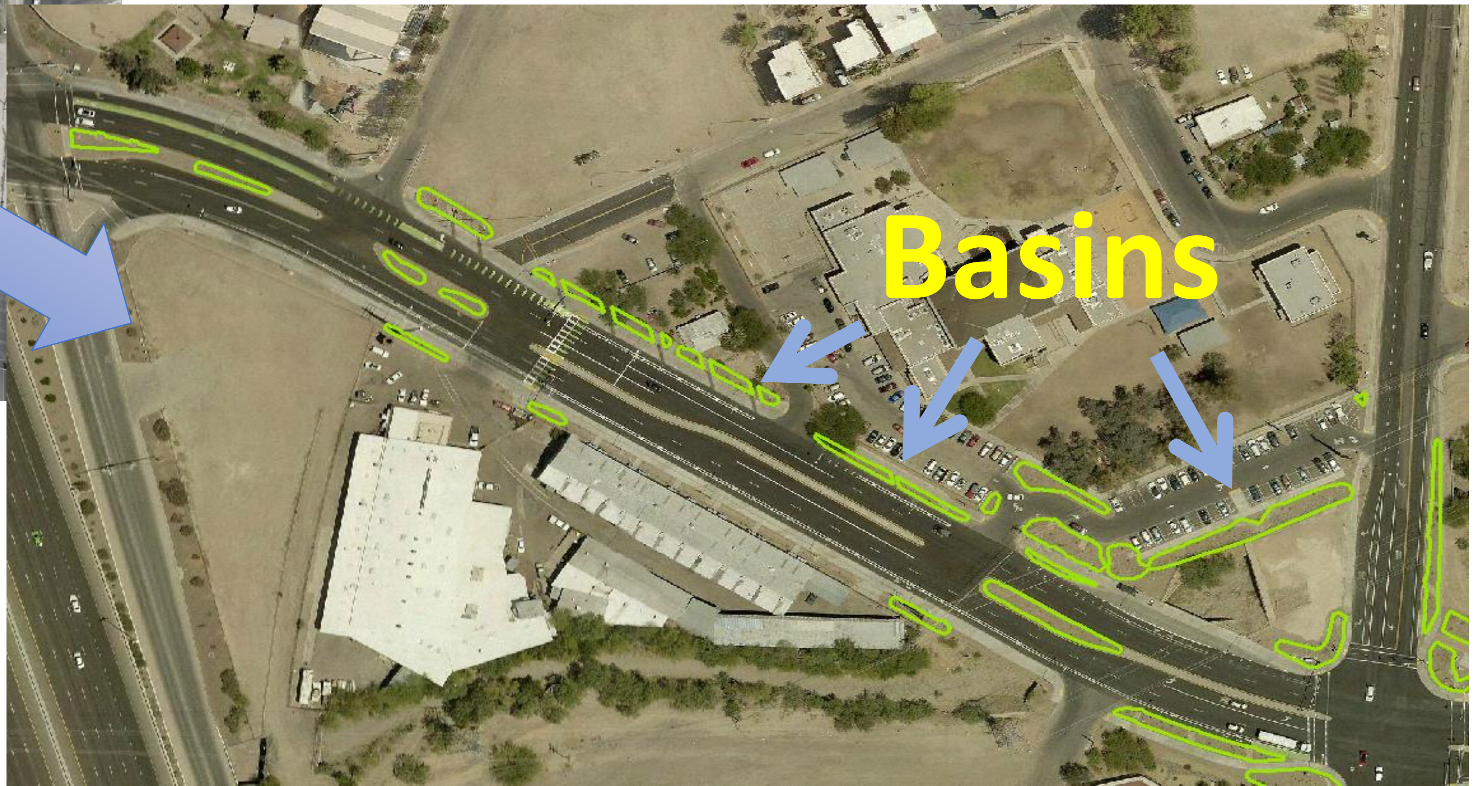
- GI/LID features (best management practices) added to the conventional design provide multiple high impact social benefits on both sites analyzed
  - Commercial Site
  - Road Re-Design



# Downtown Links: Project Site

Before the construction

After the construction



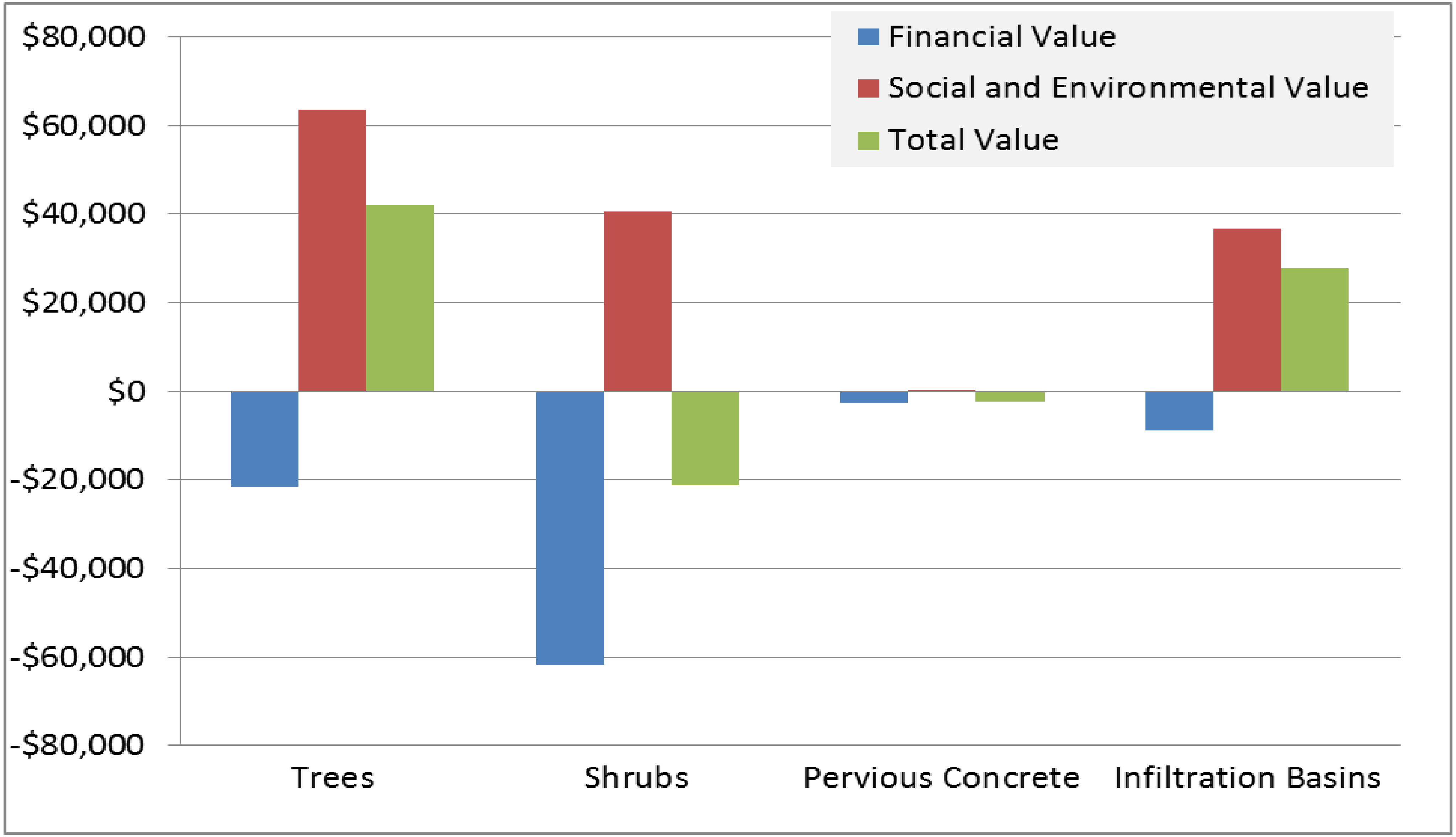
# Downtown Links: LID/GI Features

- Infiltration Basins
- Pervious Concrete
- Trees
- Shrubs

# Downtown Links: LID/GI Features

- Pervious Concrete

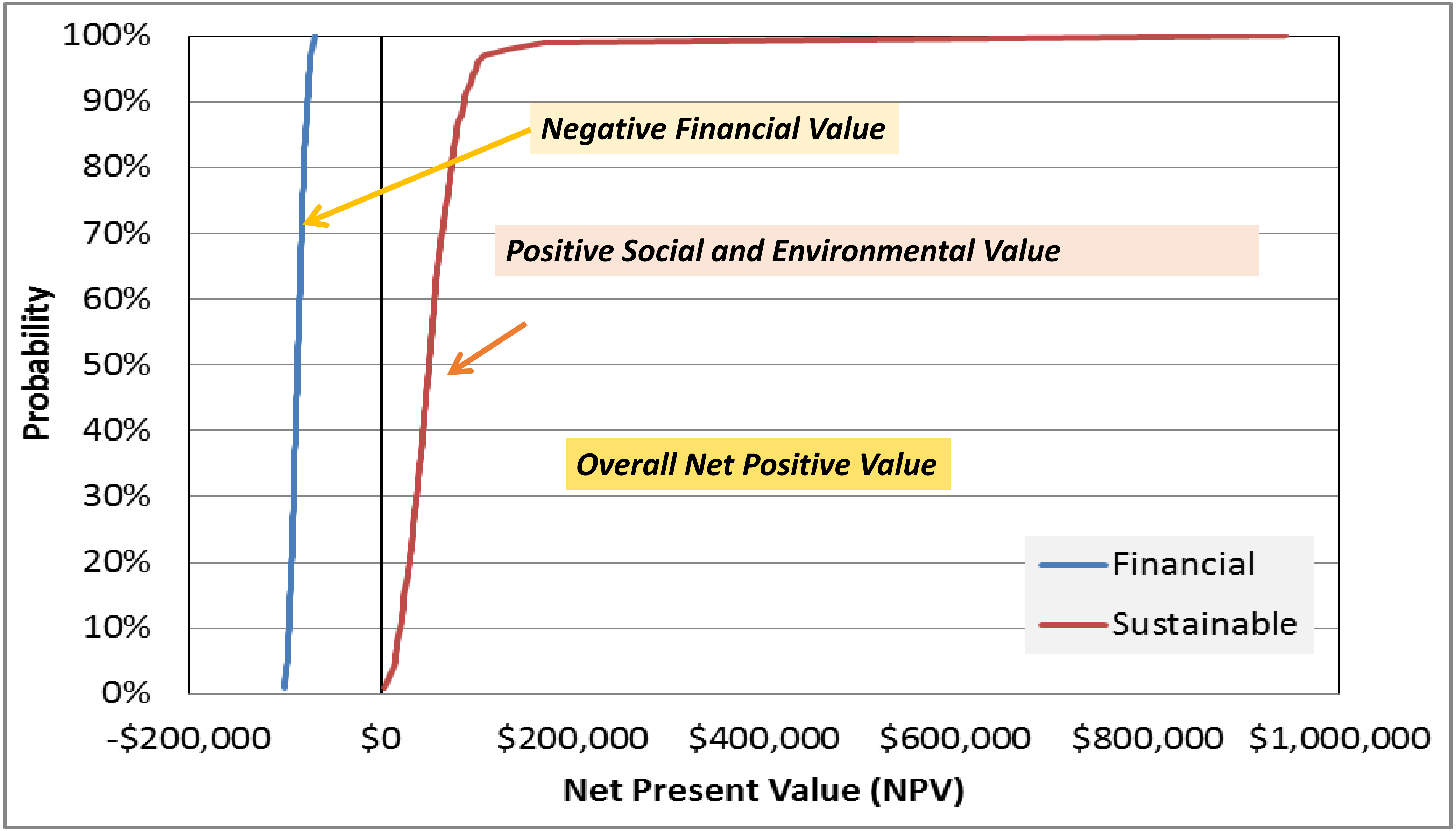
# Downtown Links: Feature Results



# Downtown Links: Net Present Value (NPV)

- Financial NPV: Costs and benefits that involve cash flows
- Sustainable NPV: Monetized value of social and environmental impacts in addition to cash flows

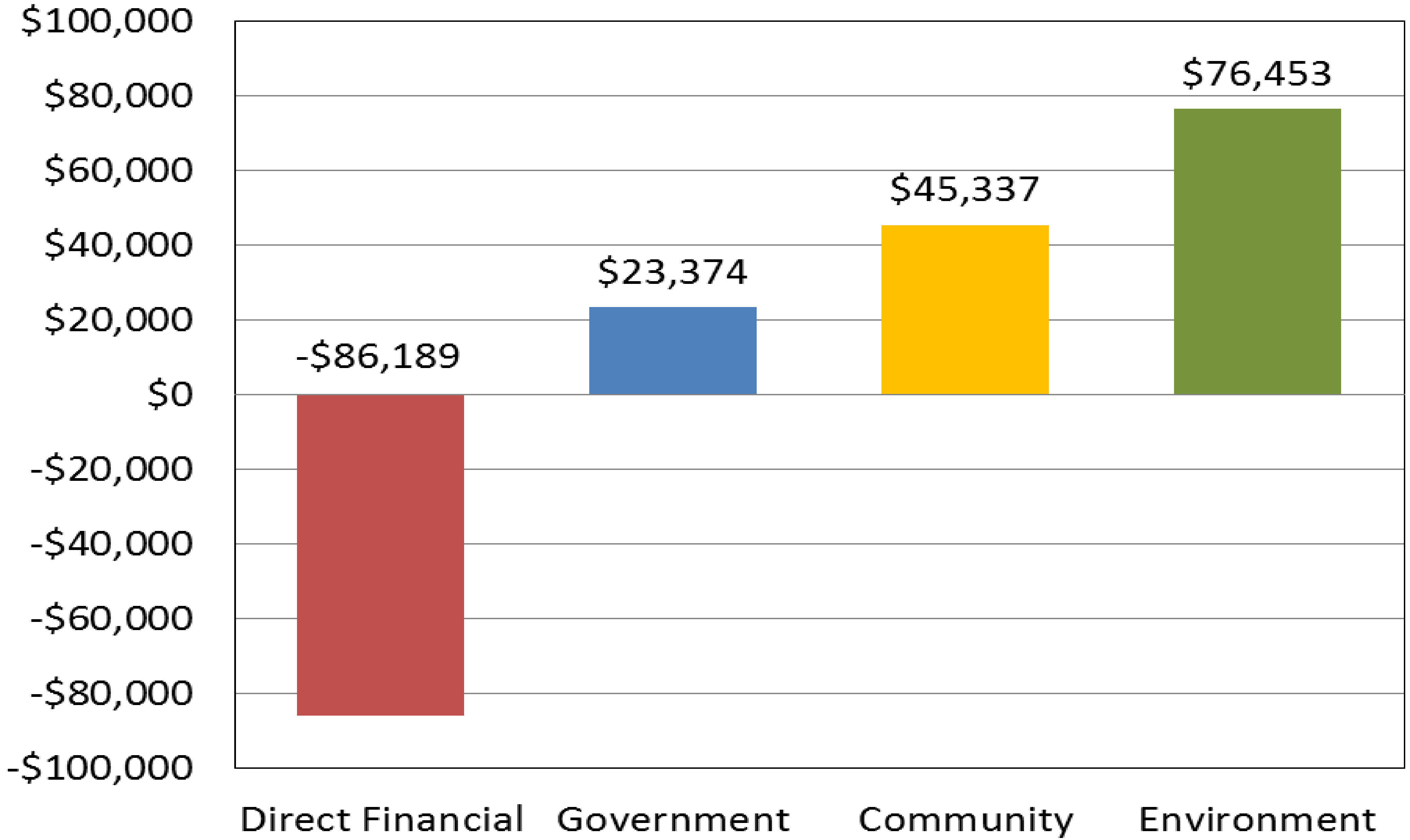
# Downtown Links: Net Present Value (NPV)



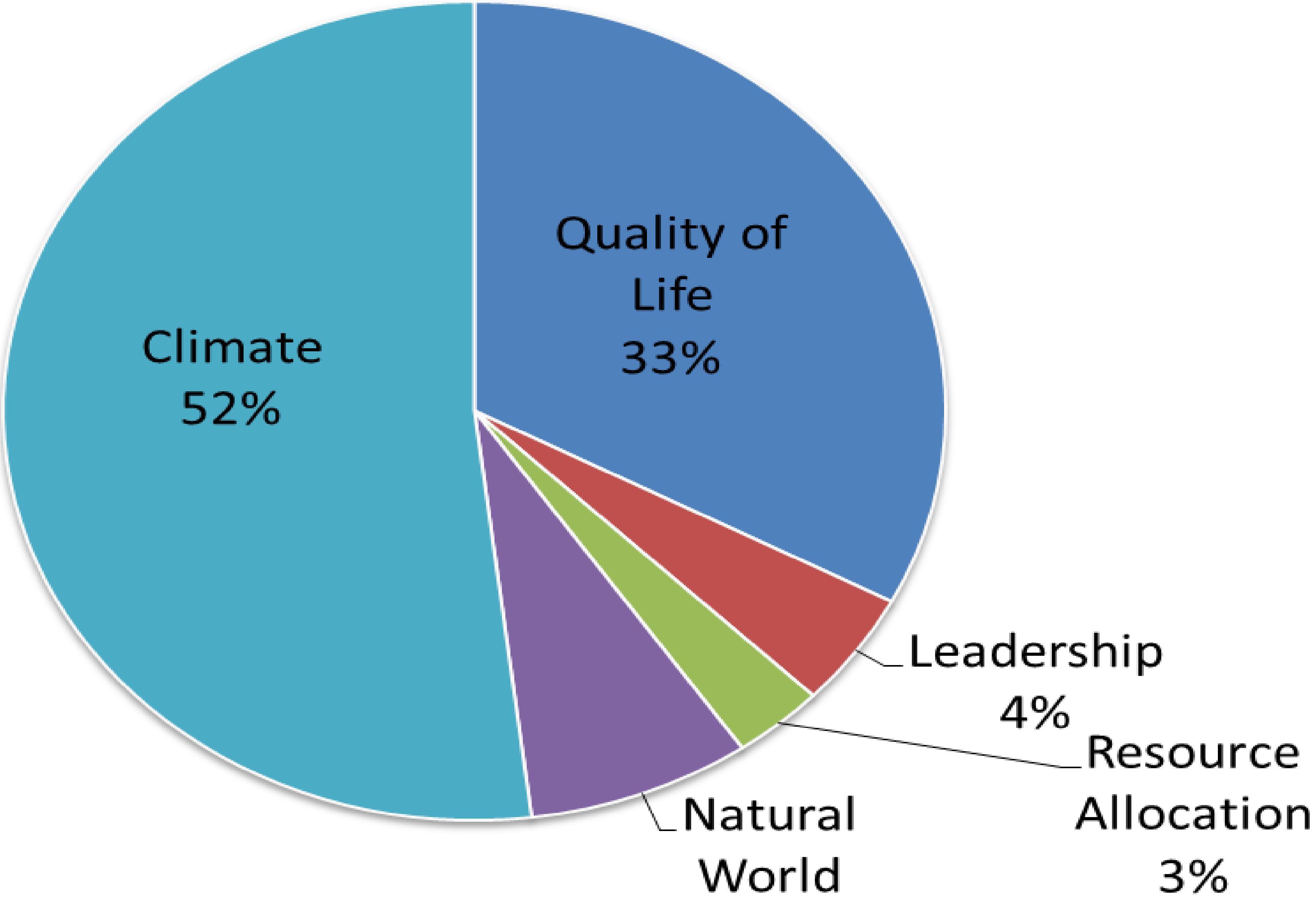
# Downtown Links: Costs and Benefits

| Cost/Benefit | Mediam Net Present Value | |
|---|---|---|
| Carbon Reduction by Vegetation | $47,914 | ***Largest Benefit*** |
| Heat Island Effect | $30,669 | |
| Air Pollution Reduced by Vegetation | $28,816 | |
| Flood Risk | $12,504 | |
| Property Value | $10,477 | |
| Water Costs | $8,679 | |
| Shadow Wage | $318 | |
| Carbon Emissions from Energy Use | $112 | |
| Air Pollution from Energy Use | $84 | |
| Replacement Costs | -$27,354 | |
| Operations and Maintenance | -$30,883 | |
| Capital Expenditures | -$36,194 | ***Largest Cost*** |

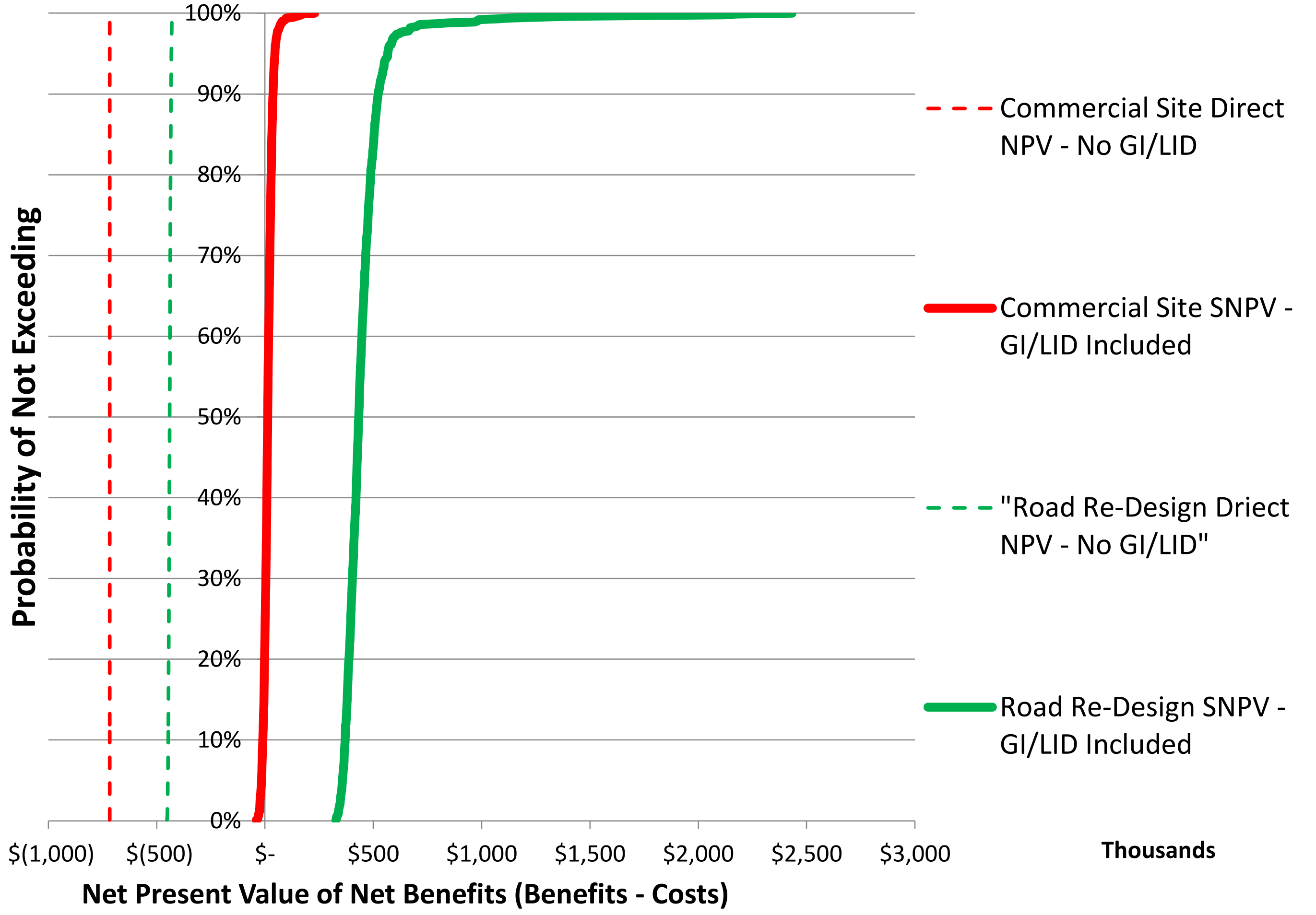
# Downtown Links: Stakeholder Value



# Downtown Links: Envision Value



# Benefits of GI/LID Features Quantified and Monetized:




- Adding GI/LID features to the commercial and road re-design sites provides net benefits to the Tucson region
- Largest benefits: heat related mortality, traffic calming, flooding, reduced water costs and reduced air pollution

# Overall Findings

- GI/LID features have a payback to governments, the environment, the economy and the community
- This approach allows all stakeholder groups to understand how they are affected by a project
  - "What's in it *for me?*"
- Ignoring benefits of GI/LID features can lead to incorrect decisions

# Recommendations

- The City of Tucson, Pima County, should continue to use this approach to demonstrate the full value of its GI/LID initiatives
- This information should be used to help make the best decisions as projects are planned and designs are modified
- The Tucson region should consider the use of Envision to communicate project benefits to outside stakeholders


# The Value of Green Infrastructure

Fort Worth, TX

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# Sustainable Return on Investment (S-ROI) Analysis Application

## Fort Worth, Texas

VERDUNITY
A better future, by design.
www.verdunity.com

**Mikel Wilkens, PE, ENV-SP, Environmental/Sustainability Program Manager VERDUNITY**
mwilkins@verdunity.com @verdunity

# Applications in Fort Worth

1) Evaluating and aligning public and private investment for development

   TRVA Panther Island Project Case Study

2) Tying capital improvement project prioritization to the City's strategic goals and comprehensive plan

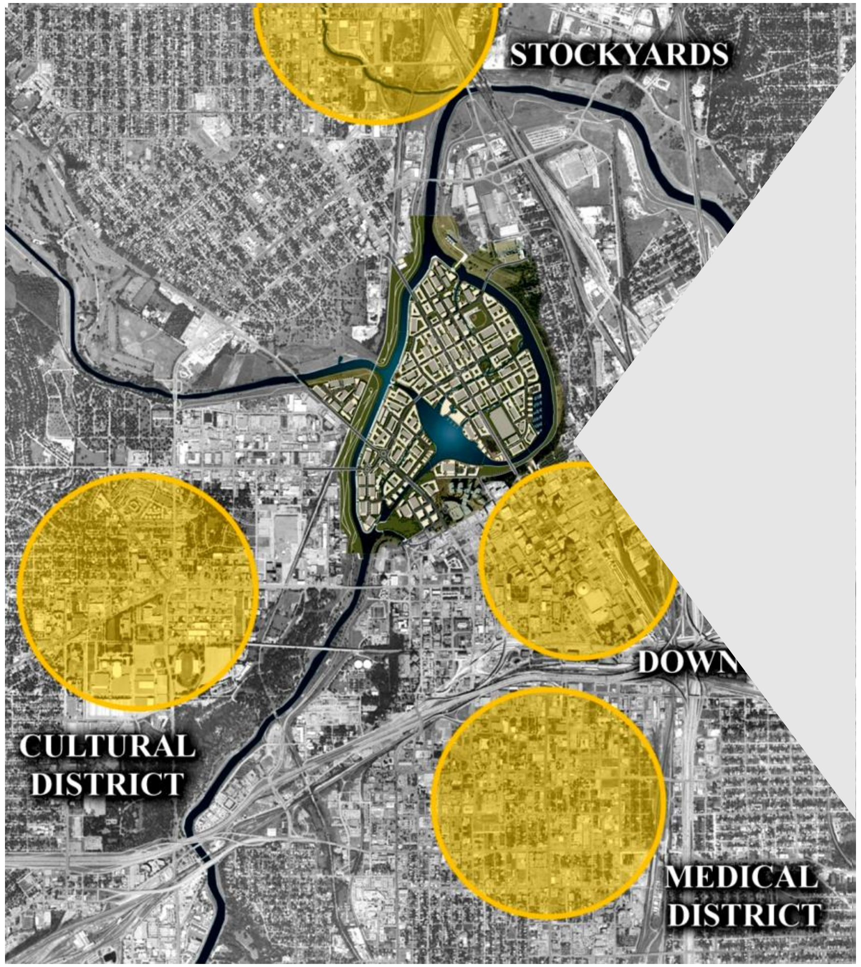
   Stormwater Management Program

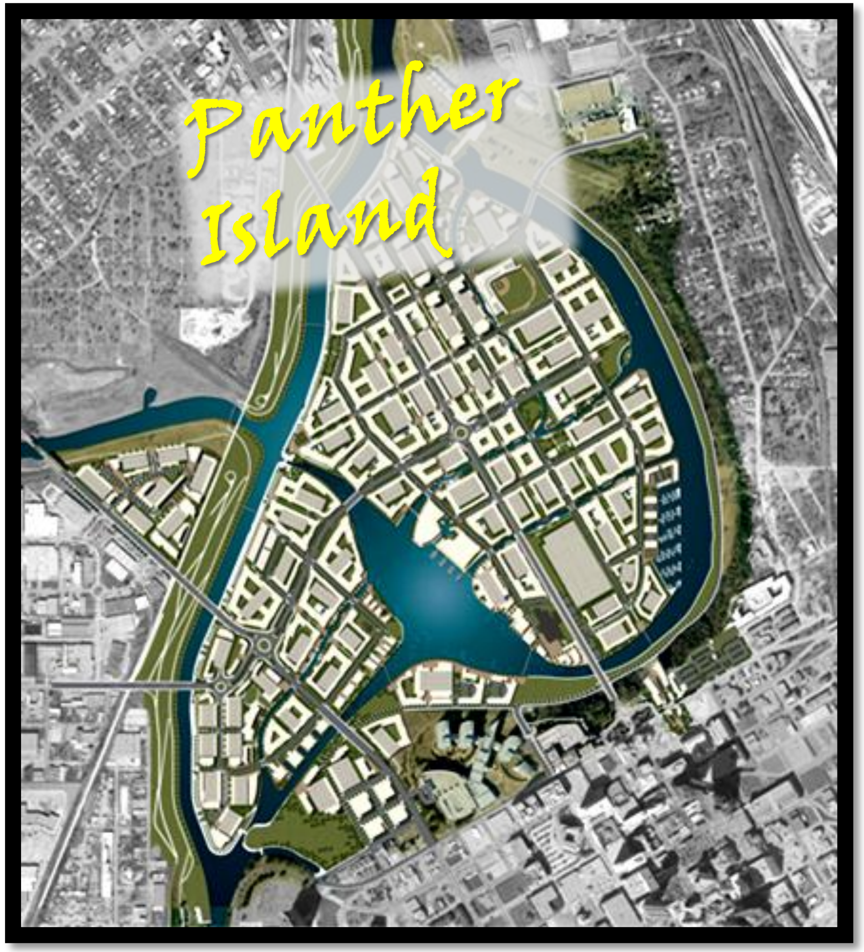
3) Refining the scope and evaluating design options for stormwater infrastructure projects

   Central Arlington Heights Neighborhood/Stormwater Improvements

# Trinity River Authority

## Panther Island Development

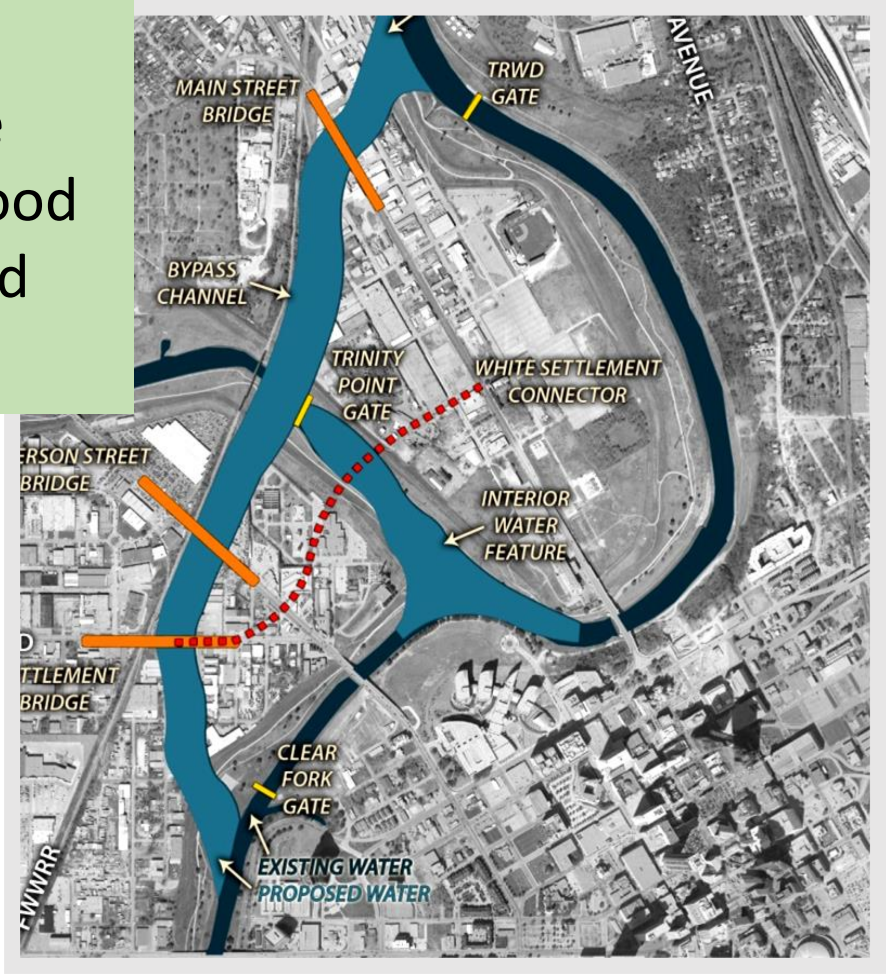


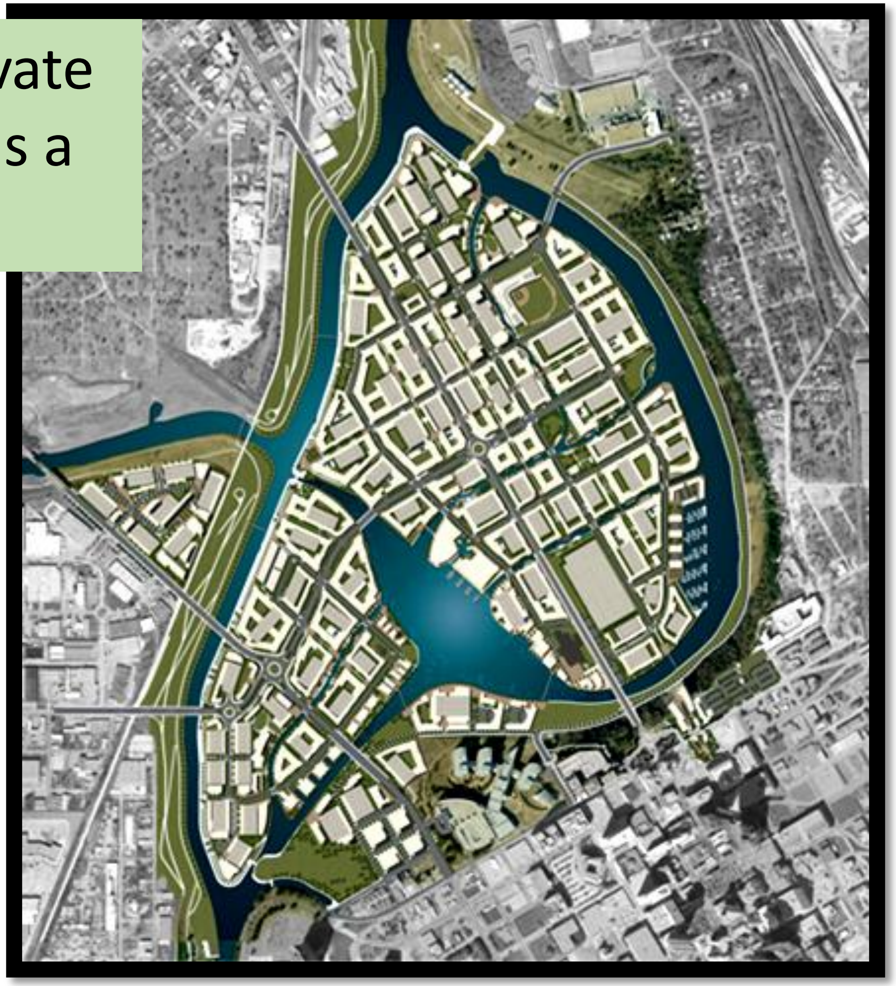
# Trinity River Authority

## Panther Island Development

Public Infrastructure Project for Flood Protection and Access




Potential Private Investment as a Result



# Trinity River Authority

## Panther Island Development

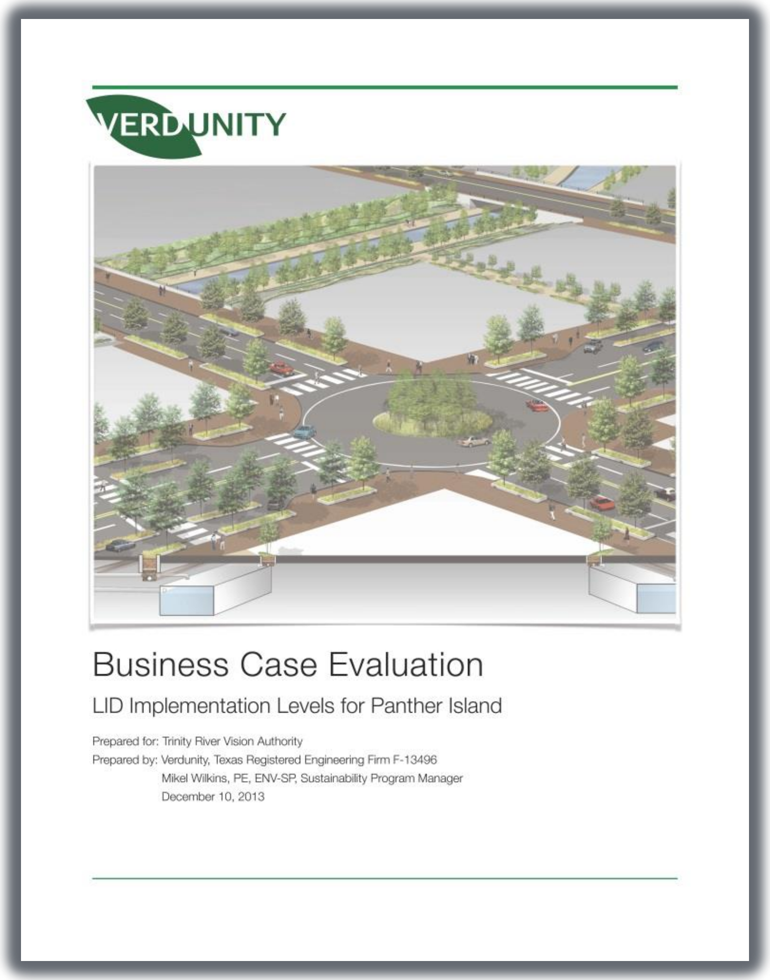
Looking south down Main Street toward downtown

# TRVA Panther Island

## Casting a vision for LID implementation


# TRVA Panther Island

## Making the business case for LID




**Primary Questions**

1) What is the economic case for additional initial investment in low impact development?

2) What is the return on investment for:
   a) the City
   b) the developer
   c) the region?

# TRVA Panther Island

## Incremental Levels of LID Implementation Evaluated

**Traditional Design**

- No green infrastructure
- Water quality addressed structurally

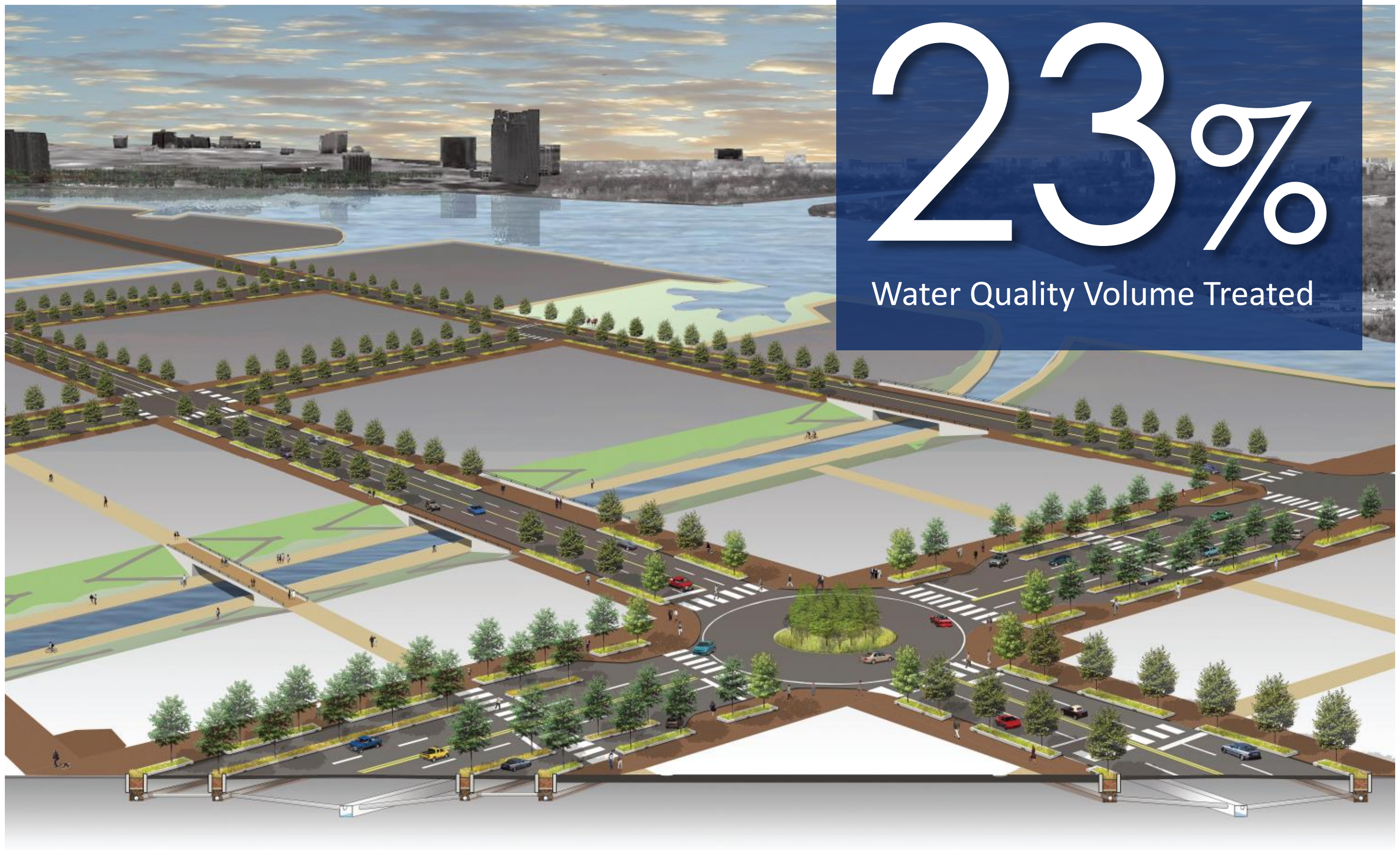
# TRVA Panther Island

## Incremental Levels of LID Implementation Evaluated

Traditional Design

**Right-of-Way Option**

- Bioretention to replace all street trees



23%

Water Quality Volume Treated

# TRVA Panther Island

## Incremental Levels of LID Implementation Evaluated

Traditional Design

Right-of-Way Option

**Open Space Option**

- Bioretention along canals and open spaces
- Allows for drainage directly to canals

# TRVA Panther Island

## Incremental Levels of LID Implementation Evaluated

Traditional Design

Right-of-Way Option

Open Space Option

**Architectural Option**

- Private implementation of green roofs
- Assumes 25% green roof coverage

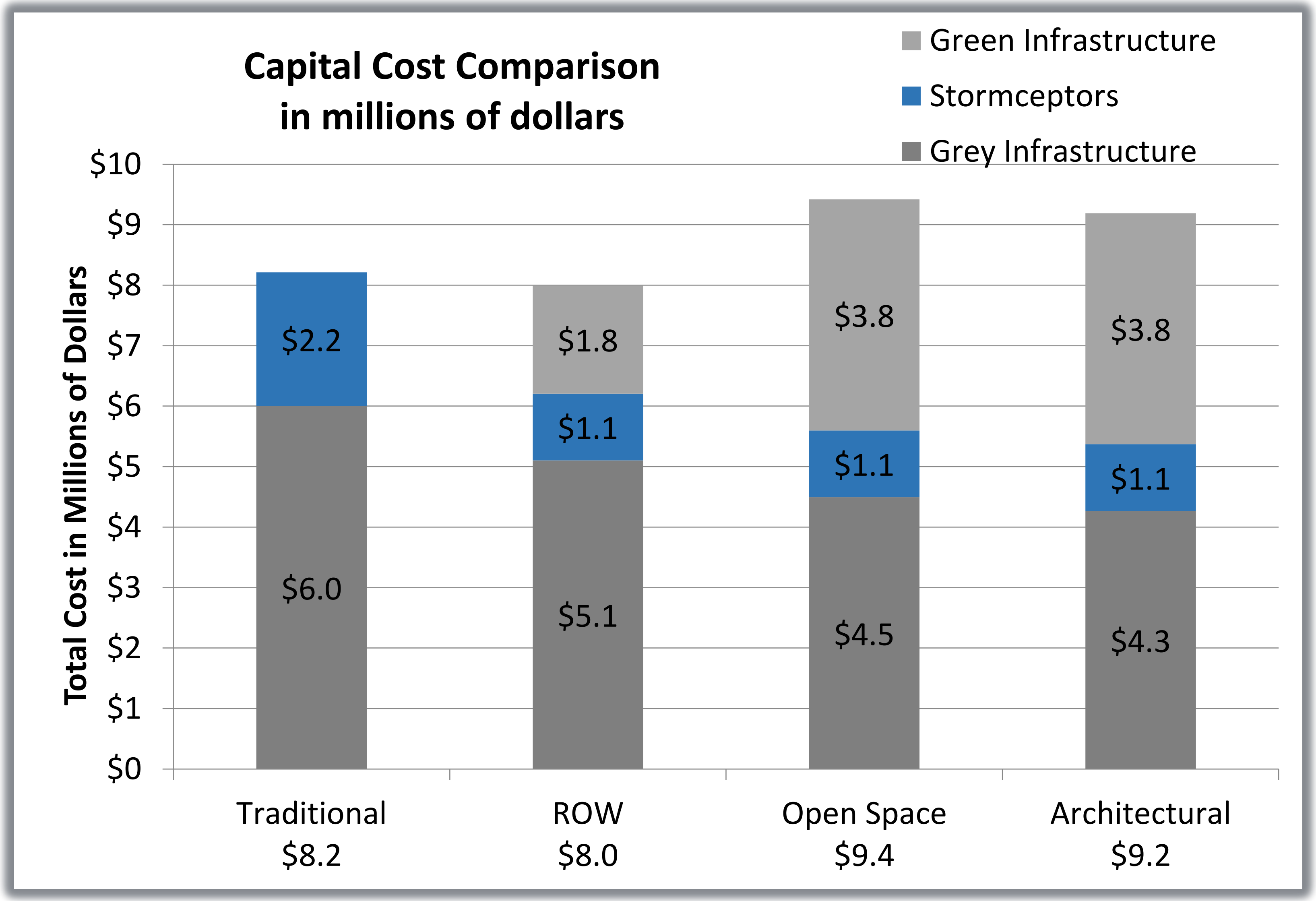
# TRVA Panther Island

## Evaluating LID Options

**Costs Evaluated**

Probable Construction Costs
- 8-Yr construction period
- 50-Yr operational period

O&M Costs
- Typical costs from EPA



# TRVA Panther Island

## Evaluating LID Options

**Property Value Worksheet**

| | Right-of-Way Response | Open Space Response |
|---|---|---|
| Total Residential Units | 10,500 | 10,500 |
| Average Value of Residential Unit (Non - LID Development) | $155,000 | $155,000 |
| LID Benefits: | | |
| Number of Units Affected | 2,100 | 4,200 |
| Estimated Value Increase | 3.36% | 3.36% |
| Total Value Increase | $10,936,800 | $21,873,600 |
| 50% Rule | -$5,468,400 | -$10,936,800 |
| Total Value Added By LID | $5,468,400 | $10,936,800 |
| **NPV** | $2,919,692 | $5,717,190 |

## Economic Benefits

### Sales Tax

- Estimated 2-4% Increase
- Base values from Economic and Fiscal Impacts of the Corps of Engineers' Trinity River Vision Project (UNT 2005)
- Conservative estimate based on prior studies

### Property Values

- Estimated 3.36% Increase based on 10,500 residential units with an average value of $150-160k

# TRVA Panther Island

## Evaluating LID Options

Environmental and Social Benefits

### Water Quality Improvements

- Based largely on Willingness-To-Pay studies conducted by USACE and others

### $CO_2$ and Air Pollution Reduction

- Based on US Forest Service estimates for pollutant removal

# TRVA Panther Island

## Evaluating LID Options

Capital Expenditures

| Capital Expenditure | Traditional | Right-of-Way Response | Open Space Response |
|---|---|---|---|
| Rain Gardens | $0 | $1,376,250 | $2,935,944 |
| Hydrodynamic Structures | $1,700,000 | $850,000 | $850,000 |
| Grey Components | $6,511,000 | $5,768,504 | $5,631,056 |
| **Total** | $8,211,000 | $7,994,754 | $9,417,000 |

| Funding Information | |
|---|---|
| Primary Entity Served | Municipality |
| Taxes | 15% |
| Grants/Donations | 5% |
| Equity | 30% |
| Nominal Rate of Return for Equity | 10% |
| Debt | 50% |
| Debt Financing Term Length | 30 years |
| Rate of Interest for Debt Financing | 4% |
| Weighted Average Cost of Capital | 4.7% |

Example inputs and analysis results

# TRVA Panther Island

## Evaluating LID Options

Example inputs and analysis results

| | Right-of-Way Response | Open Space Response |
|---|---|---|
| Costs: | | |
| Capital | (-$216,246) | $1,206,000 |
| Operations and Maintenance | $202,412 | $442,325 |
| Total | (-$13,834) | $1,648,325 |
| Benefits: | | |
| State/Local Sales Tax | $290,383 | $580,767 |
| Water Quality | $298,665 | $371,184 |
| Residential Property Tax (City/County) | $2,919,612 | $5,717,190 |
| CO2 Emissions | - | $142,858 |
| Air Pollution | - | $199,981 |
| Total | $3,460,785 | $7,011,980 |
| **Net (Benefits - Cost)** | $3,474,619 | $5,363,655 |

# TRVA Panther Island

## Evaluating LID Options

The Right-of-Way and Open Space options both showed positive returns over the Traditional approach.

Impact of LID Implementation Scenarios on Property Values and Tax Revenues

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|---|---|---|
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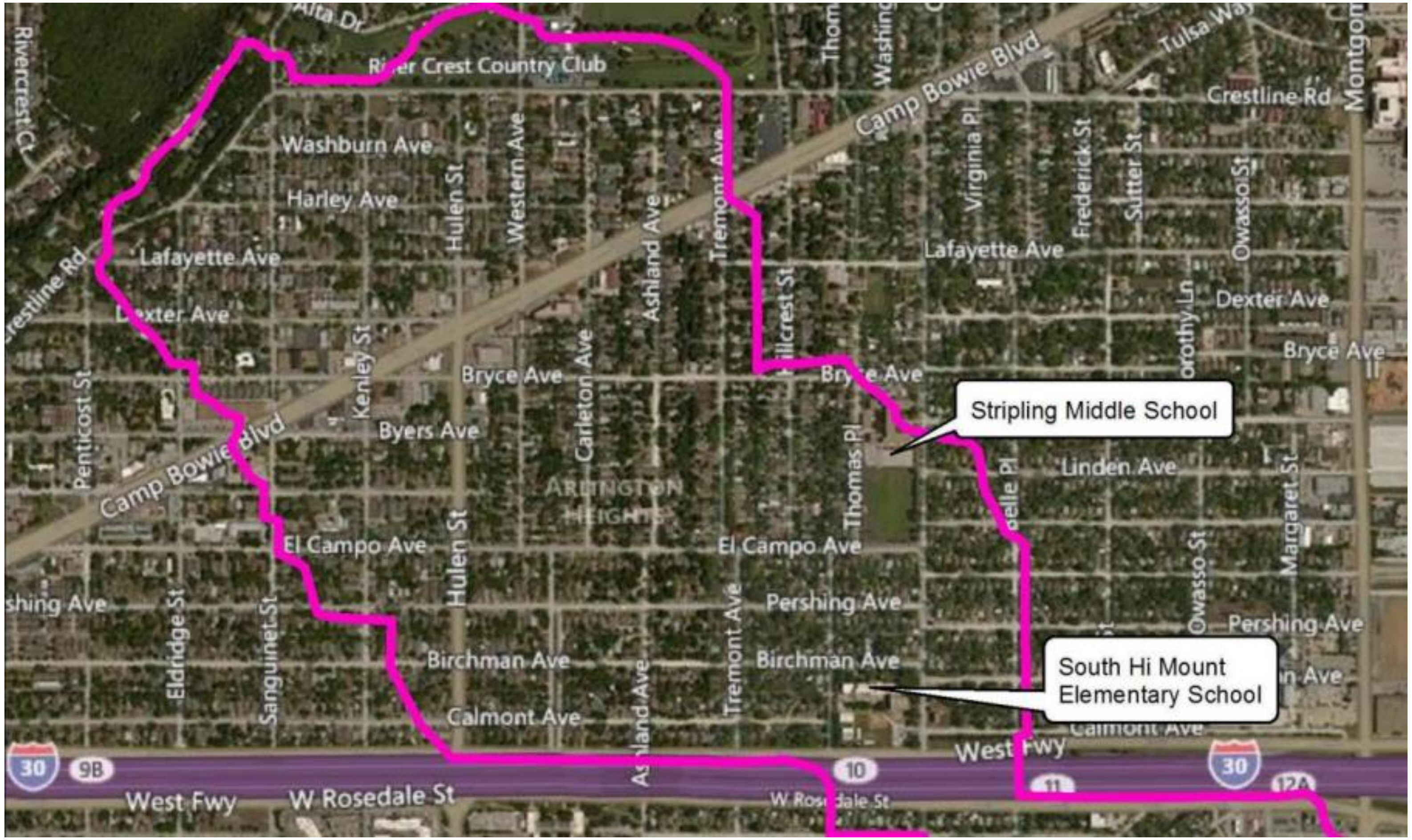
# CIP Prioritization and Design Refinement

## Central Arlington Heights Neighborhood



# Central Arlington Heights Neighborhood

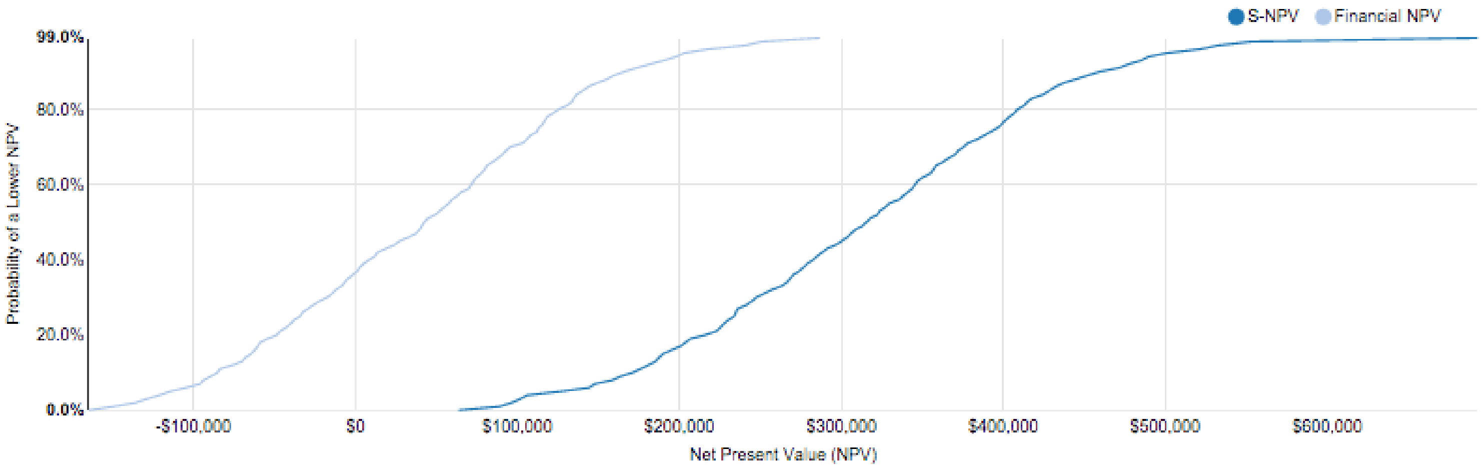
**Collinwood Avenue Greet Street**

# Central Arlington Heights Neighborhood

Collinwood Avenue Greet Street

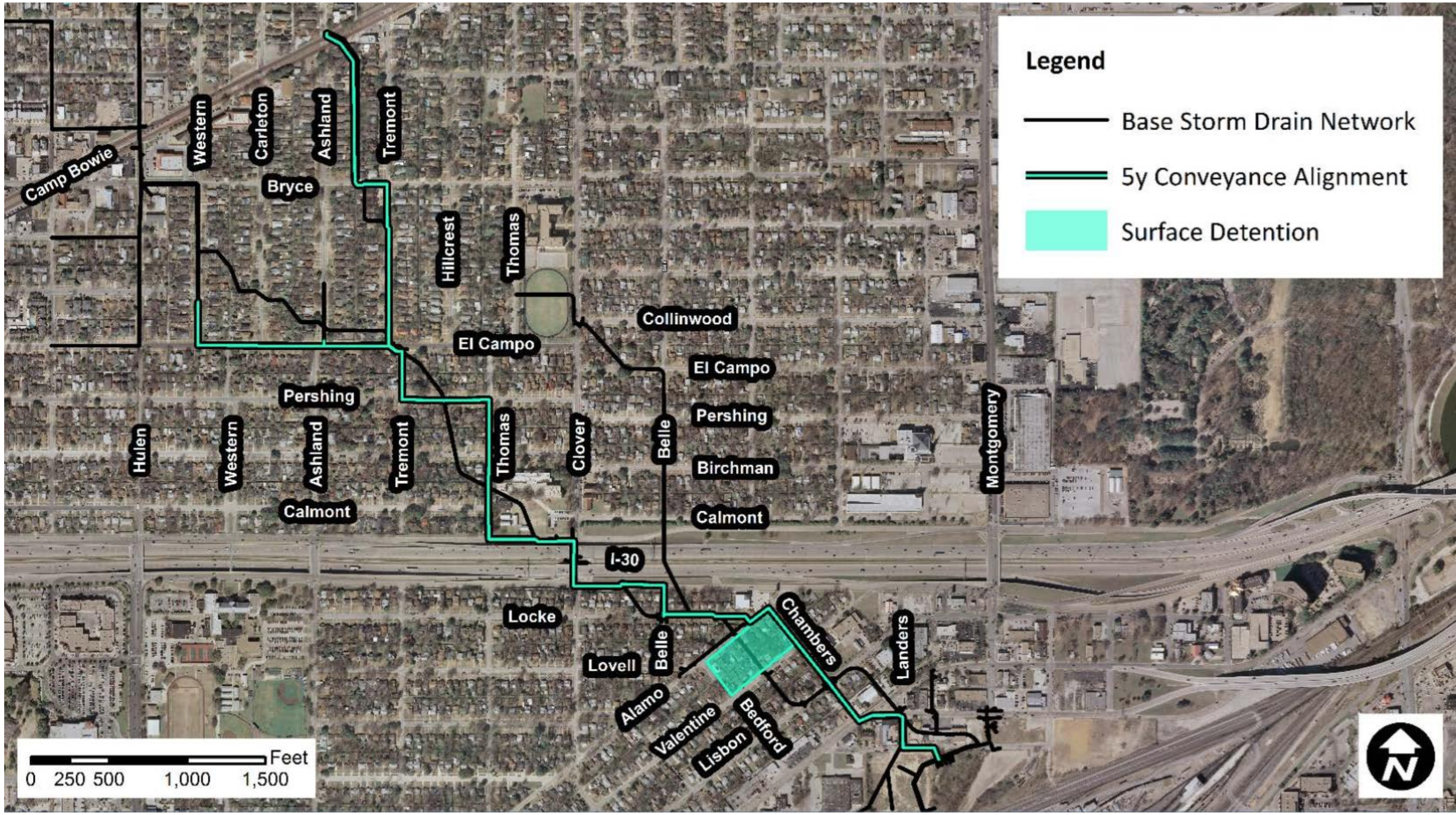
# Collinwood Avenue Greet Street

| | |
|---|---|
| FINANCIAL NPV | $40,031 |
| SUSTAINABLE NPV | $309,337 |
| TOTAL BENEFITS | $673,740 |
| TOTAL COSTS | ($374,083) |
| BENEFIT COST RATIO | 1.8 |
| DISCOUNTED PAYBACK PERIOD | 41 Years |
| REDUCED FLOOD DAMAGES | $0 |
| AIR POLLUTION REDUCTION | $35,980 |
| CARBON EMISSIONS SEQUESTRATION | $60,254 |
| HEAT ISLAND EFFECT MITIGATION | $1,050 |
| RECREATIONAL USE | $9,796 |
| FLOOD RISK MITIGATION | $0* |
| PROPERTY VALUE UPLIFT | PROPERTY TAX REVENUE INCREASE IN REVENUES |
| REPLACEMENT COSTS | ($94,045) |
| OPERATIONS AND MAINTENANCE | ($60,755) |
| REVENUES | $411,886 |

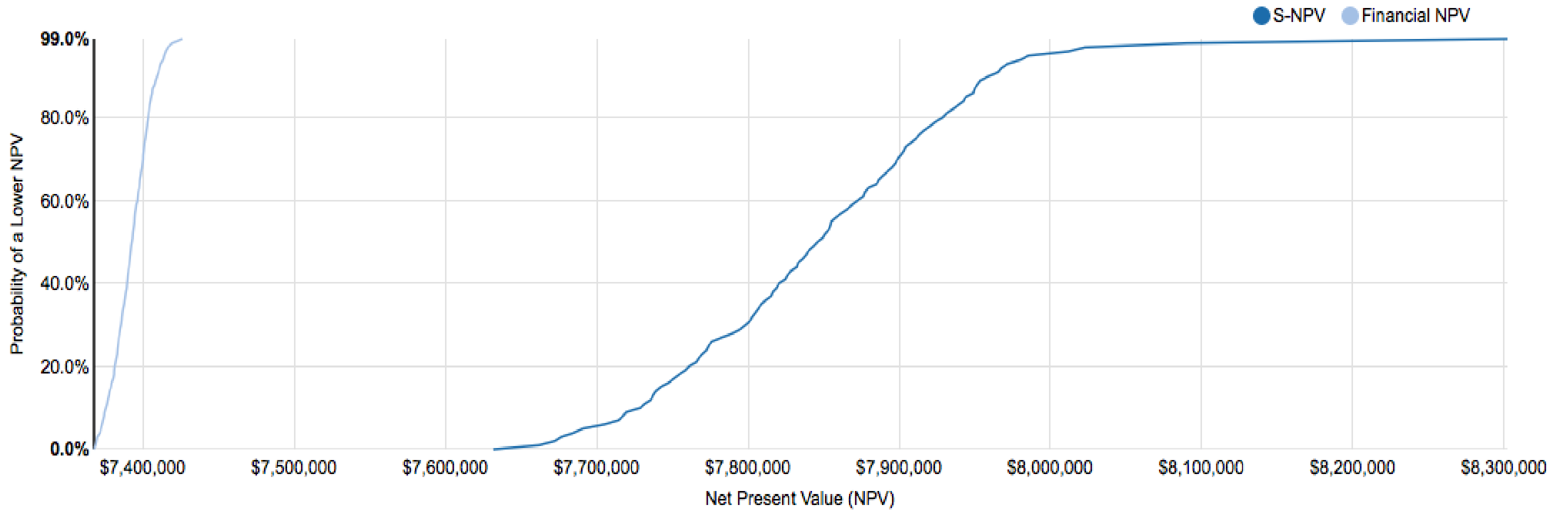


# Central Arlington Heights Neighborhood

## Conveyance and Surface Detention Alternative Evaluation



| | |
|---|---|
| FINANCIAL NPV | $7,392,530 |
| SUSTAINABLE NPV | $7,844,611 |
| TOTAL BENEFITS | $27,738,405 |
| TOTAL COSTS | ($19,908,238) |
| BENEFIT COST RATIO | 1.39 |
| DISCOUNTED PAYBACK PERIOD | 52 Years |
| REDUCED FLOOD DAMAGES | $27,300,000 |
| AIR POLLUTION REDUCTION | $265,796 |
| CARBON EMISSIONS SEQUESTRATION | $5,041 |
| HEAT ISLAND EFFECT MITIGATION | $47,344 |
| RECREATIONAL USE | $55,866 |
| FLOOD RISK MITIGATION | $24,388* |
| PROPERTY VALUE UPLIFT | $12,551 |
| REPLACEMENT COSTS | ($521,382) |
| OPERATIONS AND MAINTENANCE | ($30,345) |
| REVENUES | ($762,820) |




# Conveyance and Surface Detention Alternative Evaluation

# Sustainable Return on Investment (S-ROI) Analysis Application

## Fort Worth, Texas

VERDUNITY
A better future, by design.
www.verdunity.com

**Mikel Wilkens, PE, ENV-SP, Environmental/Sustainability Program Manager VERDUNITY**
mwilkins@verdunity.com @verdunity


# The Value of Green Infrastructure

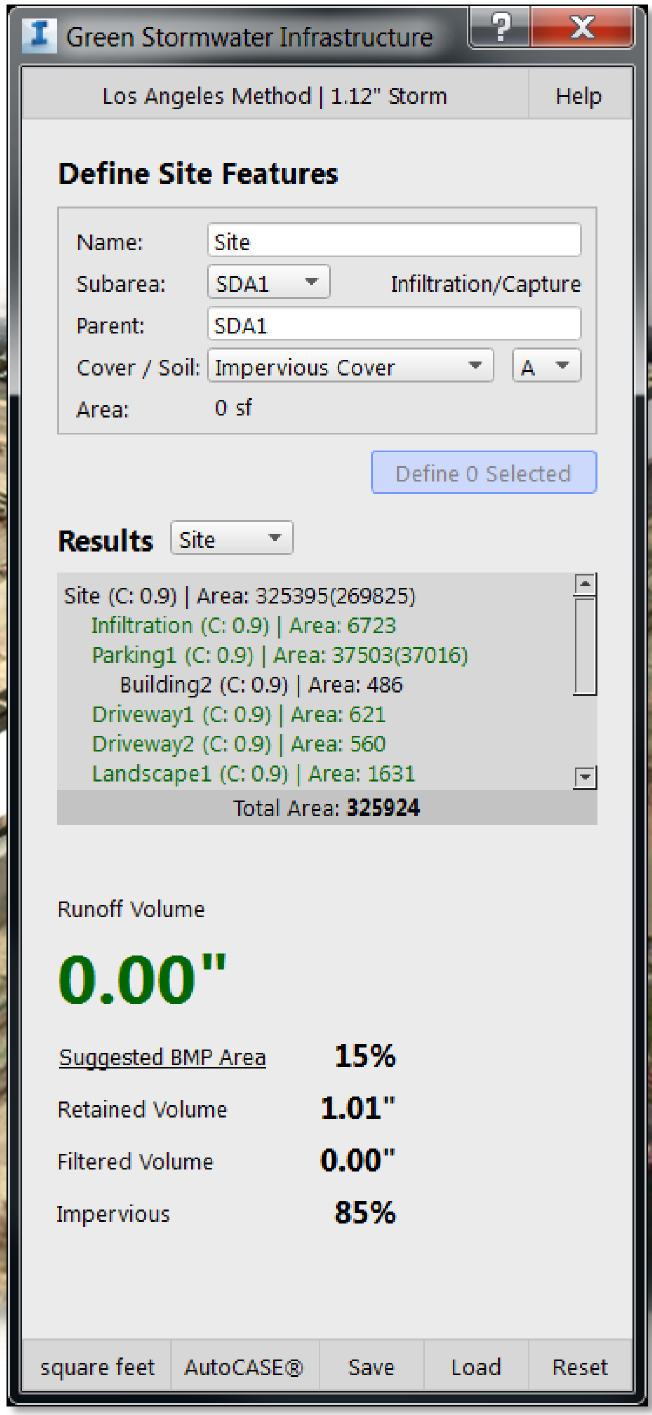
Los Angeles, CA

Impact Infrastructure

# The Study

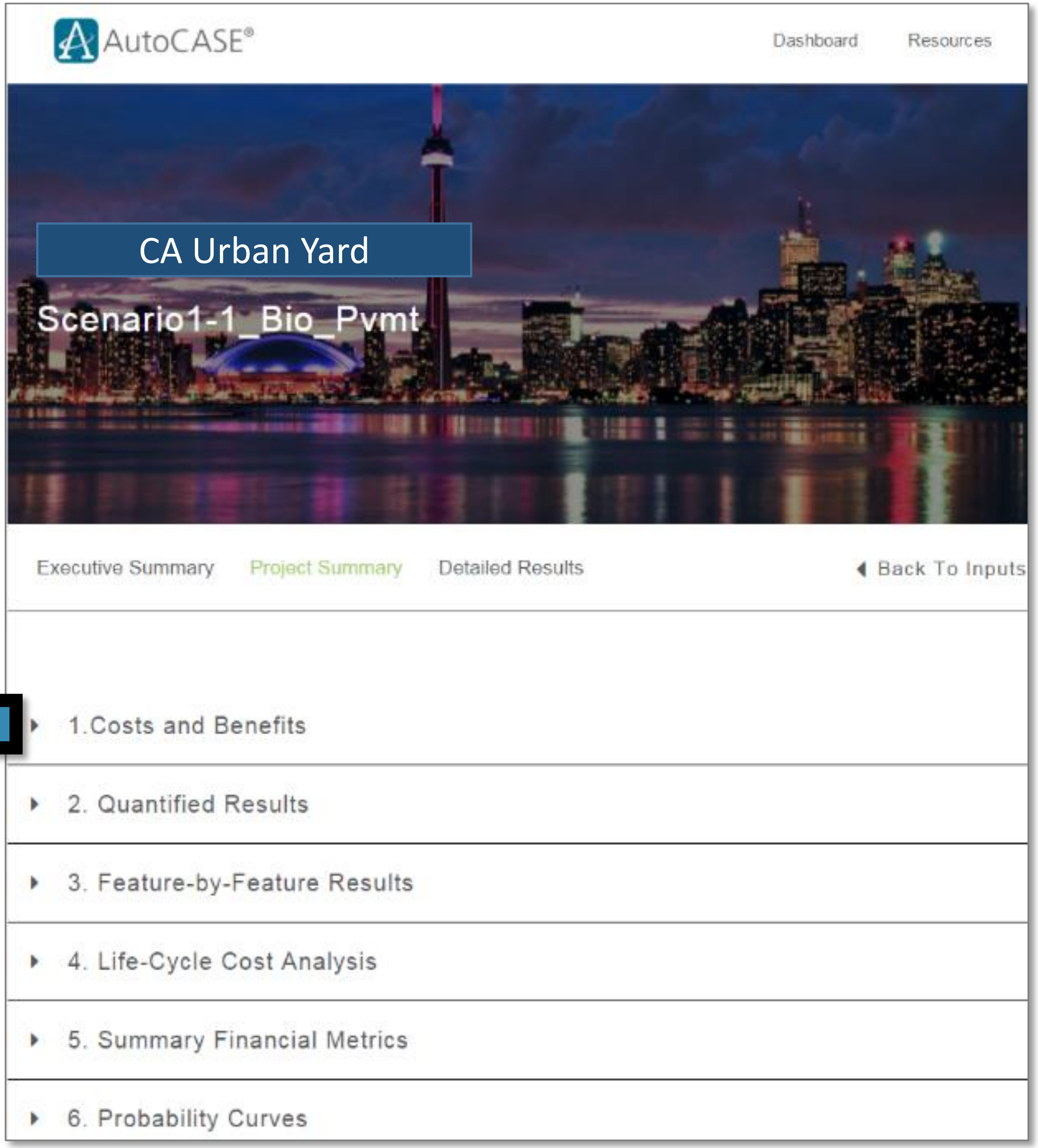
| | |
|---|---|
| **Context** | Multi-agency interest in Green Infrastructure |
| **Question** | How can various agencies plan GI projects strategically? |
| **Hypothesis** | New modeling workflows can provide decision support |
| **This Study** | CH2M piloted workflow on an CA urban works yard site |

# Design with GSI



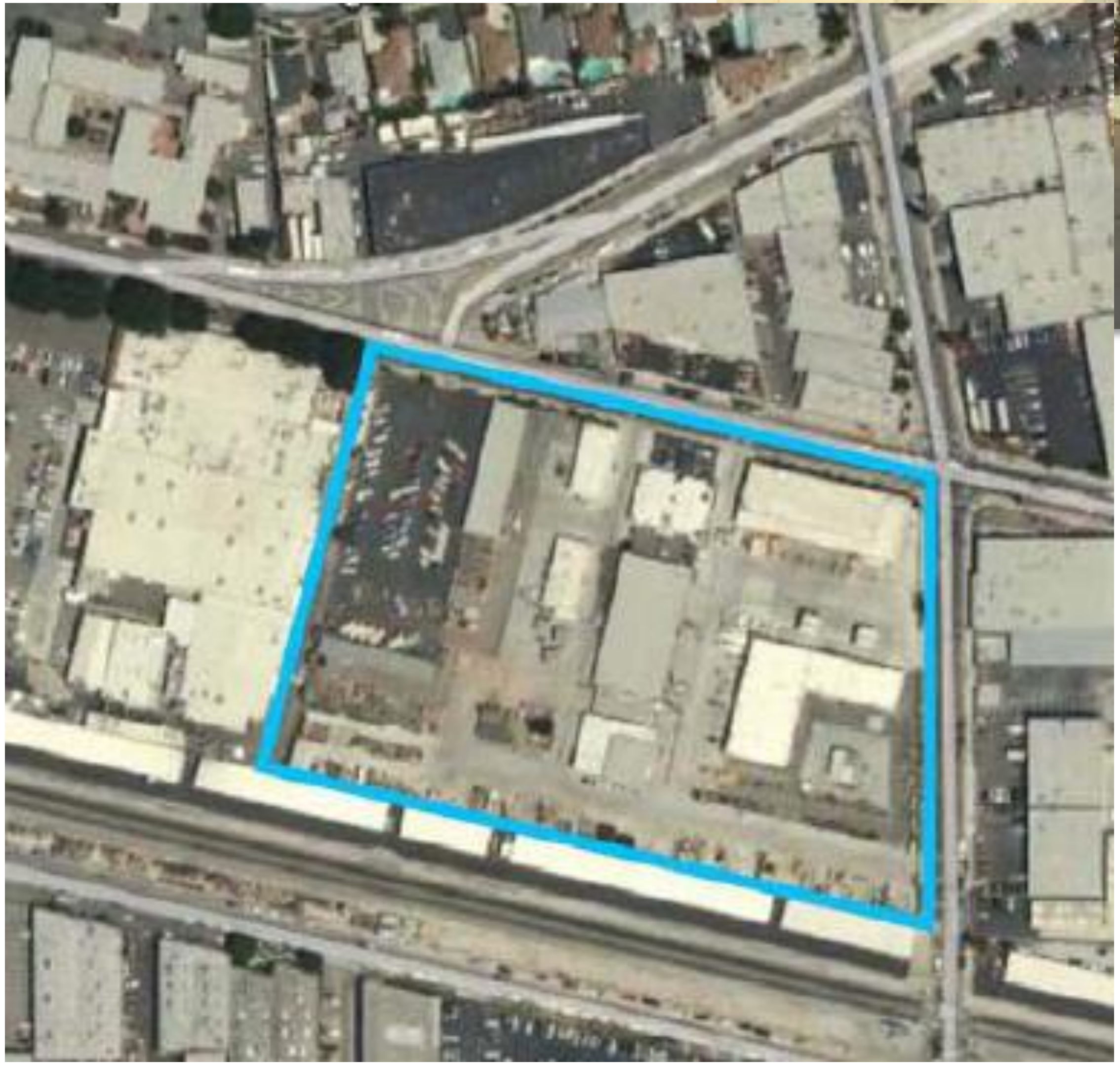
# AutoCASE

| Cost/Benefit | Value | 95% Confidence Interval |
|---|---|---|
| Shadow Wage | $48,845 | $12,625 to $115,278 |
| Property Value | $43,295 | $25,128 to $62,742 |
| Flood Risk | $41,675 | $13,735 to $454,718 |
| Heat Island Effect | $15,534 | $9,233 to $23,719 |
| Air Pollution by Vegetation | $9,384 | $5,846 to $13,824 |

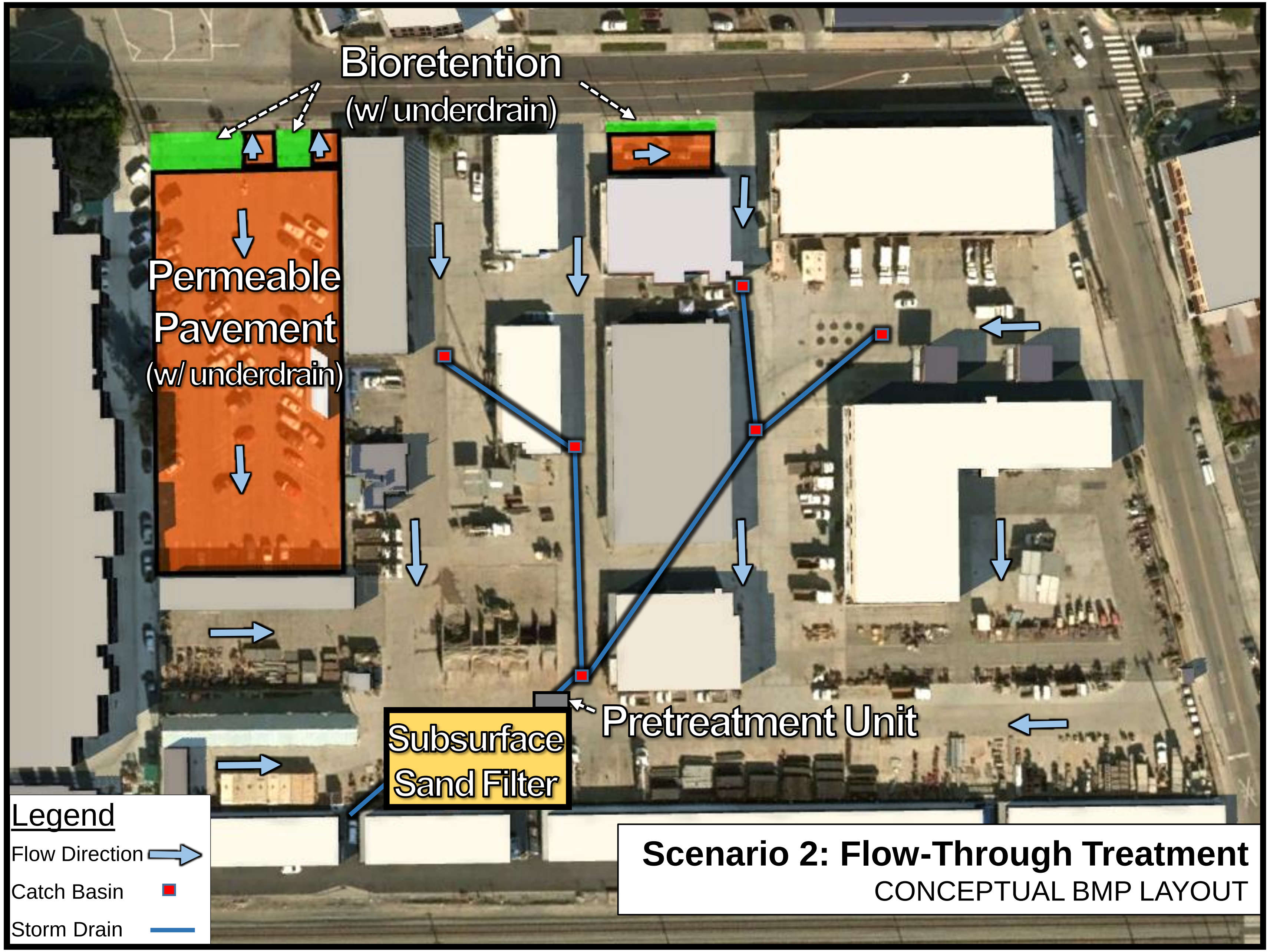


# Existing Site Conditions

- 7.5 Acres
- 98% Impervious
- 1.12" Storm Event



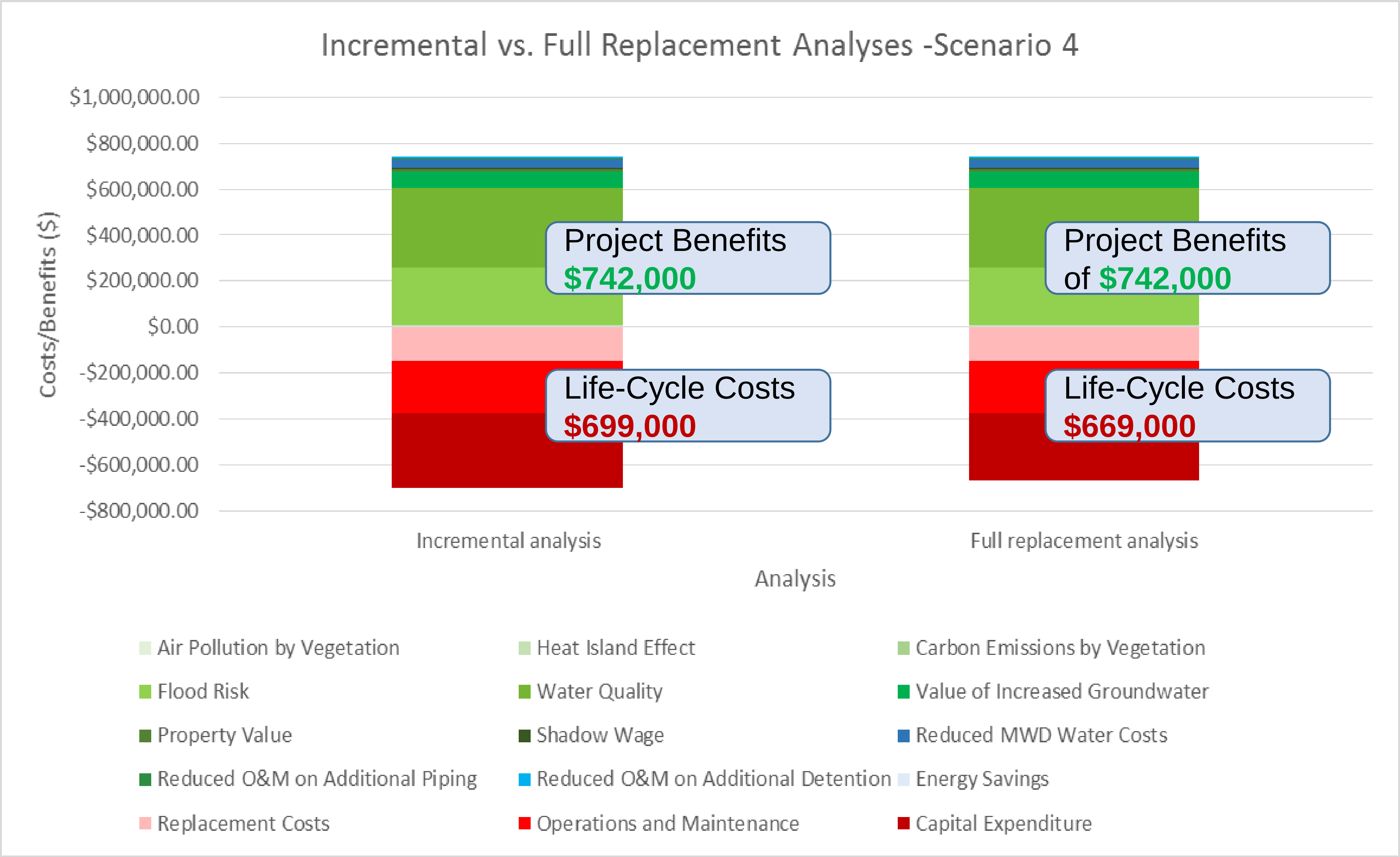

| BMP | Tributary Area (ac) | % of Total Area |
|---|---|---|
| Bioretention | 0.06 | 1% |
| Permeable Pavement | 0.93 | 12% |
| Infiltration | 6.48 | 87% |
| **Total** | **7.47** | |




| BMP | Tributary Area (ac) | % of Total Area |
|---|---|---|
| Bioretention w/ Underdrain | 0.06 | 1% |
| Permeable Pavement w/ Underdrain | 0.93 | 12% |
| Sand Filter | 6.48 | 87% |
| **Total** | **7.47** | |


| BMP | Tributary Area (ac) | % of Total Area |
|---|---|---|
| Bioretention | 1.34 | 18% |
| Permeable Pavement | 0.07 | 1% |
| Infiltration | 6.06 | 81% |
| **Total** | **7.47** | |

# Scenario 4: Hybrid Infiltration




**Positive S-NPV**

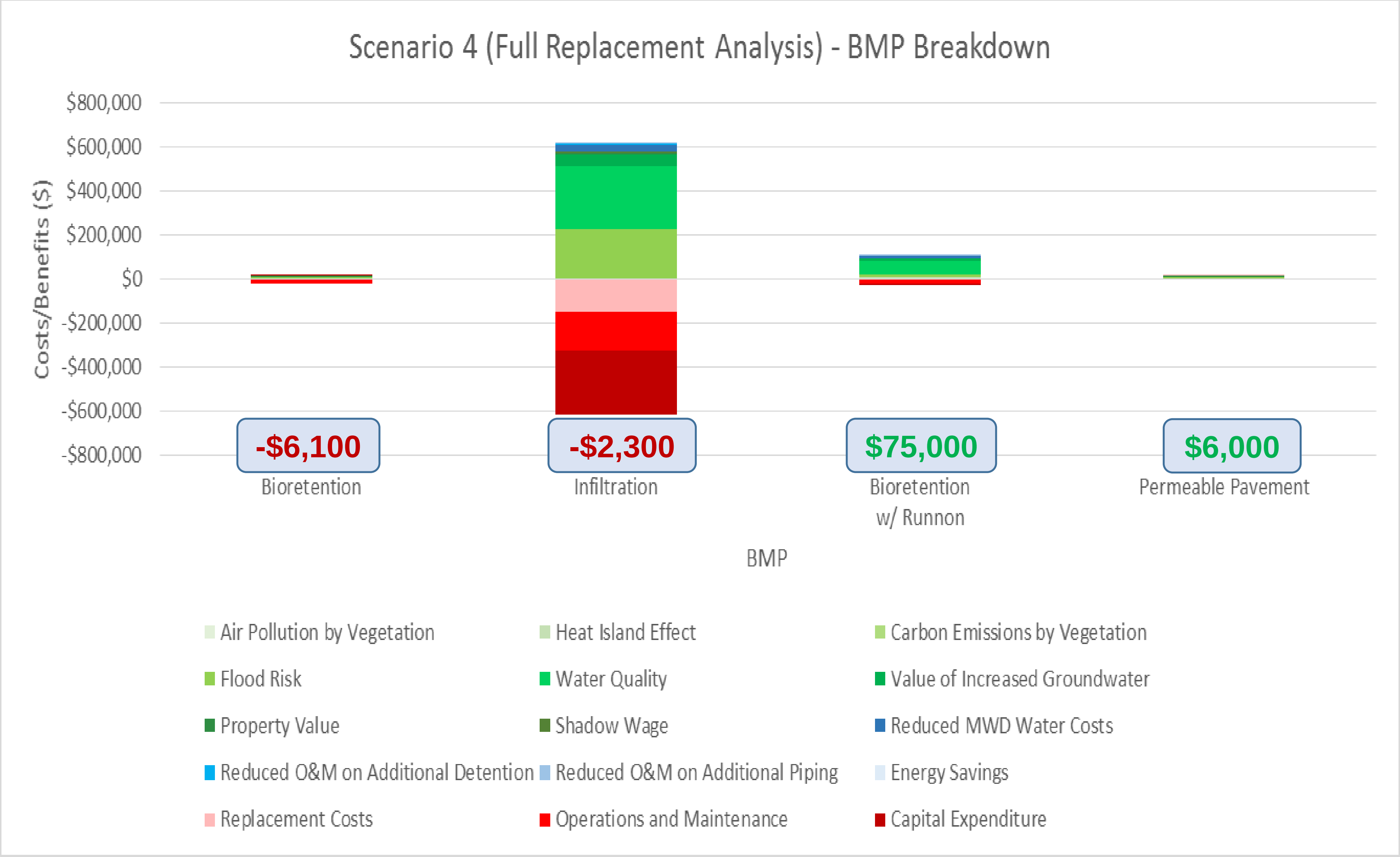
**Top 4 Benefits:**

1. Water Quality
2. Flood Risk
3. Groundwater Value
4. Property Values

**Difference in LCC**

$30,000

# Scenario 4: Hybrid Infiltration




**Positive S-NPV**

Best option overall

**Permeable Pavement**

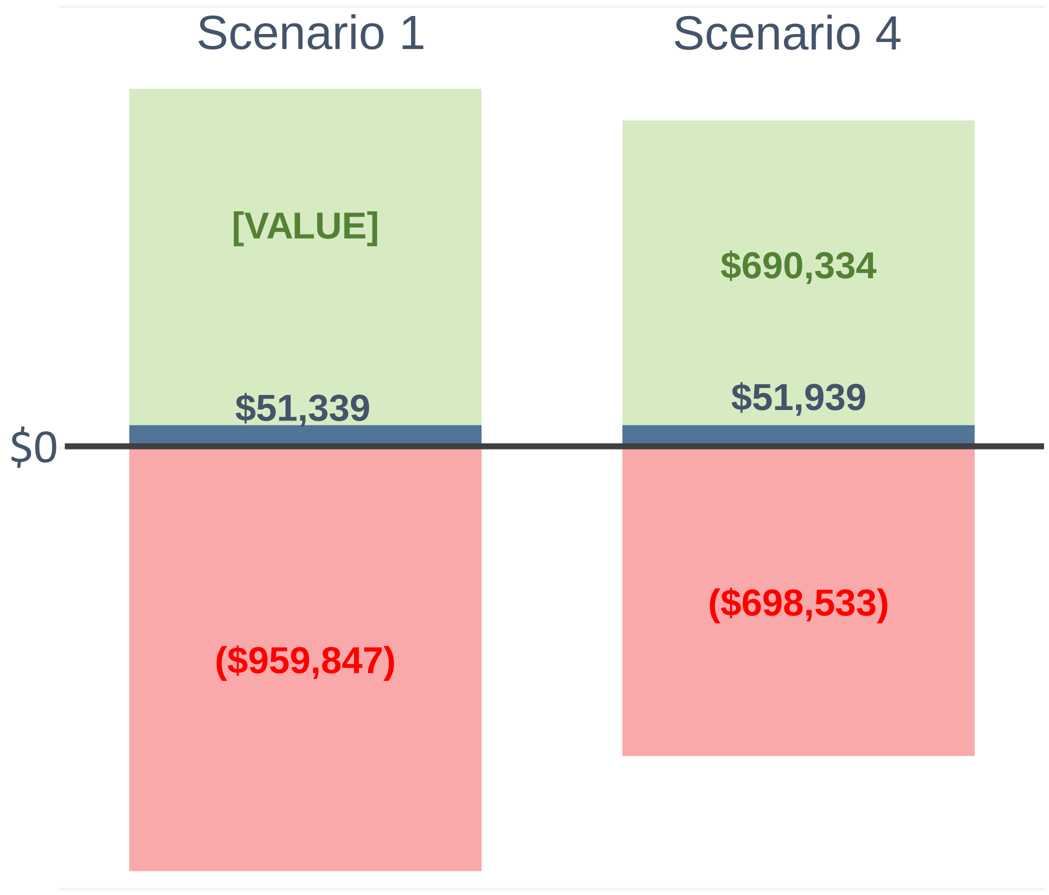
- **Positive S-NPV**

# Incremental Analysis

| Cost/Benefit Category | Scenario 1 | Scenario 4 |
|---|---|---|
| Property Value | $ 46,574 | $ 11,115 |
| Flood Risk | $ 296,159 | $ 248,637 |
| Air Pollution by Vegetation | $ 527 | $ 524 |
| Heat Island Effect | $ 2,357 | $ 9,893 |
| Shadow Wage | $ 5,918 | $ 4,029 |
| Carbon Emissions by Vegetation | $ 32 | $ 32 |
| Water Quality | $ 343,087 | $ 346,521 |
| Value of Increased Groundwater | $ 68,277 | $ 69,583 |
| Reduced MWD Water Costs | $ 41,994 | $ 42,798 |
| Reduced O&M on Additional Detention | $ 3,736 | $ 4,657 |
| Reduced O&M on Additional Piping | $ 5,609 | $ 4,484 |
| Energy Savings | $ - | $ - |
| Replacement Costs | $ (153,829) | $ (148,103) |
| Operations and Maintenance | $ (238,275) | $ (227,013) |
| Capital Expenditure | $ (567,743) | $ (323,417) |
| Life-Cycle Cost Analysis | $ (959,847) | $ (698,533) |
| FROI Net Present Value | $ (908,507) | $ (646,594) |
| SROI Net Present Value | $ (145,577) | **$ 43,740** |

Discounted Costs and Benefits

LCCA FROI SROI




**Scenario 4** has a **positive S-NPV**. Best option for building now.

# Full Replacement Analysis

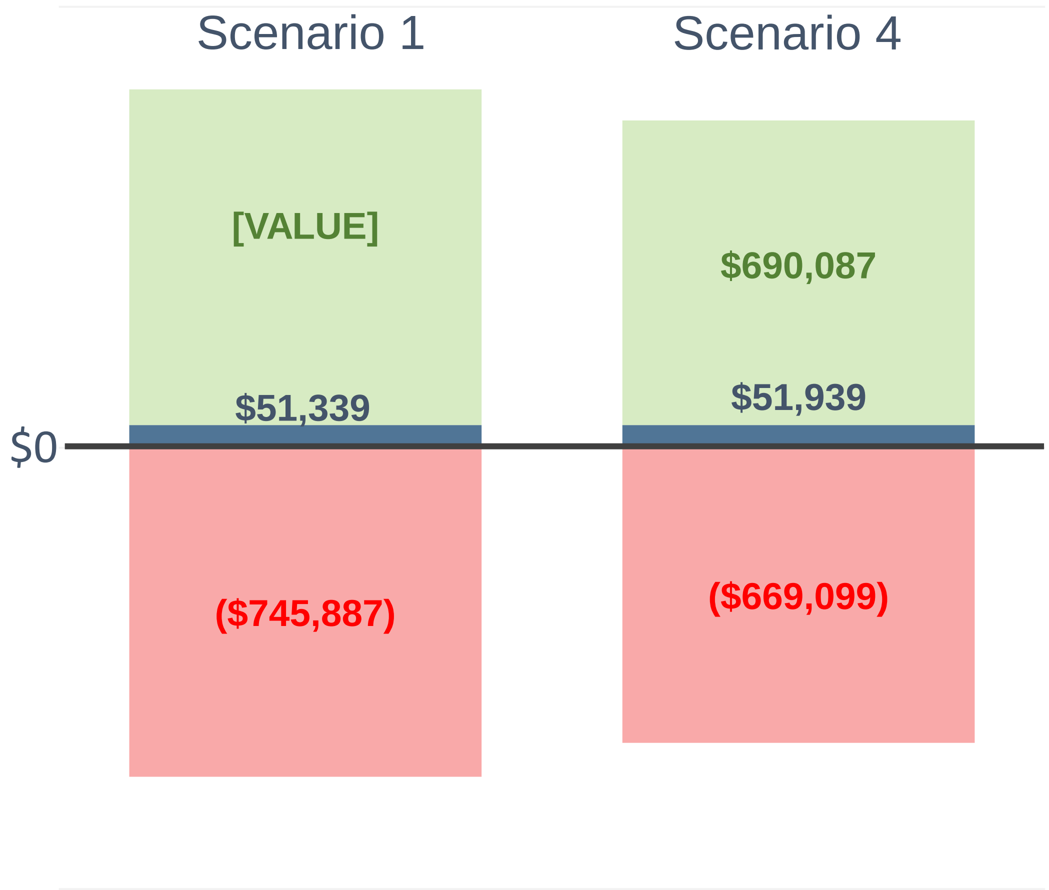
| Cost/Benefit Category | Scenario 1 | | Scenario 4 | |
|---|---|---|---|---|
| Property Value | $ | 46,574 | $ | 11,104 |
| Flood Risk | $ | 296,159 | $ | 248,637 |
| Air Pollution by Vegetation | $ | 527 | $ | 527 |
| Heat Island Effect | $ | 2,357 | $ | 9,898 |
| Shadow Wage | $ | 4,474 | $ | 3,785 |
| Carbon Emissions by Vegetation | $ | 32 | $ | 32 |
| Water Quality | $ | 343,087 | $ | 346,521 |
| Value of Increased Groundwater | $ | 68,277 | $ | 69,583 |
| Reduced MWD Water Costs | $ | 41,994 | $ | 42,798 |
| Reduced O&M on Additional Detention | $ | 3,736 | $ | 4,657 |
| Reduced O&M on Additional Piping | $ | 5,609 | $ | 4,484 |
| Energy Savings | $ | - | $ | - |
| Replacement Costs | $ | (153,829) | $ | (148,103) |
| Operations and Maintenance | $ | (238,275) | $ | (227,017) |
| Capital Expenditure | $ | (353,783) | $ | (293,979) |
| Life-Cycle Cost Analysis | $ | (745,887) | $ | (669,099) |
| FROI Net Present Value | $ | (694,547) | $ | (617,160) |
| **SROI Net Present Value** | **$** | **66,939** | **$** | **72,927** |

Discounted Costs and Benefits

LCCA

FROI

SROI




Both have a **positive S-NPV**.

S-NPV higher if wait until replacement.

# Conclusion

Whether decision is to build now or wait,
**the best option is the hybrid scenario**

| Rank | Scenario | Analysis | SROI | LCC |
|---|---|---|---|---|
| 1 | Hybrid | Full Replacement | $73,000 | -$669,000 |
| 2 | Scenario 1 | Full Replacement | $67,000 | -$746,000 |
| 3 | Hybrid | Incremental | $44,000 | -$699,000 |
| 4 | Scenario 1 | Incremental | -$145,000 | -$960,000 |
| 5 | Scenario 3 | Full Replacement | -$1,979,000 | -$2,688,000 |
| 6 | Scenario 3 | Incremental | -$2,572,000 | -$3,286,000 |
| 7 | Scenario 2 | Full Replacement | -$3,006,000 | -$3,467,000 |
| 8 | Scenario 2 | Incremental | -$3,219,000 | -$3,681,000 |

# Conclusion

Whether decision is to build now or wait,
**the best option is the hybrid scenario**

| Rank | Scenario | Analysis | SROI | LCC |
|---|---|---|---|---|
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| 6 | Scenario 3 | Incremental | -$2,572,000 | -$3,286,000 |
| 8 | Scenario 2 | Incremental | -$3,219,000 | -$3,681,000 |

# Q&A

John Parker, Impact Infrastructure

Mikel Wilkens, VERDUNITY

John Wise, Stantec

# Engineering Optimal Financial, Social, And Environmental Returns


Impact Infrastructure

Stantec

VERDUNITY

A better future, by design.