Prepared for:
The City of Guelph

Stormwater Management Master Plan

Appendix S: Innovation Strategy

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Table of Contents

List of Figures

List of Tables

List of Appendices

1 Introduction

The City of Guelph Stormwater Management Master Plan (SWM-MP) is being completed to establish stormwater management policies and guidelines for the next 20 to 30 years, address stormwater infrastructure needs, and identify and prioritize recommended works. One component of the SWM-MP is the establishment of an Innovation Strategy. The City has indicated a desire to improve the lives of their residents and businesses through innovation, data and connected technology. This was recently represented in 2019 when the City of Guelph and Wellington County received $10 million in federal grant funding through the Smart Cities Challenge, with the vision of Our Food Future, Canada's first circular food economy. The SWM-MP continues in the spirit of the Smart Cities Challenge to pursue innovative, progressive and emerging ideas that touch on the economy, environment, governance and people in order to achieve a high quality of life for all the citizens and businesses of Guelph.

The City has developed an Innovation Framework **(Appendix A)**, which outlines the City's approach for developing new and innovative processes and solutions, as this report is just one of many innovation works being completed at the City. This report includes Steps 1 and 2 of this Framework (determining when to use the framework; and identifying problems, definitions, and solutions according to the Double Diamond). Future implementation work of the innovations provided below will complete Steps 3 and 4.

Some innovations have already been integrated into the SWM-MP, which are summarized in **Section 1.1**. Additional innovations have been identified in **Sections 3** to **5**, providing next steps that City may choose to pursue at a later date.

1.1 Climate Change

The extent to which climate change will impact precipitation patterns in a given location contains inherent uncertainties. These uncertainties arise in the difficulty of predicting the rate of change in greenhouse gas emissions; downscaling global climate models to a local level; and modeling how these emissions will predict precipitation patterns. Nonetheless, it is expected that climate change will result in increased extreme rain events in southern Ontario. As such, climate change mitigation and adaptation should be integrated into stormwater management activities.

Many of the innovations listed below have the potential to improve the City's SWM program, and as such, may help the City adapt to a future climate change scenario. Examples include, but are not limited to: increasing stormwater infiltration (**Sections 2.3, 5.4, 5.5**), or making existing infrastructure more adaptable through technological innovations (**Sections 3.1, 3.2, 3.3**).

2 Innovations Integrated into the SWM-MP

The SWM-MP has already integrated several innovations into its preferred alternatives. These are summarized below.

2.1 Subwatershed Health Analysis

As the SWM-MP will present a long list of works to be completed, it will be necessary to prioritize these projects to be completed as the City's budget and staffing allows. Projects are expected to include:

- stream restoration works to mitigate erosion issues,
- drainage system improvements,

- retrofits to SWM facilities to improve water quality control,
- new SWM facilities where there are opportunities to provide quality and quantity controls where they are lacking,
- SWM road retrofits, including Low Impact Development (LID) practices and storm sewer upgrades, to provide stormwater conveyance controls within the municipal right-of-way.

Many factors including budgeting, planning, and integration with other programs and projects will contribute to prioritization of these SWM projects. While SWM system improvements provide an enhanced level of service to the public, they also provide several environmental benefits by reducing the impact of urbanized landscapes on local creeks, rivers and wetlands. Enhancements to aquatic and riparian habitat can improve water quality, reduce erosion, improve the water balance, and built resilience to climate change.

To ensure subwatersheds that would benefit most from improvements to water quality and a more natural runoff regime are targeted for SWM projects through the implementation plan, a subwatershed health analysis was undertaken and will be used as a factor in project prioritization.

Business as Usual: Projects are implemented across the City, using existing prioritization criteria. Due to lack of data, the existing criteria may not be able to fully consider the subwatershed-level benefits of each project.

Innovation: Piloted in 2016 by Aquafor Beech, the subwatershed health analysis leverages existing City GIS data sets as well as existing information to generate four (4) traceable health metrics for including terrestrial ecology, aquatic ecology, stormwater management, and erosion condition.

Outcome: Projects located in subwatersheds found to be in poorer health will generally be prioritized to improve conditions within these subwatersheds. The use of GIS data sets will allow the City to regularly update the subwatershed health analysis, as projects are completed and monitoring fills in the data gaps and most importantly, track the City's progress in achieving the goals of the SWM-MP, subwatershed studies as well as the community.

Measurement of Success: The health of subwatersheds currently in poor health should improve as implementation of projects is prioritized in these subwatersheds.

2.2 LID Implementation

Low Impact Development (LID) implementation has been slowly increasing throughout the city, as private property owners, businesses, and the City recognize the numerous benefits associated with LIDs.

Business as Usual: Since the City requires development to achieve the pre-development water balance, LID implementation has been increasing. However, the City does not have a holistic approach for LID implementation.

Innovation: A guidance document is being prepared to outline recommendations for LID implementation in the City of Guelph, including which LIDs are supported by the City, in addition to recommendations regarding LID design, approvals, assumption, operations and maintenance, tracking, staffing, and budgets. The City is also requiring 5mm of volume control to be provided from all new development or redevelopment, infill and intensification.

Outcome: Broader implementation of LID features can provide the following benefits:

- Provide water quality treatment and erosion control, especially in areas without existing end-of-pipe stormwater facilities;
- Reduce surcharging in storm sewers;
- Restore pre-development water balance, if installed where full infiltration is possible.

Future integration opportunities exist with the City's Integrated Water Management Team regarding water balance determination, as LID implementation proceeds.

Measurement of Success: As LID features are gradually implemented throughout Guelph, the benefits outline above should occur.

2.3 Infiltration Policy

As the City moves towards the installation of more LIDs, it is critical that they are implemented without putting municipal water well supplies at risk and that all practices and approaches comply with the local Source Water Protection policies. The City has been ensuring that implementation of LIDs on Industrial, Commercial or Institutional (ICI) properties is in compliance with Source Water Protection.

Business as Usual: Source water protection is considered on a case-by-case basis as infiltration facilities are proposed. This creates uncertainty in the development community, and extended review times as the City determines whether to accept a proposed infiltration facility.

Innovation: The City of Guelph is now one of only 3 ground-water dependent municipalities in Ontario (the others being the Cities of Kitchener and Waterloo) to have a dedicated Infiltration Policy. This is a new approach of defining infiltration opportunities and constraints using a risk-based approach based on current and future risks.

Outcome: The policy was developed to contextualize infiltration in existing policies, including the Grand River Source Protection Plan, the City's Official Plan, and the Provincial Policy Statement, among others, and to implement a risk-based approach to where infiltration facilities may be installed, with the goal of streamlining design and approvals, targeting areas where achievable outcomes for water quality, erosion control and groundwater recharge can be realized without placing the City's drinking water at risk.

Measurement of Success: Infiltration features will be installed in locations throughout Guelph, but will not negatively impact drinking water quality. The Infiltration Policy will set clear expectations for the City and for private property owners, enabling consistent messaging to all proponents.

2.4 Leveraging Infrastructure

Business as Usual: Stormwater infrastructure is currently integrated into the City's trail system in some parts of the City of Guelph. It is the City's intention to continue to implement stormwater management trails, as outlined in the 2021 Guelph Trail Master Plan.

Innovation: SWM presents an incredible opportunity to leverage capital construction dollars to provide social and cultural services and amenities within the urban environment. This requires a multi-functional approach to SWM design that brings together physical and social infrastructure to create diverse, meaningful and engaging urban spaces. Infrastructures like SWM facilities provide a high return on

investment (ROI) when it comes to flood damage avoidance, climate change preparation as well as water quality improvements.

Outcome (Example): Saigon Park in Mississauga has the capacity to control the 100-year storm generated by a 605-hectare drainage area (**Figure 2.1**). The City's investment in the park promises an ROI of just 1.2 years when considering average annual cost of damages due to flooding for both the public and private sector. In addition, by integrating SWM and social infrastructure, municipalities found substantial cost savings associated with efficiencies in parkland development and acquisition. Again, the investment in Saigon Park represented approximately 35-40% cost savings when considering the City's average spending on park space of similar size.[1]

Figure 2.1: Saigon Park, Mississauga (2022)

Measurement of Success: SWM blocks will provide additional social and cultural opportunities as a multi-functional space.

3 Technological Innovations

As society's technical abilities continue to expand, additional innovations arise that enable higher levels of technology to be implemented as part of an improved stormwater management system.

[1] In the City of Guelph, SWM facilities would not be part of parkland dedication, but would be kept separate as a SWM facility that is also more publicly usable. This could include retrofitting existing SWM facilities to include social and cultural amenities, without impacting parkland dedication.

3.1 Real-Time Remote Controls

Business as Usual: The controls on most City infrastructure are passive, and are only triggered when water levels reach a certain level.

Innovation: Technology today has reached a point where real-time data is both cost effective and achievable, and can be obtained remotely. The availability and use of cellular enabled monitoring devices present a real opportunity for the City to predict, react and monitor stormwater system and assets during rainfall events.

Outcome: Examples of real-time monitoring which may be beneficial to the City of Guelph include, but are not limited to:

- Water quantity monitoring of SWMF – Water level monitoring can indicate when the stormwater facility is holding water for too long (e.g., if the outlet is clogged and requires maintenance) or if the facility drains too fast (e.g., indicating the presence of a leak requiring maintenance or an oversized outlet requiring replacement).
- Water quality monitoring of SWMF – Water quality monitoring can ensure the facility is achieving the design goals (e.g., long-term average of 80% TSS removal), and can indicate when pond retrofits are therefore required if these design objectives are not being met.
- Strategic storm sewer monitoring – Flow monitoring can be used to identify and resolve storm and sanitary cross connections as well as optimize sewer capacity.

Measurement of Success: Real-time and remote controls allow for staff to more effectively and efficiently identify maintenance needs throughout the SWM system.

3.2 Predictive Modeling

Business as Usual: Currently, the City's Public Works uses weather forecasts to perform street sweeping and catch basin cleanout in flood-prone areas.

Innovation: The majority of rain events are predicted several days in advance through weather forecasting. Radar provides an additional level of detail in the hours leading up to a rain event. The combination of real-time controls of SWM infrastructure (e.g., outlet controls) and rainfall predictions (when used in combination with models of the City' stormsewer system) can be a powerful tool to manage the City's stormwater infrastructure.

Outcome: A warning of an upcoming rain event can be used to:

- Open valves in the City's stormwater facilities and ensure that there is adequate storage prior to the arrival of the storm;
- Implement flood risk plans for high risk neighborhoods;
- Dispatch City forces; and
- Notify residents, fire and police services.

The City has a network of existing rain gauges, and the SWM-MP has recommended additional rain gauges to have sufficient coverage across the City. When a high-intensity or long-duration storm event is recorded, the City can also use this to trigger inspections of vulnerable stormwater infrastructure.

Measurement of Success: The City is more prepared for large storm events, resulting in fewer flooding complaints and more efficient use of resources during and immediately after a large event.

3.3 Smart City Opportunities

Business as Usual: Existing information and communication technologies are used to obtain a limited amount of information, which must be manually interpreted before implementing any changes to the stormwater system. Through FlowWorks, the City currently has access to three (3) rain gauges and ten (10) water quality monitors.

Innovation: Real-time controls and predictive modeling can be integrated into a Smart City framework. A Smart City framework for stormwater management would use information and communication technologies to manage stormwater infrastructure.

Outcome: Examples of this include:

- Adaptive Flow Management – With predictive modeling, real time rainfall data, and real-time controls, the City would be able to facilitate automated or guided stormwater release valves to adaptively respond to potential flood conditions, optimize sewer capacity or release ecological flows based on the watershed's needs. For example:
    - Blue roofs are designed to store stormwater after a rain event, and then slowly release it into the storm sewer system. Valves can hold water on the roof for an extended period of time if the downstream storm sewer network is overwhelmed. Similar valve systems can be installed in other facilities that store stormwater, such as stormwater management facilities (dry ponds, wet ponds and subsurface storage facilities), bioretention systems, infiltration galleries, or cisterns.
    - Public spaces that would typically only be used in nice weather (i.e., outside of rain events) can be created to be floodable, providing opportunities to store stormwater during and immediately after a rain event, then slowly discharging it back to the downstream storm sewer network. **Figure 3.1** presents an example of a floodable plaza, used for street hockey in nice weather and for stormwater storage during rain events. Adaptive flow management would be used to regulate when the plaza is flooded.

  Adaptive flow management measures should be installed only if the City has implemented predictive modeling (see **Section 3.2**) to ensure that all stormwater storage is available when a large rain event is forecast.

Figure 3.1: Floodable plaza using real-time control

- Moisture sensors in LIDs – During extended dry periods, moisture sensors can provide an indication of when plants need watering to ensure the vegetation remains vigorous throughout the growing season.

- Heated Sidewalks – These sidewalks are constructed with a built-in heating system which is activated when ice or snow is present, melting the ice or snow without requiring plowing or the application of road salt. Heating sources can be conventional systems (electrical systems etc), geothermal, recovered heat from wastewater systems or manufacturing processes. Heated sidewalks may be beneficial from a Source Water Protection perspective, as they reduce the use of salt.

Measurement of Success: Since many older neighbourhoods of the City do not currently receive any kind of SWM control, the use of Smart City technologies could provide additional opportunities for adaptive flow management in these neighbourhoods, thereby reducing flooding issues. Other measurements of success can include reduced salt application (heated sidewalks) or healthier plants in LIDs (moisture sensors).

4 Social Innovations

While stormwater management has historically been viewed as a technical process, there are actually many opportunities to integrate the community into the SWM process, and for SWM infrastructure to be part of the community.

4.1 Equity, Diversity and Inclusion

Business as Usual: The City has considered Equity, Diversity and Inclusion as part of the Clair-Maltby Secondary Plan, where SWM blocks have been designed to be multifunctional and increase equity in the provision of neighbourhood amenities. The City does achieve high levels of engagement throughout the City as part of the current practices.

Innovation: Community engagement is a valuable tool when seeking to address issues of equity, diversity and inclusion within SWM. The land made available by SWM blocks present endless opportunities to tailor spaces in every neighbourhood to the needs and desires of that particular community (consistent with Natural Heritage Systems). The design of multifunctional SWM blocks requires investment in a range of community engagement tools.

Outcome (Example): The Town of Newmarket has used community bazaars, brainstorming session and immersive experiences and public design charrettes effectively in reaching residents and collecting valuable information pertaining to that community's immediate needs and their desires for the future. This information was then used to form the framework for conceptual designs that are truly community oriented.

Figure 4.1: iWonder Community Engagement Events, Town of Newmarket (2018)

By considering the community in the early stages of the design process, the SWM block can become a highly utilized space within the neighbourhood. In some cases, bringing the community together enables community lead initiatives that revolve around the SWM block and the amenities and programs it supports. Aquafor has seen community groups take ownership of SWM blocks such as Saigon Park, where the local Vietnamese Canadian community has come together and committed to contributing to

maintenance, programming and event coordination. These spaces become extensions of the community's homes and provide an opportunity to engage with each other and the nature around them but it also contributes to the long-term sustainability of the park.

Figure 4.2: Saigon Park, Mississauga Grand Opening Celebrations led by the local Vietnamese-Canadian Community (May 14, 2022)

An additional outcome of a renewed focus on Equity, Diversion and Inclusion can include exploring ways to make the City's SWM rebate and credit programs more inclusive for the community, and consider how these programs can be made more equitable and diverse.

Measurement of Success: SWM blocks are better used by the surrounding communities, as they meet the needs and desires of that particular community. Uptake of the City's SWM rebate and credit programs is improved by being more inclusive.

4.2 Circular Economy

Business as Usual: To date, most of the City's stormwater infrastructure has been developed for the sole purpose of stormwater management. The City offers rebates to residents who install rainwater harvesting systems for the purposes of reusing stormwater, but uptake for these rebates has been limited.

Innovation: The 21st century city can no longer afford to treat stormwater as a waste, but must instead treat it as a resource. Multi-functional SWM design supports circular economies by creating

opportunities to both celebrate water and take advantage of its presence within the urban environment, thereby increasing biodiversity in urban environments and providing opportunities for beneficial reuse.

Outcome: Multi-functional SWM design can utilize stormwater runoff to support diverse urban terrestrial and aquatic ecology within pond blocks. It can be used to cool the urban environment, mitigating against urban heat island effect and helping to create comfortable spaces during hot weather events forecasted to occur at greater frequency due to climate change. Capture and storage of treated stormwater also has the potential to be used for non-potable applications such as restrooms and irrigation of plant material. As the City works to improve water conservation through the 2016 Water Efficiency Strategy, application of a circular economy that considers water supply, stormwater, and wastewater will help to achieve the objectives of all three.

Rain water cistern in an industrial/commercial application at the Brampton Flying Centre, Cheltenham (**Figure 4.3**) provides a reservoir for water to be used during a fire as well as water for toilet flushing and industrial uses.

Figure 4.3: Rain water cistern at the Brampton Flying Centre, Cheltenham

SWM facilities accumulate sediment, which must be removed from the facility on a regular basis. Instead of treating this sediment as a waste product, this sediment may be reused elsewhere, provided the quality meets Provincial guidelines.

Measurement of Success: Stormwater is treated as a resource, both for human use and for the natural environment. This ultimately reduces stormwater runoff, and reduces downstream impacts of this runoff. SWMF sediment is re-used whenever possible, reducing the City's costs for sediment disposal.

4.3 Public Education

Business as Usual: The City currently works to raise stormwater awareness in the community through:

- Stormwater booth at special events,
- Public workshops,
- Social media communication,
- In-class school programs,

- Storm pond tours, and
- Education and promo videos.

Innovation: Multifunctional SWM design also presents opportunities for public education. This can take many forms whether through traditional signage and wayfinding or through more advanced methods such as public art installations, public engagement sessions and water-centred playground design. All options work to connect the public, young and old, to the land, conveying the relationship between built form and the natural world that supports us.

Outcome (Example): As the first-of-its-kind project in Ontario, the Town of Newmarket Rain Park, conceptual design integrates stormwater infrastructure with the community's desire for recreational programming. Programmed spaces focus on enabling interaction with, and celebrating water including; rain symphony instruments, a sunken playground, a waterfall feature powered by bicycle and hand pumps and a rain theatre with integrated lighting and sound systems for community events and performances. Simultaneously, the Park will provide critical water balance, water quality and quantity benefits, including phosphorus reductions. Reforestation, enhanced meadow and wetland communities in addition to pollinator gardens and orchards will both increase species diversity and improve evapotranspiration and water retention capacities as well provide a local food source. Traditional infrastructures have been designed to ensure rain events do not leave the site, providing significant water quality and quantity benefits. Facilities include; a dry pond and low flow dry swale, subsurface storage composed of recycled shipping containers, constructed wetlands, Oil Grit Separators (OGS) and a range of LID features.

Figure 4.4: Philmore Hamilton Rain Park, Newmarket – Design Visualization (2019)

Measurement of Success: Public engagement as part of SWM processes becomes more engaging, providing more opportunities for the public to respond and contribute to the designs of SWM in their communities.

5 Policy Innovations

The City has opportunities to set policies that apply to stormwater management, both for private and municipal approaches. These opportunities are listed below.

5.1 Asset Management Considerations

In 2017, Ontario passed legislation O. Reg. 588/17, the Asset Management Planning for Municipal Infrastructure, requiring municipalities to complete asset management plans that include reporting on existing levels of service for stormwater and defining desired levels of service to be achieved through asset management planning initiatives. O.Reg. 588/17 also requires every municipality to develop Strategic Asset Management Policies which consider the actions that may be required to address the vulnerabilities that may be caused by climate change to the municipality's infrastructure assets, in respect of such matters as operations, such as increased maintenance schedules, levels of service and lifecycle management. The City of Guelph developed a "Core Asset Management Plan" in 2021 to meet requirements associated with the level of service and lifecycle management planning frameworks for transportation, water, wastewater and stormwater assets.

The asset management planning initiatives undertaken to satisfy O.Reg. 588/17 offer an opportunity for municipalities to establish stronger links between stormwater levels of service, climate change risk and implementation of watershed planning recommendations and targets to protect subwatershed health.

Business as Usual: The City is complying with O.Reg. 588/17, but to date, has not explored additional opportunities for asset management. The City also recently completed a pilot project focused on natural assets and stormwater management.

Innovation: Asset Management considerations moving forward with both Stormwater Management Master Plan Implementation, especially in the context of the City's subwatershed planning initiatives, include:

- **Continual Funding to maintain / improve Level-of-Service Parameters in light of Cumulative Impacts:** Where a stormwater level of service is deemed to be acceptable considering both climate change pressures, increased demand caused by population and employment growth, and subwatershed needs, the cost to maintain this level-of-service should be allocated to stormwater management funding. Where the projected level of service is unacceptable (i.e., does not meet the desired level of service) considering climate change pressures, increased demand caused by population and employment growth, and subwatershed needs, costs to improve the level of service should be calculated as part of the evaluation process associated with future stormwater initiatives. Lifecyle management and financial/ funding strategies to meet the desired level of service(s) should be detailed as part of any update to stormwater management or subwatershed-level implementation planning initiatives. This must include estimated capital expenditures and significant operating costs to achieve and maintain the proposed levels of service(s). This financial strategy must include costs related to new construction or to upgrading of existing municipal infrastructure assets to meet the proposed levels of service, and to replace assets as they reach their end life. These plans should prioritize,

with an associated timeline, the work to be undertaken to achieve the Level of Service objectives.

- **Consideration for Enhanced Environmental Level of Service frameworks associated with Stormwater Management:** Although the technical metrics associated with stormwater management assets are defined by O.Reg. 588/17 as "Percentage of properties in municipality resilient to a 100-year storm" & "Percentage of the municipal stormwater management system resilient to a 5-year storm", additional metrics that incorporate environmental targets related to treatment, water balance and subwatershed specific objectives may prove beneficial to include in future asset management planning endeavours.

- **The expansion of Asset Management categories beyond "Core Assets":** In order to protect natural heritage features and ensure form and function are preserved within an urban context, "Natural Assets" may be defined. To do this, a detailed municipal asset inventory identifying extent and quality is the first step. Natural assets may include watercourses, wetlands, woodlands, urban trees, urban parks, aquifers, shoreline features, natural habitat, etc. Collaboration with Conservation Authority staff may be needed to discuss existing data sets, additional data needs, terminology, data collection practices and storage formats, associated attributes, spatial and temporal resolution, monitoring/assessment synergies and level of detail. The City has already completed a pilot project focused on natural assets and stormwater management.

Outcomes: By considering cumulative impacts, setting additional asset management targets, and identifying and classifying Natural Assets, the City is better able to allocate budgets and staffing to protecting and enhancing these assets. Since a core component of an Asset Management Plan includes valuing assets, this also enables the City to define replacement or rehabilitation costs if natural heritage features are damaged or require removal management.

Measurement of Success: Natural assets are fully integrated into the City's Asset Management Plan, and are thereby better protected and enhanced. Asset management is directly connected to subwatershed planning initiatives.

5.2 Integrated Subwatershed Monitoring Program(s)

Business as Usual: The City currently operates a stormwater management facility monitoring program, wherein several facilities are monitored each year. The Grand River Conservation Authority (GRCA) monitors water quality in several watercourses in the City. Data may be shared between the City and GRCA on an as-needed basis. The Natural Heritage Action Plan (2018) also includes the following recommendations, which the City is committed to implementing:

- Action 3: Launch a city-wide environmental monitoring program which establishes protocols to assess and monitor a suite of biodiversity and ecosystem indicators at three spatial scales: species, community and landscape.
- Action 5: Enhance and expand the stormwater management monitoring program to assist in improving the hydraulic performance of stormwater management facilities and downstream health of receiving watercourses.

Innovation: Comprehensive long-term subwatershed -level monitoring programs undertaken by the City and/or GRCA can play a role in analyzing the impact of stormwater management strategy implementation programs on local receivers; however, it is expected that to support long-term monitoring and adaptive management needs, additional monitoring will be needed to capture impacts at the reach, catchment, and/or natural heritage feature-level.

One way in which the link between subwatershed health and stormwater management can be strengthened is collaborative monitoring programs between conservation authorities and municipalities. Through this approach, Integrated Monitoring and Adaptive Management Plans developed at the subwatershed level would be designed to provide feedback on key subwatershed system performance indicators potentially impacted by municipal infrastructure at key nodes in the subwatershed with input from municipal infrastructure mangers. To allow for adaptive management to be undertaken in an effective manner, infrastructure performance monitoring data related to subwatershed health (e.g., stormwater chemistry, stormwater temperature and flows at outfalls, etc.) should be analyzed for target exceedances and trends along with subwatershed health data in catchments / reaches of interest. Infrastructure monitoring programs undertaken at the municipal level should also be flexible and agile and should focus the need to be shifted to new areas of concern or to changing key performance indicators / parameters of concern for subwatershed health. This approach requires continued long-term collaboration between watershed science management at conservation authorities and infrastructure managers at local municipalities.

Integrated monitoring and adaptive management plans typically include key performance indictors associated with specific attributes that contribute to four core (sub)watershed systems identified in **Table 5.1.**

Table 5.1: Subwatershed Systems Monitored as Part of a Subwatershed Study

(Sub)watershed System Components / Natural Assets	Attributes
Groundwater Resources	Groundwater levels and groundwater chemistry
Forests and Woodland Ecosystems	Tree health and dead wood, species composition, soil conditions, plants, birds and salamanders
Wetland Ecosystems	Species composition, plants, frogs, tree health and dead wood
Watercourses and Surface Water Resources	Stream stability, riparian plants, flow rate, water chemistry, water temperature, fish and aquatic invertebrates

In 2022, many municipalities in Ontario will be transitioning to a Consolidated Linear Infrastructure (CLI) Permission Approach to the approval of municipal sewage collection and stormwater management systems, including all sanitary sewers, pumping stations and stormwater facilities, within their municipal boundaries. The system-wide focus of this approvals approach presents opportunities for collaboration between subwatershed managers and municipal infrastructure managers as studies, monitoring plans / programs and reporting will be required to support consolidated approvals. It is recommended that feedback from monitoring programs established for the CLI approvals process be integrated with subwatershed-level monitoring to facilitate establishing connections between infrastructure

management and subwatershed health. This can realistically be done using a geodatabase or simplified data tracking system containing information on (sub)watershed-level monitoring and monitoring associated with those CLI projects with connections to subwatershed health (e.g. stormwater quality, storm system flow, etc.). Such a tool should be accessible by both conservation authority and municipal staff. The MECP is currently developing a monitoring guidance document that will assist municipalities in developing monitoring plans for authorized stormwater systems undertaken through the CLI process.

Outcomes: Long-term integrated monitoring and adaptive management plans can be used to gauge whether a preferred strategy is effective in meeting short, medium and long-term targets associated with hydrology, hydrogeology, terrestrial ecology, fluvial geomorphology, water quality and aquatic biology. An integrated monitoring and adaptive management plan can also be connected to the Subwatershed Health Analysis (**Section 2.1**), providing additional data for prioritization of subwatersheds.

Measurement of Success: Long-term integrated monitoring and adaptive management plans are used to gauge whether a preferred strategy is effective in meeting short, medium and long-term targets associated with hydrology, hydrogeology, terrestrial ecology, fluvial geomorphology, water quality and aquatic biology. They are also used to identify whether changes in the strategy are necessary to meet the targets.

5.3 Credit Trading

Business as Usual: The City of Guelph's existing stormwater credit program allows owners of industrial, commercial, institutional and multi-residential properties of six units or more to receive savings of up to 50% on their stormwater bill. This program incentivises private stormwater controls that reduce peak flows, reduce volume discharged to the municipal stormwater conveyance system and/or provide water quality enhancement. Non-structural measures such as education programs and pollution prevention / risk management practices may also qualify for credits.

Innovation: At this time, stormwater credits are not transferable. Depending on local market forces, a credit trading system may incentivise additional uptake of private property stormwater controls. A Credit Trading Study would first be necessary to gauge feasibility. Typically, a credit trading program would include the following elements, although these can be modified as necessary to meet local needs:

- Agency with sufficient staffing and funding to manage the program, allowing for the selling or trading of stormwater credits. This enables the implementation of stormwater controls in areas not currently undergoing development, while adding flexibility to areas being developed for how they choose to meet their required level of stormwater control.
- Clear requirements for the minimum level of SWM controls to be implemented on-site and the maximum amount of credits that can be purchased to achieve the total control required (e.g., runoff from the 90th percentile event);
- Clear requirements for the maximum amount of control that can be implemented on a site selling credits (e.g., whether it can exceed the 90th percentile event); and
- Fee in-lieu of stormwater controls for developments unable to provide sufficient SWM controls on-site and unable to purchase credits. This fee acts as an effective price ceiling for credits and should be regularly updated to account for inflation.

Example (Outcome): Washington, D.C. implemented the first stormwater credit trading program in the United States in 2013. While Washington, D.C. requires developments to retain stormwater from the 80th to 90th percentile rain event, depending on the extent of the development. Of this volume, 50% must be managed offsite, but the remainder can be provided by paying a fee in-lieu of retention or by purchasing offsite Stormwater Retention Credits (SRCs). A price floor (i.e., the Price Lock Program, an $11.5 million fund to purchase SRCs by the Department of Energy and Environment) and a price ceiling (i.e., the in-lieu fee) help to create stability and confidence in the credit trading program (MPC, 2019). By taking this flexible approach, the City found numerous benefits (EPA, 2020; MPC, 2019), including:

- Amenity space could be optimized at the site undergoing development;
- Revenues were increased, as the development could provide more underground parking;
- Structures and stormwater management systems were less expensive;
- Additional stormwater infrastructure has been constructed in areas that are not undergoing development, but which are still deficient in stormwater management;
- By distributing stormwater infrastructure, more runoff from events smaller than the 90th percentile event is captured. For example, in Washington, D.C., the 90th percentile event is 1.2 inches. If the site manages 0.6 inches on-site and 0.6 inches off-site, then more volume would be controlled than if 1.2 inches was controlled on-site (**Figure 5.1**).

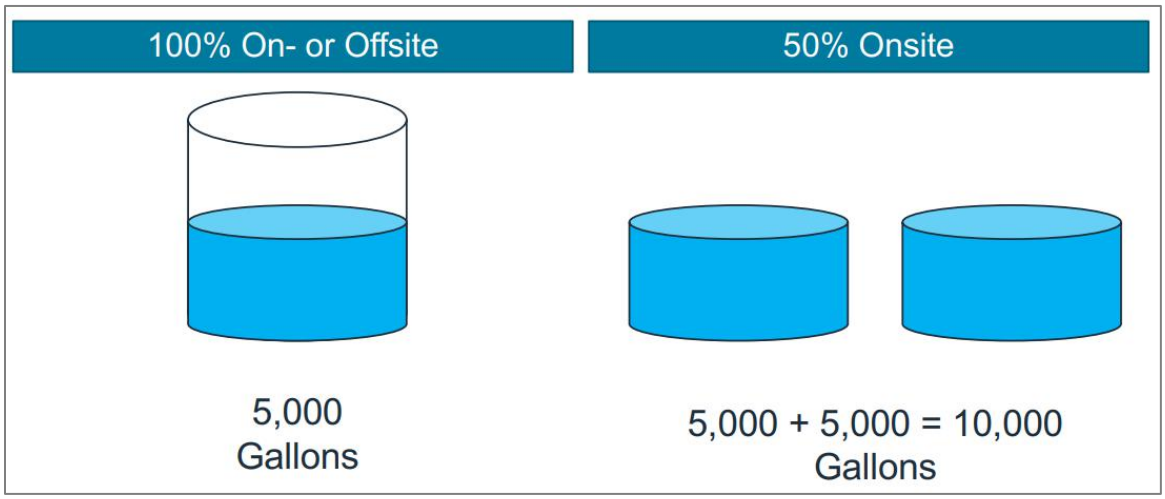

Figure 5.1: Comparison of a 0.6 inch rain event if 100% of the 90th percentile event is captured on-site (left) versus 50% on-site (right) (EPA, 2020)

Measurement of Success: The City will obtain additional funding sources which can be used to implement SWM infrastructure in areas that are deficient, without having to rely entirely on the stormwater fee. SWM controls are installed in more areas of the City, providing controls to areas that are currently uncontrolled.

5.4 Infiltration Policy Update

Business as Usual: An Infiltration Policy was developed for the City of Guelph as part of the SWM-MP. This policy states that at the City's discretion and on a case-by-case basis, for sites located within 200 metres of a surface water receiver, an appropriate analysis may be conducted including, but not limited to, a site-specific hydrogeological study to determine the ultimate fate of infiltrated water. Despite

restrictions placed on infiltration due to WHPA Vulnerability Scoring in the Infiltration Policy, infiltration of road runoff may be permitted if the ultimate fate of infiltrated road runoff is determined, through a site-specific hydrogeological study, to be a surface water receiver.

Innovation: Across the City, some water that is infiltrated will ultimately discharge to surface water bodies, and not to groundwater. This may include areas that are currently designated as Wellhead Protection Areas (WHPAs), but which are in close proximity to a surface water body, and therefore discharge to that surface water. Using particle tracking, it is possible to create mapping that differentiates between surface water and groundwater discharge points.

Outcome: The particle tracking results can then be used to refine and update the City's Infiltration Policy. Identifying areas of the city that discharge to surface water receivers, despite being in a WHPA, would therefore expand the areas of the city where infiltration LIDs may be permitted, without putting drinking water sources at risk. For example, the City of Kitchener is currently updating their Infiltration Policy using the approach outlined above, and is generally finding that opportunities for infiltration have expanded by identifying which parts of the City actually discharge infiltrated water to surface water bodies.

The Clythe Creek Subwatershed Study (ongoing) is including particle tracking, which may be used for future updates to the Infiltration Policy. As the City will be completing more subwatershed studies in the future, the particle tracking work may be done on a city-wide basis, or on a subwatershed basis.

Measurement of Success: Infiltration facilities will be permitted in more areas of the City, without impairing the City's drinking water sources.

5.5 Social Marketing and Market Transformation

While source LIDs are highly effective at reducing run-off volumes and contaminant loadings, uptake by private landowners has been low throughout the City, as is typical in most Ontario municipalities. One way of addressing this challenge is through social marketing and market transformations.

Business as Usual: The City offers some financial incentives for implementing source control LIDs, but the marketing of these incentives has generally been limited.

Innovation: Social marketing and market transformation refer to changing or maintaining people's behaviour for the benefit of individuals and society as a whole. For LID programs, a market-based approach is a multi-step process that involves analysing current market research, identifying target marks and creating a program to best benefit the scope and goals of an LID project. Marketing can be targeted to similar demographics with similar belief systems, connecting with people's intrinsic beliefs to motivate them to incorporate LID practices on to their private property.

Outcome: Past market research in southern Ontario has shown that people care about the landscapes of their community but do not necessarily connect with the idea that their home is part of the greater landscape. Community visioning and social marketing allow residents to participate in creating their community and allow them to take pride in the surrounding environment while also improving stormwater management practices, which benefits the City and helps reduce the overall SWM burden on the municipality.

Measurement of Success: Uptake for construction of source controls among private property owners will increase significantly, reducing the pressure on the City's stormwater infrastructure.

5.6 One Water

Business as Usual: Stormwater, drinking water, and wastewater are generally considered separately by the City of Guelph, although compliance with Source Water Protection does mean that stormwater and wastewater systems consider impacts to drinking water. The City is currently beginning the development of a One Water strategy as a separate process.

Innovation: A "One Water" approach is an integrated planning and implementation process that includes the urban water cycle as a whole, interconnected system. Urban water flows, including drinking water, groundwater, stormwater, and wastewater, can be considered holistically to allow the municipality to better assess their combined impact on flooding, water quality, wetlands, watercourses, and groundwater. By using existing infrastructure, conserving water, and encouraging reuse of treated wastewater, the need for building new infrastructure is minimized, and the water balance and hydrologic regime are improved for the Natural Heritage System.

Example (Outcome): York Region has implemented a One Water approach, with the following guiding principles:

- Innovation: practice and explore new concepts and ideas to promote cost efficiency and environmental sustainability;
- Integration: take a coordinated, holistic approach to water resource management; and
- Infra-stretching: maximize the useful life and capacity of built infrastructure to minimize or defer capital investment

In 2017, York Region released its first One Water Action Plan. The action plan brings together existing programs and identifies new opportunities that promote integrated water resource planning and innovation. The plan foresees inflow and infiltration reduction, water conservation and water reuse, as fundamental elements of the Region's water system and encourages greater conservation and the use of natural processes to manage water. It finds valuable new sources of water such as rainfall, snow melt and the safe reuse of treated wastewater. Water conservation, inflow and infiltration reduction efforts help sustain existing sewer infrastructure by reducing wastewater flows, thereby "infra-stretching" or maximizing the existing capacity of the infrastructure.

Measurement of Success: Stormwater, drinking water, and wastewater are considered holistically and as interconnected resources. Existing infrastructure is better used; water conservation has increased; reuse of stormwater and treated wastewater has increased; the need for building new infrastructure is minimized, and the water balance and hydrologic regime are improved for the Natural Heritage System.

5.7 Non-Traditional Policy Alternatives

Business as Usual: Most of the City's existing policies are targeted towards traditional stormwater implementation.

Innovation: While physical measures, by-laws and program can be implemented to better serve the City of Guelph, numerous North American jurisdictions are experimenting with non-traditional policy alternatives. The alternatives can operate outside the typical municipal structure and utilize a wide

range of approaches to achieve a common goal of improved stormwater control for a reduced overall cost.

Outcomes: Non-traditional policy alternatives which have been implanted in other jurisdictions based on a best-in practice review include:

- **Economic Value for Ecological Service** - Based on the 2005 UN Millennium Ecosystem Assessment Report, this method allows private land owners to maintain or modify their land to meet SWM targets to receive payment for the services being provided by their land. For example, in South Florida, a program targeted at flood control and nutrient management for Lake Okeechobee used private land agreements to store over 54 million cubic metres. The South Florida program contributes to upfront infrastructure requirements and pays a monthly maintenance fee to the land owner. The fee of $0.02-0.16 per cubic metre is cheaper than conventional SWM infrastructure.

- **Expedited Review Processes** – Municipalities can choose to expedite review processes to promote the uptake of a desired outcome, such as LID implementation. Over 40 jurisdictions in the U.S. and at least 2 Canadian jurisdictions have formal expedited review processes. Expedited permitting is one of the most popular green incentives among developers. For example, the City of Chicago has implemented a Green Permit Program, which processes permits in 30 days, instead of 60-90 days (TetraTech, 2015). A 2005 study by the American Institute of Architects found that implementation of a more responsive permit process over a five-year period could result in a 16.5 percent increase in property taxes and a 5.7 percent increase in construction spending (NEC, 2005). In 2011, “Green Development Incentive Programs Phase One Investigation: North American Case Studies” (econnics, 2011) was prepared for the City of Guelph, which included opportunities for expedited review processes.

- **Integrated Design Process (IDP)** – This is often done in conjunction with expedited review, where all parties come together to identify and scope issues and collectively work on solutions. Enbridge has funded an IDP program for Ontario developers focusing on efficiency improvements for energy, water, heating etc. for over 15 years through its Savings by Design program.

- **Green Development Standards** – The City of Guelph Natural Heritage Action Plan identified Action 29: “Prepare green development standards which will be used to assist in evaluating the environmental sustainability of development proposals and capital projects through the application of sustainability metrics.” This has been completed by the City of Toronto, whose Green Standard addresses air quality, energy use, greenhouse gas emissions, stormwater runoff, potable water consumption, protection and enhancement of ecological functions, and diversion of waste.

- **Grid/Communal LID** – LIDs constructed on a private property typically only control the runoff from that property. However, a grid, or communal, LID system may be possible by aggregating runoff from multiple properties to be controlled by one LID system. Economies of scale can therefore be introduced by only requiring one designer, one contractor, and one operations and maintenance contractor, while optimizing LID performance. The Drainage Act provides a mechanism for communal drainage works on private lands, which would include communal LIDs. Credit Valley Conservation has been investigating opportunities for grid or communal LID

systems, and has developed a draft system for the Southdown area in Mississauga, which was found to be more cost effective than traditional approaches of municipally owned and operated stormwater facilities (James and Menken, 2021).

- **Mandatory private SWM for industrial lands** per the Ontario Water Resources Act (OWRA) O.Reg 525/98 subsection 53(1) and (3), all industrial lands have lost their ECA exception, meaning that they will require a ECA from the MECP for their stormwater discharges. Private facilities reduce the size of conveyance systems, capital costs and operation and maintenance. Operations and maintenance costs are transferred to the private owner per the conditions of the site plan approval, by-laws and ECA requirements. For example, the City of London has made private stormwater facilities part of their regional stormwater strategy for medium and high density residential, as well as industrial, commercial and institutional properties. London enforces compliance in coordination with the MECP, and uses the Business Licencing renewal process, as well as sewer by-laws to ensure compliance.

Measurement of Success: The policy updates described above increase LID uptake throughout Guelph, thereby reducing pressure on the City's SWM infrastructure and providing SWM controls to areas which may not currently have any controls. The Natural Heritage System is better valued and protected.

6 Resourcing

Table 6.1 presents high level estimates for human and financial resourcing requirements for each of the innovations listed in **Sections 3** to **5**.

Table 6.1: Comparative Resourcing Needs

	Innovation	Human Resource Needs*	Financial Resource Needs**
Technological Innovations	Real-Time Remote Controls	Medium	High
	Predictive Modeling	Medium	High
	Smart City Opportunities	Medium	High
Social Innovations	Equity, Diversity and Inclusion	Medium	Medium
	Circular Economy	Low	Medium
	Public Education	Medium	Low
Policy Innovations	Asset Management Considerations	Low	Low
	Integrated Subwatershed Monitoring	Medium	High
	Credit Trading	High	Medium
	Infiltration Policy Update	Low	Low
	Social Marketing and Market Transformation	High	Medium
	One Water	Medium	Medium
	Non-Traditional Policy Alternatives	Medium	Low
* Low: 0.5-1 FTE Medium: 1-3 FTE High: 3-5 FTE			
** Low: <$250,000 Medium: $250,000 – $5,000,000			

High: >$5,000,000

6.1 Integration into Existing City Priorities

The City has many existing priorities; the addition of new processes, programs and projects must therefore be considered in the context of what is currently ongoing. The innovations listed above would not generally replace any existing processes, programs and projects, but would supplement and support the City's ongoing priorities. Some considerations include:

- The technological innovations provided in **Section 3** would increase the City's asset load, and would therefore impact asset management. Costs would include the acquisition of technology, its maintenance, and its replacement at the end of its life.
- The SWM-MP recommended that the City use the cost estimates from the SWM-MP as well as the conclusions from the ongoing Utility Rate Study to determine any future updates to the Stormwater Service Fee. The implementation of any additional innovations from this strategy would also need to be considered in the context of achieving sustainable funding from the Stormwater Service Fee.
- The City already has stormwater assets which were found to be undersized according to the City's current stormwater design guidance. As such, the SWM-MP recommended upgrading these assets to meet current guidelines. However, if financial and human resources are limited, the City would need to decide whether to upgrade deficient infrastructure, or implement new innovation strategies. This prioritization of resources will have to be determined through the City's capital budgeting and human resourcing processes, considering the context of all organizational priorities

7 Next Steps

Innovations listed in **Section 1.1** have been evaluated through the SWM-MP, while **Section 5.4** (Infiltration Policy Update) was added as a recommendation in the SWM-MP Implementation Plan, arising from the development of the City of Guelph Infiltration Policy.

In addition, the City has indicated that pursuing a Social Marketing and Market Transformation approach to increase uptake of source LID controls on private property should be included in the SWM-MP Implementation Plan. In order to generate uptake of at-source SWM and pollution prevention practices and measures by residential and industrial/commercial property owners, a "made in Guelph" market-strategy would need to be developed. A preliminary Market Research Study is therefore recommended to determine viable alternatives to current SWM programming. Market-based research involves market segmentation and analysis to determine constraints and opportunities in each market segment and across market segments or sectors. It is recommended that single-detached dwellings and industrial and commercial property owners/managers are the target sectors for the primary market research. Once the Market Research Study is complete, a Market-Based Strategy can be developed and implemented, with specific components of the strategy to be outlined by the study.

It is recommended that innovations already being pursued by the City (e.g., One Water; equity, diversity and inclusion initiatives; consideration of natural assets; and integrated subwatershed monitoring) be continued and/or expanded as possible.

The other innovations included in this strategy are not included in the SWM-MP Implementation Plan, but instead are for City consideration as time, resources, and interest permit.

8 References

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Appendix A – City of Guelph Innovation Framework

Innovation Framework

GUELPH'S INNOVATION PRINCIPLES

These principles guide **how** we approach our work. As a project team reflect on ways that you can infuse the above Innovation Principles into your work.

- Innovation is a process
- Understand the "why"
- Talk to people experiencing the problem
- Make it safe to fail
- Experiment, pilot and learn rapidly
- Make people and things better

Step 1 When to Use the Framework

Use these questions to identify **when** to use the framework.

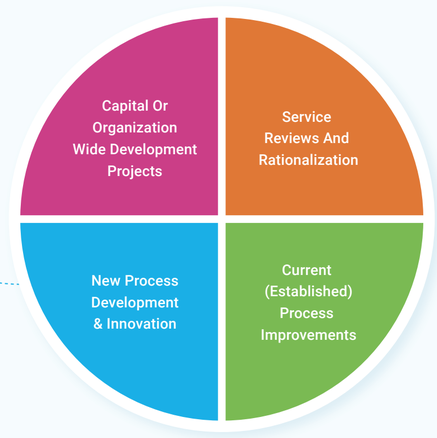
Will this work lead to a new process or solution?
→ If **yes**, use the Innovation Framework

Is this work addressing a type 4 problem?
→ If **yes**, use the Innovation Framework

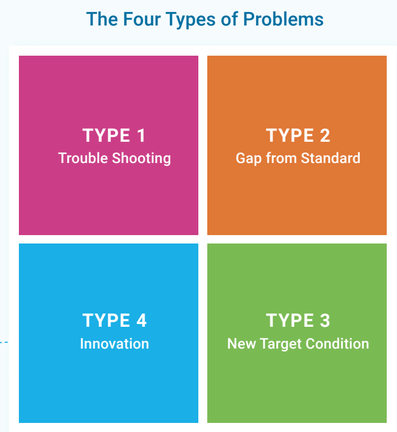
Is this work considered any of the three categories?
- Capital or Organization Wide Development Projects
- Service Reviews and Rationalization
- Current process improvements

→ If **no**, use the Innovation Framework

Continuous Improvement Office's Problem Solving Scope

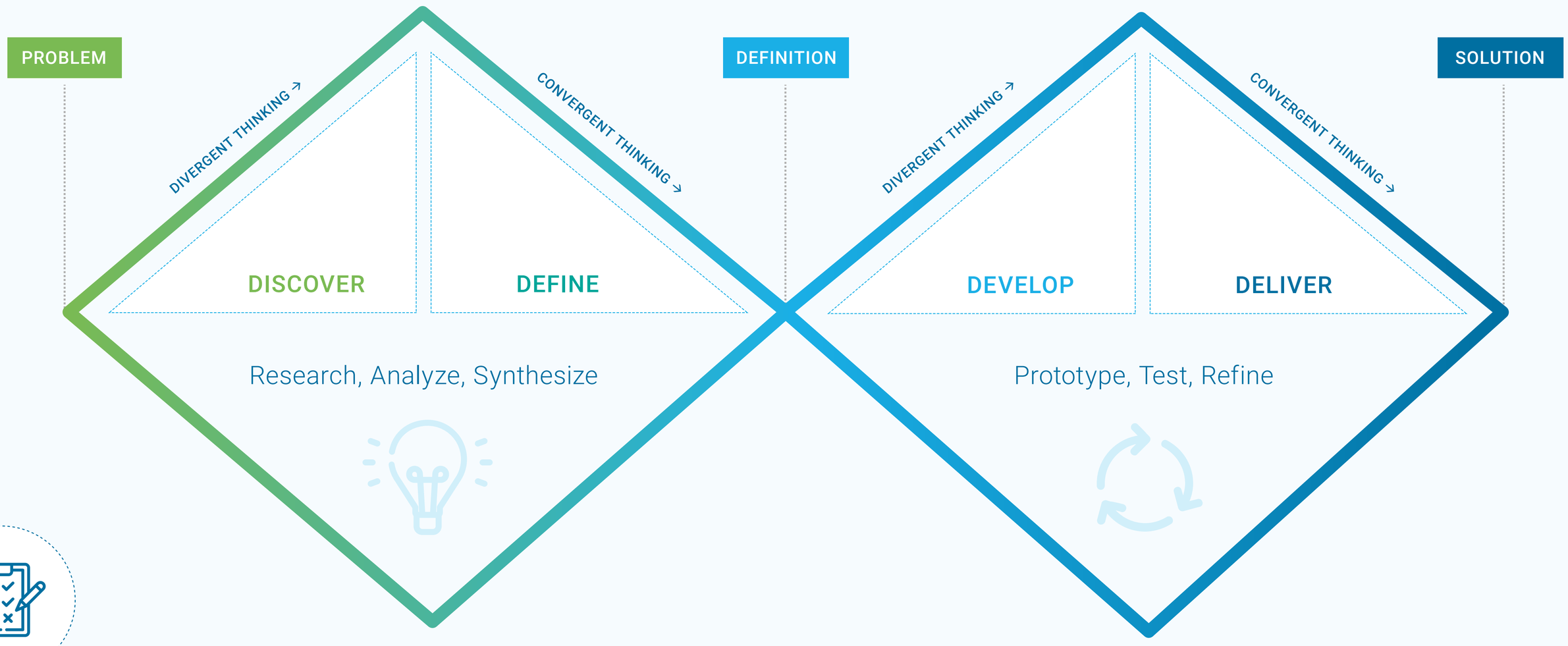


The Four Types of Problems



Step 2 The Double Diamond

The different phases of our work map onto the Double Diamond framework. The questions in the user guide act as signposts to determine when a project can proceed to the next phase.



Step 3 Evaluation Framework

Use this framework to **evaluate** the solution or outcomes of your work and provide context for the final decision makers.

CRITERIA	SCORE *(1=very unlikely, 7=very likely)*	COMMENTS
1. **POTENTIAL IMPACT: If the idea was successful, would it make a key contribution to deepening impact in the community?**	**Subtotal:**	
1.1 **Big difference:** Would the idea make a significant difference for the community? Do you believe it would generate significant impact?		
1.2 **Multiplier effect:** Does the idea have the potential to address several problems at the same time? Could it produce multiple benefits for multiple people?		
1.3 **Catalytic:** Is implementing this idea going make it easier to pursue other ideas in the future? Do you see any logical next steps that would also have a positive impact?		
2. **MOMENTUM: Does the idea have enough momentum to be carried forward, or can this momentum be generated?**	**Subtotal:**	
2.1 **Demand:** Is there demand to carry the idea forward? Do you think stakeholders (e.g. fundholders, community organizations, the City of Guelph staff) care about the problem it addresses?		
2.2 **Timeliness:** Is the environment ripe for trying out this idea? Are other current or upcoming events, initiatives and trends more likely to help or hinder the idea?		
2.3 **Intuitive hook:** Is the idea easy to communicate and understand? Can you get the gist of the idea from the name and explain the idea in a few short sentences?		
3. **ORGANIZATIONAL MATCH: Is the idea consistent with the strengths and goals of the organization?**	**Subtotal:**	
3.1 **Alignment:** Is the idea consistent with the City of Guelph mission, vision and brand? Does it work well with existing initiatives?		
3.2 **Value added:** Does the City of Guelph bring unique assets or approaches to the problem? If there are other organizations engaged on the problem, can the the City of Guelph add significant value or weight to their work?		
3.3 **Loss or gain:** How much do you think implementing the idea will benefit the organization? Does the organization have a lot to gain or lose from pursuing or not pursuing the idea?		

Step 4 Retrospective

After using the Framework, the project team **must** complete a retrospective. Use these Sails and Anchors prompts to guide the conversation

- What did we do?
- What stood out to you?
- What put wind in our sails?
- What anchors pulled us down?
- What did we learn?
- What will we do differently next time?

Do you have questions about using the framework?
Visit www.website.com to download a complete guide.