GSI Impact Calculator: User Guide

The GSI Impact Calculator was developed to address the growing need for credible information and methods for quantifying the co-benefits of green stormwater infrastructure (GSI) projects in urban and suburban areas.

The GSI Impact Calculator quantifies and monetizes the co-benefits of GSI projects implemented at the block-level scale. It is intended to inform GSI implementation early in the project planning phase with minimal user inputs. The Calculator provides high-level estimates of the benefits and costs of GSI, allowing users to input specific data and customize scenarios to reflect local conditions. By highlighting the multifaceted advantages of GSI, the Calculator empowers stakeholders to make informed, strategic decisions regarding the integration of GSI into stormwater management projects.

Important things to know when using the Calculator:

- Inputs shown in gray text represent calculations based on other user-specific inputs; they cannot be changed. For more information on how these are calculated, refer to the accompanying document titled *GSI Impact Calculator: Methods and Data Sources*.
- The Calculator is designed to evaluate block-level GSI projects. It can be applied across multiple blocks. For projects implemented across an area of greater than 4 to 5 blocks (20 to 25 acres), we recommend switching to the WRF TBL GSI Tool.
- The Calculator is designed to have minimal inputs, it therefore applies built-in assumptions and default values based on the user's location.
- All dollar values are in 2023-dollar years.
- The following sections walk through each step in the Calculator (see Figure 1), providing guidance related to the required inputs and data, as well as how to interpret results.

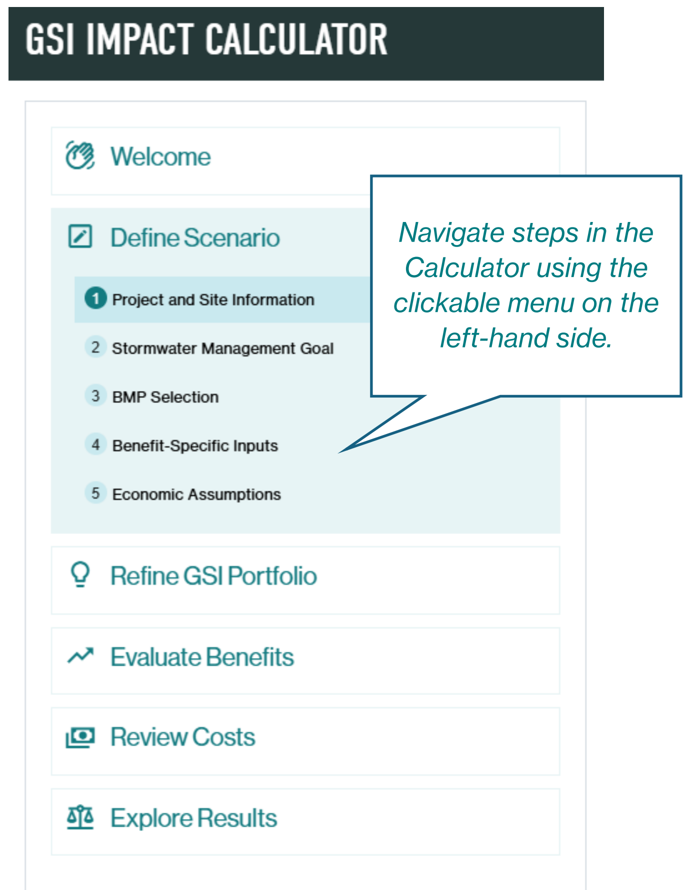


Figure 1. GSI Impact Calculator – Navigable steps

Step 1. Define Scenario

In this section, define the scenario you would like to evaluate. Across several tabs, you will input information on the location of the project, the volume of stormwater you want to manage, and the types of practices you are interested in evaluating. The inputs in this section will also help define assumptions and parameters needed to fully evaluate benefits and costs of a given scenario.

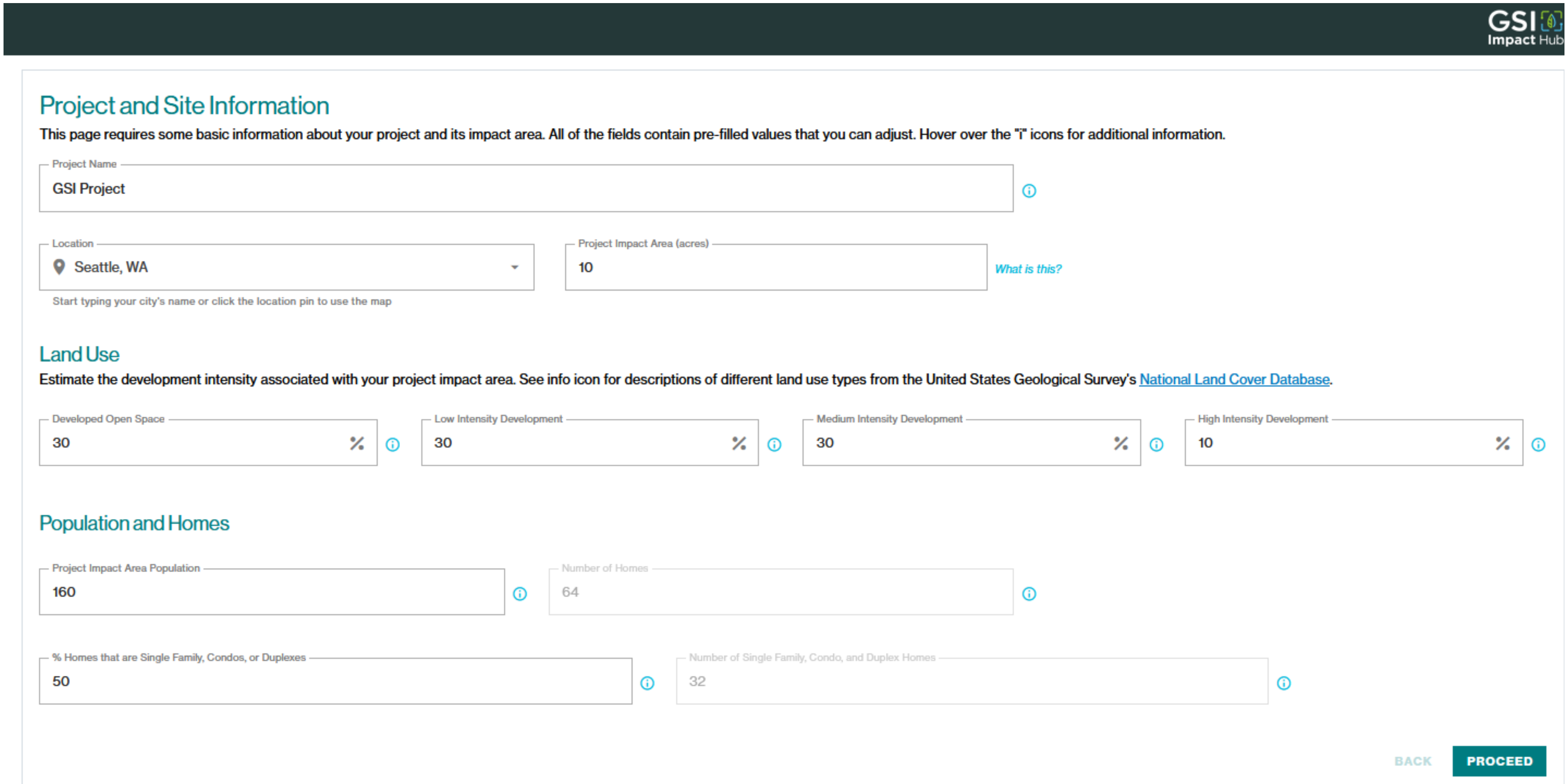
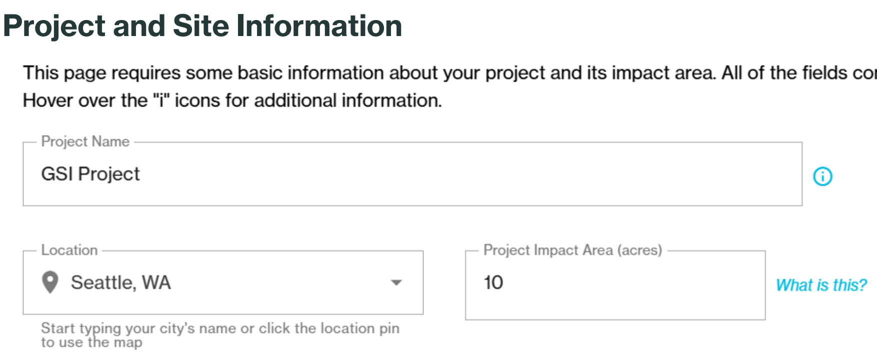


Figure 2. Define Scenario: Project and Site Information

1.1 Project and Site Information

In this section, select the location of your project and characterize the area where GSI practices will be installed (Figure 2).



- Choose a **Project Name**.
- Enter a **Location** by searching for your city in the drop-down menu or by clicking on the left-hand side of the Location box to select your city from a map. If your city is not listed/shown on the map, pick the closest and most representative major city. Select a city that is similar in climate and rainfall.
- The Calculator currently does not include Canadian cities. However, Canadian users can select cities close to them, both in geographic proximity and climate. The Calculator will apply default inputs from these cities to provide reasonable co-benefit estimates.
- Enter size of the **Project Impact Area** in acres (Figure 3). This is the broader area over which GSI will be implemented and where benefits will directly accrue. It is different from the GSI drainage area or GSI BMP footprint (see figure above). Note this calculator was designed for block-level analyses; a typical city block is 2 to 5 acres. For projects greater than 20 to 25 acres (or 5 to 6 blocks), we recommend switching to the WRF TBL GSI Tool.

Figure 3. Depiction of Project Impact Area

Land Use

Estimate the development intensity associated with your project impact area. See info icon for descriptions of different land use types from the United States Geological Survey's National Land Cover Database.

Developed Open Space	Low Intensity Development	Medium Intensity Development	High Intensity Development
30 %	30 %	30 %	10 %

In this step, estimate the development intensity within the Project Impact Area. This involves entering the approximate percentage makeup of your Impact Area by land cover type (as shown above). The Calculator corresponds with land cover categories defined by the U.S. Geological Survey National Land Cover Database (NLCD). You can either estimate based on your understanding of the area where a project will be implemented or download the GIS layers from the NLCD link and use a geospatial software to calculate the areas by level of development. The categories include:

- **Open Space**: These areas can be parks, golf courses, and large single-family home lots, as well as natural forests, wetlands, shrublands, and cultivated agricultural areas. Impervious surfaces make up less than 20% of total land cover. Corresponds with NLCD codes 21 and 31– 95.
- **Low Intensity Development**: These areas most commonly represent average lot sized single-family homes. Impervious surfaces make up 20% - 49% of total land cover. Corresponds with NLCD code 22.
- **Medium Intensity Development**: These areas most commonly represent average lot sized single-family homes. Impervious surfaces make up 50% - 79% of total land cover. Corresponds with NLCD code 23.
- **High Intensity Development**: This category represents highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial areas. Impervious surfaces make up 80% or greater of total land cover. Corresponds with NLCD code 24.

Population and Homes

Project Impact Area Population	Population Density (people/acre)	Number of Homes
160	16.0	64

% Homes that are Single Family, Condos, or Duplexes	Number of Single Family, Condo, and Duplex Homes
50	32

Enter the population of the Impact Area and the % of households that are single family, condos, or duplexes. Knowing the population within the Project Impact Area allows the Calculator to aggregate benefits across all those affected by GSI projects.

- **Impact Area Population** refers to the number of people that live within the Impact Area. If you do not know (or cannot easily estimate) the population, you can:

- Use Census Data Quick Facts for the city where your project will be located. If you know the total number of households within the Impact Area, you can multiply the "Persons per household" line from the Census table by the number of households to estimate the total population.
- Convert the "Population per square mile" line from the Census Data Quick Facts table to acres (1 square miles = 640 acres) and multiply by the size (acres) of the Impact Area.
- Look up the Census tract or Census block in which your project falls using Census Geocoder. This site requires you to enter an address that falls within the project Impact Area. Census Geocoder will identify the Census tract or block and report the area (in square meters, the AREALAND variable). You can then use ACS data to look up the population for that tract/block (ACS Table B01003). This will allow you to calculate population density and estimate the total population for your Impact Area.

Note that the population must reflect the size of the Impact Area. If, for example, the management area is 2 acres, the population cannot be 5,000. For some context, New York City has a population density of 45.8 persons per acre (across all boroughs), while Philadelphia has a population of 18.7 per acre. In Philadelphia, population density is as high as 41 persons per acre in the city center. In most U.S. suburbs, population density ranges from 2 to 5 persons per acre, on average.

- **% Homes that are Single Family and/or Duplexes:** This can be estimated if the area is well known to planners. If the housing make up is not well known, you can visit the ACS data site (advanced search) and search for *Table B25024: Units in Structure*. Select your desired geography using the "Geographies" menu in the upper lefthand selection bar. Note that you can narrow geography down to Census Tract for more accurate results (see above discussion on Census Geocoder). Add the number of single-family homes (attached and detached) and 2-unit structure homes and divide by the total number of structures reported.
- **AUTOCALCULATED VARIABLES: Population Density, Number of Homes and Number of Single-Family Homes** will be calculated based on previous inputs.

Hit "Proceed" button on the bottom right to move to the next step.

1.2 Stormwater Management Goal

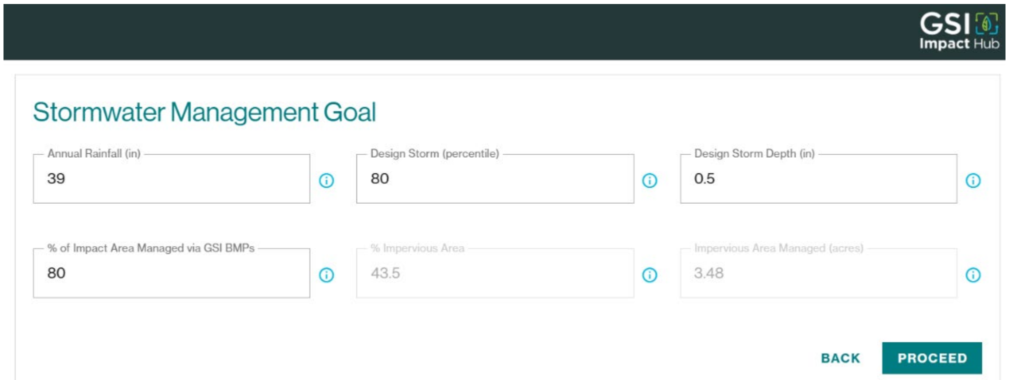


Figure 4. Define Scenario: Stormwater Management Goal

On this page, enter information about your local climate and goals for stormwater capture (Figure 4).

It requires four user inputs:

- **Annual Rainfall (in)** is where you will enter the annual rainfall that results in stormwater runoff for your project's location (in inches). The Calculator will auto populate an estimate based on your selected city.
- **Design Storm (percentile)** tells the Calculator what size storm event you intend to manage with the proposed GSI. A storm percentile indicates how frequently a particular storm intensity occurs within a historical dataset. An 80th percentile storm means that 80% of all recorded storms are smaller or equal in intensity and rainfall volume to that storm. Most GSI BMPs are designed to manage the 85th to 90th percentile storm event. NOAA's Atlas 14 contains precipitation data searchable by location.
- **Design Storm Depth (in)** indicates the depth of rainfall for your selected percentile storm event, as measured in inches.
- **% of Impact Area Managed via BMPs** is the percentage of the Project Impact Area over which stormwater runoff will be managed by the planned GSI project. This is the management area (see Figure 1) or drainage area of the GSI projects divided by the total Project Impact Area.
- **AUTOCALCULATED VARIABLES: % Effective Impervious Area** is calculated based on runoff coefficients for the different land use types entered on the previous tab. It represents the percentage of the Impact Area (in impervious area units) that generates stormwater runoff (i.e., rain does not soak into the ground). **Acres of Effective Impervious Area Managed** is the equivalent impervious area over which stormwater runoff will be managed through GSI. It is calculated by multiplying the **% Effective Impervious Area** by the % Impact Area Managed by BMPs by the total Impact Area (acres).

Hit "Proceed" button on the bottom right to move to the next step.

1.3 BMP Selection

Select the GSI BMPs you plan to include in your project (Figure 5). The Calculator will automatically determine BMP capacity and size information for selected BMPs based on previous inputs. You can customize this information in the "Refine GSI Portfolio" step.

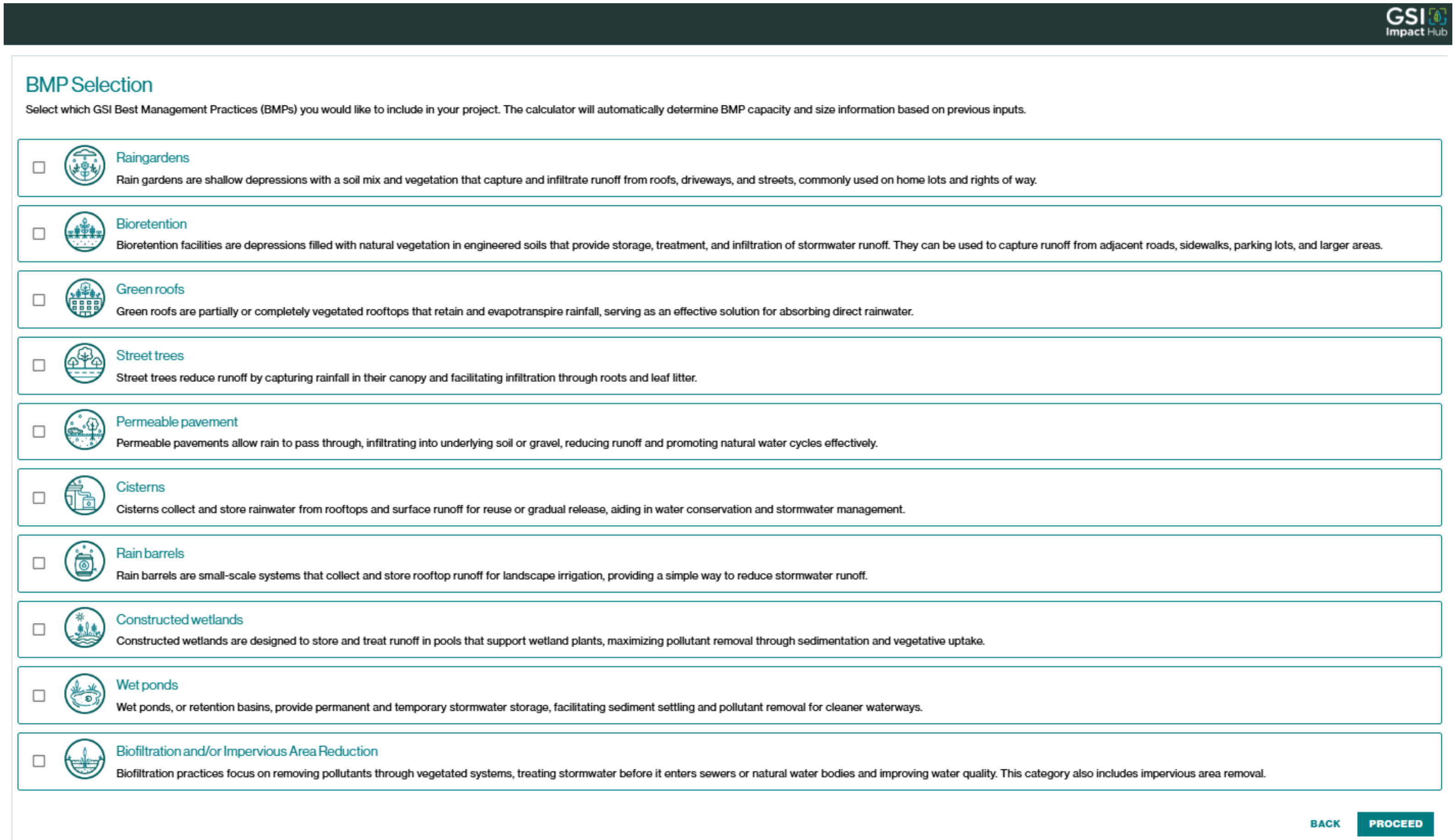
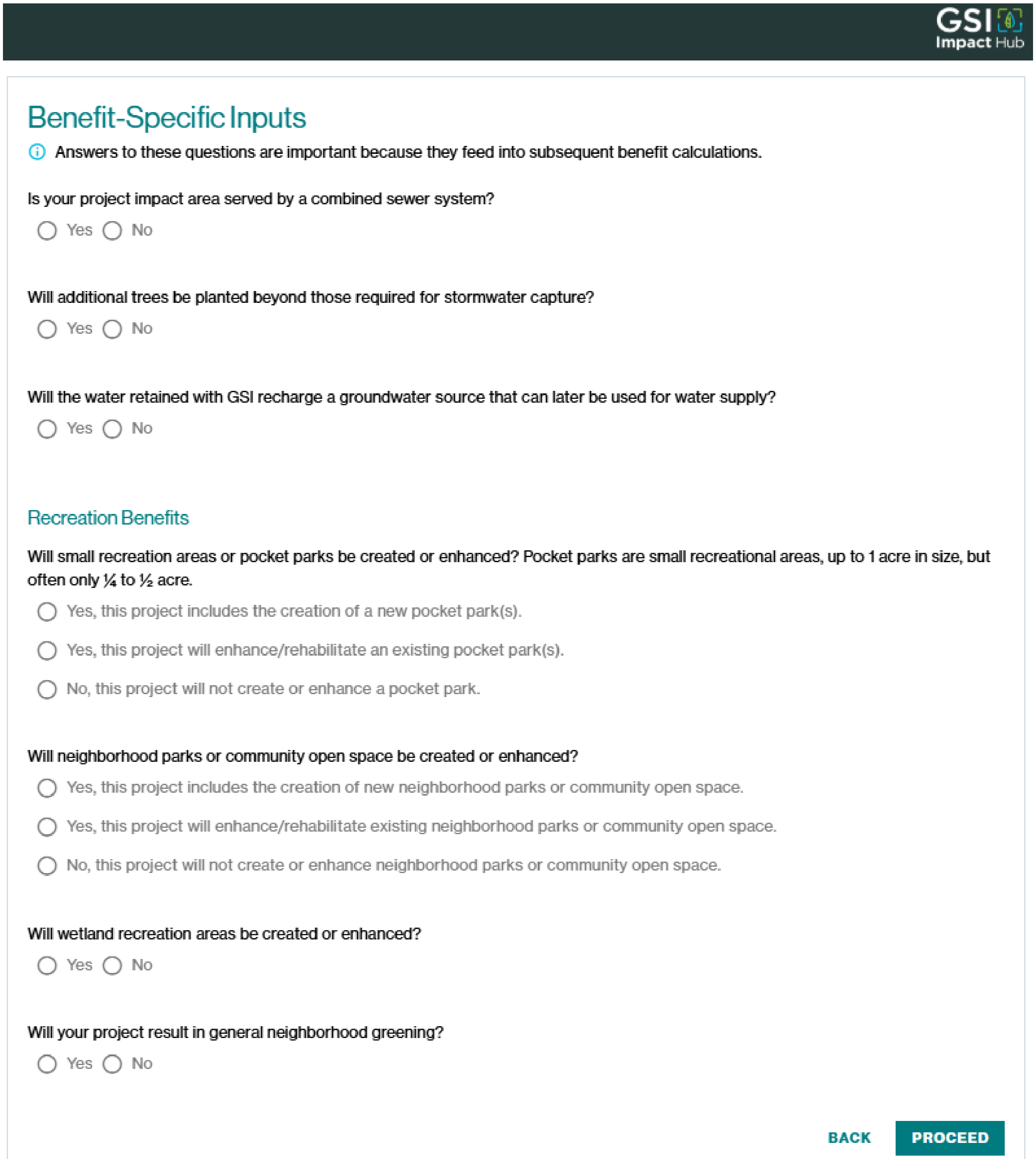


Figure 5. Define Scenario: BMP Selection

Hit "Proceed" button on the bottom right to move to the next step.

1.4 Benefit-Specific Inputs

Enter information necessary for calculating the value of several GSI co-benefits (Figure 6). Answers to these questions are important for accurately capturing benefits.



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Benefit-Specific Inputs

ⓘ Answers to these questions are important because they feed into subsequent benefit calculations.

Is your project impact area served by a combined sewer system?

○ Yes ○ No

Will additional trees be planted beyond those required for stormwater capture?

○ Yes ○ No

Will the water retained with GSI recharge a groundwater source that can later be used for water supply?

○ Yes ○ No

Recreation Benefits

Will small recreation areas or pocket parks be created or enhanced? Pocket parks are small recreational areas, up to 1 acre in size, but often only ¼ to ½ acre.

○ Yes, this project includes the creation of a new pocket park(s).

○ Yes, this project will enhance/rehabilitate an existing pocket park(s).

○ No, this project will not create or enhance a pocket park.

Will neighborhood parks or community open space be created or enhanced?

○ Yes, this project includes the creation of new neighborhood parks or community open space.

○ Yes, this project will enhance/rehabilitate existing neighborhood parks or community open space.

○ No, this project will not create or enhance neighborhood parks or community open space.

Will wetland recreation areas be created or enhanced?

○ Yes ○ No

Will your project result in general neighborhood greening?

○ Yes ○ No

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Figure 6. Define Scenario: Benefit-Specific Inputs

- **Is your project served by a combined sewer system?** Select Yes or No. If you select "Yes" the Calculator will ask you to indicate whether and how traditional stormwater management actions would be used to manage runoff in the absence of a GSI project. Options include:
    - Deep tunnels or underground storage
    - Sewer separation
    - Other gray infrastructure (selected by default)
    - None of the above – selecting this option will indicate that your project does not offset or reduce any traditional stormwater management activity.

  Select "No" if your project falls within a municipal separate storm sewer system (MS4). The Calculator will automatically assume that this project offsets or reduces the need for "other gray infrastructure."

- **Will additional trees be planted beyond those required for stormwater capture?** Select Yes or No. If you select "Yes" the Calculator will prompt you to enter the number of additional trees that will be incorporated into your GSI project.

  Trees can manage large amounts of stormwater through uptake in their root systems. They also intercept and uptake air pollutants, provide shade to reduce the urban heat island effect and cooling needs for buildings, enhance urban wildlife habitat, and beautify neighborhoods. In many cases, designers incorporate trees that do not necessarily provide additional stormwater management capacity into GSI projects to amplify these benefits.

- **Will the water-retained with GSI recharge a groundwater source that can later be used for water supply?** Select Yes or No.

  When stormwater runs off impervious surfaces in urban environments, it often flows directly into water bodies and may be swept downstream for other uses. GSI practices allow water to soak back into the ground, mimicking pre-development conditions. When conditions are right, and/or projects are intentionally designed to do so, stormwater runoff infiltrated into the ground can increase groundwater storage in aquifers that provide local water supply.

Recreation Benefits

- **Will small recreation areas or 'pocket parks' be created or enhanced?** Select the appropriate option.

  Pocket parks are usually no more than one acre in size (and are typically closer to 1/4 or 1/2 acre) in size, often located in urban neighborhoods and surrounded by houses or commercial buildings. They can include some recreational amenities such as pavilions, playgrounds, or picnic benches.

  If you select "Yes, this project includes the creation of new pocket parks," or "Yes, this project will enhance/rehabilitate an existing pocket park," the Calculator will prompt you to enter the number of pocket parks created or enhanced.

  If you select "Yes, this project will enhance/rehabilitate an existing pocket park," the Calculator will ask you to estimate the percent improvement in recreational/amenity value that the enhanced park will provide compared to existing conditions (0 – 100%). This input is key to calculating the change in net benefits associated with improving existing parks. We are looking for an approximate estimate.

- **Will neighborhood or community parks be created or enhanced?** Select the appropriate option.

  Neighborhood/community parks or public open space are generally 1 to 10 acres in size. In this context, they would be parks that would be created or greatly enhanced as part of an overall stormwater management project that incorporates GSI. These parks include public access amenities and recreational design elements such as shelters, trails, picnic areas, or wildlife viewing areas. They can also include opportunities for more active recreation, such as playgrounds, and/or basketball courts.

  If you select "Yes, this project includes the creation of new neighborhood or community park(s)," or "Yes, this project will enhance/rehabilitate an existing neighborhood or community park(s)," the Calculator will prompt you to enter the total size of the parks created or enhanced.

  If you select "Yes, this project will enhance/rehabilitate an existing neighborhood or community park," the Calculator will ask you to estimate the percent improvement in recreational/amenity value that the enhanced park will provide compared to existing conditions (0 – 100%). This input is key to calculating the change in net benefits associated with improving existing parks. We are looking for an approximate estimate. If the project enhances a portion of a larger park, take this into account in your estimate.

- **Will wetland recreation areas be created or enhanced?** Select the appropriate option. Wetland recreation areas are public spaces that include constructed wetlands and/or wet ponds. For this benefit to be applicable, there must be some recreational component to the BMP design such as picnic benches, trails, or wildlife viewing areas.

  Do not check Yes if you have already accounted for the wetland recreation area as part of your response to neighborhood or community park recreation question above.

  Select "Yes, this project will enhance/rehabilitate an existing wetland recreation area," only if the existing wetland area currently allows for recreation. Otherwise select "Yes, this project will create a wetland recreation area."

  If you select "Yes, this project will enhance/rehabilitate an existing wetland recreation area," the Calculator will ask you to estimate the percent improvement in recreational/amenity value that the enhanced park will provide compared to existing conditions (0 – 100%). This input is key to calculating the change in net benefits associated with improving existing parks. We are looking for an approximate estimate. If the project enhances a portion of a larger park, take this into account in your estimate.

- **Will your project result in general neighborhood greening?** Select Yes or No. Adding vegetation and green space in the public right-of-way can beautify neighborhoods, increase pedestrian and cyclist safety, and encourage people to spend more time outside.

1.5 Economic Assumptions

This page asks for some basic inputs about the parameters of the analysis to appropriately calibrate benefits and costs over time (Figure 7).

Figure 7. Define Scenario: Economic Assumptions

- **Analysis Period** reflects the number of years over which you want to analyze the benefits and costs of your GSI project. A 30- to 50-year analysis period is typical for stormwater management projects. Some may wish to input a 50-year analysis period to reflect and directly compare with the planning horizon for the useful life of gray infrastructure projects. When this is the case, annual GSI maintenance costs should reflect necessary rehabilitation that will occur in that timeframe.
- **Discount Rate** adjusts the estimated benefits and costs of an infrastructure project for differences in timing of when benefits and costs accrue. Most people prefer a dollar today more than an inflation-adjusted dollar available in the future. The discount rate reflects the annual rate at which current values are preferred to future values. A higher discount rate indicates a greater preference for immediate benefits, and a lower preference for benefits that occur in the future. When benefits and costs are adjusted with discount rates, they are referred to as "present values." Present values allow for costs and benefits occurring across different time periods to be added together to determine an overall net effect. In 2024, the Biden administration recommended lowering the discount rate used in federal cost-benefit analysis to 2% for projects that don't increase risk. FEMA applies a 3.1% discount rate which includes a risk premium. The default in the tool is 2% but can be changed by the user. See Calculator Methodology document for additional guidance on selecting a discount rate.
- **AUTOCALCULATED VARIABLE: Construction Period** is set to one year in the Calculator. This means that the economic analysis assumes that the project is paid for in Year 1.

Hit "Proceed" button on the bottom right to move to the next step.

Step 2. Refine GSI Portfolio

This page summarizes the GSI practices that you selected on the "BMP Selection" tab (Figure 8). For each selected BMP, the Calculator estimates:

- Percentage of stormwater runoff the practice type captures during the design storm event (e.g., if only one practice type is selected it would capture 100% of the stormwater managed)
- Total volume capacity (cubic feet) of each practice type
- Practice area footprint or number of BMPs
- Average annual stormwater runoff volume managed by the BMPs.

These estimates are largely based on assumptions related to GSI performance and design, as developed for the Water Research Foundation's (WRF) Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC) tool.

Users can adjust the percentage of stormwater runoff managed by each BMP type by clicking the "Edit" button in the top left corner of the table and then hitting. Percentages must sum to 100%. Click "Save" when you are finished editing and before clicking "Proceed."

Refine GSI Portfolio

The table below shows a recommended level of implementation by GSI BMP type based on your previous inputs. To edit the percentage of stormwater runoff managed by different BMP types click the "Edit" button. This will result in changes to the area and/or number of different BMPs.

EDIT

Active	BMP	Volume Captured by BMP (%)	Volume Managed per Event (cu ft)	BMP Area (sq ft)	BMP Number (#)	Volume Managed per Year (cu ft)
Off	Raingardens	0%	0	0		0
On	Bioretention	55%	5,524	4,021		203,291
Off	Green roofs	0%	0	0		0
On	Street trees	21%	2,065		19	75,987
On	Permeable pavement	24%	2,372	29,029		87,277
Off	Cisterns	0%	0		0	0
Off	Rain barrels	0%	0		0	0
Off	Constructed wetlands	0%	0	0		0
Off	Wet ponds	0%	0	0		0
Off	Biofiltration	0%	0	0		0
	TOTAL	**100%**	**9,961**			**366,554**

PROCEED

Figure 8. Refine GSI Portfolio

Step 3. Evaluate Benefits

This page allows you to review and access information about the project's co-benefits and to choose those that are most important or salient to decision makers and project partners. Total monetized benefits are shown in present value (PV) terms over the specified analysis period using the identified discount rate. Toggle the benefits on and off on the right-hand side of the page for inclusion in the benefit-cost analysis.

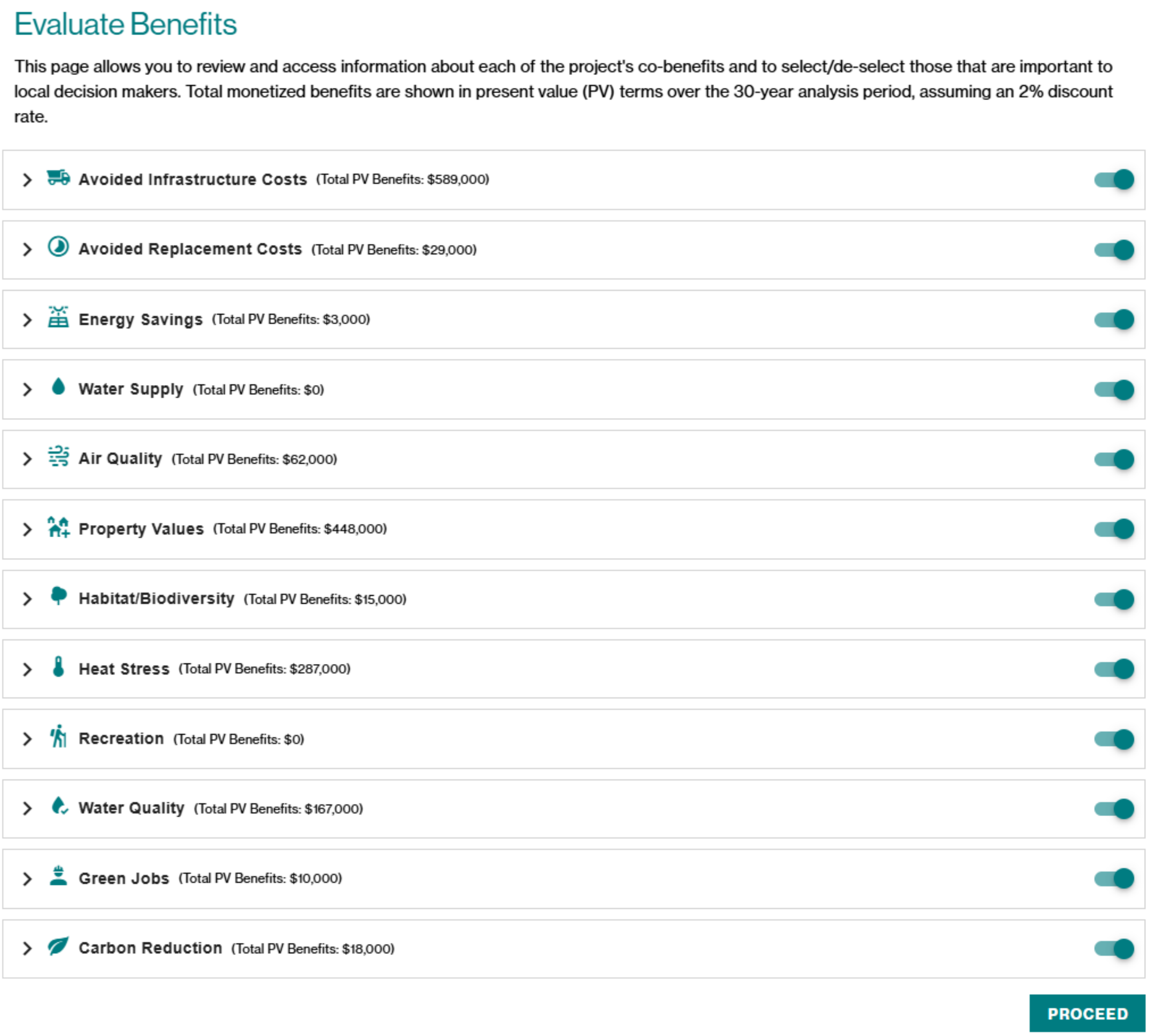

Figure 9. Evaluate Benefits

You can select the arrows to the left of each benefit to expand the benefit category. In doing so, you will be able to see a short description of the benefit, and breakout of benefit component (for example, avoided capital costs and avoided maintenance costs for traditional infrastructure). While the main benefit summarizes the **Total PV Benefits** in paratheses after the benefit title, expanding each benefit will show **Annual Average PV Benefits**. You can check or uncheck boxes to include benefits in the overall benefit cost analysis.

Step 4. Review Costs

Would you like to enter your own cost estimate? Select Yes or No.
If you enter Yes, the Calculator will prompt you to enter capital and annual operations and maintenance (O&M) costs for your GSI projects.

If you enter No, the Calculator will rely on default cost estimates for calculating return on investment (ROI) and comparing benefits to costs.

The default costs included in the Calculator are based on national averages from the WRF CLASIC Tool. Capital costs are a one-time expense representing planning, design, construction, and installation; the capital costs built into the Calculator do not include property acquisition expenses. We recommend that users input their own costs if available to better reflect average local costs for implementing GSI. O&M costs represent annual values that accrue each year to ensure proper functioning of the GSI practices.

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Review Costs

The cost estimates in the table below are based on national averages for the BMPs you've selected. Note that capital costs represent construction only and do not account for other upfront costs such as design and engineering, permitting, or property acquisition. You can also enter custom cost estimates if you prefer.

Would you like to enter your own cost estimates?

◯ Yes ◯ No

BMP	BMP Area (sq ft)	BMP Number (#)	Capital Costs ($)	Average Annual Costs ($/year)
Raingardens	1,805		$123,000	$4,000
Bioretention	0		$0	$0
Green roofs	0		$0	$0
Street trees		29	$14,000	$2,000
Permeable pavement	12,221		$208,000	$2,000
Cisterns		0	$0	$0
Rain barrels		0	$0	$0
Constructed wetlands	0		$0	$0
Wet ponds	0		$0	$0
Biofiltration	0		$0	$0
Total			**$345,000**	**$8,000**

PROCEED

Figure 10. Review Costs

Step 5. Explore Results

The final page summarizes the benefits and costs of your potential GSI project. These results are high-level estimates, intended to be used to demonstrate the potential co-benefits of selected BMPs. The summary of benefits and the associated graphics can be downloaded and shared via the "PDF" generator in the upper right corner of the page.

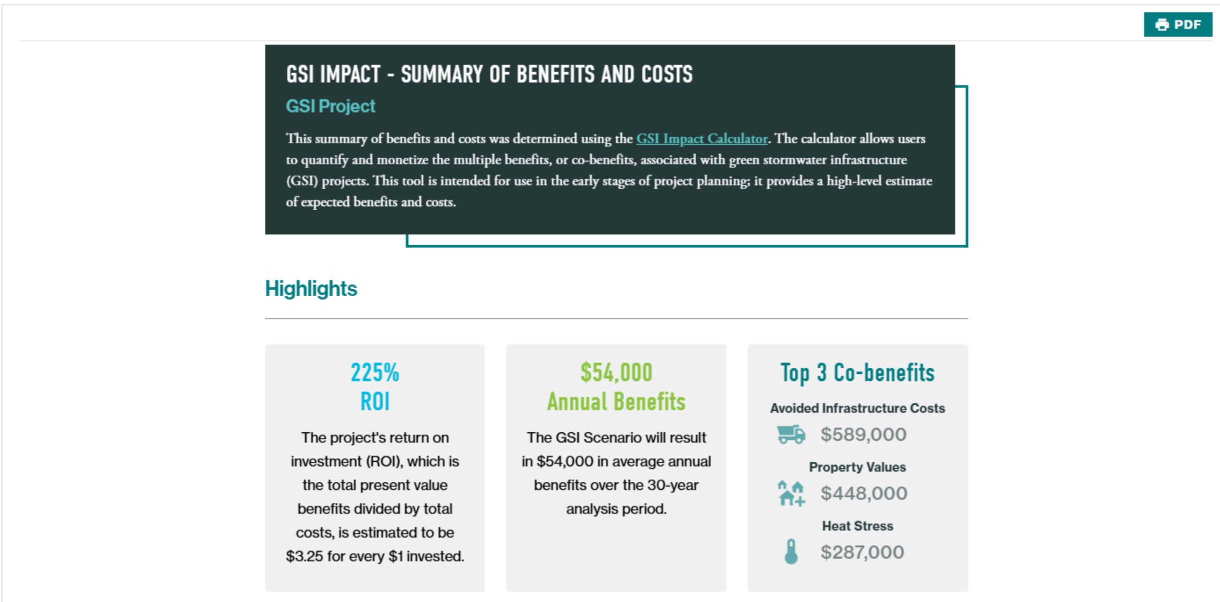

Figure 11. Explore Results - Highlights

Highlights

This section shows the expected Return on Investment (ROI), average annual benefits, and the top three co-benefit values:

- ***ROI*** is the total present value benefits divided by the total present value of costs (including O&M). This can help answer decision makers' common question of how much community benefit will be driven by an investment in GSI practices?
- ***Annual benefits*** value is equal to the sum of all benefits over the defined analysis period divided by the total years in that analysis period.
- ***Top 3 Co-benefits*** summarizes the co-benefits with the highest dollar value identified by the Calculator for the defined project scenario.

GSI Scenario Inputs

This section summarizes the project information that you input for your GSI project. This information is helpful if the outputs from the Calculator are used to compare similar projects located in different areas, or to compare different combinations of GSI BMPs.

Present Value Benefits and Costs

This graph compares the present value dollar amounts of costs and benefits. Benefits are categorized as financial, social, and environmental benefits, reflecting the Triple Bottom Line accounting framework. The ROI in the Highlights section is equal to the total present value costs divided by the total present value benefits presented in this graph. The dollar values of present value costs and benefits can be seen by hovering your curser over the graph.

GSI Benefits

The pie chart shows the breakout of total benefits by each benefit category. The benefit categories match the categories on the Evaluate Benefits page. The pie chart shows the percentage of benefits attributable to each category. By hovering your cursor over each color block in the pie chart, you can see the benefit and the associated present dollar value.

Benefits of Different GSI Practices

The small boxes in this section show the benefits associated with different GSI practices. The GSI practices selected in the BMP Selection page will have positive Present Value benefits. GSI practices that show $0 in benefits were not selected as part of the scenario. Benefits for each practice are totaled over the analysis period in present value terms, averaged into annual benefits for each year of the analysis period, and shown as a benefit per unit. The benefit per unit reflects the total present value benefit divided by the total area or number of BMPs installed.

Additional GSI Scenario Outcomes

The monetized benefit values summarized throughout the Calculator reflect monetized estimates (e.g., avoided costs and/or willingness to pay for environmental amenities). This section presents the physical benefits (i.e., non-monetized but quantified outcomes) for each benefit category, as applicable. These estimates are used to inform monetized values. For example, if your scenario includes street trees, the Calculator will estimate the total carbon sequestered by those trees and monetize the value of removing carbon from the atmosphere using the Social Cost of Carbon. This Outcomes section describes the unit value of total carbon reduced or sequestered (in this case, metric tons of carbon equivalent) used as an input to generate the dollar value of this benefit.