Sustainable
Stormwater Management

Alternatives Analysis for the Future Ford Site Development

Capitol Region Watershed District
2016

Sustainable Stormwater Management Alternatives Analysis for the Future Ford Site Development

Project conducted by the
Capitol Region Watershed District
in partnership with the
City of Saint Paul

This report prepared by
Barr Engineering Co.

About this project

Starting with the Model T and ending with the Ranger pickup, the Ford Motor Plant in Saint Paul turned out vehicles for nearly 90 years. Even before the last truck rolled off the line in 2011, planning has been underway for redevelopment of this site. Its proximity to the Mississippi River and vibrant residential neighborhoods makes it a valuable resource, demanding careful planning to manage energy, waste, transport, landscape, information, and water needs (see figure below).

This sustainable stormwater assessment for the Ford site, conducted by the Capitol Region Watershed District (CRWD) in partnership with the City of Saint Paul, has been performed in parallel with three other City assessments related to district energy, transportation, and real estate. Combined, these efforts will inform a City plan for publicly owned spaces and facilities at the Ford site.

The scope of this stormwater assessment is to compare two alternatives for managing stormwater. The goal is to better understand the trade-offs and relative value each alternative may provide the City, community, and future developer.

ENERGY
Geothermal
Hydroelectric
Nuclear
Coal
Natural Gas
Oil Refinery
Wind
Solar
Biomass

WATER
Potable Water
Capture Storage
Water Reuse
Stormwater
Flood Control

WASTE
Solid Waste
Recycling
Hazardous Waste
Collection and
Transfer

TRANSPORT
Airports
Roads
Highways
Bikes
Pedestrians
Railways
Public Transit
Ports
Waterways

LANDSCAPE
Public Realm
Parks
Ecosystem
Services

INFORMATION
Telecommunications
Internet
Phones
Satellites
Data Centers
Sensors

SCOPE

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Project Scope

The scope of this assessment was to compare two stormwater infrastructure alternatives for managing runoff at the Ford site. The goal is to better understand the trade-offs and relative value each alternative may provide the City, community, environment, and future developer.

The vision for the redeveloped Ford site is a livable, mixed-use neighborhood that looks to the future—using clean technologies and high-quality design for energy, buildings, and infrastructure. Sustainability is a key principle guiding the Ford site redevelopment. The goal is to create a site that is a "regional, national, and global model for sustainable planning, design, and day-to-day living that protects our air, water, and natural resources for future generations."

This assessment will inform the City's Zoning and Public Realm plan. The report provides a quantitative performance analysis of stormwater infrastructure, demonstrating which alternative best supports sustainable redevelopment and maximizes water resource protection.

1.0 Executive Summary

Stormwater runoff from the former Ford site primarily drains to one discharge point: Hidden Falls Creek, which flows to the nearby Mississippi River. Historic maps indicate the creek existed on the site until the 1800s. It was buried prior to construction on the site and eventually paved over for the assembly plant. Since then, impervious surfaces at the Ford site have sent uncontrolled runoff downstream without treatment, destabilizing the creek and carrying pollutants into the river.

Stormwater management during redevelopment will mitigate existing impacts, but the approach must align with principles of sustainability. This requires re-evaluating Saint Paul's parcel-by-parcel, project-by-project approach and considering comprehensive regional stormwater systems that can add value by creating shared, stacked function green infrastructure as a public-realm feature.

"Shared, stacked function" refers to situations where green infrastructure is intended to provide service for more than one parcel (public or private) on a development site, and the entire facility functions to provide additional amenities beyond stormwater management.

The vision for the Ford site is to re-create the historic **Hidden Falls Headwaters** feature, fully naturalize the existing downstream creek, reconnect the future neighborhood to the river by means of an open-water flow path, and create a model for sustainable and resilient infrastructure redevelopment.

Approach

Two conceptual stormwater infrastructure alternatives were included in this assessment. A "baseline" alternative assumes a business-as-usual stormwater management approach that meets current standards (city, watershed, state). Runoff from individual parcels would be managed separately on each development parcel in underground storage systems.

A "centralized" Hidden Falls Headwaters alternative assumes enhanced stormwater management goals to strengthen downstream protection. Runoff from the entire site would be managed in a centralized green infrastructure corridor which re-creates the buried Hidden Falls Headwaters feature.

A range of quantitative and qualitative indicators is presented in this analysis to assess and compare performance of the two stormwater infrastructure alternatives. Sustainable return on investment (SROI) is used to account for and compare each alternative's triple bottom line—its full range of economic/financial, environmental, and social impacts. Environmental performance is also estimated using a life cycle assessment (LCA) which quantifies the total energy, greenhouse gas, and water footprint associated with each alternative.

Findings

The Hidden Falls Headwaters stormwater infrastructure alternative best supports sustainable redevelopment and the protection of water resources. Monetizing social and environmental benefits illustrates the full value of this investment.

- The baseline and Hidden Falls Headwaters alternatives have construction costs of similar magnitude.
- The Hidden Falls Headwaters approach greatly outperforms the baseline. It is superior on 17 of 18 sustainability indicators. This approach:
  - **Doubles the overall benefit-to-cost ratio when considering economic, social, and environmental factors.**
  - Is nearly 75% more effective in protecting Hidden Falls Creek downstream.
  - Is more successful in mitigating urban heat island effects (25%) and reducing air impacts (27%).
  - Reduces the energy and materials used to create stormwater infrastructure by up to 32%.
  - Reduces the unit cost (capital dollars per acres served) required to manage stormwater by up to 40% (see page 10).
- The Hidden Falls Headwaters approach facilitates "naturalized" flows to Hidden Falls Creek; recreating the historic headwater feature to Hidden Falls is also feasible and paramount to achieving naturalized flows downstream.

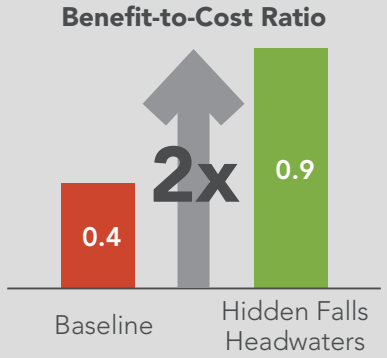
Trade-offs associated with the Hidden Falls Headwaters approach have also been considered and include the following:

- Up to 6 acres of land of the 134-acre site will be required for green infrastructure; however, the elimination of underground storage would likely allow for denser development on the remaining developable land.
- Runoff from adjacent neighborhood(s) will need to be routed to the Hidden Falls Headwaters to control all flows to Hidden Falls Creek.
- The green infrastructure will demand greater operation and maintenance expense.
- The Hidden Falls Headwaters alternative will require additional policy support because it reflects above-standard outcomes.

Recommendations

The Zoning and Public Realm plan should include:

- The Hidden Falls Headwaters approach to stormwater infrastructure, recognizing the significant sustainable benefits which result.
- Use of design standards herein which use the Atlas 14 precipitation estimates for maximum storm discharge (cfs).
- A benchmark SROI of not less than a 0.9 cost-benefit ratio for any stormwater design or alternative used on this site.



Next Steps

- **Concept Refinement**
  - Further develop water budget for Hidden Falls Headwaters feature.
  - Develop the phasing scenario(s).
  - Further evaluate design constraints (e.g., grading, bedrock, soil, or groundwater impacts).
  - As planned development patterns become known, further optimize the system to fit seamlessly into the development.
- **Conceptual Design Development**
- **Zoning Master Plan**
- **Preliminary/Schematic Design Development**
- **Detailed Design Development and Construction Documents**
- **Construction**

2.0 Stormwater Management Planning for the Ford Site

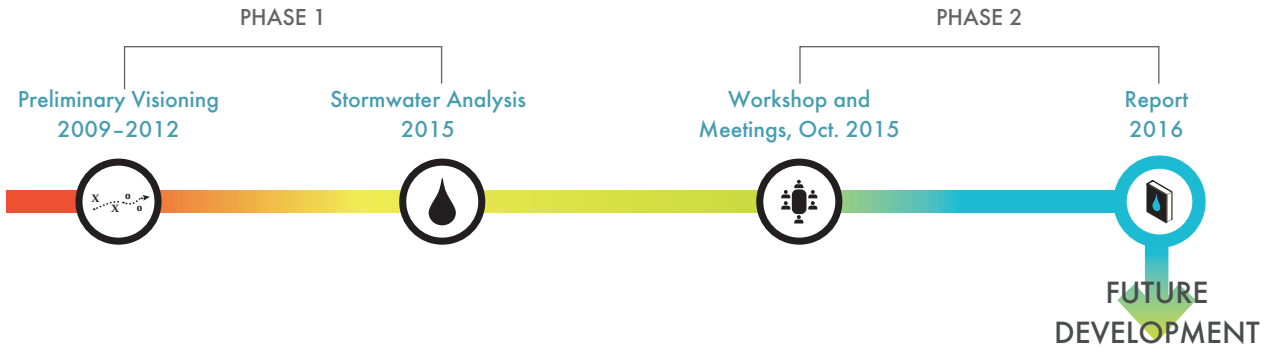
This analysis builds on almost a decade of planning, research, and reporting. The stormwater concepts presented in this report were developed in two phases (described below). The development of these concepts has required effective collaboration among City leaders and staff, public organizations, stormwater management experts, and citizens (see sidebar at right).

Phase 1 (the big picture)

- Preliminary research and reports were completed to provide data and background information.
- A stormwater model was built—identifying big-picture design parameters.
- Conceptual designs and renderings representing a redeveloped Ford site were completed (see page 2).
- City of Saint Paul and CRWD staff worked together to define the features/functions of two stormwater management alternatives: Baseline and Hidden Falls Headwaters (pages 5–6).
- The concepts were presented to the public at an open house on June 23, 2015.

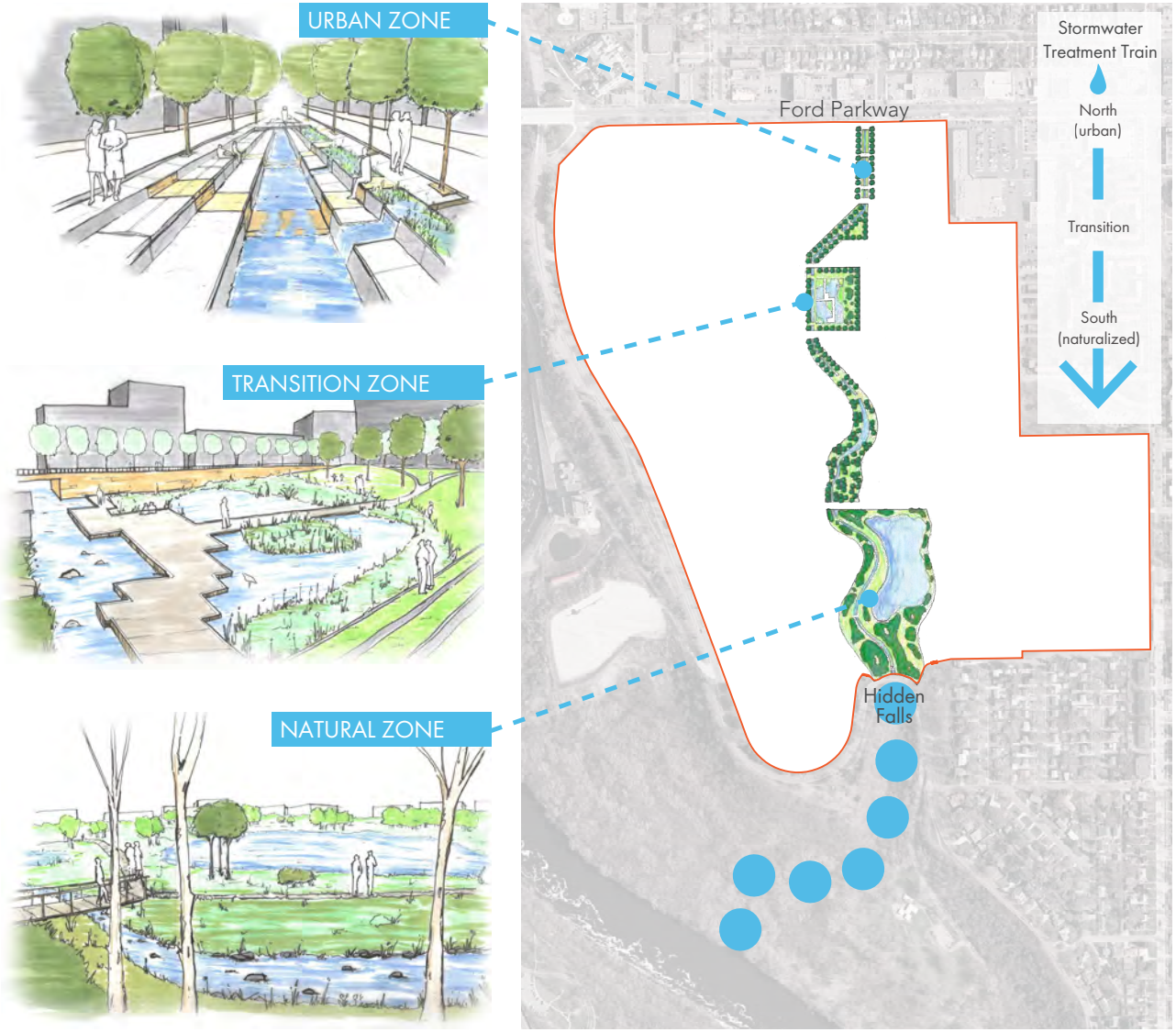
Phase 2 (the details)

- Additional stormwater modeling was done to advance the definition of the project.
- City and CRWD staff came to a consensus about features that should be included in each of the two stormwater management alternatives.
- Cost, benefit, and sustainability trade-offs were analyzed to show social, environmental, and economic benefits for both plans (pages 7–18).



Aspirational Renderings of a "Centralized" Stormwater Management Approach

(Concept presented to the public at an open house on June 23, 2015, to test ideas)



Public Process

Everything we've talked about—streets, parking, bikes, jobs, housing—revolves around the creek.

[Resident comment from June 2015 public meeting, referencing the importance of Hidden Falls Creek]

The type of stormwater infrastructure built at the Ford site will say something about the community's priorities and preferences. For that reason, numerous public engagement opportunities have occurred throughout the planning process to provide information and solicit opinions. The consensus? Integrated stormwater management is important to residents.

Ninety Saint Paul seventh graders discuss stormwater management at the Ford site.

An Opportunity to Naturalize Flows

1800s

Undeveloped land on the Ford site allowed a natural, more sustained flow for Hidden Falls Creek

1925–2011

The creek on the Ford site was buried; high stormwater runoff volumes resulted in erosion below Hidden Falls and decreased resource value

2016 +

Opportunities to mimic pre-settlement runoff rates on the Ford site with green infrastructure and to restore Hidden Falls Creek

2.1 Ford Site Redevelopment and Hidden Falls

The Ford site sits above the Mississippi River bluffs in the midst of the vibrant mixed-use Highland Park neighborhood. Redevelopment of the 134-acre site offers a unique opportunity to create what Mayor Chris Coleman terms a "21st century community." Regardless of the type and density of structures that will come to occupy this site, effective management of stormwater will be required.

Redevelopment of the Ford site also offers the opportunity to protect and restore some of the area's natural resources: Hidden Falls Creek and Hidden Falls. The creek, which once meandered across the Ford site to Hidden Falls, was buried prior to the plant's construction and operation (1925). As a result, high stormwater runoff volumes have eroded the area below the falls. Green infrastructure plans that include strategic stormwater solutions can facilitate:

- **Restoration of Hidden Falls Creek** with a more naturalized flow regime.
- **Reduction of stormwater runoff rates to their pre-settlement levels—**subsequently reducing erosion, returning the surface water-groundwater connection, and improving resiliency.
- **Development of a natural corridor amenity,** linking the redeveloped area to Hidden Falls Creek and Hidden Falls.

Stormwater management is just one part of the City's vision. A balanced blend of grey and green infrastructure will optimize use of developable land and ensure that residents and businesses benefit from a livable community, while impacts to the area's ecosystem are reduced.

The Ford site, above the Mississippi River bluffs, is located in Saint Paul's Highland Park neighborhood.

Increased stormwater runoff has created significant bank erosion at Hidden Falls Creek and increased pollutants released to the Mississippi River.

2.2 Sustainable Stormwater Management at Ford Site

The purpose of this document is to present the two conceptual stormwater management alternatives developed for the Ford site in Saint Paul:

- (B) A **baseline** conventional stormwater management alternative (see page 5)
- (H) A **centralized** stormwater management alternative, termed **"Hidden Falls Headwaters"** (see page 6)

Benefits, costs, and trade-offs were characterized to compare the two alternatives relative to the following factors:

Restoration

Restoration and protection of Hidden Falls and Hidden Falls Creek, including a natural connection to the Ford site—increasing recreation opportunities and public awareness of these resources

Stormwater Treatment

Treat stormwater as a resource, not a waste stream

Sustainability

A qualitative and quantitative comparison of City of Saint Paul sustainability indicators for the Ford site

Increase Community Benefits

Enhance community amenities while reducing big-picture impacts and conserving energy, water, and resources

Costs, Life Cycle, and Return on Investment

A tool-based quantitative comparison of sustainability indicators for the Ford site (Life Cycle Assessment and AutoCASE® sustainable return on investment)

Part Science, Part Art

The Barr Engineering Co. team worked with City of Saint Paul staff to make reasonable assumptions about how development at the Ford site might occur over time. Limited project definition at this early stage makes a comparison of stormwater management options part science and part art. **The driving question is how managing rainwater as a vital resource within the urban landscape—instead of a neglected waste stream—could factor into future planning.**

The alternatives developed are concepts (not designs) and are intended to inform the vision for development that will take shape on the Ford site.

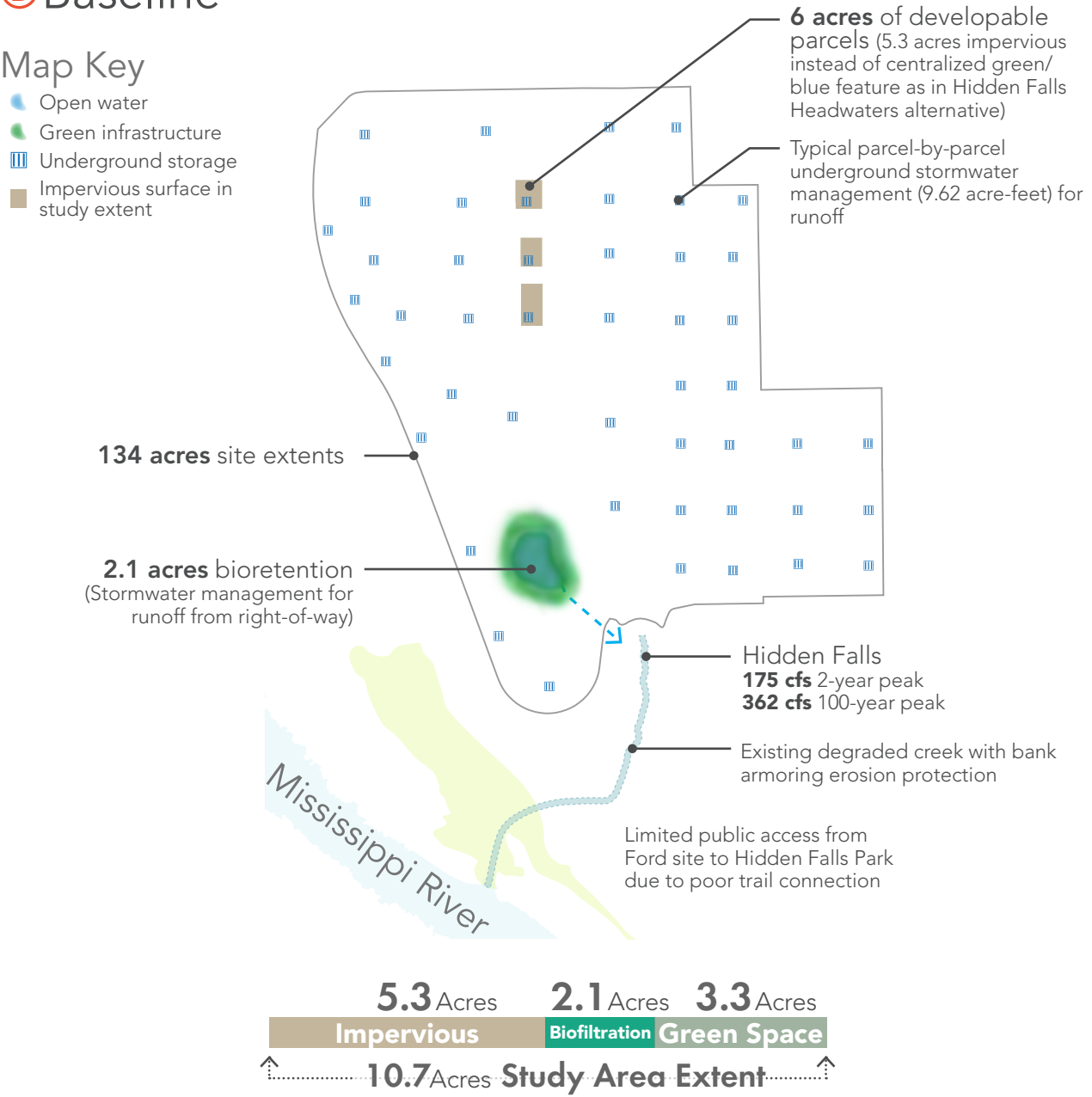
Baseline

Stormwater management under ground

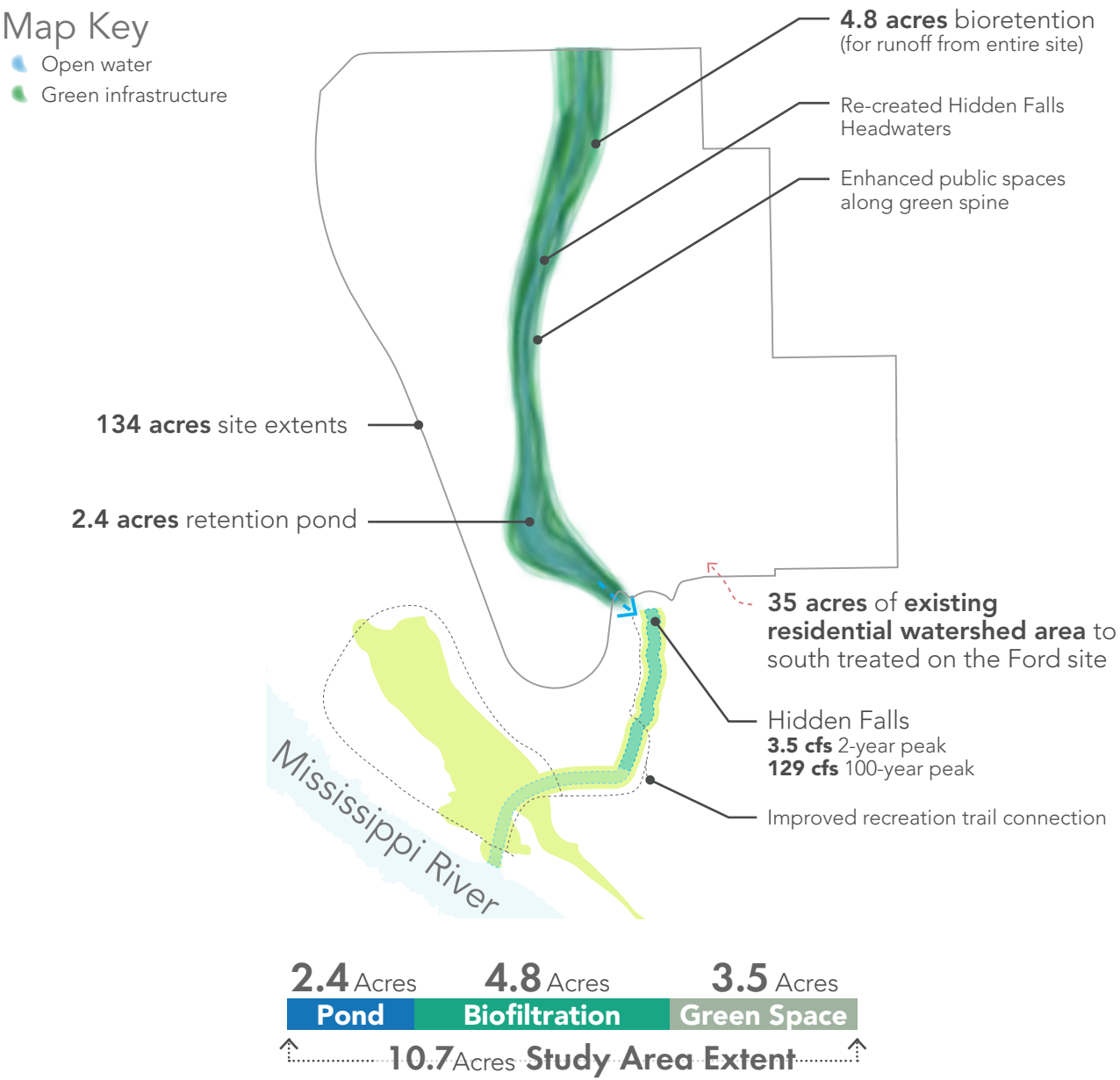
This alternative uses a **conventional approach to meet current City of Saint Paul and CRWD stormwater requirements.** As the market drives development, each parcel controls its own stormwater, typically with underground systems designed to meet minimum requirements. As the transportation network is introduced, runoff from the right-of-way would be managed with above-grade features. In essence, fewer amenities and benefits would be accepted for a greater acreage of developable parcels.

- **Underground systems:** Vaults and tanks are used for the storage of stormwater (see diagram below). Vaults are typically pipe arrays or structural facilities designed to provide stormwater treatment through infiltration/filtration.

Ⓑ Baseline



Ⓗ Hidden Falls Headwaters



Hidden Falls Headwaters

Stormwater management above ground

With this alternative, runoff from the entire site would be managed with above grade features (see examples below) in a "centralized" green infrastructure corridor. The corridor re-creates the original headwaters feature. Downstream, Hidden Falls Creek would be restored and associated natural areas linked to the development. The community would benefit from green space and developers would not be required to manage stormwater on individual parcels. **This option exceeds City and CRWD stormwater management requirements.**

- **Bioretention:** A shallow area planted with deep-rooted plants and grasses; water flows into the garden, then soaks back into the ground and is filtered/released (see illustration below).
- **Hardscape pavement:** Pavement built with materials that convey water to bioretention facilities.

Historical Perspective

The current condition of Hidden Falls Regional Park and Hidden Falls Creek represents the geological history along the Mississippi River, as well as recent activity associated with the Ford site. Prior to the development of the Ford Motor Company complex, a stream originated near what is now Cleveland Avenue and Ford Parkway—flowing southwest across the Ford site to Hidden Falls. That stream was buried during subsequent development, flowing through a culvert beneath Mississippi River Boulevard and daylighting at Hidden Falls.

The hydrology of Hidden Falls Creek is primarily generated as stormwater runoff from the surrounding watershed. The urbanization of the watershed, in conjunction with the nearly 100-foot elevation change from the falls to the river, has created a high-energy stream system.

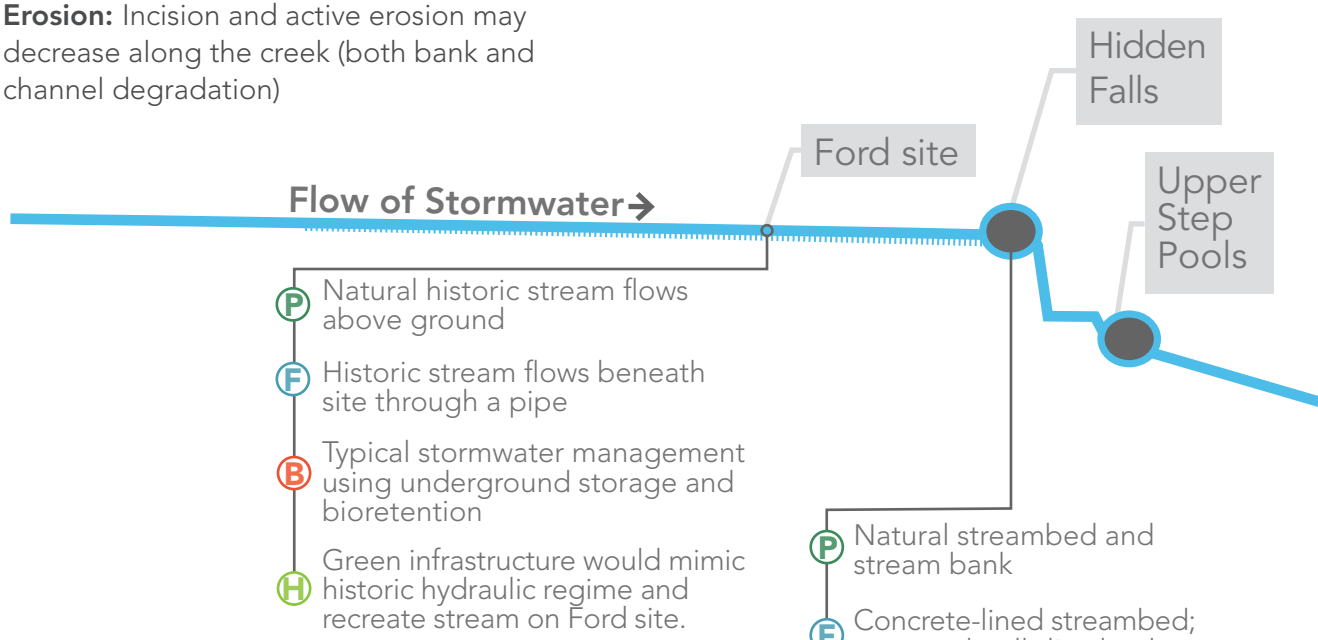
Map of Ramsey County, 1867 (Winchell)

3.0 Assessment Factor: Hidden Falls Restoration and Hidden Falls Creek

(B) Baseline

With the Baseline alternative **little change or intervention** for Hidden Falls Creek or Hidden Falls Park is anticipated.

- **Peak flow:** Will be modestly reduced from present-day conditions
- **Restoration:** Hard armoring with little ecological value
- **Erosion:** Incision and active erosion may decrease along the creek (both bank and channel degradation)
- **Floodplain:** Would remain disconnected
- **Riparian zone:** Little disturbance to the existing riparian and wetland environments; continued natural evolution of these systems may be limited by lack of lateral connectivity to floodplain and disturbed flow regimes



Storm Event Maximum Discharge (cfs)			
Development Period	2 Year	10 Year	100 Year
(P) Pre-settlement (past)	4	31	161
(F) Ford assembly plant in operation (recent past)	233	401	792
(B) Baseline (future)	175	268	362
(H) Hidden Falls Headwaters (future)	3.5	31	129

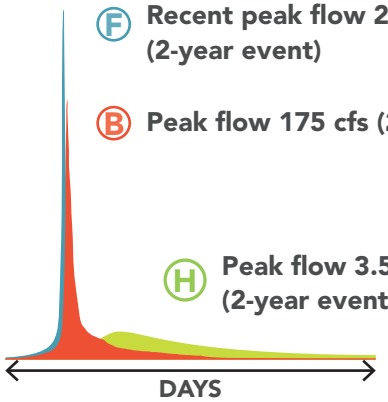
(H) Hidden Falls Headwaters

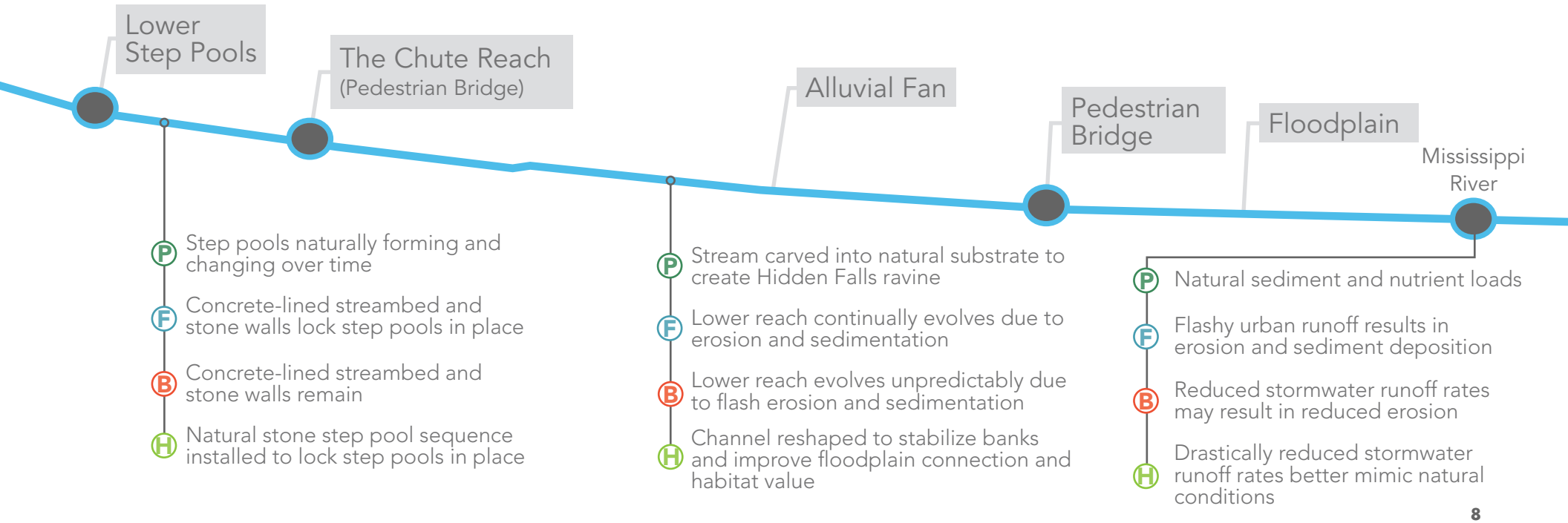
The Hidden Falls Headwaters alternative more closely reflects pre-settlement conditions.

- **Peak flow:** Flow rates are reduced to pre-settlement conditions; more naturalized streambed created to promote filtration and infiltration of water
- **Restoration:** Anticipated within the lower reach of the stream (reshaping the channel and connecting it to a floodplain bench)
- **Erosion:** Reduced by increasing stability of naturalized stream banks—**improving stream access and providing a more stable environment for visitors, wildlife, and plants**
- **Floodplain:** Improved connection to the floodplain system **restores ecological interaction among stream, wetland, and upland communities**
- **Riparian zone:** Higher functioning is anticipated; replacing the upper-reach concrete channel bed with a stone bed **may support more diverse vegetation and macroinvertebrate populations**

Key Takeaways

The **Hidden Falls Headwaters alternative restores natural hydrology that improves the resource value of Hidden Falls and Hidden Falls Creek.**





Notes about Cost Estimates

Estimated costs were benchmarked against similar projects in the region. The construction and operation and maintenance (O&M) costs include a 30% contingency, but do not include planning, engineering, design, or construction management. An assumed life of 25 years was used to estimate life cycle O&M costs. The assumed interest rate of 4% is based on current City of Saint Paul practice. **General conclusions are illustrated on the bar graph to the right.**

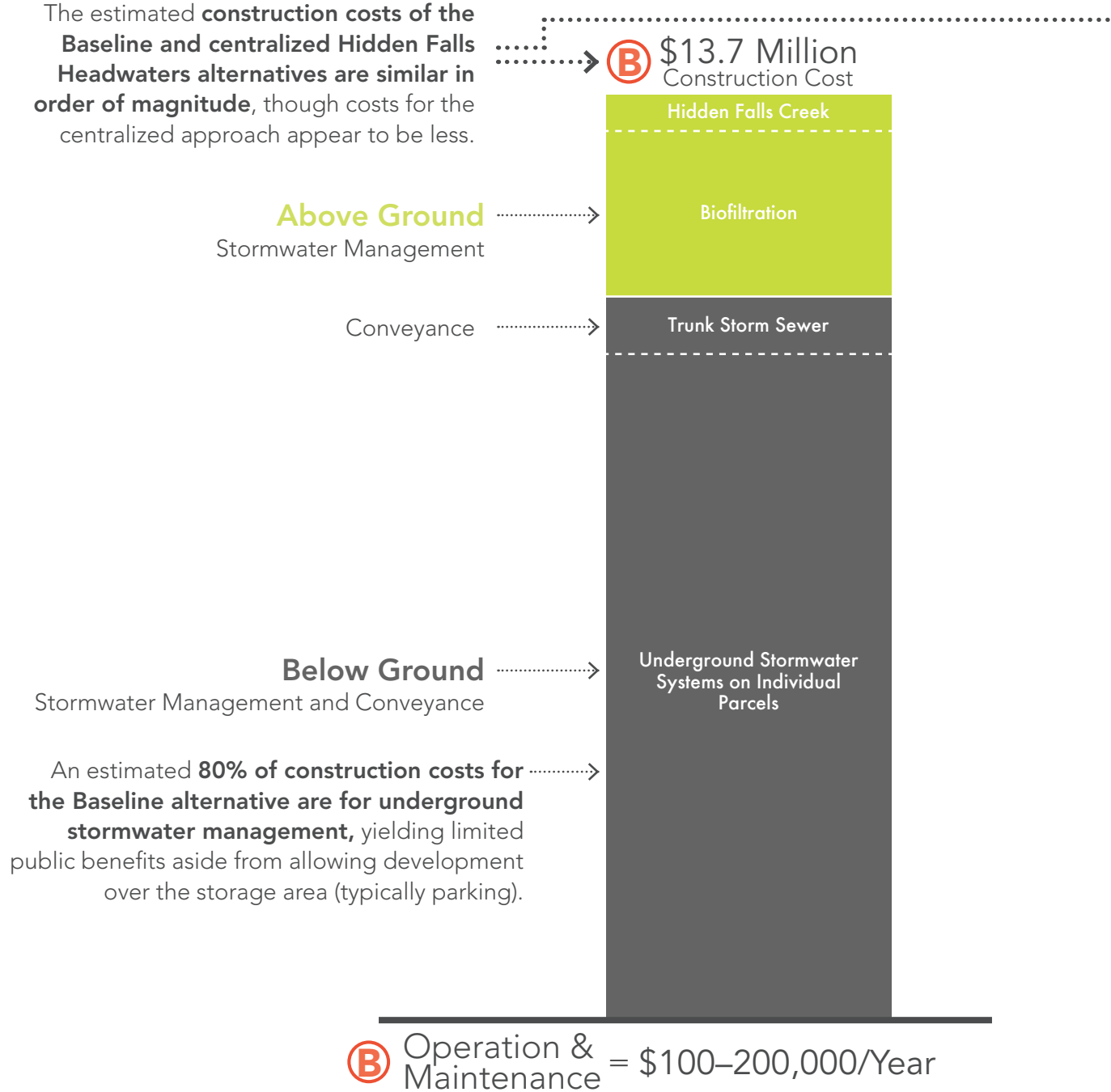
When estimating costs for conceptual designs, **it is important to acknowledge that any estimate is a "most likely" value within an anticipated accuracy range.** As project definition increases, the uncertainty in any estimate may decrease and the range may narrow. The Ford site project definition of 5% conceptual design could be associated with a range of -50% to +100%, depending on future investigations and how designs are implemented (ASTME2516-11).

How much do stormwater management systems cost?

- Typical City of Saint Paul **costs for underground stormwater management systems are on the order of $20 per cubic foot.**
- Typical CRWD costs **for bioretention systems are between $12 and $22 per square foot** depending on complexity, aesthetics, etc.

3.1 Assessment Factor: Cost Estimates for Construction/O&M

The estimated **construction costs of the Baseline and centralized Hidden Falls Headwaters alternatives are similar in order of magnitude**, though costs for the centralized approach appear to be less.



Key Takeaways

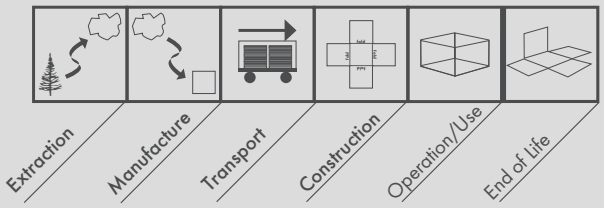
- Baseline and Hidden Falls Headwaters alternatives have similar estimated construction costs; the Hidden Falls Headwaters option may be **5–10% less.**
- The Hidden Falls Headwaters approach serves a larger drainage area; thus, construction cost per acre is **40% less** than the Baseline alternative.
- The Hidden Falls Headwaters alternative is nearly **75% more effective** in providing downstream protection of Hidden Falls Creek and has lower capital costs.
- The Hidden Falls Headwaters approach may require **double the annual operation and maintenance investment** to maintain the green infrastructure amenities.
- The possible shift of maintenance responsibilities from private to public entities and source of maintenance funding should be considered in further planning.

Life Cycle Assessment (LCA)

LCA is a "cradle-to-grave" assessment method that considers how energy and materials are used across the stages of a product's life—from raw material extraction through end-of-life (see figure below). Environmental performance can be enhanced by targeting factors that contribute to greenhouse gas, pollutants, embodied energy, water, and ecological footprints. Typically, LCA estimates are used to obtain insights about trade-offs and inform decision making, planning, and design.

LCA can also be used to implement internal sustainability programs or pursue project credentials/certifications such as:

- Leadership in Energy and Environmental Design (LEED®), a worldwide "green building" certification program.
- The Institute for Sustainable Infrastructure's (ISI) Envision® system, a sustainability rating system for civil infrastructure.
- MPCA green and sustainable remediation guidelines designed to reduce the impacts of contaminant investigation and remedial tasks.



3.2 Assessment Factor: Life Cycle Impact Assessment (LCA)

The potential environmental impacts of the two stormwater management alternatives for the Ford site are significantly different. Contributing factors can be targeted for reduction during future planning and design efforts. In general, greater big-picture impacts are observed for projects that require materials derived from intense extraction or manufacturing, or processes that regularly require significant energy, fuel, or potable water. **The tables below show the elements that comprise the Baseline and Hidden Falls Headwaters alternatives, as well as the resource inventory related to those features** (inputs of raw materials, energy and water, and emissions to air, water, and land).

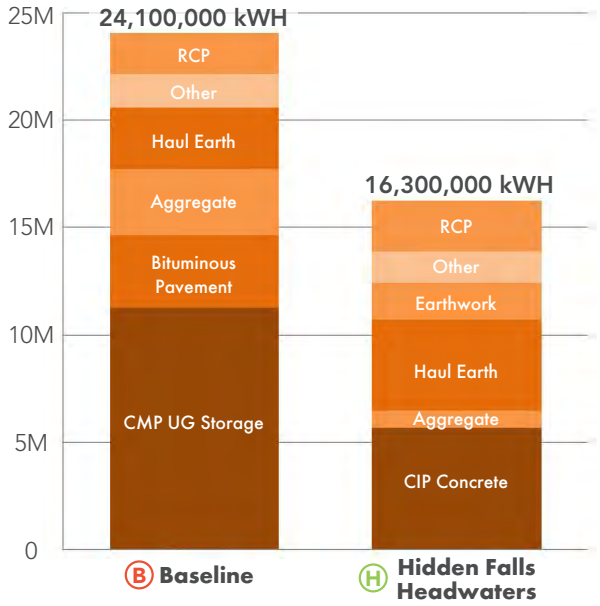
Design Parameters → INVENTORY → Estimated Quantities*

Feature	(B) Baseline	(H) Hidden Falls Headwaters
Underground storage	9.62 acre-feet	None
Biofiltration	2.1 acres	4.8 acres
Pond	None	2.4 acres
Reinforced concrete pipe (RCP) trunk sewer	3,500 linear feet	4,100 linear feet
RCP, manholes, catch basins	59	63
Developed impervious	4.3 acres bituminous	None
Cast-in-place (CIP) walls	None	1,800 linear feet
Stone walls	None	1,000 linear feet
Hidden Falls Creek	Armored bank erosion protection	Streambank restorations and recreational trail
Electricity	None	Stormwater recirculation pumping
Decorative hardscape	None	4,000 square yards

Item	(B) Baseline	(H) Hidden Falls Headwaters
Excavation/ Earthwork	134,000,000 lbs	280,000,000 lbs
Haul/Transport soil	133,000,000 lbs	200,000,000 lbs
Bituminous pavement	7,000,000 lbs	1,000,000 lbs
Concrete pavement	0 lbs	1,900,000 lbs
CIP concrete walls	0 lbs	6,000,000 lbs
Steel reinforcement	0 lbs	225,000 lbs
Precast concrete	4,000,000 lbs	5,000,000 lbs
Iron castings	65,000 lbs	20,000 lbs
Corrugated metal storage pipe	3,000,000 lbs	0 lbs
Polypropylene fabric	20,000 lbs	1,000 lbs
Riprap, large stone, aggregates	91,000,000 lbs	26,000,000 lbs
Polyethylene pipe	1,000 lbs	2,000 lbs

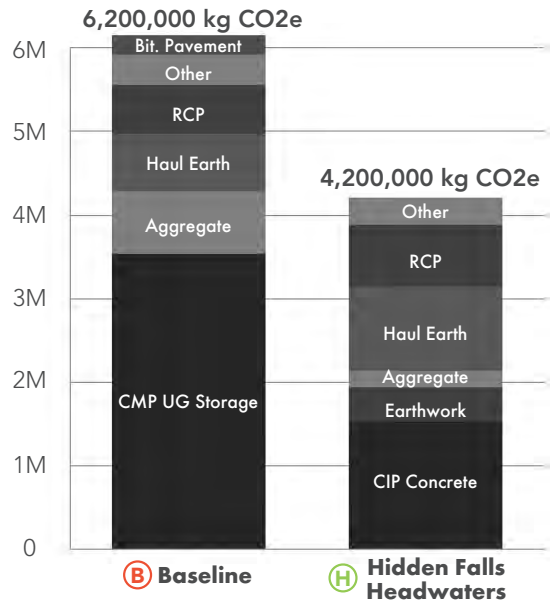
* Life cycle inventory for mined and manufactured products. Resources for growing plants not included. Electricity for pumping not included; district energy study for generation mix allocation pending.

Estimated Embodied Energy Footprint (kWH)



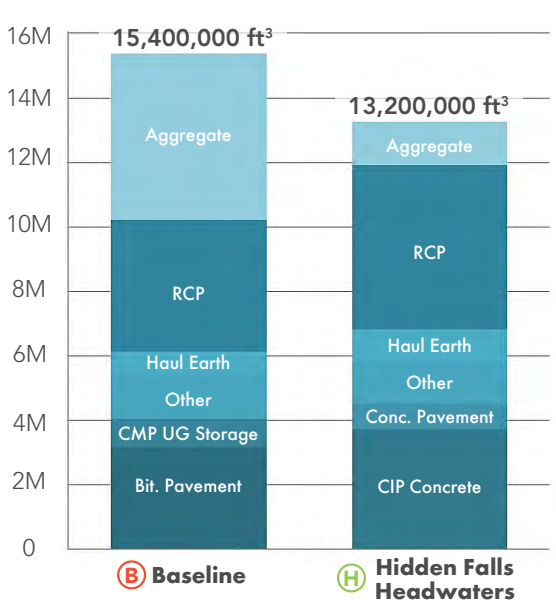
Embodied energy: The total energy consumed by a product during its life cycle: from the mining/milling of raw materials to product manufacturing, transportation, installation, and end of life

Estimated Greenhouse Gas Footprint (kg C02e)



Greenhouse gas footprint: The total amount of greenhouse gases (measured in units of carbon dioxide) produced by human activities to furnish a good or service; units above represent kgs of CO2-equivalent per year

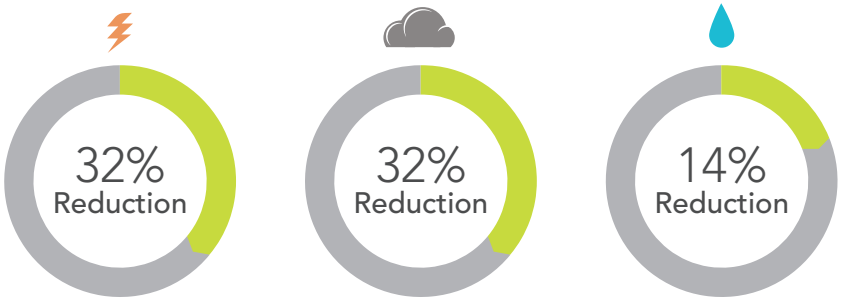
Estimated Water Footprint (ft³)



Water footprint: The water footprint of a product or service is defined as the total volume of fresh water used to produce the goods and services consumed, as measured over the entire life cycle.

Key Takeaways

The Hidden Falls Headwaters alternative results in a lower footprint for three sustainability indicators; resource-intensive elements can be targeted for reduction during future planning and design efforts.



This screening-level streamlined LCA is intended for City of Saint Paul internal planning purposes. ISO-14040 standards establish the methodology by which LCAs are to be performed.

Sustainable Return on Investment (SROI)

Sustainable return on investment (SROI) is a systematic **process for calculating and comparing the benefits and costs of a project** to justify an investment or compare one project's merits to another's. The SROI process accounts for a project's triple bottom line—its full range of economic/financial, environmental, and social impacts.

AutoCASE®

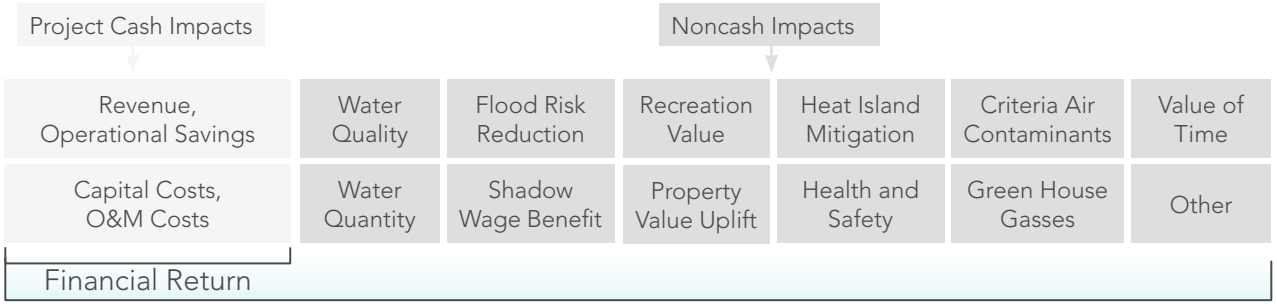
Using AutoCASE® to assess SROI

AutoCASE® is a web-based tool that assigns monetary figures to infrastructure and building projects based not only on construction costs, but benefits and sustainable design features. The tool allows designers to:

- Understand triple-bottom-line values without costly economic consulting.
- Achieve more sustainable, cost-effective results in less time.
- Reduce push back and costly delays by addressing community concerns.
- Present their case with confidence (backed by credible data).
- Build more resilient projects.
- Prioritize competing projects for financing based on societal value.

3.3 Assessment Factor: Sustainable Return on Investment

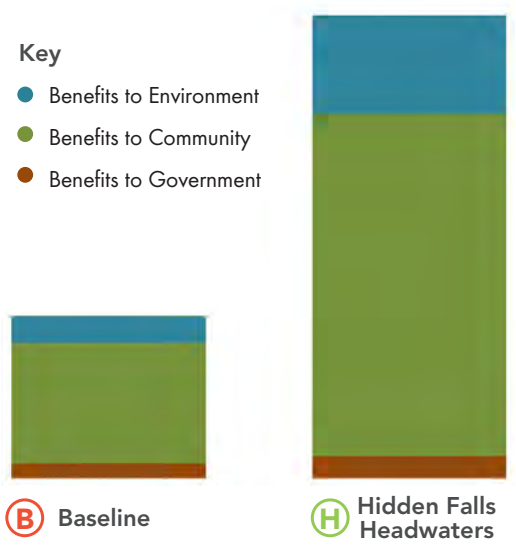
Triple Bottom Line SROI Framework



By considering a broader range of big-picture social and environmental benefits accrued during the project life, a more complete characterization of value for each stormwater alternative can be obtained. The figures below summarize anticipated benefits associated with both alternatives.

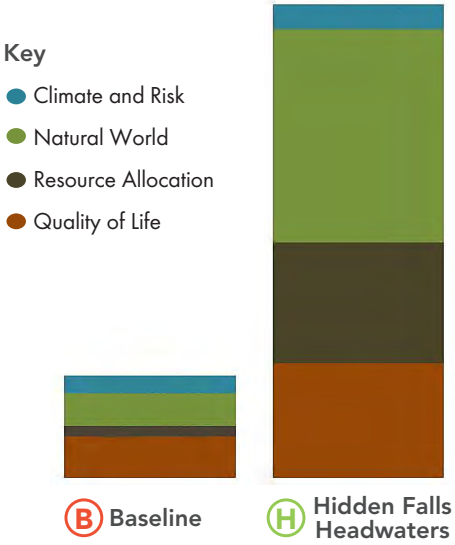
AutoCASE® Stakeholder Benefit Summary

Estimated benefits by stakeholder group

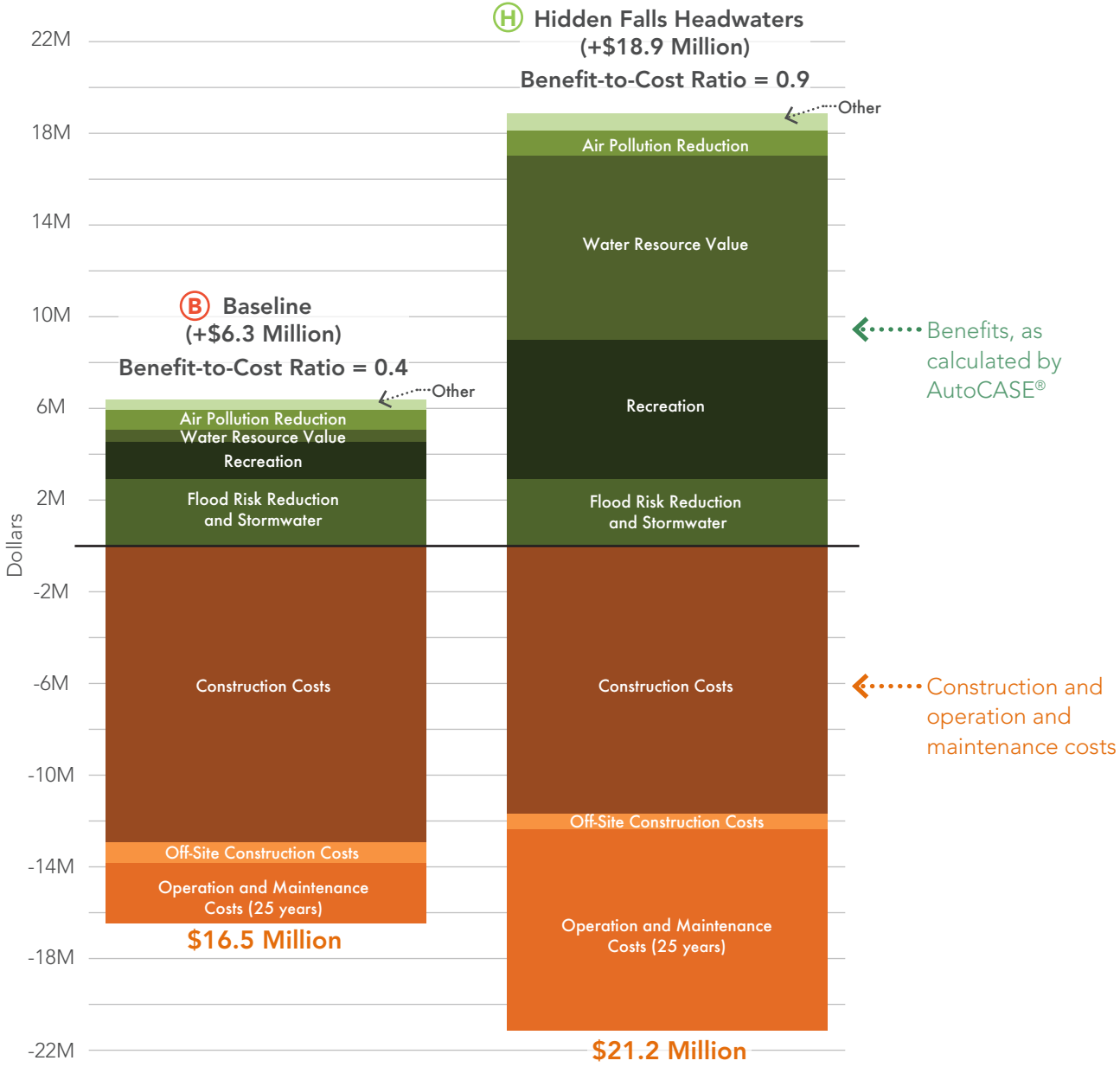


AutoCASE Envision® Benefit Summary

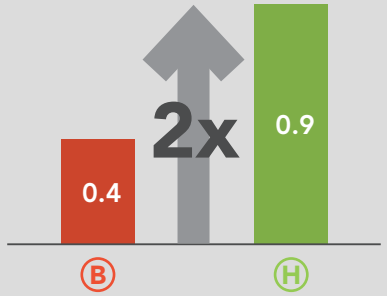
Estimated community benefits by infrastructure sustainability categories established by Envision® ratings



AutoCASE® Cost and Benefit Summary



Benefit-to-Cost Ratio



Key Takeaways

The benefit-to-cost ratio for the Hidden Falls Headwaters alternative is twice that of the Baseline alternative. Significant estimated benefits make the return on investment for the Hidden Falls Headwaters alternative more attractive. These include:

- The community value of green infrastructure and ecosystem services.
- Larger and enhanced public spaces and recreation.
- Improved connection to Hidden Falls Park.
- Restoration of Hidden Falls Creek.

Sustainability Indicators

One way to measure the successful attainment of ***value*** on a redeveloped Ford site is to compare how redevelopment alternatives perform relative to the City's listed goals, metrics, and indicators of success.

Prior to this effort, the City developed "sustainability indicators" for the Ford site. These measure how well the City addresses the community's present and future economic, social, and environmental needs—understanding that all of these factors are interrelated. A comparison of the stormwater management alternatives relative to their ability to satisfy specific sustainability indicators is provided at right. The centralized Hidden Falls Headwaters alternative was designed to meet as many indicators as possible.

The indicator list used here is not intended to be exhaustive. Many additional indicators related to waste management, social fabric, and sourcing are critical to the overall success of the final project but not included in the scope of this stormwater assessment.

3.4 Assessment Factor: Saint Paul Sustainability Indicators

Indicator	Ⓑ Baseline Stormwater System		Ⓗ Hidden Falls Headwaters Stormwater System	
Sustainable return on investment (SROI)	**Standard**	Sustainable net present value (SNPV) = -$10M	**Improved**	Sustainable net present value (SNPV) = -$2.3M (+$7.7M greater)
Restore Hidden Falls	**Standard**	Rate control **175 cfs** for a 2-year event	**Improved**	Rate control **3.5 cfs** for a 2-year extended duration event (mimics pre-settlement flow)
Improved site connection to Hidden Falls	**None**		**Improved**	Connection
Build biodiversity and natural capital	**Standard**	Green space	**Improved**	Green space and Hidden Falls Creek
Balance open space and development	**Standard**	Open space acres (16) with recreational park	**Improved**	Open space acres (21) with recreational park
Reduce greenhouse gas footprint	**Standard**	Footprint	**Improved**	32% footprint reduction
Reduce energy footprint	**Standard**	Footprint	**Improved**	32% footprint reduction
Reduce water footprint	**Standard**	Footprint	**Improved**	14% footprint reduction
Reduce life cycle impacts	**Standard**	Outperforms Hidden Falls Headwaters in three EPA TRACI LCA impact indicators	**Improved**	Outperforms Baseline in six EPA TRACI LCA impact indicators
Reduce air impacts to human health	**Standard**	AutoCASE® $800,000 benefit	**Improved**	AutoCASE® $1.1 million benefit

Indicator	Ⓑ Baseline Stormwater System		Ⓗ Hidden Falls Headwaters Stormwater System	
Manage stormwater as a resource with green infrastructure	**Standard**	Underground stormwater management (grey infrastructure)	**More**	Surface stormwater management with layered uses/benefits and living systems
Restore urban forest	**Standard**	Canopy cover	**Improved**	Canopy cover (+50% or more)
Mitigate urban heat island effect	**Standard**	AutoCASE® $300,000 benefit	**Improved**	More trees (+ 50%) increased $ benefit (+25%, Auto CASE® $400,000 benefit)
Developable acres	**Improved**	Increased acres (+6.9)	**Fewer***	
Enhance biodiversity and habitat	**Standard**	Ecological connection of Ford site to Hidden Falls Park not improved	**Improved**	Increased natural area (3x), +$3.3M benefits to environment
Use efficient district systems	**Standard**	Standard stormwater management practices ($95,000/acre)	**Improved**	Uses centralized stormwater features ($68,000/acre)
Network of parks and open space	**Standard**	Green spaces	**Improved**	Green space centrally connected through site (3x community benefit, +$9M)
Recreation	**Standard**	Potential	**Improved**	Potential includes link to Hidden Falls Creek
TOTAL	**1** Improved indicator		**17** Improved indicators	

* Although the Hidden Falls Headwaters alternative has fewer developable acres, the elimination of underground storage would likely allow for denser development on the remaining developable land, supporting the city's density goals.

Sustainability Indicators

Where Did They Come From?

Previous documents were reviewed to develop a short list of success indicators relevant to the two stormwater alternatives. A range of quantitative and qualitative indicators was used to capture the big-picture metrics of success, as envisioned by the City of Saint Paul.

Sources used to compile the priority list include:

- *Hidden Falls Water Resource Development Feasibility Study* (2014)
- *Road Map to Sustainability, Saint Paul Ford Site* (2011)
- *Ford Site Open Space Guidelines, City of Saint Paul* (2011)
- *The Great River Passage Master Plan (2013)*
- *The Ford Site Energy Study Task Force Summary* (2015)
- *Sustainable Stormwater Feasibility Report for Ford Plant Site* (2009)
- *Ford site Green Manufacturing Reuse Study* (2009)
- *Redevelopment of the Ford Motor Company Site: Phase 1 Summary Report* (2007)

Key Takeaways

The **Hidden Falls Headwaters alternative**, conceptualized with the sustainability indicators in mind, appears to **perform better on 17 of 18 indicators than the Baseline alternative**.

Comparison Summary

The bottom-line comparison between the stormwater management alternatives suggests that the centralized Hidden Falls Headwaters alternative performs better than the Baseline alternative across a range of assessment factors, particularly if CRWD and City of Saint Paul goals are to:

- **Incorporate a naturalized Hidden Falls and restored Hidden Falls Creek** into the Ford site…
- **Treat stormwater as a resource,** and not a waste stream…
- **Move toward fulfilling the City's stated sustainability and public-realm goals** for the project…
- **Increase community benefits** while reducing big-picture impacts and conserving energy, water, and resources…
- **Generate a higher sustainable return on investment** by providing more big-picture community benefits per dollar invested…

4.0 Assessment Results

Side-By-Side Comparison of Stormwater Management Alternatives

	Ⓑ Baseline	Ⓗ Hidden Falls Headwaters
Restore Hidden Falls Creek	**Ongoing maintenance** efforts and erosion prevention	MORE — Stormwater management to restore naturalized flows, daylight the creek, and return surface water groundwater connection
Natural Resources	Underground stormwater management **shrinks development potential of natural area**	MORE — Improved connectivity, restored Hidden Falls Creek and green infrastructure
Developed Impervious	MORE — Underground stormwater management makes it possible to develop more area but generates more runoff	LESS — Some developable area is replaced with green infrastructure with multiple benefits
Stormwater Management	ABOVE GROUND — 100% of runoff from the right-of-way is managed above ground BELOW GROUND — Developable parcels: 88–100% of stormwater management is below ground	ABOVE GROUND — Runoff from the entire site is centrally managed above ground
Water Quality Treatment	SAME — 1.375" storm event ↓ 60% TP, TSS removal	SAME — 1.375" storm event ↓ 60% TP, TSS removal
Cost	$ Construction= **$13.7 million** $ O&M = **$100–200,000/year**	$ Construction= **$12.4 million** $$ O&M = **$200–400,000/year**
Social and Environmental Benefits	LESS — $0.40 / $1.00 — $0.40 in benefits for each $1.00 Invested	MORE — $0.90 / $1.00 — $0.90 Benefits for each $1.00 invested = **2X benefit/cost**
City of Saint Paul Sustainability Indicators	**One** improved	**17** improved

Findings

The Hidden Falls Headwater alternative best supports sustainable redevelopment and the protection of water resources. Monetizing social and environmental benefits illustrates the full value of this infrastructure investment.

- Baseline and Hidden Falls Headwaters alternatives have construction costs of similar magnitude.
- The Hidden Falls Headwaters alternative greatly outperforms the Baseline (better on 17 of 18 sustainability indicators). This alternative:
  - Doubles the overall benefit-to-cost ratio when considering economic, social, and environmental factors.
  - Is nearly 75% more effective in protecting Hidden Falls Creek downstream.
  - Is more successful in mitigating urban heat island effects (25%) and reducing air impacts (27%).
  - Reduces the energy and materials used to create stormwater infrastructure by up to 32%.
  - Reduces the unit cost (capital dollars per acres served) required to manage stormwater by up to 40% (see page 10).
- Achieving "naturalized" flows to Hidden Falls Creek is feasible; recreating the historic headwater feature to Hidden Falls Creek is also feasible and paramount to achieving naturalized flows downstream.

Trade-offs associated with the Hidden Falls Headwaters approach have also been considered and include the following:

- Up to 6 acres of land of the 134-acre site will be required for green infrastructure; however, the elimination of underground storage would likely allow for denser development on the remaining developable land.
- Runoff from adjacent neighborhood(s) will need to be routed to the Hidden Falls Headwaters to control all flows to Hidden Falls Creek.
- The green infrastructure will demand greater operation and maintenance expense.
- The Hidden Falls Headwater alternative will require additional policy support because it reflects above-standard outcomes.

Recommendations

The Zoning and Public Realm plan should include:

- The centralized Hidden Falls Headwaters approach to stormwater infrastructure, recognizing the significant sustainable benefits which result.
- Use of design standards herein derived from the Atlas 14 precipitation estimates for maximum storm discharge (cfs).
- A benchmark SROI of not less than a 0.9 cost-benefit ratio for any stormwater design or alternative used on this site.

Implementation Road Map

- **Concept Refinement**
  - Further develop water budget for Hidden Falls Headwaters feature.
  - Develop the phasing scenario(s).
  - Further evaluate design constraints (e.g., grading, bedrock, soil, or groundwater impacts).
  - As planned development patterns become known, further optimize the system to fit seamlessly into the development.
- **Conceptual Design Development**
- **Zoning Master Plan**
- **Preliminary/Schematic Design Development**
- **Detailed Design Development and Construction Documents**
- **Construction**